ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

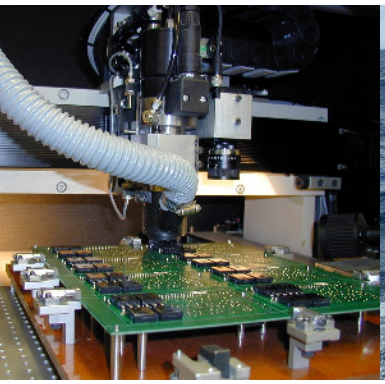
- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

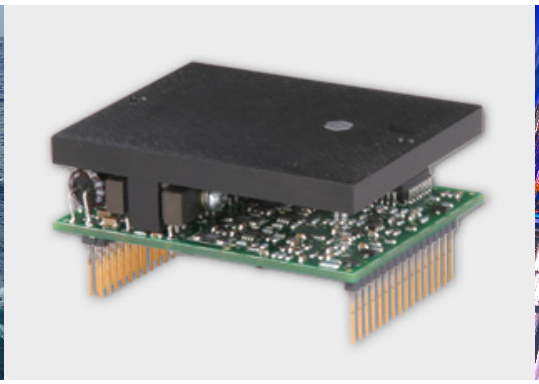
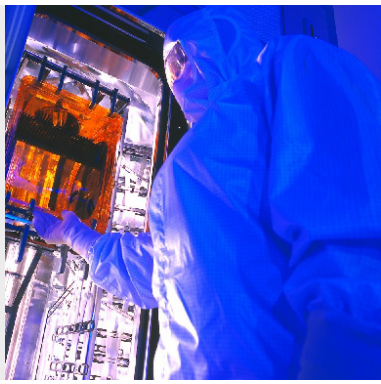
Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Advanced Motion Controls 12A8E* at our website: *Click HERE*

ADVANCED MOTION CONTROLS



Everything's possible.

AZ Analog Drives

for Servo Systems

Hardware

Installation Manual

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Preface

ADVANCED Motion Controls constantly strives to improve all of its products. We review the information in this document regularly and we welcome any suggestions for improvement. We reserve the right to modify equipment and documentation without prior notice.

For the most recent software, the latest revisions of this manual, and copies of compliance and declarations of conformity, visit the company's website at *www.a-m-c.com*. Otherwise, contact the company directly at:

ADVANCED Motion Controls • 3805 Calle Tecate Camarillo, CA • 93012-5068 USA

Agency Compliances

The company holds original documents for the following:

- UL 508c, file number E140173
- Electromagnetic Compatibility, EMC Directive - 2004/108/EC
  EN61000-6-2:2001
  EN61000-6-4:2001
  EN61000-3-2:2000
  EN61000-3-3:1995/A1:2001
- Electrical Safety, Low Voltage Directive - 72/23/EEC
  EN 60 204-1 (IEC 60 204-1)
- Reduction of Hazardous Substances (RoHS), 2002/95/EC

Trademarks

ADVANCED Motion Controls™, the combined isosceles trapezoid/right triangle logo, **DIGIFLEX®, DIGIFLEX® Performance™** and DriveWare™ are either registered trademarks or trademarks of *ADVANCED* Motion Controls in the United States and/or other countries. All other trademarks are the property of their respective owners.

Related Documentation

- Product datasheet specific for your drive, available for download at www.a-m-c.com.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Attention Symbols

The following symbols are used throughout this document to draw attention to important operating information, special instructions, and cautionary warnings. The section below outlines the overall directive of each symbol and what type of information the accompanying text is relaying.



Note - Pertinent information that clarifies a process, operation, or ease-of-use preparations regarding the product.



Notice - Required instruction necessary to ensure successful completion of a task or procedure.



Caution - Instructs and directs you to avoid damaging equipment.



Warning - Instructs and directs you to avoid harming yourself.



Danger - Presents information you must heed to avoid serious injury or death.

Revision History

Document ID	Revision #	Date	Changes
MNALAZIN-01	1	9/2008	AZ Install Manual First Release
MNALAZIN-02	2	10/31/2008	- Updated Pads Layout Diagram, Figure 3.4 - Updated Pin Layout Diagram, Figure 2.4 - Added Tachometer Velocity information (also see page 10, page 30, and page 33)

© 2008 *ADVANCED* Motion Controls. All rights reserved.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Contents

1 Safety 1

General Safety Overview 1

2 Products and System Requirements 4

AZ Drive Family Overview 4
Drive Datasheet 4
Products Covered 5
Control Modes 6
Current (Torque) 6
Open Loop (PWM Duty Cycle) 6
Hall Velocity 6
Encoder Velocity 7
Tachometer Velocity 7
Feedback Supported 7
Feedback Polarity 8
Hall Sensors 8
Using a Single Phase Motor with a Three Phase Drive 9
Encoder Feedback 10
Tachometer Feedback 10
Pin Layout 11
Single Phase (Brushed, Voice Coil, Inductive Load) Drives 12
AZxxA8 12
AZxxA8DDC 12
Block Diagrams 12
Pinouts 12
Three Phase (Brushless) Drives 13

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

AZBxxA8 13
AZBExxA8 13
AZBDCxxA8 13
AZBHxxA8 13
Block Diagrams 13
Pinouts 14
System Requirements 14
Specifications Check 14
Motor Specifications 15
Power Supply Specifications 16
Environment 17
Ambient Temperature Range and Thermal Data 17
Shock/Vibrations 17

3 Integration in the Servo System 18

Grounding 18
Wiring 19
Wire Gauge 19
Motor Wires 20
Power Supply Wires 20
Feedback Wires 20
Input Reference Wires 21
Noise Suppression 22
AC Line Filter 22
Ferrite Suppression Cores 22
Inductive Filter Cards 22
Mounting 23
Mounting Card 23
PCB Mounting Options 24
Mating Connectors 24
Soldering 25
Screw Mounting 25
PCB Design 26
Trace Width and Routing 26
Interface Circuitry Examples 27
DC Power Input 27
Motor Power Output 28
Hall Sensor Inputs 29

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Encoder Inputs 29
Tachometer Input 30
Offset Input 30

4 Operation 31

Getting Started 31
Input/Output Pin Functions 31
Current Monitor Output 31
Current Reference Output 31
Fault Output 32
Inhibit Input 32
Low Power Supply Output for Hall Sensors 32
Velocity Monitor Output 33
Tachometer Input 33
Initial Setup 33
Current (Torque) Mode Test 33
Connections Test 34
Power Supply 34
Input Command Wiring 34
Hall Sensors 35
Motor 35
Applying a Command (Analog Input) 35

A Specifications 38

Specifications Tables 38

B Troubleshooting 41

Fault Conditions and Symptoms 41
Over-Temperature 41
Over-Voltage Shutdown 41
Under-Voltage Shutdown 42
Short Circuit Fault 42
Invalid Hall Sensor State (Brushless Drives only) 42

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Inhibit Input 42
Power-On Reset 42
Overload 42
Over-Current 42
Motor Problems 43
Causes of Erratic Operation 43
Technical Support 44
Drive Model Information 44
Product Label Description 44
Warranty Returns and Factory Help 45

Index I

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1 Safety

This section discusses characteristics of your AZ Analog Drive to raise your awareness of potential risks and hazards. The severity of consequences ranges from frustration of performance, through damage to equipment, injury or death. These consequences, of course, can be avoided by good design and proper installation into your mechanism.

General Safety Overview

In order to install an AZ drive into a servo system, you must have a thorough knowledge and understanding of basic electronics, computers and mechanics as well as safety precautions and practices required when dealing with the possibility of high voltages or heavy, strong equipment.

Observe your facility's lock-out/tag-out procedures so that work can proceed without residual power stored in the system or unexpected movements by the machine.



Notice

You must install and operate motion control equipment so that you meet all applicable safety requirements. Ensure that you identify the relevant standards and comply with them. Failure to do so may result in damage to equipment and personal injury.

Read this entire manual prior to attempting to install or operate the drive. Become familiar with practices and procedures that allow you to operate these drives safely and effectively. You are responsible for determining the suitability of this product for the intended application. The manufacturer is neither responsible nor liable for indirect or consequential damages resulting from the inappropriate use of this product.



Notice

High-performance motion control equipment can move rapidly with very high forces. Unexpected motion may occur especially during product commissioning. Keep clear of any operational machinery and never touch them while they are working.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com



Warning

Keep clear of all exposed power terminals (motor, DC Bus, shunt, DC power, transformer) when power is applied to the equipment. Follow these safety guidelines:

- Always turn off the main power and allow sufficient time for complete discharge before making any connections to the drive.
- Do not rotate the motor shaft without power. The motor acts as a generator and will charge up the power supply capacitors through the drive. Excessive speeds may cause over-voltage breakdown in the power output stage. Note that a drive having an internal power converter that operates from the high voltage supply will become operative.
- Do not short the motor leads at high motor speeds. When the motor is shorted, its own generated voltage may produce a current flow as high as 10 times the drive current. The short itself may not damage the drive but may damage the motor. If the connection arcs or opens while the motor is spinning rapidly, this high voltage pulse flows back into the drive (due to stored energy in the motor inductance) and may damage the drive.
- Do not make any connections to any internal circuitry. Only connections to designated connectors are allowed.
- Do not make any connections to the drive while power is applied.



Caution

Do not reverse the power supply leads!

Severe damage will result!



Caution

Use sufficient capacitance!

Pulse Width Modulation (PWM) drives require a capacitor on the high voltage supply to store energy during the PWM switching process. Insufficient power supply capacitance causes problems particularly with high inductance motors. During braking much of the stored mechanical energy is fed back into the power supply and charges its output capacitor to a higher voltage. If the charge reaches the drive's over-voltage shutdown point, output current and braking will cease. At that time energy stored in the motor inductance continues to flow through diodes in the drive to further charge the power supply capacitance. The voltage rise depends upon the power supply capacitance, motor speed, and inductance.

A 2μH motor at 20 amps can charge a 2000 μF capacitor an additional 30 VDC. An appropriate capacitance is typically 2000 μF/A maximum output current for a 50 VDC supply.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com


Caution

Make sure minimum inductance requirements are met!

Pulse Width modulation (PWM) servo drives deliver a pulsed output that requires a minimum amount of load inductance to ensure that the DC motor current is properly filtered. The minimum inductance values for different drive types are shown in the individual data sheet specifications. If the drive is operated below its maximum rated voltage, the minimum load inductance requirement may be reduced. Most servo-motors have enough winding inductance. Some types of motors (e.g. "basket-wound", "pancake", etc.) do not have a conventional iron core rotor, so the winding inductance is usually less than 50 µH.

If the motor inductance value is less than the minimum required for the selected drive, use an external filter card.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2 Products and System Requirements

This document is intended as a guide and general overview in selecting, installing, and operating an AZ servo drive. Contained within are instructions on system integration, wiring, drive-setup, and standard operating methods.

AZ Drive Family Overview

The family of AZ analog drives are designed to offer the same high performance and accuracy of larger drives, but in a space-saving PCB-mount architecture. By utilizing high density power devices, dual sided PCB boards, and creative design AZ drives are ideal for applications with limited size and weight constraints.

The AZ drive family contains drives that can power Single Phase (brushed) and Three Phase (brushless) motors. AZ drives are powered off a single unregulated DC power supply, and provide a variety of control and feedback options. The drives accept either a +/-10V analog signal or a PWM and Direction signal as input. A digital controller can be used to command and interact with AZ drives, and a number of input/output pins are available for parameter observation and drive configuration.

Drive Datasheet

Each AZ analog drive has a separate datasheet that contains important information on the modes and product-specific features available with that particular drive. The datasheet is to be used in conjunction with this manual for system design and installation.



Caution

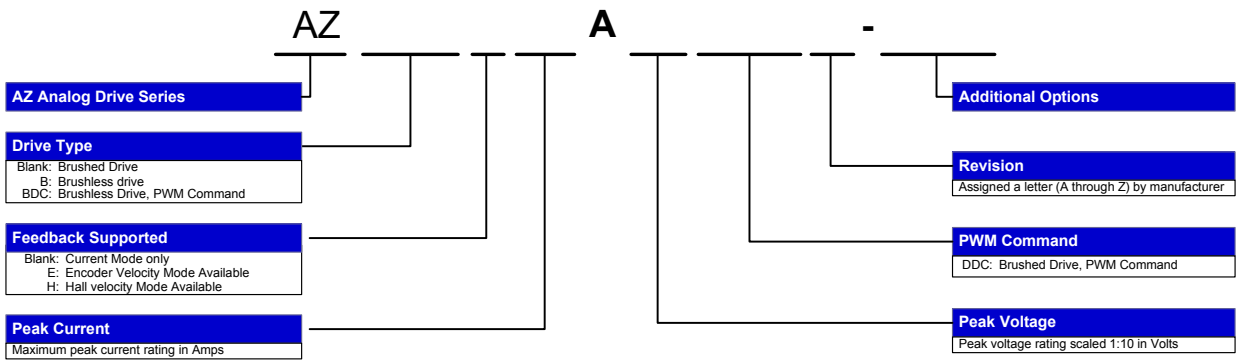
In order to avoid damage to equipment, only after a thorough reading and understanding of this manual and the specific datasheet of the AZ drive being used should you attempt to install and operate the drive.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Products Covered

The products covered in this manual adhere to the following part numbering structure. However, additional features and/or options are readily available for OEM's with sufficient ordering volume. Feel free to contact *ADVANCED* Motion Controls for further information.

FIGURE 2.1 AZ Part Numbering Structure



In general, the AZ family of analog drives can be divided into top-level categories based on the peak current rating of the drive. These categories can be further separated into subdivisions based on specifications such as whether a drive uses analog or PWM input, the type of motor(s) supported, and the feedback available on the drive.



Notice

The values and diagrams presented in this chapter are a general drive "overview". For more detailed information, consult the datasheet for a specific drive.

TABLE 2.1 Power Specifications

Power Specifications				
Description	**Units**	**AZxx6A8**	**AZxx12A8**	**AZxx20A8**
DC Supply Voltage Range	VDC	20-80		10-80
DC Bus Over Voltage Limit	VDC	88		
DC Bus Under Voltage Limit	VDC	18		9
Maximum Peak Output Current	A	6	12	20
Maximum Continuous Output Current	A	3	6	12
Maximum Power Dissipation at Continuous Current	W	12	24	48
Minimum Load Inductance	µH	100		
Switching Frequency	kHz	31		

TABLE 2.2 Control Specifications

Control Specifications						
Description	**AZ**	**AZB**	**AZ_DDC**	**AZBDC**	**AZBE**	**AZBH**
Command Sources	+/- 10V Analog	+/- 10V Analog	PWM and Direction	PWM and Direction	+/- 10V Analog	+/- 10V Analog
Commutation Methods	-	Trapezoidal	-	Trapezoidal	Trapezoidal	Trapezoidal
Control Modes	Current	Current	Current	Current	Current, Open Loop, Encoder Velocity, Tachometer Velocity	Current, Open Loop, Hall Velocity, Tachometer Velocity
Motors Supported	Single Phase	Three Phase Single Phase	Single Phase	Three Phase Single Phase	Three Phase Single Phase	Three Phase Single Phase

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Control Modes

The AZ family of analog drives offers a variety of different control methods. While some drives in the series are designed to operate solely in one mode, on other drives it is possible to select the control method by DIP switch settings. Consult the datasheet for the drive in use to see which modes are available for use.

