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Compumotor

A Drive User Guide

Compumotor Division
Parker Hannifin Corporation
88-006937-04 C

Parker

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How To Use This User Guide

This user guide is designed to help you install, develop, and maintain your system. Each chapter begins with a list of specific objectives that should be met after you have read the chapter. This section is intended to help you find and use the information in this user guide.

Assumptions

This user guide assumes that you have the skills or fundamental understanding of the following information.

- Basic electronics concepts (voltage, switches, current, etc.)
- Basic motion control concepts (torque, velocity, distance, force, etc.)

With this basic level of understanding, you will be able to effectively use this user guide to install, develop, and maintain your system.

Contents of This Manual

This user guide contains the following information.

Chapter 1: Introduction — This chapter provides a description of the product and a brief account of its specific features.

Chapter 2: Getting Started — This chapter contains a detailed list of items you should have received with your A Series shipment. It will help you to become familiar with the system and ensure that each component functions properly. You will learn how to configure the system properly in this chapter.

Chapter 3: Installation — This chapter provides instructions for you to properly mount the system and make all electrical connections. Upon completion of this chapter, your system should be completely installed and ready to perform basic operations.

Chapter 4: Application Design — This chapter discusses application considerations and provides tuning procedures.

Chapter 5: Hardware Reference — This chapter contains information on system specifications (dimensions and performance). It may be used as a quick-reference tool for proper switch settings and connections.

Chapter 6: Troubleshooting — This chapter contains information on identifying and resolving system problems.

Installation Process Overview

To ensure trouble-free operation, pay special attention to the environment in which the A Series equipment will operate, the layout and mounting, and the wiring and grounding practices used. These recommendations are intended to help you easily and safely integrate A Series equipment into your manufacturing facility. Industrial environments often contain conditions that may adversely affect solid state equipment. Electrical noise or atmospheric contamination, may also affect the A Series System.

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Developing Your Application

Before you attempt to develop and implement your application, there are several issues that you should consider and address.

1. Recognize and clarify the requirements of your application. Clearly define what you expect the system to do.
2. Assess your resources and limitations. This will help you find the most efficient and effective means of developing and implementing your application.
3. Follow the guidelines and instructions outlined in this user guide. Do not skip any steps or procedures. Proper installation and implementation can only be ensured if all procedures are completed in the proper sequence.

Installation Recommendation

Before you attempt to install this product, you should complete the following steps:

1. Review this entire user guide. Become familiar with the user guide's contents so that you can quickly find the information you need.
2. Develop a basic understanding of all system components, their functions, and interrelationships.
3. Complete the basic system configuration and wiring instructions (in a simulated environment, not a permanent installation) provided in *Chapter 2, Getting Started.*
4. Perform as many basic functions as you can with the preliminary configuration. You can only perform this task if you have reviewed the entire user guide. You should try to simulate the task(s) that you expect to perform when you permanently install your application (however, do not attach a load at this time). This will give you a realistic preview of what to expect from the complete configuration.
5. After you have tested all of the system's functions and used or become familiar with all of the system's features, carefully read *Chapter 3, Installation.*
6. After you have read Chapter 3 and clearly understand what must be done to properly install the system, you should begin the installation process. Do not deviate from the sequence or installation methods provided.
7. Before you begin to customize your system, check all of the system functions and features to ensure that you have completed the installation process correctly.

The successful completion of these steps will prevent subsequent performance problems and allow you to isolate and resolve any potential system difficulties before they affect your system's operation.

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Conventions

To help you understand and use this user guide effectively, the conventions used throughout this user guide are explained in this section.

Warnings (Personal Injury) & Cautions (System Damage)

Warning and caution notes alert you to possible dangers that may occur if you do not follow instructions correctly. Situations that may cause bodily injury are presented as warnings. Situations that may cause system damage are presented as cautions. These notes will appear in bold face and the word warning or caution will be centered and in all capital letters. Refer to the examples shown below.

WARNING

Do not touch the motor immediately after it has been in use for an extended period of time. The unit will be hot.

CAUTION

System damage will occur if you power up the system improperly.

Related Publications

Current Parker Compumotor Motion Control Catalog

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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 A Drive is a bipolar, microstepping drive designed to drive two-phase permanent magnet hybrid step motors. The drive uses MOSFET technology to give high performance in a small package while providing short circuit protection, brownout protection, over-temperature protection, and a built-in power supply. The A Drive is compatible with all Compumotor indexers.

Features

The A Drive requires no external power supply. It uses 120VAC directly for its power inputs. It comes in two versions (**AL**ow and **AH**igh), which will produce up to 3A and 6A of current/phase respectively. Compumotor's motors are two-phase hybrid motors (permanent magnet type). Four, six, or eight lead motors may be used, with the internal phases connected for either parallel or series operation provided the motor's inductance does not drop below 20 mH.

The A Drive is designed for panel mounting. You can install it in a minimum depth or width configuration by moving its mounting tabs to the side or back of the unit. The A Drive also provides the following features:

- Optically coupled step, direction, and shutdown inputs are compatible with all Compumotor indexers (25-pin D connector)
- DIP switch selectable motor resolutions (25,000; 20,000; 18,000; 10,000; 5,000; 2,000; 400; and 200 steps per revolution standard)
- An Automatic Standby function reduces motor heating when the motor is not moving
- High-voltage (170VDC) operation for good high-speed torque
- High-power version of the drive (AHigh) provides bi-polar 0 - 6 amps/phase (up to 2,400 oz-in)
- The low-power version of the drive (ALow) provides bi-polar 0 - 3 amps/phase (up to 400 oz-in)
- 95 - 130VAC, 50/60Hz input
- Microprocessor controlled microstepping provides smooth operation over a wide range of speeds and protection against mid-frequency resonance problems

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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 the system components and their interrelationships
- Ensure that each component functions properly by bench testing

What You Should Have

Inspect the A Series upon receipt for obvious damage to its shipping container. Report any such damage to the shipping company. Parker Compumotor cannot be held responsible for damage incurred in shipment. The following items should be present and in good condition.

Part	Part Number
A/C Power Cable Assembly	71-006593-01
A Drive	AL (Low) or AH (High)
A Series User Guide	88-006937-04 C
Motor	Variety of sizes available*

*Refer to Table 2-2 for specific motor sizes

Table 2-1. Ship Kit List

High and Low Power Drives

You should verify which type of drive you have before proceeding with this chapter. The high-power version of the drive (**AH**) provides bi-polar 0 - 6 amps/phase (up to 2,400 oz-in). The low-power version of the drive (**AL**) provides bi-polar 0 - 3 amps/phase (up to 400 oz-in). You can determine which drive you have by checking the installation label on the side of the drive. The label identifies the unit as **AH DRIVE** or **AL DRIVE**. You must be aware of the drive's power to set the motor current correctly (using DIP switches). There are different DIP switch settings for the two drive types.

If you did not receive the drive type that you ordered, please call Parker Compumotor at (800) 722-2282.

Quick Test

This section will show you how to set the A Drive's DIP switches and wire the unit quickly to ensure that your system is operating properly. Detailed installation instructions are provided in *Chapter 3, Installation.*

Figure 2-1 shows the location of the A Drive's DIP switches.

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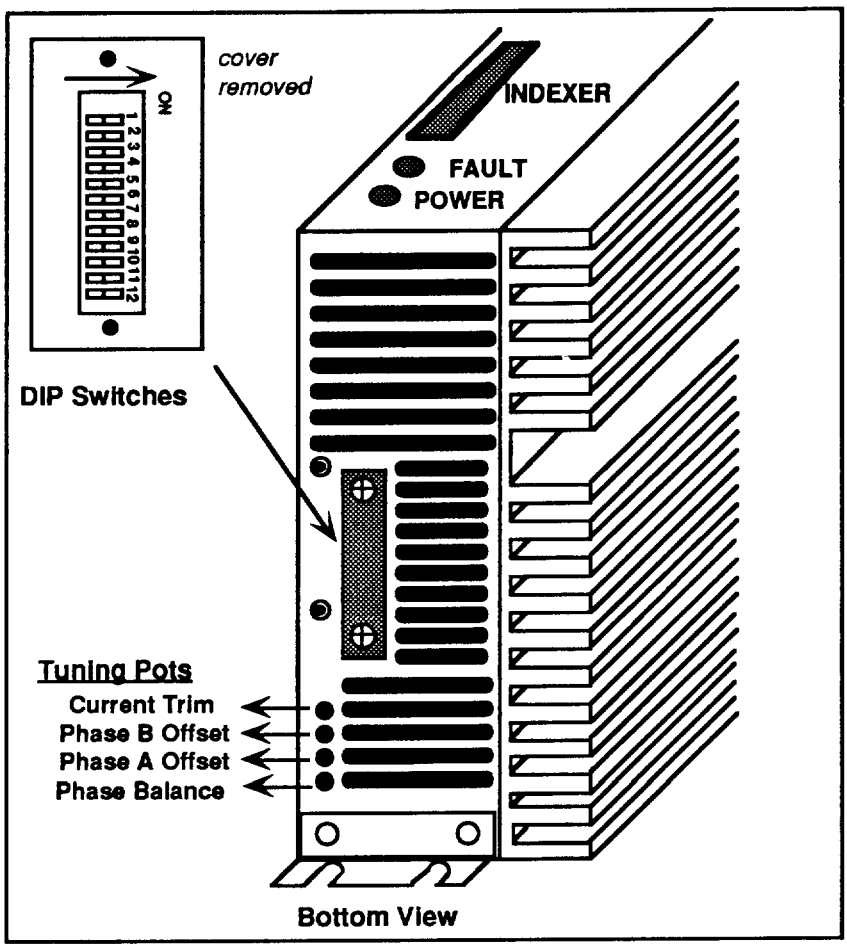


Figure 2-1. DIP Switch & Tuning Pot Locations

1. Setting DIP Switches

The first thing that you must do is set the motor current on the A Drive to match the motor that you are using. Use the directions below to set the DIP switches for your motor.

1. **Be sure that power is not applied to the unit.**
2. Remove the two screws from the panel that covers the DIP switches and remove the panel (refer to Figure 2-1).
3. Table 2-1 contains the proper motor current settings for Compumotor motors. ***DIP switches 1 - 5 control motor current.*** Make the required adjustments to match the drive and motor types that you are using.

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Motor Size	AL Current	AL Drive (3A Max) 1 2 3 4 5	AH Current	AH Drive (6A Max) 1 2 3 4 5
A57-51	0.375	off off off on on	---	Not Recommended
A57-83	0.469	off off on off off	---	Not Recommended
A57-102	0.750	off off on on on	---	Not Recommended
A83-62	0.844	off on off off off	0.938	off off on off off
A83-93	1.41	off on on on off	1.31	off off on on off
A83-135	1.97	on off on off off	1.88	off on off off on
A106-120	---	-- -- -- -- --	1.88	off on off off on
A106-178	---	-- -- -- -- --	4.13	on off on off on
A106-178	---	-- -- -- -- --	6.00*	on on on on on
A106-205	---	-- -- -- -- --	6.00**	on on on on on

* Parallel connected motors.
** The current setting for 106-205 motors is 6A in series and in parallel.

Table 2-2. Setting Motor Current (Compumotor Motors)

These current values are approximate settings in the A Drive. The actual settings may not match these recommended settings exactly.

If you are using a *non-Compumotor motor*, special precautions and instructions are required. Read the instructions in *Chapter 3, Installation* for non-Compumotor motors thoroughly before attempting to set the motor current or wire your motor.

4. To test the system, you will use the Automatic Run function. ***DIP switch 6 controls this function.*** The Automatic Run function turns the motor at 1 rps (50 poles/sec) upon power up, using a 25,000-step resolution. ***To enable the Automatic Run function, turn DIP switch 6 off.***

5. After you have properly set DIP switches 1 - 6, you may screw the plate that covers the DIP switches back onto the drive. ***Do not change any other DIP switch settings*** (leave switches 7 - 12 on).

2. Attaching the Motor

WARNING

POWER MUST BE OFF before cabling the drive. Lethal voltages are present inside the drive and on its screw terminals.

The A Drive is configured at the factory for the motor size that you ordered. The A Series motor is pre-wired. Plug the pre-wired motor cable into the `Motor` connector on the drive (refer to Figure 2-2). If you use a non-Compumotor motor, you must refer to *Chapter 3, Installation* for instructions on how to wire the motor to the drive.

Do not connect the motor to the load at this time.

