

## Chapter 3. INSTALLATION

### Chapter Objectives

The information in this chapter will enable you to:

- Mount all system components properly
- Connect all electrical and non-electrical system inputs and outputs properly
- Ensure that the complete system is installed properly
- Perform basic system operations

### Complete System Configuration

In this section, you will go through complete set-up procedures for setting drive and indexer functions, and setting encoder functions (if you are using an encoder). This section addresses all of the procedures that you must complete before you wire or apply power to your system.

#### WARNING

**Ensure that AC power is disconnected before attempting to do any wiring. NEVER disconnect the motor with power applied to the drive. NEVER adjust DIP switch settings when the power is on. Lethal voltages are present inside the drive and on the screw terminals.**

Drive and indexer functions are set using the 8-position DIP switch located on the side opposite the heatsink fins (see Figure 3-1). Table 3-1 provides the functions incorporated in the 8-position DIP switch.

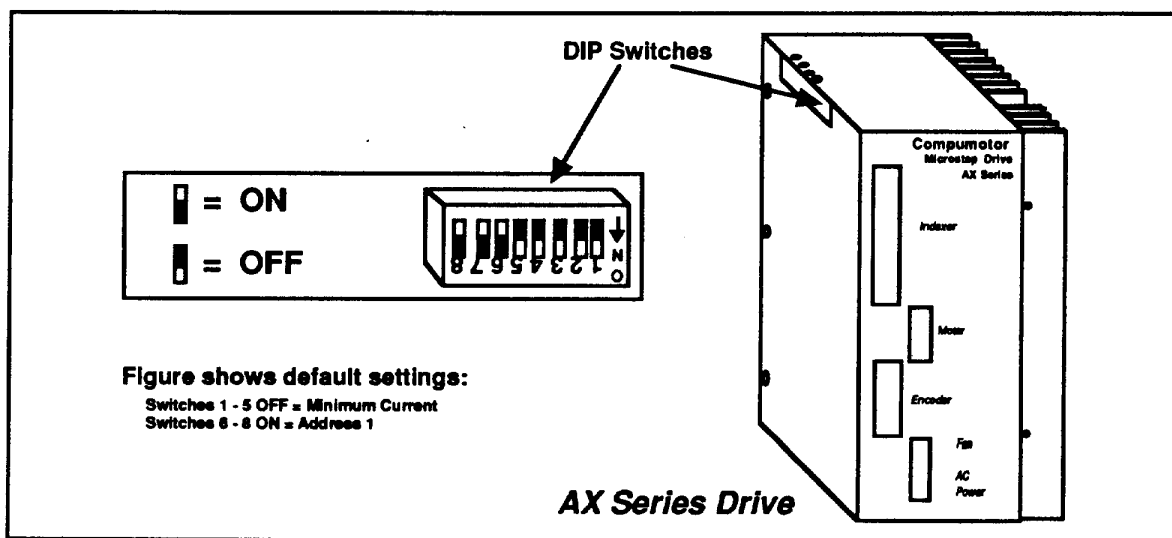


Figure 3-1. DIP Switch Location

Switch	Function	Optional Settings
1	Current	See Table 3-2
2	"	"
3	"	"
4	"	"
5	"	"
6	Device Address	See Table 3-3
7	"	"
8	"	"

Table 3-1. DIP Switch Functions

When purchased as a motor/drive system, the current is factory-set for the accompanying motor. The address is factory-set to 1. If you need to adjust these DIP switches, use the following procedure:

- STEP 1 Remove AC power from the AX Drive.
- STEP 1 Remove the DIP switch cover.
- STEP 2 Check all DIP switch settings. Use the tables provided in this chapter to ensure that the switches are set properly.
- STEP 3 If you must adjust the DIP switches, use a narrow instrument such as a thin, flat screw driver.

**Setting Drive Output Current**

If you are using motors supplied by Compumotor, refer to Chapter 2, Getting Started, for motor current settings. If you are not using motors supplied by Compumotor, refer to Chapter 6, Hardware Reference, for motor current settings.

**Setting Indexer Address**

Each AX Drive, as shipped, is factory-set to device address 1. If you ordered more than one AX Drive and you want to daisy-chain (communicate serially with more than one unit), you must establish unique addresses for each AX Drive. The device address can be changed with switches 6 through 8 (see Figure 3-1). Refer to Table 3-2 for valid address settings.

Daisy-chain wiring instructions are discussed later in this chapter.

Address	SW6	SW7	SW8
1*	ON*	ON*	ON*
2	OFF	ON	ON
3	ON	OFF	ON
4	OFF	OFF	ON
5	ON	ON	OFF
6	OFF	ON	OFF
7	ON	OFF	OFF
8	OFF	OFF	OFF

\* Factory Default Setting

Table 3-2. Valid AX Address Settings

## Environmental Considerations

The AX Drive system should be operated in accordance with the following environmental constraints:

Parameter	Value
Operating	32°F - 104°F (0°C - 40°C)
Humidity	0 - 95% non-condensing
Storage	-40°F - 185°F (-40°C - 85°C)
Motor	Max. case temp. = 212°F (100°C) - for Compumotor-supplied motors

Table 3-3. Environmental Specifications

An internal thermostat will shut down the drive if the internal drive temperature reaches 149°F (65°C). **NOTE:** *Current settings in excess of 4A in high ambient temperature environments (above 104°F) may require fan cooling to keep the heatsink temperature within allowable limits and to keep the drive from shutting itself down due to over-temperature. The fan kit is standard with all AXH Drives.*

## System Mounting

You should give special attention to the environment and location in which you will operate your AX Drive system. Consider atmospheric contamination and excess heat before you install and operate your AX Drive system.

### Motor Mounting

The AX Drive system will operate rotary stepper motors with the specified minimum inductance only. **Do not attempt to use this product with a linear motor.** Refer to Chapter 6, Hardware Reference, for minimum inductance specifications and dimensional drawings of NEMA 23, 34, and 42 stepper motors.

Rotary stepper motors should be mounted using flange bolts and centered by the pilot on the front face. Foot-mount configurations are a less desirable alternative because the torque of the motor is not evenly distributed around the motor case. 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.**

#### CAUTION

**Do not machine the motor shaft without consulting a Compumotor Applications Engineer at (800) 358-9070. Improper shaft machining can destroy the motor bearings.**

The motors used with the AX Drive 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 up to the task. 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.

#### CAUTION

**Do not attach the load to the motor yet. Methods for coupling the load to the motor are discussed later in this chapter.**

### **Drive Mounting**

Proper mounting and panel layout are essential for trouble-free operation of the AX Drive. You should allow sufficient space for unrestricted air flow over the heatsink.

Since stepper motors are drawing full current at all times, heat transfer is very important. For best results the drive should be mounted vertically to allow convective heat transfer along the heatsink and through the enclosure's vents. In addition, the drive should always be enclosed and have at least six inches of clearance in all directions.

The AX Drive is designed to be mounted for either minimum depth or minimum width, depending on how the mounting clips are attached to the AX Drive. Use #10 mounting screws.

### **Enclosure Considerations**

You should install the AX Drive system in an enclosure to protect it against atmospheric contaminants such as oil, moisture, and dirt (see Figure 3-2). The National Electrical Manufacturers Association (NEMA) has established standards that define the degree of protection that electrical enclosures provide. The enclosure should conform to NEMA Type 12 standards if the intended environment is industrial and contains airborne contaminants. If you mount the AX Drive in an enclosure, observe the following guidelines:

- The vertical clearance between the AX Drive and other equipment, or the top or bottom of the enclosure, should be no less than 6 inches (see Figure 3-2).
- The horizontal clearance should be no less than 6 inches.
- Do not mount large, heat-producing equipment directly beneath the AX Drive.
- The maximum allowable ambient temperature directly below the AX Drive is 40°C. Fan cooling may be necessary if adequate air flow is not provided. Compumotor offers an optional fan kit for the AXL Drive. The fan kit is standard with all AXH Drives.

