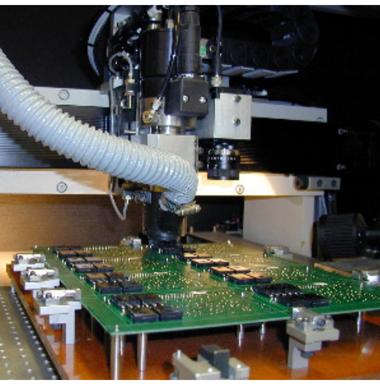


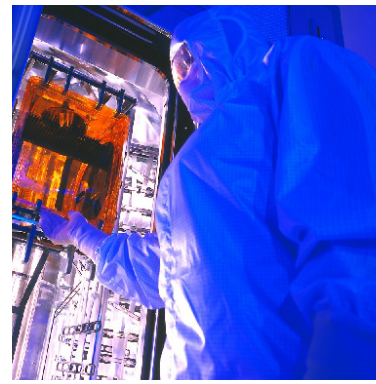

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DigiFlex® Performace™ DPR Drives

RS485 and Modbus RTU Communication

Hardware Installation Manual

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ORIGINAL INSTRUCTIONS

MNDGDRIN-12

Preface

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

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

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

Agency Compliances

The company holds original documents for the following:

- UL 508c, file number E140173
- Electromagnetic Compatibility, EMC Directive - 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
- Functional Safety Type Approved, TUV Rheinland

Trademarks

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Related Documentation

- Product datasheet specific for your drive, available for download at www.a-m-c.com
- DriveWare Software Guide, available for download at www.a-m-c.com
- Serial Communication Manual, available for download at www.a-m-c.com
- Modbus Communication Manual, available for download at www.a-m-c.com

Attention Symbols

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

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

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

Caution - Instructs and directs you to avoid damaging equipment.

Warning - Instructs and directs you to avoid harming yourself.

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

Revision History

Document ID	Revision #	Date	Changes
MNDGDRIN-01	1	6/2009	DPR Install Manual First Release
MNDGDRIN-02	2	3/2010	- Removed DPRNLIR control module
MNDGDRIN-03	3	3/2011	- Added DPRxxxx-015S400 drive model information
MNDGDRIN-04	4	9/2012	- Updated for DriveWare 7 information - Updated for RMS Charge-Based Limiting Capabilities
MNDGDRIN-05	5	10/2013	- Added DPRxxxx-C060A400 and DPRxxxx-C100A400 drive model information
MNDGDRIN-06	6	10/2014	- Added STO wiring recommendation
MNDGDRIN-07	7	2/2015	- Removed DPRAHIA, DPRAHIR, DPRNLIE control modules
MNDGDRIN-08	8	3/2015	- Added Modbus RTU Support
MNDGDRIN-09	9	1/2016	- Removed DPRxxxx-015A400 drive model information (reserved)
MNDGDRIN-10	10	3/2017	- Added DPRxxxx-040A400 drive model information
MNDGDRIN-11	11	11/2017	- Added DPRxxxx-100B080 drive model information
MNDGDRIN-12	12	5/2018	- Added 2-Phase Stepper Motor Information - Added PDO power-up delay information

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Index I

1 Safety

This section discusses characteristics of your DPR 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 DPR 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.

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:

- When using a separate logic supply, turn on the 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.

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.

2 Products and System Requirements

This document is intended as a guide and general overview in selecting, installing, and operating *ADVANCED* Motion Controls® DigiFlex® Performance™ digital servo drives that use RS-485 or Modbus RTU for networking. These specific drives are referred to herein and within the product literature as DPR drives. Other drives in the DigiFlex Performance product family that utilize other methods of network communication such as CANopen®, EtherCAT®, or POWERLINK / Modbus TCP / Ethernet are discussed in separate manuals that are available at www.a-m-c.com. Contained within each DigiFlex Performance product family manual are instructions on system integration, wiring, drive-setup, and standard operating methods.

2.1 DPR Drive Family Overview

The DPR ddrive 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. The command source can be generated externally or can be supplied internally. A digital controller can be used to command and interact with DPR drives, and a number of dedicated and programmable digital and analog input/output pins are available for parameter observation and drive configuration. DPR drives are capable of operating in Current (Torque), Velocity, or Position Mode, and utilize Space Vector Modulation, which results in higher bus voltage utilization and reduced heat dissipation compared to traditional PWM. DPR drives also offer a variety of feedback options.

DPR drives offer RS-485 or Modbus RTU communication for multiple drive networking, and feature an RS-232 serial communication interface for drive configuration and setup. Drive commissioning is accomplished using DriveWare® 7, the setup software from *ADVANCED* Motion Controls, available for download at www.a-m-c.com.

2.1.1 Drive Datasheet

Each DPR 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.

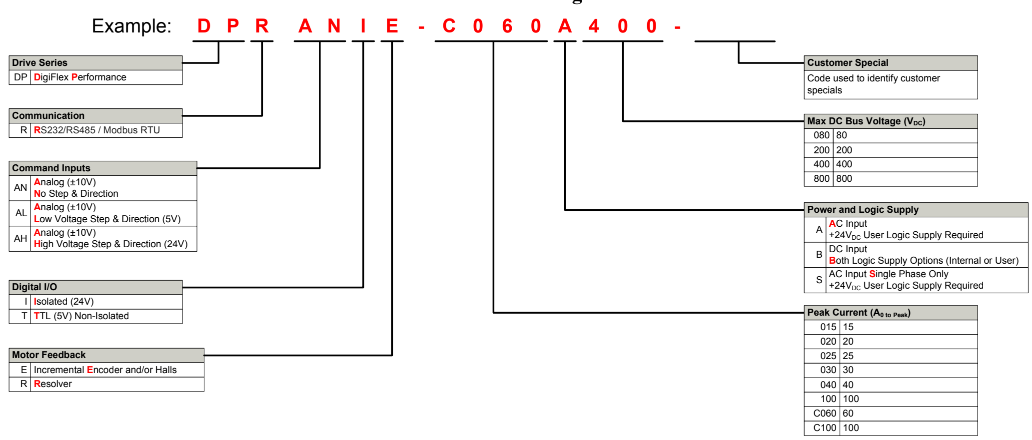
Caution

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

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 **DPR Part Numbering Structure***



* Note that not all possible part number combinations are offered as standard drives. For a list of standard drives, see "Drive Models" on page 7.

When selecting a DPR drive, follow the part numbering structure above to determine the Digital I/O, Motor Feedback, and Power Module choices that are applicable for the end application. The tables below outline the features and specifications that are available for standard DPR drive models.

TABLE 2.1 **Control Specifications**

Description	Control Specifications DPRAHIx	DPRANIx	DPRALTx
Network Communication	RS-485 or Modbus RTU		
Command Sources	±10V Analog, 24V Step and Direction, Encoder Following, Over the Network, PWM and Direction, Sequencing, Indexing, Jogging	±10V Analog, Encoder Following, Over the Network, PWM and Direction, Sequencing, Indexing, Jogging	±10V Analog, 5V Step and Direction, Encoder Following, Over the Network, Sequencing, Indexing, Jogging
Commutation Methods	Sinusoidal, Trapezoidal		
Control Modes[1]	Current (Torque), Velocity, Hall Velocity, Position		
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	10/4		6/4
Programmable Analog I/O	4/0	4/1	3/2
Primary I/O Logic Level	24 VDC		5V TTL

1. Hall Velocity mode may not be supported on certain drives. Check the drive datasheet to see if Hall Sensors are supported.

TABLE 2.2 Feedback Options

Description	Feedback Supported DPRxxxE	DPRxxxR
Hall Sensors	✔	
Incremental Encoder	✔	
Auxiliary Incremental Encoder	✔	✔
Resolver		✔
1Vp-p Sine/Cosine Encoder		
±10 VDC Position	✔	✔
Tachometer (±10 VDC)	✔	✔

TABLE 2.3 Power Specifications - AC Input DPR Drives

Description	Units	Power Specifications 015S400	030A400	040A400	C060A400	C100A400	030A800	060A800
Rated Voltage	VAC(VDC)	240 (339)	240 (339)	240 (339)	240 (339)	240 (339)	480 (678)	480 (678)
AC Supply Voltage Range	VAC	100-240	100-240	100-240	200-240	200-240	200-480	200-480
AC Supply Minimum	VAC	90	90	90	180	180	180	180
AC Supply Maximum	VAC	264	264	264	264	264	528	528
AC Input Phases[2]	-	1	3	3	3	3	3	3
AC Supply Frequency	Hz	50-60	50-60	50-60	50-60	50-60	50-60	50-60
DC Supply Voltage Range	VDC	123-373	127-373	127-373	255-373	255-373	255-747	255-747
DC Bus Over Voltage Limit	VDC	394	429	394	420	420	850	850
DC Bus Under Voltage Limit	VDC	55	55	55	205	205	230	230
Maximum Peak Output Current	A (Arms)	15 (10.6)	30 (21.2)	40 (28.3)	60 (42.4)	100 (70.7)	30 (21.2)	60 (42.4)
Maximum Continuous Output Current	A (Arms)	7.5 (7.5)	15 (15)	20 (20)	30 (30)	50 (50)	15 (10.6)	30 (21.2)
Max. Continuous Output Power @ Rated Voltage[2]	W	2415	4831	6441	9662	16103	6840	13680
Max. Continuous Power Dissipation @ Rated Voltage	W	127	254	339	509	848	360	720
Internal Bus Capacitance	µF	540	1410	660	1120	1120	330	330
PWM Switching Frequency	kHz	20	20	20	14	10	10	10
External Shunt Resistor Minimum Resistance	Ω	25	20	25	20	20	note 3	40
Minimum Load Inductance (Line-To-Line)	µH	600	600	600	600	600	3000	3000

1. Certain 3-phase drive models can operate on single-phase VAC if peak/cont. current ratings are reduced by at least 30%.
2. P = (DC Rated Voltage) * (Cont. RMS Current) * 0.95
3. Contact factory before using an external shunt resistor with this power module

TABLE 2.4 Power Specifications - DC Input DPR Drives

Description	Units	Power Specifications 020B080	040B080	060B080	100B080	025B200	015B200
DC Supply Voltage Range	VDC	20-80	20-80	20-80	20-80	20-190	40-190
DC Bus Over Voltage Limit	VDC	86	86	86	88	198	198
DC Bus Under Voltage Limit	VDC	17	17	17	17	17	35
Maximum Peak Output Current	A (Arms)	20 (14.1)	40 (28.3)	60 (42.4)	100 (70.7)	25 (17.7)	15 (10.6)
Maximum Continuous Output Current	A (Arms)	10 (10)	20 (20)	30 (30)	60 (60)	12.5 (12.5)	7.5 (7.5)
Max. Continuous Output Power	W	760	1520	2280	4560	2256	1354
Max. Continuous Power Dissipation	W	40	80	120	230	118	71
PWM Switching Frequency	kHz	20	20	20	20	20	20
Internal Bus Capacitance	µF	33	500	500	500	50	20
Minimum Load Inductance (Line-To-Line)	µH	250	250	250	250	300	250

2.3 Drive Models

The standard drive models in the below tables are formed by combining a power module and a control module that will best suit the end application and system requirements.

TABLE 2.5 AC Drive Models

Drive Number	VAC (Nominal)	Peak Current (A)	Continuous Current (A)
DPRAHIE-015S400	100-240	15	7.5
DPRAHIE-030A400	100-240	30	15
DPRAHIE-040A400	100-240	40	20
DPRAHIE-C060A400	200-240	60	30
DPRAHIE-C100A400	200-240	100	50
DPRAHIE-030A800	200-480	30	15
DPRAHIE-060A800	200-480	60	30
DPRANIE-015S400	100-240	15	7.5
DPRANIE-030A400	100-240	30	15
DPRANIE-040A400	100-240	40	20
DPRANIE-C060A400	200-240	60	30
DPRANIE-C100A400	200-240	100	50
DPRANIE-030A800	200-480	30	15
DPRANIE-060A800	200-480	60	30
DPRANIR-015S400	100-240	15	7.5
DPRANIR-030A400	100-240	30	15
DPRANIR-040A400	100-240	40	20
DPRANIR-C060A400	200-240	60	30
DPRANIR-C100A400	200-240	100	50
DPRANIR-030A800	200-480	30	15
DPRANIR-060A800	200-480	60	30

TABLE 2.6 DC Drive Models

Drive Number	VDC (Nominal)	Peak Current (A)	Continuous Current (A)
DPRALTE-020B080	20-80	20	10
DPRALTE-040B080	20-80	40	20
DPRALTE-060B080	20-80	60	30
DPRALTE-015B200	40-190	15	7.5
DPRALTE-025B200	20-190	25	12.5
DPRALTR-020B080	20-80	20	10
DPRALTR-040B080	20-80	40	20
DPRALTR-060B080	20-80	60	30
DPRALTR-015B200	40-190	15	7.5
DPRALTR-025B200	20-190	25	12.5
DPRANIE-100B080	20-80	100	60

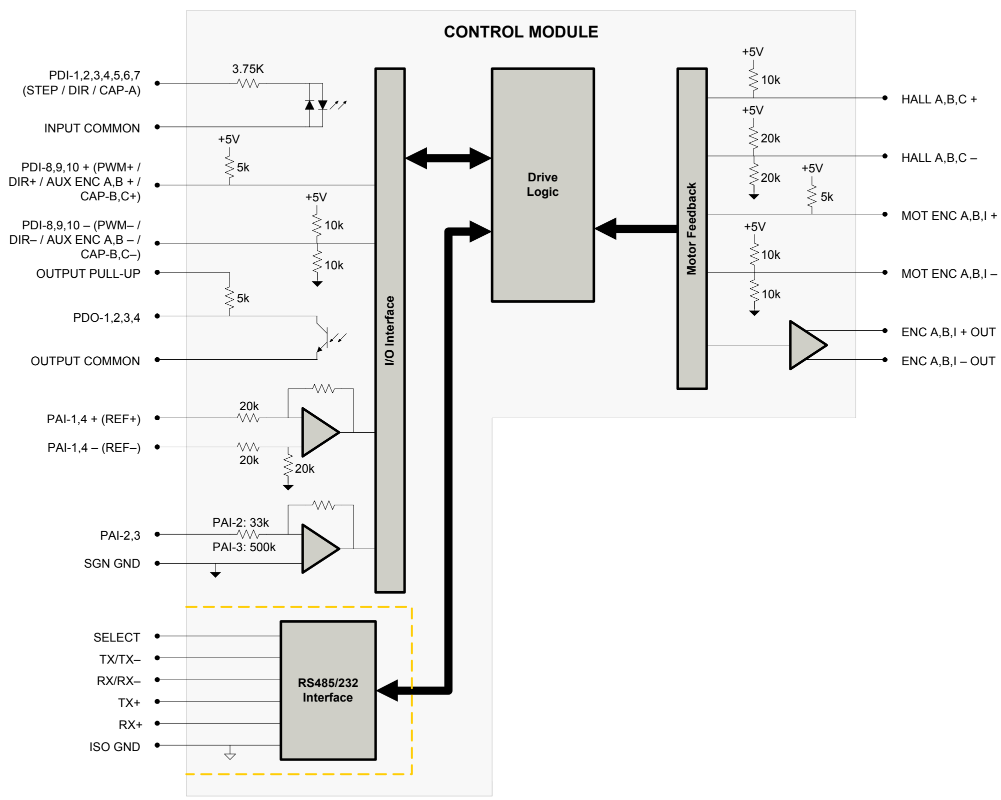
2.3.1 Control Modules

The DPR drive family consists of 5 different control modules. They are primarily differentiated by the method of command, the type of feedback allowed, and the primary I/O logic level. The diagrams in this section show the general block diagrams for the different control modules. For complete pinouts, consult the specific drive's datasheet.