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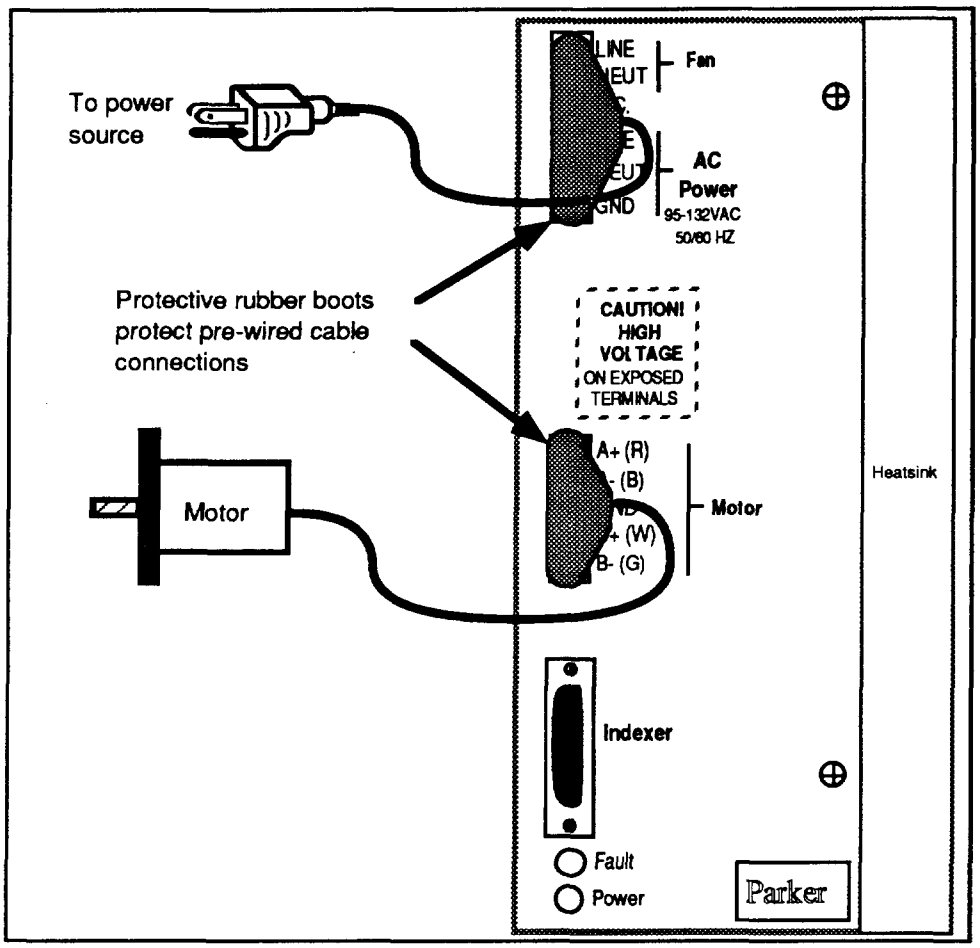


Figure 2-2. Quick Test Configuration

3. Applying Power

The power cable is pre-wired. Plug the pre-wired cable into the power connector on the drive (refer to Figure 2-2). To apply power to the drive, plug the other end of the cable into a 115VAC power source. The motor should run continuously at 1 rps. The **green** Power LED should be on.

To stop the motor, you must unplug the power cable from the power source.

The successful completion of this test indicates that the amplifier, motor, and microprocessor are operating properly. You can now test the indexer interface (the Step, Direction, and Shutdown inputs). Be sure that power is not applied to the system when you begin. To perform this test, complete the following steps.

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Quick Test with Indexer

With no power applied to the drive, perform the following steps to test the indexer interface.

1. Remove the panel that covers the DIP switches. Turn DIP switch 6 **on** to disable the Automatic Run function. **Do not change any other DIP switch settings**. Screw the panel back onto the drive.

2. Connect your Compumotor indexer to the drive's 25-pin D indexer connector (refer to Figure 2-3). The appropriate cable is provided with the indexer.

   If you are using a non-Compumotor indexer, refer to Chapter 3, Installation for wiring instructions.

3. Ensure that the pre-wired motor cable that you connected in the previous test is still connected (refer to Figure 2-3). **Apply power to the drive and indexer**.

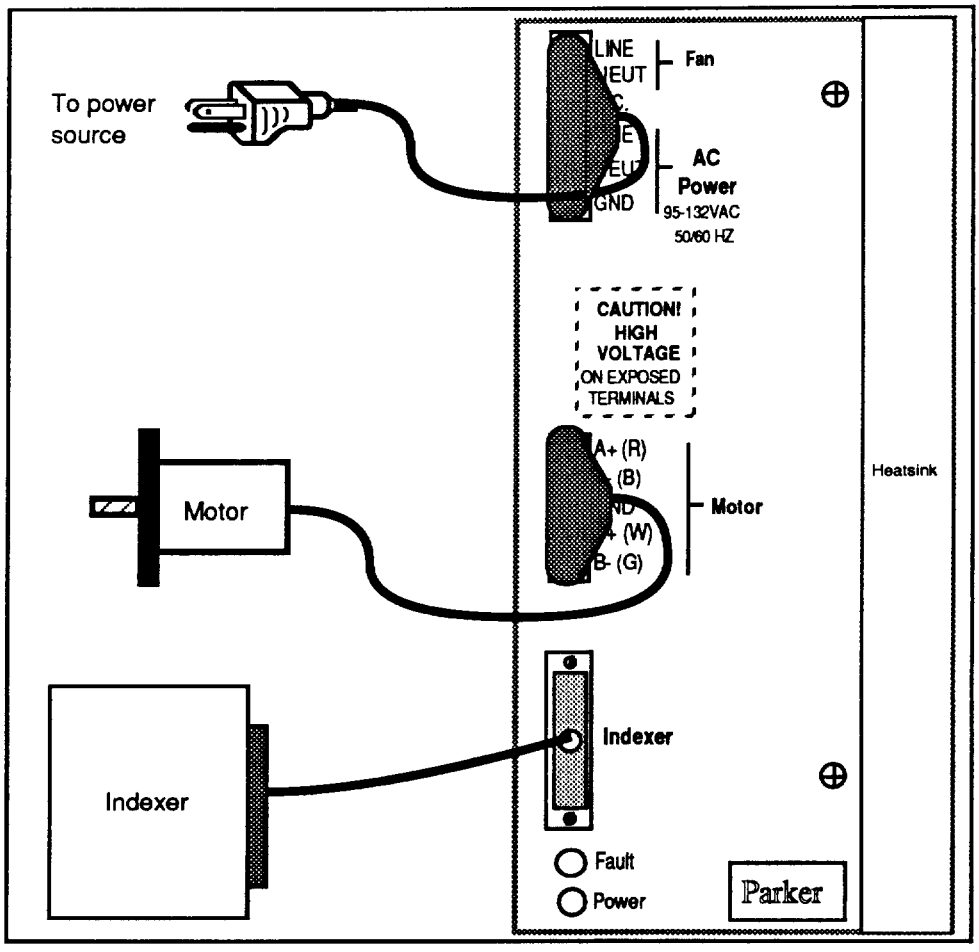


Figure 2-3. Quick Test Configuration (with Indexer)

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4. Using the indexer, send step pulses to the drive that will rotate the motor one CW revolution (25,000 step pulses) at an acceleration of 1 rps^2 and a velocity of 1 rps (25,000 steps per second).

   When the drive receives the step pulses, the motor should rotate one CW revolution. The **green** Power LED should be on.

5. Using the indexer, send step pulses to the drive that will rotate the motor one CCW revolution at an acceleration of 1 rps^2 and a velocity of 1 rps (25,000 steps per second):

   When the drive receives the step pulses, the motor should rotate one CCW revolution. The **green** Power LED should be on.

6. Now you will test the Shutdown input. With no step pulses applied to the drive, activate the Shutdown input. When you activate the Shutdown input, the **red** Fault LED will turn on. In this situation, the Fault LED indicates that the amplifier has been disabled.

   By activating the Shutdown input, all current will be removed from the motor. You should be able to turn the motor shaft manually. Try to turn the shaft slowly now. If you can turn it easily, the Shutdown input is working properly. If the shaft still has torque, check your wiring and try the test again.

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Chapter 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.*

Configuration of the Drive

In this section, you will become familiar with the various DIP switch selectable drive functions and settings and the connections to other system components. The following DIP switch settings will be discussed:

- Motor Current setting
- Auto Run function
- Auto Standby function
- Motor Resolution setting
- Motor Waveform setting

This chapter will guide you through the following connections:

- Drive/Motor
- Drive/Indexer
- AC Power

You will perform a test at the completion of this chapter to ensure that you have configured the A Drive properly.

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

Installation Precautions

Environmental Considerations

An internal thermostat will shut down the drive if it reaches 167°F (75°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 heatsink 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.

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Wiring Considerations

WARNING

There are hazardous voltages present on the A drive'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 operate the A drive with low-inductance motors (less than 20 mH end to end).
- Never operate the A drive with the following Compumotor low-inductance motors:
  - Linear motors
  - C/CX motors
  - Rack system motors
- 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 will cause the motor to overheat and result in a motor and drive failure.
- **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 your 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.**

DIP Switches

This section explains the location, functions, and settings for the A Drive's DIP switches (refer to Figure 3-1). To modify any of the drive's switch settings, power must be removed from the drive. Once power is removed, use the following directions:

1. Remove the panel that covers the DIP switches.
2. Make the required adjustments.
3. Screw the panel back into place over the switches.

The A Drive recognizes changes to its switch settings during power up only. This applies to all settings.

WARNING

NEVER adjust switches with power applied to the unit. Hazardous voltages are contained within the drive when power is applied.

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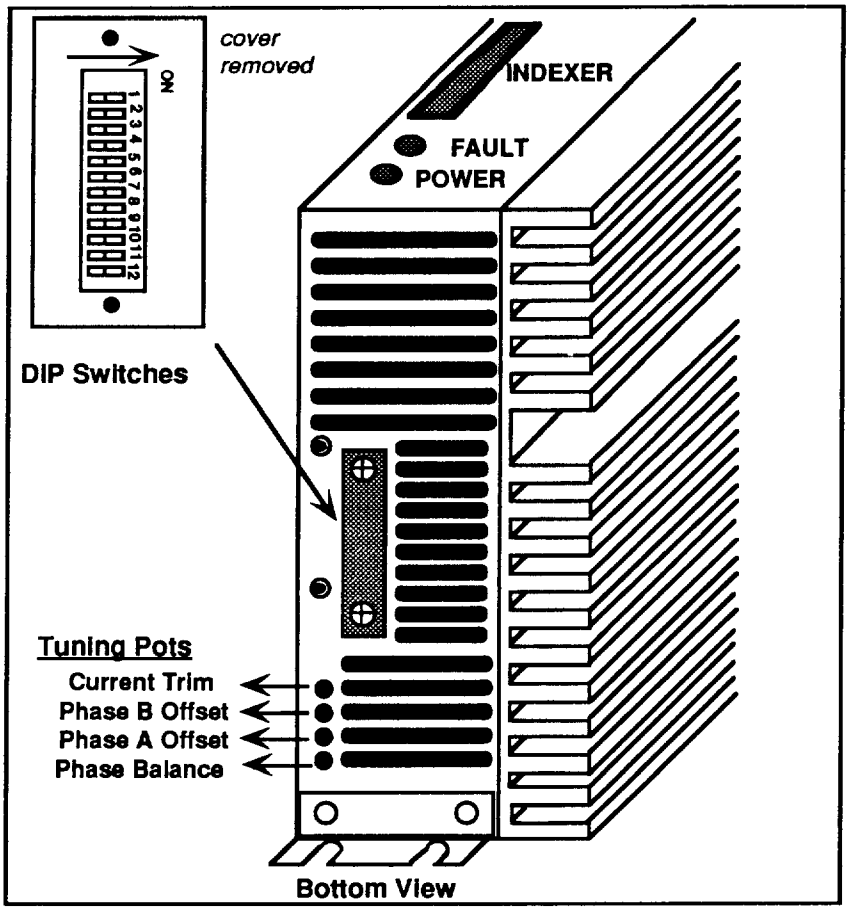


Figure 3-1. DIP Switch & Tuning Pot Locations

Setting Motor Current

Set the switches as required to adjust the current for the motor you will be using. Table 3-1 contains the proper motor current settings for Compumotor motors.

Motor Size	AL Current	AL Drive (3A Max) 1 2 3 4 5	AH Current	AH Drive (6A Max) 1 2 3 4 5
A57-51	0.375	off off off on on	---	Not Recommended
A57-83	0.469	off off on off off	---	Not Recommended
A57-102	0.750	off off on on on	---	Not Recommended
A83-62	0.844	off on off off off	0.938	off off on off off
A83-93	1.41	off on on on off	1.31	off off on on off
A83-135	1.97	on off on off off	1.88	off on off off on
A106-120	---	-- -- -- -- --	1.88	off on off off on
A106-178	---	-- -- -- -- --	4.13	on off on off on
A106-178	---	-- -- -- -- --	6.00*	on on on on on
A106-205	---	-- -- -- -- --	6.00**	on on on on on

* Parallel connected motors.
** The current setting for 106-205 motors is 6A in series and in parallel.

Table 3-1. Setting Motor Current (Compumotor Motors)

The current values are approximate settings in the A Drive. The Actual current may not match recommended settings exactly.

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Motor Current Settings (Non-Compumotor Motors)

Compumotor does not recommend that you use non-Compumotor motors with the A Drive. If you do use a non-Compumotor motor, refer to the formulas below that correspond to your motor (4-lead, 6-lead, or 8-lead) and use Table 3-2 to set the motor's current. **Never increase current more than 10% above the specified rating.**

4-Lead Motors

If you use a 4-lead motor, the manufacturer's current setting will translate directly to the values shown in Table 3-2.

6-Lead Motors

If you use a 6-lead motor, and the manufacturer specifies the motor current as a unipolar rating, you must use the following formula to convert the unipolar current rating to the correct bipolar rating.

Unipolar Current X .707 = Bipolar Current

After you make the conversion, use Table 3-2 to set the motor current.

If the manufacturer specifies the motor current as a bipolar rating, you can use Table 3-2 directly (no conversion) to set motor current.

8-Lead Motors

If you are using an 8-lead motor, manufacturers generally rate the motor current in one of two ways:

- If the motor current is listed as a unipolar rating, you must use the following formula to convert the unipolar current rating to the correct bipolar rating.

  Unipolar Current X .707 = Bipolar Current

  If you are wiring the motor in ***series***, use Table 3-2 and the converted value to set the motor current.

  If you wire the motor in ***parallel***, you must **double** the converted value and then use Table 3-2 to set the motor current.

- If the motor current is listed as a rating per winding or phase, you can wire the motor in ***series*** and use Table 3-2 directly (no conversion) to set motor current.

  If the motor current is listed as a rating per winding or phase and you wire the motor in ***parallel***, you must **double** the manufacturer's rating and then use Table 3-2 to set the motor current.