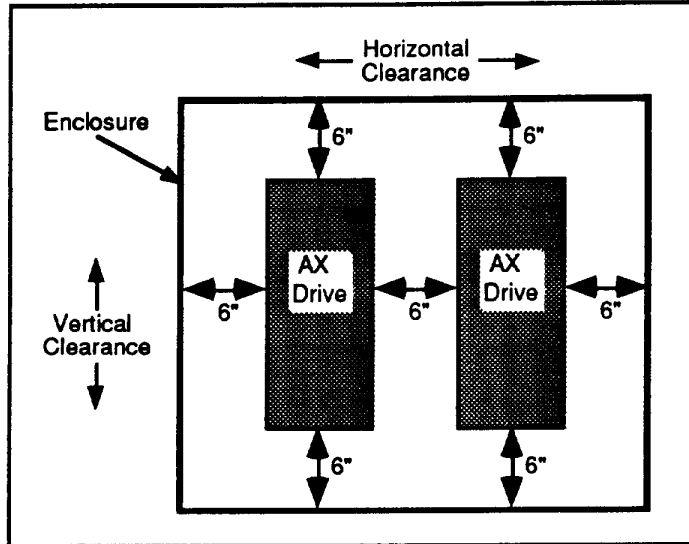


Figure 3-2. Panel Layout Guidelines

#### Minimum Width

Two mounting brackets are attached to the side of the drive opposite the power connectors for minimum panel width (see Figure 3-3). This gives the user the maximum amount of panel space possible. *NOTE: Units are shipped in this configuration.*

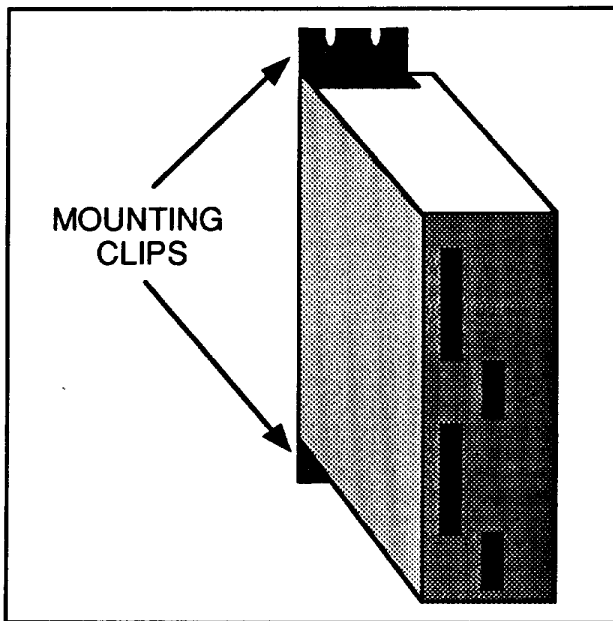


Figure 3-3. Minimum-Width Panel Mount

**Minimum  
Depth**

To mount the drive for minimum depth, remove the two existing mounting brackets and, together with the two extra brackets from the ship kit, attach them to the drive on the side opposite the heatsink (see Figure 3-4). This allows you to mount the drive in the shallowest possible mounting enclosure.

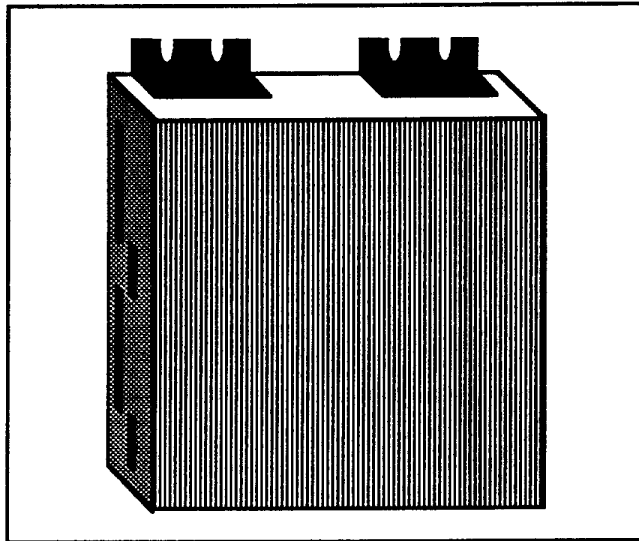


Figure 3-4. Minimum-Depth Panel Mount

**Encoder  
Mounting**

When mounting the encoder on the load, make sure to accurately align the encoder. This will ensure accurate positional feedback.

If you are using the IL encoder, refer to the *AL/IL Linear Encoder Mounting Guide* shipped with the IL encoder.

Use the following procedure for mounting Compumotor encoders to the motor. The 106-E encoder must be mounted with the heat isolation bracket (see Figure 3-5). *NOTE: If you are using an encoder from another vendor, refer to the manufacturer's installation instructions.*

- STEP 1** Remove the retaining screws on the back plate of the motor.
- STEP 2** Attach the coupler to the end of the encoder shaft and tighten with an allen wrench.
- STEP 3** Align the encoder on the back of the motor, making sure to slide the coupler onto the motor shaft and aligning the screw holes on the encoder with the mounting holes on the back plate of the motor.
- STEP 4** Tighten the coupler to the motor shaft with the allen wrench.
- STEP 5** Re-install the retaining screws, fastening the encoder mounting flange to the back plate of the motor.

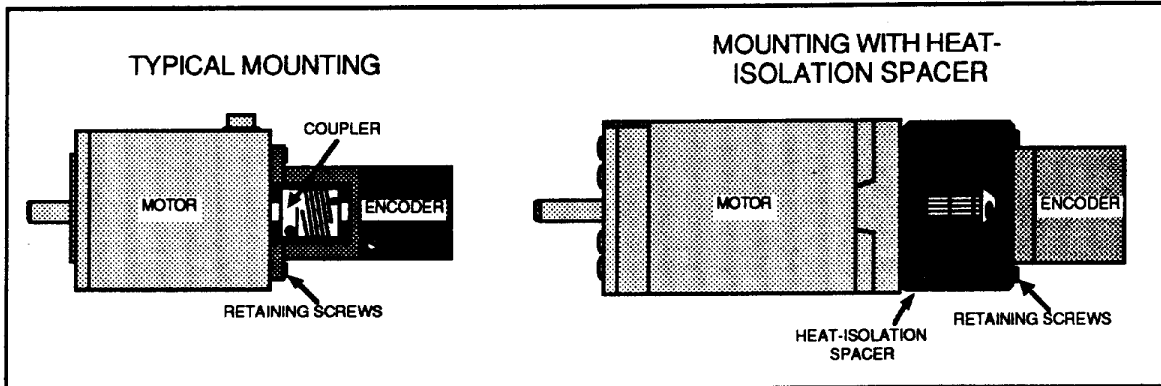


Figure 3-5. Mounting the Encoder to the Motor

## System Connections

### *Wiring Guidelines*

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

#### **CAUTION**

**The common (COM) connection on drive's auxiliary connector is signal ground, or common, as opposed to earth ground (GND) on the motor and power connectors. The COM on the auxiliary connector should be isolated from the earth ground. Do not connect COM on the auxiliary connector to GND on the motor or power connectors. This type of miswiring can cause system damage.**

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

One commonly used method is to prepare components and mounting surfaces prior to installation so that good electrical contact is made between mounting surfaces of equipment and enclosure. Remove the paint from equipment surfaces where the ground contact will be bolted to a panel and use star washers to ensure solid bare metal contact. You should connect the case of the motor to the motor GND terminal on the AX Drive. (This is done for you with Compumotor-supplied cables.)

You must connect the GND terminal on the AC power connector to the earth ground.

**Electrical  
Noise**

The AX Drive provides power to the motor by switching 170 VDC at 20 KHz (lo-power), 16 KHz (hi-power). 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 as the AX Drive does not have a transformer on its input to isolate the bridge circuitry from the line.

