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Everything's possible.

DZ Digital Drives
for Servo Systems

Hardware
Installation Manual

ORIGINAL INSTRUCTIONS

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:

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Agency Compliances

The company holds original documents for the following:

- UL 508c, file number E140173
- Electromagnetic Compatibility, EMC Directive - 2014/30/EU
  EN61000-6-2:2005
  EN61000-6-4:2007/A1:2011
- Electrical Safety, Low Voltage Directive - 2014/35/EU
  EN 60204-1:2006/A1:2009
- Reduction of Hazardous Substances (RoHS III), 2015/863/EU

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Related Documentation - available for download at www.a-m-c.com

- Product datasheet specific for your drive
- DriveWare Software Startup Guide
- CANopen Communication Manual
- Serial Communication Manual

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
MNDGDZIN-01	1	12/2008	DZ Install Manual First Release
MNDGDZIN-02	2	1/2009	Updated default connection setting to 115200 baud rate
MNDGDZIN-03	3	12/2009	Updated for 40 amp drive models
MNDGDZIN-04	4	8/2011	- Updated for DZ-060L080, DZ-010L200, and DZ-025L200 drive models - Updated for MC1XDZx02-xx mounting card models
MNDGDZIN-05	5	9/2012	- Updated for DriveWare 7 information - Updated for RMS Charge-Based Limiting capabilities
MNDGDZIN-06	6	3/2015	- Added Modbus RTU capability for DZR drives
MNDGDZIN-07	7	5/2018	- Added 2-Phase Stepper motor information

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1 Safety

This section discusses characteristics of your DZ Digital 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.

1.1 General Safety Overview

In order to install a DZ 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.

⚠️ **Caution**	Over current protective devices recognized by an international safety agency must be installed in line before the servo drive. These devices shall be installed and rated in accordance with the device installation instructions and the specifications of the servo drive (taking into consideration inrush currents, etc.). Servo drives that incorporate their own primary fuses do not need to incorporate over current protection in the end user's equipment.

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⚠️ 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.
⚠️ **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: • Turn on the external logic power supply first before turning on the main power supply. • 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! • If using relays or other means to disconnect the motor leads, be sure the drive is disabled before reconnecting the motor leads to the drive. Connecting the motor leads to the drive while it is enabled can generate extremely high voltage spikes which will damage the drive.

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⚠ 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.

⚠ 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.

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2 Products and System Requirements

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

2.1 DZ Drive Family Overview

The family of DZ digital drives is 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 DZ drives are ideal for applications with limited size and weight constraints.

The DZ drive family can power three phase or single phase brushless or brushed servomotors, two phase or three phase closed loop stepper motors, and closed loop vector AC induction motors. DZ drives are powered off a single isolated DC power supply, and provide a variety of control and feedback options. A digital controller can be used to command and interact with DZ drives, and a number of dedicated and programmable digital and analog input/output pins are available for parameter observation and drive configuration. DZ drives are capable of operating in current (torque), velocity, or position modes, and utilize Space Vector Modulation, which results in higher bus voltage utilization and reduced heat dissipation compared to traditional PWM. DZ drives feature a serial communication interface for drive configuration and setup as well as offering either CANopen, RS-485, or Modbus RTU communication protocols for drive networking applications. Drive commissioning is accomplished using DriveWare® 7, the setup software from *ADVANCED* Motion Controls®, available for download at www.a-m-c.com.

TABLE 2.1 Standard DZ Drive Family Part Numbers

|	Voltage	10-80V				40-175V
	Peak Current	12A	20A	40A	60A	25A
Network Communication	CANopen	DZCANTE-012L080	DZCANTE-020L080	DZCANTE-040L080	DZCANTE-060L080	DZCANTE-025L200
	RS485/232	DZRALTE-012L080	DZRALTE-020L080	DZRALTE-040L080	DZRALTE-060L080	DZRALTE-025L200

2.1.1 Drive Datasheet

Each DZ digital drive has a separate datasheet that contains important information on the options 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.

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2.2 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 DZ Part Numbering Structure
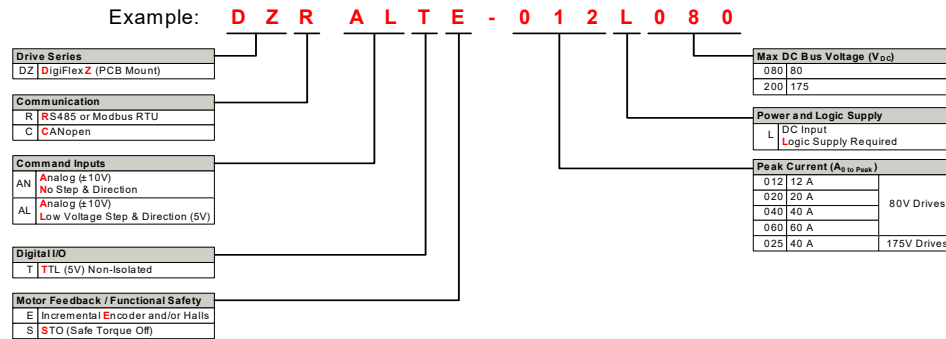
In general, the DZ family of digital drives can be categorized either by the drive communication control method, or by the drive power rating. Drives that use the CANopen protocol are referred to herein as DZC drives, while drives that use RS-485 or Modbus RTU communication are referred to as DZR drives.

TABLE 2.2 Power Specifications

Description	Units	DZ-012L080	DZ-020L080	DZ-040L080	DZ-060L080	DZ-025L200
DC Supply Voltage Range[1]	VDC	20-80	10-80			40-175
DC Bus Over Voltage Limit	VDC	88				195
DC Bus Under Voltage Limit	VDC	17	8			32
Logic Supply Voltage	VDC	5 (±5%)				
Maximum Peak Output Current[2]	A (A_{rms})	12 (8.5)	20 (14.1)	40 (28.3)	60 (42.4)	25 (17.7)
Maximum Continuous Output Current	A (A_{rms})	6 (6)	12 (12)	20 (20)	30 (30)	12.5 (12.5)
Maximum Power Dissipation at Continuous Current	W	24	48	80	120	109
Internal Bus Capacitance[1]	μF	33	94	141	30	20
Minimum Load Inductance[3]	μH	250				
Switching Frequency	kHz	20				
Maximum Output PWM Duty Cycle	%	92				

1. For DZ-040L080 drives, if the drive is operated at a supply voltage over 60 VDC, an external 33μF, 100V electrolytic capacitor is required between High Voltage and Power Ground. For DZ-060L080 drives, an external 470μF, 100V electrolytic capacitor is required between High Voltage and Power Ground. For DZ-025L200 drives, an external 100μF, 200V electrolytic capacitor is required between High Voltage and Power Ground.
2. Capable of supplying drive rated peak current for 2 seconds with 10 second foldback to continuous value. Longer times are possible with lower current limits.
3. Lower inductance is acceptable for bus voltages well below minimum. Use external inductance to meet requirements.

TABLE 2.3 Control Specifications

Description	DZR	DZC
Network Communication	RS485 or Modbus RTU	CANopen (RS-232 for Configuration)
Command Sources	±10V Analog, Over the Network, Encoder Following, PWM & Direction, 5V Step & Direction, Sequencing, Indexing, Jogging	±10V Analog, Over the Network, Encoder Following, PWM & Direction, Sequencing, Indexing, Jogging
Commutation Methods	Sinusoidal, Trapezoidal	Sinusoidal, Trapezoidal
Control Modes	Current, Hall Velocity, Position, Velocity	Profile Modes, Cyclic Synchronous Modes, Current, Velocity, Position, Interpolated Position Mode (PVT)
Motors Supported	Three Phase (Brushless Servo), Single Phase (Brushed Servo, Voice Coil, Inductive Load), Stepper (2- or 3-Phase Closed Loop), AC Induction (Closed Loop Vector)	
Hardware Protection	40+ Configurable Functions, Over Current, Over Temperature (Drive & Motor), Over Voltage, Short Circuit (Phase-Phase & Phase-Ground), Under Voltage	
Programmable Digital I/O	5 Inputs, 3 Outputs	5 Inputs, 3 Outputs
Programmable Analog I/O	1 Input	1 Input
Feedback Supported	Hall Sensors, Differential Incremental Encoder, Aux. Incremental Encoder, ±10 VDC Position, Tachometer (±10 VDC)	

2.3 Communication Protocol

DZ digital drives offer networking capability through either CANopen or RS-485 communication: CANopen is used with DZC drives, and RS-485 or Modbus RTU is used with DZR drives. Both DZC and DZR drives include an auxiliary RS-232 serial port used for configuring the drive through DriveWare. DZR drives can also connect to DriveWare through RS-485.

2.3.1 CANopen

CANopen is an open standard embedded machine control protocol that operates through the CAN communication interface on DZC digital drives. The CANopen protocol is developed for the CAN physical layer. The CAN interface for *ADVANCED* Motion Controls DZ drives follows the CiA (CAN in Automation) 301 communications profile and the CiA 402 device profile. CiA is the non-profit organization that governs the CANopen standard. More information can be found at www.can-cia.org.

On DZC drives, a CAN interface is provided through a transmit pin and a receive pin. A user-supplied external transceiver which meets a CAN physical layer standard (ex. ISO 11898-2) is required for CAN communication. This transceiver acts as a medium between chip-level CAN signals and bus-level CAN signals. When choosing a transceiver, make sure it matches with the physical layer standard of the CAN bus being used. It is also recommended to isolate the transceiver from the DZ drive. See "CAN Transceiver" on page 34 for more information on interfacing with a CAN transceiver.

CAN communication works by exchanging messages between a CANopen "host" and CANopen "nodes". The messages contain information on specific drive functions, each of which is defined by a group of objects. An object is roughly equivalent to a memory location that holds a certain value. The values stored in the drive's objects are used to perform the drive functions (current loop, velocity loop, position loop, I/O functions, etc.). For more detailed information on CANopen communication with DZC drives and a complete list of CAN objects, consult the *ADVANCED* Motion Controls CANopen Communication Manual, available for download at www.a-m-c.com.

2.3.2 RS-485 Communication

ADVANCED Motion Controls' proprietary serial protocol is a byte-based, binary, master-slave standard to access drive "commands" used on DZR drives. The drive commands provide read or write access to drive parameters, with each command containing one or more parameters. Each command is assigned a unique index number, and parameters within a command are given offset values. As a result, parameters are referenced using a combination of the command index and parameter offset values. The serial protocol utilizes variable length commands to access one or more parameters within an index. On DZR drives, the RS-485 interface is provided through a transmit pin and a receive pin. These pins should be connected to the appropriate locations on a serial cable connector, as specified by the serial protocol. The reference point for the RS-485 signals is common with the signal ground of the drive. See "RS-485/232 Interface" on page 35 for more information on the DZ drive serial interface connection. For more detailed information on RS-485 communication with DZ drives, consult the *ADVANCED* Motion Controls Serial Communication Manual.

2.3.3 Modbus RTU

Modbus is an open standard, master slave system developed for communication between multiple devices using a single wire. The Modbus protocol uses a defined message structure, regardless of the physical layer of the network used to communicate. A master device initiate a "query", and slave devices return a "response", supplying the requested data or taking the requested action. The query can be made to individual devices or broadcast to all connected devices. For more detailed information on Modbus RTU communication with DZR drives and a complete list of register definitions, consult the *ADVANCED* Motion Controls' Modbus Communication Manual available for download at www.a-m-c.com.

The Modbus RTU protocol for *ADVANCED* Motion Controls' DZR drives follows the Modbus Application Protocol Specification V1.1b. More information can be found at www.Modbus-IDA.org.

2.4 Control Modes

The DZ family of digital drives operate in a variety of operating modes. The setup and configuration parameters for these modes are commissioned through DriveWare. See the DriveWare Software Guide for mode configuration information.

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.

2.4.1 Profile Modes

In Profile Modes, the trajectory is limited by the drive, using the Command Limiter values to limit the maximum command rate. If the host sends a large command step, the drive spreads the demand over some period of time to stay equal to or below the maximum defined rate.

2.4.2 Current (Torque) or Profile Current (Torque)

In these modes, the input command voltage controls the output current. The drive will adjust the output duty cycle to maintain the commanded output current. Current modes are used to control torque for rotary motors (force for linear motors), but the motor speed is not controlled. The output current and other parameters can be monitored in DriveWare through the digital oscilloscope function. DriveWare also offers configuration of maximum and continuous current limit values.

ⓘ 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 output 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.

2.4.3 Velocity or Profile Velocity

In these modes, the input command voltage controls the motor velocity. Velocity modes require the use of a feedback element to provide information to the drive about the motor velocity. DZ drives allow velocity control with either Hall Sensors, an encoder, or a tachometer as the feedback element. The motor velocity and other parameters can be monitored in DriveWare through the digital oscilloscope function. The feedback element being used for velocity control must be specified in DriveWare, which also offers configuration of velocity limits. See "Feedback Supported" on page 10 for more information on feedback devices.

2.4.4 Position or Profile Position

In these modes, the input command voltage controls the actual motor position. Position modes require the use of a feedback element to provide information to the drive about the physical motor location. DZ drives allow position control with either an Encoder or ±10V Position

feedback. The motor position and other parameters can be monitored in DriveWare through the digital oscilloscope function. The feedback element being used for position control must be specified in DriveWare, which also offers configuration of position limits. See "Feedback Supported" on page 10 for more information on feedback devices.

2.4.5 Cyclic Synchronous Modes

Cyclic Synchronous Modes give responsibility of trajectory control to the host. The drive interpolates between command points, defining the rate by dividing the change in command by the interpolation time period. This allows the drive to respond smoothly to each step in command.

Cyclic Synchronous Current   In Cyclic Synchronous Current Mode, the drive closes the current loop. The host is allowed more control by having the ability to instantly add current feedforward values. This allows for gain compensation in applications with varying loads.

Cyclic Synchronous Velocity   In Cyclic Synchronous Velocity Mode, the drive closes two control loops: velocity and current. The host is allowed more control by having the ability to instantly add velocity and current feedforward values. This allows for gain compensation in applications with varying loads.

Cyclic Synchronous Position   In Cyclic Synchronous Position Mode, the drive closes three control loops: position, velocity, and current. The host can send target position, velocity feedforward, and current feedforward values to the drive. This allows for gain compensation in applications with varying loads.

2.4.6 Interpolated Position Mode (PVT)

Interpolated Position Mode (PVT) is typically used to stream motion data between multiple axes for coordinated motion. Arbitrary position and velocity profiles can be executed on each axis. A PVT command contains the position, velocity, and time information of the motion profile's segment end points. The drive performs a third order interpolation between segment end points, resulting in a partial trajectory generation where both host controller and drive generate a specific portion of the overall move profile trajectory. The host controller calculates position and velocity of intermittent points on the overall trajectory, while the drive interpolates between these intermittent points to ensure smooth motion. The actual position loop is closed within the drive. This reduces the amount of commands that need to be sent from host controller to drive, which is critical in distributed control systems. For more information on how to operate a DZC drive in PVT mode, consult the DriveWare Software Manual.