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SW1	SW2	SW3	SW4	SW5	AL Drive 3A	AH Drive 6A
off	off	off	off	off	0.094	0.188
off	off	off	off	on	0.188	0.375
off	off	off	on	off	0.281	0.563
off	off	off	on	on	0.375	0.750
off	off	on	off	off	0.469	0.938
off	off	on	off	on	0.563	1.125
off	off	on	on	off	0.656	1.313
off	off	on	on	on	0.750	1.500
off	on	off	off	off	0.844	1.688
off	on	off	off	on	0.938	1.875
off	on	off	on	off	1.031	2.063
off	on	off	on	on	1.125	2.250
off	on	on	off	off	1.219	2.438
off	on	on	off	on	1.313	2.625
off	on	on	on	off	1.406	2.813
off	on	on	on	on	1.500	3.000
on	off	off	off	off	1.594	3.188
on	off	off	off	on	1.688	3.375
on	off	off	on	off	1.781	3.563
on	off	off	on	on	1.875	3.750
on	off	on	off	off	1.969	3.938
on	off	on	off	on	2.063	4.125
on	off	on	on	off	2.156	4.313
on	off	on	on	on	2.250	4.500
on	on	off	off	off	2.344	4.688
on	on	off	off	on	2.438	4.875
on	on	off	on	off	2.531	5.063
on	on	off	on	on	2.625	5.250
on	on	on	off	off	2.719	5.438
on	on	on	off	on	2.813	5.625
on	on	on	on	off	2.906	5.813
on	on	on	on	on	3.000	6.000

Table 3-2. Setting Motor Current (Non-Compumotor Motors)

Automatic Run Function

The Automatic Run function turns the motor at 1 rps (50 poles/sec) upon power up, using a 25,000-step resolution. The Automatic Standby function and motor resolution and waveform settings are disabled when you use the Automatic Run function. To disable the Automatic Run function, remove power from the unit, turn **SW6** on, and apply power.

SW6-ON Disables the function*
SW6-OFF Enables the function

* Default Setting

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Automatic Standby Function

The Automatic Standby function allows the motor to cool when it is not moving. This function drops the current to the motor by 50% when the drive does not receive a step pulse for one second. Automatic Standby is enabled when you turn off SW7. Full power is restored upon first step pulse that the drive receives.

The Automatic Standby function may allow the motor shaft to move slightly in a low-friction system. *This function should not be enabled in systems that use an indexer and an encoder for position maintenance.* ***If it is used in this environment, the system will go in and out of the Auto Standby mode.***

SW7-ON Disables the function*
SW7-OFF Enables the function

* Default Setting

Setting Motor Resolutions

Switches 8 - 10 (SW8 - SW10) control motor resolution. **Your indexer and drive must be set to the same resolution.** If the drive and indexer's motor resolution settings do not match, commanded accelerations and velocities will not be performed accurately. Table 3-3 contains the DIP switch settings for the available motor resolutions.

Microsteps Resolution	Switch #8	Switch #9	Switch #10
25,000 steps*	**on**	**on**	**on**
20,000 steps	off	on	on
18,000 steps	on	off	on
10,000 steps	off	off	on
5,000 steps	on	on	off
2,000 steps	off	on	off
400 steps	on	off	off
200 steps	off	off	off

* Default Setting

Table 3-3. Motor Resolution Settings

Setting Current Waveforms

Three different microstepping waveforms are available (refer to Table 3-4). The various waveforms help you to overcome resonance problems and allow the motor to run smoothly. Switches 11 and 12 (SW11 & SW12) control the waveform shape. Use Table 3-4 to select your desired current waveform.

Waveform Shape	Switch #11	Switch #12
Pure Sine*	**on**	**on**
+4% 3rd Harmonic	on	off
-4% 3rd Harmonic	off	on
Pure Sine Wave	off	off

* Default Setting

Table 3-4. Motor Waveform Settings

The waveform function will not operate when you use the 200- and 400-step resolution options.

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Drive Mounting

You can mount the A Drive in either a minimum depth or width configuration, depending on the position of the mounting clips (refer to Figure 3-2). **Use only 6-32 X 1/4" screws to attach the mounting clips.**

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 away from the heatsink to create a minimum depth configuration.

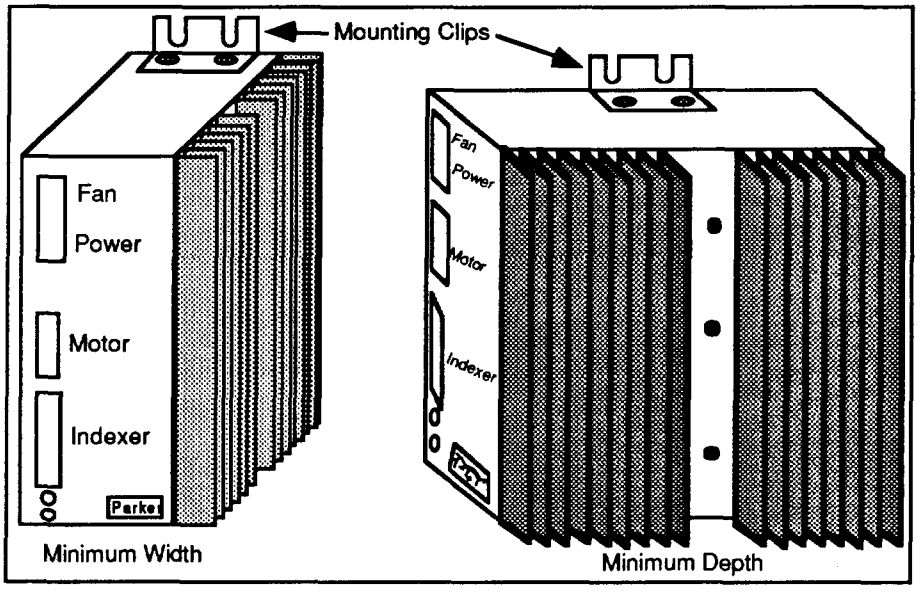


Figure 3-2. Mounting the Drive

Panel Layout

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

1. The vertical and horizontal clearance between the A Drive and other equipment, or the top or bottom of the enclosure, should be no less than 3 inches (see Figure 3-3).
2. Do not mount large, heat-producing equipment directly beneath the A Drive.
3. Do not mount the A Drive directly below an indexer (the A Drive produces more heat than an indexer).
4. Fan cooling may be necessary if air flow is inadequate.

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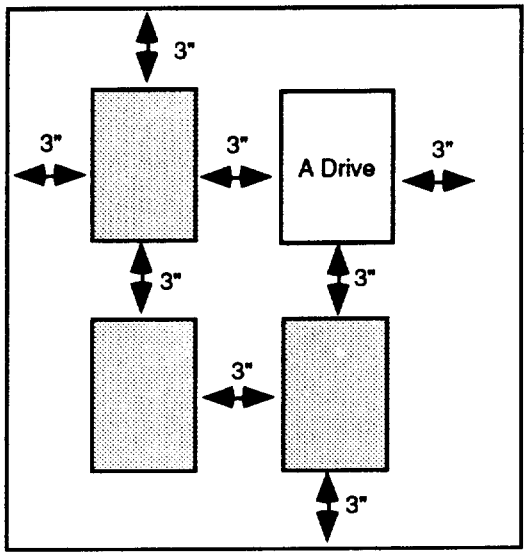


Figure 3-3. Panel Layout Guidelines

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.

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.

The motors used with the A 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 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.**

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System Installation

In this section, you will complete a set-up procedure for indexer, motor, fan, and power connections.

Wiring Guidelines

Proper grounding of electrical equipment is essential to ensure safety. You can reduce the effects of electrical noise due to electromagnetic interference by grounding. All Compumotor equipment should be properly grounded. Refer to the National Electrical Code published by the National Fire Protection Association of Boston, MA for more information on grounding requirements.

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. 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.

For temporary installation, or when you cannot implement the grounding method described above, connect the GND terminal on the AC power connector to earth ground. Whenever possible, route high-power signals (i.e., motor and power) away from logic signals (i.e., RS-232C, RS-422/485, parallel output) to prevent electrical noise problems.

Preventing Electrical Noise Problems

The A Drive provides power to the motor by switching 170VDC (120VAC input) at 16 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. Use the following steps to prevent problems caused by electrical noise generated by the A Drive:

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

2. Avoid extended motor cable runs. Mount the drive close to the motor.
3. Mount equipment that is sensitive to electrical noise as far as possible from the A Drive and motor.
4. Filter the power to the A Drive using a PI type filter (*3A RMS* for the low-power drive and *6A RMS* for the high-power drive) and an isolation transformer. The filter reduces the AC line noise that the A Drive generates. The Corcom® EP Series filter works well with the A Drive.

   Corcom
   1600 Winchester Road
   Libertyville, IL 60048 Telephone: (312) 680-7400

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5. Provide a separate power line for the A Drive. Do not use the same power circuit for equipment that is sensitive to electrical noise and the A Drive.
6. Shield the motor cable in conduit and ensure the conduit is taken to a low impedance earth ground.

System Wiring

The A Drive is configured at the factory for the motor size that you requested with your order. The front panel of the A Drive and the color codes are shown in Figure 3-4. All of these connections (except for the fan, which is optional) were addressed in *Chapter 2, Getting Started*. Additional information about these connections for your permanent configuration are provided in this chapter.

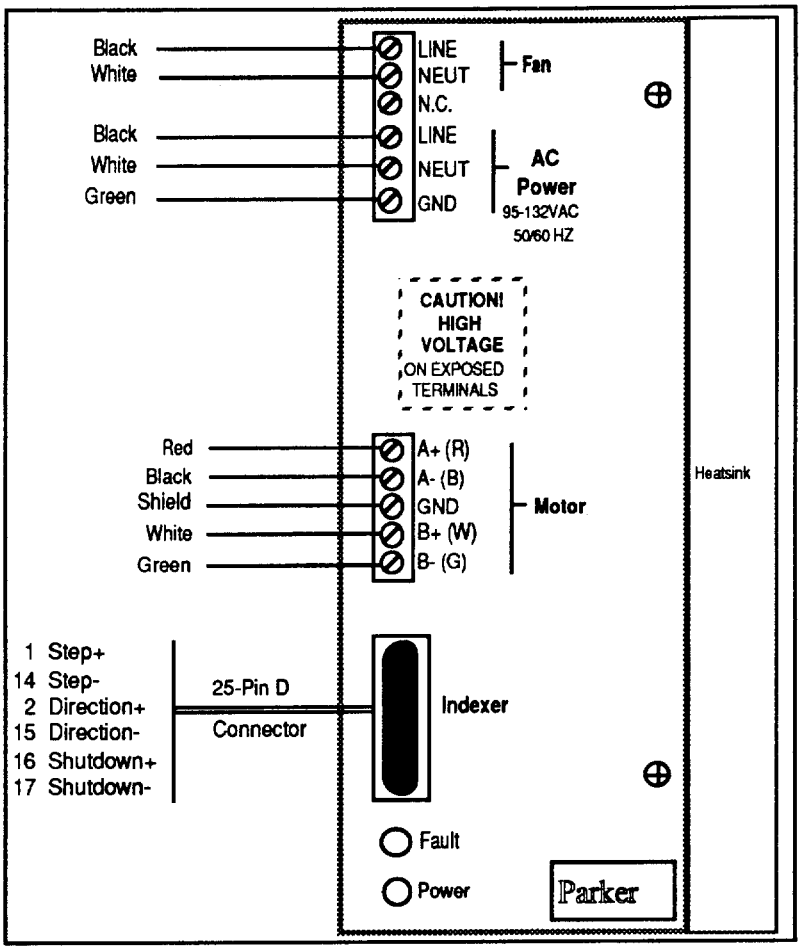


Figure 3-4. A Drive Wiring Diagram

1. Drive/Indexer Connection

If you are using a Compumotor indexer, you can simply plug the indexer cable into the A Drive's **Indexer** connector. If you are using a non-Compumotor indexer, the indexer must meet the specifications listed below. Use Figure 3-4 to wire the indexer to the drive.

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Input Signal Specification

The inputs are optically isolated and may be driven (activated) by providing a positive pulse to the *plus* input with respect to the *minus* input. These inputs may also be differentially driven. The input driver must provide a minimum of 10 mA (20 mA maximum). Figure 3-5 is a schematic of the inputs.

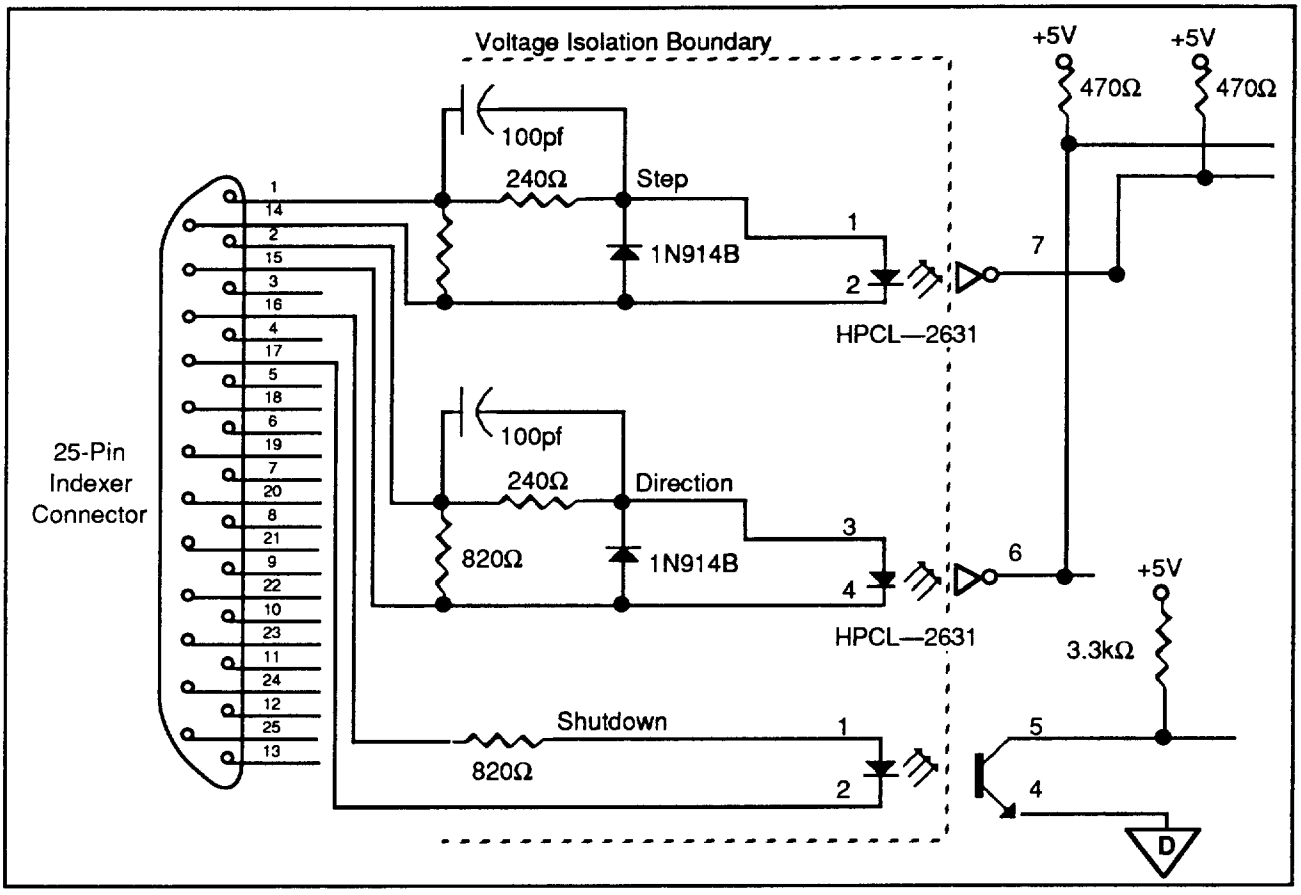


Figure 3-5. A Drive Input Schematic

Step Pulse Input

The step pulse input has the following limitations.