DPRAHIE

- RS-485 or Modbus RTU Communication
- ±10 VDC Position, Incremental Encoder, Hall Sensor, Auxiliary Incremental Encoder, Tachometer (±10 VDC) Feedback
- ±10 V Analog, 24V Step and Direction, Encoder Following, PWM and Direction, Sequencing, Indexing, Jogging, or Network Command Sources
- Drives Three Phase and Single Phase Motors
- 10 Programmable Digital Inputs (PDIs)
- 4 Programmable Digital Outputs (PDOs)
- 4 Programmable Analog Inputs (PAIs)
- 24 VDC Primary I/O Logic Level

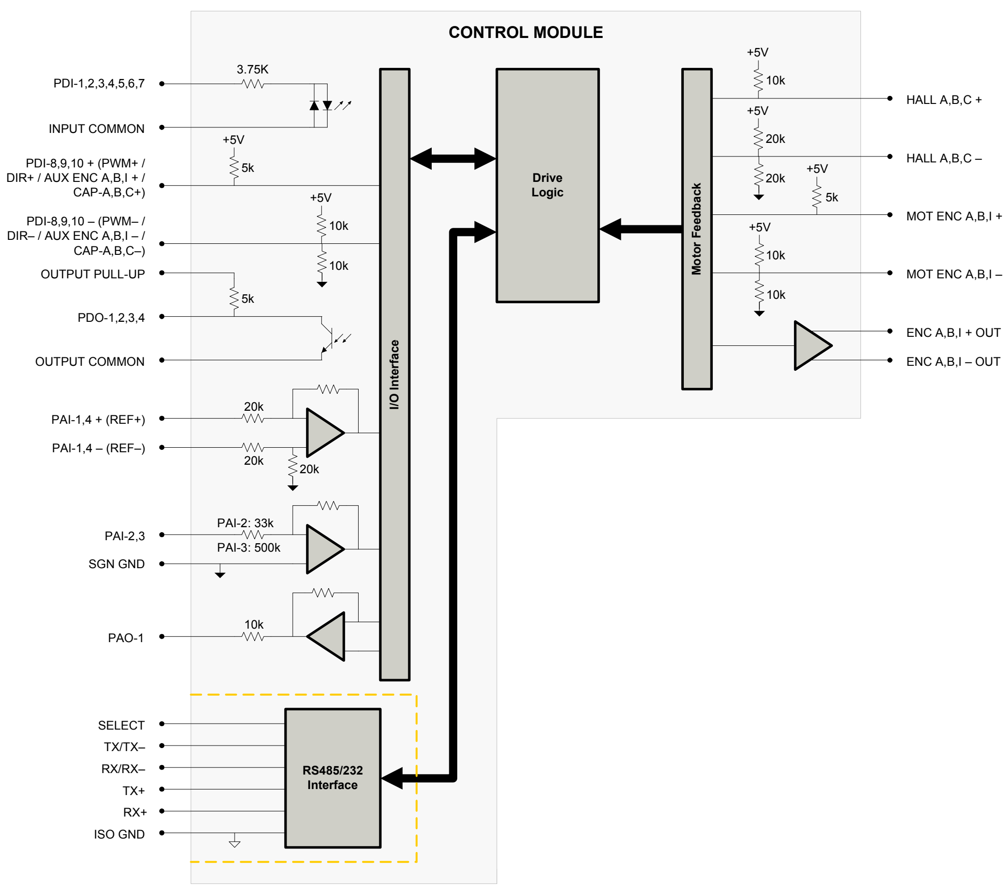
FIGURE 2.2 DPRAHIE Control Module



DPRANIE

- RS-485 or Modbus RTU Communication
- ±10 VDC Position, Auxiliary Incremental Encoder, Hall Sensor, Incremental Encoder, Tachometer (±10 VDC) Feedback
- ±10 V Analog, Encoder Following, PWM and Direction, Sequencing, Indexing, Jogging, or Network Command Sources
- Drives Three Phase and Single Phase Motors
- 10 Programmable Digital Inputs (PDIs)
- 4 Programmable Digital Outputs (PDOs)
- 4 Programmable Analog Inputs (PAIs)
- 1 Programmable Analog Output (PAO)
- 24 VDC Primary I/O Logic Level

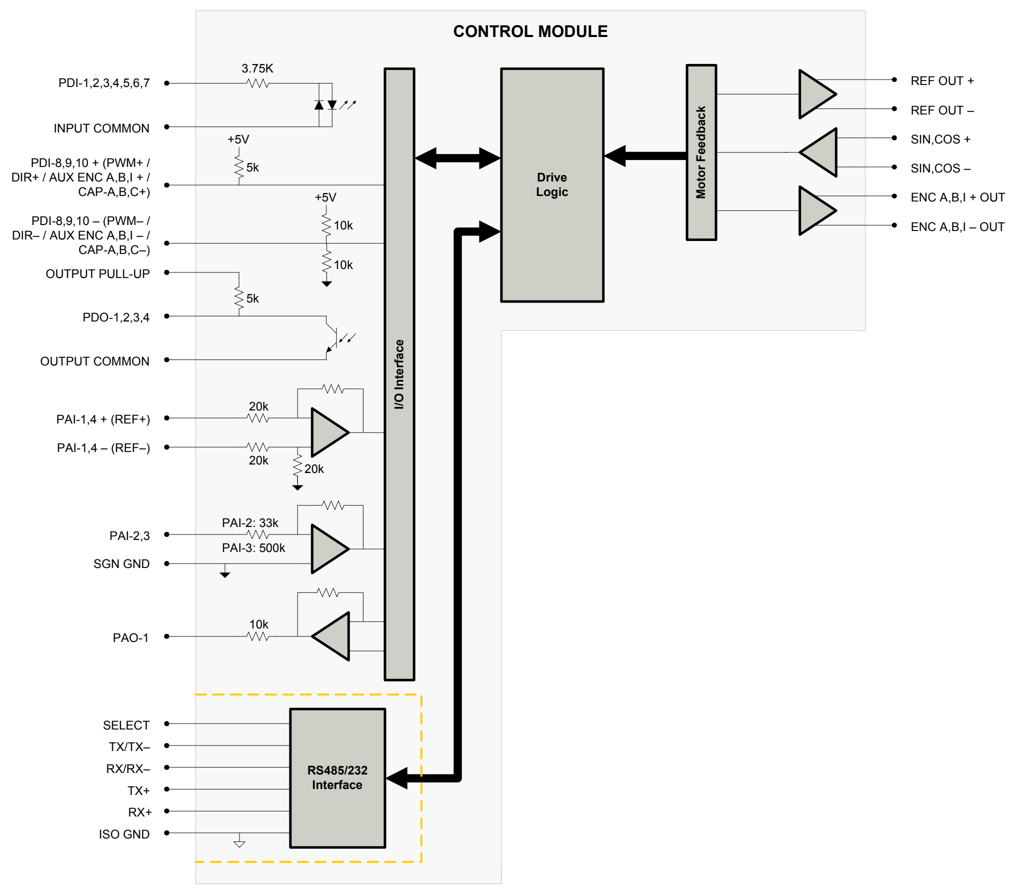
FIGURE 2.3 **DPRANIE Control Module**



DPRANIR

- RS-485 or Modbus RTU Communication
- ±10 VDC Position, Auxiliary Incremental Encoder, Resolver, Tachometer (±10 VDC) Feedback
- ±10 V Analog, Encoder Following, PWM and Direction, Sequencing, Indexing, Jogging, or Network Command Sources
- Drives Three Phase and Single Phase Motors
- 10 Programmable Digital Inputs (PDIs)
- 4 Programmable Digital Outputs (PDOs)
- 4 Programmable Analog Inputs (PAIs)
- 1 Programmable Analog Output (PAO)
- 24 VDC Primary I/O Logic Level

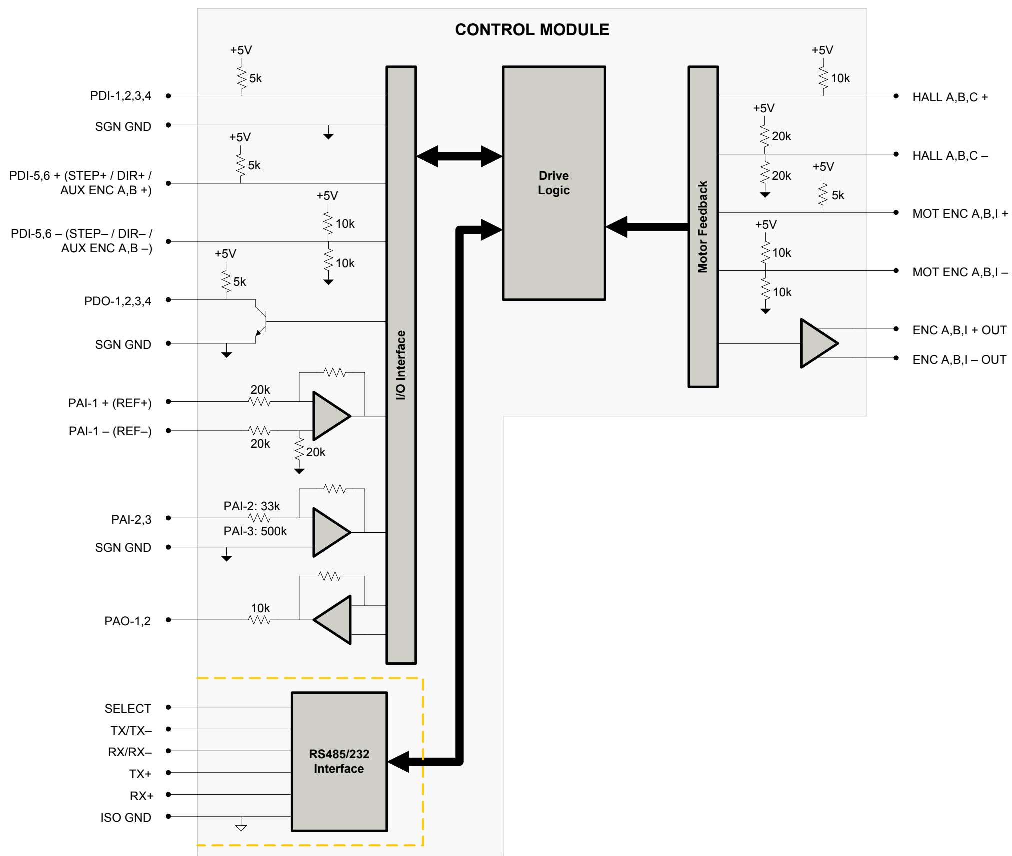
FIGURE 2.4 **DPRANIR Control Module**



DPRALTE

- RS-485 or Modbus RTU Communication
- ±10 VDC Position, Auxiliary Incremental Encoder, Halls, Incremental Encoder, Tachometer (±10 VDC) Feedback
- ±10 V Analog, 5V Step and Direction, Encoder Following, Sequencing, Indexing, Jogging, or Network Command Sources
- Drives Three Phase and Single Phase Motors
- 6 Programmable Digital Inputs (PDIs)
- 4 Programmable Digital Outputs (PDOs)
- 3 Programmable Analog Inputs (PAIs)
- 2 Programmable Analog Outputs (PAOs)
- 5V TTL Primary I/O Logic Level

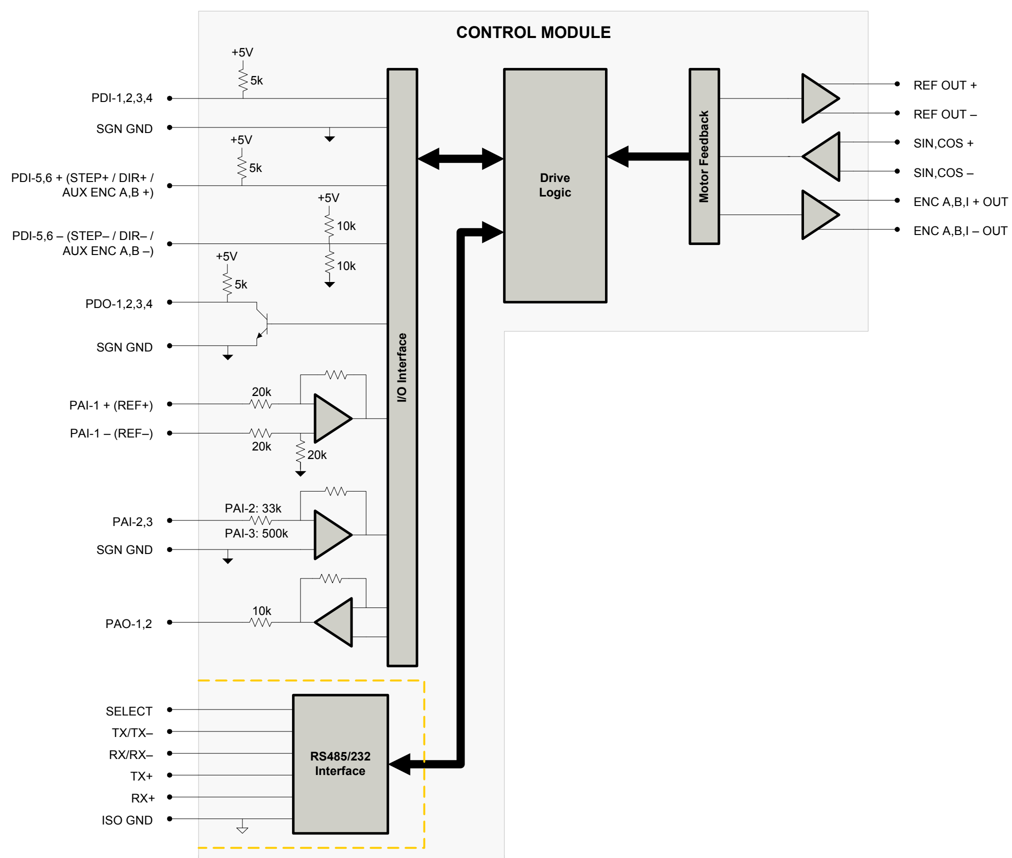
FIGURE 2.5 **DPRALTE Control Module**



DPRALTR

- RS-485 or Modbus RTU Communication
- ±10 VDC Position, Auxiliary Incremental Encoder, Resolver, Tachometer (±10 VDC) Feedback
- ±10 V Analog, 5V Step and Direction, Encoder Following, Sequencing, Indexing, Jogging, or Network Command Sources
- Drives Three Phase and Single Phase Motors
- 6 Programmable Digital Inputs (PDIs)
- 4 Programmable Digital Outputs (PDOs)
- 3 Programmable Analog Inputs (PAIs)
- 2 Programmable Analog Outputs (PAOs)
- 5V TTL Primary I/O Logic Level

FIGURE 2.6 DPRALTR Control Module



2.3.2 AC Power Modules

There are 6 AC power modules in the DPR drive family, providing a wide variety of current output and supply voltage selections.