The name of the mode refers to which servo loop is being closed in the drive, not the end-result of the application. For instance, a drive operating in Current (Torque) Mode may be used for a positioning application if the external controller is closing the position loop. Oftentimes, mode selection will be dependent on the requirements and capabilities of the controller being used with the drive as well as the end-result application.

Current (Torque)

In Current (Torque) Mode, the input command voltage controls the output current. The drive will adjust the output duty cycle to maintain the commanded output current. This mode is used to control torque for rotary motors (force for linear motors), but the motor speed is not controlled. The output current can be monitored through an analog current monitor output pin. The voltage value read at the "Current Monitor Output" can be multiplied by a scaling factor found on the drive datasheet to determine the actual output current. All AZ drives are able to operate in Current (Torque) Mode.


Note

While in Current (Torque) Mode, the drive will maintain a commanded torque output to the motor based on the input reference command. Sudden changes in the motor load may cause the drive to be outputting a high torque command with little load resistance, causing the motor to spin rapidly. Therefore, Current (Torque) Mode is recommended for applications using a digital position controller to maintain system stability.

Open Loop (PWM Duty Cycle)

In Open Loop (PWM Duty Cycle) Mode, the input command voltage controls the output PWM duty cycle of the drive, indirectly controlling the output voltage. However, any fluctuations of the DC power supply voltage will affect the voltage output to the motor. This mode is available as a DIP switch selectable mode on AZBExxA8 and AZBHxxA8 drives.


Note

This mode is recommended as a method of controlling the motor velocity when precise velocity control is not critical to the application, and when actual velocity feedback is unavailable.

Hall Velocity

In Hall Velocity Mode, the input command voltage controls the motor velocity, with the Hall Sensor frequency closing the velocity loop. An analog velocity monitor output allows observation of the actual motor speed through a Hz/V scaling factor found on the drive datasheet. The voltage value read at the velocity monitor output can be used to determine the

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

motor RPM through the scaling factor. See "Velocity Monitor Output" on page 33 for the motor RPM equation. This mode is available as a DIP switch selectable mode on AZBHxxA8 drives.

Note

Due to the inherent low resolution of motor mounted Hall Sensors, Hall Velocity Mode is not recommended for low-speed applications below 300 rpm for a 6-pole motor, 600 rpm for a 4-pole motor, or 900 rpm for a 2-pole motor. Hall Velocity Mode is better suited for velocity control applications where the motor will be spinning at higher speeds.

Encoder Velocity

In Encoder Velocity Mode, the input command controls the motor velocity, with the frequency of the encoder pulses closing the velocity loop. An analog velocity monitor output allows observation of the actual motor speed through a kHz/V scaling factor found on the drive datasheet. The voltage value read at the velocity monitor output can be used to determine the motor RPM through the scaling factor. See "Velocity Monitor Output" on page 33 for the motor RPM equation. This mode is available as a DIP switch selectable mode on AZBExxA8 drives.

Note

The high resolution of motor mounted encoders allows for excellent velocity control and smooth motion at all speeds. Encoder Velocity mode should be used for applications requiring precise and accurate velocity control, and is especially useful in applications where low-speed smoothness is the objective.

Tachometer Velocity

In Tachometer Velocity Mode, the input command voltage controls the motor velocity. This mode uses an external DC tachometer to close the velocity loop. The drive translates the DC voltage from the tachometer into motor speed and direction information. This mode is available as a DIP switch selectable mode on AZBExxA8 and AZBHxxA8 drives.

Note

DC Tachometers have infinite resolution, allowing for extremely accurate velocity control. However, they also may be susceptible to electrical noise, most notably at low speeds.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Feedback Supported

There are a number of different feedback options available in the AZ family of analog drives. The feedback element can be any device capable of generating a voltage signal proportional to current, velocity, position, or any parameter of interest. Such signals can be provided directly by a potentiometer or indirectly by other feedback devices such as Hall Sensors or Encoders. These latter devices must have their signals converted to a DC voltage, a task performed by the AZ drive circuitry.

TABLE 2.3 Feedback Supported

	Feedback Supported					
Description	**AZ**	**AZB**	**AZ_DDC**	**AZBDC**	**AZBE**	**AZBH**
Hall Sensors for Commutation		✔		✔	✔	✔
Hall Sensors for Velocity Control						✔
Single- Ended Incremental Encoder					✔	

Feedback Polarity

The feedback element must be connected for *negative* feedback. This will cause a difference between the command signal and the feedback signal, called the *error signal*. The drive compares the feedback signal to the command signal to produce the required output to the load by continually reducing the error signal to zero. For AZ drives, this becomes important when using "Encoder Feedback" and "Hall Sensors", as connecting these feedback elements for positive feedback will lead to a motor "run-away" condition. In a case where the feedback lines are connected to the drive with the wrong polarity in either Hall Velocity or Encoder Velocity Mode, the drive will attempt to correct the "error signal" by applying more command to the motor. With the wrong feedback polarity, this will result in a positive feedback run-away condition. To correct this, either change the order that the feedback lines are connected to the drive, or change Switch 4 on the DIP switch bank to the opposite setting to reverse the internal feedback velocity polarity. See the drive datasheet for more information on DIP switch settings.

Hall Sensors

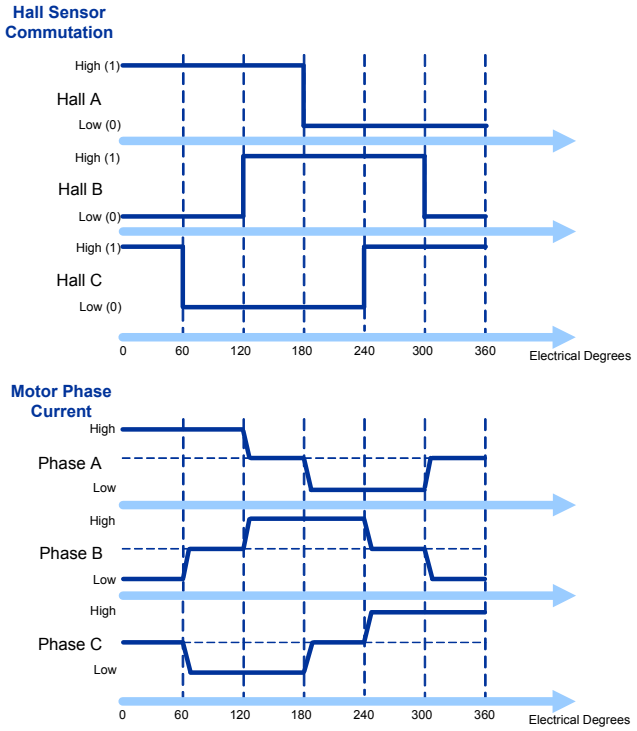
DC Three Phase (Brushless) AZ drives use single-ended Hall Sensors for commutation feedback, and in the special case of the AZBHxxA8 drives, for velocity control. The Hall Sensors (typically three) are built into the motor to detect the position of the rotor magnetic field. These sensors are mounted such that they each generate a square wave with 120-degree phase difference over one electrical cycle of the motor. Depending on the motor pole count, there may be more than one electrical cycle for every motor revolution. For every actual mechanical motor revolution, the number of electrical cycles will be the number of motor poles divided by 2. For example:

- a 6-pole motor contains 3 electrical cycles per motor revolution
- a 4-pole motor contains 2 electrical cycles per motor revolution
- a 2-pole motor contains 1 electrical cycle per motor revolution.

The drive powers two of the three motor phases with DC current during each specific Hall Sensor state:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

FIGURE 2.2 Hall Sensor Commutation and Motor Phase Current for 120-Degree Phasing



The table below shows the valid commutation states for both 120-degree and 60-degree phasing.

TABLE 2.4 Commutation Sequence Table

	60 Degree			120 Degree			Motor		
	Hall 1	Hall 2	Hall 3	Hall 1	Hall 2	Hall 3	Phase A	Phase B	Phase C
Valid	1	0	0	1	0	0	HIGH	-	LOW
	1	1	0	1	1	0	-	HIGH	LOW
	1	1	1	0	1	0	LOW	HIGH	-
	0	1	1	0	1	1	LOW	-	HIGH
	0	0	1	0	0	1	-	LOW	HIGH
	0	0	0	1	0	1	HIGH	LOW	-
Invalid	1	0	1	1	1	1	-	-	-
	0	1	0	0	0	0	-	-	-

By default, AZ drives are always set to 120-degree phasing. Three phase (Brushless) drives do however have a surface-mount jumper (JE2) on the drive PCB that can be removed to manually set the drive to 60-degree phasing.

Using a Single Phase Motor with a Three Phase Drive Three Phase (Brushless) drives are also compatible with Single Phase (Brushed) motors. However, because there are no Hall Sensors on a brushed motor, one of the following course of actions must be taken to properly commutate the drive:

- Remove the JE2 jumper to set the drive for 60-degree phasing. Leave all the Hall Sensor inputs on the drive open. These inputs are internally pulled high to +5V, creating a "1-1-1"

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

commutation state (see Table 2.4 above) which is a valid state in 60-degree phasing. Connect only two of the motor output wires, Motor A and Motor B.

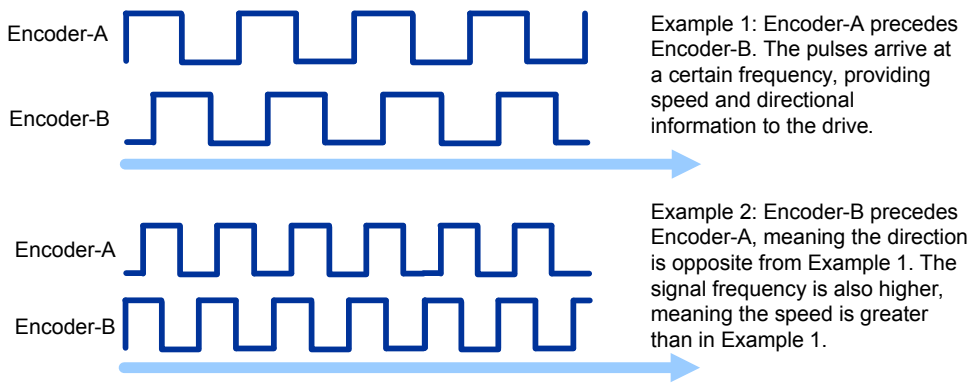
or:

- Tie one of the Hall Sensor inputs on the AZ drive to signal ground. Since the Hall Sensor inputs are by default internally brought high to +5V, this will put the AZ drive in a commutation state where two Hall inputs are high, and one is low (as shown in Table 2.4, having all three Hall inputs pulled high is an invalid commutation state in 120-degree phasing). Depending on which Hall Sensor input is tied to ground, consult Table 2.4 above to determine which two motor output wires will be conducting current for that specific commutation state.

Encoder Feedback

AZBExxA8 drives utilize two single-ended incremental encoder inputs for velocity control. The encoder provides incremental position feedback that can be extrapolated into very precise velocity information. The encoder signals are read as "pulses" that the AZ drive uses to essentially keep track of the motor's position and direction of rotation. Based on the speed and order in which these pulses are received from the two encoder signals, the drive can interpret the motor velocity. The diagram below represents encoder "pulse" signals, showing how dependent on which signal is read first and at what frequency the "pulses" arrive, the speed and direction of the motor shaft can be extrapolated.

FIGURE 2.3 Encoder Feedback Signals



Tachometer Feedback

AZBExxA8 and AZBHxxA8 drives offer the option of using a DC Tachometer for velocity control. The tachometer provides an analog DC voltage feedback signal that is related to the actual motor speed and direction. The drive subsequently adjusts the output current based on the error between the tachometer feedback and the input command voltage. The maximum range of the tachometer feedback signal is ±60 VDC.

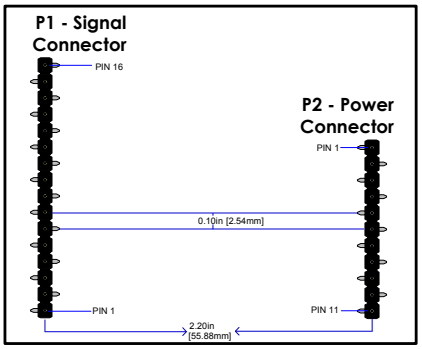
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Pin Layout

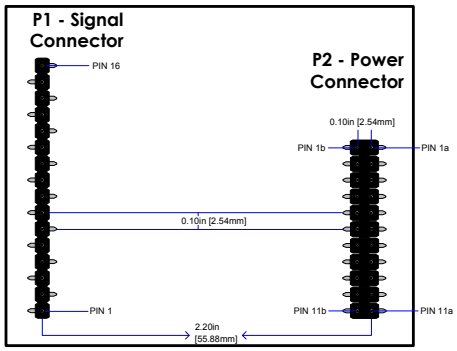
The diagrams below show the pin layout and location on AZ drives, as seen from the PCB where the drive is mounted. Note that AZ20 drives uses a double row for the power header. More detailed dimensional information can be found in "Physical Dimensions" on page 39 and in "Mating Connectors" on page 24.