- 500 nanosecond-pulse minimum
- 40% - 60% duty cycle at 15mA (750 kHz max pulse rate).

Input currents greater than 15 mA may result in lost steps at high pulse rates.

Direction Input

This input meets the input signal specifications listed above. A minimum of 2 ms of set-up time is required before and after receipt of the step pulse.

Shutdown Input (Amplifier Disable)

This input has the same electrical characteristics as the STEP input. You can enable it when the motor is not moving. The input must be activated for 100 ms to disable the amplifier. The Shutdown input must be deactivated for 100 ms before the first step pulse is received.

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2. Drive/Motor Connection

Compumotor motors are pre-wired and require no setup other than being plugged into the drive. When using non-Compumotor motors, refer to the instructions and tables in this chapter to connect the motor to the drive.

Figure 3-4 shows the **Motor** connector. Before connecting the motor, you must determine which motor wires correspond to Phase A and Phase B. Once you determine the wiring configuration of the motor, connect the motor to the drive's screw terminals as follows:

1. Connect Phase A motor lead to **Motor** connector pin #1.
2. Connect Phase A motor lead to **Motor** connector pin #2.
3. Connect Phase B motor lead to **Motor** connector pin #4.
4. Connect Phase B motor lead to **Motor** connector pin #5.
5. When using motors not supplied by Compumotor, center taps (if any) of both phases must be left insulated and floating (DO NOT CONNECT CENTER TAPS TOGETHER OR TO EARTH).
6. Connect shield to **Motor** connector pin 3. **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 terminal pin 3.

Motor Inductance

For non-Compumotor motors, the inductance must be 20 mH (minimum) end to end.

Non-Compumotor Motor Connections

Compumotor does not recommend that you use non-Compumotor motors with the A Drive. If you do use a non-Compumotor motor, it must meet the following requirements:

1. A minumum inductance of 20 mH (end to end)
2. A minimum of 500VDC high-pot insulation rating from phase-to-phase and phase-to-ground
3. The motor must not have riveted rotors or stators
4. Do not use solid rotor motors
5. Test all motors carefully. Verify that the motor temperature in your application is within the system limitations (the maximum allowable motor case temperature is 212°F). You should test the motor over a 2 to 3 hour period. Motors tend to have a long thermal time constant, but can still overheat, which results in motor and drive damage.

CAUTION

Consult a Compumotor Applications Engineer if you intend to use a non-Compumotor motor. Low inductance motors will damage the drive.

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You can determine the motor's wiring configuration with the manufacturer's motor specifications (supplied with the motor). You can also determine the wiring configuration with an ohmmeter. Once you have determined the correct motor wiring configuration, follow the terminal connection procedures below for connection to the A Drive's motor connector.

Determining 4-Lead Wiring Configuration

Step 1 Label one motor lead **A+**.

Step 2 Connect one lead of an ohmmeter to the **A+** lead and touch the other lead of the ohmmeter to the three remaining motor leads until you find the lead that creates continuity. Label this lead **A-**.

Step 3 Label the two remaining leads **B+** and **B-**. *NOTE: Verify that there is continuity between the B+ and B- leads.*

Step 4 Proceed to the *Terminal Connections* section below.

Determining 6-Lead Wiring Configuration

Step 1 Determine, with an ohmmeter, which three of the six motor leads are common (one phase).

Step 2 Label each one of these three motor leads **A**.

Step 3 Using the ohmmeter, verify that the remaining three leads are common.

Step 4 Label the other three leads **B**.

Step 5 Set the ohmmeter range to approximately the 100 ohm scale.

Step 6 Connect the negative lead of the ohmmeter to one of the motor leads labeled **A**. Alternately measure the resistance to the two remaining motor leads also labeled **A**. The resistance measurements will reflect one of the following scenarios:

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**. Proceed to step 7.

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**. Label the third motor lead **A-**. Label the motor lead connected to the ohmmeter **A+**. Proceed to step 7.

Step 7 Repeat the procedure as outlined in step 6 for the three leads labeled **B**.

Step 8 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.

Step 9 Proceed to the *Terminal Connections* section below.

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Determining 8-Lead Wiring Configuration

Because of the complexity involved in phasing an 8-lead motor, you must refer to the manufacturer's motor specification document. You can configure the 8-lead motor in parallel or series. Using the manufacturer's specifications, label the motor leads as shown in Figure 3-6.

Parallel Configuration

Use the following procedures for parallel configurations.

Step 1 Connect motor leads labeled A1 and A3 together and relabel this common point **A+**.

Step 2 Connect motor leads labeled A2 and A4 together and relabel this common point **A-**.

Step 3 Connect motor leads labeled B1 and B3 together and relabel this common point **B+**.

Step 4 Connect motor leads labeled B2 and B4 together and relabel this common point **B-**.

Series Configuration

Use the following procedures for series configurations.

Step 1 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 A Drive.

Step 2 Relabel the A1 lead to **A+**.

Step 3 Relabel the A4 lead to **A-**.

Step 4 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 A Drive.

Step 5 Relabel the B1 lead to **B+**.

Step 6 Relabel the B4 lead to **B-**. Proceed to the *Terminal Connections* section below.

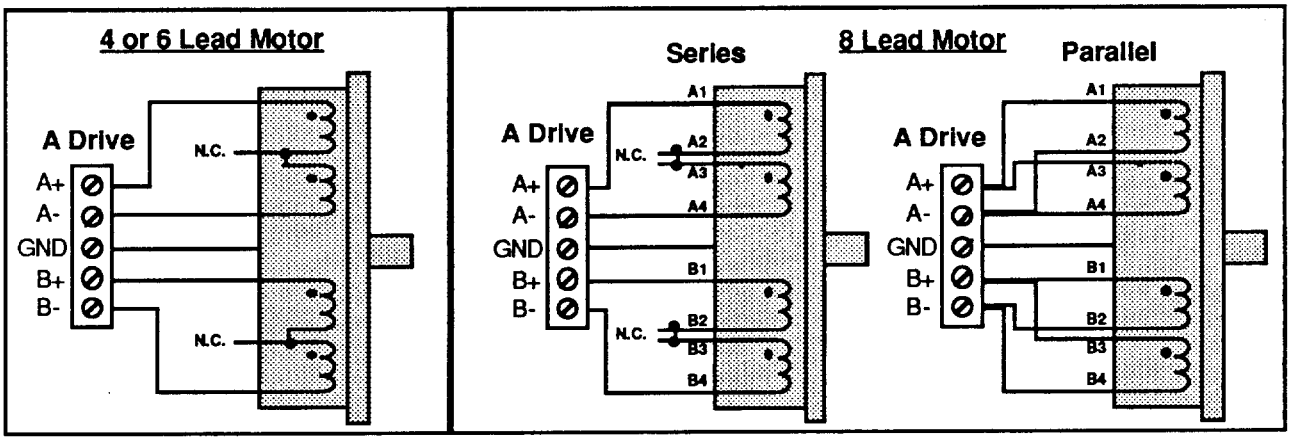


Figure 3-6. Motor Wiring Diagram (Non-Compumotor Motors)

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Terminal Connections

After you determine the motor's wiring configuration, connect the motor leads to the five-pin `Motor` connector (see Figure 3-6) according to the following procedure:

> **CAUTION**
>
> **Do not connect or disconnect the motor with the power on. This will damage the contacts of the motor connector and possibly damage the drive.**

Step 1 Make sure that there is a ground wire leading from the motor case. ***If your motor does not include a case ground wire, you must add one. You may connect this wire to the motor at one of the mounting holes with a ground lug. The ground wire must be run with the rest of the motor leads to the motor connector.***

Step 2 Connect phase **A+** motor lead to motor terminal pin 1

Step 3 Connect phase **A-** motor lead to motor terminal pin 2.

Step 4 Connect phase **B+** motor lead to motor terminal pin 4.

Step 5 Connect phase **B-** motor lead to motor terminal pin 5.

Step 6 Connect the motor case ground wire to motor terminal pin 3. *This is a very important safety precaution.*

Step 7 Inspect the wires after you connect them to the `Motor` connector to verify that there are no *whiskers* that can short out the motor connections. If the motor turns the wrong direction after you have connected the motor wires to the connector and the connector to the drive, you can change the direction by reversing the leads going to pins #1 and #2 (swap A+ and A-) on the motor terminal.

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A106-178 Series Connected

The A106-178 is pre-wired in series. If you remove the back panel, you can wire it in parallel.

Connecting an A106-178 in Series

- Jumper 2 & 6
- Jumper 7 & 8

Connecting an A106-178 in Parallel

- Jumper 1 & 2
- Jumper 3 & 6
- Jumper 5 & 8
- Jumper 4 & 7

Series and Parallel

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

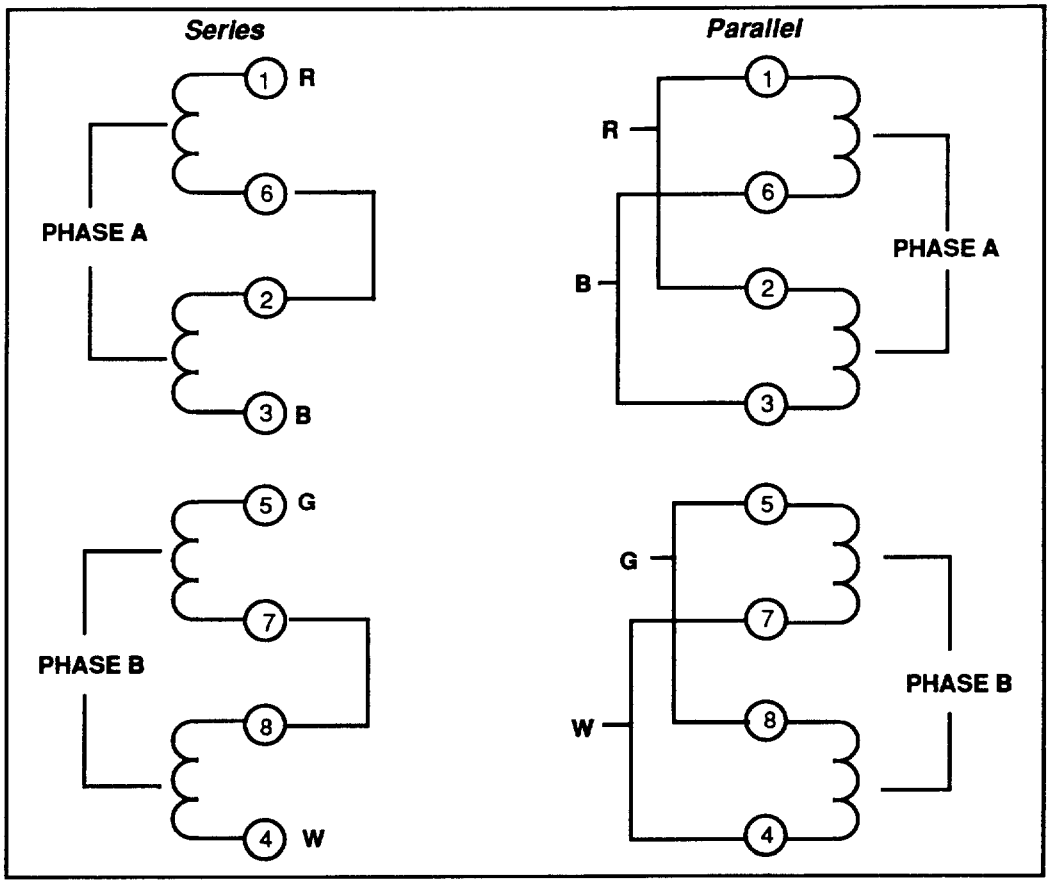


Figure 3-7. 106-178 Wiring Diagram

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A106-205 Parallel Connected

The A106-205 is pre-wired in series. If you remove the back panel, you can wire it in parallel.