If electrical noise generated by the AX Drive causes problems with your equipment, you should take note of the following steps:

1. Shield the motor cable in conduit and ensure the conduit is taken to a low impedance earth ground (tied to one end only).
2. Avoid extended motor cable runs. Be sure to separate logic and high-power cables.
3. Provide a separate power line for the AX Drive. Do not use the same power circuit for the sensitive electronics and the AX Drive.
4. Ground the motor casing. (This is already done for you with Compumotor-supplied motors).
5. Mount the sensitive equipment as far as possible from the AX Drive and motor.
6. Filter the power to the AX Drive using an active filter or an isolation transformer.
7. If more details are needed, contact a Compumotor Applications Engineer at (800) 358-9070.

**System Pinouts**

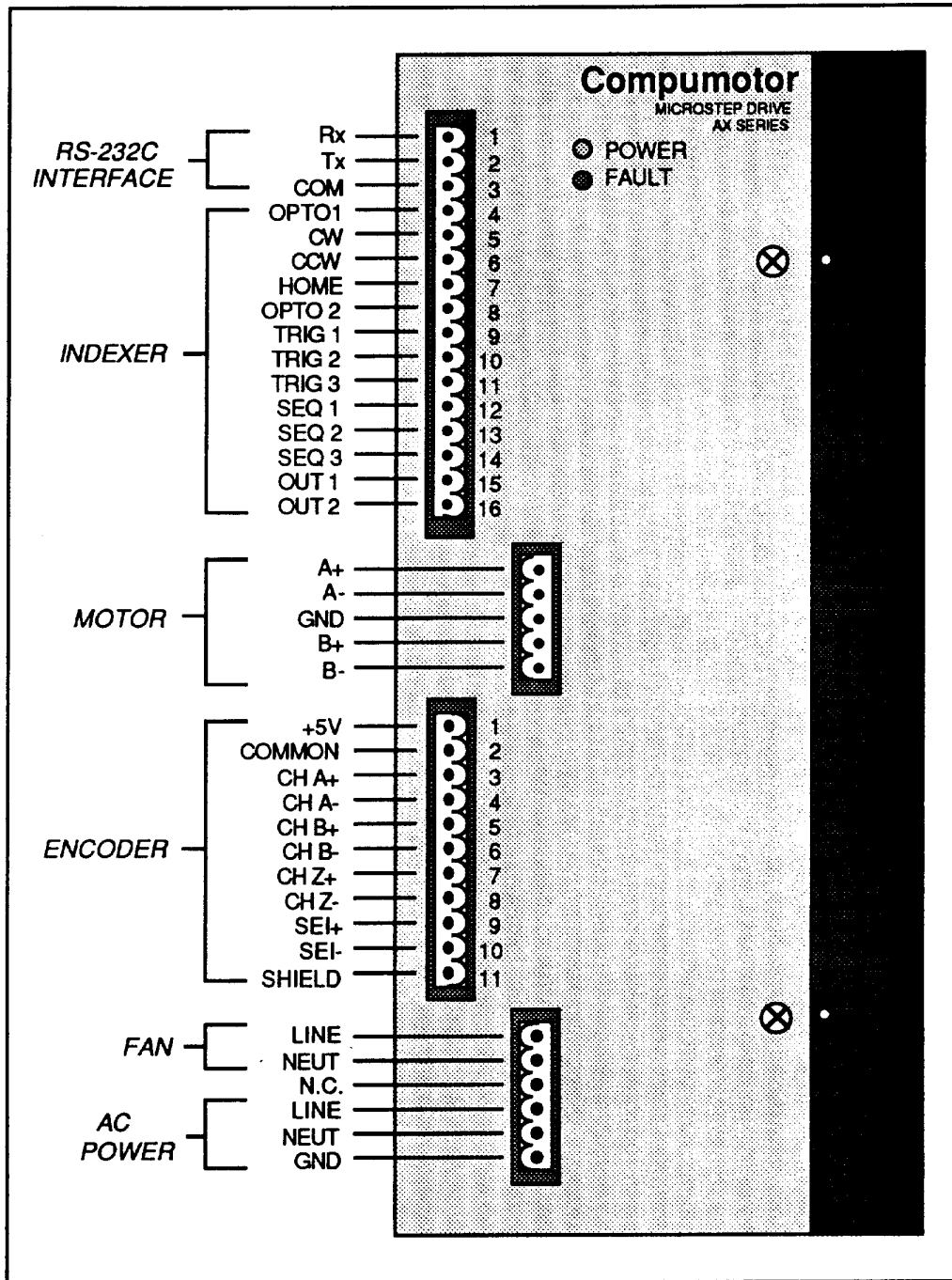


Figure 3-6. AX Drive Pinouts

**Extending Motor Cables**

The minimum recommended wire sizes (AWG) for motor cable extensions are presented in Table 3-4. Table 3-5 supplies the resistance values of the various wire sizes. Refer also to the guidelines on the AX label (located on the bottom of the drive, below the DIP switches).

Motor Series	Maximum current/phase	Up to 100 ft (20.5M)	100 to 200 feet (30.5 to 71M)
AX57	0.68A	22AWG	20AWG
AX83	1.90A	20AWG	18AWG
AX106	6.00A	16AWG	14AWG

Table 3-4. Extended Motor Cables

*NOTE: Cable runs over 200 feet (71M) are not recommended.*

Wire size (AWG)	Resistance (ohms/100 ft)
14	0.26
16	0.40
18	0.64
20	1.00
22	1.60

Table 3-5. Motor Wire Resistance Values

**Transformer Connections (Optional)**

An isolation transformer can enhance phase-to-earth ground short-circuit protection, personal safety, and electrical noise immunity. Chapter 2, Getting Started, provides detailed instructions for connecting a transformer to the AX.

**WARNING**

**Do not connect the transformer to the AX DRIVE while power is applied to the transformer. Do not touch the wiring studs on the transformer after it is plugged into an AC outlet. This can cause serious personal injury.**

**Power Connections**

Refer to Chapter 2, Getting Started, for power connection procedures.

**Fan Connections**

The fan kit is a standard feature of the AXH Drive. If you wish, you may order the fan kit from your Automated Technology Center or Compumotor Distributor.

The fan kit for the AX drive is precabled for easy connection to the fan connector terminals. Connect the leads to the LINE and NEUT terminals (see Figure 3-6).

**Encoder Connections**

To implement the closed loop functions, it is necessary to connect an incremental optical encoder to the AX. The AX will supply up to 250 mA to drive the encoder. Encoder outputs must be 3-5 VDC, square wave, and TTL compatible. When encoders with single ended outputs are used, the unused Channel A-, B- and Z- should be left unconnected. See Figure 3-7 for connections.

AX Drives ordered with encoders (-E option) are shipped with the encoder leads prewired to the AX phoenix connector. Pinouts and color codes for Compumotor encoders are provide in Chapter 6, Hardware Reference. Figure 3-8 illustrates the encoder input circuit to the AX.