2.5 Feedback Supported

There are a number of different feedback options available in the DZ family of digital drives. The feedback element must be 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, an encoder, or a tachometer. These latter devices must have their signals converted to a DC voltage, a task performed by the DZ drive circuitry and configuration software.

2.5.1 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 DZ 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, 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 use DriveWare to reverse the internal velocity feedback polarity setting. The AutoCommutation routine in DriveWare will typically determine the proper feedback polarity setting.

2.5.2 Hall Sensors

DZ drives can use single-ended Hall Sensors for commutation and/or velocity control. The Hall Sensors (typically three) are built into the motor to detect the position of the rotor magnetic field. With Hall Sensors being used as the feedback element, the input command voltage controls the motor velocity, with the Hall Sensor frequency closing the velocity loop. The Hall Sensor frequency is converted into velocity feedback that the drive uses to control the motor speed and direction. The actual motor speed can be monitored in DriveWare through the digital oscilloscope function.

> **i** Note
> Due to the inherent low resolution of motor mounted Hall Sensors, using Hall Sensors for velocity feedback 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.

For more information on using Hall Sensors for trapezoidal commutation, see "Trapezoidal Commutation" on page 51.

> **i** Note
> Users designing their own PCB interface may also design the appropriate circuitry on their PCB interface to allow differential inputs. See "Hall Sensor Inputs" on page 37 for circuitry recommendation.

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2.5.3 Encoder Feedback

DZ drives can utilize differential encoder inputs for velocity or position control, with the option of also using the encoder to commutate the motor. The encoder provides incremental position feedback that can be extrapolated into very precise velocity or position information. With an Encoder being used as the feedback element, the input command controls the motor velocity or motor position, with the frequency of the encoder signal closing either the velocity or position loop. The encoder signals are read as "pulses" that the DZ drive uses to essentially keep track of the motor's speed, position and direction of rotation. Based on the speed and order in which these pulses are received from the encoder, the drive can interpret the motor velocity and physical location. The actual motor speed and physical location can be monitored in DriveWare through the digital oscilloscope function. Both the "A" and "B" channels of the encoder are required for operation. DZ drives also accept an optional differential "index" channel that can be used for absolute position reference.
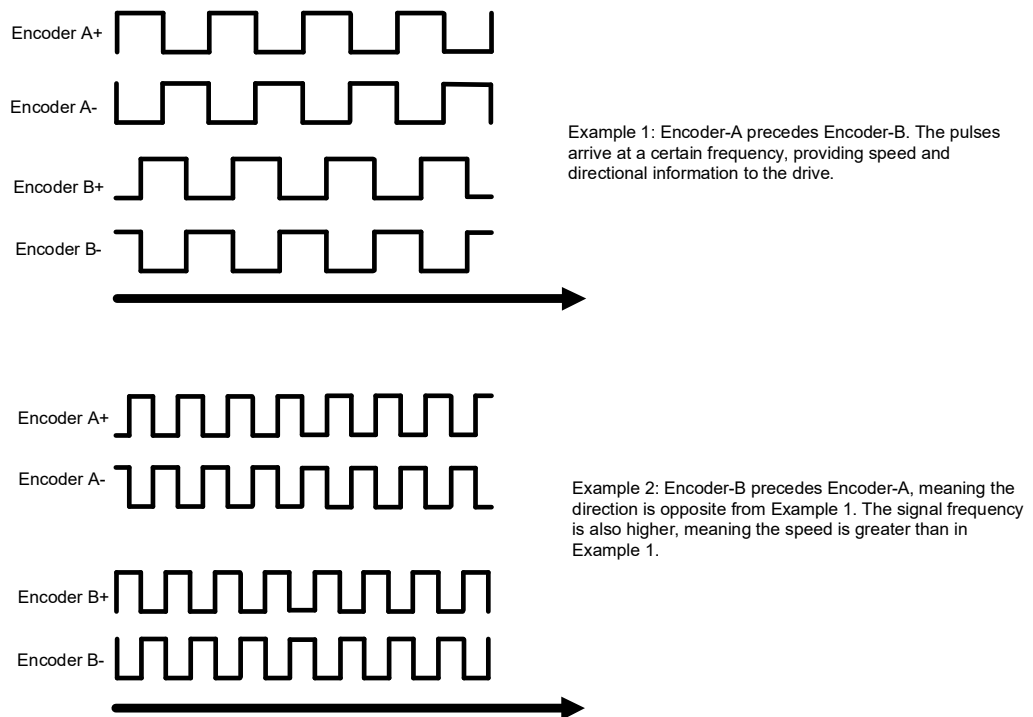
(i) Note The MC1XDZ_02 mounting cards provide the option of using single-ended encoder inputs. Users designing their own PCB interface may also design the appropriate circuitry on their PCB interface to allow single-ended inputs. See "Encoder Inputs" on page 38 for circuitry recommendation.

Figure 2.2 below represents differential 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. By keeping track of the number of encoder "pulses" with respect to a known motor "home" position, DZ drives are able to ascertain the actual motor location.

FIGURE 2.2 Encoder Feedback Signals

Example 1: Encoder-A precedes Encoder-B. The pulses arrive at a certain frequency, providing speed and directional information to the drive.

Example 2: Encoder-B precedes Encoder-A, meaning the direction is opposite from Example 1. The signal frequency is also higher, meaning the speed is greater than in Example 1.

DZ drives can also use encoder feedback for sinusoidal commutation by using the AutoCommutation routine in DriveWare. Encoder feedback is also used in the "Phase Detect" procedure in DriveWare, which is necessary when using a three phase (brushless) motor without Hall Sensors. The Phase Detect routine will have to be run before AutoCommutation. Phase Detect works by sending a small current signal to the motor, prompting the motor to vibrate slightly for a few seconds. The encoder feedback from this movement provides a starting position for the motor, allowing the drive to then be properly commutated. See the Driveware Software Guide for more information on Phase Detect.

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

2.5.4 Tachometer (±10 VDC)

DZ drives support the use of a tachometer for velocity feedback. The tachometer measures the rotary speed of the motor shaft and returns an analog voltage signal to the drive for velocity control. DZ drives provide a Programmable Analog Input on the motor Feedback Connector that is available for use with a tachometer. The tachometer signal is limited to ±10 VDC.

> **i**
> Note
>
> When using the Programmable Analog Input for tachometer feedback, the drive cannot use a ±10V Analog input command through the reference inputs. See the Command Sources section below for other available types of command inputs.

2.5.5 ±10 VDC Position

DZ drives accept an analog ±10 VDC Position feedback, typically in the form of a load-mounted potentiometer. The feedback signal must be conditioned so that the voltage does not exceed ±10 V, and is connected to the DZ drive through the Programmable Analog Input. In DriveWare, the connection method that is used must be selected under the Position Loop Feedback options. See the DriveWare Software Guide for more information.

> **i**
> Note
>
> When using the Programmable Analog Input for ±10 VDC Position feedback, the drive cannot use a ±10V Analog input command through the reference inputs. See the Command Sources section below for other available types of command inputs.

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2.6 Command Sources

The input command source for DZ drives can be provided by one of the following options.

2.6.1 ±10V Analog

Both DZC and DZR drives accept a differential or single-ended analog signal with a range of ±10 V from an external source. The input command signals should be connected to pins P1-3 and P1-4. See "Programmable Analog Input" on page 48 for more information.

2.6.2 Encoder Following

Both DZC and DZR drives can utilize Encoder Following as a form of input command. In Encoder Following mode, an auxiliary differential encoder signal can be used to command the drive in a master/slave configuration. The gearing ratio (input counts to output counts ratio) can be configured in DriveWare by the user. Encoder Following is only a valid option when the DZ drive is operated in position mode. The auxiliary encoder signal input should be connected to pins P1-17, P1-18, P1-19, and P1-20. See "Auxiliary Encoder Input" on page 48 for more information.

2.6.3 Over the Network

Both DZC and DZR drives can utilize network communication as a form of input command. DZC drives can provide an input reference command through the CAN interface, and DZR drives can provide an input reference command through the RS-485 interface using the ADVANCED Motion Controls serial command set or Modbus RTU. In order to send commands to the drive using Modbus RTU, the command source in DriveWare must be set to Interface Input 1. For more information on CANopen and RS-485, see "Communication Protocol" on page 6.

2.6.4 PWM and Direction

DZ drives accept either a PWM and Direction or a Single Input PWM signal as the command source input type. The Direction inputs commands the direction of rotation, while the PWM input duty cycle commands the drive output. The PWM input is connected to P1-17, while the Direction input is connected to P1-19. Scaling, offset, and command inversion may be configured for customized control. The PWM and Direction command source supports broken wire detection for cases when the PWM command reaches 0% or 100% duty cycle. The frequency range of the PWM and Direction command input is 1kHz - 125kHz.

2.6.5 Indexing and Sequencing

DZ drives allow configuration of up to 16 separately defined Index tasks in DriveWare. Indexes can be either Absolute (commands a pre-defined move to an absolute position) or Relative (commands a pre-defined move relative to the current position). Indexes can be combined with Homing routines and other control functions to form up to 16 different Sequences. Sequences can be configured to initiate on power-up, via a digital input, or by using an external network command.

2.6.6 Jogging

DZ drives allow configuration of two separate Jog velocities in DriveWare, commanding motion at a defined constant velocity with infinite distance.

## 2.6.7 5V TTL Step and Direction (DZR Drives Only)

DZR drives accept a differential Step and Direction input command from an external source. The Direction input commands the direction of rotation, while each pulse of the Step input commands the motor to "step" in that direction. Since the input is directly controlling the actual position of the motor, the physical motor location can be determined without any other feedback element. The differential Step input signal should be connected to pins P1-17 and P1-18, and the differential Direction input signal should be connected to pins P1-19 and P1-20. See for more information.
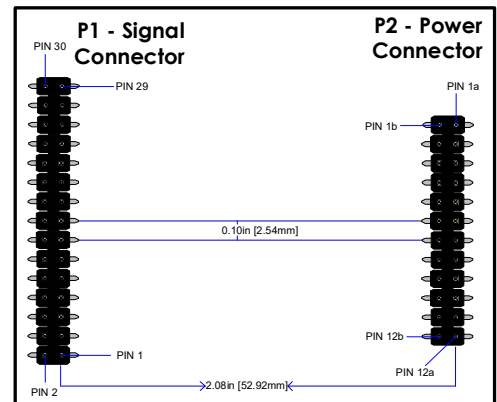
2.7 Pin Layout

Figure 2.3 below shows the pin layout and location on DZ drives, as seen from the PCB where the drive is mounted. More detailed dimensional information can be found in "Physical Dimensions" on page 54 and in "Mating Connectors" on page 31.

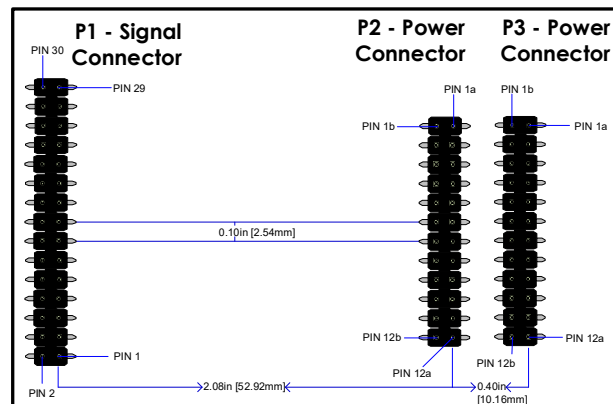**FIGURE 2.3** **DZ Drives Pin Layout**
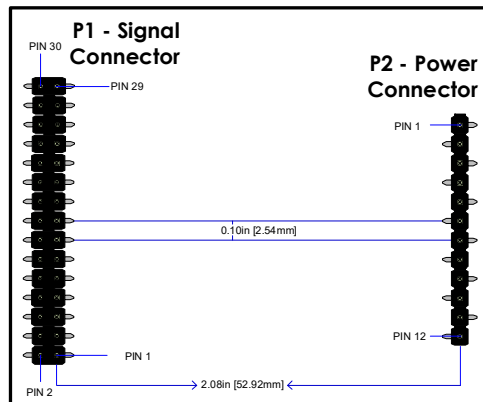
2.8 DZC Drives

- CANopen Networking
- ±10V Analog, Encoder Following, PWM / Direction, Sequencing, Indexing, Jogging, or Over the Network
- Hall Sensor Feedback
- Encoder Feedback
- ±10V Analog Feedback
- Tachometer Feedback (±10VDC)

- 5V TTL Logic Level
- RS232 Configuration
- Programmable Digital I/O's
- Programmable Analog Input
- 3 High Speed Captures
- Compatible with Three Phase and Single Phase Motors
- Programmable Current, Voltage, and Velocity Limits

2.8.1 Block Diagram

FIGURE 2.4 DZC Drives Block Diagram
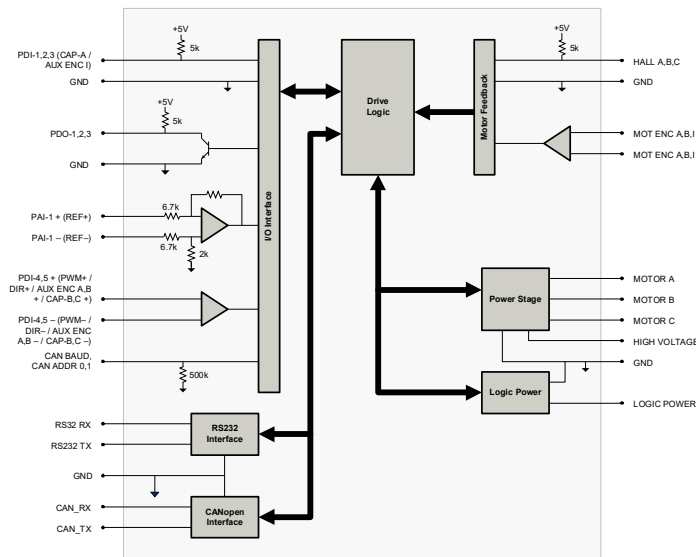
2.8.2 Pinouts

TABLE 2.4 DZC Pin Functions

Pin	Description	Pin	Description
DZC Signal Connector - P1		
1	CAN ADDR 0	2	CAN ADDR 1
3	PAI-1 + (REF+)	4	PAI-1 - (REF -)
5	GROUND	6	CAN BAUD
7	PDO - 1	8	PDO - 2
9	PDO - 3	10	PDI - 1
11	PDI - 2	12	PDI - 3 (CAP-A / AUX ENC I)
13	RS232 RX	14	CAN RX
15	RS232 TX	16	CAN TX
17	PDI-4 + (AUX ENC A+/PWM+/CAP-B)	18	PDI-4 - (AUX ENC A-/PWM-)
19	PDI-5 + (AUX ENC B+/CAP-C/DIR+)	20	PDI-5 - (AUX ENC B-/DIR-)
21	GROUND	22	HALL A
23	HALL B	24	HALL C
25	MOT ENC I+	26	MOT ENC I-
27	MOT ENC A+	28	MOT ENC A-
29	MOT ENC B+	30	MOT ENC B-