015S400

- 15 A Peak Output Current
- 7.5 A Cont. Output Current
- 20 - 30 VDC Logic Supply Voltage
- 240 VAC (339 VDC) Rated Supply Voltage
- 1-Phase 100 - 240 VAC (127 - 373 VDC) Supply Voltage Range
- 2415 W Maximum Continuous Output Power at Rated Voltage.
- Internal Shunt Regulator
- External Shunt Resistor Connections

030A400

- 30 Amps Peak Output Current
- 15 Amps Continuous Output Current
- 20 - 30 VDC Logic Supply Voltage
- 240 VAC (339 VDC) Rated Supply Voltage
- 3-Phase 100 - 240 VAC (127-373 VDC) Supply Voltage Range
- 4831 W Max. Continuous Output Power at Rated Voltage
- Internal Shunt Regulator
- External Shunt Resistor Connections

040A400

- 40 Amps Peak Output Current
- 20 Amps Continuous Output Current
- 20 - 30 VDC Logic Supply Voltage
- 240 VAC (339 VDC) Rated Supply Voltage
- 3-Phase 100 - 240 VAC (127-373 VDC) Supply Voltage Range
- 6441 W Max. Continuous Output Power at Rated Voltage
- Internal Shunt Regulator
- External Shunt Resistor Connections

C060A400

- 60 Amps Peak Output Current
- 30 Amps Continuous Output Current
- 240 VAC (339 VDC) Rated Supply Voltage
- 3-Phase 200 - 240 VAC (255 - 373 VDC) Supply Voltage Range
- 9662 W Maximum Continuous Output Power at Rated Voltage
- 20 - 30 VDC Logic Supply Voltage
- Internal Shunt Regulator
- External Shunt Resistor Connections

C100A400

- 100 Amps Peak Output Current
- 50 Amps Continuous Output Current
- 240 VAC (339 VDC) Rated Supply Voltage
- 20 - 30 VDC Logic Supply Voltage
- 3-Phase 200 - 240 VAC (255 - 373 VDC) Supply Voltage Range
- 16103 W Max. Continuous Output Power at Rated Voltage
- Internal Shunt Regulator
- External Shunt Resistor Connections

030A800

- 30 Amps Peak Output Current
- 15 Amps Continuous Output Current
- 480 VAC (678 VDC) Rated Supply Voltage
- 3-Phase 200 - 480 VAC (255 - 747 VDC) Supply Voltage Range
- 6840 W Maximum Continuous Output Power at Rated Voltage
- 20 - 30 VDC Logic Supply Voltage
- Internal Shunt Resistor
- Internal Shunt Regulator
- External Shunt Resistor Connections

060A800

- 60 Amps Peak Output Current
- 30 Amps Continuous Output Current
- 480 VAC (678 VDC) Rated Supply Voltage
- 3-Phase 200 - 480 VAC (255 - 747 VDC) Supply Voltage Range
- 13680 W Maximum Continuous Output Power at Rated Voltage
- 20 - 30 VDC Logic Supply Voltage
- Internal Shunt Regulator
- External Shunt Resistor Connections

2.3.3 DC Power Modules

There are 5 DC power modules in the DPR drive family, each with a unique current output and supply voltage rating.

020B080

- 20 Amps Peak Output Current
- 10 Amps Cont. Output Current
- 20 - 80 VDC Supply Voltage Range
- 760 W Maximum Continuous Output Power
- 20 - 80 VDC Logic Supply Voltage (optional)

040B080

- 40 Amps Peak Output Current
- 20 Amps Cont. Output Current
- 20 - 80 VDC Supply Voltage Range
- 1520 W Maximum Continuous Output Power
- 20 - 80 VDC Logic Supply Voltage (optional)

060B080

- 60 Amps Peak Output Current
- 30 Amps Cont. Output Current
- 20 - 80 VDC Supply Voltage Range
- 2280 W Maximum Continuous Output Power
- 20 - 80 VDC Logic Supply Voltage (optional)

100B080

- 100 Amps Peak Output Current
- 60 Amps Cont. Output Current
- 20 - 80 VDC Supply Voltage Range
- 4560 W Maximum Continuous Output Power
- 20 - 80 VDC Logic Supply Voltage (optional)

015B200

- 15 Amps Peak Output Current
- 7.5 Amps Cont. Output Current
- 40 - 190 VDC Supply Voltage Range
- 1354 W Maximum Continuous Output Power
- 40 - 190 VDC Logic Supply Voltage (optional)

025B200

- 25 Amps Peak Output Current
- 12.5 Amps Cont. Output Current
- 20 - 190 VDC Supply Voltage Range
- 2256 W Maximum Continuous Output Power
- 40 - 190 VDC Logic Supply Voltage (optional)

2.4 Communication Protocol

DPR digital drives offer networking capability through either RS-485 or Modbus RTU communication.

2.4.1 RS-485 Communication

ADVANCED Motion Controls' proprietary serial protocol is a byte-based, binary, master-slave standard to access drive "commands" used on DPR 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 DPR 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 "Communication and Commissioning" on page 56 for information on how to correctly setup and wire a RS-485 network using DPR drives.

For more detailed information on RS-485 communication, consult the *ADVANCED* Motion Controls Serial Communication Manual, available for download at www.a-m-c.com.

2.4.2 Modbus RTU Communication

Modbus

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 DPR 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' DPR drives follows the Modbus Application Protocol Specification V1.1b. More information can be found at www.Modbus-IDA.org.

2.5 Feedback Supported

There are a number of different feedback options available in the DPR family of digital drives. The feedback element can be any device capable of generating a signal proportional to current, velocity, position, or any parameter of interest. Such signals can be provided directly by a potentiometer or indirectly by other feedback devices such as Hall Sensors or encoders. For information on the functional operation of the feedback devices, see “Feedback Operation” on page 48.

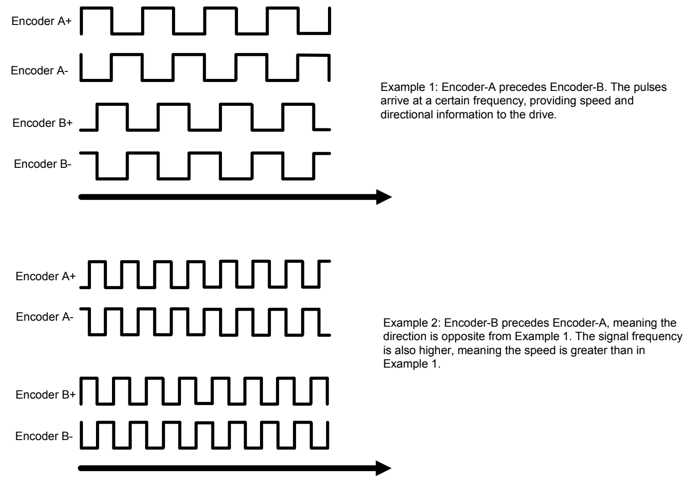
Feedback Polarity The drive compares the feedback signal to the command signal to produce the required output to the load by continually reducing the error signal to zero. The feedback element must be connected for *negative* feedback. Connecting the feedback element for positive feedback will lead to 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. The correct feedback polarity will be determined and configured during commissioning of the drive. Otherwise, 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. For more information on how to properly connect the feedback element, see “Feedback Wires” on page 31.

2.5.1 Incremental Encoder

DPRxxxE drive models can utilize incremental encoder feedback 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 pulses closing the velocity and/or position loop. The encoder signals are read as "pulses" that the 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 within the configuration software, or externally through network commands.

Figure 2.7 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, DPR drives are able to ascertain the actual motor location.

FIGURE 2.7 Encoder Feedback Signals



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.

2.5.2 Auxiliary Incremental Encoder

The auxiliary encoder input pins can be used as a command source for encoder following mode, or as a secondary feedback device input for closing the position loop. The particular function is configured in DriveWare.

2.5.3 Hall Sensors

DPRxxxE drive models allow 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 controls the motor velocity, with the Hall Sensor frequency closing the velocity loop. For more information on using Hall Sensors for trapezoidal commutation, see "Trapezoidal Commutation" on page 58.

Note

Hall velocity mode is not optimized for relatively high or relatively low frequencies. To determine if Hall velocity mode is right for your application, contact Applications Engineering.

2.5.4 Resolver

DPRxxxR drives support resolver feedback for both velocity and position feedback. A resolver functions similar to a rotary transformer, in that when the resolver rotor winding is excited with an AC signal, the resolver stator windings then produce an AC voltage output that varies in amplitude according to the sine and cosine of the resolver shaft position. The AC voltage output is then read through a specialized converter as the velocity or position feedback signal. DPRxxxR drives support resolvers with a carrier frequency of 5kHz, an excitation voltage of 4Vrms, and a 0.5 transformation ratio. The drive configuration software allows the user to determine the interpolation for 12-bit (high speeds) or 14-bit (high precision) resolution. In general, resolvers are less common and more expensive than encoders, and are typically used in harsh physical environments.

Note

Resolvers using the inductive (brushless) method to couple the stator and rotor windings are very reliable in hostile industrial environments, as they are resilient to vibration and dirt and have a longer lifetime than brush type resolvers.

2.5.5 ±10 VDC Position

DPR 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 through the Programmable Analog Input. In DriveWare, the connection method that is used must be selected under the Position Loop Feedback options.

2.5.6 Tachometer (±10 VDC)

All DPR 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. DPR 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.

2.6 Control Modes

The DPR family of digital drives operate in either Current (Torque), Velocity, or Position Mode. 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.

2.6.1 Current (Torque)

In Current (Torque) Mode, the input command controls the output current. The drive will adjust the output duty cycle to maintain the commanded output current. This mode is used to control torque for rotary motors (force for linear motors), but the motor speed is not controlled. The output current and other parameters can be monitored within the configuration software, or externally through network commands.

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.

2.6.2 Velocity

In Velocity Mode, the input command controls the motor velocity. This mode requires the use of a feedback element to provide information to the drive about the motor velocity. The motor velocity and other parameters can be monitored within the configuration software, or externally through network commands. See “Feedback Supported” on page 17 for more information on velocity feedback devices.

2.6.3 Position

In Position Mode, the input command controls the actual motor position. This mode requires the use of a feedback element to provide information to the drive about the physical motor location. The motor position and other parameters can be monitored within the configuration software, or externally through network commands. See “Feedback Supported” on page 17 for more information on position feedback devices.

2.7 Command Sources

The input command source for DPR drives can be configured for one of the following options.

2.7.1 PWM and Direction

All DPRxxIx drives support PWM and Direction as a command source for current, velocity or position control. The drive can be configured for standard PWM and Direction, using two inputs, or for Single Input PWM Control, using only a single input for bi-directional control. Additionally, 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.

2.7.2 Step and Direction

Most DPR drives support a differential or single-ended Step and Direction input command to control the motor in a simulated stepper motor configuration. The Direction input commands the direction of rotation, while each pulse of the Step input commands the motor to "step" in the specified direction based on a scaling value that is entered in DriveWare. Since the input is directly controlling the actual position of the motor, the physical motor location can be determined without any other feedback element. DPRAHxx drives offer +24V Step and Direction, and DPRALxx drives offer +5V Step and Direction.

2.7.3 ±10V Analog

DPRAxxx drives accept a single-ended or differential analog signal with a range of ±10 V from an external source. The input command signals should be connected to the programmable input on the I/O Signal Connector. See “Programmable Analog I/O” on page 47 for more information.

2.7.4 Encoder Following

DPR drives can utilize Encoder Following as a form of input command. In Encoder Following mode, an auxiliary 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 DPR drive is operated in position mode.

2.7.5 Indexing and Sequencing

DPR 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.

2.7.6 Jogging

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

2.7.7 Over the Network

DPR drives can utilize RS485/232 or Modbus RTU network communication as a form of input command through the serial interface. 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 using serial communication to command the drive, see "Communication Protocol" on page 16.

2.8 System Requirements

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

2.8.1 Specifications Check

Before selecting a DPR 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 DPR servo drive, be sure all the following items are available:

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

2.8.2 Motor Specifications

DPR 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 DPR drive may be selected that will best suit the motor capabilities. Some general guidelines that are useful when pairing a DPR servo drive with a motor:

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

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

Where:

K_T -motor torque constant

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

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

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

Where:

K_E -motor back EMF constant

S_M -motor speed (use the maximum speed expected for the application)

I_M -motor current (use the maximum current expected for the application)
R_M -motor line-to-line resistance

- The motor inductance is vital to the operation of DPR 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 DPR 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 DPR 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.

2.8.3 Power Supply Specifications

Depending on the drive model, a DPR servo drive operates off either an AC Power Supply or an isolated DC Power Supply. 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 DPR 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 power supply current rating is based on the maximum current that will be required by the system. If the power supply powers more than one drive, then the current requirements for each drive should be added together. Due to the nature of servo drives, the current into the drive does not always equal the current out of the drive. However, the *power* in is equal to the *power* out. Use the following equation to calculate the **power supply output current**, $\mathbf{I_{PS}}$, based on the motor current requirements.

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

Where:

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

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.

2.8.4 Environment

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

TABLE 2.7 Environmental Specifications

Environmental Specifications	
Parameter	**Description**
Humidity	90%, non-condensing
Mechanical Shock	10g, 11ms, Half-sine
Vibration	2 - 2000 Hz @ 2.5g
Altitude	0-3000m

Baseplate Temperature Range DPR drives contain a built-in over-temperature disabling feature if the baseplate temperature rises above a certain value. Table 2.8 below shows the maximum allowable temperature range for standard drive power modules. It is recommended to mount the baseplate of the DPR drive to a heatsink for best thermal management results. For mounting instructions see "Mounting" on page 38.