*NOTE: Compumotor does not recommend extending the encoder cables. If you think extending the cables is necessary, contact a Compumotor Applications Engineer first.*

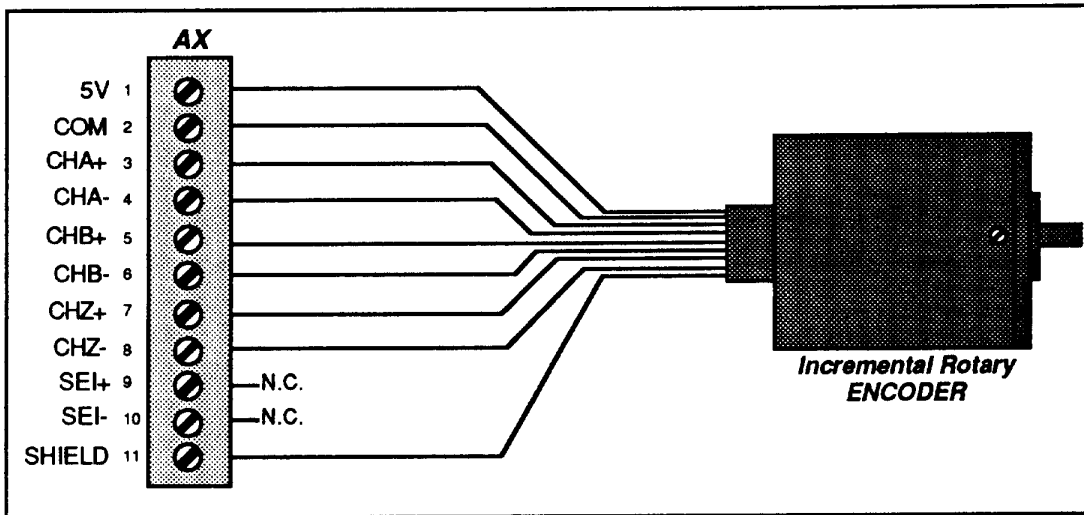


Figure 3-7. Encoder Connection Diagram

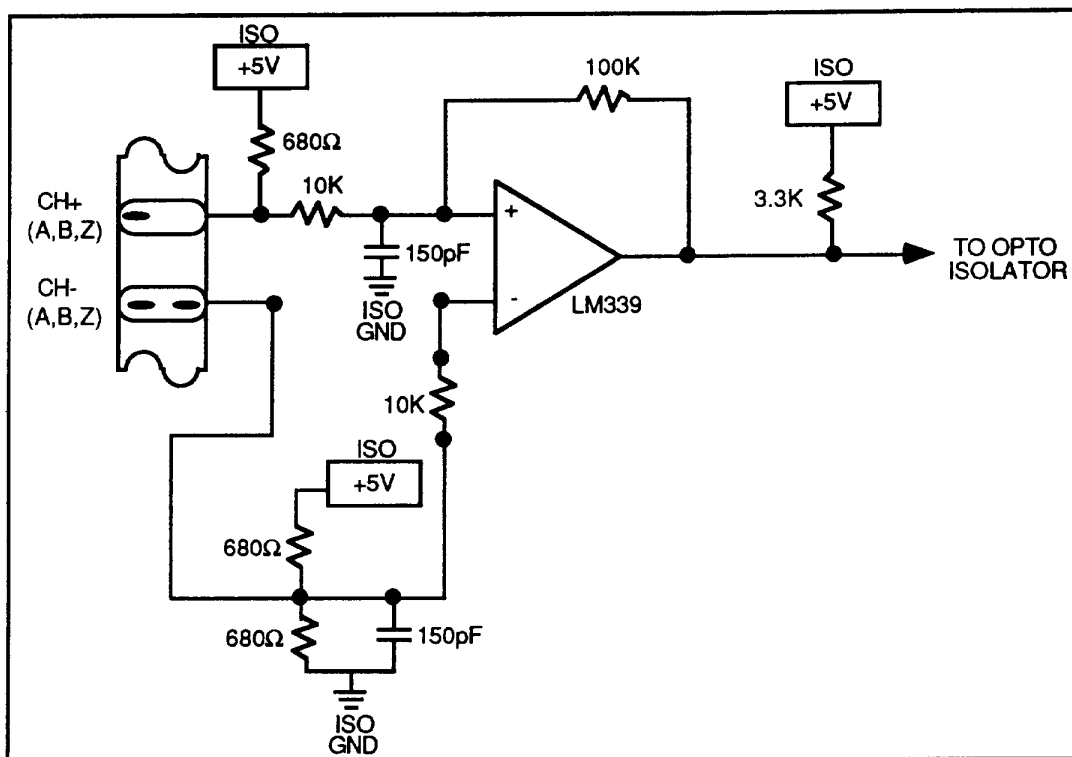


Figure 3-8. Encoder Input Circuit to the AX Drive

**RS-232C Connections**

Detailed instructions for establishing the RS-232C interface are provided in Chapter 2, Getting Started.

**Daisy-Chain Connections**

You can daisy-chain up to 8 AX Drives to a single RS-232C port on a computer or terminal. Use Figure 3-9 as a guide for daisy-chain connections. You must establish a unique device address for each AX Drive so that you can distinguish them when programming. The device address is set with DIP switches 6 through 8 (refer to Chapter 6, Hardware Reference, for valid address settings).

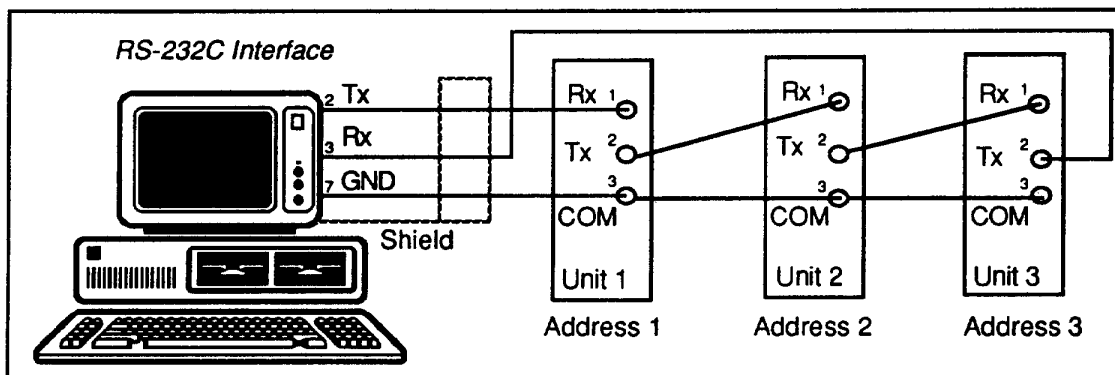


Figure 3-9. Daisy-Chaining AX Drives

**I/O Connections**

This section discusses wiring the user I/O interface circuits from the 16-pin connector on the AX Drive. Note that pins 1, 2, and 3 are for RS-232C communication with the computer or terminal. Figure 3-10 illustrates the other I/O connections.

*NOTE: The AX I/O should be wired as shown with optical isolation in actual applications. This will prevent erratic behavior due to electrical noise.*

