

Chapter 1. INTRODUCTION

Chapter Objective

The information in this chapter will enable you to understand the product's basic functions and features

Product Description

The AX Drive combines the functions of a micro-stepping drive and an RS-232C Indexer in one compact system. The AX is easily programmed over RS-232C and has a set of 70 commands. The combination of the powerful command language and user-defined inputs and outputs allows you to develop complex motion control programs. You can create and store up to 7 programs in the AX Drive's non-volatile (EEPROM) memory. These programs can be executed remotely with simple BCD switches or a programmable logic controller (PLC). You can also execute these programs by sending an execute command over the three-wire RS-232C interface from a computer or terminal.

The AX Drive is available in the high-powered (6A max.) AXH model or the low-powered (3A max.) AXL model.

An additional feature of the AX Drive is the optically isolated encoder interface which permits closed loop operation. The interface is designed to operate with TTL quadrature (rotary or linear) incremental encoders.

The motors provided with the AX Drives are high-accuracy 1.8° hybrid step motors that have been optimized for smooth micro-stepping operation. Unique lamination materials ensure low power losses and low heating when driven by the AX's 16 to 20 KHz pulse width modulated amplifiers.

AX Drives feature switch-selectable motor currents, eliminating the need for motor/drive matching. Amplifier adjustments are available to the user to compensate for typical motor-to-motor variations. This is important for critical applications that require maximum smoothness.

The AX is compatible with the Compumotor Model 72 and Model 72-I/O interface. The Model 72 provides adjustable thumbwheel switches to enter and change AX motion control parameters.

Product Features

The AX Drive provides the following features:

- System is available in the high-powered version (AXH) or the low-powered version (AXL)
- Each model includes a motor along with a drive, indexer, heatsink, cables, and power supply in a single compact package
- Drive resolution is 12,800 steps/revolution
- Includes a full-featured RS-232C indexer with a subset of the X Series command language
- Up to 8 drives can be daisy-chained on a single RS-232C port
- 2,000 characters of non-volatile memory can store up to 7 motion programs
- Nine optically isolated inputs:
 - End-of travel (2)
 - Home
 - Triggers (3)
 - Sequence (3)
- Two optically isolated programmable outputs
- User-selectable micro-stepping waveforms for optimal smoothness
- Automatic power-up motion sequence execution
- Motion sequence selection via RS-232C or external switches
- Sequence upload, download, and automatic verify
- Incremental encoder interface is standard
- 23, 34, and 42 frame motors available with torques from 50 to 2,400 oz-in. 10 foot motor cables standard
- The system offers high output voltage (170VDC) operation for optimum high-speed performance
- 95-135VAC, 50/60Hz input power
- System is protected from short-circuit (phase-to-phase, but not phase-to-ground), brownout, and over-temperature
- Microprocessor-controlled micro-stepping provides smooth operation over a wide range of speeds, and improved mid-frequency performance

Theory of Operation

The AX Drive's built-in indexer receives ASCII commands (from a computer, PLC, or terminal) or BCD signals (from remote switches or a PLC). The indexer then converts these commands or signals to step pulses and sends them internally to the drive portion of the AX. These step pulses are coupled with a direction signal to control motor velocity, acceleration, direction, and position. The drive portion converts the step pulses to varied motor currents to control the stepper motor's rotation and angular position. The motor converts electrical pulses into discrete mechanical motion (shaft rotation). An incremental encoder mounted either on the motor or on the load provides positional feedback (encoder pulses) to the built-in indexer. Figure 1-1 is a functional block diagram of the AX Drive system's processes.