Connecting an A106-205 in Series

- Jumper 6 & 5
- Jumper 2 & 4

Connecting an A106-205 in Parallel

- Jumper 1 & 5
- Jumper 6 & 3
- Jumper 8 & 4
- Jumper 2 & 7

Series and Parallel

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

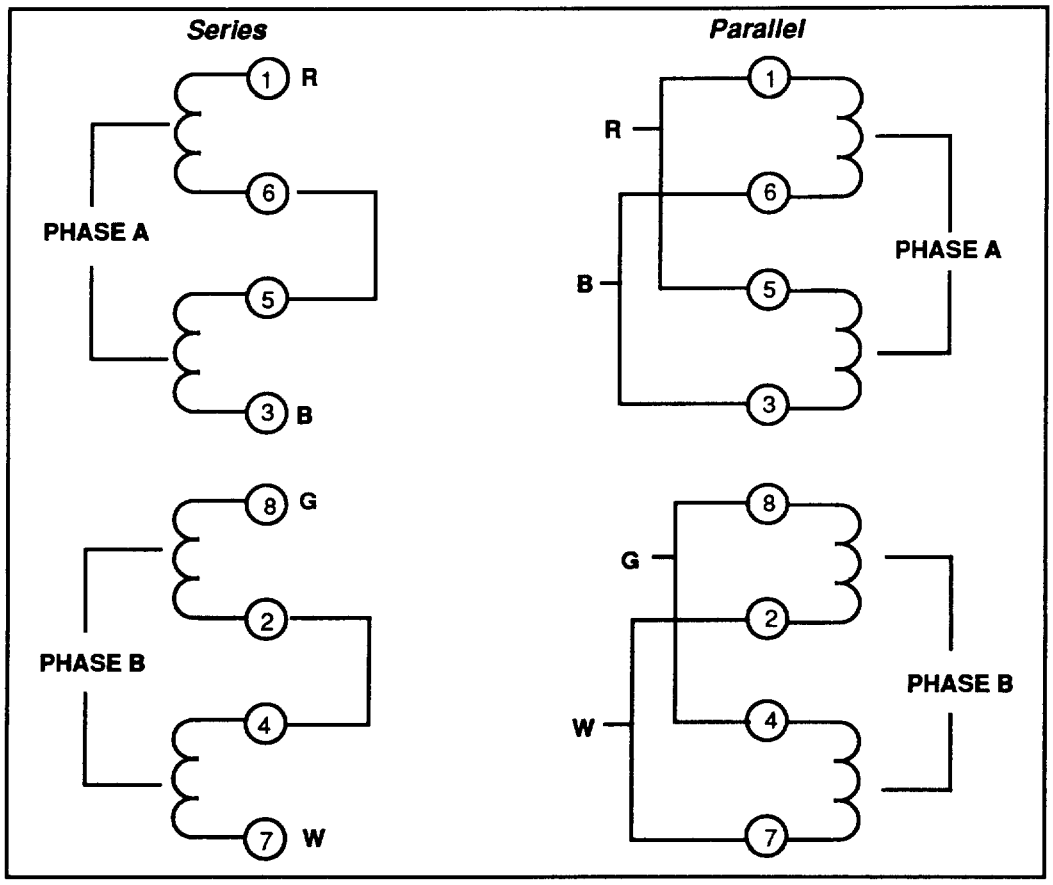


Figure 3-8. 106-205 Wiring Diagram

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Extended Motor Cables

Table 3-5 contains the recommended motor cables for various motor types. Table 3-2 contains the minimum recommended motor/driver wire size (AWG) and resistance.

Motor Series	Maximum current per phase (Amps)	Less than 100 ft (20.5M)	100 - 200 feet (30.5M - 71M)
A57	1	22 AWG	20 AWG
A83	2	20 AWG	18 AWG
A106	6	16 AWG	14 AWG

Table 3-5. Recommended Motor Cables

Cable runs of more than 200 feet (71M) are not recommended.

3. Fan Connection

The fan kit is a standard feature of the **AH** (high-power) Drive. If you are using the **AL** (low-power) Drive, you may order the fan kit from your Automated Technology Center or Compumotor Distributor.

The fan kit for the A Drive is pre-cabled for easy connection to the fan connector terminals. Connect the leads to the LINE and NEUT terminals labeled for the fan.

4. AC Power Connection

The power cable is pre-wired for you. Simply plug the pre-wired cable into the A Drive's power connector and a 95 - 132VAC power source (refer to Figure 3-4).

CAUTION

Input power is limited to 132VAC. Higher voltages may damage the drive.

Transformers

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

Refer to the transformer user guide to determine which output leads correspond to LINE, NEUTRAL, and GROUND. As illustrated in Figure 3-9, connect the transformer leads to the AC power connector on the drive.

WARNING

Do not connect the transformer to the A Drive 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. This can cause serious personal injury.

The A Drive has limited motor phase to earth ground short circuit protection. Use of an isolation transformer assures motor phase to earth ground short circuit protection.

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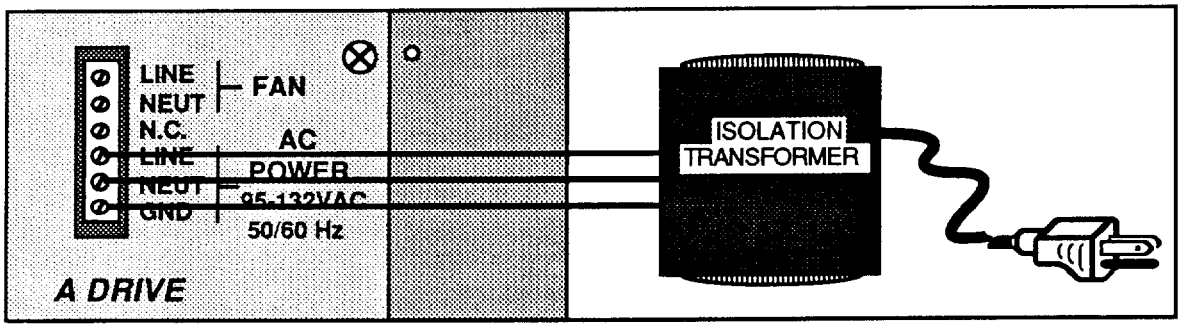


Figure 3-9. Transformer Connections

Testing the System

You can verify proper operation of the A Drive with the procedures provided in ***Chapter 2, Getting Started.*** Follow the instructions provided in the *Testing the Drive* and *Testing the Indexer Interface* sections of Chapter 2. The successful completion of these tests indicate that the amplifier, motor, microprocessor, and indexer interface are operating properly.

Attaching the Load

This section discusses the main factors involved when attaching the load to the motor.

Couplings

Special couplings that accommodate different types of misalignments are available. 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.

Special couplings can accommodate these misalignments and transmit the desired torque. Consult the manufacturer of your coupling to ensure that you are using it 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.

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.*

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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.

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Chapter 4. APPLICATION DESIGN

Chapter Objectives

The information in this chapter will enable you to:

- Recognize and understand important considerations that must be addressed before you implement your application
- Understand the capabilities of the system

Application Considerations

This section contains the issues and concerns that you should be aware of as you 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 A Drive'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 4, Hardware Reference for the maximum inertia ratings for your motor.*

The A Drive is factory tuned to minimize resonance problems.

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. The A Drive's software prevents most mid-range instability problems.

Tuning

You can tune the A Drive to minimize resonance and optimize smoothness by adjusting the small potentiometers (pots) on the bottom of the unit. It is not usually necessary to adjust these pots, tuning is done at the factory. User 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.

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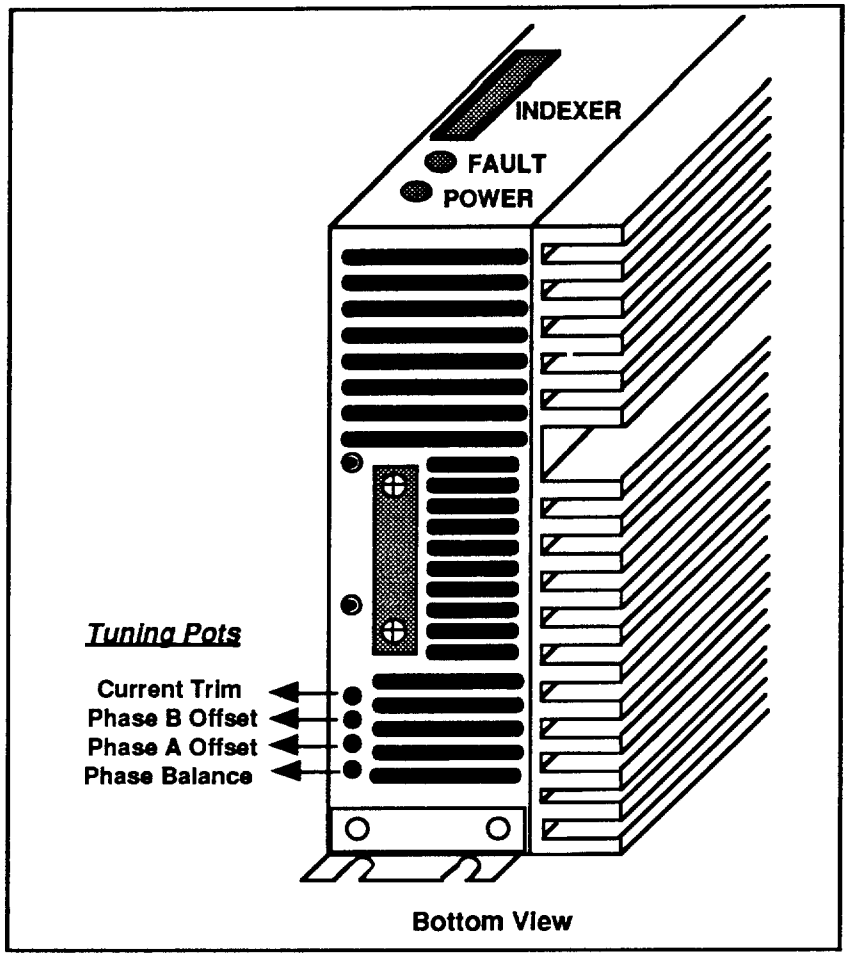


Figure 4-1. Location of Tuning Pots

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.

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Stethoscope Method

When you tune your motor under loaded conditions, you can hear the audible vibration caused by the motor's ***resonance speed*** 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

To tune the A Drive, follow the directions below:

1. Connect an indexer and set the indexer controls so that the motor is running at maximum roughness as shown in Table 4-1 for the 1st speed resonance. Adjust the balance for best smoothness. *The values in Table 4-1 are approximate resonant speed values. Use one of the methods described above to locate the exact resonant speed.*

Motor Size	1st Speed Resonance	2nd Speed Resonance
A57-51	0.9 rps	1.8 rps
A57-83	0.9 rps	1.8 rps
A57-102	0.9 rps	1.8 rps
A83-62	0.7 rps	1.4 rps
A83-93	0.7 rps	1.4 rps
A83-135	0.7 rps	1.4 rps
A106-120	0.4 rps	0.8 rps
A106-178	0.4 rps	0.8 rps
A106-205	0.4 rps	0.8 rps

Table 4-1. Motor Resonance

2. Double the motor speed (2nd speed resonance) until the motor once again is running rough. Adjust offsets A and B for best smoothness.

   The current trim pot may be adjusted for smoothness but is normally left at the center position.

3. Repeat above steps until no further improvement is noted.

The potentiometers are on the bottom of the A Drive. Figure 4-1 shows the location of the potentiometers and their functions. A description of each function is listed below.

A. Current Trim: Adjust the current approximately +10%.

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

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

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

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Chapter 5. HARDWARE REFERENCE

Chapter Objectives

The information in this chapter will enable you to:

- Use this chapter as a quick-reference tool for most system specifications (dimensions and performance)
- Use this chapter as a quick-reference tool for DIP switch settings

Environmental Specifications

Drive Temperature

132°F (55°C) measured at the heatsink fins. An internal thermostat will shut down the drive if the unit reaches 167°F (75°C) internally.

Current settings in excess of 4A in high ambient temperature environments (above 45°C) 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.

Motor Temperature

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

Electrical Specifications

Input Power

95VAC to 132VAC @ 50/60 Hz

Output Power

Low power: 0.1 to 3A per phase at 170VDC
High power: 0.2 to 6A per phase at 170VDC

Output Type

Two phase MOSFET bipolar (H-bridge) switching at 16 kHz (nominal) for AL and AH drives, pulse width modulated

Minimum Motor Winding Inductance

20 mH (measured series or end to end)

Maximum Motor Winding Inductance

No maximum

Minimum Motor Hipot

500VAC

Input Signal Specification

The input is optically isolated and may be driven (activated) by providing a positive pulse to the *plus* input with respect to the *minus* input. The input may also be differentially driven. The input driver must provide a minimum of 10 mA (20 mA maximum).

Step Pulse Input

The step pulse input has the following limitations.

- 500 nanosecond-pulse minimum
- 40% - 60% duty cycle at 15mA (750 kHz max pulse rate)

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Direction Input

This input meets the input signal specifications listed above. A minimum of 2 ms of set-up time is required before and after receipt of the step pulse.

Shutdown Input (Amplifier Disable)

This input has the same electrical characteristics as the STEP input. You can enable it when the motor is not moving. The input must be activated for 100 ms to disable the amplifier. The Shutdown input must be deactivated for 100 ms before the first step pulse is received.

Operational Specifications

Motor Resolutions

A Drive: Eight switch-selectable motor resolutions: 25,000; 20,000; 18,000; 10,000; 5,000; 2,000; 400; and 200 steps per revolution.

Accuracy

±5 arcminutes typical (unloaded, bidirectional) with Compumotor motors.

Repeatability

±5 arcseconds typical (unloaded, unidirectional).

Hysteresis

Less than 2 arcminutes (0.0334°) unloaded, bidirectional.

Rotor Inertia

Size 23	Rotor Inertia oz-in^2	Rotor Inertia Kg-cm^2
A57-51	0.48	0.088
A57-83	1.28	0.234
A57-102	1.75	0.320
Size 34		
A83-62	3.50	0.64
A83-93	6.70	1.23
A83-135	10.24	1.87
Size 42		
A106-120	21.5	3.92
A106-178	44.0	8.05
A106-205	52.0	9.51

Table 5-1. Rotor Inertia (Compumotor Motors)

Motor Curent & Torque

Refer to the current Compumotor catalog for detailed speed/torque curves for the A Drive.