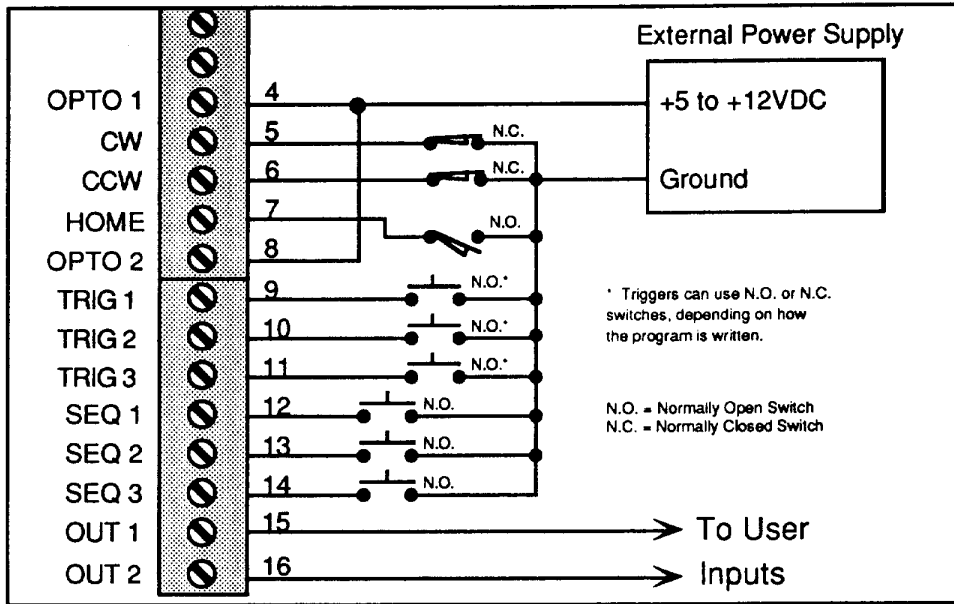


Figure 3-10. I/O Wiring Diagram

**Typical I/O Circuits**

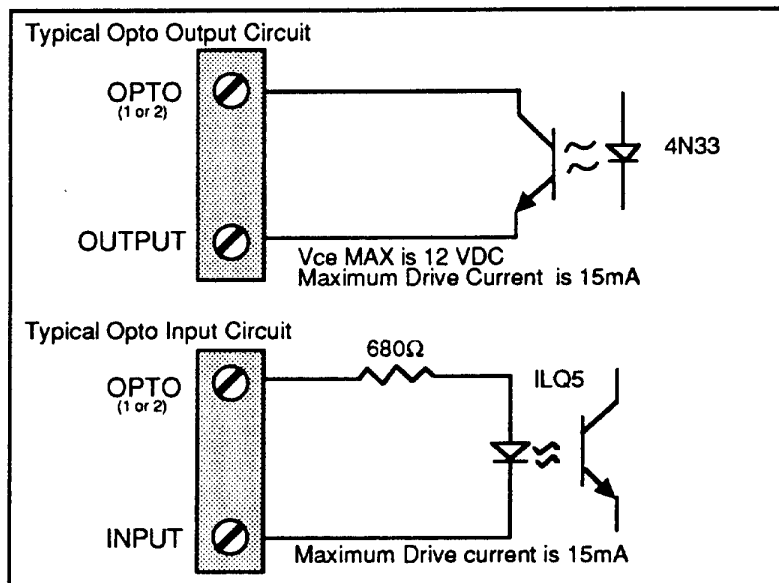


Figure 3-11. Typical I/O Circuits

**Opto 1 & 2** These inputs (pins 4 and 8) require a user-supplied 5 - 12 VDC to optically isolate the AX's I/O. An external supply is strongly recommended but is not required for operation. *NOTE: Pin 1 on the encoder connector (+5V) can also be used **only if the encoder is not connected**.* The Opto 1 input powers the limit and home switches, and the Opto 2 input powers the other I/O. In most cases, Opto 1 and Opto 2 are connected together. Refer to Figure 3-10 for connections.

**End-of-Travel Inputs** Pins 5 and 6 are the Clockwise and Counter-clockwise end-of-travel limit inputs. The CW and CCW limit inputs are activated in the high state and require a normally closed load-activated switch to the external supply ground. It is also necessary to connect a +5 to +12VDC power source to the OPTO 1 input (Pin 4); the Ground of this supply is used as the ground for the limit inputs. Refer to Figure 3-10 for limit switch connections.

When the motor is traveling in the direction of the active limit, the limit switch input (either CW or CCW) goes active and brings the motor to an immediate halt (no deceleration); the motor will not be able to move in the direction of the active limit until the limit input goes inactive. If the motor is not moving in the direction of the active limit, motion will not be affected.

These inputs therefore prevent the load from crashing into a mechanical stop and damaging equipment or injuring personnel. These inputs are optically isolated to increase the AX's noise immunity.

**HOME INPUT** You can use the home input (pin 7) to establish a home reference position. The Home limit input on the AX is optically isolated, and is normally high. A normally open, load-activated switch to the external supply ground is the most common way for determining the home position in both motor step and encoder step mode. In encoder step mode, the Z channel pulse from the encoder is used in conjunction with the home limit switch to determine the home position. Refer to Figure 3-10 for switch connections.

You can initiate the Go Home function by issuing the Go Home (**GH**) command. When you issue the **GH** command, you must include the direction and velocity that the motor should use to search for home. When you issue the **GH** command to the AX, the motor will begin to move in the direction and at the velocity specified. It performs this move at the last defined acceleration rate, and looks for the home limit input to go active. If the motor encounters an end-of-travel limit while searching for home, it will reverse direction and look for the home limit input to go active in the opposite direction. If the motor encounters the other limit before it detects the home signal, the Go Home move will be aborted and the motor will stop.

*NOTE: Compumotor cannot guarantee performance with Home and End-of-Travel limits tied together. It is also not possible to keep the home input grounded and search for the Z Channel in encoder step mode.*

<b>Trigger Inputs</b>	The AX has three trigger inputs. They are normally high and optically isolated. Trigger inputs 1 - 3 are connected to pins 9 - 11 respectively (see Figure 3-10). The +5 to +12VDC power source is still needed at the OPTO 2 input (Pin 8). The return line for the Trigger inputs is the OPTO 2 power source ground. See the <b>TR</b> and the <b>TS</b> command descriptions in Chapter 7 for functional description of these inputs.
<b>Sequence Inputs</b>	The AX has three optically isolated Sequence Select inputs (SEQ1, SEQ2, and SEQ3). They are normally in the high state. These optically isolated inputs require that 5 - 12 VDC be connected to the OPTO 2 input (pin 8). These inputs (pins 12 - 14) are active <i>low</i> , which means to energize them they must be at logic 0 or, ground. Therefore, <i>ON</i> is equivalent to the input being energized, or <i>pulled down</i> to 0VDC. <i>OFF</i> is equivalent to the input being de-energized, or logic <i>high</i> . These inputs are normally high. Refer to Figure 3-10 for Sequence switch connections.
<b>Outputs</b>	The AX is equipped with 2 optically isolated programmable output bits. They are open-emitter outputs and are normally in the high state (not conducting current). Due to the TTL current capabilities of these outputs, a current boost circuit may be needed to drive your input (see Figure 3-12). Pins 15 and 16 are Outputs #1 and #2. Both of these outputs are programmable and may be used to signal a peripheral device that some event in the AX has just been completed, such as completing a move or meeting a required trigger input configuration. An external 5 - 12 VDC power supply is required at the OPTO 2 input in order for these outputs to function. Refer to Figure 3-13 for output connections.

These outputs are controlled with the **O** command.