DZC Power Connector - P2, P3			
DZ-012L080	DZ-020L080 (P2) DZ-040L080 / DZ-060L080 / DZ-025L200 (P2 & P3)		
Pin	Description	Pin	
1	LOGIC PWR (1,1a-P2) N/C (1b-P2), (1a,1b-P3)	1a	1b
2	GROUND	2a	2b
3		3a	3b
4	HIGH VOLTAGE	4a	4b
5		5a	5b
6	RESERVED	6a	6b
7	MOTOR C	7a	7b
8		8a	8b
9	MOTOR B	9a	9b
10		10a	10b
11	MOTOR A	11a	11b
12		12a	12b

2.9 DZR Drives

- RS-485 or Modbus RTU Networking
- ±10V Analog, Encoder Following, PWM and Direction, 5V Step and Direction, Sequencing, Indexing, Jogging, or Over the Network
- Programmable Current, Voltage, and Velocity Limits
- RS-485/232 Configuration
- Hall Sensor Feedback

- Encoder Feedback
- ±10V Analog Feedback
- Tachometer Feedback (±10VDC)
- Programmable Digital I/O's
- Programmable Analog Input
- 3 High Speed Captures
- Compatible with Three Phase and Single Phase Motors

2.9.1 Block Diagram

FIGURE 2.5 DZR Drives Block Diagram
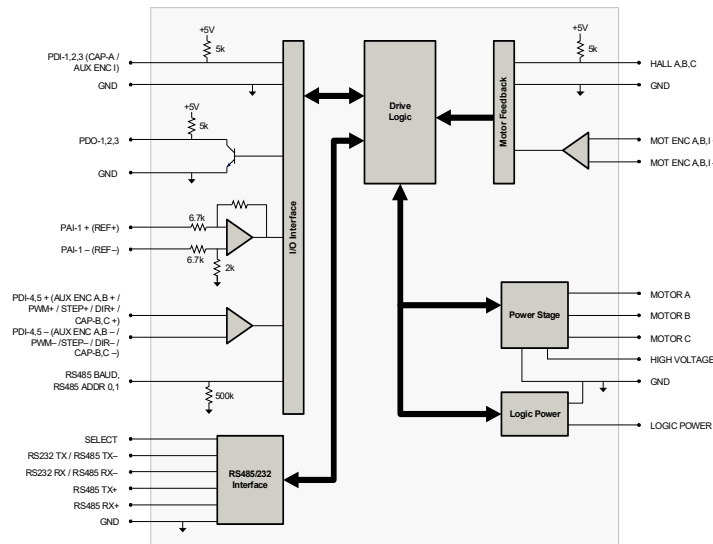
2.9.2 Pinouts

TABLE 2.5 DZR Pin Functions

DZR Signal Connector - P1			
Pin	Description	Pin	Description
1	RS485 ADDR 0	2	RS485 ADDR 1
3	PAI-1 + (REF+)	4	PAI-1 - (REF -)
5	GROUND	6	RS485 BAUD
7	PDO - 1	8	PDO - 2
9	PDO - 3	10	PDI - 1
11	PDI - 2	12	PDI - 3 (CAP-A / AUX ENC I)
13	RS232 RX / RS485 RX-	14	RS485 RX+
15	RS232 TX / RS485 TX-	16	RS485 TX+
17	PDI-4 + (PWM+/ STEP+ / AUX ENC A+/CAP-B)	18	PDI-4 - (PWM- / STEP- / AUX ENC A-)
19	PDI-5 + (DIR+ / AUX ENC B+/ CAP-C)	20	PDI-5 - (DIR- / AUX ENC B-)
21	GROUND	22	HALL A
23	HALL B	24	HALL C
25	MOT ENC I+	26	MOT ENC I-
27	MOT ENC A+	28	MOT ENC A-
29	MOT ENC B+	30	MOT ENC B-

DZR Power Connector - P2, P3			
DZ-012L080	DZ-020L080 (P2) DZ-040L080 / DZ-060L080 / DZ-025L200 (P2 & P3)		
Pin	Description	Pin	
1	LOGIC PWR (1,1a-P2) N/C (1b-P2)/(1a,1b-P3)	1a	1b
2	GROUND	2a	2b
3		3a	3b
4	HIGH VOLTAGE	4a	4b
5		5a	5b
6	RESERVED	6a	6b
7	MOTOR C	7a	7b
8		8a	8b
9	MOTOR B	9a	9b
10		10a	10b
11	MOTOR A	11a	11b
12		12a	12b

2.10 System Requirements

To successfully incorporate a DZ digital servo drive into your system, you must be sure it will operate properly based on electrical, mechanical, and environmental specifications while anticipating impacts on performance.

2.10.1 Specifications Check

Before selecting a DZ digital servo drive, a user should consider the requirements of their system. This involves calculating the 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 a DZ servo drive, be sure all the following items are available:

- DZ Digital Servo Drive
- DZ Servo Drive Datasheet (specific to your model)
- DZ Series Digital Hardware Installation Manual
- DriveWare Software Guide

ℹ️ **Note**
DZ 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 30 for the *ADVANCED* Motion Controls DZ mounting card. Customized mounting options are also available for orders with sufficient volume.

2.10.2 Motor Specifications

DZ digital 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, a DZ drive may be selected that will best suit the motor capabilities. Some general guidelines that are useful when pairing a DZ 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**, $\mathbf{V_M}$, required to achieve the move profile.

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

Where:

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

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

> ⚠️ **Caution**
>
> A motor that does not meet the rated minimum inductance value of the DZ 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 DZ drive can be found in the drive datasheet. If the drive is operated below the maximum rated voltage, the minimum load inductance requirement may be reduced.

2.10.3 Power Supply Specifications

DZ servo drives operate off an isolated unregulated DC Power Supply (see Table 2.2 for drive model power supply ranges and over-voltage shutdown values). 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 DZ 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 a DZ-012L080 drive using an external shunt regulator.

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FIGURE 2.6 Sample DZ-012L080 Power Supply Selection
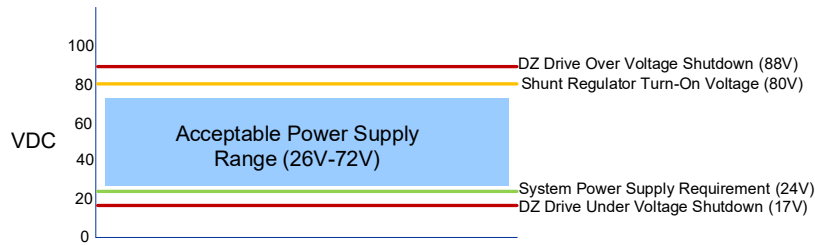
The power supply current rating is based on the maximum current that will be required by the system. If the power supply powers more than one drive, then the current requirements for each drive should be added together. Due to the nature of servo drives, the current into the drive does not always equal 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**, 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

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.

2.10.4 Environment

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

TABLE 2.6 Environmental Specifications

Environmental Specifications	
Parameter	**Description**
Ambient Temperature Range	See Figure 2.7
Baseplate Temperature Range[1]	0 - 65 ℃ (DZ-012L080) ; 0 - 75 ℃ (DZ-020L080 / DZ-040L080 / DZ-060L080 / DZ-025L200)
Humidity	90%, non-condensing
Mechanical Shock	15g, 11ms, Half-sine
Vibration	30 grms for 5 minutes in 3 axes
Altitude	0-3000m

1.Thermal shutdown occurs when PCB temperature reaches this value. For DZ-060L080 and DZ-025L200 drives, the base plate temperature at this point may be between 60ºC and 75ºC depending on rate of base plate cooling (additional heat sinking), ambient temperature, and output current.

Ambient Temperature Range and Thermal Data   DZ drives contain a built-in over-temperature disabling feature if the baseplate temperature rises above the maximum baseplate temperature value, specified in Table 2.6. When operating at a specific output current and with maximum DC supply voltage, Figure 2.7 below specifies an upper limit to the

ambient temperature range DZ drives can operate within while keeping the baseplate temperature below the maximum baseplate temperature. It is recommended to mount the baseplate of the DZ drive to a heatsink for best thermal management results. Note that DZ-012L080 drives operated at supply voltages approaching 80VDC will require additional heatsinking to achieve rated characteristics, so no natural convection data is given.

FIGURE 2.7 **DZ Drives Maximum Ambient Temperature Range**
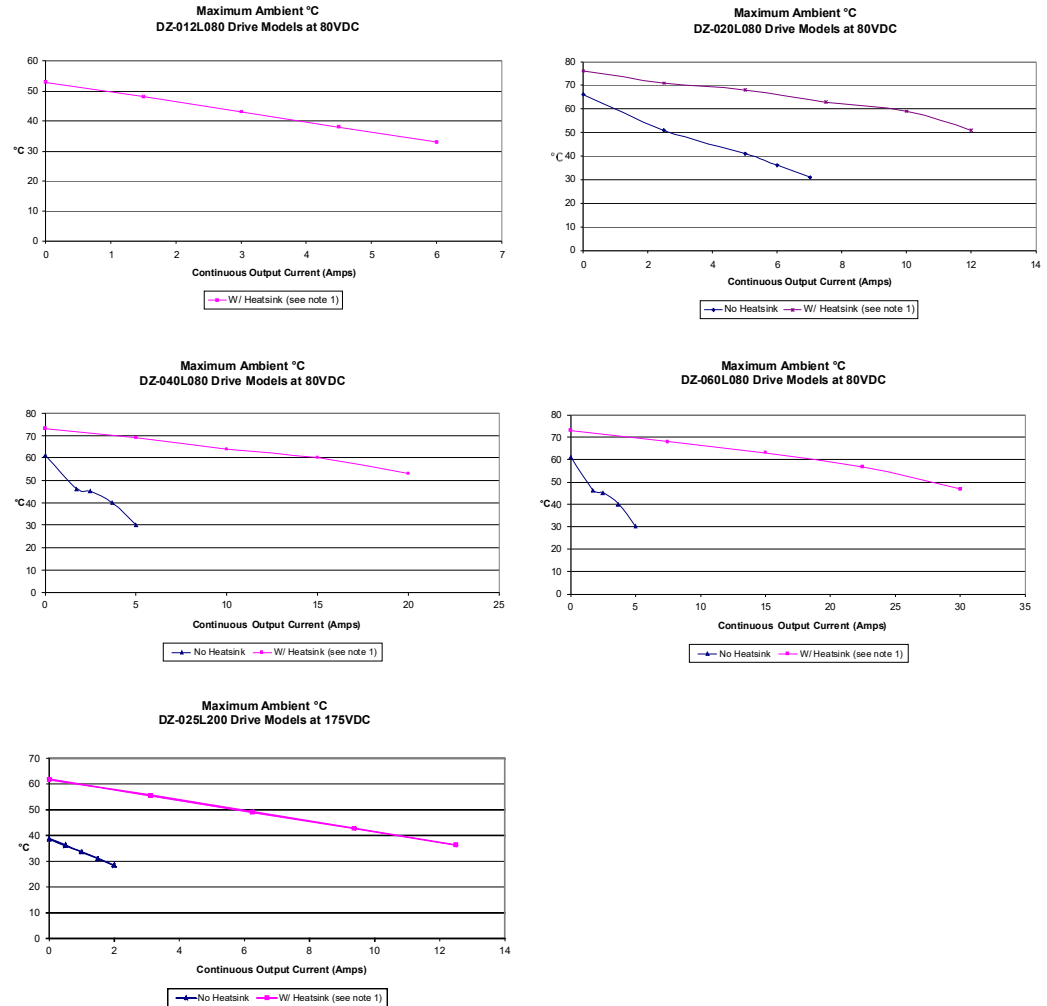
1. The heatsink used in the above tests is 15" x 22" x 0.65" aluminum plate.

Shock/Vibrations   While DZ 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 DZ drive against its baseplate. For information on mounting options and procedures, see "Mounting" on page 30.

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.

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3 Integration in the Servo System

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

3.1 LVD Requirements

The servo drives covered in the LVD Reference report were investigated as components intended to be installed in complete systems that meet the requirements of the Machinery Directive. In order for these units to be acceptable in the end users' equipment, the following conditions of acceptability must be met.

1. European approved overload and current protection must be provided for the motors as specified in section 7.2 and 7.3 of EN60204.1.
2. A disconnect switch shall be installed in the final system as specified in section 5.3 of EN60204.1.
3. All drives that do not have a grounding terminal must be installed in, and conductively connected to a grounded end use enclosure in order to comply with the accessibility requirements of section 6, and to establish grounding continuity for the system in accordance with section 8 of EN60204.1.
4. A disconnecting device that will prevent the unexpected start-up of a machine shall be provided if the machine could cause injury to persons. This device shall prevent the automatic restarting of the machine after any failure condition shuts the machine down.
5. European approved over current protective devices must be installed in line before the servo drive, these devices shall be installed and rated in accordance with the installation instructions (the installation instructions shall specify an over current rating value as low as possible, but taking into consideration inrush currents, etc.). Servo drives that incorporate their own primary fuses do not need to incorporate over protection in the end users' equipment.

These items should be included in your declaration of incorporation as well as the name and address of your company, description of the equipment, a statement that the servo drives must not be put into service until the machinery into which they are incorporated has been declared in conformity with the provisions of the Machinery Directive, and identification of the person signing.

3.2 CE-EMC Wiring Requirements

The following sections contain installation instructions necessary for meeting EMC requirements.

Contact the factory for assistance in determining the type of drive in use.

General

1. Shielded cables must be used for all interconnect cables to the drive and the shield of the cable must be grounded at the closest ground point with the least amount of resistance.

2. The drive's metal enclosure must be grounded to the closest ground point with the least amount of resistance.

3. The drive must be mounted in such a manner that the connectors and exposed printed circuit board are not accessible to be touched by personnel when the product is in operation. If this is unavoidable there must be clear instructions that the amplifier is not to be touched during operation. This is to avoid possible malfunction due to electrostatic discharge from personnel.

Analog Input Drives

4. A Fair Rite model 0443167251 round suppression core must be fitted to the low level signal interconnect cables to prevent pickup from external RF fields.

PWM Input Drives

5. A Fair Rite model 0443167251 round suppression core must be fitted to the PWM input cable to reduce electromagnetic emissions.

MOSFET Switching Drives

6. A Fair Rite model 0443167251 round suppression core must be fitted at the load cable connector to reduce electromagnetic emissions.

7. An appropriately rated Cosel TAC series AC power filter in combination with a Fair Rite model 5977002701 torroid (placed on the supply end of the filter) must be fitted to the AC supply to any MOSFET drive system in order to reduce conducted emissions fed back into the supply network.