FIGURE 2.4 AZ-series Pin Layouts

AZ6 and AZ12 Drives



AZ20 Drives



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Single Phase (Brushed, Voice Coil, Inductive Load) Drives

AZxxA8

- Designed to drive brush-type motors with a +/-10 V analog input.
- Current (Torque) Mode

AZxxA8DDC

- Designed to drive brush-type motors with a PWM input command.
- Current (Torque) Mode

Block Diagrams

FIGURE 2.5 AZxxA8 Drive Structure

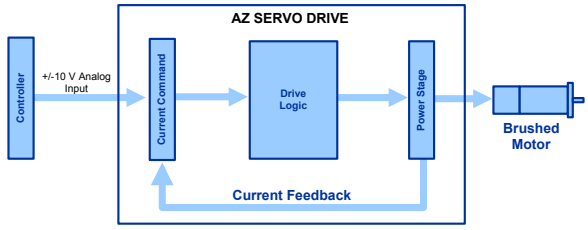
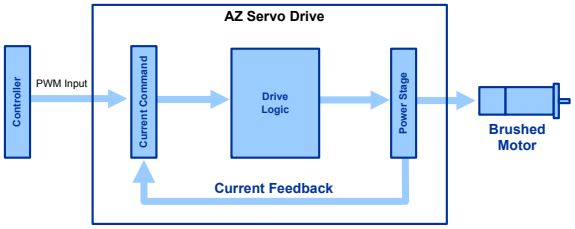


FIGURE 2.5.1 AZxxA8DDC Drive Structure



Pinouts

TABLE 2.5 Single Phase Signal Connector

Pin	AZ6/AZ12/AZ20 Analog Command Description	AZ6/AZ12/AZ20 PWM Command Description
1	+REF IN	PWM IN
2	SIGNAL GROUND	SIGNAL GROUND
3	–REF IN	DIR IN
4	CURRENT MONITOR	CURRENT MONITOR
5	INHIBIT IN	INHIBIT IN
6	RESERVED	RESERVED
7	SIGNAL GROUND	SIGNAL GROUND
8	RESERVED	RESERVED
9	RESERVED	RESERVED
10	RESERVED	RESERVED
11	CURRENT REF OUT	CURRENT REF OUT
12	FAULT OUT	FAULT OUT
13	RESERVED	RESERVED
14	RESERVED	RESERVED
15	RESERVED	RESERVED
16	RESERVED	RESERVED

TABLE 2.5.1 Single Phase Power Connector

AZ6 / AZ12 All Configurations		AZ20 All Configurations		
Pin	Description	Pin		Description
1	HIGH VOLTAGE	1b	1a	HIGH VOLTAGE
2		2b	2a	
3	NC (KEY)	3b	3a	RESERVED (3B)
				NC - KEY (3a)
4	POWER GROUND	4b	4a	POWER GROUND
5		5b	5a	
6	RESERVED	6b	6a	RESERVED
7		7b	7a	
8	MOTOR B	8a	8b	MOTOR B
9		9b	9a	
10	MOTOR A	10b	10a	MOTOR A
11		11b	11a	

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Three Phase (Brushless) Drives

AZBxxA8

- Designed to drive brushless motors with a +/-10 V analog input
- Current (Torque) Mode
- Hall Sensor trapezoidal Commutation

AZBDCxxA8

- Designed to drive brushless motors with a PWM input command
- Current (Torque) Mode
- Hall Sensor trapezoidal Commutation

AZBExxA8

- Designed to drive brushless motors with a +/-10 V analog input
- DIP Switch selectable modes - Current (Torque), Open Loop (PWM Duty Cycle), Encoder Velocity, Tachometer Velocity
- Hall Sensor trapezoidal commutation
- Single-ended incremental encoder feedback for velocity control
- External potentiometer input pin for command offset adjustment

AZBHxxA8

- Designed to drive brushless motors with a +/-10 V analog input
- DIP Switch selectable modes - Current (Torque), Open Loop (PWM Duty Cycle), Hall Velocity, Tachometer Velocity
- Hall Sensor trapezoidal commutation
- Single-ended Hall Sensor feedback for velocity control
- External potentiometer input pin for command offset adjustment

Block Diagrams

FIGURE 2.6 AZBxxA8 Drive Structure

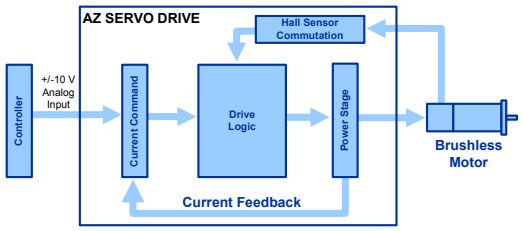


FIGURE 2.6.1 AZBDCxxA8 Drive Structure

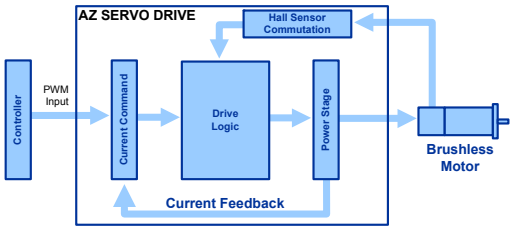


FIGURE 2.7 AZBExxA8 Drive Structure

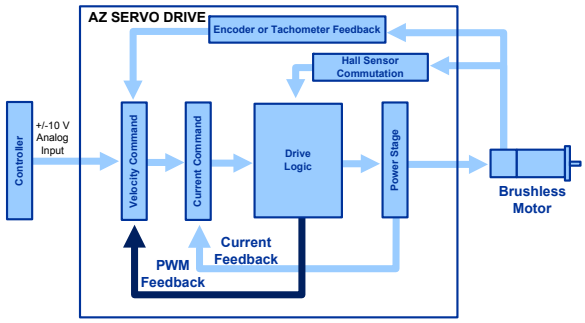
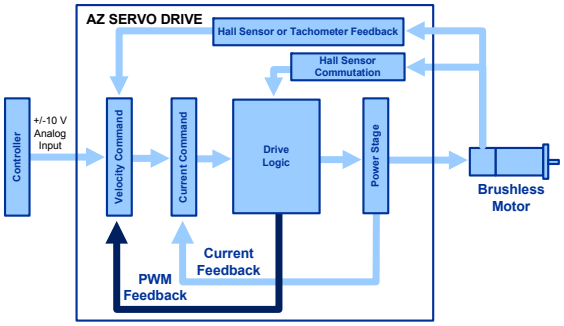


FIGURE 2.7.1 AZBHxxA8 Drive Structure



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Pinouts

TABLE 2.6 Three Phase Signal Connector

Pin	AZ6/AZ12/AZ20 Analog Input Description	AZ6/AZ12/AZ20 PWM Input Description	AZ6/AZ12/AZ20 Analog Input Encoder Vel. Description	AZ6/AZ12/AZ20 Analog Input Hall Vel. Description
1	+REF IN	PWM IN	+REF IN	+REF IN
2	SIGNAL GROUND	SIGNAL GROUND	SIGNAL GROUND	SIGNAL GROUND
3	-REF IN	DIR IN	-REF IN	-REF IN
4	CURRENT MONITOR	CURRENT MONITOR	CURRENT MONITOR	CURRENT MONITOR
5	INHIBIT IN	INHIBIT IN	INHIBIT IN	INHIBIT IN
6	+V HALL OUT	+V HALL OUT	+V HALL OUT	+V HALL OUT
7	SIGNAL GROUND	SIGNAL GROUND	SIGNAL GROUND	SIGNAL GROUND
8	HALL 1	HALL 1	HALL 1	HALL 1
9	HALL 2	HALL 2	HALL 2	HALL 2
10	HALL 3	HALL 3	HALL 3	HALL 3
11	CURRENT REF OUT	CURRENT REF OUT	CURRENT REF OUT	CURRENT REF OUT
12	FAULT OUT	FAULT OUT	FAULT OUT	FAULT OUT
13	RESERVED	RESERVED	ENCODER-B IN	RESERVED
14	RESERVED	RESERVED	ENCODER-A IN	RESERVED
15	RESERVED	RESERVED	VEL. MONITOR OUT/TACH IN	VEL. MONITOR OUT/TACH IN
16	RESERVED	RESERVED	OFFSET	OFFSET

TABLE 2.6.1 Three Phase Power Connector

AZ6 / AZ12 All Configurations Pin	AZ6 / AZ12 All Configurations Description	AZ20 All Configurations Pin		AZ20 All Configurations Description
1	HIGH VOLTAGE	1b	1a	HIGH VOLTAGE
2		2b	2a	
3	NC (KEY)	3b	3a	RESERVED (3b)
				NC - KEY (3a)
4	POWER GROUND	4b	4a	POWER GROUND
5		5b	5a	
6	MOTOR C	6b	6a	MOTOR C
7		7b	7a	
8	MOTOR B	8a	8b	MOTOR B
9		9b	9a	
10	MOTOR A	10b	10a	MOTOR A
11		11b	11a	

System Requirements

To successfully incorporate an AZ analog servo drive into your system, you must be sure it will operate properly based on electrical, mechanical, and environmental specifications, follow some simple wiring guidelines, and perhaps make use of some accessories in anticipating impacts on performance.

Specifications Check

Before selecting an AZ analog servo drive, a user should consider the requirements of their system. This involves calculating the required voltage, current, torque, and power requirements of the system, as well as considering the operating environment and any other equipment the drive will be interfacing with. Before attempting to install or operate an AZ servo drive, be sure all the following items are available:

- AZ Servo Drive
- AZ Servo Drive Datasheet (specific to your model)
- AZ Series Analog Hardware Installation Manual



Note

AZ servo drives are shipped with no other connectors or mounting components other than the signal and power header pins on the drive PCB itself. However, mounting cards and mating connectors are readily available. See "Mounting Card" on page 23 for the *ADVANCED* Motion Controls AZ mounting card. Customized mounting options are also available for orders with sufficient volume.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Motor Specifications

AZ analog servo drives have a given current and voltage rating unique to each drive. Based on the necessary application requirements and the information from the datasheet of the motor being used, an AZ drive may be selected that will best suit the motor capabilities. Some general guidelines that are useful when pairing an AZ servo drive with a motor:

- The **motor current I_M** is the required motor current in amps DC, and is related to the torque needed to move the load by the following equation:

$$I_M = \frac{Torque}{K_T}$$

Where:

K_T -motor torque constant

The motor current will need to be calculated for both continuous and peak operation. The peak torque will be during the acceleration portion of the move profile. The continuous torque is the average torque required by the system during the move profile, including dwell times.

- The system voltage requirement is based on the motor properties and how fast and hard the motor is driven. The system voltage requirement is equal to the **motor voltage**, **V_M**, required to achieve the move profile.

$$V_M = (K_E \cdot S_M) + (I_M \cdot R_M)$$

Where:

K_E -motor back EMF constant
S_M -motor speed (use the maximum speed expected for the application)
I_M -motor current (use the maximum current expected for the application)
R_M -motor line-to-line resistance

- The motor inductance is vital to the operation of AZ servo drives, as it ensures that the DC motor current is properly filtered.



A motor that does not meet the rated minimum inductance value of the AZ drive may damage the drive! If the motor inductance value is less than the minimum required for the selected drive, use of an external filter card is necessary.

A minimum motor inductance rating for each specific AZ drive can be found in the datasheet. If the drive is operated below the maximum rated voltage, the minimum load inductance requirement may be reduced.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Power Supply Specifications

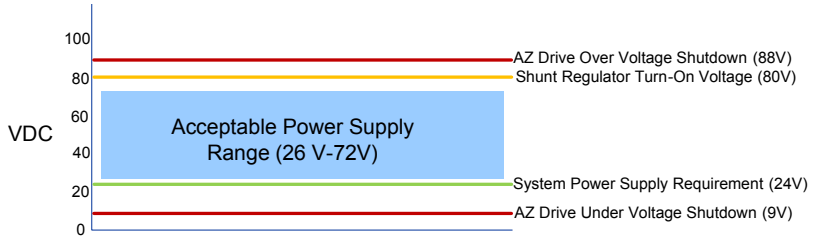
AZ servo drives operate off an isolated unregulated DC Power Supply. The AZ12 and AZ6 drives have a DC supply range of 20-80 VDC, while the AZ20 series has a range of 10-80 VDC. All AZ servo drives have an over-voltage shutdown of 88 VDC. To avoid nuisance over- or under-voltage errors caused by fluctuations in the power supply, the system power supply voltage should be at least 10% above the entire system voltage requirement, and at least 10% below the lowest value of the following:

- Drive over voltage
- External shunt regulator turn-on voltage

Use of a shunt regulator is necessary in systems where motor deceleration or a downward motion of the motor load will cause the system's mechanical energy to be regenerated via the drive back onto the power supply. This regenerated energy can charge the power supply capacitors to levels above that of the AZ drive over-voltage shutdown level. If the power supply capacitance is unable to handle this excess energy, or if it is impractical to supply enough capacitance, then an external shunt regulator must be used to dissipate the regenerated energy. The shunt regulator will "turn-on" at a certain voltage level (set below the drive over-voltage shutdown level) and discharge the regenerated electric energy in the form of heat.

The diagram below provides a possible example of an appropriate system power supply voltage for an AZ20 drive using an external shunt regulator.

FIGURE 2.8 AZ20 Power Supply Selection



The power supply current rating is based on the maximum current that will be required by the system. If the power supply powers more than one drive, then the current requirements for each drive should be added together. Due to the nature of servo drives, the current into the drive does not always equal the current out of the drive. However, the *power* in is equal to the *power* out. Use the following equation to calculate the **power supply output current**, $\mathbf{I_{PS}}$, based on the motor current requirements.

$$I_{PS} = \frac{V_M \cdot I_M}{V_{PS} \cdot (0.98)}$$

Where:

V_{PS} -nominal power supply voltage
I_M -motor current
V_M -motor voltage

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Use values of V and I at the point of maximum power in the move profile (when $V_M I_M$ = max). This will usually be at the end of a hard acceleration when both the torque and speed of the motor is high.

Environment

To ensure proper operation of an AZ servo drive, it is important to evaluate the operating environment prior to installing the drive.

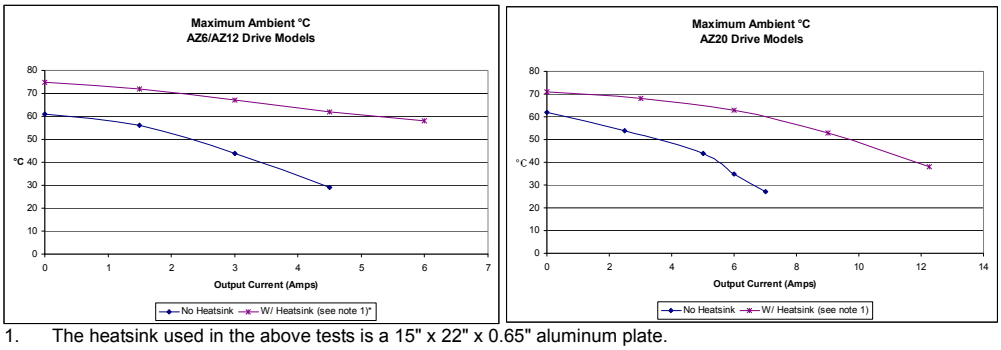
TABLE 2.7 Environmental Specifications

Environmental Specifications	
Parameter	**Description**
Ambient Temperature Range	See Figure 2.9
Baseplate Temperature Range	0 - 75 C
Humidity	90%, non-condensing
Mechanical Shock	15g, 11ms, Half-sine
Vibration	2 - 2000 Hz @ 2.5g
Altitude	0-3000m

Ambient Temperature Range and Thermal Data

AZ drives contain a built-in over-temperature disabling feature if the baseplate temperature rises above 75ºC. For a specific output current, the graphs below specify an upper limit to the ambient temperature range AZ drives can operate within while keeping the baseplate temperature below 75ºC. It is recommended to mount the baseplate of the AZ drive to a heatsink for best thermal management results. For mounting instructions and diagrams see "Mounting" on page 23.

FIGURE 2.9 AZ Ambient Temperature Ranges



1. The heatsink used in the above tests is a 15" x 22" x 0.65" aluminum plate.

Shock/Vibrations

While AZ drives are designed to withstand a high degree of mechanical shock and vibration, too much physical abuse can cause erratic behavior, or cause the drive to cease operation entirely. Be sure the drive is securely mounted in the system to reduce the shock and vibration the drive will be exposed to. The best way to secure the drive against mechanical vibration is to use screws to mount the AZ drive against its baseplate. For information on mounting options and procedures, see "Mounting" on page 23.