*NOTE: Output terminals are open emitter. The maximum current is 15mA.*

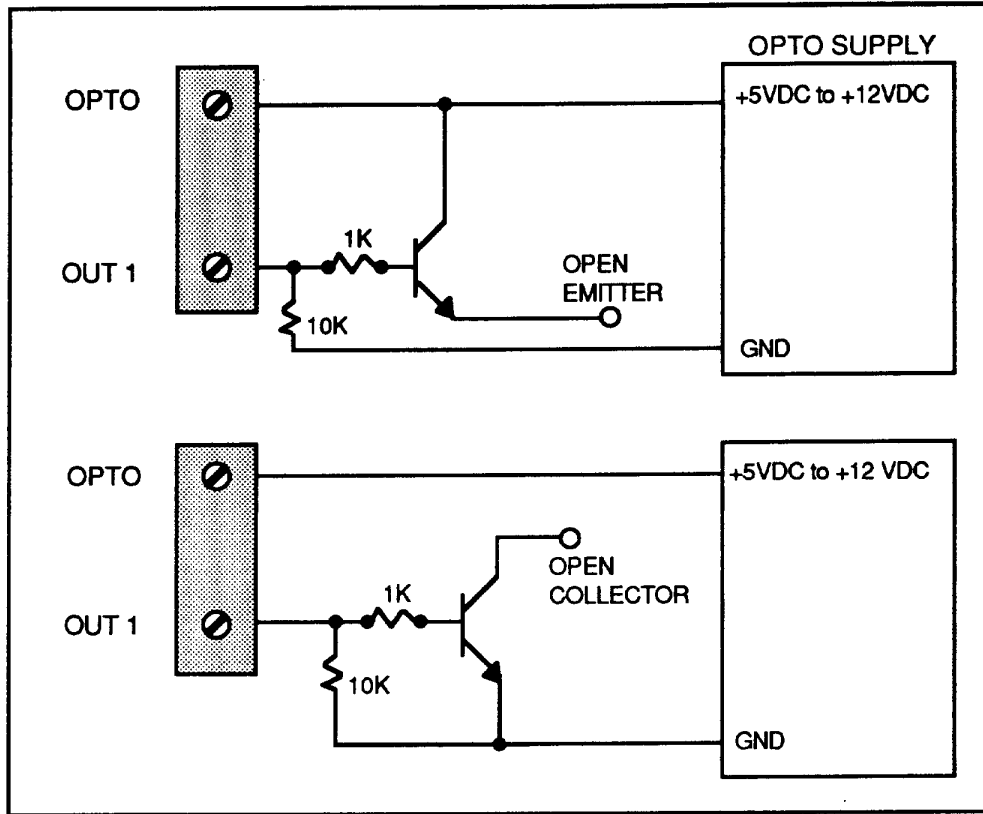


Figure 3-12. Current Boost Circuits for OUT 1 and OUT 2

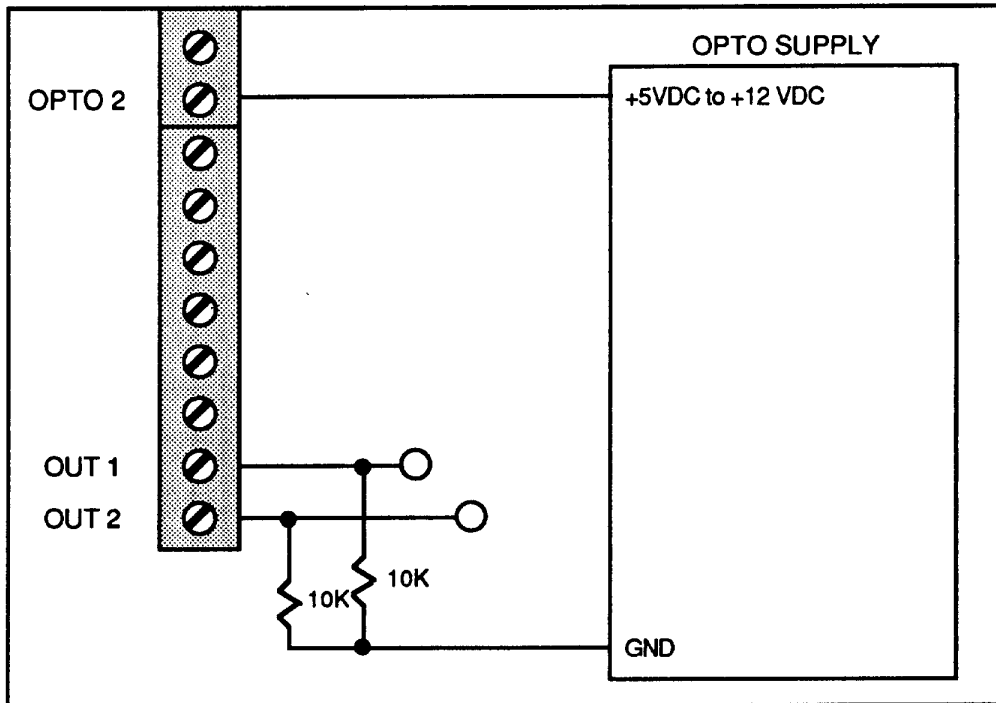


Figure 3-13. Output Connections

## Verifying Proper Installation

Now that you have connected the power, motor, RS-232C interface, I/O switches, and encoder to the AX Drive, you should verify if the AX system operates properly with these connections.

### CAUTION

**Do not attach the load to the motor yet.**

This section provides instructions to test proper installation of a single-axis AX system. If you have a multi-axis (daisy-chained) system, you should test every axis. To test every axis, you must repeat every device-specific command for each axis. All universal commands will be performed by every AX unit in the chain. Status reports for each axis should yield the same response. For example, the following is a series of universal commands which will be performed by every axis:

<u>Command</u>	<u>Description</u>
<b>LD3</b>	Disables limit switches ( <i>use only if limits are not installed</i> )
<b>MN</b>	Sets mode to normal (all axes)
<b>A1 Ø</b>	Sets acceleration to 10 rev/sec <sup>2</sup>
<b>V2</b>	Sets velocity to 2 rps
<b>D12,800</b>	Sets distance to 12,800 steps (1 rev)
<b>G</b>	Executes the move (Go)
<b>PZ</b>	Sets absolute counter to zero (all axes)
<b>G</b>	Executes the move (Go)

Each motor on every axis will perform a 12,800-step (1 rev) move.

To Report the encoder position on all axes, you will have to issue a **PX** command (a device-specific command) with the appropriate device address as follows:

<u>Command</u>	<u>Description</u>
<b>FSB1</b>	Sets Indexer to Encoder Step Mode (all axes)
<b>1PX</b>	Reports Encoder Position for AX unit 1
<b>2PX</b>	Reports Encoder Position for AX unit 2
<b>3PX</b>	Reports Encoder Position for AX unit 3

The encoder position report for each axis should be the same.

## Verifying RS-232 Link

You should test for proper RS-232C communication before continuing with this section. Refer to Testing the System in Chapter 2, Getting Started, for RS-232C testing procedures.

## Open-Loop Moves

This section contains examples of open-loop moves that you can perform with the AX system. Open-loop moves *do not* use external sensors to provide position correction.

### Testing Normal Mode Moves

To test the Normal Mode (**MN**) moves, enter the following string of commands.

<u>Command</u>	<u>Description</u>
<b>LD3</b>	Disables limit switches ( <i>use only if limits are not installed</i> )
<b>MN</b>	Sets move to normal mode
<b>A5</b>	Sets acceleration to 5 rev/sec <sup>2</sup>
<b>V2</b>	Sets velocity to 2 rps
<b>D12800</b>	Sets distance to 12,800 steps
<b>G</b>	Executes the move (Go)

The motor moves CW one revolution. To move the motor in the opposite direction (CCW), enter the following string of commands:

<u>Command</u>	<u>Description</u>
<b>D-12800</b>	Sets distance to 12,800 steps
<b>G</b>	Executes the move (Go)

The motor will move the same distance in the opposite direction.

### Testing Continuous Mode Moves

The Continuous Mode (**MC**) is useful for applications that require constant movement of the load, when the motor must stop after a period of time has elapsed (rather than after a fixed distance), or when the motor must be synchronized to external events such as trigger input signals. To test continuous mode moves, enter the following string of commands. Use the **S** or **K** command to stop the motor in an emergency.

<u>Command</u>	<u>Description</u>
<b>MC</b>	Move continuous
<b>A25</b>	Sets acceleration to 25 rev/sec <sup>2</sup>
<b>V5</b>	Sets velocity to 5 rev/sec
<b>CTM5</b>	Remain at velocity for 5 seconds
<b>CV1</b>	Decelerate at 25 rev/sec <sup>2</sup> to 1 rev/sec
<b>CTRXX0</b>	Wait for trigger input 3 to go low
<b>CA5</b>	Accelerate at 5 rev/sec <sup>2</sup>
<b>CV10</b>	To velocity 10 rev/sec
<b>CTM5</b>	Remain at previous velocity for 5 seconds
<b>CV0</b>	Change velocity to zero rev/sec (stop)
<b>G</b>	Executes the move (Go)

This sequence sets the indexer to the Continuous Mode. The motor reaches 5 rps, waits 5 seconds, changes velocity to 1 rps, and waits for trigger three to go low. When you ground trigger three, the motor accelerates at 5 rps<sup>2</sup> to 10 rps, waits 5 seconds, and then stops. Note that the buffered **CV0** command stops the motor (the **S** command is not a buffered command and cannot be used in a sequence).

**Testing CW and CCW Limit Switch Operation**

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

- Ensure that the CW and CCW limit switches are wired properly (normally closed switches that open when the load moves to the limit position).
- Make sure that the load is not attached to the motor.
- Make sure that you can manually open and close the limit switches.

Use the following procedures to test the limit input switches:

- STEP 1** Open both CW and CCW switches.
- STEP 2** Type **1IS** . If no other inputs are closed, the response should be 1111001111; this means that both CW and CCW limits (represented by the 5<sup>th</sup> and 6<sup>th</sup> digits) are on.
- STEP 3** Turn off (close) the CW limit.
- STEP 4** Type **1IS**. Assuming no other inputs are closed, the response to this command should be 1111101111.
- STEP 5** Turn off (close) the CCW limit switch.
- STEP 6** Type **1IS**. The response should be 1111001111.