IGBT Switching Drives

8. An appropriately rated Cosel TAC series AC power filter in combination with a Fair Rite model 0443167251 round suppression core (placed on the supply end of the filter) must be fitted to the AC supply to any IGBT drive system in order to reduce conducted emissions fed back into the supply network.

9. A Fair Rite model 0443164151 round suppression core and model 5977003801 torroid must be fitted at the load cable connector to reduce electromagnetic emissions.

Fitting of AC Power Filters

10. 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

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adversely affected by the noise. AC power filters can filter this noise and keep it from getting on the AC power signal. The above mentioned AC power filters should be mounted flat against the enclosure of the product using the mounting lugs provided on the filter. Paint should be removed from the enclosure where the filter is fitted to ensure good metal to metal contact. The filter should be mounted as close to the point where the AC power filter enters the enclosure as possible. Also, the AC power cable on the load end of the filter should be routed far from the AC power cable on the supply end of the filter and all other cables and circuitry to minimize RF coupling.

3.2.1 Ferrite Suppression Core Set-up

If PWM switching noise couples onto the feedback 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. TDK ZCAT series snap-on filters are recommended for reducing radiated emissions on all I/O cables.

3.2.2 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.

3.3 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 through a single low resistance wire for each case ground 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
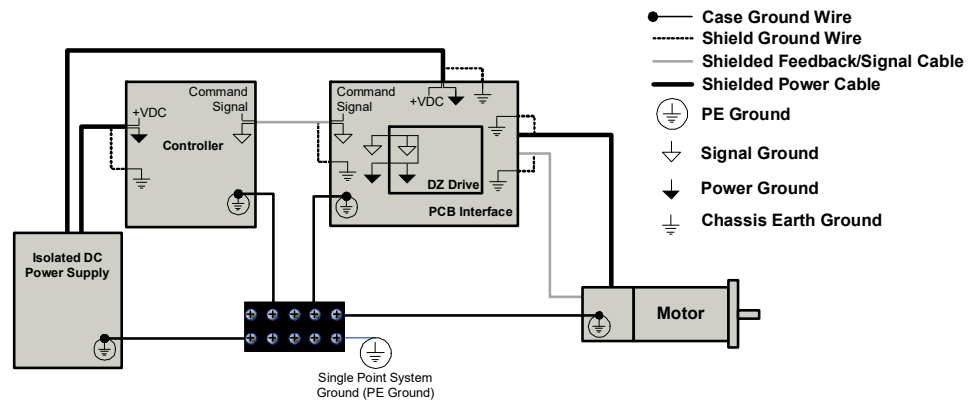
Ground cable shield wires at the mounting card or PCB interface side to a chassis earth ground point. The DC power ground and the input reference command signal ground are oftentimes at a different potential than chassis/PE ground. The signal ground of the controller must be connected to the signal ground of the DZ drive to avoid picking up noise due to the "floating" differential servo drive input. On all DZ 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.

> ⚠️ **Warning**
> 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.

3.4 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 or a noise suppression device 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.

3.4.1 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 of larger diameter wire rather than too thin. This recommendation becomes more critical as the cable length increases.

3.4.2 Motor Wires

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

- For a single phase motor or voice coil, twist the two motor wires together as a group.
- For a three phase 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!

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3.4.3 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.

3.4.4 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 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
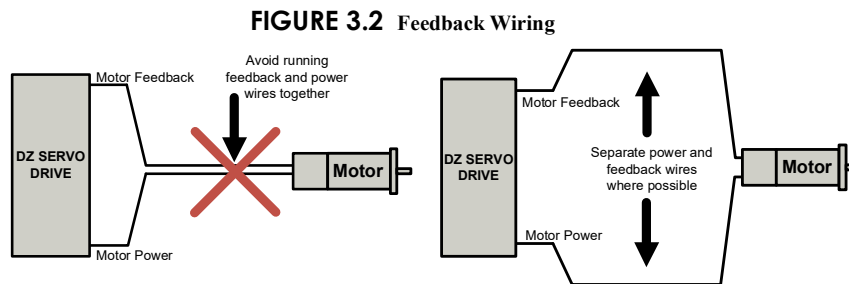
3.4.5 Input Reference Wires

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.

3.4.6 Communication Wires

DZ drives support standard RS-232 data transmission between a PC and the drive. Connect the PC transmit pin (Tx) to the drive receive pin (Rx), the PC receive pin (Rx) to the drive transmit pin (Tx), and connect the PC RS-232 ground to the drive signal ground.

3.5 Mounting

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

3.5.1 Mounting Card

DZ servo drives are designed to interface directly with the *ADVANCED* Motion Controls mounting cards **MC1XDZx03-xx**.

TABLE 3.1 MC1XDZx03-xx Mounting Card Models

Mounting Card	Network	Motor/Power Connector Type	Compatible Drive Models
MC1XDZC03	CANopen	Side-entry screw terminal	DZC models up to 40 A peak current
MC1XDZC03-HP1			DZC models up to 60A peak current (excludes 175 V models)
MC1XDZC03-QD		Vertical-entry quick disconnect	DZC models up to 25 A peak current
MC1XDZR03	RS485/232 Modbus RTU	Side-entry screw terminal	DZR models up to 40 A peak current
MC1XDZR03-HP1			DZR models up to 60 A peak current (excludes 175 V models)
MC1XDZR03-QD		Vertical-entry quick disconnect	DZR Models up to 25 A peak current

FIGURE 3.3 MC1XDZx03-xx Mounting Cards

| MC1XDZx03 | MC1XDZx03-QD | MC1XDZx03-HP1 |

Pinouts, dimensions, and ordering information for the mounting cards are obtainable on the mounting card datasheets, available for download at www.a-m-c.com. The datasheets include information on mating connectors and DIP Switch options.

MC1XDZx03-QD mounting card models are shipped with the following included screw terminal connectors:

TABLE 3.2 MC1XDZx03-QD Included Mating Connectors

Description	Qty. Included	Manufacturer and Part Number
4-terminal, 5.08 mm spaced insert connector	1	Phoenix Contact: P/N 1757035
3-terminal, 5.08 mm spaced insert connector	1	Phoenix Contact: P/N 1757022

Mating Connector Kit   Mating connector housing and crimp pins for the MC1XDZx03-xx mounting card models can be ordered as a kit using *ADVANCED* Motion Controls part number **KC-MC1XDZ02**. This includes mating connector housing and crimp style contacts for the I/O, Feedback, and Auxiliary Feedback connectors. The recommended tool for crimping the contacts is Molex part number **63811-6300**.

TABLE 3.3 Mating Connector Kit KC-MC1XDZ02 Included Connectors

Description	Qty. Included	Manufacturer and Part Number
16-port, dual-row, 2.00 mm spaced plug	1	Molex: P/N 51353-1600 (housing); 56134-9100 (contacts)
12-port, dual-row, 2.00 mm spaced plug	1	Molex: P/N 51353-1200 (housing); 56134-9100 (contacts)
10-port, dual-row, 2.00 mm spaced plug	1	Molex: P/N 51353-1000 (housing); 56134-9100 (contacts)

In addition, users may design their own mounting card to mate with a DZ servo drive. For more information on designing a DZ compatible PCB interface card, see "PCB Design" on page 33 and "Interface Circuitry Examples" on page 34.

3.5.2 PCB Mounting Options

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

Mating Connectors   DZ 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 DZ drives are shown in the table below. For detailed DZ physical dimensions, see "Physical Dimensions" on page 54.

TABLE 3.4 DZ Drives Socket Mating Connectors

Connector	Pins	Manufacturer and Part Number
Signal Connector - All DZ Drives	30	Samtec: BCS-115-L-D-PE
Power Connector - DZ-012L080	12	Samtec: BCS-112-L-S-PE
Power Connector - DZ-020L080, DZ-040L080*, DZ-060L080*, DZ-025L200*	24	Samtec: BCS-112-L-D-PE

*DZ-040L080, DZ-060L080, and DZ-025L200 drives will require two BCS-112-L-D-PE mating connectors for the power connectors

DZ 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 DZ 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 DZ drive. The diagram below shows the PCB mounting footprint for the DZ family. For specific dimensions, see "Mounting Dimensions" on page 55.

FIGURE 3.4 DZ Drive PCB Footprint
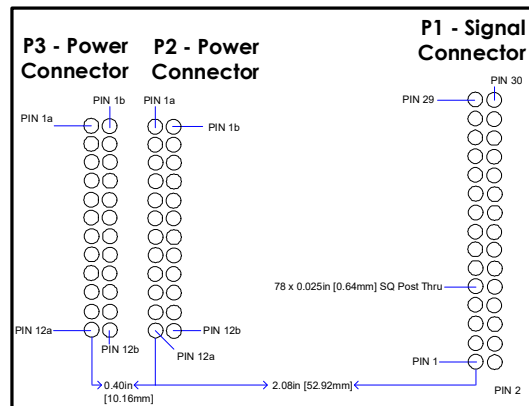
DZ-012L080 drives connect to P1 and the outside "A" row of P2, while DZ-020L080 drives connect to P1 and both rows of P2. DZ-040L080, DZ-060L080, and DZ-025L200 models connect to P1, P2, and P3.

Soldering Soldering a DZ board directly to a PCB provides added support against mechanical shocks and vibration. It is recommended to solder DZ drives to a PCB following the industry standard for Acceptability of Electronic Assemblies IPC-A-610D. Use solder with no-clean flux. DZ 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, DZ drives can be mounted with screws in tandem with one of the options above. DZ drives use 4/40 thread drive mounting screws to maintain mechanical stability between the baseplate and drive PCB. One or both of these drive mounting screw holes can also be used to secure the DZ drive to a mounting card or external PCB interface. See "Physical Dimensions" on page 54 and/or the specific drive's datasheet for exact screw locations and dimensions.

DZ drives can also be screw mounted through the two drive mounting screw holes or the two 4/40 thread screw holes on either side of the DZ 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 20 for more info.

3.6 PCB Design

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

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

- **Keep high current traces short -** Traces carrying high current, such as the DC Power traces and Motor Power traces, should be kept short and close together to minimize noise emissions. Also, keep DC Power traces separate from Motor Power 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 DZ 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 DZ 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.

3.7 Interface Circuitry Examples

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

Address Line Inputs   The two address line inputs on DZ drives are sensitive to voltage level. Voltages slightly above 3V can lead to damage of the drive. The user's interface card must be designed to take this into consideration, and ensure voltages greater than 3V are not applied to the address lines. The address lines should not be left floating. They should either have a voltage applied to them or be grounded (grounding both address lines will utilize the default address that is stored in non-volatile memory).

FIGURE 3.5 **Recommended Address Line Input**
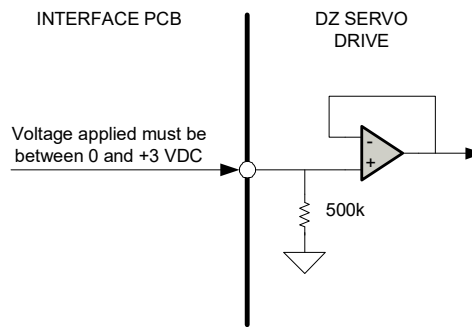
Be sure not to apply voltages greater than 3V to the address lines to prevent damage to the drive! Example voltage levels are given in "Address Selector" on page 46 and on the drive's datasheet.

Caution

CAN Transceiver   For DZC drives, the CAN transceiver is not supplied on the drive. A CAN transceiver and additional circuitry must be provided on the user's interface card. The recommended circuitry is shown in Figure 3.6. DZR drives do not require a CAN transceiver.

FIGURE 3.6 **Recommended CAN Transceiver**
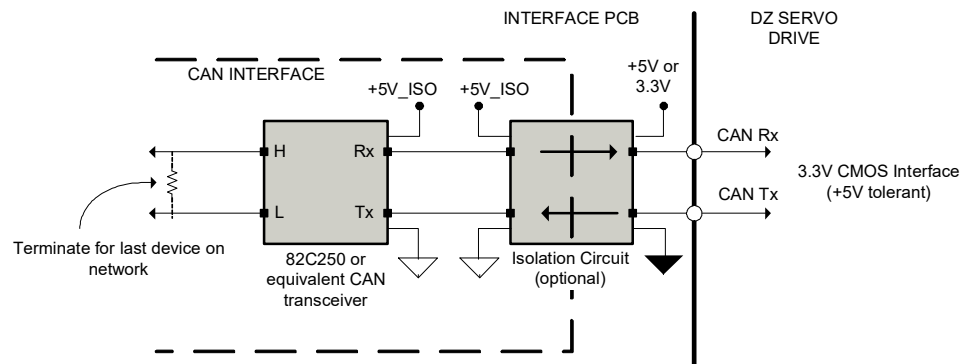
RS-485/232 Interface Figure 3.7 is an example of how the RS-485/232 connections could be realized when designing a mounting card or PCB interface for a DZR drive. Note that the default communication setting for DZR drives is RS-232. In order to select RS-485, a jumper must be installed on the drive. See "RS-485 Selection Jumper" on page 49 for more information.

FIGURE 3.7 RS-485/232 Interface
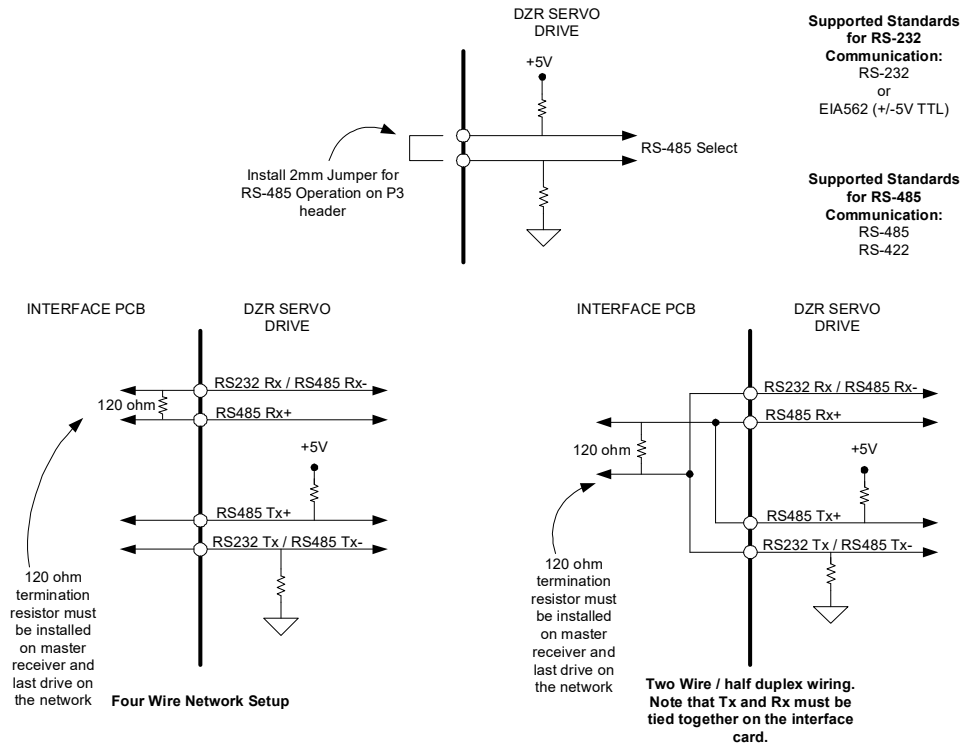
Digital Inputs (High Speed) DZ drives provide differential programmable digital inputs. These inputs can be used for Capture, Step and Direction, PWM and Direction, or Auxiliary Encoder inputs. Figure 3.8 below is an example of how the mounting card/interface board should be designed for proper operation. For single-ended operation, use only the positive input, and provide a +2.5V reference to the negative input. A voltage divider as shown in Figure 3.8 is the recommended method to provide the necessary input. Note that if using any of the MC1XDZx03-xx mounting cards, the voltage divider circuitry is provided on the mounting card.