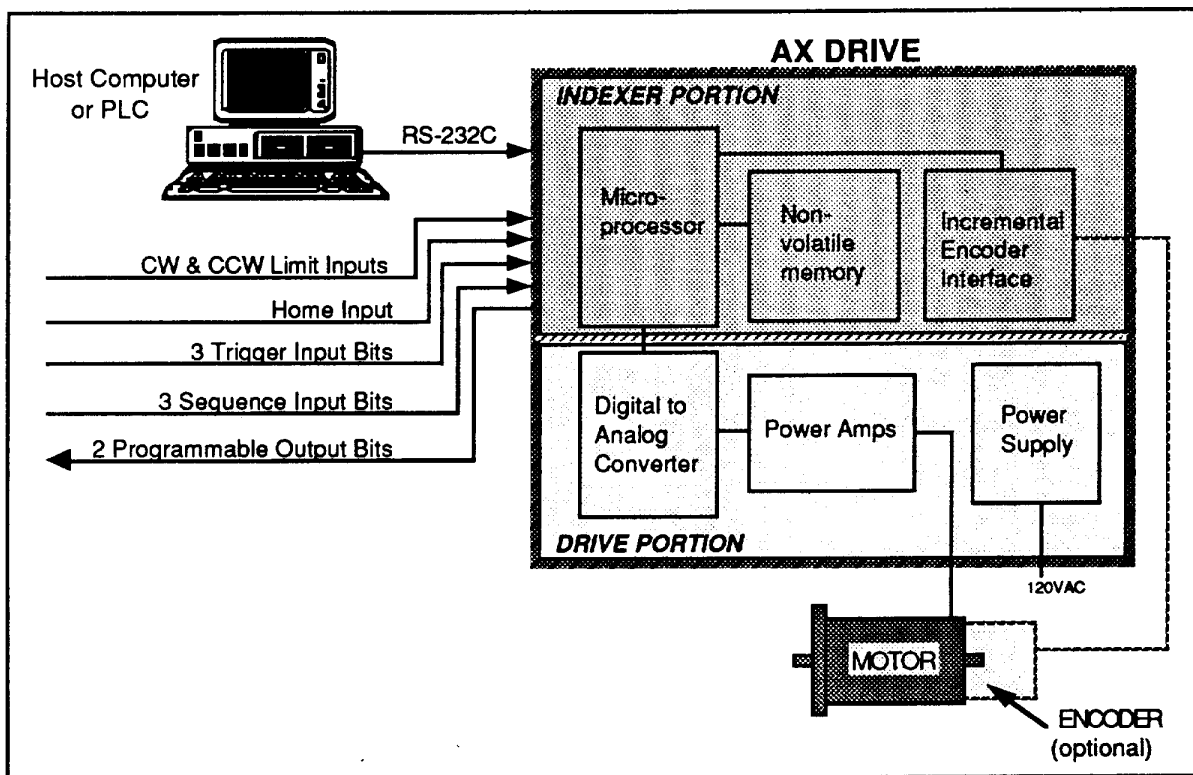


Figure 1-1. AX Drive System Functional Block Diagram

For a detailed description of stepper motor construction and operation, refer to the Compumotor Catalog.

Chapter 2. GETTING STARTED

Chapter Objectives

The information in this chapter will enable you to:

- Verify that each component of your system has been delivered safely
- Become familiar with system components and their interrelationships
- Ensure that each component functions properly
- Configure the system properly

NOTE: If you are using more than one AX Drive, repeat the configuration and test procedures in this chapter with each drive.

What You Should Have

You should inspect your AX Drive shipment upon receipt for obvious damage to its shipping container. Report any such damage to the shipping company as soon as possible. Parker Compumotor cannot be held responsible for damage incurred in shipment. Carefully unpack and inspect your AX Drive shipment. The items listed in Table 2-1 should be present and in good condition. *NOTE: The only way to determine if you have an AXH Drive or an AXL Drive is to check the serial plate or the installation label on the side of the drive opposite the heatsink fins.*

Ship Kit Table

Part Description	Part Number
Ship Kit	74-006583-02
Choice of two drives:	
AXH	AXH-DRIVE
AXL	AXL-DRIVE
Fan Kit (standard on AXH Drives)	AFK
Mechanical Screws (6-32 x 1/4)	51-006037-01
(2) Universal Mounting Bracket Pkgs.	53-006007-01
Users Guide	88-006938-05
Motor(s): See Table 2-2 for Compumotor-supplied motors .	