TABLE 2.8 Baseplate Temperature Ranges

Baseplate Maximum Allowable Temperature	
Power Board	**Temperature Range**
015S400	0 - 75 °C
030A400	0 - 75 °C
040A400	0 - 75 °C
C060A400	0 - 75 °C
C100A400	0 - 75 °C
030A800	0 - 75 °C
060A800	0 - 75 °C
020B080	0 - 65 °C
040B080	0 - 75 °C
060B080	0 - 75 °C
100B080	0 - 75 °C
015B200	0 - 65 °C
025B200	0 - 75 °C

Shock/Vibrations While DPR 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 DPR drive against its baseplate. For information on mounting options and procedures, see "Mounting" on page 38.

Caution

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

3 Integration in the Servo System

This chapter will give various details on incorporating a DPR servo drive into a system, such as how to properly ground the DPR drive along with the entire system, and how to properly connect motor wires, power supply wires, feedback wires, communication cables, and inputs into the DPR 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

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

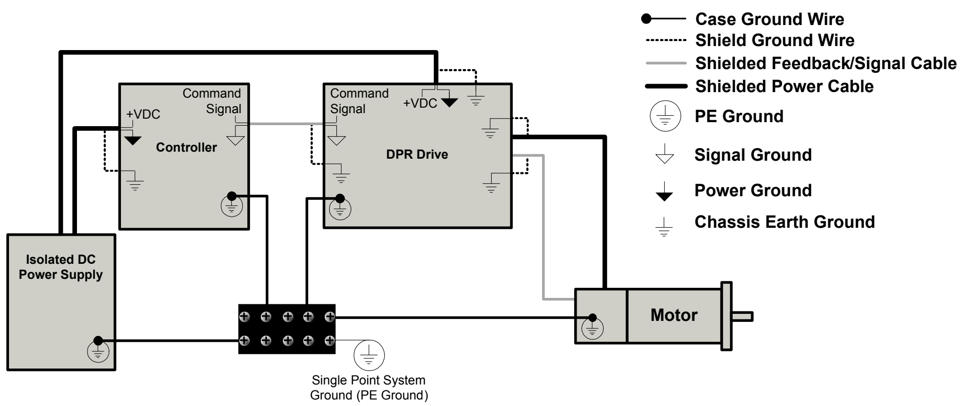
Inductive filter cards are added in series with the motor and are used to increase the load inductance in order to meet the minimum load inductance requirement of the drive. They also serve to counteract the effects of line capacitance found in long cable runs and in high voltage systems. These filter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

3.3 Grounding

In most servo systems the case grounds of all the system components 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 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
- DPR drive chassis

FIGURE 3.1 System Grounding



Ground cable shield wires at the drive 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 DPR drive to avoid picking up noise due to the "floating" differential servo drive input. 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.

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.

ADVANCED Motion Controls recommends using the following hand crimp tools for the appropriate I/O and Feedback cable and wire preparation. Consult the drive datasheet to see which connectors are used on a specific drive.

Drive Connector	Hand Crimp Tool Manufacturer and Part Number
6-pin, 3.96 mm spaced, friction lock header	Tyco: P/N 770522-1
High Density D-sub headers	Tyco: P/N 90800-1

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 becomes more critical as the cable length increases. The following table provides recommendations for selecting the appropriate wire size for a specific current. These values should be used as reference only. Consult any applicable national or local electrical codes for specific guidelines.

Current (A)	Minimum Wire Size (AWG)	mm^2
10	#20	0.518
15	#18	0.823
20	#16	1.31
35	#14	2.08
45	#12	3.31

Current (A)	Minimum Wire Size (AWG)	mm^2
60	#10	5.26
80	#8	8.37
120	#6	13.3
150	#0	53.5
200	#00	67.4

3.4.2 Motor Wires

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

- For a 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 drive chassis ground. The motor power leads should be bundled and shielded in their own cable and kept separate from feedback signal wires.

Caution

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

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 drive chassis ground.

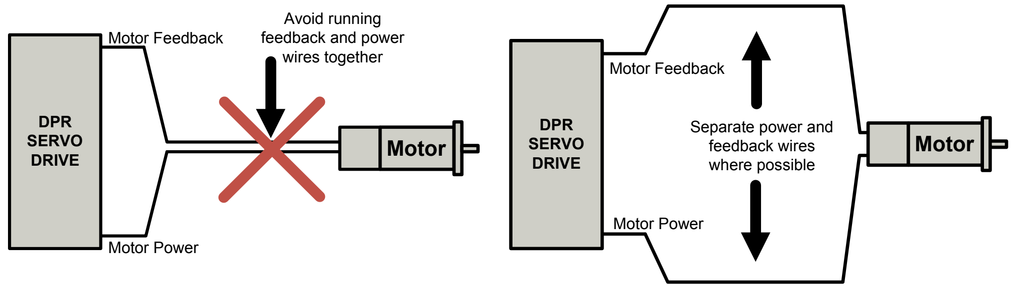
When multiple drives are installed in a single application, precaution regarding ground loops must be taken. Whenever there are two or more possible current paths to a ground connection, damage can occur or noise can be introduced in the system. The following rules apply to all multiple axis installations, 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 drive chassis ground. Also make sure that the feedback connector and D-sub shell preserve the shield continuity. 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 I/O and Signal Wires

Use of a twisted, shielded pair for the I/O and Signal wires is recommended. Connect the shield to the drive 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 when using ±10V command input, 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.

3.5 Connector Types

Depending on the specific drive model, typically a DPR drive connection interface will consist of:

- **Power Connectors -** used for Logic, Motor, and AC or DC Power, as well as optional external shunt regulator connections
- **Feedback Connectors -** used for primary and auxiliary feedback connections, programmable inputs and outputs, and other drive functions
- **RS-485/232 Communication Connector -** used for RS-485 networking, and necessary for RS-232 commissioning with DriveWare
- **I/O Signal Connector -** used for programmable inputs and outputs as well as some feedback connections.
- **STO Connector -** used for Safe Torque Off (STO) functionality.

The different types of connectors used in the DPR drive series are shown in the sections below. Consult the specific drive datasheet for the actual connectors and pin labels used on the drive.

3.5.1 Power Connectors

TABLE 3.1 +24V LOGIC - Logic Power Connector

+24V LOGIC - Logic Power Connector		
Connector Information		2-port, 5.08 mm spaced, enclosed, friction lock header with threaded flange
Mating Connector	Details	Phoenix Contact: P/N 1777808
	Included with Drive	Yes

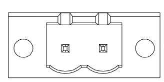


TABLE 3.2 +24V LOGIC - Logic Power Connector

+24V LOGIC - Logic Power Connector		
Connector Information		2-port, 5.08 mm spaced, enclosed, friction lock header
Mating Connector	Details	Phoenix Contact: P/N 1757019
	Included with Drive	Yes

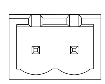


TABLE 3.3 POWER / MOTOR POWER / BRAKE LOGIC - Power Connector

BRAKE/LOGIC - Logic Power Connector		
Connector Information		4-contact, 13 mm spaced, dual-barrier terminal block
Mating Connector	Details	Not applicable
	Included with Drive	Not applicable

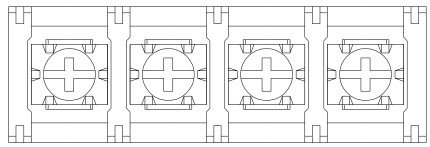


TABLE 3.4 POWER / MOTOR POWER / DC BUS / BRAKE RESISTOR - Power Connector

DC BUS / BRAKE RESISTOR - Power Connector		
Connector Information		5-contact, 13 mm spaced, dual-barrier terminal block
Mating Connector	Details	Not applicable
	Included with Drive	Not applicable

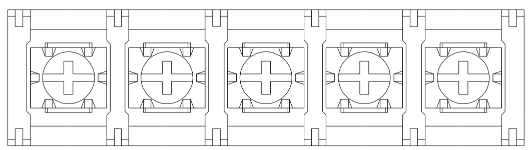


TABLE 3.5 POWER - DC Power Connector

POWER - DC Power Connector		
Connector Information		8-contact, 11.10 mm spaced, dual-barrier terminal block
Mating Connector	Details	Not applicable
	Included with Drive	Not applicable

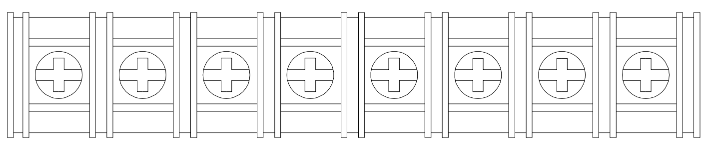


TABLE 3.6 POWER - DC Power Connector

POWER - DC Power Connector		
Connector Information		6-pin, 3.96 mm spaced, friction lock header
Mating Connector	Details	AMP: Plug P/N 770849-6; Terminals P/N 770522-1 (loose) or 770476-1 (strip)
	Included with Drive	Yes

TABLE 3.7 MOTOR POWER - Motor Power Connector

MOTOR POWER - Motor Power Connector		
Connector Information		3-port, 7.62 mm spaced, enclosed, friction lock header
Mating Connector	Details	Phoenix Contact: P/N 1804917
	Included with Drive	Yes

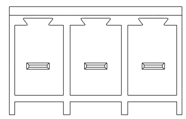


TABLE 3.8 POWER - Power Connector

POWER - DC Power Connector		
Connector Information		8-port, 7.62 mm spaced, enclosed, friction lock header
Mating Connector	Details	Phoenix Contact: P/N 1767067
	Included with Drive	Yes

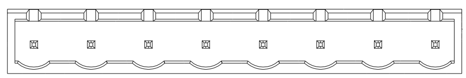


TABLE 3.9 POWER - Power Connector

POWER - Power Connector		
Connector Information		10-port,5.08 mm spaced, enclosed, friction lock header
Mating Connector	Details	Phoenix Contact: P/N 1781069
	Included with Drive	Yes

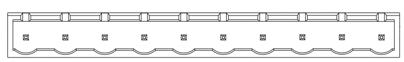


TABLE 3.10 POWER / MOTOR POWER / DC BUS - Power Connector

DC BUS - Power Connector		
Connector Information		4-port, 7.62 mm spaced, enclosed, friction lock header
Mating Connector	Details	Phoenix Contact: P/N 1804920
	Included with Drive	Yes

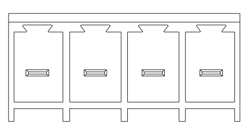


TABLE 3.11 AC POWER / MOTOR POWER / DC POWER - Power Connector

AC POWER / MOTOR POWER / DC POWER - Power Connector		
Connector Information		4-port, 10.16 mm spaced, enclosed, friction lock header
Mating Connector	Details	Not applicable
	Included with Drive	Not applicable

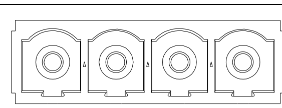


TABLE 3.12 AC POWER / MOTOR POWER - Power Connector

AC POWER / MOTOR POWER / DC POWER - Power Connector		
Connector Information		4-port, 5.0 mm spaced, push-in front spring connection header
Mating Connector	Details	Push-in direct plug-in method for solid or stranded conductors with or without ferrules
	Included with Drive	No

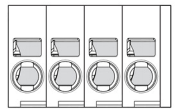
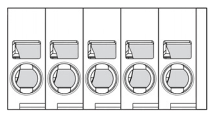


TABLE 3.13 DC POWER - Power Connector

AC POWER / MOTOR POWER / DC POWER - Power Connector		
Connector Information		5-port, 5.0 mm spaced, push-in front spring connection header
Mating Connector	Details	Push-in direct plug-in method for solid or stranded conductors with or without ferrules
	Included with Drive	Not applicable



3.5.2 Feedback Connectors

TABLE 3.14 FEEDBACK - Feedback Connector

FEEDBACK - Feedback Connector		
Connector Information		15-pin, high-density, female D-sub
Mating Connector	Details	TYCO: Plug P/N 748364-1; Housing P/N 5748677-1; Terminals P/N 1658670-2 (loose) or 1658670-1 (strip)
	Included with Drive	No

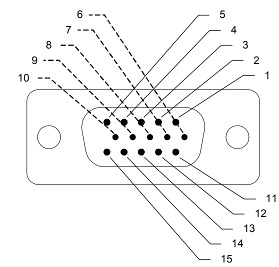
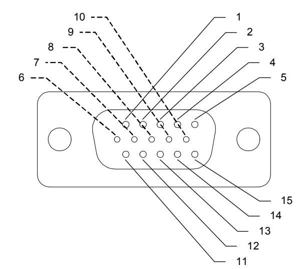


TABLE 3.15 AUX ENCODER - Auxiliary Feedback Connector

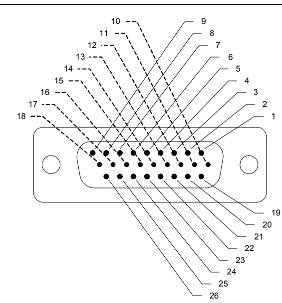
AUX ENCODER - Auxiliary Feedback Connector		
Connector Information		15-pin, high-density, male D-sub
Mating Connector	Details	TYCO: Plug P/N 1658681-1; Housing P/N 5748677-1; Terminals P/N 1658686-2 (loose) or 1658686-1 (strip)
	Included with Drive	No



3.5.3 I/O Connectors

TABLE 3.16 I/O - Signal Connector

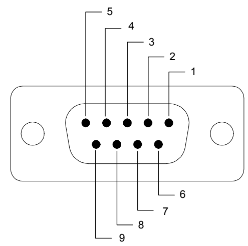
I/O - Signal Connector		
Connector Information		26-pin, high density, female D-sub
Mating Connector	Details	TYCO: Plug P/N 1658671-1; Housing P/N 5748677-2; Terminals P/N 1658670-2 (loose) or 1658670-1 (strip)
	Included with Drive	No



3.5.4 Communication Connectors

TABLE 3.17 COMM - RS232/RS485 Communication Connector

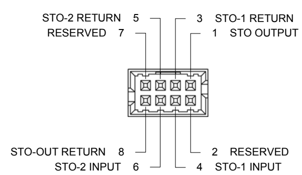
COMM - RS232/RS485 Communication Connector		
Connector Information		9-pin, female D-sub
Mating Connector	Details	TYCO: Plug P/N 205204-4; Housing P/N 5748677-1; Terminals P/N 1658540-5 (loose) or 1658540-4 (strip)
	Included with Drive	No



3.5.5 STO Connector

TABLE 3.18 Safe Torque Off (STO) connector

STO Connector		
Connector Information		8-port, 2.00 mm spaced, enclosed, friction lock header
Mating Connector	Details	Molex: P/N 51110-0860 (housing); 50394-8051 (pins)
	Included with Drive	No



3.6 Mounting

DPR drives provide a number of mounting configuration options. The drive baseplate includes perimeter mounting screwholes allowing different mounting arrangements depending on the requirements or space limitations of the system. See the drive datasheet for specific mounting dimensions and screwhole locations.