FIGURE 3.8 Recommended High Speed Digital Inputs Interface
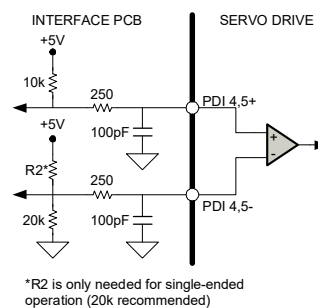
Digital Inputs (Standard)   DZ drives provide single-ended TTL level programmable digital inputs. Figure 3.9 below is an example of how the mounting card/interface PCB should be designed for proper operation.

FIGURE 3.9   **Recommended Standard Digital Inputs Interface**
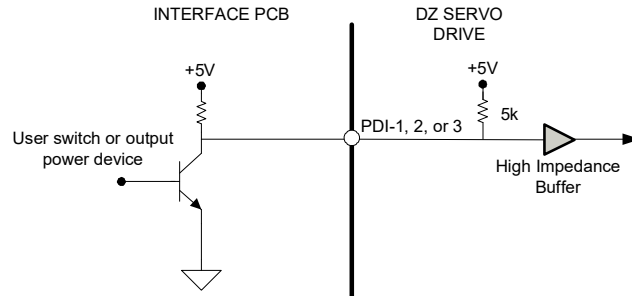
Digital Outputs   DZ drives provide single-ended programmable digital outputs. Figure 3.10 is an example of how the mounting card/interface PCB should be designed for proper operation.

FIGURE 3.10   **Recommended Digital Outputs Interface**
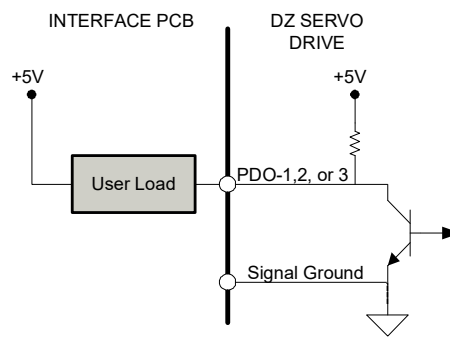
Digital Outputs will be pulled low for ~90ms when the drive logic is initialized. For applications using the digital outputs with a brake, it is recommended to select the Active Low configuration for the output to avoid a disturbance due to toggling at power-up or reset.

Analog Inputs   DZ drives provide one programmable analog input. Figure 3.11 below is an example of how the mounting card/interface PCB should be designed for proper operation.

FIGURE 3.11   **Recommended Analog Inputs Interface**
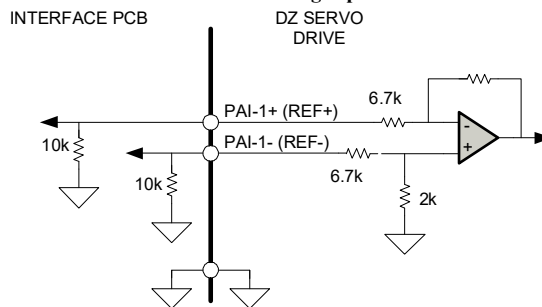
Tachometer Input   DZ drives support the use of a tachometer for velocity feedback. The Programmable Analog Input is available for use with a tachometer. The tachometer signal is limited to ±10 VDC.

FIGURE 3.12 **Recommended Tachometer Interface Wiring**
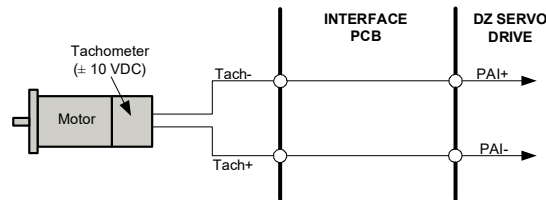
Hall Sensor Inputs   DZ drives allow single-ended Hall Sensor inputs both for commutation and velocity feedback. For single-ended Halls, no additional circuitry is required on the PCB interface. For differential Halls, the inputs must first go through a signal conditioning amplifier. Users designing their own mounting card or interface PCB must be sure to include this feature in their design. Figure 3.13 shows the recommended single-ended Hall Sensor inputs, as well as the signal conditioning circuitry that is required for differential inputs.

FIGURE 3.13 **Recommended Hall Sensor Interface Wiring**

i
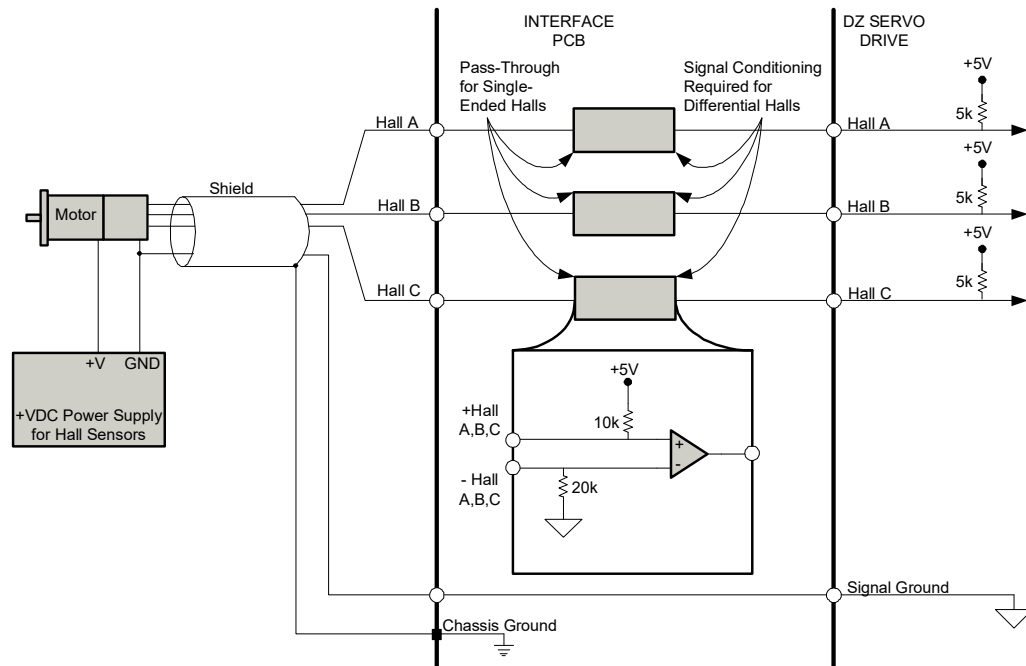
While DZ drives are designed for single-ended Hall Sensor inputs, the mounting card or PCB interface board may be designed for use with differential Hall Sensor inputs.

Note

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Encoder Inputs DZ drives support differential incremental encoder inputs. **The encoder inputs are not filtered on the drive. Users designing their own interface card must provide this circuitry on their interface card.** Figure 3.14 below shows how the recommended filter circuitry should be designed into the interface PCB for each differential encoder input. This filter circuitry is highly recommended even if the encoder is physically close to the DZ drive in the system. The encoder also must be powered by an external power supply that is referenced to the same ground as the DZ drive's signal ground. 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 a DZ drive.

FIGURE 3.14 **Recommended Encoder Input Interface Wiring**

*R2 is only needed for single-ended operation. (20K recommended)
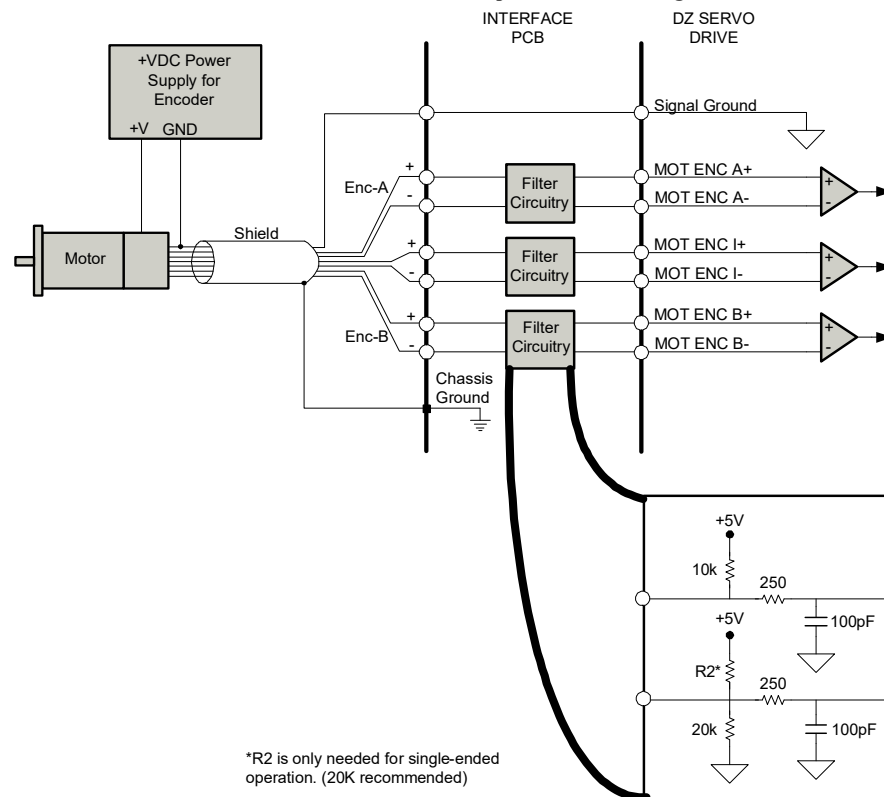
While DZ drives accept differential encoder inputs, the mounting card or PCB interface can be designed for use with single-ended inputs.

Note

For single-ended operation, use only the positive input, and provide a +2.5V reference to the negative input. A voltage divider as shown in Figure 3.14 is the recommended method to provide the necessary input. Note that if using any of the MC1XDZx03-xx mounting cards, the voltage divider circuitry is provided on the mounting card.

Logic Supply Input DZ drives require an external 5 VDC (±5%) Logic Power Supply. This logic power should be referenced to the DZ drive signal ground (internally tied to DZ power ground). Figure 3.15 shows how to connect a Logic Power Supply through a mounting card/interface PCB.

> ⚠️
> Caution
>
> The external +5VDC logic power must be turned on before the main power supply.

FIGURE 3.15 **Recommended Logic Supply Input Wiring**
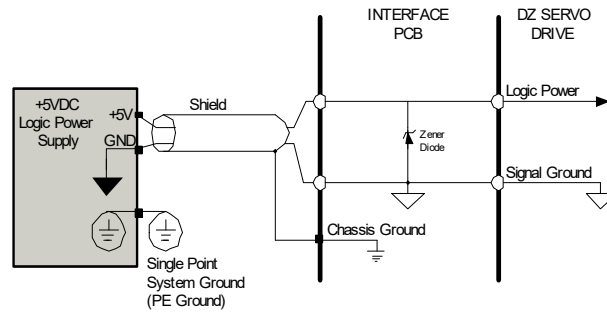
> ⚠️
> Caution
>
> For applications where a stable +5VDC supply cannot be guaranteed, it is recommended to include a 5.6V / 500mW-min Zener diode on the interface PCB or mounting card between the external +5VDC logic supply and the DZ servo drive to protect the drive logic circuitry.
>
> In the event of an over-voltage occurrence on the +5VDC supply, the Zener diode will prevent damage to the drive. Note that frequent or sustained over-voltage events can eventually damage the Zener diode and result in damage to the drive. For applications where this could occur, a 0.5A-max resettable or 0.4A-max fast blow fuse is recommended on the interface card or PCB input line of the +5V source.

DC Power Input   Figure 3.16 shows how a DZ 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 3.16 **Recommended DC Power Input Wiring**
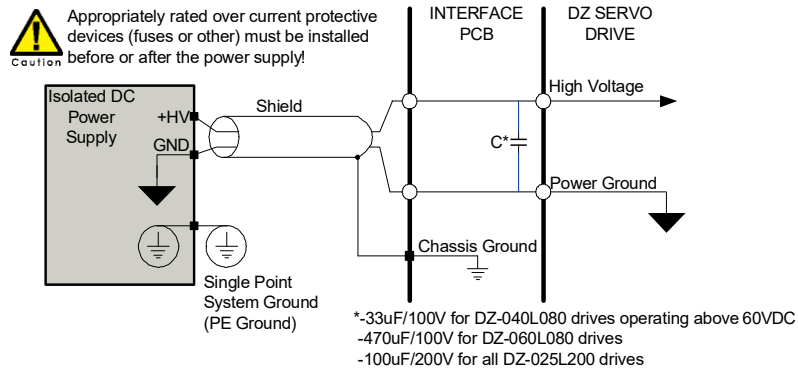
Depending on the power capacity of the DZ drive model being used there may be multiple pins for DC Input Power connections. Refer to the datasheet of the specific model being used. The maximum current capacity per pin is 3A continuous.

Notice

For DZ-040L080 drives operating at a supply voltage above 60 VDC, an additional 33µF, 100V electrolytic capacitor is required close to the drive between High Voltage and Power Ground.

For DZ-060L080 drives, an external 470µF, 100V capacitor is required close to the drive between High Voltage and Power Ground

For DZ-025L200 drives, an external 100µF, 200V electrolytic capacitor is required close to the drive between High Voltage and Power Ground.

Caution

Motor Power Output The figures below shows how a DZ servo drive connects to various motor types through a mounting card/interface PCB. 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 3.17 **Recommended Motor Power Output Wiring**

THREE PHASE BRUSHLESS MOTOR
(Servo – BLDC/PMAC, Closed Loop Vector, Closed Loop Stepper)

INTERFACE PCB   DZ SERVO DRIVE
Motor C
Motor B
Motor A
Shield
Motor
Single Point System Ground (PE Ground)
Chassis Ground

SINGLE PHASE MOTOR
(Brushed, Voice Coil, Inductive Load)

INTERFACE PCB   DZ SERVO DRIVE
Motor B
Motor A
Shield
Motor
Single Point System Ground (PE Ground)
Chassis Ground

Specify in DriveWare which two motor phases are being used

TWO PHASE STEPPER MOTOR
(Closed Loop Stepper)

INTERFACE PCB   DZ SERVO DRIVE
A+   Motor A
A-   Motor C
B-
B+   Motor B
Shield
Motor
Single Point System Ground (PE Ground)
Chassis Ground

Note that the two negative motor leads are tied together, and both are connected to the MOTOR C output.