Caution

Care should be taken to ensure the drive is securely mounted in a location where no moving parts will come in contact with the drive.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3 Integration in the Servo System

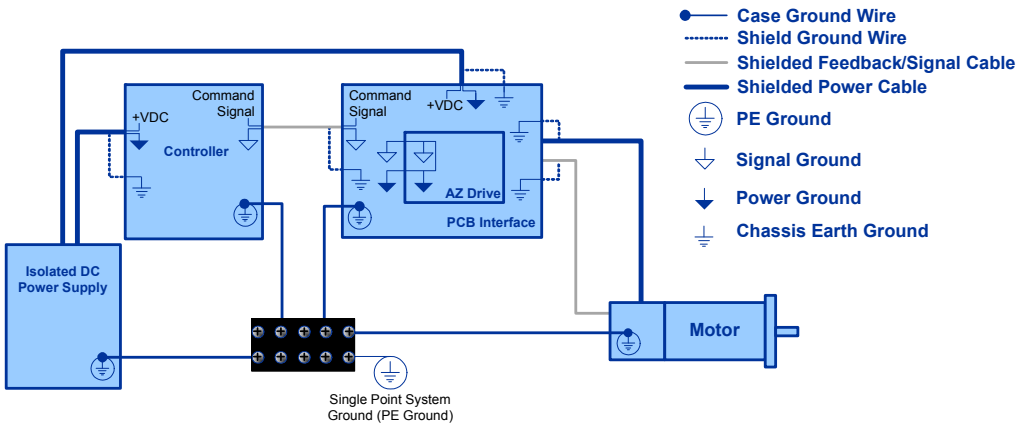
This chapter will give various details on incorporating an AZ servo drive into a system, such as how to design the PCB traces on an interface board, how to properly ground both the AZ drive along with the entire system, and how to properly connect motor wires, power supply wires, feedback wires, and inputs into the AZ drive.

Grounding

In most servo systems all the case grounds should be connected to a single Protective Earth (PE) ground point in a "star" configuration. Grounding the case grounds at a central PE ground point reduces the chance for ground loops and helps to minimize high frequency voltage differentials between components. All ground wires must be of a heavy gauge and be as short as possible. The following should be securely grounded at the central PE grounding point:

- Motor chassis
- Controller chassis
- Power supply chassis
- PCB Interface chassis

FIGURE 3.1 System Grounding



Ground cable shield wires at the mounting card or PCB interface side to a chassis earth ground point.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The DC power ground and the input reference command signal ground are oftentimes at a different potential than chassis/PE ground. The signal ground of the controller must be connected to the signal ground of the AZ drive to avoid picking up noise due to the "floating" differential servo drive input. On all AZ drives, the DC power ground and the input command signal ground are referenced to each other internally. In systems using an isolated DC power supply, signal ground and/or power ground can be referenced to chassis ground. First decide if this is both appropriate and safe. If this is the case, they can be grounded at the central grounding point.



Grounding is important for safety. The grounding recommendations in this manual may not be appropriate for all applications and system machinery. It is the responsibility of the system designer to follow applicable regulations and guidelines as they apply to the specific servo system.

Wiring

Servo system wiring typically involves wiring a controller (digital or analog), a servo drive, a power supply, and a motor. Wiring these servo system components is fairly easy when a few simple rules are observed.

As with any high efficiency PWM servo drive, the possibility of noise and interference coupling through the cabling and wires can be harmful to overall system performance. Noise in the form of interfering signals can be coupled:

- Capacitively (electrostatic coupling) onto signal wires in the circuit (the effect is more serious for high impedance points).
- Magnetically to closed loops in the signal circuit (independent of impedance levels).
- Electromagnetically to signal wires acting as small antennas for electromagnetic radiation.
- From one part of the circuit to other parts through voltage drops on ground lines.

Experience shows that the main source of noise is the high DV/DT (typically about 1V/nanosecond) of the drive's output power stage. This PWM output can couple back to the signal lines through the output and input wires. The best methods to reduce this effect are to move signal and motor leads apart, add shielding, and use differential inputs at the drive. For extreme cases, use of an inductive filter card is recommended.

Unfortunately, low-frequency magnetic fields are not significantly reduced by metal enclosures. Typical sources are 50 or 60 Hz power transformers and low frequency current changes in the motor leads. Avoid large loop areas in signal, power-supply, and motor wires. Twisted pairs of wires are quite effective in reducing magnetic pick-up because the enclosed area is small, and the signals induced in successive twist cancel.

Wire Gauge

As the wire diameter decreases, the impedance increases. Higher impedance wire will broadcast more noise than lower impedance wire. Therefore, when selecting the wire gauge for the motor power wires, power supply wires, and ground wires, it is better to err on the side

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

of being too thick rather than too thin. This recommendation becomes more critical as the cable length increases.

Motor Wires

The motor power wires supply power from the drive to the motor. Use of a twisted, shielded pair for the motor power cables is recommended to reduce the amount of noise coupling to sensitive components.

- For a brushed motor or voice coil, twist the two motor wires together as a group.
- For a brushless motor, twist all three motor wires together as a group.

Ground the motor power cable shield at one end only to the mounting card or PCB interface chassis ground. The motor power leads should be bundled and shielded in their own cable and kept separate from feedback signal wires.



DO NOT use wire shield to carry motor current or power!

Power Supply Wires

The PWM current spikes generated by the power output-stage are supplied by the internal power supply capacitors. In order to keep the current ripple on these capacitors to an acceptable level it is necessary to use heavy power supply leads and keep them as short as possible. Reduce the inductance of the power leads by twisting them. Ground the power supply cable shield at one end only to the mounting card or PCB interface chassis ground.

When multiple drives are installed in a single application, precaution regarding ground loops must be taken. Whenever there are two or more possible current paths to a ground connection, damage can occur or noise can be introduced in the system. The following rules apply to all multiple axis installations, regardless of the number of power supplies used:

1. Run separate power supply leads to each drive directly from the power supply filter capacitor.
2. Never "daisy-chain" any power or DC common connections. Use a "star"-connection instead.

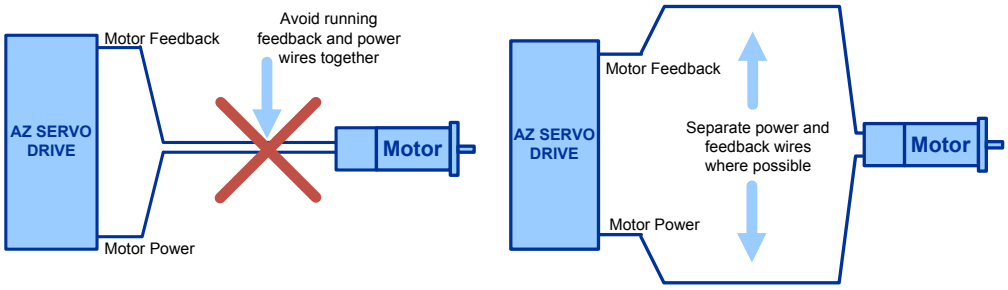
Feedback Wires

Use of a twisted, shielded pair for the feedback wires is recommended. Ground the shield at one end only to the mounting card or PCB interface chassis ground. Route cables and/or wires to minimize their length and exposure to noise sources. The motor power wires are a major source of noise, and the motor feedback wires are susceptible to receiving noise. This is why it is never a good idea to route the motor power wires with the motor feedback wires, even if they are shielded. Although both of these cables originate at the drive and terminate at the

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

motor, try to find separate paths that maintain distance between the two. A rule of thumb for the minimum distance between these wires is 10cm for every 10m of cable length.

FIGURE 3.2 Feedback Wiring



Input Reference Wires

Use of a twisted, shielded pair for the input reference wires is recommended. Connect the reference source "+" to "+REF IN", and the reference source "-" (or common) to "-REF IN". Connect the shield to the mounting card or PCB interface chassis ground. The servo drive's reference input circuit will attenuate the common mode voltage between signal source and drive power grounds.


Notice

In case of a single-ended reference signal, connect the command signal to "+ REF IN" and connect the command return and "- REF IN" to signal ground.

Long signal wires (10-15 feet and up) can also be a source of noise when driven from a typical OP-AMP output. Due to the inductance and capacitance of the wire the OP-AMP can oscillate. It is always recommended to set a fixed voltage at the controller and then check the signal at the drive with an oscilloscope to make sure that the signal is noise free.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Noise Suppression

While the above wiring and grounding practices should be sufficient to reduce noise and interference issues to a minimum, in some systems sizing or other constraints do not allow these guidelines to be put into use effectively. In these cases, the below items provide extra means of noise suppression.

AC Line Filter

It is possible for noise generated by the machine to "leak" onto the main AC power, and then get distributed to nearby equipment. If this equipment is sensitive, it may be adversely affected by the noise. AC line filters can filter this noise and keep it from getting on the AC power signal.

The AC power filter should be mounted flat against the enclosure of the system using the mounting lugs provided on the filter. Paint should be removed from the enclosure where the filter is fitted to ensure effective metal to metal contact. The filter should be mounted as close to the point where the AC power enters the enclosure as possible. Also, the AC power cable on the load end of the filter should be routed as far from the AC power cable on the supply end of the filter and all other cables and circuitry to minimize RF coupling.

Ferrite Suppression Cores

If PWM switching noise couples onto the encoder signals or onto the signal ground, then a ferrite suppression core can be used to attenuate the noise. Take the motor leads and wrap them around the suppression core as many times as reasonable possible, usually 2-5 times. Make sure to strip back the cable shield and only wrap the motor wires. There will be two wires for single phased (brushed) motors and 3 wires for three phase (brushless) motors. Wrap the motor wires together as a group around the suppression core and leave the motor case ground wire out of the loop. The suppression core should be located as near to the drive as possible.

Inductive Filter Cards

Inductive filter cards are added in series with the motor and are used to increase the load inductance in order to meet the minimum load inductance requirement of the drive. They also serve to counteract the effects of line capacitance found in long cable runs and in high voltage systems. These filter cards also have the added benefit of reducing the amount of PWM noise that couples onto the signal lines. This means they can be used in place of the suppression cores mentioned above.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Mounting

This section provides instructions and information on the different ways to mount an AZ servo drive to a PCB board.

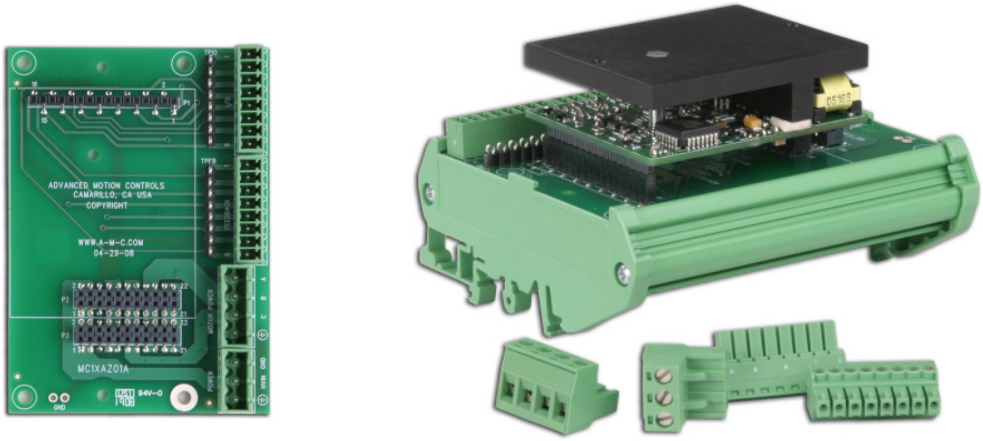
Mounting Card

AZ servo drives are designed to interface directly with the *ADVANCED* Motion Controls mounting card **MC1XAZ01**. Pinouts, dimensions, and ordering information for the mounting card are obtainable on the MC1XAZ01 datasheet, available for download at www.a-m-c.com. The MC1XAZ01 is designed for easy mounting and installation on a standard DIN-rail tray, available from Phoenix Contact (www.phoenixcontact.com, part number 2952020/UM72/10.16/GN6021). The MC1XAZ01 is shipped with the following included connectors:

TABLE 3.1 MC1XAZ01 Connectors

MC1XAZ01 Connectors		
Description	Qty. Included	Manufacturer and Part Number
3-position 5.08mm spaced plug terminal	1	Phoenix Contact: 1757022
4-position 5.08mm spaced plug terminal	1	Phoenix Contact: 1757035
8-position 3.5mm spaced plug terminal	2	Phoenix Contact: 1840421

FIGURE 3.3 **MC1XAZ01 and AZ20 Drive Mounted on MC1XAZ01 and Phoenix Contact DIN Tray (mating Connectors shown are included with MC1XAZ01, DIN tray shown for reference only, available from Phoenix Contact)**



In addition, users may design their own mounting card to mate with an AZ servo drive. For more information on designing an AZ compatible PCB interface card, see "PCB Design" on page 26.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

PCB Mounting Options

AZ servo drives can be directly integrated onto a PCB, either by mounting the board on socket connectors or by actually soldering the AZ drive to the board.

Mating Connectors

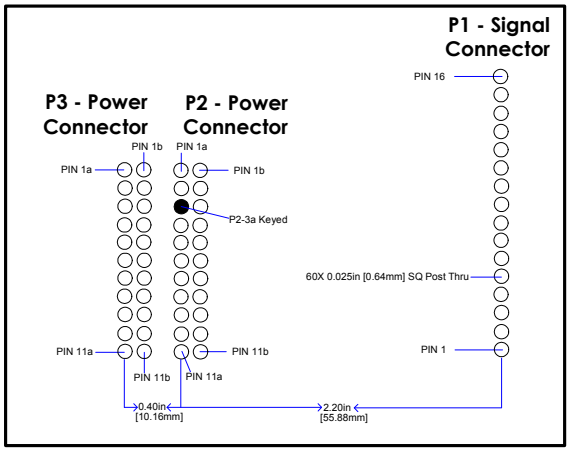
AZ drives use 0.64 mm square post male headers (2.54 mm pin spacing) for signal and power pins that are designed for fast and easy removal from PCB-mount socket connectors, making this option particularly useful when prototyping. The socket mating connectors compatible with AZ drives are shown in the table below. For detailed physical dimensions, see "Physical Dimensions" on page 39.

TABLE 3.2 AZ Drives Socket Mating Connectors

AZ Socket Mating Connectors		
Connector	**Pins**	**Manufacturer and Part Number**
Signal Connector - All AZ Drives	16	Samtec: BCS-116-L-S-PE
Power Connector - AZ6 and AZ12	11	Samtec: BCS-111-L-S-PE
Power Connector - AZ20	22	Samtec: SSM-111-L-DV

AZ drives are designed with a common pin layout throughout the entire drive family, providing the user with the option of designing only one mounting card or PCB interface that is compatible with every AZ drive. For an application that may have different versions with higher or lower power requirements, the same mounting card or PCB interface can be used for each application version with the appropriate AZ drive. The diagram below shows the PCB mounting footprint for the entire AZ family. For specific dimensions, see Figure A.3 on page 40.