Table 2-1. Ship Kit List

Compumotor Motors (Optional)

Compumotor-supplied Motors
AX57-51-MO
AX57-83-MO
AX57-102-MO
AX83-62-MO
AX83-93-MO
AX83-135-MO
AX106-120-MO
AX106-178-MO
AX106-205-MO

MO = Motor Only

Table 2-2. Compumotor-Supplied Motors

Basic System Configuration

AX drives are protected against brownout, short-circuit (except phase-to-earth ground), and over-temperature. *Compumotor does not recommend that you test these features or operate your system in a way that will induce brownout, short-circuit, or over-temperature situations.*

CAUTION

The AX Drive is not completely open-circuit protected. Ensure the AC power is disconnected before attempting to perform any system connections. Never disconnect or reconnect the motor with power on; this will damage the drive and the motor connector contacts. Follow the steps described below to complete the basic configuration of your system.

Installation Label

The installation label, located on the side of the drive opposite the heatsink fins, provides default DIP switch settings. The label also provides general guidelines for drive mounting, wiring, and I/O connections.

Setting Drive Functions

Drive functions are set using the 8-position DIP switch located on the bottom of the AX Drive (see Figure 2-1). For the procedures in this chapter, leave the address (set with switches 6 through 8) set to 1 (factory-setting).

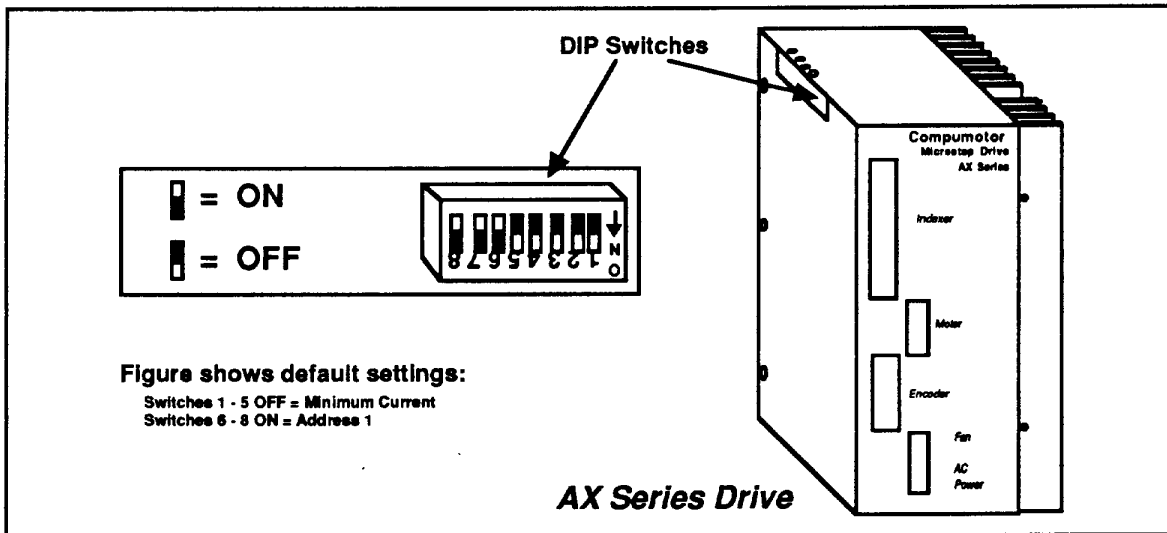


Figure 2-1. DIP Switch Location

Current Programming

DIP switches 1 through 5 are used for setting drive output current to the motor. See Figure 2-1 for the location of the drive DIP switches. Table 2-3 provides DIP switch settings for Compumotor-supplied motors. Be sure not to confuse the settings for an AXL Drive with the settings for an AXH Drive. *NOTE: When purchased as a motor/drive system, the current is factory-set for the accompanying motor. When purchased as a drive-only system, the drive current is factory set to minimum (0.094A for AXL, 0.188A for AXH).*

Consult Compumotor's Application Department first if you plan to use a motor not supplied by Compumotor. If you are using a motor **not** supplied by Compumotor, refer to Chapter 6, Hardware Reference, for the full range of motor current settings.

WARNING

NEVER adjust DIP switch settings when the power is on.