To test the CW limit with the AX system, enter the following string of commands:

<u>Command</u>	<u>Description</u>
<b>LD Ø</b>	Enables CW and CCW limits
<b>MC</b>	Sets indexer to continuous mode
<b>A 5</b>	Sets acceleration to 5 revs/sec <sup>2</sup>
<b>V 2</b>	Sets velocity to 2 rps
<b>H +</b>	Changes motor direction (+ = CW)
<b>G</b>	Executes the move (G0)

The motor moves at a constant velocity until you close the CW limit switch. The motor then comes to an immediate halt.

To test the CCW limit, enter the following string of commands:

<u>Command</u>	<u>Description</u>
<b>MC</b>	Sets indexer to Continuous mode
<b>A 1</b>	Sets acceleration to 1 rev/sec <sup>2</sup>
<b>V 1</b>	Sets velocity to 1 rps
<b>H -</b>	Sets move to the CCW direction
<b>G</b>	Executes the move (Go)

The motor moves at a constant velocity until you close the CCW limit switch. The motor then comes to an immediate halt. If the motor continues to move, open the CW limit switch. If the motor stops when you open the CW limit input, switch the CW and CCW limit wires.

If neither of these limit switches stop the motor, recheck your switch wiring and refer to Chapter 7, Maintenance and Troubleshooting.

**Homing The Motor**

You can initiate the Go Home function by issuing the Go Home (**GH**) command. When you issue the Go Home command, you must include the direction and velocity that the motor should use to search for home. The home limit input on the AX is optically isolated, and is normally high. A normally open, load-activated switch to ground is the most common way to determine the home position in both motor step and encoder step mode.

When you command the AX to go home, the motor begins to move in the direction and at the velocity you specified. It performs this move at the last defined acceleration rate, and looks for the home limit input to go active. If the motor encounters an end-of-travel limit while it searches for home, it will reverse direction and look for the home limit input to go active in the opposite direction. If the motor encounters the other limit before it detects the home signal, the Go Home move will be aborted and the motor will stop.

To test the functionality of the home input switch, manually open the switch and type **1IS**. Assuming your end-of-travel limits are closed and all other inputs are open, the response will be 1111001111. The last digit in the response represents the home input status. Now close the home switch and type **1IS**; the response should be 1111001110. This verifies that the switch is functioning properly.

Use the following procedure to test the AX's homing function:

**STEP 1**

Enter the following string of characters:

<u>Command</u>	<u>Description</u>
<b>A 5</b>	Sets acceleration to 5 revs/sec <sup>2</sup>
<b>GH+2</b>	Instructs the motor to go home at 2 rps

The motor moves in the positive direction at a constant velocity (2 rps).

**STEP 2**

Momentarily ground (close) the home limit input (turn it on).

The motor decelerates to a stop, then moves in a negative direction.

**STEP 3**

Momentarily close the home switch again to stop the motor.

When the home limit input (pin 7) goes active after a **GH** command, the system recognizes the location where the input became active as *home*. The drive decelerates the motor at the last rate specified. At the end of the Go Home move, the indexer automatically resets the absolute counter to zero. This is equivalent of issuing the Position Zero (**PZ**) command.

**Closed-Loop Moves**

This section contains examples of closed-loop moves that you can perform with the AX system. Closed-loop moves use external sensors to provide position or velocity correction.

**Testing Encoder Resolution**

The AX system's encoder feedback functions will not operate properly if the encoder resolution or signal polarity are wrong. The effects of an erroneous Encoder Resolution (**ER**) command are not always obvious. As you set up your system, verify that the system functions as expected without active encoder feedback (open loop), before the encoder functions are enabled.

The best tests for proper function involve status requests. You should be familiar with open-loop commands and status requests before attempting to execute the tests described below.

The Encoder Resolution (**ER**) command defines the number of positions (steps) received by the drive per revolution of motor movement. If you have an encoder, refer to the operator's manual for the resolution of your encoder. Use the following example as a guide for setting your encoder resolution:

<u>Command</u>	<u>Description</u>
<b>ER4000</b>	Tells the indexer that the encoder has a resolution of 4,000 steps/rev after quadrature (1,000 lines)

You may test the encoder resolution setting with the following procedure. The idea is to move the motor with open-loop moves and verify that the number of feedback encoder counts meet with your expectations.

**STEP 1** Issue the **1FR** status request command to verify that all encoder functions are off for the test axis. The response should be: 00000000.

**STEP 2** Set the internal position to zero with the Position Zero (**PZ**) command. Make the motor move 1 revolution.

<u>Command</u>	<u>Description</u>
<b>MN</b>	Sets mode to normal
<b>FSB0</b>	Sets indexer to motor step mode
<b>A10</b>	Sets acceleration to 10 rev/sec <sup>2</sup>
<b>V2</b>	Sets velocity to 2 rps
<b>D12800</b>	Sets distance to 12,800 steps
<b>G</b>	Executes the move (Go)
<b>PZ</b>	Sets absolute counter to zero
<b>G</b>	Executes the move (Go)

**STEP 3** Report the encoder position with the following commands:

<u>Command</u>	<u>Description</u>
<b>FSB1</b>	Sets indexer to encoder step mode
<b>1PX</b>	Reports Encoder Position

**STEP 4**

Repeat the test to ensure that the backlash or motor windup are not interfering with the test. Issuing the encoder position report (**PX**) command should yield a number very close to the parameter that you specify with the Encoder Resolution (**ER**) command.

*If the encoder position report is negative, encoder channels A and B are reversed. You can correct this by either swapping Pin 1 and Pin 2 on the motor connector (reversing motor direction), or by swapping encoder channel A+ with B+ and A- with B- (reversing encoder direction). **Be sure to turn power off before reversing any wires.***

Once the encoder resolution is set, it should be safe to enable Encoder Step Mode (**FSB1**) and enable Position Maintenance (**FSC1**), and all other encoder functions *except* stop-on-stall. Verify proper operation of the Go Home function *before* enabling Stop-on-Stall.

**Testing the Closed-Loop Homing Function**

You can use this function to establish a home reference position. You can instruct the AX to move the motor to a home position with the Go Home (**GH**) command. This home position is typically established by mounting a load-activated switch and connecting it to the home limit input so that the switch turns on when the load is in the desired position.

When you use an encoder, the Z Channel or Index Channel, if any, must be used in conjunction with the home limit switch to establish the home position. The home position is located between the referenced edges selected with the **OSH** command. (i.e., the AX recognizes the home position as the position where the home limit signal makes a transition from ON to OFF, or from OFF to ON, depending on the selected edge and the initial direction of the Go Home move). Once it recognizes the selected edge, the motor decelerates to a stop. After coming to a stop, the AX positions the motor 1/32 of a revolution away from the selected edge of home limit signal in the opposite direction of the initial direction of the Go Home move. After coming to a stop a second time, the AX creeps the motor towards the selected edge at 0.1 rps until the home limit input becomes active again (open loop = no encoder connected), or the home limit and the encoder Z Channel pulse are active at the same time (closed loop = encoder connected). The homing function is designed to accommodate encoder index signals that are typically of short duration. The function works best with this kind of home signal.

You must ensure that the final approach starts from the opposite side of the signal from the selected edge. If the final approach direction is positive, the final move must start from the negative side of the selected edge. If there is significant overshoot in the system, and the indexer is instructed to go home in the clockwise direction, the motor may end up on the wrong side of the signal and execute its final approach in the wrong direction.

This problem can also occur if the motor's Go Home speed is high, and the Home limit signal is delayed (by a relay or Programmable Controller, for example). In such a situation, you should initiate homing operations from the opposite side of the selected edge of home.

When you conclude the homing operation, the indexer automatically resets its internal position counter to zero. You can determine the true indexer position referenced to an encoder with the Report Absolute Encoder Position (**PX**) command.