FIGURE 3.4 AZ Drive PCB Footprint



AZ6 and AZ12 drive models connect to P1 and the "A" row of P2, while AZ20 drives connect to P1 and both rows of P2. Higher power AZ models planned for the future will connect to P1, P2, and P3.

Notice

The MC1XAZ01 contains a "keyed" socket connector on P2 to coincide with the "keyed" power header on AZ drives. It is recommended to include this feature on user designed mounting cards as well in order to avoid connecting the drive with the wrong orientation.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Soldering

Soldering an AZ board directly to a PCB provides added support against mechanical shocks and vibration. It is recommended to solder AZ drives to a PCB following the industry standard for Acceptability of Electronic Assemblies IPC-A-610D. Use solder with no-clean flux. AZ drives can be soldered by any of the following methods:

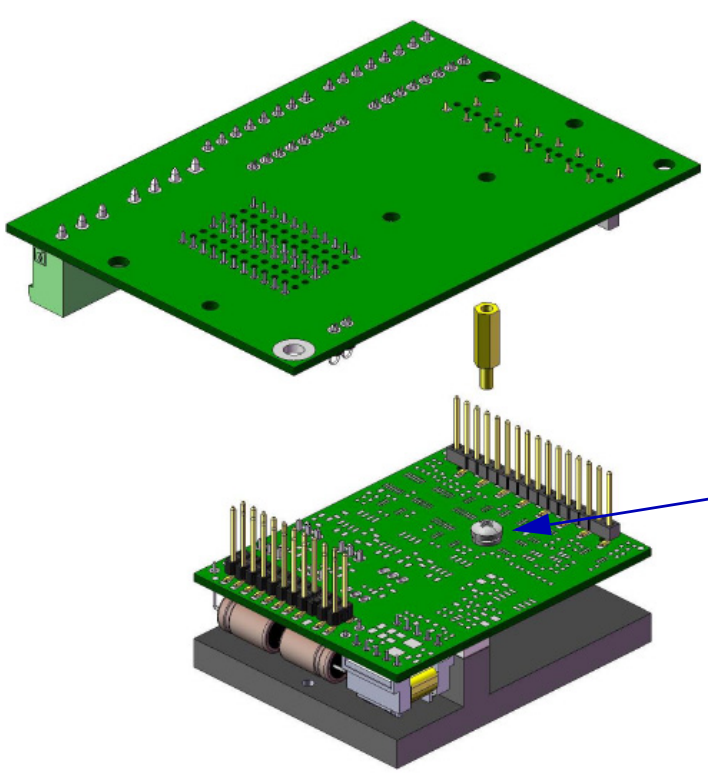
- wave soldering
- hand soldering
- selective wave soldering

To clean the PCB and drive after soldering, it is recommended to gently apply isopropyl alcohol or a cleaning agent with a soft-bristled brush. Use care not to apply downward pressure, but rather lightly brush the PCB and drive. Do not immerse the drive in a cleaning agent.

Screw Mounting

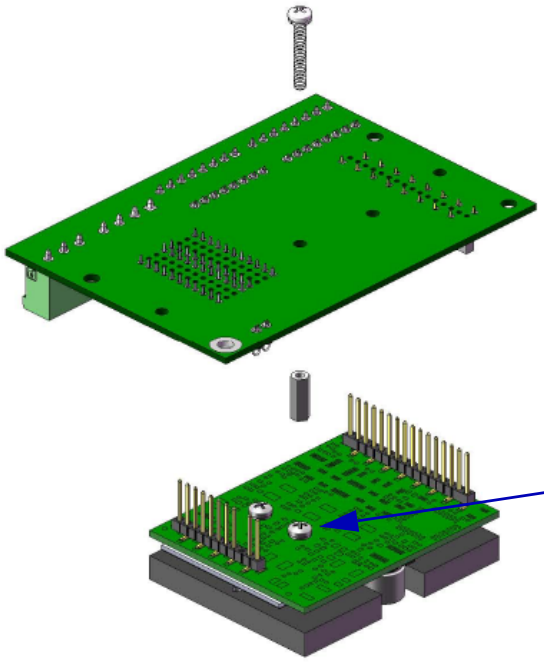
For added stability and support, AZ drives can be mounted with screws in tandem with one of the options above. Figure 3.5 shows how an AZ20 drive can be mounted to the MC1XAZ01 mounting card using a spacer. See "Physical Dimensions" on page 39 and/or the specific drive's datasheet for exact screw locations and dimensions.

FIGURE 3.5 AZ20 Screw Mount Diagram



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

FIGURE 3.6 AZ6/AZ12 Screw Mount Diagram



Remove drive mounting screw, and align spacer* over empty screw hole on drive PCB. Use a 4/40 thread, 1" screw to secure mounting card to drive from the bottom of the mounting card through the spacer after drive has been inserted in mounting card socket connectors.

Drive Mounting Screw

*Spacer not included with AZ drive or mounting card. Spacer shown is #4 clear, 7/16" length.

AZ drives can also be screw mounted through two 4/40 thread screw holes on either side of the AZ baseplate onto an external heatsink or other mounting plate for added stability and resiliency against mechanical vibration. Mounting to an external heatsink also provides better thermal management behavior than other mounting options. See "Ambient Temperature Range and Thermal Data" on page 17 for more info.

PCB Design

When designing a PCB board to interface with an AZ drive, there are some key features that must be kept in mind to ensure proper operation.

Trace Width and Routing

The proper design and implementation of the PCB traces on an interface card is essential in maximizing drive efficiency and noise reduction.

- **Keep high and low power signals separated -** Although AZ servo drives have an internal connection between power and signal ground, the traces emitting from the Power Connector, P2, carry high currents and voltages, while the traces emitting from the Signal Connector, P1, carry low currents voltages. Refrain from routing traces from P2 near traces from P1, and never route them in parallel. If power traces and signal traces need to cross, they should do so at right angles.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- **Keep high current traces short -** Traces carrying high current, such as the DC Power traces and Motor Signal traces, should be kept short and close together to minimize noise emissions. Also, keep DC Power traces separate from Motor Signal traces where possible.
- **Design for maximum values -** Adjacent traces can carry a voltage potential equal to the maximum DC power supply value, and carry current of both the AZ servo drive's peak and continuous current ratings. The trace width and copper plating thickness will need to take these maximum values into account. Also, be aware that AZ servo drive pin headers have a maximum current rating of 3 amps DC per pin. In order to achieve a higher overall peak current capability, some high current signals "share" a group of pins to spread the current between them. High current traces running to these pin groups should be inter-connected on the PCB board. Consult the drive's datasheet or the "Pinouts" section in "Products Covered" on page 5 for these pin groupings.

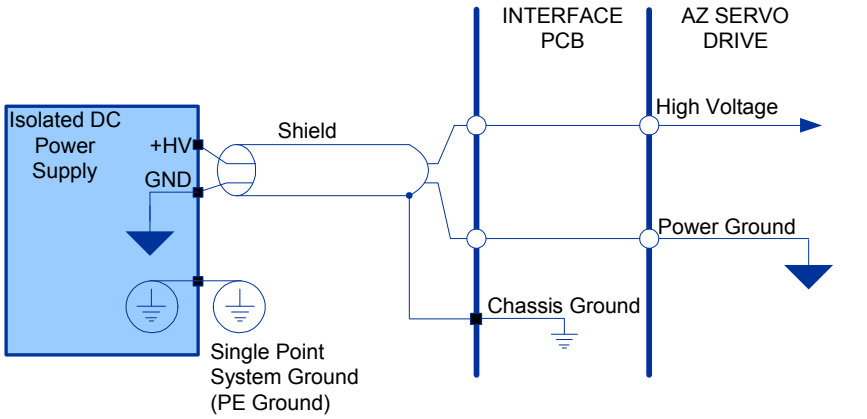
Interface Circuitry Examples

The following sections show examples of how an interface board could be designed to work with an AZ servo drive, and also contain general connection rules and instructions.

DC Power Input

The diagram below shows how an AZ servo drive connects to an isolated DC Power Supply through a mounting card/interface PCB. Notice that the power supply wires are shielded, and that the power supply case is grounded at the single point system ground (PE Ground). The cable shield should be grounded at the mounting card or PCB interface side to chassis ground.

FIGURE 3.7 DC Power Input Wiring



Notice

Depending on the power capacity of the AZ drive model being used there may be multiple pins for DC Input Power connections. Refer to the datasheet of the specific model being used. The maximum current capacity per pin is 3A continuous.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Motor Power Output The diagram below shows how an AZ servo drive connects to a motor through a mounting card/interface PCB. Both brush-type and brushless motors should follow this general setup. Notice that the motor wires are shielded, and that the motor housing is grounded to the single point system ground (PE Ground). The cable shield should be grounded at the mounting card or PCB interface side to chassis ground.

FIGURE 3.8 Three Phase Motor Power Output Wiring

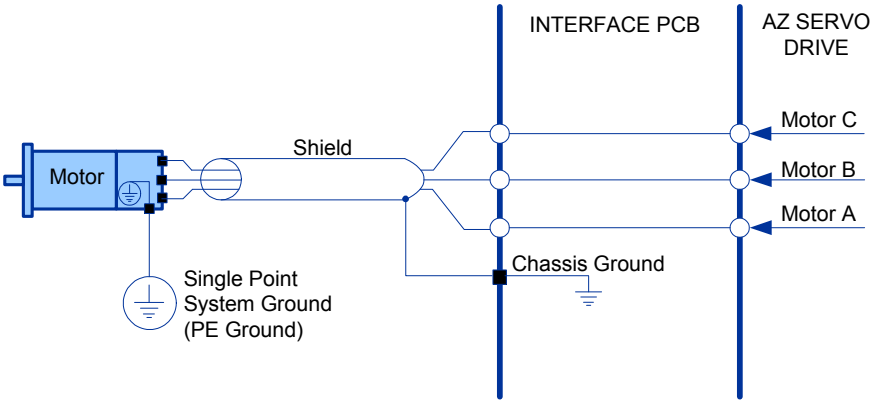
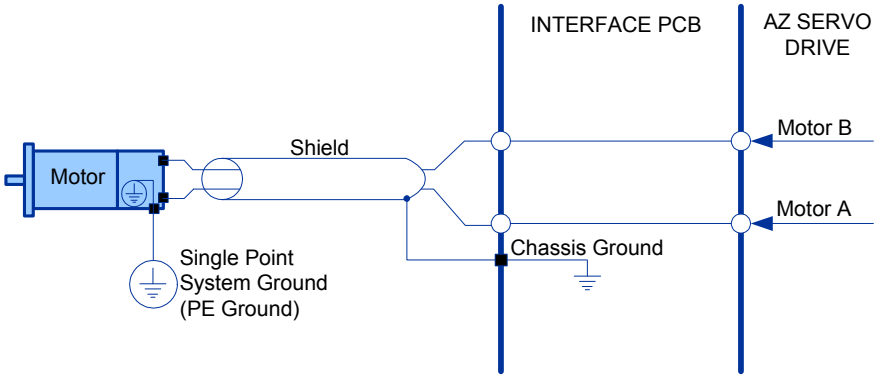


FIGURE 3.9 Single Phase Motor Power Output Wiring




Notice

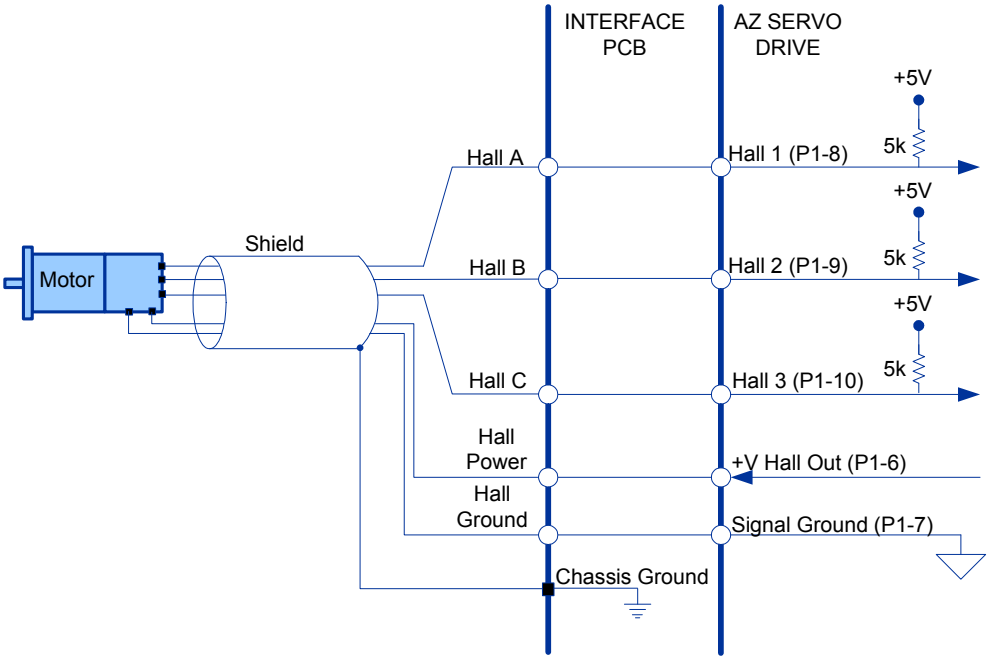
Depending on the power capacity of the AZ drive model being used there may be multiple pins for Motor Power connections. Refer to the datasheet of the specific model being used. The maximum current capacity per pin is 3A continuous.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Hall Sensor Inputs

Brushless AZ drives allow single-ended Hall Sensor inputs both for commutation, and in the special case of AZBHxxA8 drives, for velocity feedback. AZ drives provide a +6V low power supply to power the Hall Sensors. Below is the recommended circuitry when designing a mounting card to interface with an AZ drive.