Use the following procedure to adjust the DIP switches:

- STEP 1 Remove AC power from the AX Drive.
- STEP 2 Remove the DIP switch cover panel.
- STEP 3 Check all DIP switch settings. Use Table 2-3 as a guide to ensure that the switches are set properly.
- STEP 4 If you must adjust the DIP switches, use a narrow instrument such as a thin, flat screw driver.

CAUTION

Improper motor current settings can damage both the drive and the motor.

Motor size	Current	AXL					AXH				
		DIP Switch Settings					DIP Switch Settings				
		1	2	3	4	5	1	2	3	4	5
AX57-51	0.375A	OFF	OFF	OFF	ON	ON	Not Recommended				
AX57-83	0.469A	OFF	OFF	ON	OFF	OFF	Not Recommended				
AX57-102	0.750A	OFF	OFF	ON	ON	ON	Not Recommended				
AX83-62	0.844A	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
AX83-93	1.406A	OFF	ON	ON	ON	OFF	OFF	OFF	ON	ON	OFF
AX83-135	1.969A	ON	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF	ON
AX106-120	1.875A	ON	OFF	OFF	ON	ON	OFF	ON	OFF	OFF	ON
AX106-178	4.125A	----	----	----	----	----	ON	OFF	ON	OFF	ON
AX106-178	6.000A*	----	----	----	----	----	ON	ON	ON	ON	ON
AX106-205	6.000A*	----	----	----	----	----	ON	ON	ON	ON	ON

* Parallel connect motors

Table 2-3. Motor Current Settings (Compumotor-Supplied Motors)

NOTE: The current values in Table 2-3 are approximate settings in the AX Drive. The actual settings will not match these recommended settings exactly. The current setting for 106-205 motors is 6 amps in series and in parallel.