Motor Size	Current	Phase Torque (in-oz)
A57-51	0.34	60
A57-83	0.47	80
A57-102	0.68	120
A83-62	0.88	140
A83-93	1.36	260
A83-135	1.90	400
A106-120	1.87	480
A106-178	4.10	1,300
A102-205	6.00	2,400

Table 5-2. Motor Specifications

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Drive Dimensions with Optional Fan

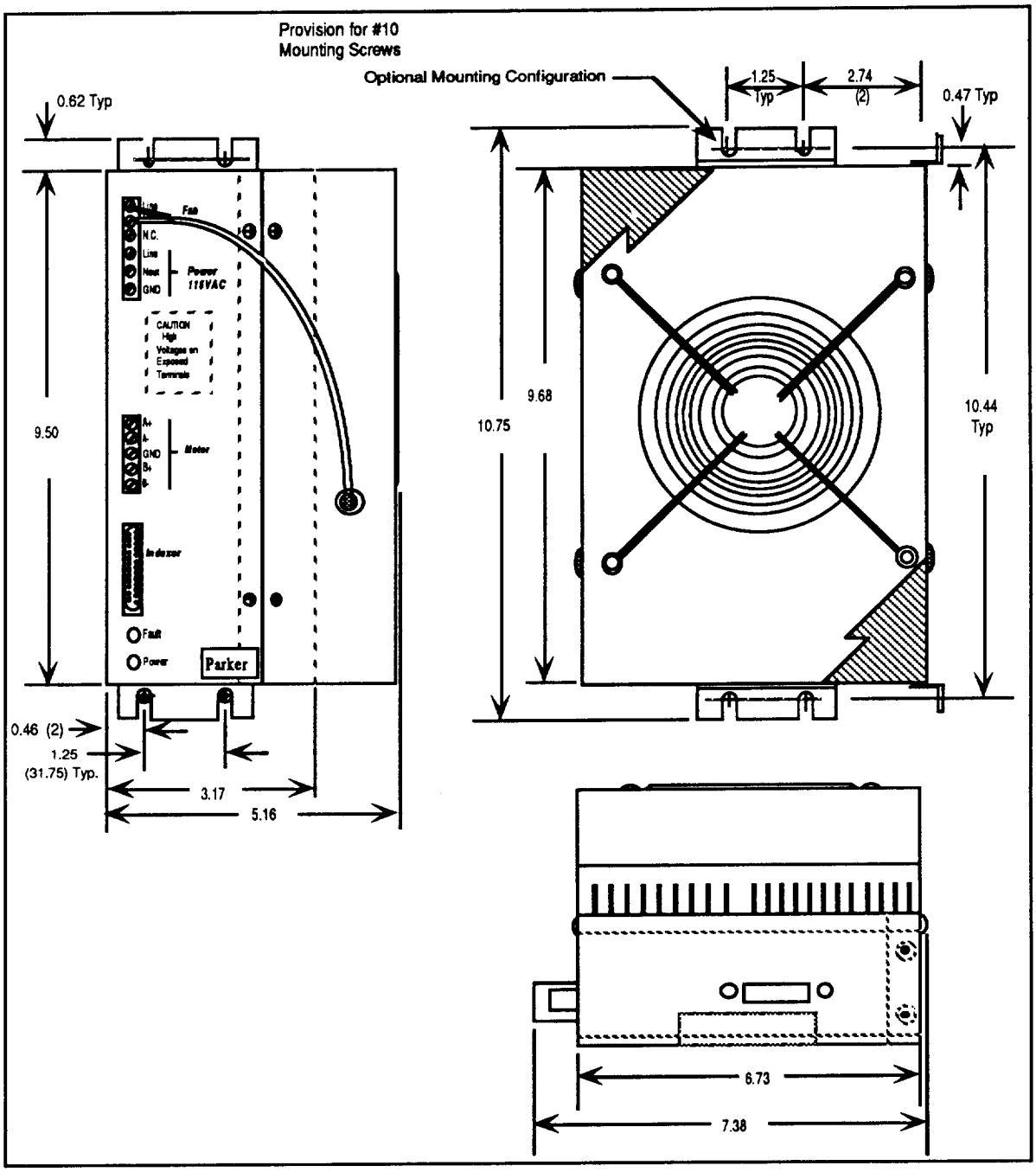
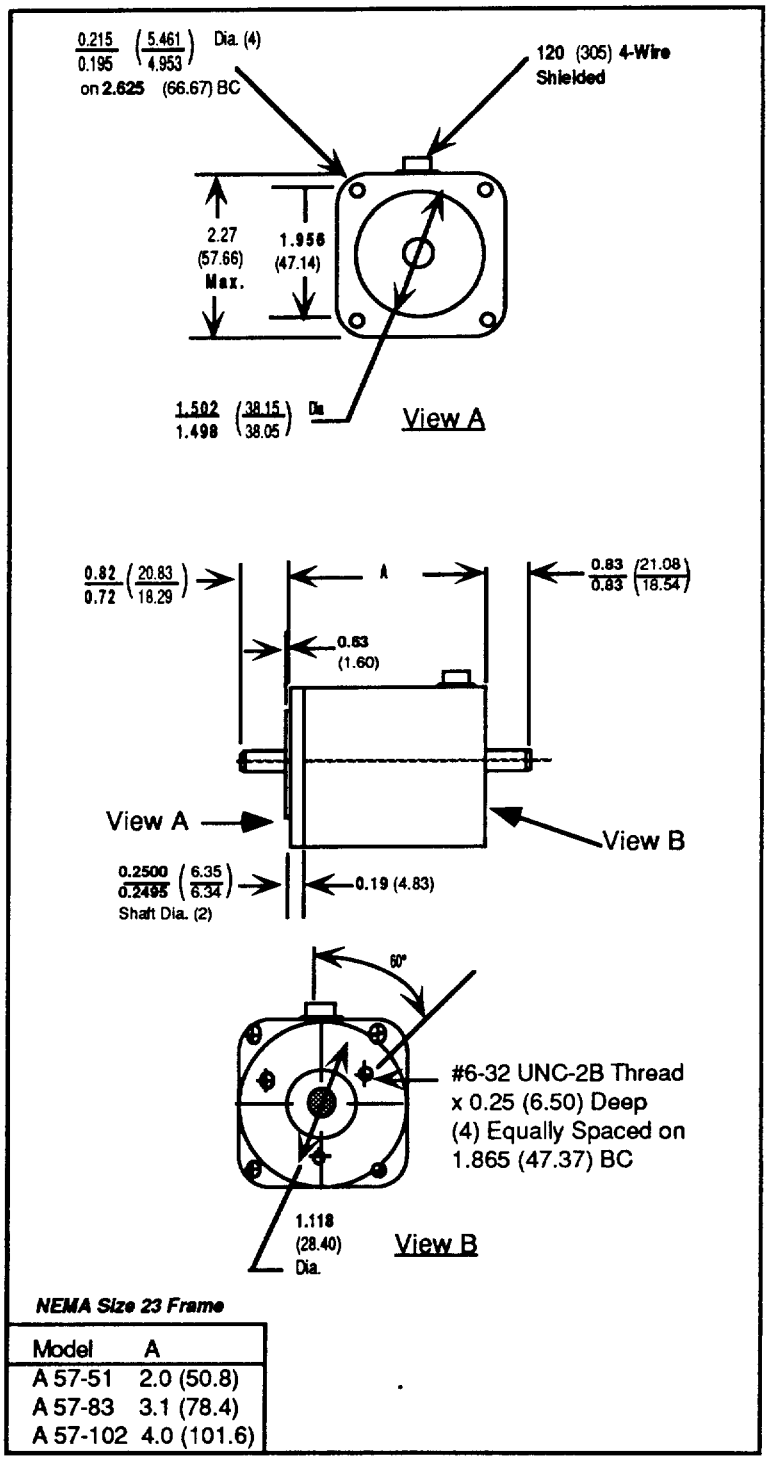


Figure 5-1. A Drive Dimensions with Optional Fan

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Motor Dimensions

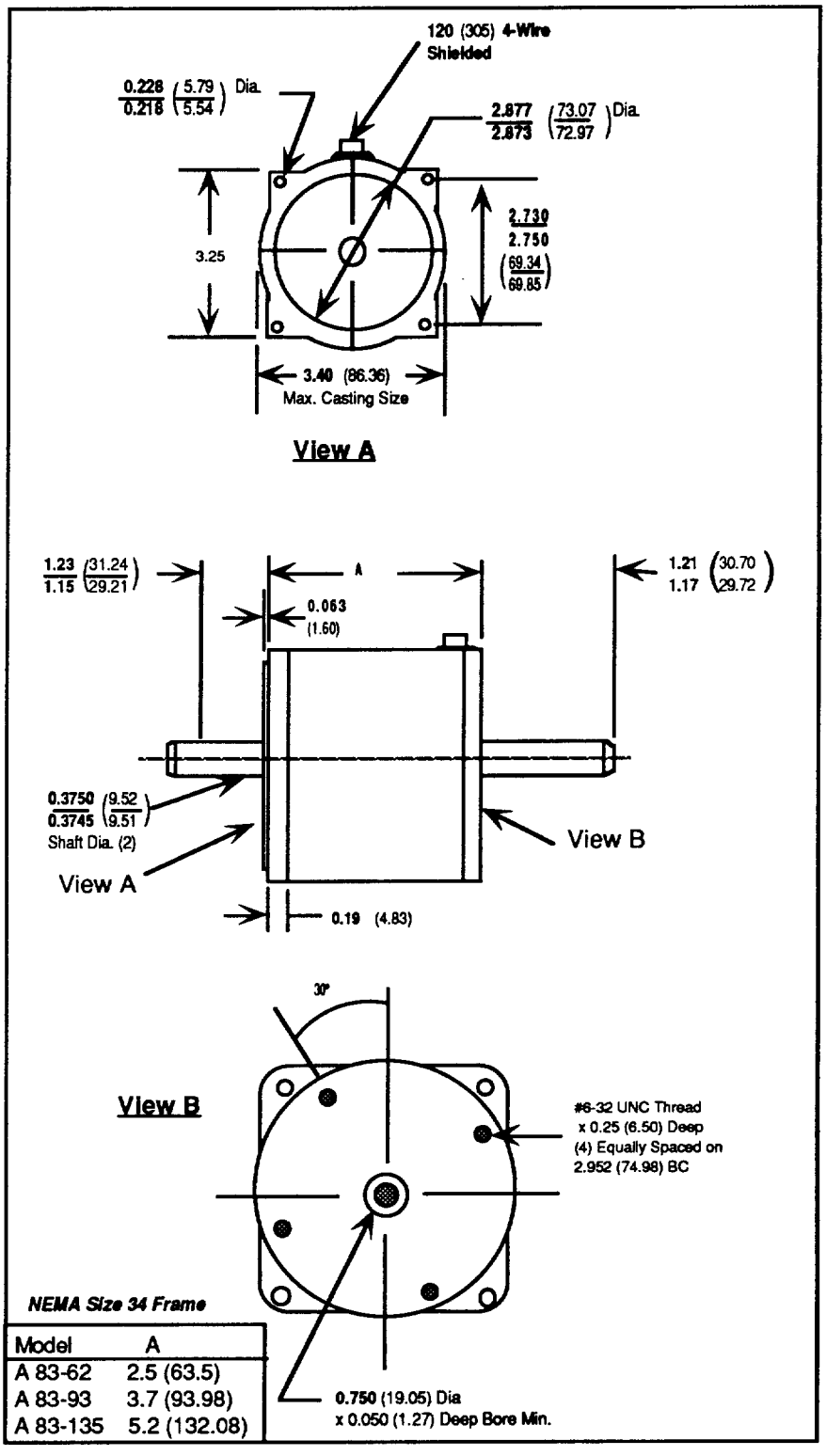


NEMA Size 23 Frame

Model	A
A 57-51	2.0 (50.8)
A 57-83	3.1 (78.4)
A 57-102	4.0 (101.6)

Figure 5-2. NEMA 23 Motor

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Model	A
A 83-62	2.5 (63.5)
A 83-93	3.7 (93.98)
A 83-135	5.2 (132.08)