4 Operation and Features

This chapter will present a brief introduction on how to test and operate a DPR 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 DPR drive, be sure to read and understand the previous chapters in this manual as well as the drive datasheet and the DriveWare Software Guide. Ensure that all system specifications and requirements have been met, and become familiar with the capabilities and functions of the DPR 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:

- DPR Servo Drive
- Motor
- AC or DC Power Supply and Logic Power Supply for supplying power to system
- DriveWare Setup Software and Software Guide for detailed instructions on how to setup, tune and configure a DPR drive in DriveWare

The following steps outline the general procedure to follow when commissioning a DPR drive for the first time. The DriveWare Software Guide 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.

Caution

Do not apply power to the system until certain all wiring and grounding has been setup safely and properly!

For drives using a separate logic power supply, turn on the 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 Logic supply first for drives using a separate logic supply, then turn on the main 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 DPR drive should be 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 64.
4. **Configure the drive in DriveWare:** DriveWare allows the user to manually configure user units, motor and feedback information, system parameters and limits, tune the Current, Velocity and Position Loops, commutate the motor, and assign drive and software "actions" to specific events. Consult the DriveWare Software Guide for detailed instructions.
5. **Connect to the Controller:** Once the drive has been properly commissioned, use an external controller to command an input signal to the drive. The controller wiring and setup should follow the safety and grounding guidelines and conventions as outlined in “Grounding” on page 29.

4.1.2 Input/Output Pin Functions

DPR 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.

Programmable Digital I/O

The single-ended and differential Programmable Digital I/O can be assigned to over 40 different functions in DriveWare. The polarity of the signals can be set to active HIGH or active LOW depending on the preference of the user. The differential high speed inputs can also be used as command source inputs with an Auxiliary Encoder (see "Auxiliary Encoder Input" below) or for PWM and Direction input (see PWM and Direction below). They also may be used as a High Speed Capture input (see "Capture Inputs" below). DPR drives offer both isolated and non-isolated Programmable Digital I/O.

Note: Depending on the configuration, digital outputs will be pulled either low or high for a period of time after a power cycle or drive reset. The delay period for each control module is given below.

FIGURE 4.1 **Programmable Digital Output Power-up Delay**

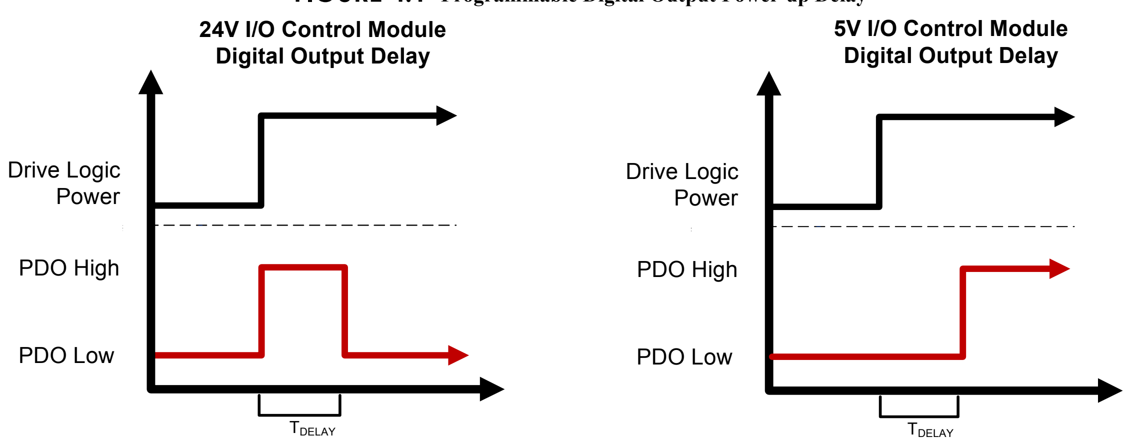


TABLE 4.1 **Programmable Digital Output Power-up Delays**

		Active High		Active Low	
		Power Cycle Delay (ms)	Reset Delay (ms)	Power Cycle Delay (ms)	Reset Delay (ms)
24V I/O Control Modules	DPRAHIE	350	100	-	-
	DPRANIE	200	100	-	-
	DPRANIR	300	100	-	-
5V I/O Control Modules[1]	DPRALTE	-	60	250	100
	DPRALTR	-	60	200	100

1. 5V I/O control modules exhibit an ~100mV voltage spike when set to Active High when a drive reset is commanded.

24VDC Digital I/O Specification

The 24VDC Digital I/O is designed to be compatible with controllers that interface with 24VDC signals, using optical isolation that separates the drive signal ground from the controller signal ground. Isolation increases a system's noise immunity by helping to eliminate current loops and ground currents.

- **Inputs -** The Isolated Digital Inputs use bi-directional optical isolators to detect signals from the controller. Dual LED's in the optical isolator allow current to flow in either direction. Current flow through the LED activates the transistor, and the drive responds depending on whether the transistor is active or not. The presence or absence of current in the LED determines the logic level, not the direction of current. This flexibility allows the Isolated Digital Inputs to be compatible with a wide range of controllers.

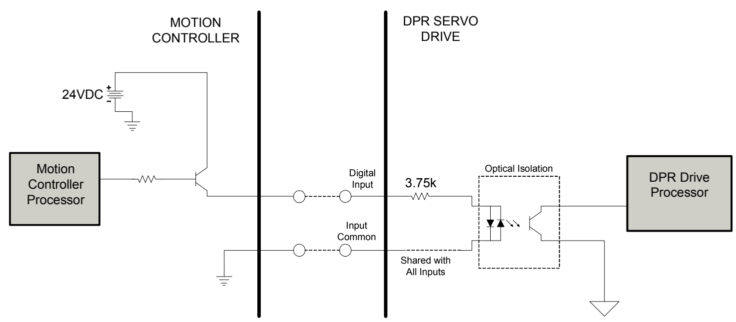
TABLE 4.2 24VDC Isolated Digital Input

24VDC Isolated Digital Input	
Logical LOW	0-1V
Logical HIGH	15-30V (24V Nominal)
Maximum Current	7mA @ 24V

When current flows into the digital input it is acting as a sinking input. When current flows out of the digital input it is acting as a sourcing input. Since current is allowed to flow in either direction, the inputs can either sink or source. The voltage at the Input Common pin determines whether the inputs sink or source. The Input Common pin is common to all of the inputs, but is isolated from the drive signal ground.

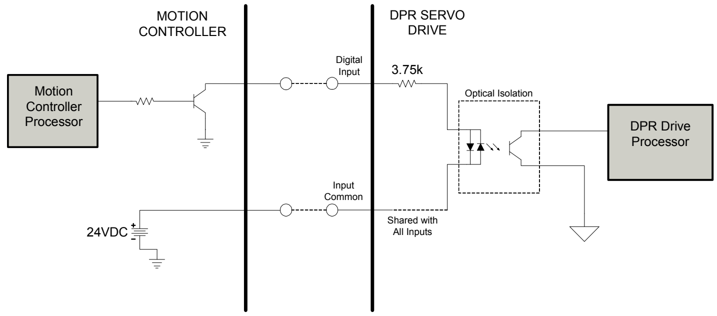
To configure the Isolated Digital Inputs as sinking, the 24V ground is applied to the Input Common and 24V is modulated at the digital input. Figure 4.2 shows a sourcing output from the motion controller feeding the sinking input at the drive. In this example the controller uses a transistor to control the 24V to the drive input. A mechanical switch, relay or other voltage-controlling device can be used in place of the transistor.

FIGURE 4.2 **24VDC Isolated Digital Input configured as a sinking input**



To configure the Isolated Digital Input as sourcing 24V is applied to the Input Common and the 24V ground is modulated at the digital input. Figure 4.3 shows the 24V supply rearranged so it feeds into the Input Common pin. As in the previous example, other switching devices can control the inputs besides a transistor.

FIGURE 4.3 24VDC Isolated Digital Input configured as a sourcing input.



- **Outputs -** The Isolated Digital Outputs are pulled up with a 2.5k resistor via the pin labeled Output Pull-Up and have a common grounding point labeled Output Common.

TABLE 4.3 24VDC Isolated Digital Output (Sinking)

24VDC Isolated Digital Output (Sinking)	
Output Pull-Up Voltage	15-30V (24V nominal, supplied by user)
Logical LOW	0-2V
Logical HIGH	Same as Output Pull-Up Voltage
Maximum Current	50mA

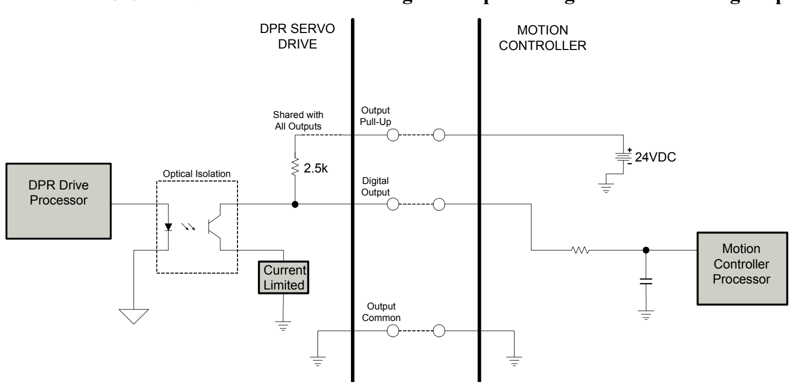
TABLE 4.4 24VDC Isolated Digital Output (Sourcing)

24VDC Isolated Digital Output (Sourcing)	
Output Pull-Up Voltage	15-30V (24V nominal, supplied by user)
Logical LOW	0-2V
Logical HIGH	Same as Output Pull-Up Voltage
Maximum Current	9.6mA

A transistor controls the voltage at each digital output. The Isolated Digital Output can sink or source depending on how the wiring is configured.

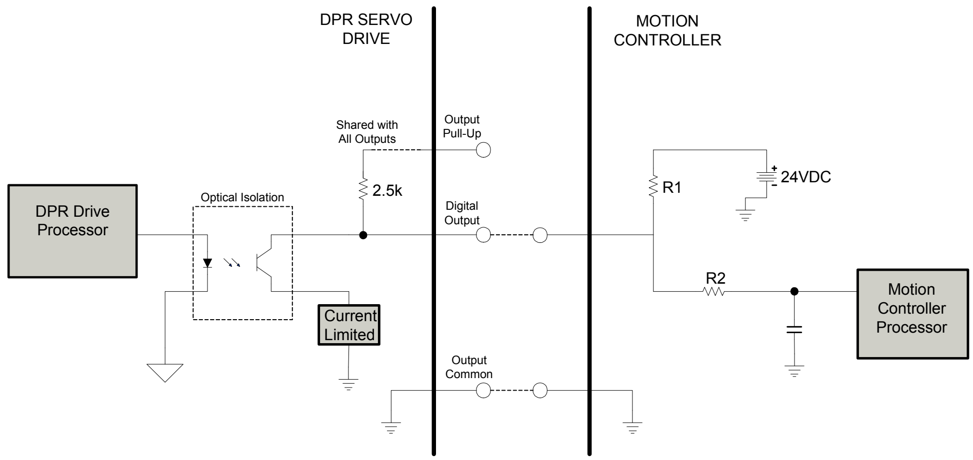
For sourcing outputs the Output Pull-Up pin is pulled to 24V and the 24V ground goes to the output common, as shown in Figure 4.4. A transistor controls the voltage at the digital output. When the transistor is open the voltage at the digital output is HIGH. When the transistor is closed the voltage is pulled to ground, which causes the output to go LOW.

FIGURE 4.4 24VDC Isolated Digital Output configured as a sourcing output.



For sinking outputs the Output Pull-Up pin is not connected and the digital output pin is interfaced as an open collector, as shown in Figure 4.5. 24V is applied to the digital output through a resistor R1 and the 24V ground goes to Output Common. As in the previous example a transistor controls the voltage of the digital output. R1 should be greater than 600Ω to limit the current into the digital output to less than 50mA.

FIGURE 4.5 24VDC Isolated Digital Output configured as a sinking output.



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
24V I/O Control Modules	85 Hz (50% duty cycle)[1]
5V I/O Control Modules	5 kHz (for 20 kHz switching frequency)[2]

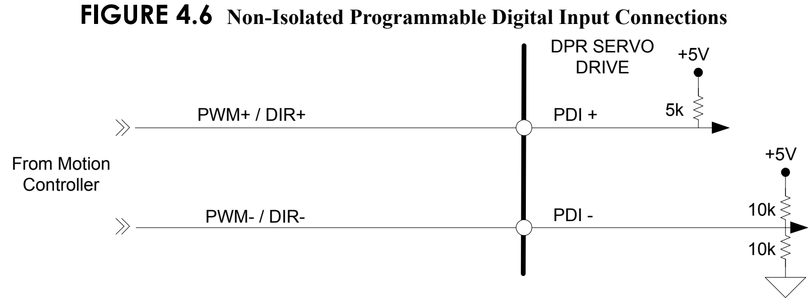
1. Higher duty cycles will result in higher maximum frequencies due to hardware filtering.

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

PWM and Direction Inputs

DPRAHIx, and DPRANIx drives allow configuration of PWM and Direction as a command source using High-Speed digital inputs. When configured for PWM and Direction control these inputs cannot use the Auxiliary Encoder, Step and Direction or Capture features. The command source must be set to PWM and Direction and configured in the Command Source window within DriveWare.

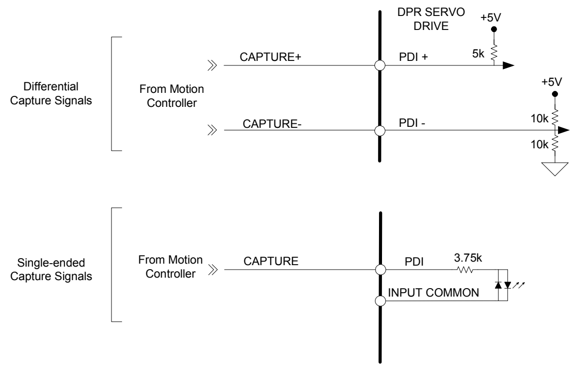
FIGURE 4.6 Non-Isolated Programmable Digital Input Connections



Capture Inputs

DPR drives using an AC power module allow configuration of differential and single-ended Capture inputs using digital inputs. When configured for Capture signals, these inputs cannot be used for Auxiliary Encoder, Step and Direction, or PWM and Direction control. The Capture signals can be used to capture and view internal signals on a designated trigger (rising edge, falling edge, or both). Parameters and options for the Capture signals can be entered and configured in DriveWare.