**Basic System
Wiring Diagram**

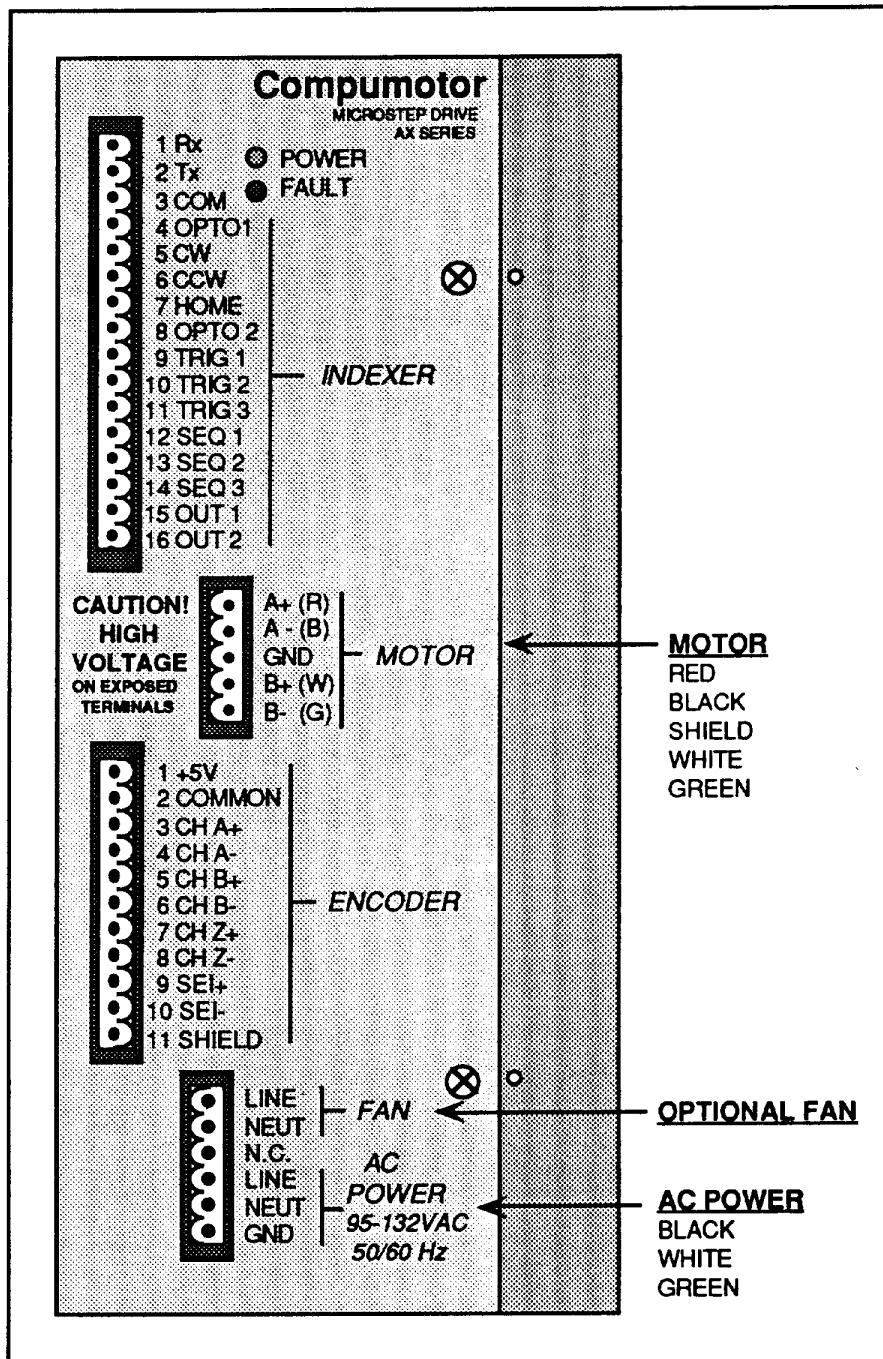


Figure 2-2. System Wiring Diagram

Transformer Connections (Optional)

This section addresses connecting an optional transformer to the AX system. An isolation transformer can enhance phase-to-earth ground short-circuit protection, personal safety, and electrical noise immunity. If you not are using a transformer with this system, simply proceed to the Motor Connections section. *NOTE: When using a transformer, the AX Drive requires an input current equal to 0.6 x the DIP switch current setting.*

CAUTION

Do not apply power to the AX Drive at this time. AC power to the AX Drive is limited to 132VAC. Higher voltages will damage the drive. The low-voltage limit is 95VAC.

Refer to the transformer user guide to determine which output leads correspond to LINE, NEUTRAL, and GROUND. As illustrated in Figure 2-3, connect the transformer leads to the AC power connector on the drive.

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.

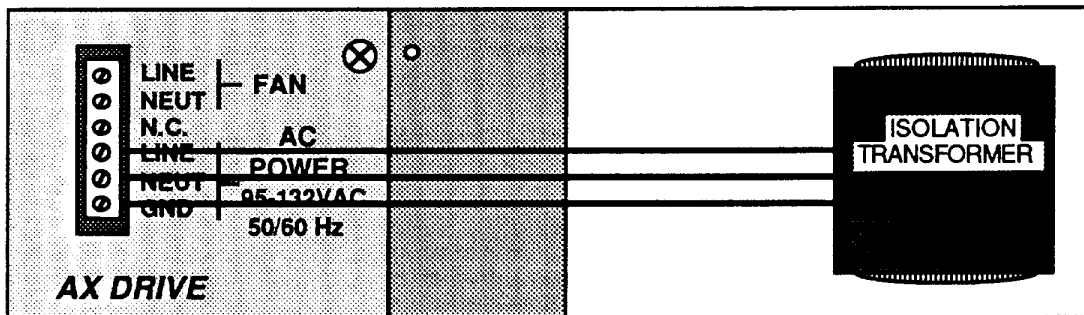


Figure 2-3. Transformer Connections (Optional)

Motor Connections

CAUTION

Consult a Compumotor Applications Engineer if you intend to use a motor not supplied by Compumotor. Low inductance motors will damage the drive. The AX requires motors with a minimum inductance of 20 mH/phase (measured end-to-end). Chapter 5, Hardware Reference, contains procedures for connecting motors not supplied by Compumotor.