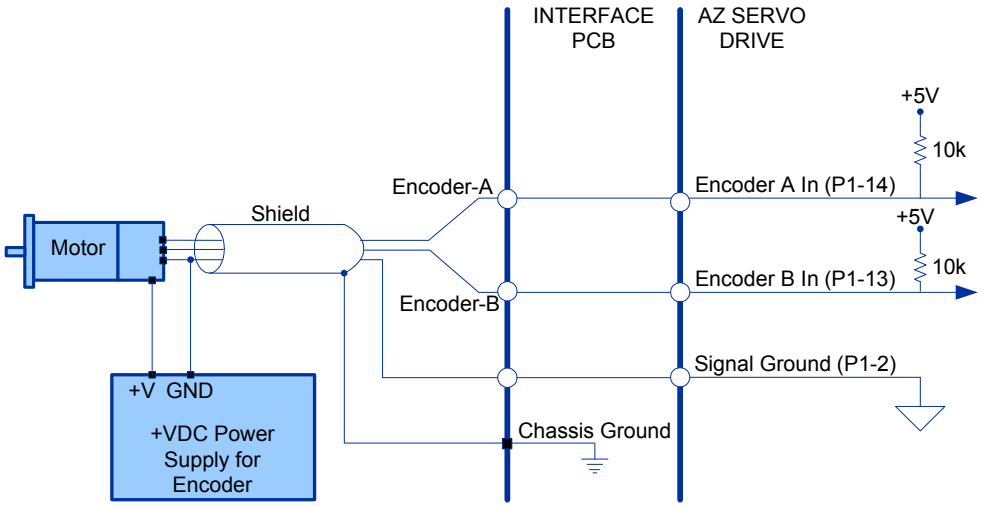
FIGURE 3.10 Hall Sensor Interface Wiring



Encoder Inputs

AZBExxA8 drives support single-ended incremental encoder inputs. The encoder must be powered by an external power supply. Check the motor and encoder specifications for the encoder voltage and current requirements. Below is the recommended circuitry when designing a mounting card to interface with an AZ drive.

FIGURE 3.11 Encoder Input Interface Wiring

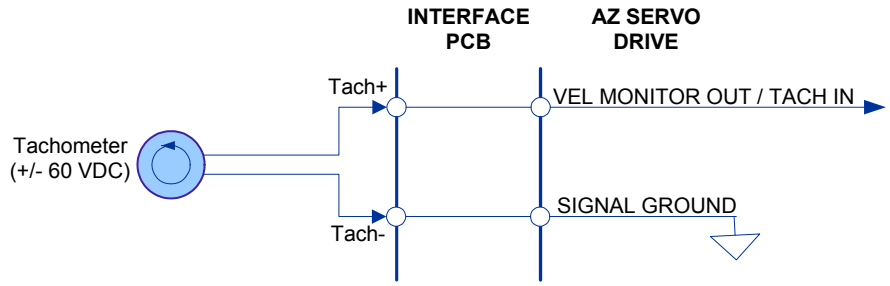


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Tachometer Input

For drive models that allow an external DC Tachometer for velocity control, the tachometer is connected between the Velocity Monitor Output / Tachometer Input pin (P1-15) and signal ground (either P1-7 or P1-2). The tachometer is limited to a feedback voltage range of ±60 VDC. The diagram below shows the recommended connection method.

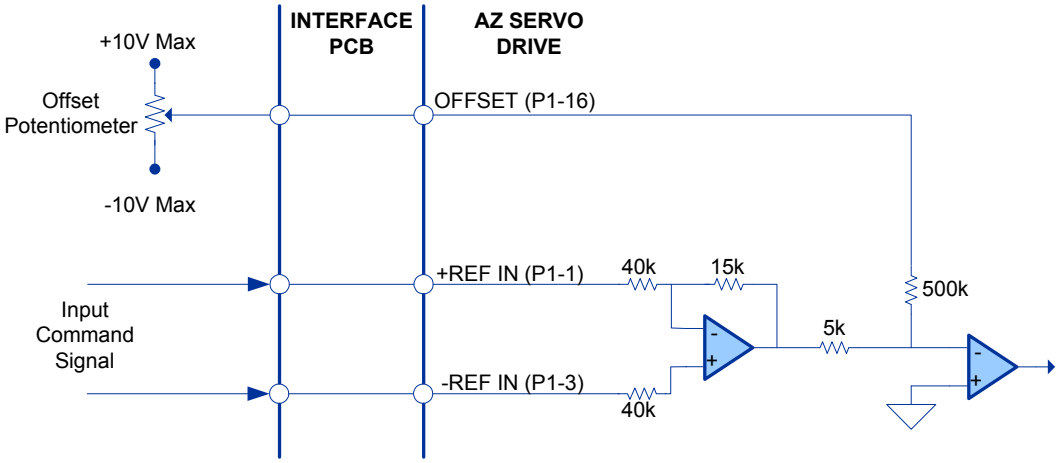
FIGURE 3.12 DC Tachometer Input Wiring



Offset Input

For drive models that have an external offset input option, a potentiometer can be used in addition to the input command signal when an input offset adjustment is desired. The diagram below shows one possible connection method using a potentiometer for the offset input.

FIGURE 3.13 Offset Input Wiring



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4 Operation

This chapter will present a brief introduction on how to test and operate an AZ servo drive. Read through this entire section before attempting to test the drive or make any connections.

Getting Started

To begin operation with your AZ drive, be sure to read and understand the previous chapters in this manual as well as the drive datasheet. Be sure that all system specifications and requirements have been met, and become familiar with the capabilities and functions of the AZ drive. Also, be aware of the "Troubleshooting" section at the end of this manual for solutions to basic operation issues.

Input/Output Pin Functions

The family of AZ drives provide a number of various input and output pins for parameter observation and drive configuration options. Consult the drive datasheet to see which input/output pin functions are available for each drive.

Current Monitor Output The current monitor pin is available on all AZ drive models. Measured relative to signal ground, it provides an analog voltage output signal that is proportional to the actual current output. The scaling factor for each individual drive can be found on the drive datasheet.

Example Measurement

The current monitor pin on an AZ drive with a current monitor scaling factor of 4 A/V is measured to be 1.3V. This would mean the drive is outputting: (4 A/V)(1.3V) = **5.2A**.

Current Reference Output The current reference pin is available on all AZ drive models. Measured relative to signal ground, it provides an analog voltage output signal that is proportional to the command signal to the internal current loop. When the drive output

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

reaches the maximum peak current value, the current reference pin will read 7.45V. The command to the internal current loop can be solved for by the following equation:

$$I_{\text{command}} = V_{\text{current ref}} \cdot \frac{I_{\text{peak}}}{7.45\,V}$$

Where:

$I_{command}$ -command current to the internal current loop
$V_{current\ ref}$ -measured voltage at current reference pin
I_{peak} -peak current value of AZ drive

Example Measurement

The current reference pin on an AZ drive with a peak current value of 12A is measured to be 2.63V. Following the above equation to solve for $I_{command}$, the command current to the internal current loop would be **4.24A**.

Fault Output The fault output is available on all AZ drive models. This pin provides a +5V TTL output that will become high when the drive is subject to one of the following fault conditions: inhibit, invalid Hall State, output short circuit, over voltage, over temperature, or power-up reset. This pin will remain low when the drive is enabled.

AZ drives automatically self-reset once one of the above-mentioned fault conditions are removed. For instance if the DC power supply rises above the over-voltage shutdown level of an AZ drive, the Fault Output will go high, and the drive will be disabled. Once the DC power supply level is returned to a value below the drive over-voltage shutdown level, the Fault Output will become low, and the drive will automatically become enabled.

Inhibit Input The inhibit input pin is available on all AZ drive models. This pin provides a +5V TTL input that allows a user to enable/disable the drive by either connecting this pin to ground or by applying a +5VDC voltage level to this pin, referenced to signal ground. By default, all AZ drives will be enabled if this pin is high, and disabled if this pin is low. This logic can be reversed, however, by removing the jumper JE1 from the drive PCB.

Low Power Supply Output for Hall Sensors The low power Hall Sensor supply is available on three phase (brushless) AZ drives only. This pin provides a +6 VDC, 30 mA output that can be used to power Hall Sensors (consult the motor datasheet to find out which feedback wire is the Hall Sensor power supply wire).



Notice

Do not use this +6V supply to power an encoder. An encoder will require a separate external power supply. Consult the encoder datasheet or specifications to determine the encoder voltage and current requirements. Typical values are +5VDC at 150mA.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Velocity Monitor Output

The velocity monitor output pin is available on AZBE and AZBH drive models only. This pin provides an analog voltage output that is proportional to the actual motor speed.

- For AZBE drives in Encoder Velocity Mode, substitute the voltage value read at the velocity monitor pin, $V_{monitor}$, into the below equation to determine the motor RPM:

$$\text{Motor Velocity [RPM]} = \frac{V_{\text{monitor}} \cdot 22\frac{kHz}{V} \cdot 60}{\text{Number of encoder lines}}$$

- For AZBH drives in Hall Velocity Mode, substitute the voltage value read at the velocity monitor pin, $V_{monitor}$, into the below equation to determine the motor RPM:

$$\text{Motor Velocity [RPM]} = \frac{V_{\text{monitor}} \cdot 100\frac{Hz}{V} \cdot 120}{\text{Number of motor poles}}$$

Tachometer Input

For AZBE and AZBH drive models, when the drive is set to Tachometer Velocity mode by DIP-switch setting, the Velocity Monitor Output pin is used as a DC Tachometer Input. The drive *must* be in Tachometer Velocity Mode in order to properly use the tachometer input. The maximum input allowed at the tachometer input pin is ±60 VDC.



Notice

When using a DC Tachometer in Tachometer Velocity mode, the velocity monitor output function is inactive.

Initial Setup

Carefully follow the grounding and wiring instructions in the previous chapters to make sure your system is safely and properly set up. For initial testing purposes, it is not necessary to use a controller to provide a command input, or to have any load attached to the motor. The items required will be:

- AZ Servo Drive attached to Mounting Card or PCB Interface
- Motor
- DC Power Supply for supplying power to system
- Digital Multimeter (or ohmmeter and voltmeter)

Current (Torque) Mode Test

Initially, the AZ drive should be placed in Current (Torque) Mode. By default, all AZ drives are shipped already set for Current (Torque) Mode. However, AZBE and AZBH drives have the option of using DIP switches to configure the drive for other modes. If using an AZBE or AZBH drive model, check the DIP switch configuration to be certain the drive is in Current (Torque) Mode. Mode configuration tables can be found on the drive datasheet.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Connections Test

Before applying power to the drive, connect the AZ drive to the mounting card or PCB interface, using any of the mounting options from "Mounting" on page 23. Using an ohmmeter or digital multimeter, test the connections between the mounting card or PCB interface headers and the AZ drive pins. Check for any shorts or open circuits. At this point, also check the ground connection of the whole system (AZ drive, mounting card, Motor). All these elements should have their case or chassis connected to a central grounding point in a "star" configuration. For review, see "Grounding" on page 18.

Power Supply

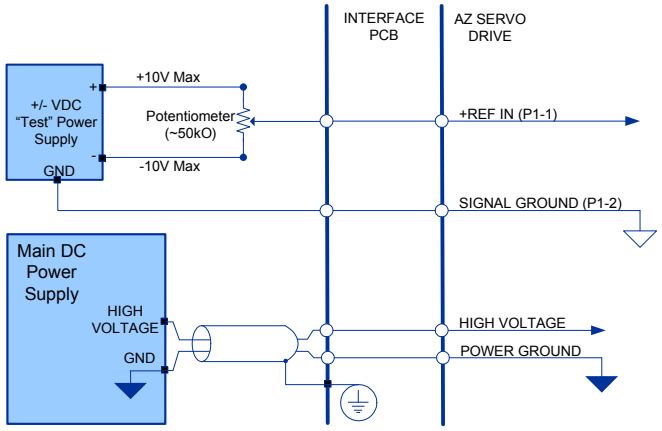
1. Before wiring the DC power supply to the mounting card and AZ drive, use a voltmeter or digital multimeter to make sure the DC voltage level is within specifications.
2. Do not turn on the DC power supply yet. Connect the DC power supply wires to the mounting card or PCB interface. Do not connect directly to the AZ drive header pins. Be sure the high voltage and ground connections do not get reversed, as this will damage the drive.
3. Turn on the DC power supply. Monitor the DC voltage on the mounting card test points or PCB interface to be sure the voltage level is within specifications. Once certain that power is being properly applied to the AZ drive, turn the DC power supply off.

Input Command Wiring

Follow the instructions below to properly wire the input command of the AZ drive, but do not apply any power or input signal yet.

- For drives that use +/-10 V analog input, one method of testing the functionality of the AZ drive within the system is by using an external reference potentiometer (approximately 50 kΩ) as an input command signal. By applying a positive DC voltage (10V max) to one end of the potentiometer, and a negative DC voltage (10V max) to the other end of the potentiometer, a +/- analog signal can be sent through the potentiometer's wiper into the +REF input pin, P1-1, on the mounting card or PCB interface (see drive datasheet or "Pinouts" on page 12 for pin labels). The voltages applied to the external reference potentiometer should come from a "test" power supply that is different than the main DC power. This separate +/-VDC "test" power supply should be referenced to the AZ drive signal ground.

FIGURE 4.1 **Reference Input Potentiometer**



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

  - Without connecting the potentiometer wiper to the mounting card or PCB interface, apply the "test" +/-VDC to the two sides of the potentiometer.
  - Measure the wiper of the potentiometer with a voltmeter or digital multimeter, and verify that by turning the potentiometer in both directions, the full range of +/-VDC is observable on the potentiometer wiper. This voltage will serve as a "test" command.
  - Once the full range of +/-VDC has been verified, turn the potentiometer so that approximately 0 VDC is observed on the potentiometer wiper, then turn off the "test" power supply.
  - With no voltage command applied to the potentiometer, connect the wiper to the +REF IN input pin on the mounting card or PCB interface. Connect the "test" power supply ground or common to the AZ drive signal ground on the mounting card or PCB interface.
- For drives that use PWM and Direction input, a Function Generator should be set up to generate a simple +5V square wave at a frequency of 10-25 kHz. Connect the Function Generator signal to the PWM input pin on the AZ drive, P1-1 (see drive datasheet or "Pinouts" on page 12 for pin labels) and the common to the signal ground pin on the AZ drive, P1-2.

Hall Sensors

1. (Three Phase Drives Only) With the DC power supply still turned off, connect the Hall Sensors to the Hall input pins on the mounting card or PCB interface. Also, connect the +V HALL OUT +6V supply from the AZ drive to the Hall Power line (consult the motor datasheet to see which wires from the motor are the Hall Input lines and Hall Power line).
2. Turn on the DC power supply to the system.
3. Use a digital multimeter or voltmeter, to monitor the Fault Output pin (see "Fault Output" on page 32 for more information).
4. Manually rotate the motor shaft by hand a few revolutions. If all the Hall Sensors are functioning properly, the Fault Output signal should stay low. If the Fault Output signal goes high, this could indicate either a short or bad connection in the Hall Sensor wires, or an invalid commutation state. See "Hall Sensors" on page 8 for information on Hall commutation.
5. Once verified, turn off the DC power supply.

Motor

With the DC power supply still turned off, connect the motor wires to the appropriate motor output pins on the mounting card or PCB interface.

- For three phase (brushless) motors, there will be three wires to connect. For now, connect the wires in any order to the motor output pins on the mounting card or PCB interface. These may need to be changed later in order to properly commutate the motor.
- For single phase (brushed) motors, there will be two wires to connect. Connect them in any order to the motor output pins on the mounting card or PCB interface. If using a three phase (brushless) drive with a single phase (brushed) motor, there are special considerations that must be taken into account for this configuration to work. See "Using a Single Phase Motor with a Three Phase Drive" on page 9 for more information.