Additional setup information for 2-phase stepper motors can be found in Applications Note 37.

Notice — Depending on the power capacity of the DZ drive model being used there may be multiple pins / connectors for Motor Power connections - current is distributed equally across all pins / connectors per phase. Refer to the datasheet of the specific model being used. The maximum current capacity per pin is 3A continuous.

Caution — If using relays or other means to disconnect the motor leads, be sure the drive is disabled before reconnecting the motor leads to the drive. Connecting the motor leads to the drive while it is enabled can generate extremely high voltage spikes which will damage the drive.

Caution — For applications using stepper motors, the maximum motor speed will be limited (typically ~600 RPM max).

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STO (Safe Torque Off) Interface

DZCANTS models feature an external dedicated +24VDC STO safety function designed to monitor an external 24V STO input from the user system and disable the motor output during an STO event. The STO circuit uses +24VDC sinking single-ended isolated inputs for STO functionality. Both STO1 and STO2 must be active (HIGH) to allow torque output at the drive motor outputs.

TABLE 3.5 STO Signal Behavior

STO 1	STO 2	Motor Outputs	STO OUT
Active (HIGH)	Active (HIGH)	Enabled	Open
Active (HIGH)	Not Active (LOW)	Disabled	Closed
Not Active (LOW)	Active (HIGH)	Disabled	Closed
Not Active (LOW)	Not Active (LOW)	Disabled	Closed

The STO circuitry also features an STO status output (STO OUT) that signifies when an STO condition has occurred. This status is also viewable in the setup software as an indicator only. The STO OUT output functions as a switch. When an STO event occurs, the STO OUT switch becomes CLOSED. When the drive is in normal functional operation (STO 1 and STO 2 = 24V) the STO OUT switch is OPEN.

FIGURE 3.18 STO Connections

See "Mounting" on page 30 and "PCB Design" on page 33 for connector and mating hardware information, and "Pinouts and Pin Layouts" on page 14 for pin numbering information. Functional Safety is TÜV Rheinland certified and meets requirements of the following standards:

- EN ISO 13849-1 -- Category 4 / PL e
- EN IEC 61800-5-2 -- STO (SIL 3)
- EN 62061 -- SIL CL3
- IEC 61508 -- SIL 3
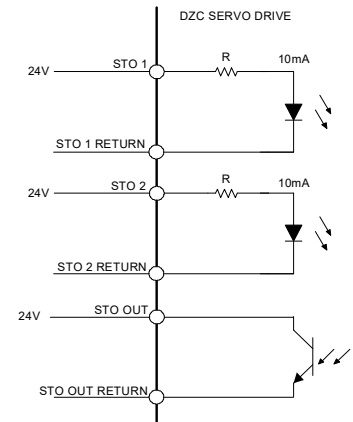
The user must verify proper operation of the monitoring circuit (STO1 and STO 2) at least once per month to maintain SIL 3, Cat 4 / PL e certification. The monitoring circuit is required to be examined by an external logic element when STO is incorporated into a complete drive system in order for proper diagnostics to be fully implemented and utilized in the FMEA calculation (see "STO Operation Test" on page 43). The calculation of the safety relevant parameters are based on a proof test interval of one year and have shown that the requirements of up to SIL 3 are fulfilled. The safety relevant parameters are:

- Safe-Failure-Fraction: SFF = 97%
- Probability of a dangerous failure per hour: PFH = 1.3×10^{-8} 1/h
- Average probability of a dangerous failure on demand (1 year): PFD_{avg} = 1.7×10^{-5}

> ⓘ **Note**
> The above assessment and safety values defined were assessed with the STO function incorporated into the DigiFlex Performance DZC drive family. Product data for the DZC drive family can be found by visiting www.a-m-c.com.

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STO Operation Test To maintain SIL 3, Cat 4 / PL e certification, the operation of the STO monitoring circuit (STO1 and STO2) must be verified at least once per month. The following procedure provides an example of a method to verify correct STO functionality. Note that it is the responsibily of the system operator to ensure all personal and machine safety requirements for the system are properly enforced during the proof test.

1. Power on the drive.
2. Verify the drive is in an Enabled state (by viewing the GREEN Status LED or by monitoring via a digital controller or network commands).
3. Remove the voltage signal from the STO1 input pin via a digital controller signal, network command, or by physically removing the STO Connector if safe to do so.
4. Verify that the drive is in a Disabled state (by viewing the Status LED is RED, or by verifying the STO OUT switch has closed).
5. Re-apply the voltage signal to the STO1 pin. Verify that the drive is once again in an Enabled state (by viewing the GREEN Status LED or by monitoring via a digital controller or network commands).
6. Repeat the above steps for the STO2 signal.

> **(i) Note**
> End-product certification may require a different interval test schedule or test requirements. It is the responsibility of the end-user to determine the required test interval and requirements for certifications other than stated above.

4 Operation and Features

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

4.1 Features and Getting Started

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

4.1.1 Initial Setup and Configuration

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:

- DZ Servo Drive attached to Mounting Card or PCB Interface
- Motor
- DC Power Supply and Logic Power Supply for supplying power to system
- DriveWare Setup Software and Software Manual for detailed instructions on how to setup, tune and configure a DZ drive in DriveWare

The following steps outline the general procedure to follow when commissioning a DZ drive for the first time. The DriveWare Software Manual contains more detailed information on each step.

1. **Check System Wiring:** Before beginning, check the wiring throughout the system to ensure proper connections and that all grounding and safety regulations have been followed appropriately for the system.

> ⚠️ **C a u t i o n**
>
> Do not apply power to the system until certain all wiring and grounding has been setup safely and properly!
>
> Turn on the external logic supply first before turning on the main power supply.

2. **Apply Power:** Power must be applied to the drive before any communication or configuration can take place. Turn on the +5 VDC Logic supply, then turn on the main DC Power supply. Use a multimeter or voltmeter to check that both power supply levels are within their specified ranges.

3. **Establish Connection:** Open DriveWare on the PC. The DZ drive should be attached to a mounting card or PCB interface, and connected to the PC with a serial cable. Choose the "Connect to a drive" option when DriveWare starts, and enter the appropriate communication settings in the options window that appears. See the DriveWare Software Guide for more information on connecting to a drive. For connection issues, see "Connection Problems" on page 58.

4. **Input Motor Data:** Once DriveWare has connected to the DZ drive, the motor and feedback information must be entered in DriveWare. This information is required for the drive to be configured properly.

5. **Set User Units:** User Units allows the user to set the general units that will be used in DriveWare. A variety of unit types are available, and DriveWare also offers the option of using custom units.

6. **Configure Drive Limits and Events:** DriveWare allows the user to manually configure system parameters and limits, and assign "actions" to specific events. The limits and their corresponding actions are used as both safety measures to avoid system damage, as well as parameter observation tools for drive configuration and troubleshooting.

7. **Tune the Current Loop:** Once the drive parameters are configured properly, the current loop must be tuned. This is the innermost loop and forms the basis of all motion. The current loop gains can be calculated based on the motor and application data entered in the previous two steps, or they can be set manually. The DriveWare Software Manual contains instructions on current loop tuning.

8. **Commutate the Motor:** For Three Phase (Brushless) motors, commutation is necessary to maintain the optimal torque generation at any motor position. Typically this is accomplished by running the AutoCommutation routing in DriveWare. Also see "Commutation" on page 50.

Once the drive has been commutated successfully, the drive is ready for further use, such as velocity or position loop tuning. Consult the DriveWare Software Manual for the correct procedure.

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4.1.2 Input/Output Pin Functions

DZ 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.

Address Selector   The Address Selector Inputs are used for CAN bus addressing on DZC drives and RS-485 network addressing on DZR drives, by applying certain voltage values to the two Address Selector Input pins, P1-1 and P1-2.

> The Address Selector Input pins have a voltage range of 0 to 3V. Do not apply voltages greater than 3V to avoid damaging the drive!
>
> C a u t i o n

- For DZC drives, to set the CAN node address of a drive, use the formula:

$$\text{CANAddress} = \frac{7 \cdot \text{Addr0}}{3} + 8 \cdot \frac{7 \cdot \text{Addr1}}{3}$$

Where:

CANAddress	. . . . the desired node address
Addr0	. . . . voltage applied to pin CAN ADDR 0 (P1-1)
Addr1	. . . . voltage applied to pin CAN ADDR 1 (P1-2)

Values for Addr0 and Addr1 are always integer multiples of 3/7 V within the range of 0 to 3 V. Examples of the voltages required to set certain node addresses are given in Table 4.1 below. Note that setting a CAN address of 0 will utilize the address stored in non-volatile memory.

- For DZR drives, to set the address of a drive, use the formula:

$$\text{RS485Address} = \frac{7 \cdot \text{Addr0}}{3} + 8 \cdot \frac{7 \cdot \text{Addr1}}{3}$$

Where:

RS485Address	. . . . the desired drive address
Addr0	. . . . voltage applied to pin RS485 ADDR 0 (P1-1)
Addr1	. . . . voltage applied to pin RS485 ADDR 1 (P1-2)

Values for Addr0 and Addr1 are always integer multiples of 3/7 V within the range of 0 to 3 V. Examples of the voltages required to set certain node addresses are given in Table 4.2 below. Note that setting a drive address of 0 will utilize the address stored in non-volatile memory.

TABLE 4.1 CAN Address Example Values

CAN Address Values			
CAN ADDR 0 Value (V)	CAN ADDR 1Value (V)	CAN ADDR Tolerance (V)	CAN Address (Node #)
0	0	+/-0.1	Address stored in non-volatile memory
3/7 (0.43)	0	+/-0.1	1
6/7 (.86)	0	+/-0.1	2
9/7 (1.3)	0	+/-0.1	3
...	...	+/-0.1	...
18/7 (2.57)	21/7 (3.0)	+/-0.1	62
21/7 (3.0)	21/7 (3.0)	+/-0.1	63

TABLE 4.2 RS485 Address Example Values

RS485 Address Values			
RS485 ADDR 0 Value (V)	RS485 ADDR 1Value (V)	RS485 ADDR Tolerance (V)	RS485 Address (Address #)
0	0	+0.1	Address stored in non-volatile memory
3/7 (0.43)	0	+/-0.1	1
6/7 (.86)	0	+/-0.1	2
9/7 (1.3)	0	+/-0.1	3
...	...	+/-0.1	...
18/7 (2.57)	21/7 (3.0)	+/-0.1	62
21/7 (3.0)	21/7 (3.0)	+/-0.1	63

Baud Rate Selector   The Baud Rate Selector Input is used to set the CAN bit rate on DZC drives and the RS-485 baud rate on DZR drives, by applying a certain voltage value to the Baud Rate Selector input, P1-6. Note that applying zero voltage to the Baud Rate Selector pin will utilize the baud rate stored in non-volatile memory (additional rates possible other than listed below).

- For DZC drives, the CAN bit rate is set by applying the appropriate voltage to the Baud Rate Selector Input (P1-6) as given in Table 4.3.

TABLE 4.3 CAN Bit Rate Values

CAN Bit Rate Values		
CAN BAUD Value	CAN BAUD Tolerance	CAN Bus Bit Rate (bits/s)
0	+/-0.388	Bit rate stored in non-volatile memory
1	+/-0.388	500k
2	+/-0.388	250k
3	+/-0.3880	125k

- For DZR drives, the RS-485 baud rate is set by applying the appropriate voltage to the Baud Rate Selector Input (P1-6) as given in Table 4.4.

TABLE 4.4 RS-485 Baud Rate Values

RS-485 Baud Rate Values		
RS-485 BAUD Value	RS-485 BAUD Tolerance	RS-485 Baud Rate (bits/s)
0	+/-0.388	Bit rate stored in non-volatile memory
1	+/-0.388	9.6k
2	+/-0.388	38.4k
3	+/-0.3880	115.2k

Programmable Digital Inputs   DZ drives provide three single-ended (P1-10, P1-11, P1-12) and two differential (P1-17/18, and P1-19/20) Programmable Digital Inputs. These can be assigned to one or more functions in DriveWare. The differential high speed inputs can also be used as command source inputs for PWM and Direction (see "PWM and Direction Input"),

with an Auxiliary Encoder (see "Auxiliary Encoder Input"), or as an external Step and Direction input (see "Step and Direction Input (DZR drives only)").

Programmable Digital Outputs DZ drives provide three single-ended Programmable Digital Outputs on pins P1-7, P1-8, and P1-9. These can be assigned to one or more functions in DriveWare.

Programmable Limit Switch (PLS) Outputs

When a digital output is configured as a Programmable Limit Switch through the setup software, the maximum frequency of the output will correspond to the table below.

TABLE 4.5 Maximum Digital Output Frequency for PLS Outputs

	Maximum Frequency
5V I/O Control Modules	5 kHz (for 20 kHz switching frequency)[1]

1. Lower switching frequencies will result in lower output frequencies due to sampling on 5V I/O control modules.

Programmable Analog Input Pins P1-3 and P1-4 can be used as a differential Programmable Analog Input if they are not being used as an analog reference command input. A drive function can be assigned to the analog input in DriveWare. A tachometer can also be connected to the PAI as a velocity feedback device.

Capture Inputs DZ drives provide three Capture signals that can be used to capture and view internal signals on a designated trigger (rising edge, falling edge, or both). The Capture signals are connected to the DZ drive at pins P1-12, P1-17, and P1-19. If using pins P1-17 and P1-19 for Capture inputs, the drive will not be able to utilize the PWM and Direction, Auxiliary Encoder, or Step and Direction features.

Parameters and options for the Capture signals can be entered and configured in DriveWare.

Auxiliary Encoder Input DZ drives accept a differential auxiliary encoder input that can be used when operating the drive in Encoder Following mode. The auxiliary encoder signals are connected to the DZ drive at the High Speed Programmable Digital Input pins, P1-17 through P1-20. The auxiliary encoder index (single-ended only) should be connected to pin P1-12. If using these pins for an auxiliary encoder input, the drive will not be able to utilize the High Speed Capture, PWM and Direction, or Step and Direction features.

Hardware settings and options for the auxiliary encoder can be entered and configured in DriveWare. The DZ drive will have to be operating in Position Mode in order to utilize the auxiliary encoder input.

> ⓘ **Note** The MC1XDZx03-xx mounting cards provides the option of using a single-ended auxiliary encoder signal. Users designing their own PCB interface may also design the appropriate circuitry on their PCB interface to allow single-ended inputs. See "Digital Inputs (High Speed)" on page 35 for circuitry recommendation.