Figure 5-3. NEMA 34 Motor

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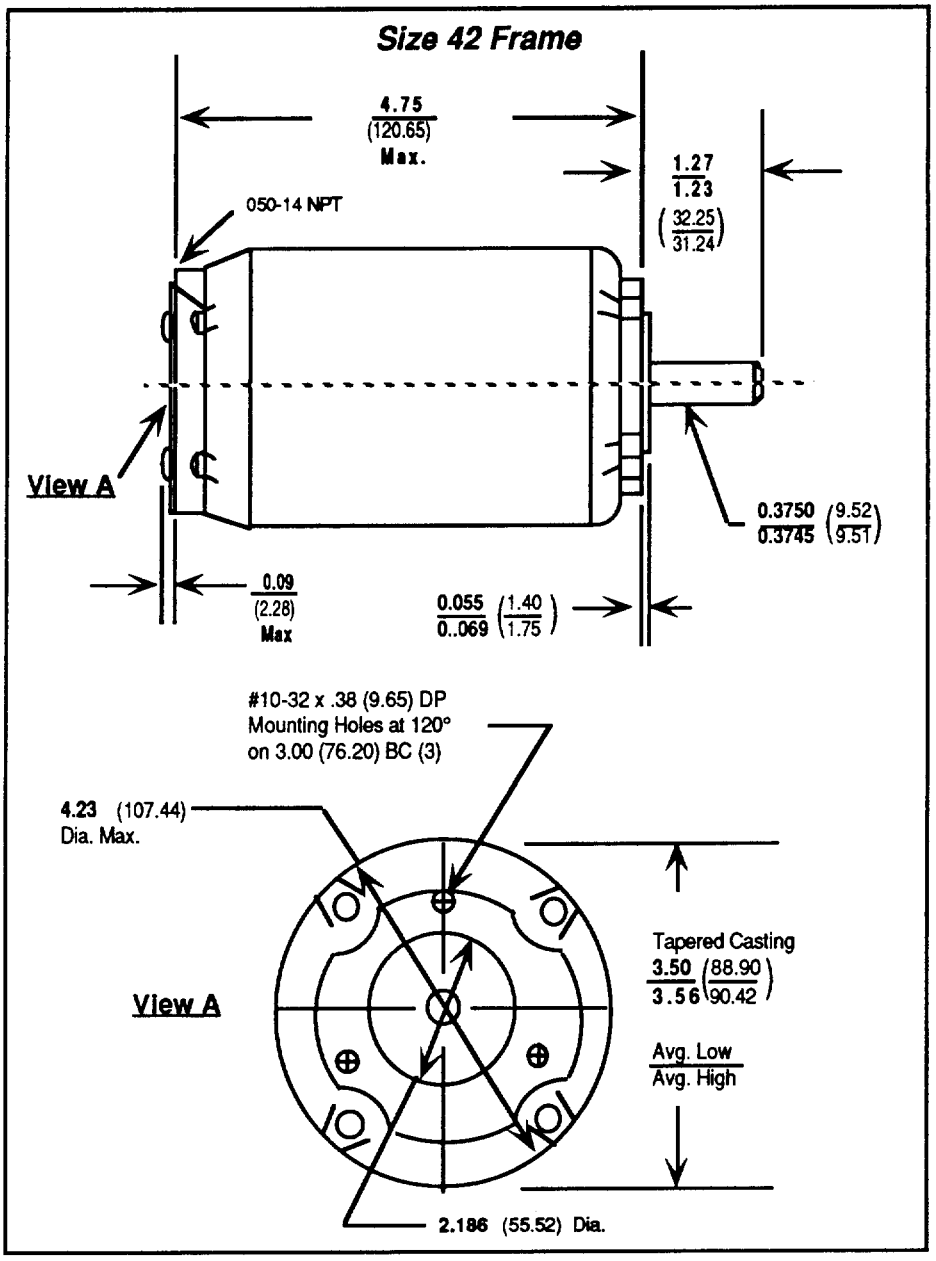


Figure 5-4. NEMA 42 Motor

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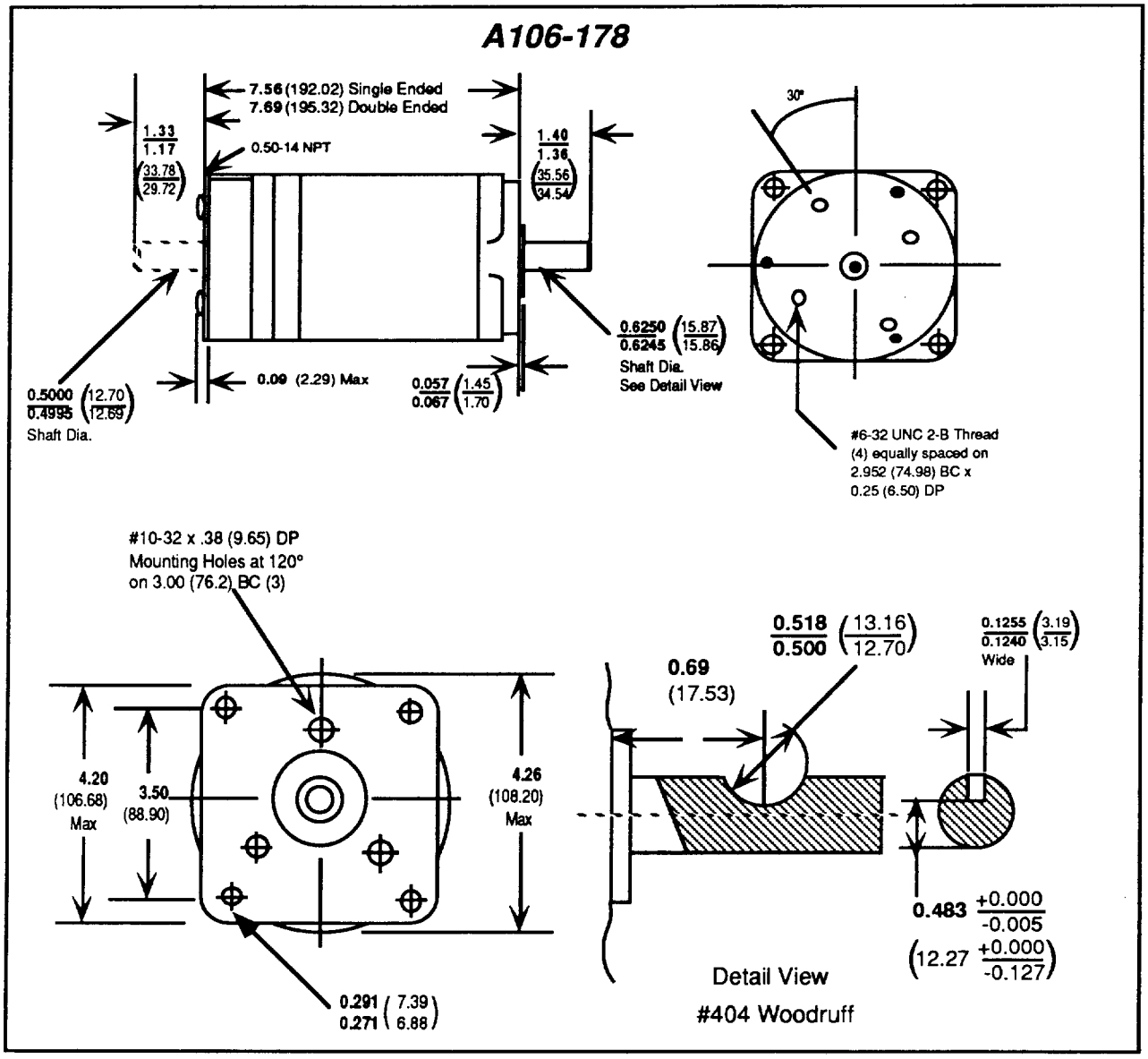


Figure 5-5. A106-178 Motor

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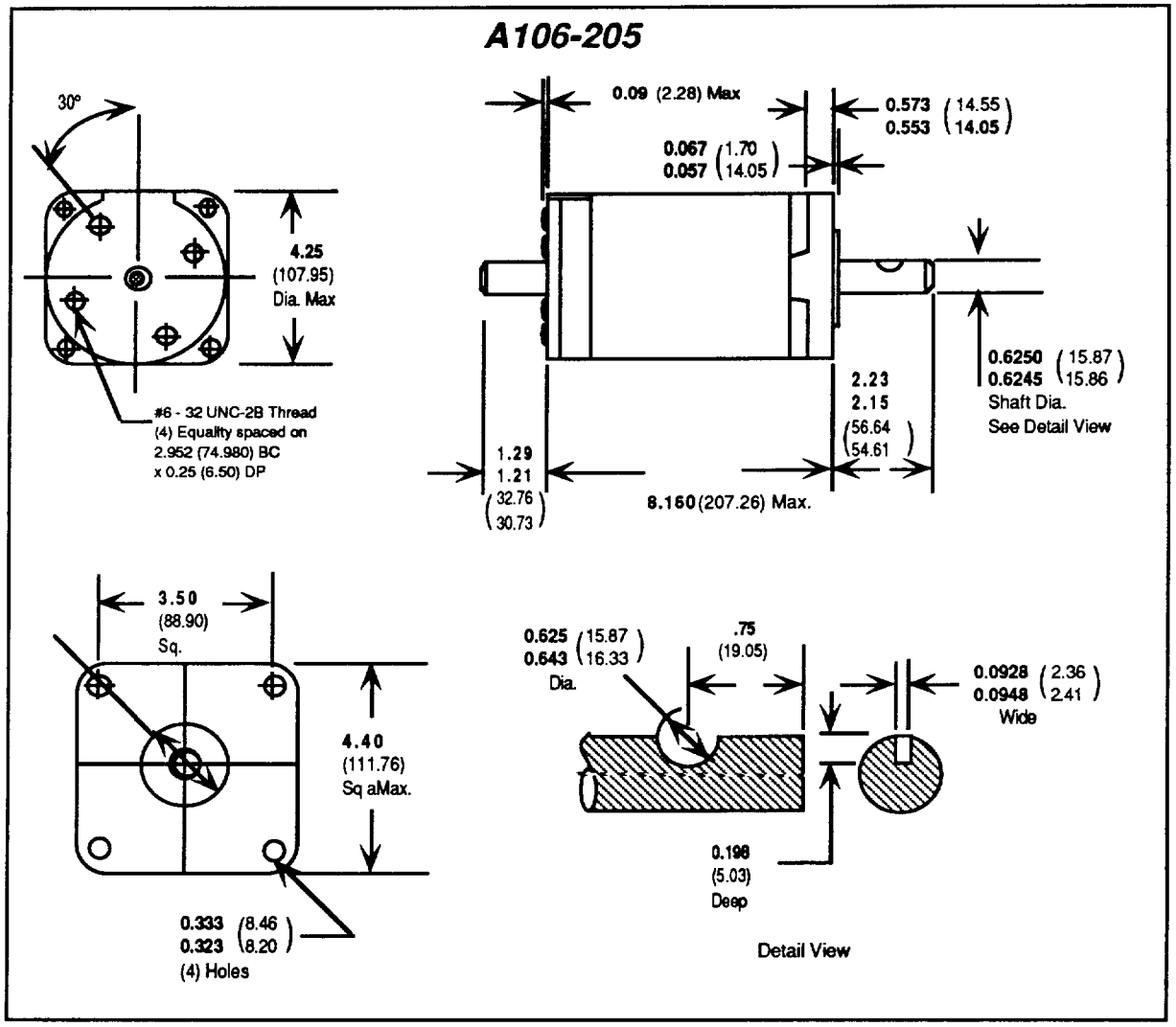


Figure 5-6. A106-205 Motor

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DIP Switch Summary

Switch #	Function
1	Current - most significant bit
2	Current
3	Current
4	Current
5	Current - least significant bit
6	Auto Run = off, Normal operation = on
7	Auto Standby = off, Normal operation = on
8	Motor Resolution
9	Motor Resolution
10	Motor Resolution
11	Waveform
12	Waveform

Table 5-3. DIP Switch Summary

Motor Current

Table 5-4 contains the proper motor current settings for non-Compumotor motors. Table 5-5 contains the proper motor current settings for Compumotor motors.

SW1	SW2	SW3	SW4	SW5	Low 3A	High 6A
off	off	off	off	off	0.094	0.188
off	off	off	off	on	0.188	0.375
off	off	off	on	off	0.281	0.563
off	off	off	on	on	0.375	0.750
off	off	on	off	off	0.469	0.938
off	off	on	off	on	0.563	1.125
off	off	on	on	off	0.656	1.313
off	off	on	on	on	0.750	1.500
off	on	off	off	off	0.844	1.688
off	on	off	off	on	0.938	1.875
off	on	off	on	off	1.031	2.063
off	on	off	on	on	1.125	2.250
off	on	on	off	off	1.219	2.438
off	on	on	off	on	1.313	2.625
off	on	on	on	off	1.406	2.813
off	on	on	on	on	1.500	3.000
on	off	off	off	off	1.594	3.188
on	off	off	off	on	1.688	3.375
on	off	off	on	off	1.781	3.563
on	off	off	on	on	1.875	3.750
on	off	on	off	off	1.969	3.938
on	off	on	off	on	2.063	4.125
on	off	on	on	off	2.156	4.313
on	off	on	on	on	2.250	4.500
on	on	off	off	off	2.344	4.688
on	on	off	off	on	2.438	4.875
on	on	off	on	off	2.531	5.063
on	on	off	on	on	2.625	5.250
on	on	on	off	off	2.719	5.438
on	on	on	off	on	2.813	5.625
on	on	on	on	off	2.906	5.813
on	on	on	on	on	3.000	6.000

Table 5-4. Motor Current (Non-Compumotor Motors)

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Motor Size	AL Current	AL Drive (3A Max) 1 2 3 4 5	AH Current	AH Drive (6A Max) 1 2 3 4 5
A57-51	0.375	off off off on on	---	Not Recommended
A57-83	0.469	off off on off off	---	Not Recommended
A57-102	0.750	off off on on on	---	Not Recommended
A83-62	0.844	off on off off off	0.938	off off on off off
A83-93	1.41	off on on on off	1.31	off off on on off
A83-135	1.97	on off on off off	1.88	off on off off on
A106-120	---	-- -- -- -- --	1.88	off on off off on
A106-178	---	-- -- -- -- --	4.13	on off on off on
A106-178	---	-- -- -- -- --	6.00*	on on on on on
A106-205	---	-- -- -- -- --	6.00**	on on on on on

* Parallel connected motors.
** The current setting for 106-205 motors is 6A in series and in parallel.

Table 5-5. Motor Current (Compumotor Motors)

Automatic Run Function

SW6-ON Disables the function*
SW6-OFF Enables the function

* Default Setting

Automatic Standby Function

SW7-ON Disables the function*
SW7-OFF Enables the function

* Default Setting

Motor Resolutions

Microsteps Resolution	Switch #8	Switch #9	Switch #10
25,000 steps	on	on	on
20,000 steps	off	on	on
18,000 steps	on	off	on
10,000 steps	off	off	on
5,000 steps	on	on	off
2,000 steps	off	on	off
400 steps	on	off	off
200 steps	off	off	off

Table 5-6. Motor Resolutions

Motor Waveforms

Waveform Shape	Switch #11	Switch #12
Pure Sine	off	off
+4% 3rd	on	off
-4% 3rd	off	on
Pure Sine	on	on

Table 5-7. Motor Waveforms

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Chapter 6. TROUBLESHOOTING

Chapter Objectives

The information in this chapter will enable you to:

- Maintain the system's components to ensure smooth, efficient operation
- Isolate and resolve system hardware problems

Maintenance

The following items, which are included with the A Drive, can be reordered from Compumotor.