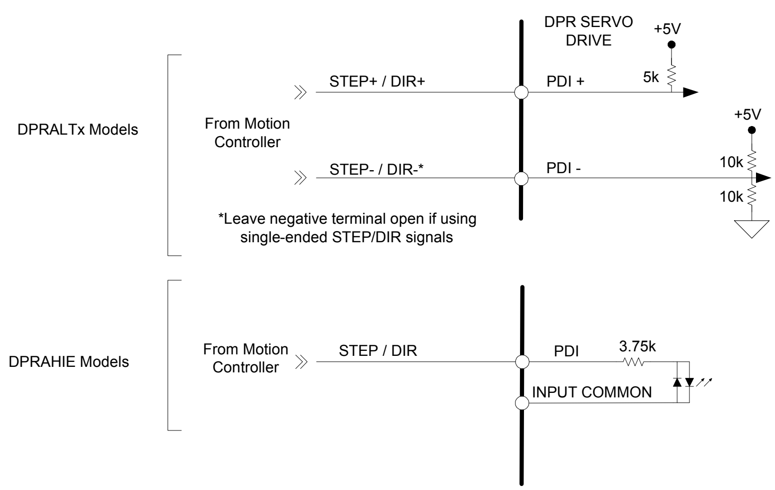
FIGURE 4.7 **Capture Input Connections**



Step and Direction Inputs

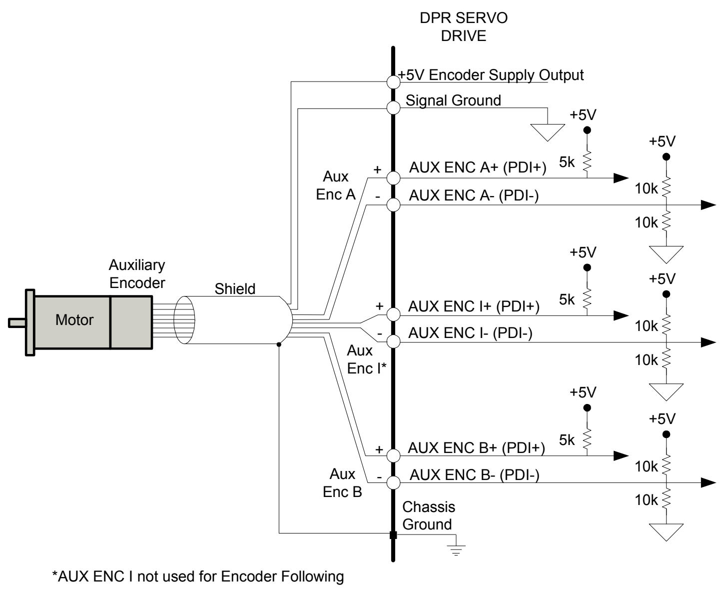
Certain DPR models allow configuration of Step and Direction as a command source using digital inputs. DPRAHIE drives offer +24V Step and Direction, and DPRALTx drives offer +5V Step and Direction. When configured for Step and Direction control these inputs cannot use the Auxiliary Encoder, PWM and Direction, or Capture features. The command source must be set to Step and Direction and configured in the Command Source window within DriveWare.

FIGURE 4.8 **Step and Direction Input Connections**



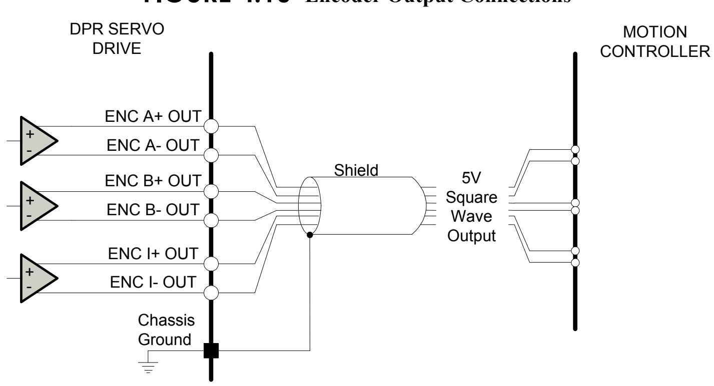
Auxiliary Encoder Input DPR drives accept a differential auxiliary encoder input that can be used for auxiliary position feedback, or for a command source when configured for Encoder Following. The auxiliary encoder signals are connected through High-Speed Programmable Digital Inputs. If using these pins for an auxiliary encoder input, the drive will not be able to utilize the Capture, Step and Direction, or PWM and Direction features. Hardware settings and options for the auxiliary encoder can be entered and configured in DriveWare.

FIGURE 4.9 Auxiliary Encoder Input Connections



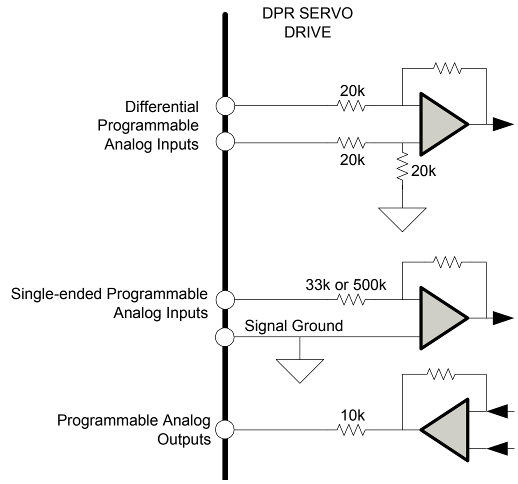
Encoder Output The Encoder Output pins provide a differential encoder output that can be used to synchronize the command to other axes, or to close the position loop. Depending on the type of feedback in use, the drive outputs either a 5V square wave buffered encoder signal (DPRxxxE/S/A drives) or a 5V square wave emulated encoder signal (DPRxxxR/S/A drives). The buffered encoder output has a 1:1 input-to-output ratio, while the emulated encoder input-to-output ratio is configurable within DriveWare (for resolver feedback the emulated output will match the resolver resolution setting). There is a small phase lag between the sinusoidal feedback to the drive and the emulated output due to the time required to process the emulated signal.

FIGURE 4.10 Encoder Output Connections



Programmable Analog I/O The Programmable Analog I/O can be assigned to drive functions in DriveWare. These can be used to monitor drive signals, and are also useful for troubleshooting unexpected drive behavior. The drive I/O Signal Connector provides a differential programmable analog input that may be used for a ±10V analog input command.

FIGURE 4.11



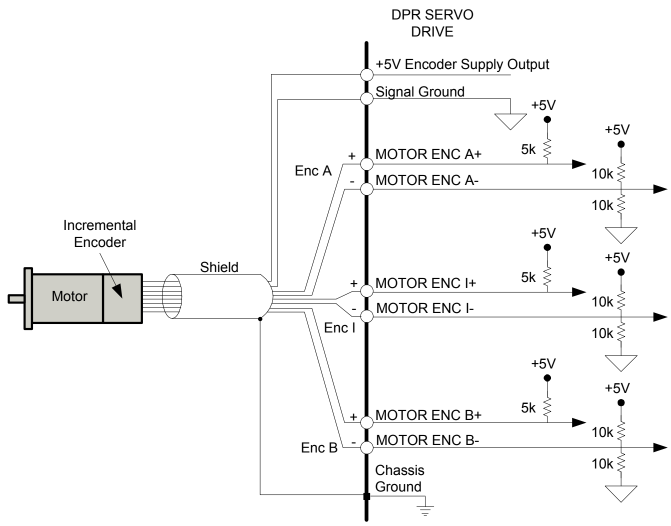
4.1.3 Feedback Operation

The functional operation of the feedback devices supported by DPR drives is described in this section. For more information on feedback selection, see “Feedback Supported” on page 17. See the datasheet of the drive in use for specific pin locations.

Incremental Encoder

DPRxxxE drives support incremental encoder feedback. The drive Feedback Connector allows inputs for differential and single-ended inputs. For single-ended encoder inputs, leave the negative terminal open. Both the "A" and "B" channels of the encoder are required for operation. DPRxxxE drives also accept an optional differential "index" channel that can be used for synchronization and homing. A +5V Encoder Supply Output pin is provided to supply power to the encoder.

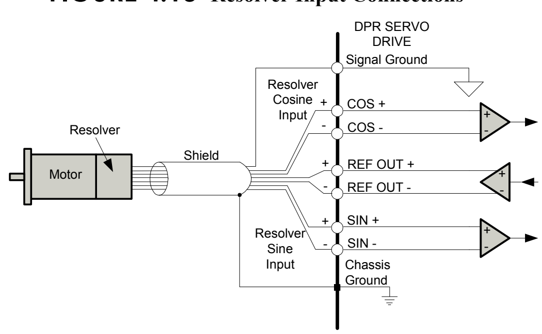
FIGURE 4.12 Incremental Encoder Connections



Resolver

DPRxxxR drives support resolver feedback with a carrier frequency of 5kHz, an excitation voltage of 4Vrms, and a 0.5 transformation ratio. The drive Feedback Connector provides a differential Resolver Reference/Excitation output, and allows differential sine and cosine resolver inputs.

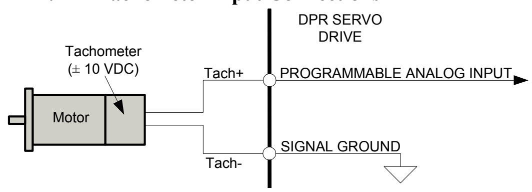
FIGURE 4.13 Resolver Input Connections



Tachometer (±10 VDC)

All DPR drives support the use of a tachometer for velocity feedback. The Programmable Analog Input on the motor Feedback Connector is available for use with a tachometer. The tachometer signal is limited to ±10 VDC.

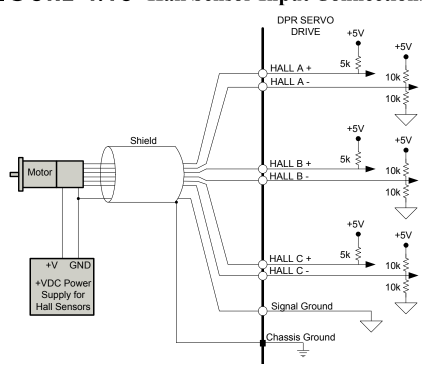
FIGURE 4.14 Tachometer Input Connections



Hall Sensors

DPRxxxE drives accept Hall Sensor feedback primarily for commutation, although they can also be used for velocity control. The drive Feedback Connector allows differential or single-ended Hall Sensor inputs. For single-ended Hall signals leave the negative terminals open.

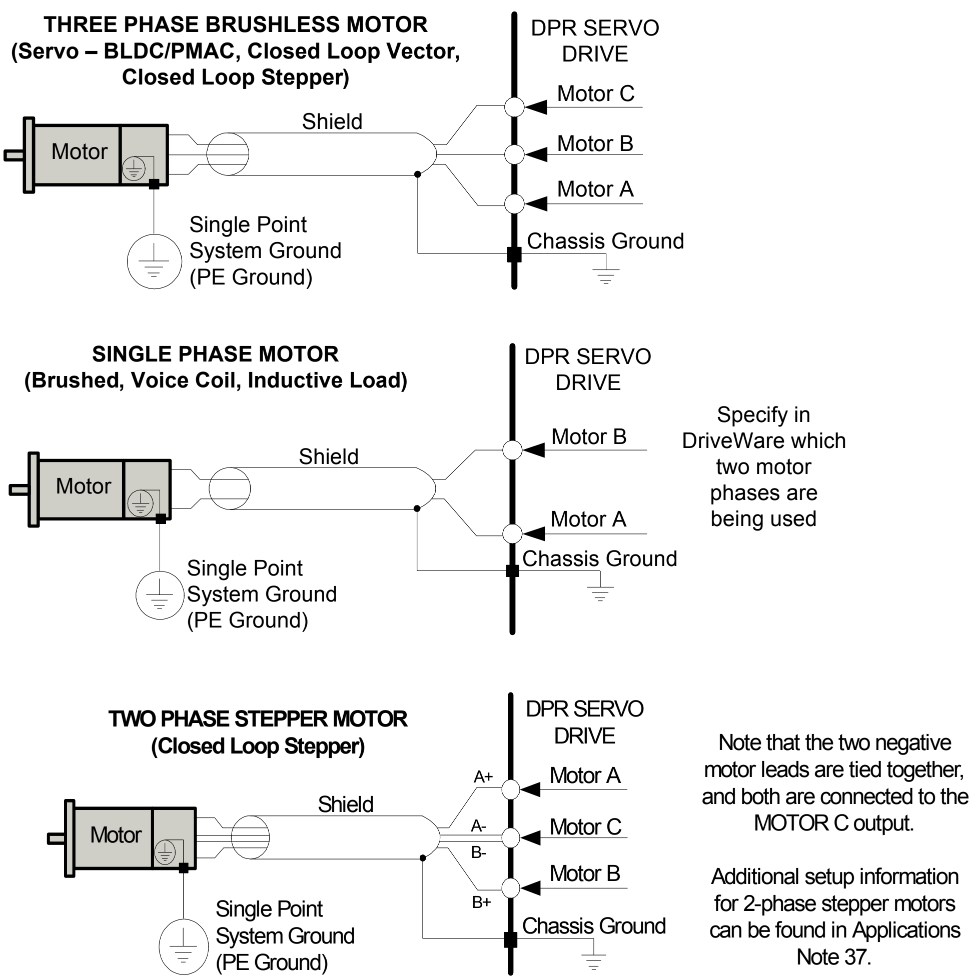
FIGURE 4.15 Hall Sensor Input Connections



4.1.4 Motor Connections

The diagrams below show how a DPR drive connects to various motor types. 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 drive side to chassis ground.

FIGURE 4.16 **Motor Power Output Wiring.**



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).