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PWM and Direction Input   DZ drives accept a PWM and Direction or a Single Input PWM signal as the command source input. The PWM and Direction input signals are connected to the DZ drive at the High Speed Programmable Digital Input pins, P1-17 through P1-20. If using these pins for an auxiliary encoder input, the drive will not be able to utilize the High Speed Capture, Auxiliary Encoder, or Step and Direction features.

> **ⓘ**
> **Note**
>
> The MC1XDZx03-xx mounting cards provides the option of using a single-ended auxiliary encoder signal. Users designing their own PCB interface may also design the appropriate circuitry on their PCB interface to allow single-ended inputs. See "Digital Inputs (High Speed)" on page 35 for circuitry recommendation.

Step and Direction Input (DZR drives only)   DZR drives accept a differential Step and Direction input command. The Step and Direction input signals are connected to the DZ drive at the High Speed Programmable Digital Input pins, P1-17 through P1-20. If using these pins for Step and Direction command, the drive will not be able to utilize the High Speed Capture, PWM and direction, or Auxiliary Encoder features.

Limits and options for the Step and Direction command signal can be entered and configured in DriveWare.

> **ⓘ**
> **Note**
>
> The MC1XDZx03-xx mounting cards provides the option of using single-ended Step and Direction input signals. Users designing their own PCB interface may also design the appropriate circuitry on their PCB interface to allow single-ended inputs. See "Digital Inputs (High Speed)" on page 35 for circuitry recommendation.

4.1.3 RS-485 Selection Jumper

DZR drives have the option of switching between RS-232 and RS-485 communication. To select RS-485 communication, a jumper (2mm) must be installed between pins 1 and 2 of the 6-pin jumper header between the drive PCB and heatsink (two vertical pins closest to the corner of the PCB).

FIGURE 4.1 **RS-485 Selection Header Jumper Pins**
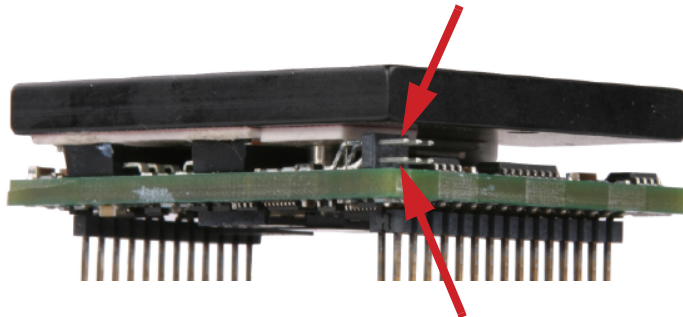
Leaving these two pins open will automatically configure the drive for RS-232 communication. Once the jumper has been installed, the drive must be power cycled to enable RS-485 communications. See "RS-485/232 Interface" on page 35 for more information.

The default communication parameters for RS-232 and RS-485 communication are 115200 Baud and drive address 63, respectively. These parameters can be changed within DriveWare once a connection is established. The recommended baud rate setting is 115200 for RS-232, and 115200 or higher for RS-485. If necessary, a baud rate of 9600 can be used to connect to the drive, but the baud rate should be increased prior to commissioning the drive.

The RS-485 communication parameters are independent of RS-232 parameters. If the drive is returned to RS-232 mode, the original communication parameters that were set in RS-232 mode will take effect.

4.1.4 Homing

DZ drives can be configured in DriveWare to "home" to a certain reference signal. This reference signal can be any number of different signal types, such as limit switches, home switches, or encoder index pulses. See the DriveWare Software Manual for more information on Homing.

4.1.5 Commutation

Motor commutation is the process that maintains an optimal angle between the magnetic field created by the permanent magnets in the motor and the electromagnetic field created by the currents running through the motor windings. This process ensures optimal torque or force generation at any motor position. Single phase (brushed) motors accomplish this process with internal commutators built into the motor housing. Three phase (brushless) motors require a correctly configured drive to commutate properly, however. There are two ways to configure a DZ digital drive to commutate a three phase (brushless) motor in DriveWare:

- AutoCommutation: Most applications can use the AutoCommutation routine in DriveWare for configuring a drive to a specific motor. This routine will automatically detect the feedback devices attached to the motor and ask the user to verify them against the motor's data sheet.
- Manual Commutation: This process requires more time, and may not be as accurate as AutoCommutation. This method will have to be performed if:
  - The motor is mechanically restrained such that it is unable to rotate (AutoCommutation requires the motor to rotate 2 revolutions + 1 electrical cycle in both directions for a rotary motor, and 3 electrical cycles for a linear motor).
  - The motor or load has a significant amount of inertia.

For three phase (brushless) drives that use encoder feedback but no Hall Sensors, it is required to run the "Phase Detect" routine in DriveWare before AutoCommutation. Phase Detect works by sending a small current signal to the motor, prompting the motor to vibrate slightly for a few seconds. The encoder feedback from this movement provides a starting position for the motor, allowing the drive to then be properly commutated.

See the DriveWare Software Manual for more information on AutoCommutation, Manual Commutation, and Phase Detect.

DZ drives allow either sinusoidal or trapezoidal commutation.

Sinusoidal Commutation

Sinusoidal commutation provides greater performance and efficiency than trapezoidal commutation. DZ drives can commutate sinusoidally when connected to a motor-mounted encoder. Sinusoidal Commutation works by supplying current to each of the three motor phases smoothly in a sinusoidal pattern. The flow of current through each phase is shifted by 120 degrees. The sum of the current flowing through all three phases adds up to zero. Figure 4.2 shows one electrical cycle of the motor phase currents.

FIGURE 4.2 **Sinusoidal Commutation Motor Phase Currents**
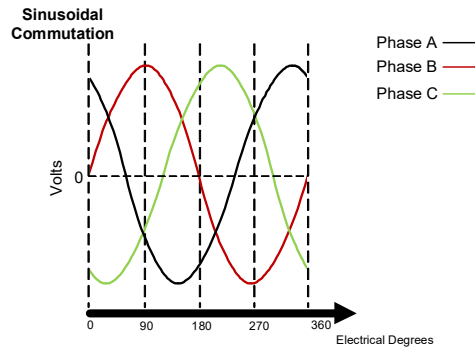
Trapezoidal Commutation

Trapezoidal commutation is accomplished with the use of Hall Sensors on three phase (brushless) motors. DZ drives can commutate trapezoidally when used with properly spaced Hall Sensors. Unlike sinusoidal commutation, current flows through only two motor phases at a time with trapezoidal commutation. The Hall Sensors each generate a square wave with a certain phase difference (either 120- or 60-degrees) over one electrical cycle of the motor. This results in six distinct Hall states for each electrical cycle. Depending on the motor pole count, there may be more than one electrical cycle per motor revolution. The number of electrical cycles in one motor revolution is equal to 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 as shown in Figure 4.3.

FIGURE 4.3 Hall Sensor Commutation and Motor Phase Current for 120-Degree Phasing
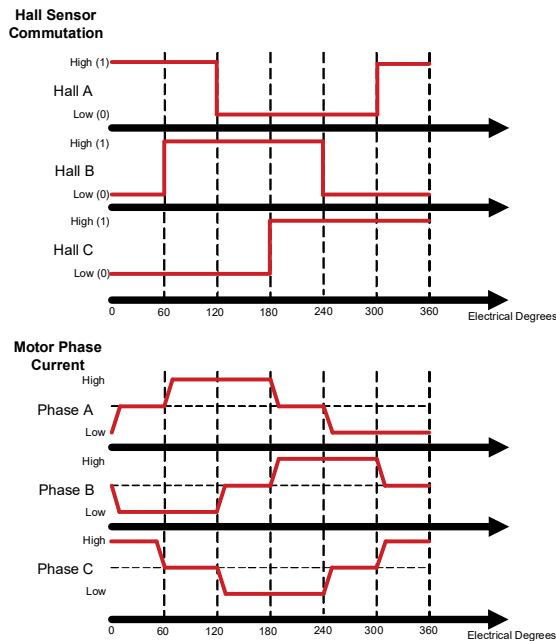
Note: DZ drives use a different commutation logic than other ADVANCED Motion Controls' servo drives. The diagrams provided here should be used only with DZ drives.

Table 4.6 shows the default commutation states for 120-degree and 60-degree phasing. Depending on the specific setup, the sequences may change after running AutoCommutation.

TABLE 4.6 Digital Drive 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	-	LOW	HIGH
	1	1	0	1	1	0	HIGH	LOW	-
	1	1	1	0	1	0	HIGH	-	LOW
	0	1	1	0	1	1	-	HIGH	LOW
	0	0	1	0	0	1	LOW	HIGH	-
	0	0	0	1	0	1	LOW	-	HIGH
Invalid	1	0	1	1	1	1	-	-	-
	0	1	0	0	0	0	-	-	-

4.1.6 Logic Power Supply

DZ drives require an external +5 VDC (±5%) power supply to provide power to the logic circuitry. The logic power supply ground should be referenced to the DZ drive signal ground. See "Logic Supply Input" on page 39 for more information.

4.1.7 Firmware

DZ drives are shipped with the latest version of firmware already stored in the drive. Periodic firmware updates are posted on *ADVANCED* Motion Controls' website, www.a-m-c.com. See the DriveWare Software Manual for information on how to check the drive's firmware version, and how to download new firmware into the drive when necessary.

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A Specifications

A.1 Specifications Tables

TABLE A.1 Power Specifications

Description	Units	DZ-012L080	DZ-020L080	DZ-040L080	DZ-060L080	DZ-025L200
DC Supply Voltage Range[1]	VDC	20-80	10-80			40-175
DC Bus Over Voltage Limit	VDC	88				195
DC Bus Under Voltage Limit	VDC	17	8			32
Logic Supply Voltage	VDC	5 (±5%)				
Maximum Peak Output Current[2]	A (A$_{rms}$)	12 (8.5)	20 (14.1)	40 (28.3)	60 (42.4)	25 (17.7)
Maximum Continuous Output Current	A (A$_{rms}$)	6 (6)	12 (12)	20 (20)	30 (30)	12.5 (12.5)
Maximum Power Dissipation at Continuous Current	W	24	48	80	120	109
Internal Bus Capacitance[1]	μF	33	94	141	30	20
Minimum Load Inductance[3]	μH	250				
Switching Frequency	kHz	20				
Maximum Output PWM Duty Cycle	%	92				

1. For DZ-040L080 drives, if the drive is operated at a supply voltage over 60 VDC, an external 33μF, 100V electrolytic capacitor is required between High Voltage and Power Ground. For DZ-060L080 drives, an external 470μF, 100V electrolytic capacitor is required between High Voltage and Power Ground. For DZ-025L200 drives, an external 100μF, 200V electrolytic capacitor is required between High Voltage and Power Ground.
2. Capable of supplying drive rated peak current for 2 seconds with 10 second foldback to continuous value. Longer times are possible with lower current limits.
3. Lower inductance is acceptable for bus voltages well below minimum. Use external inductance to meet requirements.

TABLE A.2 Control Specifications

Description	DZR	DZC
Network Communication	RS485/232 or Modbus RTU	CANopen (RS-232 for Configuration)
Command Sources	±10V Analog, Over the Network, Encoder Following, PWM & Direction, 5V Step & Direction, Sequencing, Indexing, Jogging	±10V Analog, Over the Network, Encoder Following, PWM & Direction, Sequencing, Indexing, Jogging
Commutation Methods	Sinusoidal, Trapezoidal	Sinusoidal, Trapezoidal
Control Modes	Current, Hall Velocity, Position, Velocity	Profile Modes, Cyclic Synchronous Modes, Current, Velocity, Position, Interpolated Position Mode (PVT)
Motors Supported	Three Phase (Brushless Servo), Single Phase (Brushed Servo, Voice Coil, Inductive Load), Stepper (2- or 3-Phase Closed Loop), AC Induction (Closed Loop Vector)	
Hardware Protection	40+ Configurable Functions, Over Current, Over Temperature (Drive & Motor), Over Voltage, Short Circuit (Phase-Phase & Phase-Ground), Under Voltage	
Programmable Digital I/O	5 Inputs, 3 Outputs	5 Inputs, 3 Outputs
Programmable Analog I/O	1 Input	1 Input
Feedback Supported	Hall Sensors, Differential Incremental Encoder, Aux. Incremental Encoder, ±10 VDC Position	

TABLE A.3 Environmental Specifications

Parameter	Description
Ambient Temperature Range	See Figure A.1
Baseplate Temperature Range	0 - 65 ℃ (DZ-012L080) ; 0 - 75 ℃ (DZ-020L080 / DZ-040L080)
Humidity	90%, non-condensing
Mechanical Shock	15g, 11ms, Half-sine
Vibration	30 grms for 5 minutes in 3 axes
Altitude	0-3000m

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FIGURE A.1 DZ Ambient Temperature Ranges

Maximum Ambient °C
DZ-012L080 Drive Models at 80VDC

Maximum Ambient °C
DZ-020L080 Drive Models at 80VDC

Maximum Ambient °C
DZ-040L080 / DZ-060L080 Drive Models at 80VDC (see note 2)

Maximum Ambient °C
DZ-025L200 Drive Models at 175VDC
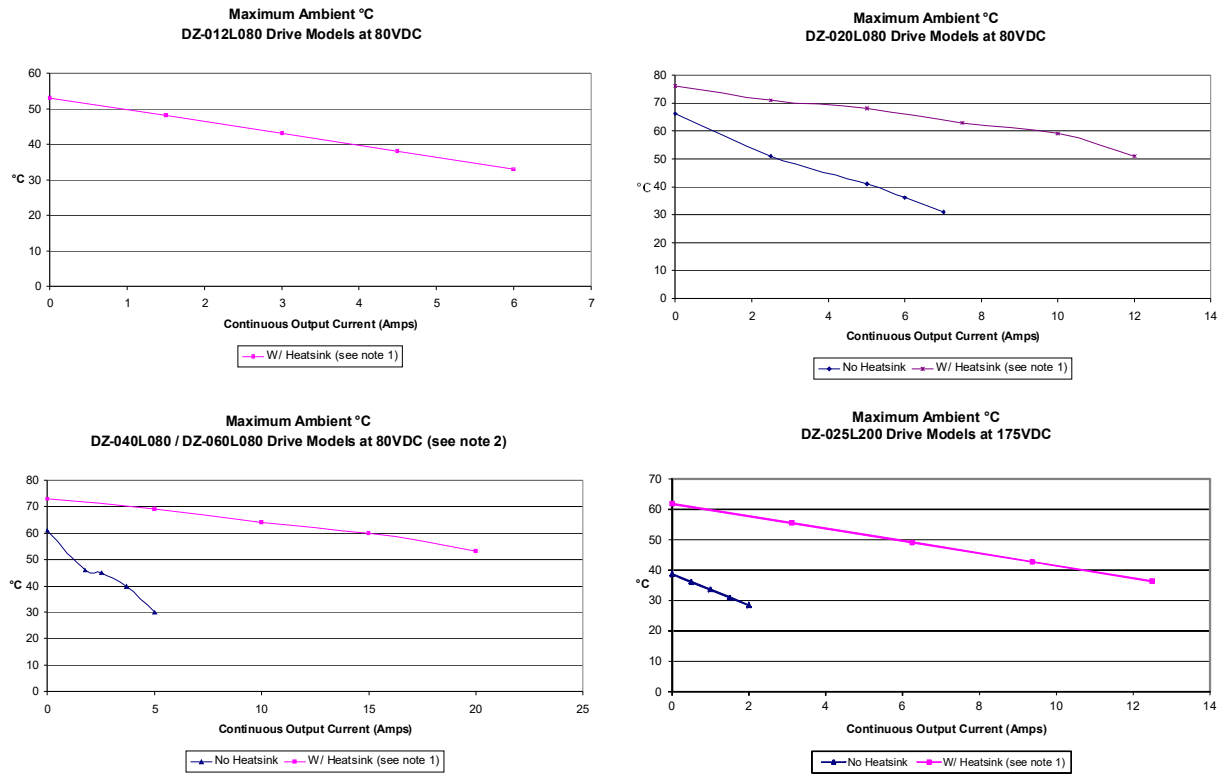
1. The heatsink used in the above tests is 15" x 22" x 0.65" aluminum plate.
2. For DZ-060L080 models at 80VDC, operating at continuous currents above 20 amps will require additional forced air cooling.
3. Contact *ADVANCED* Motion Controls for DZ-010L200 thermal data.