Part	Part Number
6-Pin Phoenix Connector	43-006599-01
6-Pin Boot	58-008819-06
5-Pin Phoenix Connector	43-006589-01
5-Pin Boot	58-008819-05
25-Pin D Connector	43-004875-01*
AC Cable	71-006593-01
Mounting Bracket	53-006007-01
Hole Cover	53-006008-01

* Not included in original ship kit

Table 6-1. Spare Parts List

Drive Maintenance

Ensure that the drive heatsink is free of particles and has a free flow of air over its entire surface. 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.

Motor Maintenance

You should inspect all mechanical parts of the motor regularly to ensure that no bolts or couplings have become loose during normal operation. This will prevent some minor problems from developing into more serious problems.

You should inspect the motor cable periodically for signs of wear. This inspection interval is duty-cycle, environment, and travel-length dependent. The cable should not have excessive tensile force applied to it and should not be bent beyond a one-inch radius of curvature during normal operation. Tighten all cable connectors.

Problem Isolation

When your system does not function properly (or as you expect it to operate), the first thing that you must do is identify and isolate the problem. When you accomplish this, you can effectively begin to resolve and eradicate the problem.

The first step is to isolate each system component and ensure that each component functions properly when it is run independently. You may have to dismantle your system and put it back together piece by piece to detect the problem. If you have additional units available, you may want to use them to replace existing components in your system to help identify the source of the problem.

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Determine if the problem is mechanical, electrical, or software-related. Can you repeat or re-create the problem? Do not make quick rationalizations about the problems. Random events may appear to be related, but they may not be contributing factors to your problem. Carefully investigate and decipher the events that occur before the subsequent system problem.

You may be experiencing more than one problem. You must solve one problem at a time. Document all testing and problem isolation procedures. You may need to review and consult these notes later. This will also prevent you from duplicating your testing efforts.

Once you have isolated the problem, take the necessary steps to resolve it. Refer to the problem solutions contained in this chapter. If your system's problem persists, contact Parker Compumotor at 800-358-9070.

Front Panel LEDs

There are two LEDs on the front panel of the A Drive—Fault and Power (refer to Figure 2-2).

The Power LED is **green** and turns on when the internal bias supply is operating and providing +5V.

The Fault LED is **red** and turns on when the amplifier is disabled. The Fault LED will be activated when any of the following conditions occur:

- Motor short-circuit
- Over-temperature
- Undervoltage (<70VAC)
- Shutdown enabled

Common Problems and Solutions

Table 6-2 contains common problems, probable causes, and solutions to the problems. It should help you eradicate most of the problems you might have with the A Drive.

Problems	Probable Causes	Solutions
The power LED is not on (illuminated).	A. The drive is not receiving AC voltage.	A1. Verify that the connector on the drive is fully seated.
		A2. Verify that there is AC voltage at the AC outlet that the drive is plugged into.
		A3. Verify that there is AC voltage at the drive at the AC power connector.
	B. The drive is defective.	B1. Return the drive and motor to Compumotor for servicing.
The power LED is flashing.	A. AC Line voltage is too low.	A1. Check the AC line voltage (95VAC minimum).
	B. There is insufficient load regulation on the AC line.	B1. Increase the AC line wire size. Increase the isolation transformer size (if used).
	C. The internal drive supply is defective.	C1. Return the drive and motor to Compumotor for servicing.

Table 6-2. Problems & Solutions Table

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Problems	Probable Causes	Solutions
There is little or no holding torque. The power LED is on. The fault LED is off.	A. The motor current is set too low.	A1. Check the current select switches and verify that the current is set correctly.
	B. The motor winding or cable is open.	B1. Check the motor and cable with an ohmmeter.
	C. The Auto Standby function is enabled.	C1. Disable the Auto Standby function if this function does not allow enough holding torque for your application.
The fault LED is on (red)	A. The shutdown input has been enabled.	A1. Disconnect the indexer cable to test if the shut down input is being activated. If it is activated, resolve the problem at you indexer.
	B. There is insufficient AC voltage.	B1. Measure the AC voltage and correct the power line problem if the AC voltage is less than 95VAC.
	C. The drive is experiencing an overtemperature condition.	C1. Provide additional cooling for the drive. Add a fan or air conditioning unit.
	D. The drive has been damaged	D1. Return the drive and motor to Compumotor for servicing.
The motor moves erratically at low speeds.	A. Motor current is set incorrectly.	A1. Check the current select switches and verify that the current is set correctly.
	B. Indexer pulses are being sent to the drive erratically.	B1. Verify, with an oscilloscope, that the indexer pulses are being sent at a constant rate and are not being frequency modulated.
	C. Motor resolution is set for 200 or 400 steps per revolution	C1. Full and half step modes will cause the motor to run roughly at low speeds.
	D. One motor phase is defective.	D1. Return the drive and motor to Compumotor for servicing.
	E. The motor has a short.	E1. Return the motor for replacement
The drive loses pulses at high speed.	A. The indexer is overdriving the step input.	A1. Verify that the step input current is not greater than 15 mA.
	B. The indexer is underdriving the step input.	B1. Verify that the step input current is greater than 6.25 mA.
	C. The indexer is sending pulses too fast.	C1. Verify that the indexer is not exceeding the 750 kHz maximum pulse rate.
	D. The motor is out of torque.	D1. Verify that the motor is sized correctly for your application.
The motor stalls at high speeds.	A. The velocity is too high.	A1. The drive can handle a maximum pulse rate of 750 kHz or 30 rps, whichever comes first. Decrease the velocity.
	B. Motor current is not set correctly.	B1. Check the current DIP switches and verify that the current is set correctly.
	C. The motor is undersized for your application.	C1. Verify that the motor is sized correctly for your application.
The motor stalls during acceleration.	A. Motor current is not set correctly.	A1. Check the current select switches and verify that the current is set correctly.
	B. The acceleration is set too high.	B1. Decrease the acceleration.
	C. There is insufficient rotor inertia.	C1. Add inertia to the motor shaft.
	D. The motor is undersized for the application.	D1. Verify that the motor is sized correctly for your application

Table 6-2. Problems & Solutions Table (continued)

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Problems	Probable Causes	Solutions
The motor (unloaded) stalls at nominal speed.	A. There is insufficient rotor inertia.	A1. Add inertia to the motor shaft.
The motor does not move the commanded distance.	A. The motor resolution is set incorrectly.	A1. Determine the resolution on your indexer and verify that the drive resolution setting is the same.
	B. The indexer cable is faulty	B1. Use an ohmmeter to check the cable for continuity.
	C. The indexer is overdriving the step input.	C1. Verify that the step input current is not greater than 15 mA.
	D. The indexer is underdriving the step input.	D1. Verify that the step input current is greater than 6.25 mA.
	E. The indexer is sending pulses too fast.	E1. Verify that the indexer is not exceeding the 750 kHz maximum pulse rate.
The motor will not change direction when commanded to do so.	A. The direction input is not being enabled.	A1. Verify that the direction input is being enabled (6.4 mA to 15 mA)
The indexer moves the motor in the wrong direction.	A. There is a direction conflict within the indexer.	A1. Change the direction sense within your indexer.
		A2. Change the motor direction by swapping motor leads A+ and A- at the drive connector.

Table 6-2. Problems & Solutions Table (continued)

Testing the Motor

If the motor fails to move, you should test the motor with an ***ohmmeter*** to examine the resistance between the motor connections. If the motor is not malfunctioning, the source of the problem is probably within the drive. If you operate a faulty drive with a reliable motor, you may damage the motor. If you find that the motor is not faulty, remove power, and remove the motor from the drive. Use the following steps to test the motor.

1. Remove power from the system. Detach the motor from the drive.
2. With the motor detached from the system, use an ohmmeter to check the resistance across Phase A. **It should be approximately 2 ohms.**
3. Now use the ohmmeter to check the resistance across Phase B. **It should be approximately 2 ohms too (*the resistance across Phase A and Phase B should be nearly identical*).**
4. Use the ohmmeter to check the resistance between Phase A and Phase B. **It should be infinite (∞).**
5. Use the ohmmeter to check the resistance between Phase A and Earth (the motor case shaft). **It should be infinite (∞).**
6. Use the ohmmeter to check the resistance between Phase B and Earth (the motor case shaft). **It should be infinite (∞).**
7. Turn the shaft manually. **There should be little torque.**

If the motor responds as described to each of these steps, it is functioning properly. The source of the problem is probably within the drive.

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Returning The System

If your A Drive system is faulty, you must return the drive and motor for replacement or repair. A failed drive can damage motors, and a faulty motor can damage subsequent drives. If you must return your A Drive to effect repairs or upgrades, use the following steps:

Step 1

Get the serial number and the model number of the defective unit(s), and a purchase order number to cover repair costs in the event the unit is determined by Parker Compumotor to be out of warranty.

Step 2

Before you ship the drive to Parker Compumotor, have someone from your organization with a technical understanding of the A Drive and its application include answers to the following questions:

- What is the extent of the failure/reason for return?
- How long did it operate?
- How many units are still working?
- How many units failed?
- What was happening when the unit failed (i.e., installing the unit, cycling power, starting other equipment, etc)?
- How was the product configured (in detail)?
- What, if any, cables were modified and how?
- With what equipment is the unit interfaced?
- What was the application?
- What was the system sizing (speed, acceleration, duty cycle, inertia, torque, friction, etc.)?
- What was the system environment (temperature, enclosure, spacing, unit orientation, contaminants, etc.)?
- What upgrades, if any, are required (hardware, software, user guide)?

Step 3

Call Parker Compumotor [(800) 358-9070] for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number.

Step 4

Ship the unit to: Parker Compumotor Corporation
5500 Business Park Drive
Rohnert Park, CA 94928
Attn: RMA # xxxxxxx

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Glossary

Acceleration
The change in velocity as a function of time. Acceleration usually refers to increasing velocity and deceleration describes decreasing velocity.

Accuracy
A measure of the difference between expected position and actual position of a motor or mechanical system. Motor accuracy is usually specified as an angle representing the maximum deviation from expected position.

Ambient Temperature
The temperature of the cooling medium, usually air, immediately surrounding the motor or another device.

Block Diagram
A simplified schematic representing components and signal flow through a system.

Closed Loop
A broadly applied term relating to any system where the output is measured and compared to the input. The output is then adjusted to reach the desired condition. In motion control, the term describes a system wherein a velocity or position (or both) transducer is used to generate correction signals by comparison to desired parameters.

Detent Torque
The minimal torque present in an un-energized motor. The detent torque of a Compumotor or step motor is typically about one percent of its static energized torque.

Efficiency
The ratio of power output to power input.

Encoder
A device that translates mechanical motion into electronic signals used for monitoring position or velocity.

Friction
A resistance to motion caused by surfaces rubbing together. Friction can be constant with varying speed (Coulomb friction) or proportional to speed (viscous friction).

Holding Torque
Sometimes called static torque, it specifies the maximum external force or torque that can be applied to a stopped, energized motor without causing the rotor to rotate continuously.

Home
A reference position in a motion control system, usually derived from a mechanical datum. Often designated as the *zero* position.

Hysteresis
The difference in response of a system to an increasing or a decreasing input signal.

Inertia
A measure of an object's resistance to a change in velocity. The larger an object's inertia, the larger the torque that is required to accelerate or decelerate it. Inertia is a function of an object's mass and its shape.

Inertial Match
For most efficient operation, the system coupling ratio should be selected so that the reflected inertia of the load is equal to the rotor inertia of the motor.

Microstepping
An electronic control technique that proportions the current in a step motor's windings to provide additional intermediate positions between poles. Produces smooth rotation over a wide speed range and high positional resolution.

Open Loop
Refers to a motion control system where no external sensors are used to provide position or velocity correction signals.

Opto-Isolated
A method of sending a signal from one piece of equipment to another without the usual requirement of common ground potentials. The signal is transmitted optically with a light source (usually a Light Emitting Diode) and a light sensor (usually a photosensitive transistor). These optical components provide electrical isolation.

Pulse Rate
The frequency of the step pulses applied to a motor driver. The pulse rate multiplied by the resolution of the motor/drive combination (in steps per revolution) yields the rotational speed in revolutions per second.

Ramping
The acceleration and deceleration of a motor. May also refer to the change in frequency of the applied step pulse train.

Rated Torque
The torque producing capacity of a motor at a given speed. This is the maximum torque the motor can deliver to a load and is usually specified with a torque/speed curve.

Relative Accuracy
Also referred to as *Step-to-Step Accuracy*, this specification tells how microsteps can change in size. In a perfect system, microsteps would all be exactly the same size, but drive characteristics and the absolute accuracy of the motor cause the steps to expand and contract by an amount up to the relative accuracy figure. The error is not cumulative.

Repeatability
The degree to which the positioning accuracy for a given move performed repetitively can be duplicated.

Resolution
The smallest positioning increment that can be achieved. Frequently defined as the number of steps required for a motor's shaft to rotate one complete revolution.

Ringing
Oscillation of a system following a sudden change in state.

Slew
In motion control, the portion of a move made at a constant non-zero velocity.

Speed
Used to describe the linear or rotational velocity of a motor or other object in motion.

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Static Torque
The maximum torque available at zero speed.

Step Angle
The angle the shaft rotates upon receipt of a single step command.

Stiffness
The ability to resist movement induced by an applied torque. Is often specified as a torque displacement curve, indicating the amount a motor shaft will rotate upon application of a known external force when stopped.

Synchronism
A motor rotating at a speed correctly corresponding to the applied step pulse frequency is said to be in synchronism. Load torques in excess of the motor's capacity (rated torque) will cause a loss of synchronism. This condition is not damaging to a step motor.

Torque
Force tending to produce rotation.

Torque-to-Inertia Ratio
Defined as a motor's holding torque divided by the inertia of its rotor. The higher the ratio, the higher a motor's maximum acceleration capability will be.

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