4.1.5 STO (Safe Torque Off)

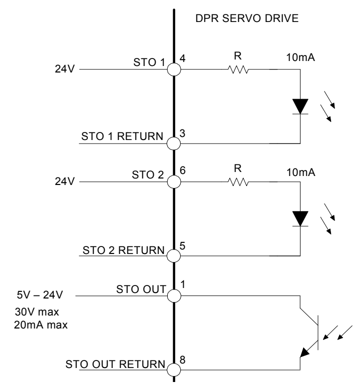
Some models of the DPR drive family feature an external dedicated +24VDC STO safety function designed to monitor an external 24V STO input from the user system and disable the motor output during an STO event. The STO circuit uses +24VDC sinking single-ended isolated inputs for STO functionality. Both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

TABLE 4.6 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 4.17 STO Connections



See “STO Connector” on page 38 for a drawing and description of the physical STO connector and mating hardware. 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 (STO 1 and STO2) 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 52). 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:

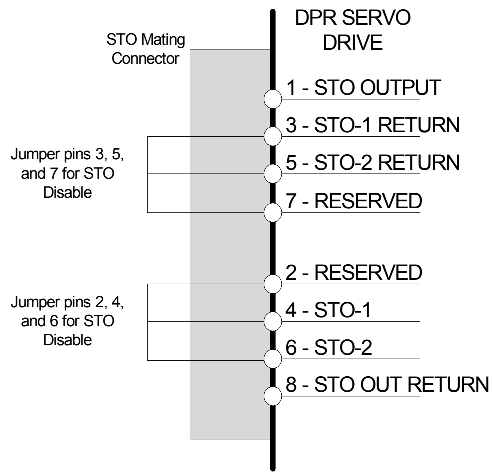
- Safe-Failure-Fraction: SFF = 97%
- Probability of a dangerous failure per hour: PFH = 1.3×10^{-8} 1/h
- Average probability of a dangerous failure on demand (1 year): $PFD_{avg} = 1.7 \times 10^{-5}$

Note

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

STO Disable For applications that do not require Safe Torque Off functionality, disabling of the STO feature is required for proper drive operation. A dedicated STO Disable Key connector is available for purchase and must be installed for applications where STO is not in use. Contact the factory for ordering information. Altenatively, STO may be disabled by installing the included mating connector for the STO connector, and wiring the designated pins together as given below in figure.

FIGURE 4.18 STO Disable Connections



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.

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.

4.1.6 External Shunt Resistor Connections

Most AC powered DPR drives allow the option of connecting an external shunt resistor to protect against damage that may occur due to over-voltage. Drives that do not include an internal shunt resistor require an external shunt resistor for the internal shunt regulator to operate. The figures below show how an external shunt resistor should be connected to the drive for the different AC Power Modules. The shunt regulator must be enabled and configured in DriveWare in order to operate.

FIGURE 4.19 030A400 Power Module External Shunt Resistor Connection

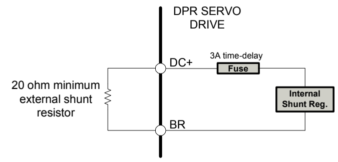


FIGURE 4.20 C060A400 Power Module External Shunt Resistor Connection

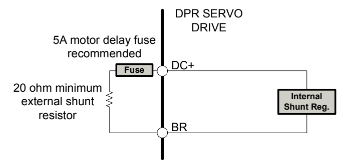


FIGURE 4.21 C100A400 Power Module External Shunt Resistor Connection

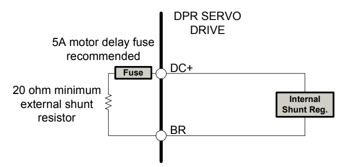


FIGURE 4.22 030A800 Power Module External Shunt Resistor Connection

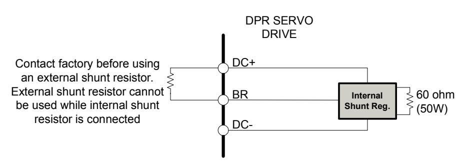
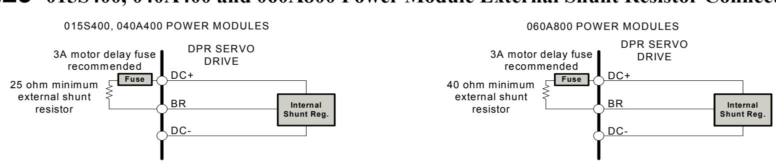


FIGURE 4.23 015S400, 040A400 and 060A800 Power Module External Shunt Resistor Connections



4.1.7 Logic Power Supply

An external +24 VDC logic power supply (850 mA) is required on drives using AC power modules. The logic power supply ground should be referenced to the DPR drive signal ground. The logic power inputs are made through a separate Logic Power connector on the drive.

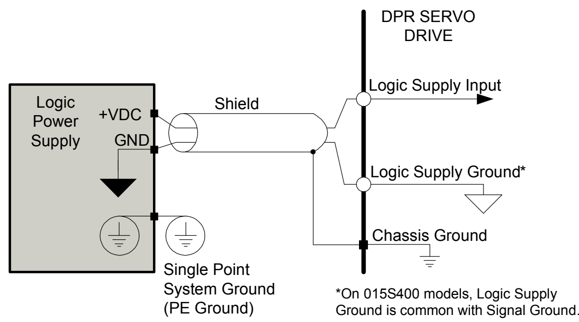
Caution

When using a separate logic power supply, the logic power must be turned on before the main power supply.

TABLE 4.7 AC Power Module Logic Supply Range

AC Power Module	Logic Supply Range (VDC)	Input Current (mA)
015S400, 030A400, 040A400, C060A400, C100A400, 030A800, 060A800	20-30	850

FIGURE 4.24 AC Power Module Logic Power Supply Inputs

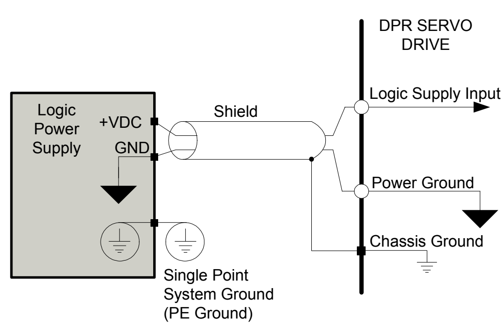


On drives using DC power modules, an external logic supply is optional. If no external logic power supply is connected the drive will use the main DC power supply for logic power. If an external logic power supply is used, the voltage must be below the main DC power value. Table 4.8 shows the different DC power modules and their corresponding logic supply ranges.

TABLE 4.8 DC Power Module Logic Supply Ranges.

DC Power Module	Logic Supply Range (VDC)
020B080	20-80
040B080	20-80
060B080	20-80
100B080	20-80
015B200	40-190
025B200	20-190

FIGURE 4.25 DC Power Module Logic Power Supply Inputs



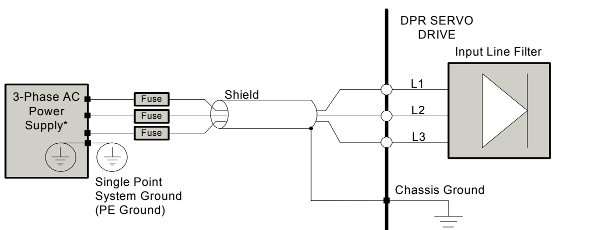
4.1.8 Power Supply Connections

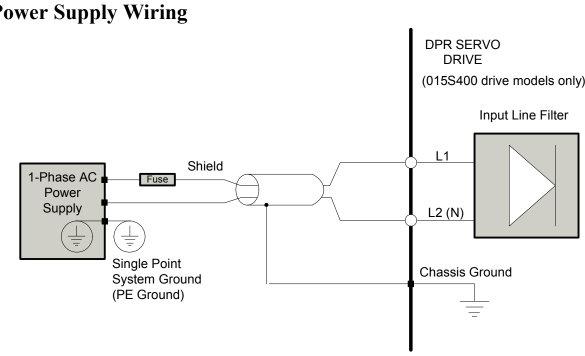
The figures below show how an external power supply should be connected to the DPR drive.

AC or DC Power Modules

For drive models designed for a three-phase AC power supply, connect the AC supply to L1, L2, and L3. On certain drive models, a single-phase AC supply can be connected to any two of the three (L1, L2, L3) AC terminals with the result that some drive power de-rating may occur. See Figure 4.26 below or the drive datasheet for the specific model characteristics. For drives designed for a single phase AC supply, connect the AC supply to the L1 and L2 (N) AC terminals for. Figure 4.26 below shows the recommended connections.

FIGURE 4.26 AC Power Supply Wiring





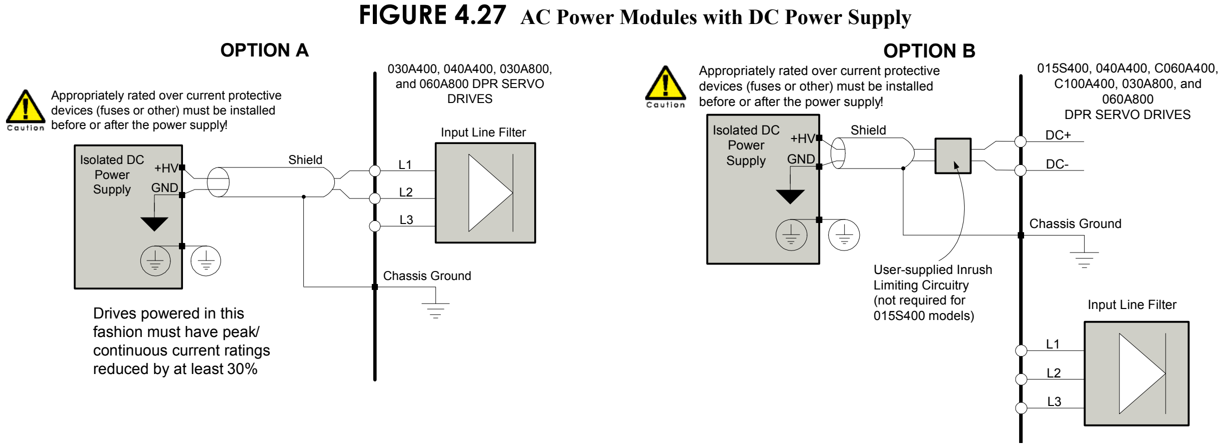
*To use a single-phase AC Supply with a drive designed for a three-phase AC supply, connect AC lines to any two of L1, L2, and L3. Do not connect AC line neutral to ground! See the chart below for specific drive model de-rating information for drives powered by single-phase AC.

Model	Single-Phase AC De-rating Characteristics
030A400	Peak and continuous current ratings will be reduced by 30%
040A400	Peak and continuous current ratings will be reduced by 30%
C060A400	Output power must not exceed 3KW. No current limit de-rating.
C100A400	Output power must not exceed 3kW. Current limits de-rated to 30A cont. / 60A peak.

If using a DC supply to power a drive with an AC power module, follow one of the methods below, depending on the connections available for the specific power module (Figure 4.27 below shows the recommended connections):

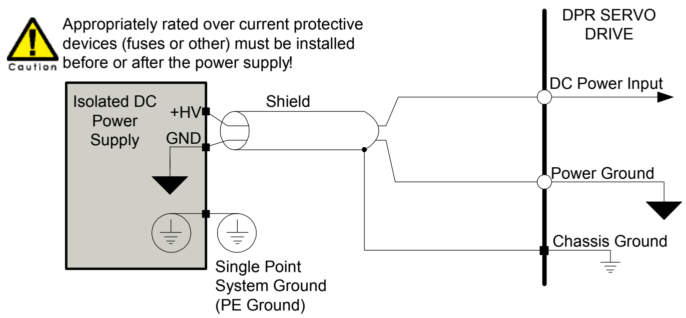
- (Option A) Connect the isolated DC supply between any two of the three (L1, L2, L3) power terminals. Note that drives powered in this fashion must have peak and continuous current ratings reduced by at least 30% and should not be given current commands that exceed this derating.
- (Option B) Some drives feature DC+ and DC- terminals which can be used as DC inputs rather than using L1, L2, or L3. Except for 015S400 power modules, powering the drive in this fashion will require external inrush limiting circuitry that must be properly scaled to the application and drive power requirements.

FIGURE 4.27 AC Power Modules with DC Power Supply



DC Power Modules For drives using a DC power module, connect the isolated DC supply high voltage to the DC Power Input terminal, and the DC supply ground to the power ground terminal, as shown in Figure 4.28 below.

FIGURE 4.28 **DC Power Supply Wiring**



4.1.9 Communication and Commissioning

DPR drives include a single serial interface for networking and drive configuration and setup. The RS-485 address and baud rate are set by dipswitches on the DPR drive. The dipswitch settings are different from and do not affect the RS-232 connection settings. Table 4.9 shows the RS-485 drive address and baud rate dipswitch information. The RS-485 drive address and baud rate settings will apply when using Modbus RTU.

TABLE 4.9 **Binary RS-485 Drive Address and Baud Rate Dipswitch Settings**

Switch	Description	Setting	
		On	Off
1	Bit 0 of binary RS-485 drive address	1	0
2	Bit 1 of binary RS-485 drive address	1	0
3	Bit 2 of binary RS-485 drive address	1	0
4	Bit 3 of binary RS-485 drive address	1	0
5	Bit 4 of binary RS-485 drive address	1	0
6	Bit 5 of binary RS-485 drive address	1	0
7	Bit 0 of drive RS-485 baud rate setting	1	0
8	Bit 1 of drive RS-485 baud rate setting	1	0

The drive can be configured to use the RS-485 address and/or baud rate stored in non-volatile memory by setting the address and/or baud rate value to 0. The baud rate settings are given in Table 4.10.

TABLE 4.10 **RS-485 Drive Baud Rate Settings**

Baud Rate (kbits/sec)	Value For Baud Rate Setting
Load from non-volatile memory	0
9.6	1
38.4	2
115.2	3

Upon connecting to the drive for the first time, the factory default settings for drive address and baud rate must be used. The default drive address and baud rate for both RS-232 and RS-485 is 63 and 115200, respectively. 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. After connecting to the drive, by setting the RS-485 baud rate dipswitches to 0, the RS-485 baud rate can be configured in DriveWare or by serial commands up to a baud rate of 921600.

RS-485/232 Interface DPR drives include a Communication port for connection to RS-485/232 hardware interface. In order to select between RS-232 and RS-485 communication, the RS-485/232 selection pin SELECT (Pin 1 on Communication port) must be pulled to ground for RS-485, or left open for RS-232. DPR drives support both two wire and four wire RS-485 networks.

FIGURE 4.29 RS-232 Interface

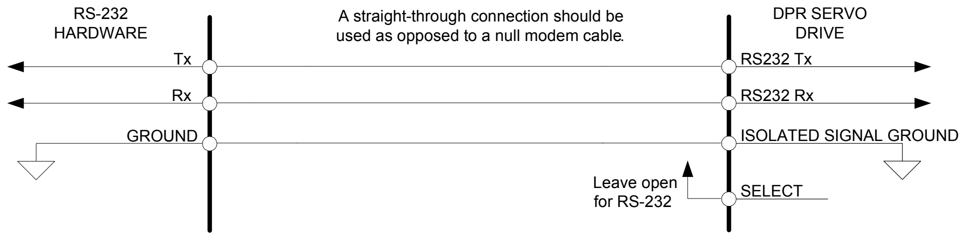
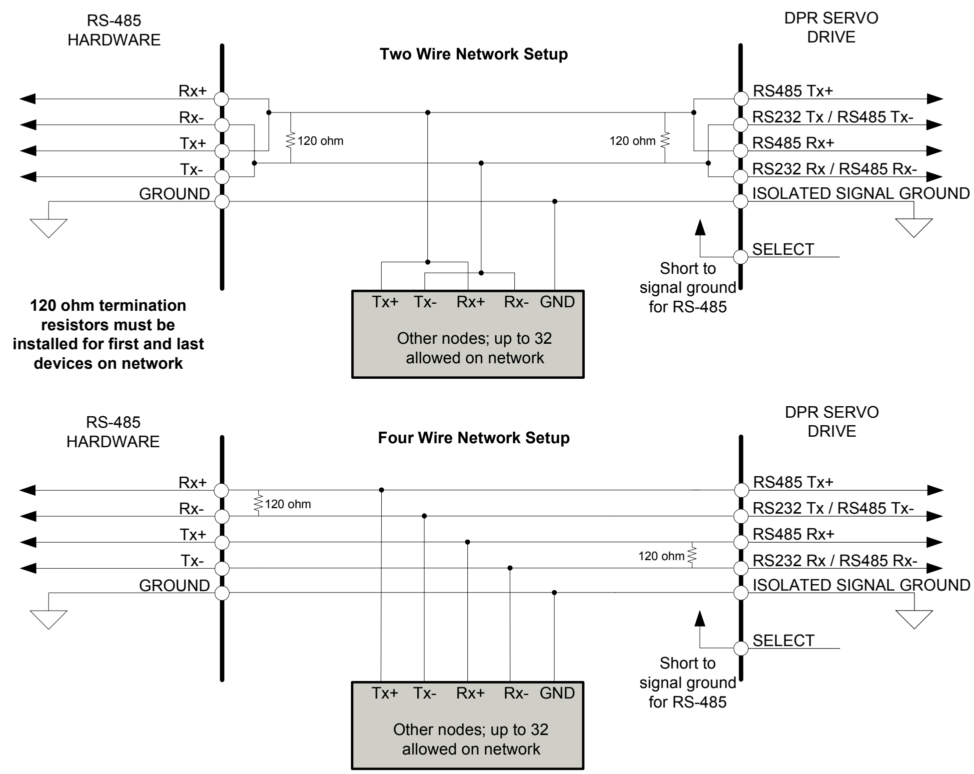


FIGURE 4.30 RS-485 Interface



4.1.10 LED Functionality

DPR drives feature LED status indicators for supply power and power bridge status. Certain models also include an LED to indicate regeneration mode status.

Power LED The Power LED indicates whether power is being supplied to the drive, as well as shunt regulator operation.

Power LED	
State	**Description**
GREEN	Power is being supplied to the drive
OFF	No power is being supplied to the drive
FLASHING RED	Drive is shunting excess energy through the shunt regulator (may appear as flashing RED/GREEN as the shunt regulator is turning off and on during regeneration)

Status LED The Status LED indicates whether the drive power bridge is enabled or disabled.

Status LED	
State	**Description**
GREEN	Power output bridge is enabled
RED	Power output bridge is disabled (via inhibit or fault)

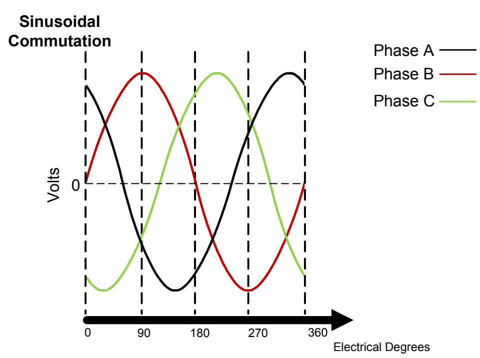
4.1.11 Commutation

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.

See the DriveWare Software Guide for more information on AutoCommutation, Manual Commutation, and Phase Detect. DPR drives allow either sinusoidal or trapezoidal commutation.

Sinusoidal Commutation Sinusoidal commutation provides greater performance and efficiency than trapezoidal commutation. DPR 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 4.31 shows one electrical cycle of the motor phase currents.

FIGURE 4.31 **Sinusoidal Commutation Motor Phase Currents**

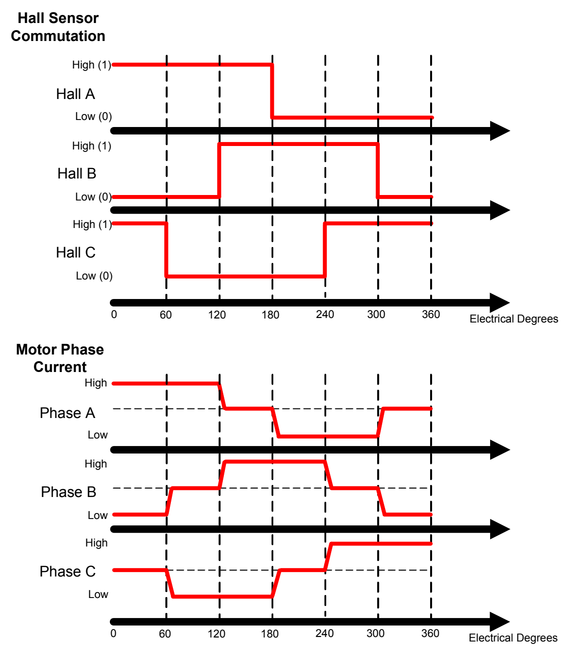


Trapezoidal Commutation Trapezoidal commutation is accomplished with the use of Hall Sensors on three phase (brushless) motors. DPR drives can commutate trapezoidally when used with properly spaced Hall Sensors. Unlike sinusoidal commutation, current flows through only two motor phases at a time with 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 4.32.

FIGURE 4.32 **Hall Sensor Commutation and Motor Phase Current for 120-Degree Phasing**



Note: Not all *ADVANCED* Motion Controls' servo drive series use the same commutation logic. The commutation diagrams provided here should be used only with drives covered within this manual.

Table 4.11 shows the default commutation states for 120-degree and 60-degree phasing. Depending on the specific setup, the sequences may change after running Auto Commutation.

TABLE 4.11 **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	HIGH	-	LOW
	1	1	0	1	1	0	-	HIGH	LOW
	1	1	1	0	1	0	LOW	HIGH	-
	0	1	1	0	1	1	LOW	-	HIGH
	0	0	1	0	0	1	-	LOW	HIGH
	0	0	0	1	0	1	HIGH	LOW	-
Invalid	1	0	1	1	1	1	-	-	-
	0	1	0	0	0	0	-	-	-

4.1.12 Homing

DPR 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 Guide for more information on Homing.

4.1.13 Firmware

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

A Specifications

A.1 Specifications Tables

TABLE A.1 Power Specifications - AC Input DPR Drives

		Power Specifications						
Description	Units	015S400	030A400	040A400	C060A400	C100A400	030A800	060A800
Rated Voltage	VAC(VDC)	240 (339)	240 (339)	240 (339)	240 (339)	240 (339)	480 (678)	480 (678)
AC Supply Voltage Range	VAC	100-240	100-240	100-240	200-240	200-240	200-480	200-480
AC Supply Minimum	VAC	90	90	90	180	180	180	180
AC Supply Maximum	VAC	264	264	264	264	264	528	528
AC Input Phases[2]	-	1	3	3	3	3	3	3
AC Supply Frequency	Hz	50-60	50-60	50-60	50-60	50-60	50-60	50-60
DC Supply Voltage Range	VDC	123-373	127-373	127-373	255-373	255-373	255-747	255-747
DC Bus Over Voltage Limit	VDC	394	429	394	420	420	850	850
DC Bus Under Voltage Limit	VDC	55	55	55	205	205	230	230
Maximum Peak Output Current	A (Arms)	15 (10.6)	30 (21.2)	40 (28.3)	60 (42.4)	100 (70.7)	30 (21.2)	60 (42.4)
Maximum Continuous Output Current	A (Arms)	7.5 (7.5)	15 (15)	20 (20)	30 (30)	50 (50)	15 (10.6)	30 (21.2)
Max. Continuous Output Power @ Rated Voltage[2]	W	2415	4831	6441	9662	16103	6840	13680
Max. Continuous Power Dissipation @ Rated Voltage	W	127	254	339	509	848	360	720
Internal Bus Capacitance	µF	540	1410	660	1120	1120	330	330
PWM Switching Frequency	kHz	20	20	20	14	10	10	10
External Shunt Resistor Minimum Resistance	Ω	25	20	25	20	20	note 3	40
Minimum Load Inductance (Line-To-Line)	µH	600	600	600	600	600	3000	3000

1. Certain 3-phase drive models can operate on single-phase VAC if peak/cont. current ratings are reduced by at least 30%.
2. P = (DC Rated Voltage) * (Cont. RMS Current) * 0.95
3. Contact factory before using an external shunt resistor with this power module

TABLE A.2 Power Specifications - DC Input DPR Drives

		Power Specifications					
Description	Units	020B080	040B080	060B080	100B080	025B200	015B200
DC Supply Voltage Range	VDC	20-80	20-80	20-80	20-80	20-190	40-190
DC Bus Over Voltage Limit	VDC	86	86	86	88	198	198
DC Bus Under Voltage Limit	VDC	17	17	17	17	17	35
Maximum Peak Output Current	A (Arms)	20 (14.1)	40 (28.3)	60 (42.4)	100 (70.7)	25 (17.7)	15 (10.6)
Maximum Continuous Output Current	A (Arms)	10 (10)	20 (20)	30 (30)	60 (60)	12.5 (12.5)	7.5 (7.5)
Max. Continuous Output Power	W	760	1520	2280	4560	2256	1354
Max. Continuous Power Dissipation	W	40	80	120	230	118	71
PWM Switching Frequency	kHz	20	20	20	20	20	20
Internal Bus Capacitance	µF	33	500	500	500	50	20
Minimum Load Inductance (Line-To-Line)	µH	250	250	250	250	300	250

TABLE A.3 Control Specifications

Control Specifications			
Description	**DPRAHIx**	**DPRANIx**	**DPRALTx**
Network Communication	RS-485/RS232 or Modbus RTU		
Command Sources	±10V Analog, 24V Step and Direction, Encoder Following, Over the Network, PWM and Direction, Sequencing, Indexing, Jogging	±10V Analog, Encoder Following, Over the Network, PWM and Direction, Sequencing, Indexing, Jogging	±10V Analog, 5V Step and Direction, Encoder Following, Over the Network, Sequencing, Indexing, Jogging
Commutation Methods	Sinusoidal, Trapezoidal		
Control Modes[1]	Current (Torque), Velocity, Hall Velocity, Position		
Motors Supported	Three Phase Brushless (Servo, Closed Loop Vector, Closed Loop Stepper), Single Phase (Brushed, Voice Coil, Inductive Load)		
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	10/4		6/4
Programmable Analog I/O	4/0	4/1	3/2
Primary I/O Logic Level	24 VDC		5V TTL

1. Hall Velocity mode may not be supported on certain drives. Check the drive datasheet to see if Hall Sensors are supported.

TABLE A.4 Environmental Specifications

Parameter	Description
Humidity	90%, non-condensing
Mechanical Shock	10g, 11ms, Half-sine
Vibration	2 - 2000 Hz @ 2.5g
Altitude	0-3000m

TABLE A.5 Baseplate Temperature Ranges

Power Board	Temperature Range
015S400	0 - 75 °C
030A400	0 - 75 °C
040A400	0 - 75 °C
C060A400	0 - 75 °C
C100A400	0 - 75 °C
030A800	0 - 75 °C
060A800	0 - 75 °C
020B080	0 - 65 °C
040B080	0 - 75 °C
060B080	0 - 75 °C
015B200	0 - 65 °C
025B200	0 - 75 °C

TABLE A.6 Feedback Specifications

Parameter	Value
Maximum Incremental Encoder Input Frequency	20MHz (5 pre-quadrature)
Maximum Sin/Cos Encoder Input Frequency	200kHz
Maximum Hall Sensor Input Frequency	0.15 x PWM Switching Frequency
Resolver Specifications	5kHz, 4Vrms, 0.5 transformation ratio
Maximum Tachometer Voltage	±10VDC

TABLE A.7 24 VDC Digital I/O Specifications

24VDC Isolated Digital Input	
Logical LOW	0-1V
Logical HIGH	15-30V (24V Nominal)
Maximum Current	7mA @ 24V

24VDC Isolated Digital Output	
Output Pull-Up Voltage	15-30V (24V nominal, supplied by user)
Logical LOW	0-2V
Logical HIGH	Same as Output Pull-Up Voltage
Maximum Current	50mA sinking, 8mA sourcing

B Troubleshooting

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

B.1 Fault Conditions and Symptoms

A 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 65ºC (149ºF). 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 24 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.

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 "Commutation" on page 58 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 this particular limiting event 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 DPR drives are a Drive Address of 63 and 115200 Baud Rate (some older drives may have a default Baud Rate of 9600). 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. Also check that all port hardware (USB-to-serial, etc.) is properly installed and configured.

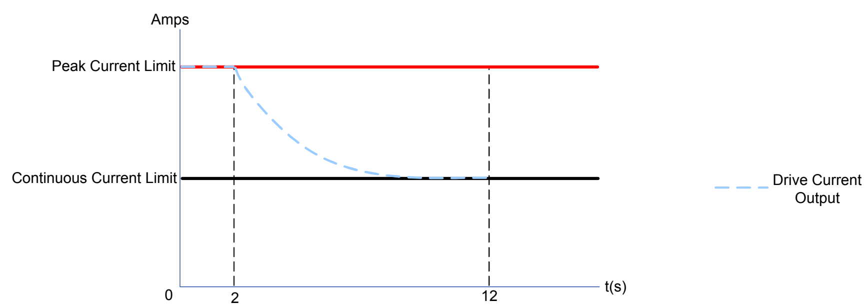
B.1.3 Overload

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 datasheets 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. 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.
- 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:

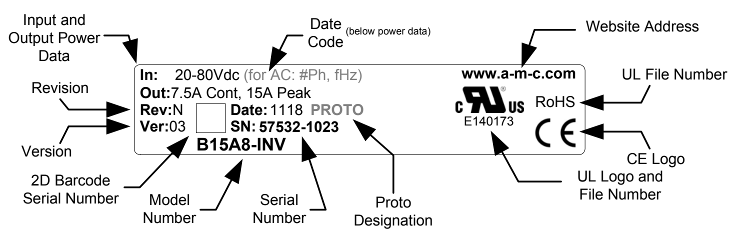
B.2.1 Drive Model Information

- 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



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. Input and Output Power Data: Includes basic power parameters of the product.
8. 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:

web	www.a-m-c.com/download/form/form_rma.html
telephone	(805) 389-1935
fax	(805) 389-1165

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