If you purchased an AX drive/motor package, the motor will be pre-wired and ready to connect to the AX Drive motor connector (see Figure 2-2).

Connect your motor to the AX Drive and verify that the color code is correct. The wire colors provided below are for Compumotor-supplied motors.

- A+ = Red
- A- = Black
- GND = Shield
- B+ = White
- B- = Green

For added personal protection, Compumotor includes a motor connector *boot*. Ensure that the boot covers the connector once it is in place.

CAUTION

Be sure to properly connect the motor to the AX Drive. Incorrect connections can cause extensive damage to the drive and the motor. The AX motor outputs are protected from phase-to-phase shorts. They are not protected from phase-to-ground shorts.

Power Connections

Connect the power cable to the AX Drive (see Figure 2-2) and verify that the color codes are correct.

- LINE = Black
- NEUT = White
- GND (Earth) = Green

NOTE: If you are using an isolation transformer, be sure to connect the transformer's output AC line, neutral, and ground to the proper terminals on the AX Drive power/fan connector (see Figure 2-3).

CAUTION

Do not apply power to the AX Drive at this time. AC power to the AX Drive is limited to 132VAC. Higher voltages will damage the drive. The low-voltage limit is 95VAC.

**Establish
Communications**

To communicate with the AX system, your computer or terminal must have an RS-232C serial port. If it does not, you can purchase one from your local computer dealer.

You cannot change the communication parameters on the AX. Therefore, you must set your computer/terminal to the following RS-232C protocol parameters:

- Baud Rate: 9,600
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Echo: Off (Full Duplex)

Refer to your computer/terminal user guide for instructions on how to set the communication parameters so that they are compatible with the AX Drive's settings.

**RS-232C
Connections**

The AX Drive uses a simple three-wire implementation of RS-232C serial communication. Receive Data (Rx), Transmit Data (Tx) and Common (COM) signals are transmitted via pins 1, 2, and 3 on the AX Drive's two-part screw terminal connector. Use Figure 2-4 as a guide for connecting the AX to the computer/terminal communication port.

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.

The AX does not support handshaking of any form; therefore, you should disable the handshaking function of the computer or terminal sending characters to the AX. Typically, the handshaking function is disabled by connecting RTS to CTS (usually pins 4 and 5) and DSR to DTR (usually pins 6 and 20) on the computer's or terminal's 25-pin RS-232C port (see Figure 2-4). Refer to your computer or terminal user guide for the exact instructions to disable handshaking.

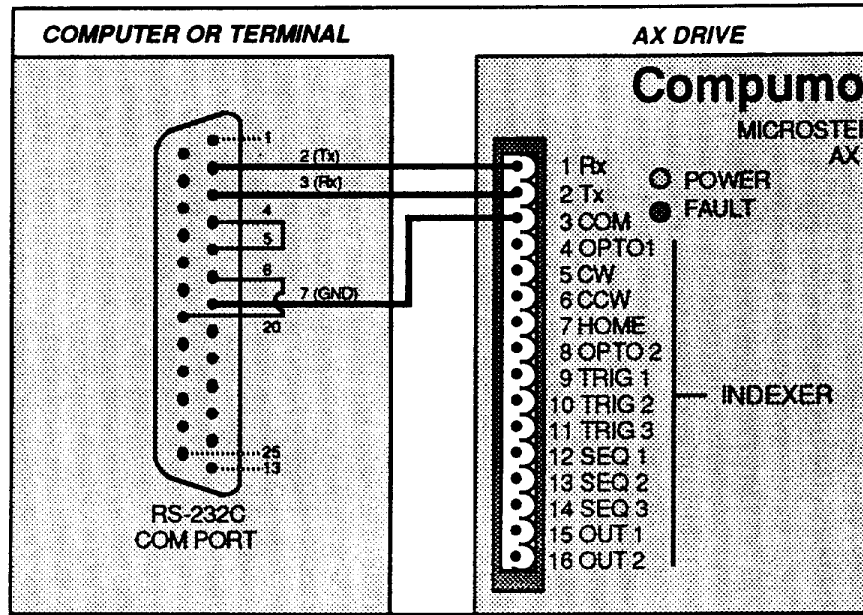


Figure 2-4. RS-232C Interface Connections

Powering up the System

When you apply power to the system, the *POWER* (green) LED on the AX Drive front panel should illuminate. The *FAULT* (red) LED should blink and then turn off. If the *FAULT* LED remains illuminated, immediately disconnect power and consult Chapter 7, Maintenance and Troubleshooting.