TABLE A.4 Physical Dimensions

Physical Dimensions				
		DZ-012L080	DZ-020L080	DZ-40L080 DZ-060L080 DZ-025L200
Description	Units	Value	Value	Value
Height	mm (in)	63.50 (2.50)	63.50 (2.50)	76.2 (3.00)
Length	mm (in)	50.80 (2.00)	50.80 (2.00)	50.80 (2.00)
Depth (not including pin lengths)	mm (in)	18.44 (0.73)	22.9 (0.90)	22.9 (0.90)
Weight	g (oz)	99.8 (3.5)	105 (3.7)	123.9 (4.4)
Baseplate Thickness	mm (in)	7.85 (0.31)	6.35 (0.25)	6.35 (0.25)

A.2 Mounting Dimensions

FIGURE A.2 DZ-012L080 Mounting Dimensions (inches and [mm])
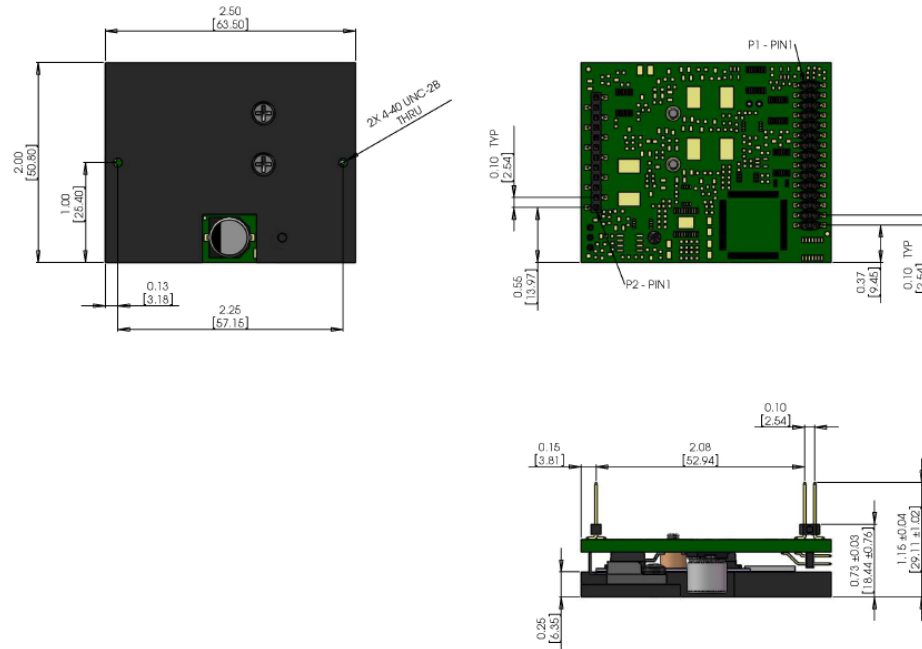
FIGURE A.3 DZ-020L080 Mounting Dimensions (inches and [mm])
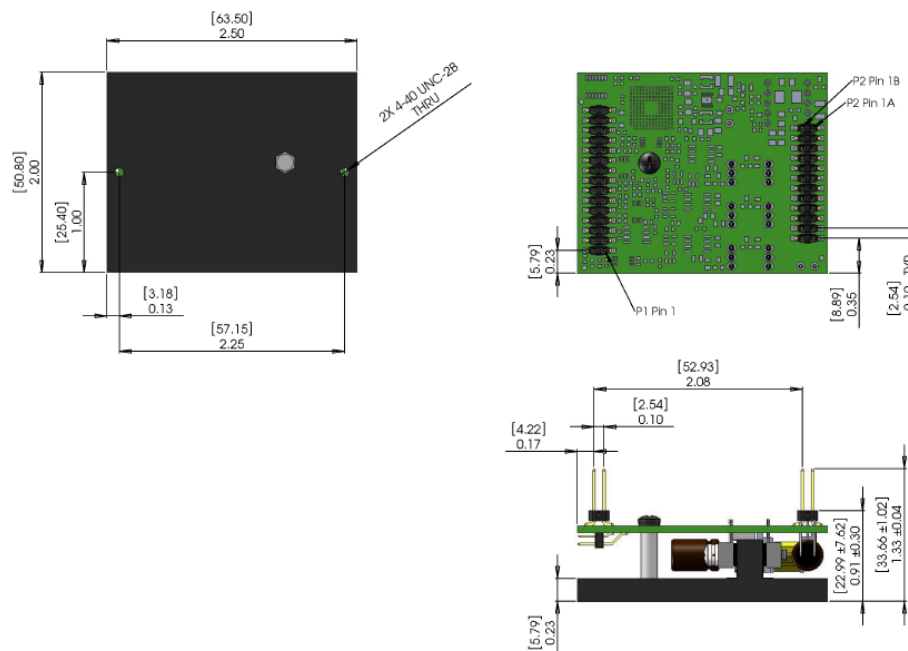
FIGURE A.4 DZ-040L080 / DZ-060L080 / DZ-025L200 Mounting Dimensions (inches and [mm])

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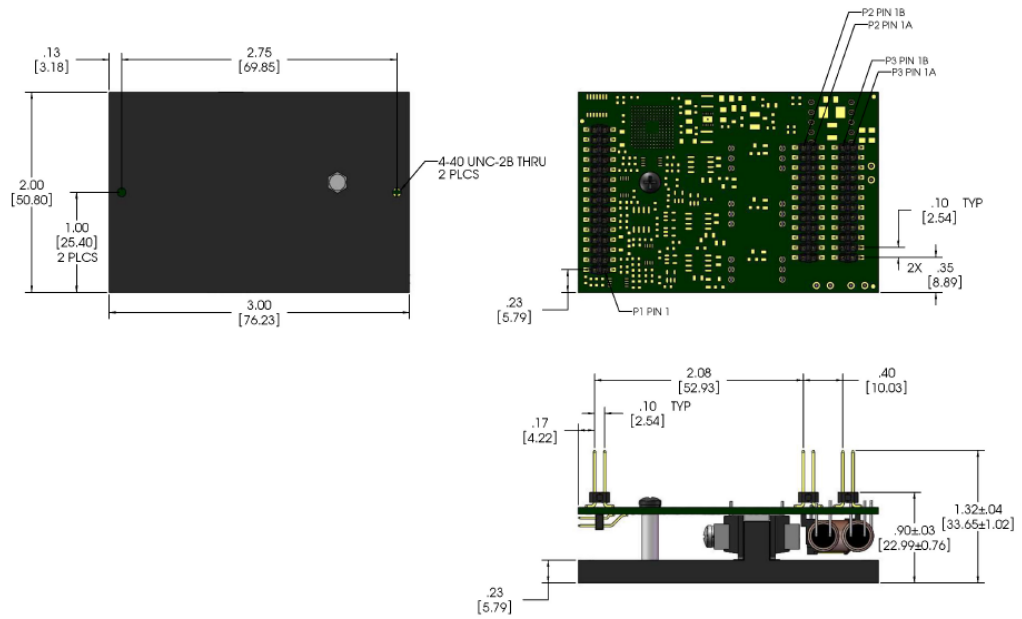
This section discusses how to ensure optimum performance and, if necessary, get assistance from the factory.

B.1 Fault Conditions and Symptoms

An inoperative drive is typically an indication of a disabling fault condition. The fault condition can either be caused by a system parameter in excess of software or hardware limits, or by an event that has been user-configured to disable the drive upon occurrence.

To determine whether the drive is in a fault state, use the Drive Status function in DriveWare to view active and history event items and drive fault conditions. See the DriveWare Software Guide for more information on reading the Drive Status window. Some common fault conditions caused by hardware issues are listed below.

Over-Temperature Verify that the baseplate temperature is less than the maximum allowable baseplate temperature value. 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 19 for more information.

Under-Voltage Shutdown Verify power supply voltage 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.

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Short Circuit Fault

1. Check each motor lead for shorts with respect to motor housing, power ground, and also phase-to-phase. 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

See the "Commutation Sequence" table in "Hall Sensors" on page 10 for valid commutation states. If the drive is disabled check the following:

1. Check the voltage levels for all the Hall sensor inputs.
2. Make sure all Hall Sensor lines are connected properly.

B.1.1 Software Limits

Because DriveWare allows user configuration of many system parameters such as current, velocity, and position limits, as well as an associated "event action" for DriveWare to take when the system reaches this limit, it is possible for a drive to appear to be inoperative when in actuality it is simply in an assigned disable state.

For example, the motor velocity can be limited by giving a value to the Motor Over Speed selection in DriveWare. An "event action", such as "Disable the Power Bridge", can also be assigned for DriveWare to take if the motor reaches this speed. If the motor does happen to reach this velocity limit, DriveWare will automatically cut power to the drive's output in this particular case, and the drive will be disabled. In the Drive Status window, "Motor Over Speed" will be shown as a "history" event, and "Commanded Disable" will be shown as an "Action" event.

Depending on each specific system and application, there are many different options available for assigning system limits and associated actions. See the DriveWare Software Guide for more information.

B.1.2 Connection Problems

Connection problems are oftentimes caused by incorrect communication settings in DriveWare. The default factory setting for DZ drives is a Drive Address of 63 and 115200 Baud Rate. When connecting to the drive with DriveWare for the first time, these default factory settings will have to be used along with the appropriate serial port being used with the PC. Once the connection has been established, the Drive Address and Baud Rate may be changed. Check all communications settings to be sure that the Drive Address, Baud Rate, and serial port are correct. If unable to determine the appropriate settings, the Auto Detect routine will automatically scan for serial port and Baud Rate settings.

Faulty connection cables are also a possible cause of connection problems. Check all cables for any shorts or intermittent connections.

For network communication over CAN or RS-485, the DZ drive must be configured for the appropriate communication protocol. See "RS-485 Selection Jumper" on page 49 for more information.

B.1.3 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.

B.1.4 Current Limiting

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 2 second (each direction). Currents below this peak current but above the continuous current can be sustained for a longer time period, and the drive will automatically fold back at an approximate rate of "I^2t" to the continuous current limit within a time frame of less than 10 seconds. An over-current condition will not cause the drive to become disabled unless configured to do so in DriveWare.

FIGURE B.1 **Peak Current Fold-Back**
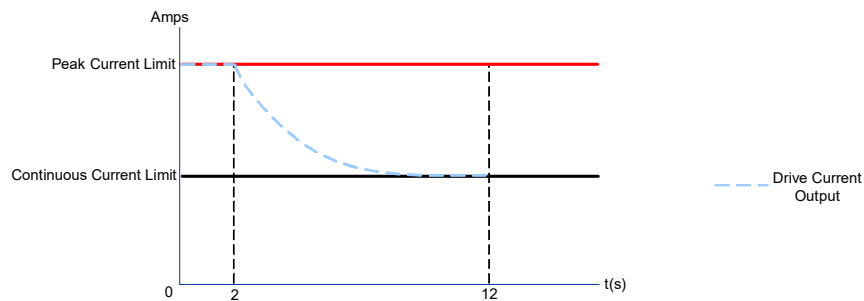
B.1.5 Motor Problems

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 by using DriveWare to reverse the internal velocity feedback polarity setting.

Another common motor issue is when the motor spins faster in one direction than in the other. This is typically caused by improper motor commutation or poor loop tuning. Follow the steps in the DriveWare Software Guide to properly commutate and tune the motor.

B.1.6 Causes of Erratic Operation

- Improper grounding (i.e., drive signal ground is not connected to source signal ground).
- Noisy command signal. Check for system ground loops.
- Mechanical backlash, dead-band, slippage, etc.
- Noisy inhibit input line.
- Excessive voltage spikes on bus.

B.2 Technical Support

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

B.2.1 Drive Model Information

- DC bus voltage and range.
- Motor type, including inductance, torque constant, and winding resistance.
- 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.

B.2.2 Product Label Description

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

FIGURE B.2   **Product Label**

Square Product Labels (0.375" x 0.375")
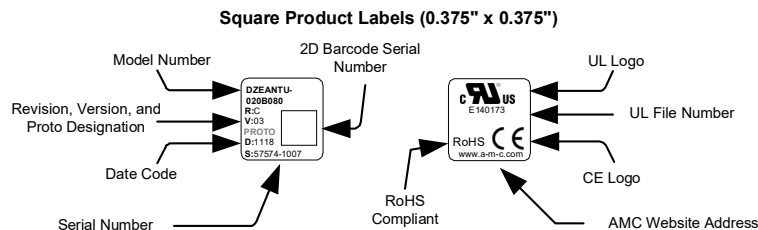
1. Model Number: This is the main product identifier. The model number can have a suffix designating a change from the base model.
2. Revision Letter: Product revision level letter ('A' is the earliest release from any model).
3. Version: The version number is used to track minor product upgrades with the same model number and revision letter ('01' is the earliest release of any revision).
4. Proto Designation: When included, indicates that the model is a prototype unit and model number will also begin with an 'X' designator.
5. Serial Number: The serial number consists of a 5-digit lot number followed by a 4-digit sequence number. Each product is assigned a unique serial number to track product life cycle history.
6. Date Code: The date code is a 4-digit number signifying the year and week of manufacture. The first two digits designate the year and the second two digits designate the week (e.g. the drive label shown would have been built in the year 2011 during the 18th week).
7. General Information: Displays applicable agency approvals, UL file reference number, and compliance approvals. More complete product information is availabe by following the listed website.

B.2.3 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
web	www.a-m-c.com/download/form/form_rma.html

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DZ Digital Drives
Hardware Installation Manual
MNDGDZIN-07

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