Applying a Command (Analog Input)

At this stage, everything that is needed to test operation should be connected to the AZ drive through the mounting card or PCB interface, all

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

the elements should be properly grounded in a central point location, and no power or input command should be applied to any element in the system.

Once certain that all these steps have been safely and properly followed, turn on the main DC power supply. Use a voltmeter or digital multimeter to once again check the DC power supply level.

Analog Input Drives

1. Turn on the "test" power supply connected to the external potentiometer.
2. Slowly turn the potentiometer in one direction while observing the motor shaft.



Only make very slight adjustments to the reference potentiometer to avoid causing damage to the motor. Since the drive is in Current (Torque) Mode and there is no load on the motor shaft, even a small potentiometer adjustment can create high speeds at the motor shaft. Exercise caution when adjusting the potentiometer.

- For single phase motors, this should cause the motor shaft to energize in one direction. Slowly turning the potentiometer further in that same direction, and also in the opposite direction should cause the motor shaft to move smoothly in response to the input.
- For three phase motors, the three motor wires may have to be changed in order to properly commutate the motor. There are six different ways that the three motor wires can be attached to the mounting card or PCB interface. All six will have to be tested in order to find the right commutation.



Before removing the motor wires, turn off both the main DC power supply and the "test" power supply. Never remove or make any connections to the drive while power is applied!

The proper combination of motor wires will yield smooth motion and identical speeds in both directions. Improper combinations will cause jerky motion, slow movement in one direction, and/or audible noise. Once the proper combination has been found, turning the potentiometer slowly in both directions should cause the motor shaft to rotate appropriately in response to the input.

PWM Input Drives

1. Turn on the function generator to apply the PWM signal to the PWM IN pin.
2. Monitor the Function Generator PWM signal on an oscilloscope. Be sure to keep the PWM frequency within the 10-25 kHz range. By varying the duty cycle of the PWM input signal, the motor shaft should rotate in response to the input.

- For single phase motors, this should cause the motor shaft to energize in one direction. Slowly varying the PWM duty cycle should cause the motor shaft to move smoothly in response to the input.
- For three phase motors, the three motor wires may have to be changed in order to properly commutate the motor. There are six different ways that the three motor wires

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

can be attached to the mounting card or PCB interface. All six will have to be tested in order to find the right commutation.



Before removing the motor wires, turn off both the main DC power supply and the Function Generator. Never remove or make any connections to the drive while power is applied!

The proper combination of motor wires will yield smooth motion and identical speeds in both directions. Improper combinations will cause jerky motion, slow movement in one direction, and/or audible noise. Once the proper combination has been found, varying the duty cycle should cause the motor shaft to rotate appropriately in response to the input.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Specifications

Specifications Tables

TABLE A.1 Power Specifications

Description	Units	AZ6	AZ12	AZ20
DC Supply Voltage Range	VDC	20-80		10-80
DC Bus Over Voltage Limit	VDC	88		
DC Bus Under Voltage Limit	VDC	18		9
Maximum Peak Output Current	A	6	12	20
Maximum Continuous Output Current	A	3	6	12
Maximum Power Dissipation at Continuous Current	W	12	24	48
Minimum Load Inductance	µH	100		
Switching Frequency	kHz	31		

TABLE A.2 Control Specifications

Description	AZ	AZB	AZ_DDC	AZBDC	AZBE	AZBH
Command Sources	+/- 10V Analog	+/- 10V Analog	PWM and Direction	PWM and Direction	+/- 10V Analog	+/- 10V Analog
Commutation Methods	-	Trapezoidal	-	Trapezoidal	Trapezoidal	Trapezoidal
Control Modes	Current	Current	Current	Current	Current, Open Loop, Encoder Velocity, Tachometer Velocity	Current, Open Loop, Hall Velocity, Tachometer Velocity
Motors Supported	Single Phase	Three Phase Single Phase	Single Phase	Three Phase Single Phase	Three Phase Single Phase	Three Phase Single Phase

TABLE A.3 Feedback Supported

Description	AZ	AZB	AZ_DDC	AZBDC	AZBE	AZBH
Hall Sensors for Commutation		✔		✔	✔	✔
Hall Sensors for Velocity Control						✔
Single-Ended Incremental Encoder					✔	
Tachometer (±60 VDC Max)					✔	✔

TABLE A.4 Hardware Protection

Description	AZ Single Phase Drives (Brushed)	AZ Three Phase Drives (Brushless)
Over Current	✔	✔
Over Temperature	✔	✔
Over Voltage	✔	✔
Under Voltage	✔	✔
Short Circuit (Phase-Phase)	✔	✔
Short Circuit (Phase-Ground)	✔	✔
Invalid Hall Commutation		✔

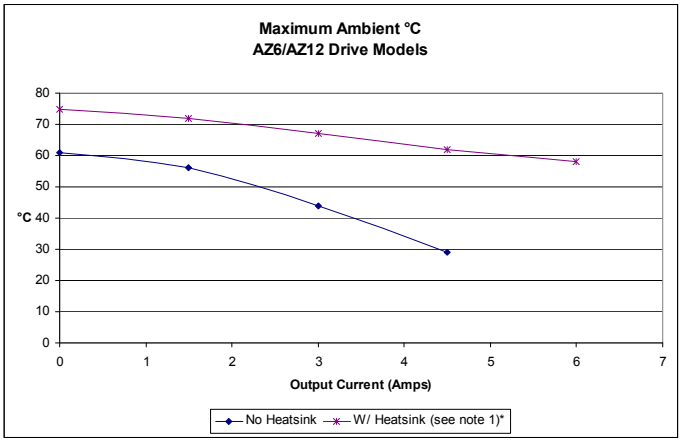
1. See "Fault Conditions and Symptoms" on page 41 for more information on hardware protection.

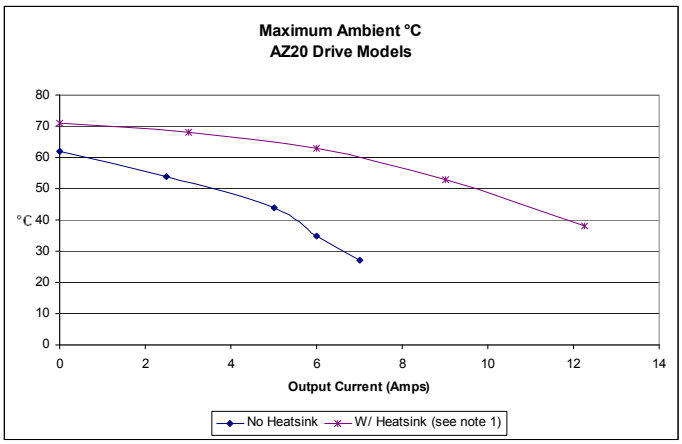
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

TABLE A.5 Environmental Specifications

Parameter	Description
Ambient Temperature Range	See Figure A.1
Baseplate Temperature Range	0 - 75 C
Humidity	90%, non-condensing
Mechanical Shock	15g, 11ms, Half-sine
Vibration	2 - 2000 Hz @ 2.5g
Altitude	0-3000m

FIGURE A.1 AZ Ambient Temperature Ranges





1. The heatsink used in the above tests is a 15" x 22" x 0.65" aluminum plate.

TABLE A.6 Physical Dimensions

Description	Units	AZ6/AZ12	AZ20
Height	mm (in)	27.51 (1.08)	33.53 (1.32)
Length	mm (in)	63.50 (2.50)	63.50 (2.50)
Depth	mm (in)	50.80 (2.00)	50.80 (2.0)
Weight	kg (oz)	84.9 (3.0)	94.5 (3.3)
Baseplate Thickness	mm (in)	6.35 (0.25)	5.79 (0.228)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

FIGURE A.2 AZ12 and AZ6 Mounting Diagrams (dimensions in inches and [mm])

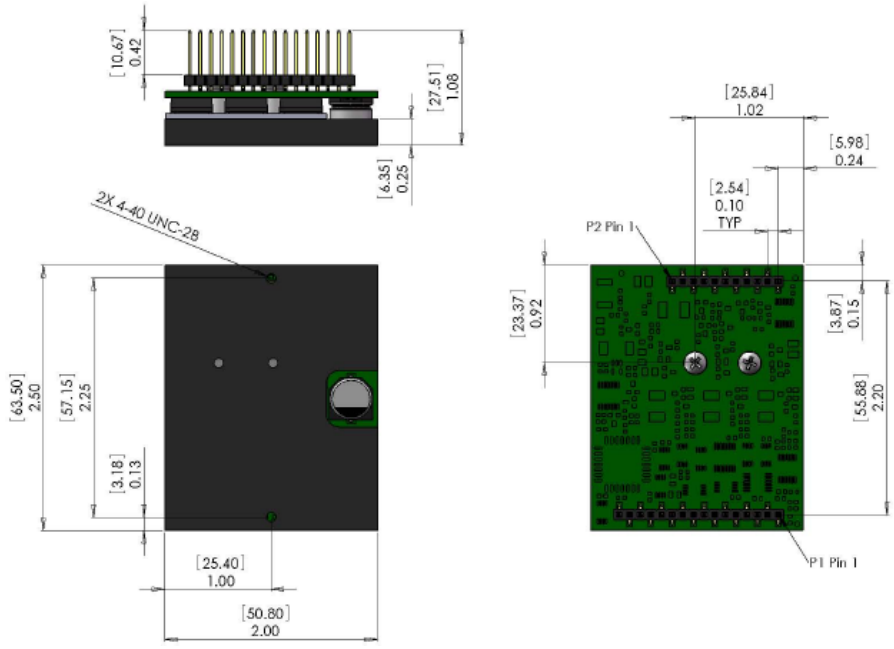
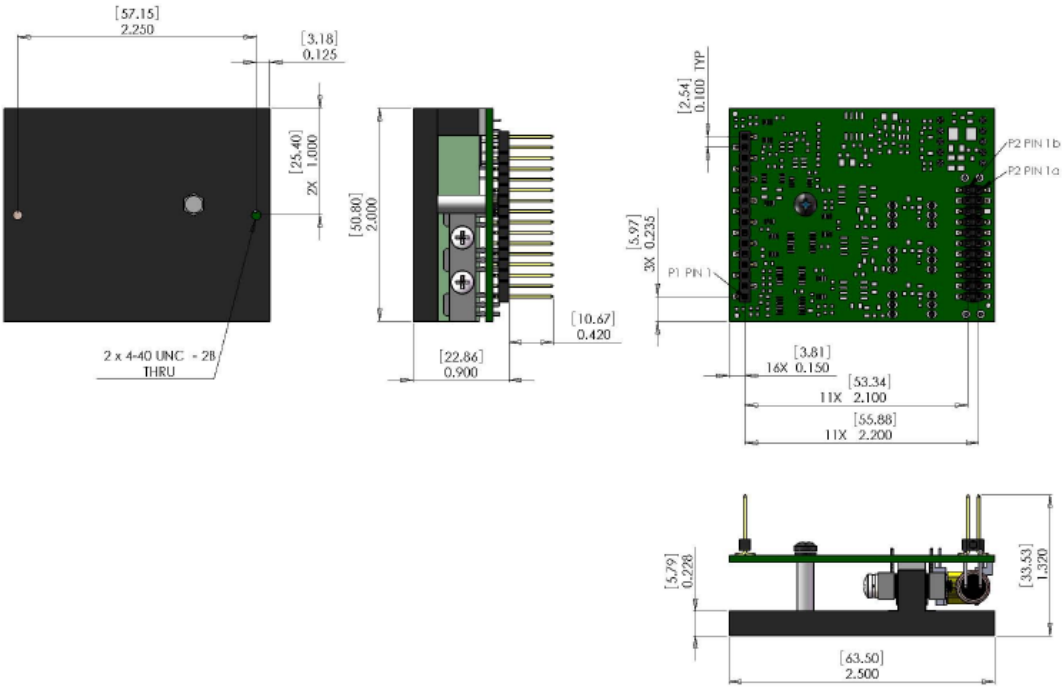


FIGURE A.3 AZ20 Mounting Diagrams (dimensions in inches and [mm])



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

B Troubleshooting

This section discusses how to ensure optimum performance and, if necessary, get assistance from the factory.

Fault Conditions and Symptoms

An inoperative drive can indicate any of the following fault conditions:

- over-temperature
- over-voltage
- under-voltage
- short-circuits
- invalid commutation
- inhibit input
- power-on reset

All of the above fault conditions are self-reset by the drive. Once the fault condition is removed the drive will become operative again without cycling power.

To determine whether the drive is in a fault state, measure the "Fault Output" pin with a digital multimeter or voltmeter. A high at this pin will indicate that the drive is subject to one of the above fault conditions, and the drive will be disabled until the drive is no longer in a fault state. To remove the fault condition, follow the instructions in the sections below describing each possible fault state.

Over-Temperature

Verify that the baseplate temperature is less than 75ºC (167º F). The drive remains disabled until the temperature at the drive baseplate falls below this threshold.

Over-Voltage Shutdown

1. Check the DC power supply voltage for a value above the drive over-voltage shutdown limit. If the DC bus voltage is above this limit, check the AC power line connected to the DC power supply for proper value.
2. Check the regenerative energy absorbed during deceleration. This is done by monitoring the DC bus voltage with a voltmeter or oscilloscope. If the DC bus voltage increases above the drive over-voltage shutdown limit during deceleration or regeneration, a shunt regulator may be necessary. See "Power Supply Specifications" on page 16 for more information.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Under-Voltage Shutdown

Verify power supply voltages for minimum conditions per specifications. Also note that the drive will pull the power supply voltage down if the power supply cannot provide the required current for the drive. This could occur when high current is demanded and the power supply is pulled below the minimum operating voltage required by the drive.

Short Circuit Fault

1. Check each motor lead for shorts with respect to motor housing and power ground. If the motor is shorted it will not rotate freely when no power is applied while it is uncoupled from the load.
2. Disconnect the motor leads to see if the drive will enable without the motor connected.
3. Measure motor armature resistance between motor leads with the drive disconnected.

Invalid Hall Sensor State (Brushless Drives only)

See the "Commutation Sequence" table in "Hall Sensors" on page 8 for valid commutation states. If the drive is disabled check the following:

1. Make sure that the 60 or 120 degree phasing jumper (JE2) is in the correct setting per motor data sheets. When driving a single phase (brushed type) motor with a three phase (brushless) drive use the 60-degree phase setting (see "Using a Single Phase Motor with a Three Phase Drive" on page 9 for more information on this particular configuration).
2. Check the voltage levels for all the Hall sensor inputs.
3. Make sure all Hall Sensor lines are connected properly.

Inhibit Input

Check inhibit input for correct polarity (that is, pull-to-ground to inhibit or pull-to-ground to enable). Inhibit configuration depends on JE1 on the PCB. Also, keep in mind that noise on the inhibit line could be a cause for a false inhibit signal being given to the drive.

Power-On Reset

All drives have a power-on reset function to ensure that all circuitry on the board is functional prior to enabling the drive. The board will only be disabled momentarily, and will quickly enable upon power up.