Deactivate Limit Inputs for Tests

The AX is equipped with two end-of-travel limit inputs: clockwise (CW) and counter-clockwise (CCW). You can control these inputs with software commands and load-activated switches. The CW and CCW limit inputs prevent the load from crashing into a mechanical stop and damaging equipment or injuring personnel.

At this time, you do not need to set up load-activated switches in your system (you will establish these switches in Chapter 3, Installation). To test your motor and the RS-232C interface, you must now disable the limit inputs by issuing the Limit Disable (**LD3**) command. Compumotor ships the AX from the factory with the limits enabled. This means that the motor will not run unless you issue the **LD3** command.

Testing the System

Before testing the system, check DIP switches 6, 7, and 8 to make sure they are all set to the ON position (see Figure 2-1). This sets the address to 1.

Testing RS-232C Interface

To test for proper three-wire RS-232C serial communication, power-up your computer or terminal *and then* power-up the AX system. If your terminal displays garbled characters, check the computer's protocol set-up; the baud rate setting is probably not equal to the AX's (9,600 baud). If the baud rates are equal, press the space bar several times. If the cursor does not move, switch the transmit (Tx) and receive (Rx) wires (AX pins 1 and 2) and try this test again.

Once you are able to make the cursor move, enter some characters. These characters should appear on the computer CRT. If each character appears twice, your computer is set to half-duplex. It should be set to full-duplex. Consult your computer user guide for instructions on how to change the set-up to full-duplex.

Test Routine

AX Drives with software revision E2 or higher allow you to issue a **TEST** command to verify the system's operability. *NOTE: The **TEST** command disables the limit switches. **Never attach a load when you disable the limit switches.*** When you issue this command, the following sequence is automatically executed:

<u>Commands</u>	<u>Description</u>
LD3	Disables CW and CCW limits
MN	Sets indexer to normal mode
MPI	Sets positioning mode to incremental
A2	Sets acceleration to 2 rps ²
V1	Sets velocity to 1 rps
D12800	Sets distance to 12,800 steps
G	Executes the move (Go)
T.5	Waits 0.5 seconds after finishing the move
H	Changes the direction of the next move
G	Executes the move (Go)

After issuing the **TEST** command the motor turns one CW revolution, pauses for 0.5 seconds, and turns one CCW revolution.

Verifying Indexer Status

Enter the characters shown below. If communication is successful and the indexer is ready for normal operation, the corresponding response will be displayed as follows:

<u>Input from keyboard</u>	<u>AX Response</u>
1 R	*R

If you are unsuccessful, check the address setting and interface wiring and type the command again. If you are still unsuccessful, check your wiring and consult Chapter 7, Maintenance & Troubleshooting.

**Making An
Open-Loop
Move**

Type the following commands: *(The following example disables the limit switches. **Never attach a load when you disable the limit switches.**)*

<u>Commands</u>	<u>Description</u>
LD3	Disables CW and CCW limits (all axes)
A1	Sets acceleration to 1 rps ²
V1	Sets velocity to 1 rps
D12800	Sets distance to 12,800 steps
G	Executes the move (Go)
1PR	Requests the position report for device 1

The motor moves 12,800 steps (one revolution). After the motor stops, you should see the following response on your computer CRT:

+0000012800

If the motor does not move, refer to Chapter 7, Maintenance & Troubleshooting.

If you were able to perform the open-loop move and the test routine successfully, try to perform as many moves as possible with the basic configuration. Simulate the moves you intend to perform with your permanent application. For other applicable commands refer to Chapter 5, Software Reference. After you complete these exercises, read Chapter 3, Installation.

NOTE: If you are using more than one AX Drive, repeat the configuration and test procedures in this chapter with each drive.