You can use the home limit input in conjunction with the encoder's Z Channel input to select one of many index signals. You must use the Set Indexer to Encoder Mode (**FSB1**) command to activate the Z Channel input as a final home position. In this situation, a load-activated switch connected to the Home Limit input locates the general home position area, and the indexer channel signal from the encoder is used for final Home positioning. The Z Channel and Home Enable inputs must both be active to mark the home position.

Under interface control, the Go Home (**GH**) command has the form **GH**<direction><velocity>. This indicates which direction to move, and at what velocity. For example, the command **GH-2** sends the motor in the negative direction at 2 rps in search of the home signal. The acceleration parameter for this move is the last defined value for acceleration (**A** command). If an end-of-travel limit is activated before home is found, the AX reverses direction and attempts to find the home position again. If the other end-of-travel limit is activated before the AX finds home, the AX will stop trying to go Home. The AX can indicate whether or not the homing process was successful by responding to the Request Indexer Status (**R**) and Go Home Status (**RC**) commands.

**STEP 1** Issue the following commands:

<u>Command</u>	<u>Description</u>
<b>FSB1</b>	Enable encoder step mode
<b>LDØ</b>	Enable positive and negative limit inputs
<b>A 1</b>	Sets acceleration to 1 rev/sec <sup>2</sup>
<b>GH+1</b>	Set Go Home in the positive direction at 1 rev/sec

**STEP 2** While the motor is moving, turn on (close) the home input switch.

Upon encountering the home switch, the motor will come to a stop. The motor will change direction and search the home switch again. When it sees the switch, the motor changes direction again and looks for the Z channel to turn on while the home limit switch is closed. When it finds the Z channel, it will stop. In encoder mode, the home limit switch and the Z channel input must be on at the same time to Go Home successfully.

**Testing  
Motor Stall  
Detection**

When the motor moves, with the Stall Detect function enabled (**FSH1**), the AX repeatedly compares the number of encoder steps coming in against the number of motor steps being sent out to verify that no gross discrepancy exists (as in the case of a motor stall). If the encoder position deviates excessively from the desired position in the course of a move, the AX assumes that the motor has stalled.

Several configuration options pertain to this feature. These include setting a *window* of allowable deviation to account for mechanical backlash. This is set with the Dead Band Window (**DW**) command. The AX detects a stall when the encoder position lags the motor position by the distance set with the **DW** command. You can set the AX to stop the motor when it detects a stall (**FSD1** command). The AX can also activate an output when it detects a stall (**FSE1** command).

*Each comparison is independent of the prior one. Hence, if an allowable error exists every time the comparison is made, the AX will not detect a stall. Such a condition might occur, for example, if there is minor slipping in the motor or encoder coupling, or slop in the gear train.*

Enter the following commands to verify that the Stall Detect function is operating properly.

STEP 1	<u>Command</u>	<u>Description</u>
	<b>FSB1</b>	Enable Encoder mode
	<b>FSH1</b>	Enable Stall detect
	<b>FSD1</b>	Terminate move on stall detect
	<b>DW100</b>	Sets backlash to 100 motor steps
	<b>A1</b>	Sets acceleration to 1 rev sec <sup>2</sup>
	<b>V.1</b>	Sets velocity to .1 rps
	<b>D12800</b>	Sets distance to 12,800 steps
	<b>G</b>	Executes the move (Go)

While the motor is making its move you should inhibit the move either by holding the motor shaft or by carefully disconnecting the +5V lead from encoder connector pin #1. The motor then stalls and abandons the current move.

**STEP 2** Use the **RC** command to verify the stall detection. The response to this command should be either **\*A** or **\*C**, depending on the status of the Go Home command. **\*A** means the stall was detected and the Go Home was successful. **\*C** means the stall was detected, and the Go Home was unsuccessful.

**Testing  
Stop-On-  
Stall**

When you enable the Stop-on-Stall function with the **FSD1** command, the move will terminate, without any delay, as soon as a stall is detected. This function works either in Motor Step or Encoder Step mode.

**CAUTION**

**Disabling the Stop-on-Stall function with the FSD0 command will allow the AX to finish the move regardless of a stall detection, even if the load is jammed. This can potentially damage user equipment.**

The **FSD1** command is valid only if the Enable Stall Detection (**FSH1**) command has been issued.

The Stop-on-Stall function depends on the setting for backlash (set with the **DW** command) to give optimum operation. The factory default setting for backlash is 0 motor steps. If you mount the encoder on the motor, you should leave this parameter set to zero for the most accurate response.

To test the stop-on-stall function, carefully disconnect the +5V lead from encoder connector pin #1. Then use the following command sequence:

<u>Command</u>	<u>Description</u>
<b>MN</b>	Sets Mode normal
<b>FSB0</b>	Sets indexer to motor step mode
<b>FSH1</b>	Enables stall detect.
<b>FSD1</b>	Enables stop on stall.
<b>DW100</b>	Sets backlash to 100 motor steps
<b>A5</b>	Sets acceleration to 5 revs/sec <sup>2</sup>
<b>V1</b>	Sets velocity to 1 rps
<b>D1000</b>	Sets distance to 1000 steps
<b>G</b>	Executes the move (Go)

Having disconnected the encoder power, the AX does not receive any encoder pulses. The AX does not detect a stall until the encoder position lags the motor position by a distance equal to the backlash (set by the **DW** command). Therefore, after the motor moves 100 steps, the AX will automatically detect a stall and stop the motor immediately.

**Inputs & Outputs**

This section presents information about the AX's inputs and outputs. The following inputs and outputs will be addressed:

- Trigger Inputs
- Programmable Outputs

**Inputs**

The AX has three trigger inputs: TRIG 1, TRIG 2, and TRIG 3 (AX I/O connector pins 9 - 11). See Chapter 5, Software Reference for a functional description of these inputs.

**Verifying  
Proper  
Trigger Input  
Wiring**

Use the following steps to verify that you have wired the trigger inputs properly.

**STEP 1** Type **1TS**. If all the Trigger and Sequence inputs are off, you should receive the following response:

111

**STEP 2** Turn on (close) the TRIG 1 input switch.

**STEP 3** Type **1TS**. You should receive the following response:

011

**STEP 4** This verifies that TRIG 1 input is turned on.

Repeat this process for each trigger input.

**Verifying Proper Trigger Function**

To verify that the Trigger function is operating properly, type the following:

<u>Command</u>	<u>Description</u>
<b>FSHØ</b>	Disable Stall Detect
<b>LD3</b>	Disables all limits
<b>A 2</b>	Sets acceleration to 2 revs/sec <sup>2</sup>
<b>V 2</b>	Sets velocity to 2 rps
<b>D128ØØ</b>	Sets distance to 12,800 steps
<b>TRØXX</b>	Wait for Trigger Input 1 to turn on
<b>G</b>	Executes the move (Go)

The motor moves when you turn on trigger input 1.

**Verifying Proper Programmable Output Function**

The AX is equipped with two programmable output bits. You may use them to signal a peripheral device that the AX has just completed some event. These outputs are controlled with the **O** Command.

Perform the following steps to verify that you have wired the outputs properly:

**STEP 1** Type **O11**.

The response from this command should be a **ØVDC**, as measured between OPTO 2 and OUT 1 or OUT 2. The output LEDs (if installed) for OUT1 and OUT2 should light.

**STEP 2** You may change the reading for outputs 1 and 2 to 12VDC by entering the following command: **ØØØ**. The LEDs (if installed) should turn off.

### ***Coupling the Load***

Special couplings that accommodate different types of misalignments are available. The following are the three types of misalignments; they 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

Special couplings are used to accommodate the above misalignments and to transmit the desired torque. The coupling manufacturer should be consulted to ensure that the coupling is being used within its specified torque capacity and misalignment ranges.

Shaft couplings may be divided into three types: 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.

#### **CAUTION**

**Do not machine the motor shaft without consulting a Compumotor Applications Engineer at (800) 358-9070. Improper shaft machining can destroy the motor bearings.**

#### **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 leads 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.*