Overload

Verify that the minimum inductance requirement is met. If the inductance is too low it could appear like a short circuit to the drive and thus it might cause the short circuit fault to trip. Excessive heating of the drive and motor is also characteristic of the minimum inductance requirement not being met. See drive data sheets for minimum inductance requirements.

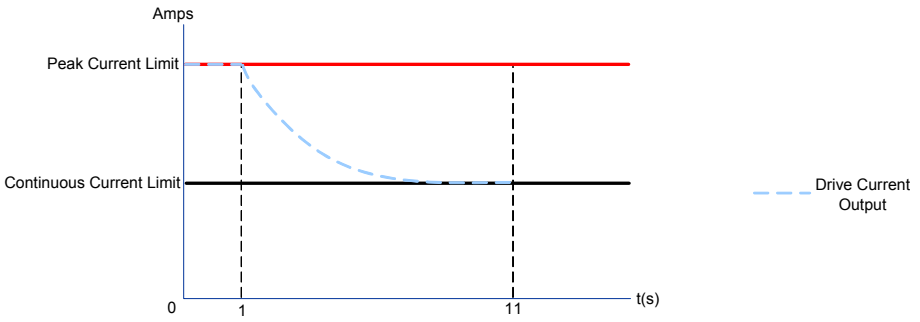
Over-Current

All drives incorporate a "fold-back" circuit for protection against over-current. This "fold-back" circuit uses an approximate "I^2t" algorithm to protect the drive. All drives can run at peak current for a maximum of 1 second (each direction). Currents below this peak current but above the continuous current can be sustained during a time period of approximately (peak current/current) 2 seconds. If such a current is commanded for a longer time period, the drive will automatically fold back at an approximate rate of "I^2t" to the continuous current limit,

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

within a time frame of less than 10 seconds. An over-current condition will not cause the drive to become disabled.

FIGURE B.1 Peak Current Fold-Back





Sustained maximum current demand, when switching between positive and negative maximum current without allowing sufficient time for fold-back, will result in drive damage. Drive RMS current should be below the continuous current setting!

Motor Problems

A motor run-away condition is when the motor spins rapidly with no control from the command input. The most likely cause of this error comes from having the feedback element connected for positive feedback. This can be solved by changing the order that the feedback element lines are connected to the drive, or for AZBH and AZBE drives, changing Switch 4 on the DIP switch bank to the opposite setting. See the drive datasheet for more information on DIP switch settings.

Another common motor issue is when the motor spins faster in one direction than in the other. This is typically caused by improper commutation, usually because the motor power wires are connected in the wrong order. Try all six combinations of connecting the motor power wires to the drive to find the correct commutation order. The proper combination of motor wires will yield smooth motion and identical speeds in both directions. Improper combinations will cause jerky motion, slow movement in one direction, and/or audible noise. As a final verification that the commutation is correct, use the Velocity Monitor Output pin to measure motor speed in both directions (see "Velocity Monitor Output" on page 33 for more information). This can also be caused by invalid Hall Commutation. Check to see if the drive is set for 120- or 60-degree phasing, and whether this setting corresponds to the type of motor being used (typically 120-degree for three phase motors, and 60-degree for single phase motors). See "Hall Sensors" on page 8 for more information.

Causes of Erratic Operation

- Improper grounding (for example, drive signal ground is not connected to source signal ground).
- Noisy command signal. Check for system ground loops.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Mechanical backlash, dead-band, slippage, etc.
- Noisy inhibit input line.
- Excessive voltage spikes on bus.

Technical Support

For help from the manufacturer regarding drive set-up or operating problems, please gather the following information

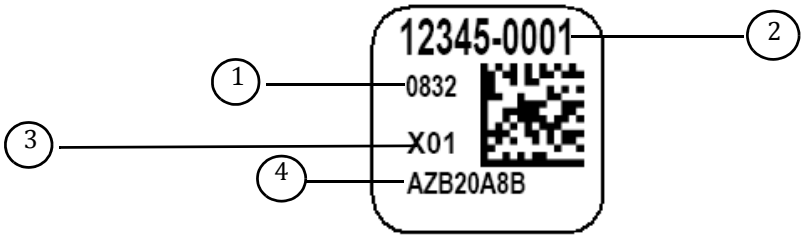
Drive Model Information

- DC bus voltage and range.
- Motor type, including inductance, torque constant, and winding resistance.
- Position of all DIP-switches.
- Length and make-up of all wiring and cables.
- If brushless, include Hall sensor information.
- Type of controller, plus full description of feed back devices.
- Description of problem: instability, run-away, noise, over/under shoot, or other description.
- Complete part number and serial number of the product. Original purchase order is helpful, but not necessary.

Product Label Description

The following is a typical example of a product label as it is found on the drive:

FIGURE B.2 AZ Product Label



1. EIA Date Code: The date code is a 4-digit number signifying the year and week that the drive was manufactured. The first two digits designate the year and the second two digits designate the week. For example, the above part would have been built during the thirty-second week of 2008.
2. Serial number: The serial number is a 5-digit number followed by a 4-digit number.
3. Version number: Three digit code that refers to product version. Different versions reflect minor component value changes.
4. Part number: Refer to the drive data sheets for typical part numbers. The last letter refers to the revision (in the above example B). The part number can be proceeded by an X,

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

which signifies a prototype unit. The part number can also have a suffix (e.g. AZB20A8B-AM1), which designates a special version of the standard drive (AZB20A8B is the standard drive, -AM1 designates the special version).

Warranty Returns and Factory Help

Seller warrants that all items will be delivered free from defects in material and workmanship and in conformance with contractual requirements. The Seller makes no other warranties, express or implied and specifically NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

The Seller's exclusive liability for breach of warranty shall be limited to repairing or replacing at the Seller's option items returned to Seller's plant at Buyer's expense within one year of the date of delivery. The Seller's liability on any claim of any kind, including negligence, for loss or damage arising out of, connected with or resulting from this order, or from the performance or breach thereof or from the manufacture, sale, delivery, resale, repair or use of any item or services covered by or furnished under this order shall in no case exceed the price allocable to the item or service or part thereof which gives rise to the claim and in the event Seller fails to manufacture or deliver items other than standard products that appear in Seller's catalog. Seller's exclusive liability and Buyer's exclusive remedy shall be release of the Buyer from the obligation to pay the purchase price. IN NO EVENT SHALL THE SELLER BE LIABLE FOR SPECIAL OR CONSEQUENTIAL DAMAGES.

Buyer will take all appropriate measures to advise users and operators of the products delivered hereunder of all potential dangers to persons or property, which may be occasioned by such use. Buyer will indemnify and hold Seller harmless from all claims of any kind for injuries to persons and property arising from use of the products delivered hereunder. Buyer will, at its sole cost, carry liability insurance adequate to protect Buyer and Seller against such claims.

All returns (warranty or non-warranty) require that you first obtain a Return Material Authorization (RMA) number from the factory.

Request an RMA number by:

telephone	(805) 389-1935
fax	(805) 389-1165
e-mail	amcsupport@a-m-c.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com



Reminders

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Index

A

AC Line Filter 22
Agency Compliances ii
Altitude 17
Ambient Temperature Range .. 17, 39
Attention Symbols iii
AZ12 16
  Dimensions 40
  Pin Layout 11
AZ20 16
  Dimensions 40
  Pin Layout 11
AZ6 16
  Dimensions 40
  Pin Layout 11
AZBDCxxA8 13
  Block Diagram 13
  Pinout 14
AZBExxA8 13
  Block Diagram 13
  Pinout 14
AZBHxxA8 ..... 8, 13
  Block Diagram 13
  Pinout 14
AZBxxA8 13
  Block Diagram 13
  Pinout 14
AZxxA8 12
  Block Diagram 12
  Pinout 12
AZxxA8DDC 12
  Block Diagram 12
  Pinout 12

B

Baseplate Temperature Range 17
Brushed Drives 12
Brushless Drives 13–14

C

Central Point Grounding 18
Command Sources 5, 38
Commutation Methods 5, 38
Commutation Phasing 9
Commutation Sequence Table 9
Company Website ii
Control Modes 5, 6–7, 38
  Current(Torque) 6
  Encoder Velocity 7
  Hall Velocity 6
  Open Loop 6
  Tachometer Velocity 7
Control Specifications 5, 38
Current (Torque) 6
Current (Torque) Mode Test ... 33–37
CURRENT MONITOR 12, 14
Current Monitor Output 31
CURRENT REF OUT 12, 14
Current Reference Output 31

D

Date Code 44
DC Bus Over Voltage Limit 5, 38
DC Bus Under Voltage Limit 5, 38
DC Power Input 27
DC Supply Range 16
DC Supply Voltage Range 5, 38
Differential Inputs 19
DIP Switch Settings 8
DIR IN 12, 14
Drive Datasheet 4, 14
Dwell Time 15

E

EIA Date Code 44
Encoder 8
Encoder Feedback 10
Encoder Inputs 29
Encoder Velocity Mode 7
Environment 17
  Shock/Vibration 17
Environmental Specifications 39
Error Signal 8
External Filter Card 15, 19

F

Fault Conditions 41–43
  Inhibit Input 42
  Invalid Hall Commutation 42
  Over-Temperature 41
  Over-Voltage Shutdown 41
  Power-on Reset 42
  Short Circuit Fault 42
  Under-Voltage Shutdown 42
FAULT OUT 12, 14
Fault Output 32
Feedback Polarity 8
Feedback Supported 7–10, 38
  Encoder 10
  Hall Sensors 8
  Tachometer 10
Feedback Wires 20
Ferrite Suppression Cores 22
Fold-back 42

G

Ground Loops 18, 20
Grounding 18–19
  Controller Chassis 18
  Drive Case 18
  Motor Chassis 18
  PCB Interface Chassis 18
  Power Supply Chassis 18
  Shielding 18

H

Hall Sensor Inputs 29
Hall Sensor Power Supply 32
Hall Sensors 8, 35, 38
Hall Velocity Mode 6
Hand Soldering 25
Hardware Protection 38
HIGH VOLTAGE 12, 14
Humidity 17

I

Impedance 19
Inductive Filter Cards 22
Inductive Load Drives 12
INHIBIT IN 12, 14
Inhibit Input 32, 41, 42
Input Reference Wires 21
Input/Output Pin Functions 31–33
  Current Monitor 31
  Current Reference 31
  Fault 32
  Hall Power 32
  Inhibit 32
  Tachometer 33
  Velocity Monitor 33
Interface Circuitry Examples 27
Interference Coupling 19
  Capacitive 19

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Electromagnetic 19
Magnetic 19
Voltage Drops 19
Invalid Commutation 41
Invalid Hall Commutation 38, 42

L

Lock-out/tag-out Procedures 1

M

Mating Connectors 24
Maximum Continuous Output Current 5, 38
Maximum Peak Output Current 5, 38
Maximum Power Dissipation at Continuous Current 5, 38
MC1XAZ01 23
Mechanical Shock 17
Minimum Load Inductance 5, 38
Model Information 44
Model Mask 5
Motor 35
Motor "Run-Away" 8
Motor Back EMF Constant 15
Motor Current 15, 16
Motor Inductance 3, 15
Overload 42
Motor Line-to-Line Resistance 15
Motor Power Output 28
Motor Problems 43
Motor Specifications 15
Motor Speed 15
Motor Torque Constant 15
Motor Voltage 15, 16
Motor Wires 20
Motors Supported 5, 38
Mounting 23–26
Mounting Card 23
PCB Mounting Options 24
Mating Connectors 24
Soldering 25
Screw Mounting 25
Mounting Card 23
MC1XAZ01 23
Mounting Diagrams 40
Move Profile 15, 17

N

Negative Feedback 8
Noise 19
Noise Suppression 22
Nominal Power Supply Voltage 16

O

Offset Input 30
Open Loop Mode 6
Operation 31
Over Current 38
Over Temperature 38
Over Voltage 38
Over-Current 42
Overload 42
Over-Temperature 41
Over-Voltage 41
Over-Voltage Shutdown 16, 41

P

Part Number 44
Part Numbering Structure 5
PCB Circuitry Design Examples
Tachometer Input 30
PCB Design 26
Circuitry Examples 27
DC Power 27
Encoder 29
Hall Sensors 29
Motor Power 28
Offset Input 30
Trace Routing 26
Trace Width 26
PCB Mounting Footprint 24
PCB Mounting Options 24
PE Ground 18
Peak Current Fold-back 42
Physical Dimensions 39
Pin Layout 11
AZ12 11
AZ20 11
AZ6 11
Positive Feedback 8
POWER GROUND 12, 14
Power Ground 19
Power Specifications 5, 38
Power Supply Capacitance 2, 20
Power Supply Output Current 16
Power Supply Specifications 16
Power Supply Wires 20
Power-on Reset 41, 42
Product Label 44
Products Covered 5
Protective Earth 18
PWM IN 12, 14

R

REF IN, - 12, 14, 21
REF IN, + ... 12, 14, 21
Regeneration 16
Returns 45
Revision History iii

S

Safety 1–3
Scaling Factor 6, 7
Screw Mounting 25
Selective Wave Soldering 25
Serial number 44
Shielding 18, 19
Shock/Vibration 17
Short Circuit (Phase-Ground) 38
Short Circuit (Phase-Phase) 38
Short Circuit Fault 42
Short-Circuit 41
Shunt Regulator 16
SIGNAL GROUND 12, 14
Signal Ground 19
Single Phase Drives 12
AZxxA8 12
AZxxA8DDC 12
Block Diagrams 12
Pinouts 12
Power Connector 12
Signal Connector 12
Soldering 25
Specifications Check 14–17
Environment 17
Motor 15
Power Supply 16
Specifications Tables 38–40
Switching Frequency 5, 38
System Requirements 14–17
System Voltage Requirement 15

T

Tachometer Feedback 10
Tachometer Input 30, 33
Tachometer Velocity Mode 7
Technical Support 44
Three Phase Drives 13–14
AZBDCxxA8 13
AZBExxA8 13
AZBHxxA8 13
AZBxxA8 13
Block Diagrams 13
Pinouts 14
Power Connector 14
Signal Connector 14
Torque 15
Trace Routing 26
Trace Width 26
Trademarks ii
Troubleshooting 41–45
Twisted Pair Wires 19

U

Under-Voltage 41
Under-Voltage Shutdown 42

V

V HALL OUT 14
Velocity Control 8, 38
Velocity Monitor Output 33
Vibration 17
Voice Coil Drives 12

W

Warning Symbols iii
Warranty Info 45
Warranty Returns 45
Wave Soldering 25
Wire Diameter 19
Wire Gauge 19
Wiring 19–21
Feedback Wires 20
Input Reference Wires 21
Motor Wires 20
Power Supply Wires 20
Wire Gauge 19

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

AZ Analog Drive
Hardware Installation Manual
MNALAZIN-02

ADVANCED MOTION CONTROLS

3805 Calle Tecate • Camarillo, CA 93012-5068
Tel: (805) 389-1935 Fax: (805) 389-1165 www.a-m-c.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP