ION Digital Drive
User's Manual

PMD

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Revision 1.6 May 2010

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Related Documents

Magellan Motion Processor User's Guide

Complete description of the Magellan Motion Processor features and functions with detailed theory of its operation.

Magellan Motion Processor Programmer's Command Reference

Descriptions of all Magellan Motion Processor commands, with coding syntax and examples, listed alphabetically for quick reference.

Pro-Motion User's Guide

User's guide to Pro-Motion, the easy-to-use motion system development tool and performance optimizer. Pro-Motion is a sophisticated, easy-to-use program which allows all motion parameters to be set and/or viewed, and allows all features to be exercised.

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1. Introduction

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- ION Digital Drive Overview
- ION Features and Functions

1.1 ION Digital Drive Overview

The ION Digital Drives are a family of single-axis motion controllers with integrated power electronics and serial network communications. Various models are available to drive DC brush, brushless DC, and step motors. In addition, two overall power levels are available: The ION 500, providing up to 500 watts of power output, and the ION 3000, providing up to 3,000 watts of power output.

ION digital drives are based on PMD's Magellan Motion Processor technology and perform profile generation, encoder position feedback, position servo compensation, step motor stall detection, brushless DC motor commutation, microstep generation, and digital current/torque control. Network communications options include CANbus, RS485, and RS232.

All members of the ION family have integrated, high-power drive stages which fully protect from overcurrent, undervoltage, overvoltage, overtemperature, and short circuit faults. In addition to extensive motion I/O capability, ION also features Auxiliary Encoder inputs and dedicated Enable input and Fault output safety interlocks. ION's flexible mounting configurations include both a vertical and a horizontal option, while ION 500 offers an additional DIN rail mount option with optional heatsink.

This manual describes the features and functions of the ION family of Digital Drives. For more information on the Magellan Motion Processor and its software command set, refer to the *Magellan Motion Processor User's Guide* and the *Magellan Motion Processor Programmer's Command Reference.*

1.2 ION Features and Functions

At the heart of ION is the Magellan Motion Processor. This enhanced member of the Magellan family provides an extensive list of motion control functions including:

- Serial host communications over RS232, RS485, or CANBus
- Trajectory generation, including trapezoidal and S-curve point-to-point profiling, velocity contouring, and electronic gearing modes
- Advanced PID position loop with integration limit, derivative sample time, velocity and acceleration feedforward, output bias, dual biquad filters, and support for dual encoder feedback
- Two encoder input channels capable of up to 10 Mcounts per second
- Sinusoidal and six-step (Hall) brushless DC commutation modes
- Microstepping outputs with up to 256 microsteps per step
- Digital current loop with choice of standard A/B or Field Oriented Control (FOC) for both brushless DC and step motors
- Single phase current loop for DC brush motors
- Pulse and direction input (ION 3000 only)

The ION module adds power electronics and signal conditioning circuitry to create a complete digital drive with these key features:

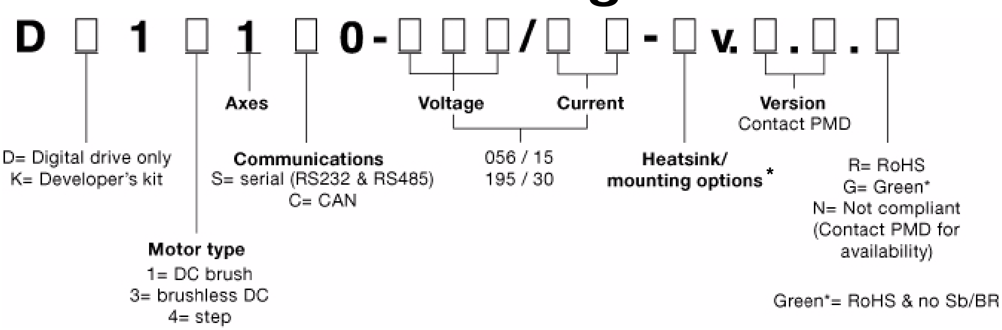
- High-efficiency MOSFET power stages with versions for single-phase brush DC motors, two-phase step motors, and three-phase brushless DC motors
- I^2t current foldback limiting
- Selectable 20 kHz and 40 kHz PWM frequencies to support a broad range of motor inductance
- Overcurrent, short circuit, overvoltage, undervoltage, and overtemperature protection
- Single supply operation. An onboard DC/DC converter supplies all internal circuitry and also provides 5V for encoders and other external I/O.
- Enable input and Fault output safety interlock
- Differential or single-ended encoder input buffers for all encoder channels
- Signal conditioning buffers and analog filters on all I/O signals

ION comes packaged in a rugged enclosure with flexible mounting options and reliable signal and power connectors. ION is fully RoHS compliant and CE marked. Additionally, ION 3000 is certified by UL (Underwriters Laboratories).

2. Installation

In This Chapter

2.1 ION Model Numbering



*ION 500 only

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The ION family consists of versions to drive three motor types (DC brush, brushless DC, and step) with the choice of two communications ports (CAN or Serial). In addition, two overall power levels are available, the ION 500 and ION 3000 models. For the ION 500, heat sink and DIN rail mounting options can be specified in the part number. Note that the Serial version of ION supports both RS485 and RS232 serial standards.

2.1.1 ION 500 Part Numbers

The following table shows the base part number configurations for the ION 500. Note that for ION 500 models, it is possible to order units in DIN rail mount and with an optional heat sink. See the above part number diagram for details.

Model Number	Motor Type	Communications Port
DD131S0-056/15	Brushless DC	Serial
DD131C0-056/15	Brushless DC	CANBus
DD111S0-056/15	DC Brush	Serial
DD111C0-056/15	DC Brush	CANBus
DD141S0-056/15	Step Motor	Serial
DD141C0-056/15	Step Motor	CANBus

2.1.2 ION 3000 Part Numbers

The following table shows the base part number configurations for the ION 3000.

Model Number	Motor Type	Communications Port
DD131S0-195/30	Brushless DC	Serial
DD131C0-195/30	Brushless DC	CANBus
DD111S0-195/30	DC Brush	Serial
DD111C0-195/30	DC Brush	CANBus
DD141S0-195/30	Step Motor	Serial
DD141C0-195/30	Step Motor	CANBus

2.2 ION Developer's Kits

To facilitate initial system development and integration, ION is offered in a Developer's Kit version. A model number beginning with DK instead of DD specifies the Developer's Kit version.

The following software and accessory products are included in every ION Developer's Kit:

- Pro-Motion CD and User's Guide
- C-Motion and VB-Motion CD including PDFs of all ION documentation
- Communications cable (CAN or Serial, depending on model ordered)
- CAN terminator (CAN version only)
- Stub cable set–a complete set of cables with matching ION connectors on one end and flying leads on the other

For more information on these accessory products, refer to Chapter 4, Options and Accessories.

2.2.1 Developer's Kit Model Number Examples

Model Number	Power	Motor Type	Comm Port
DK141S0-056/15	ION 500	Step Motor	Serial
DK131C0-195/30	ION 3000	Brushless DC	CAN

2.3 Required Hardware

To install an ION Digital Drive, the following hardware is required:

- A host controller. The recommended PC platform is an Intel (or compatible) processor, Pentium or better, one available COMM port, 30 MB of available disk space, 32MB of available RAM, and a CD-ROM drive. The supported PC operating systems are Windows 9X/ME/NT/XP.
- For RS485 or CAN communications, a PCI card, PCMCIA card, or USB adapter (supporting that communications standard) connected to the PC
- Mounting screws to attach the ION module to your cabinet or system
- Properly sized DC bus power supply
- Step, DC brush, or brushless DC motor, with encoder as required by the application
- Cables. Either the Stub cable set that comes with ION Developer's Kits or custom cables designed for the system
- Limit switches and other I/O as required for the application

2.4 ION Hardware Configuration and Mounting

There are no user-settable switches, jumpers, or potentiometers within the ION module. All hardware features are software-configurable from the host computer via the communications port.

The module should be firmly mounted in the desired orientation with adequate space to allow it to be effectively cooled. ION is designed to allow maximum mounting flexibility.

2.4.1 ION 500 Mounting Options

Cooling Method	Recommended Orientation	Recommended Mounting Surface	Mounting Method
Coldplate	Any	Either	Horizontal - 4 screws Vertical - 2 screws
Convection	Vertical	Back (small side)	2 screws or DIN rail adapter
Convection with Optional Heatsink	Vertical	Back (small side)	2 screws or DIN rail adapter
Forced Air	Any	Either	2 or 4 screws, or DIN rail adapter
Forced Air with Optional Heatsink	Any	Back (small side)	Horizontal - 4 screws Vertical - 2 screws

Refer to Section 6.6, ION 500 Mechanical, for information on mounting dimensions and mounting hole sizes for the ION 500.

2.4.2 ION 3000 Mounting Options

Cooling Method	Recommended Orientation	Recommended Mounting Surface	Mounting Method
Coldplate	Any	Either	Horizontal - 4 screws Vertical - 2 screws
Convection	Vertical	Back (small side)	2 screws
Forced Air	Any	Either	2 or 4 screws, or DIN rail adapter

To minimize electrical noise problems, the metal base of the ION enclosure should be grounded. This is usually accomplished automatically when the module is mounted to a metal part of a grounded system. When mounted to a DIN rail using the optional DIN rail adapter or when mounted to a non-conductive or non-grounded surface, one of the free mounting holes can be used to attach a ground strap.

Refer to Section 7.6, ION 3000 Mechanical, for information on mounting dimensions and mounting hole sizes for the ION 3000.

2.5 Connector Pinouts and Wiring

2.5.1 Connector Locator

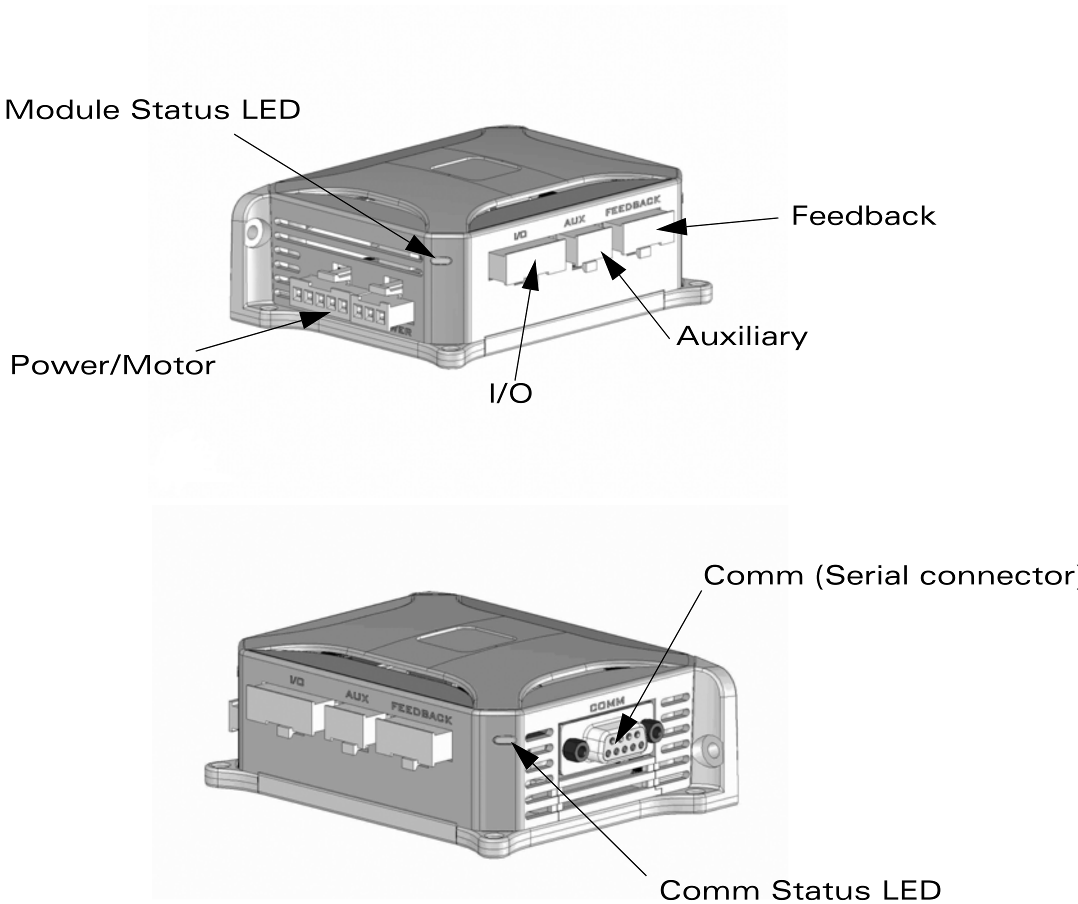
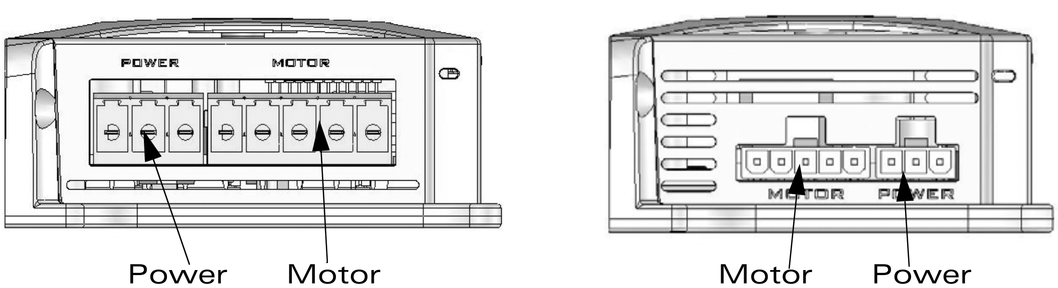


Figure 2-1: Connector locator

Note: Connector location diagrams above are shown for the ION 500. The ION 3000 form factor is somewhat different, but with similar overall connection locations. The diagrams below show the left connector view for both the ION 3000 and the ION 500.



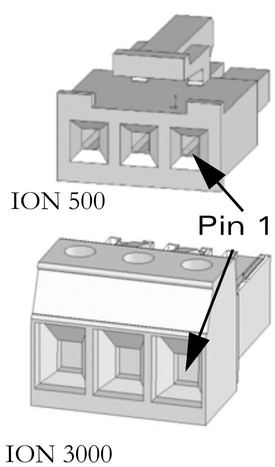
ION 3000 Left View **ION 500 Left View**

2.5.2 Motor/Module Type Quick Reference

The following table summarizes the recommended connections for the various motor types and the corresponding ION modules:

Module Type	Connector	Required Signals	Optional Signals
All	Power	+HV, Pwr_Gnd	AuxV
DC brush	Motor	Motor+, Motor-, Case/Shield	
	Feedback	Main encoder (Quad A+, Quad A-, Quad B+, Quad B-, Index+, Index-), IO_Gnd, Shield	IO_5V
Brushless DC	Motor	Motor A, Motor B, Motor C, Case/Shield	
	Feedback	Main encoder (Quad A+, Quad A-, Quad B+, Quad B-, Index+, Index-), IO_Gnd, Shield	Commutation (Hall A, Hall B, Hall C), IO_5V
Microstepping	Motor	Motor A+, Motor A-, Motor B+, Motor B-, Case/Shield	
	Feedback		Main encoder (Quad A+, Quad A-, Quad B+, Quad B-, Index+, Index-), IO_Gnd, IO_5V, Shield
All	Auxiliary		Auxiliary encoder (Quad A+, Quad A-, Quad B+, Quad B-) IO_Gnd IO_5V, Shield Pulse and Direction input (ION 3000 only; Pulse+, Pulse-, Direction+, Direction-)
All	I/O	/Enable, IO_Gnd	+Limit, -Limit, Home, High Speed Capture, AxisIn, AxisOut, FaultOut, IO_5V, Shield
Serial	Comm	RS232: Tx, Rx, IO_Gnd, Select	
		RS485: Select, Tx+, Tx-, Rx+, Rx-, IO_Gnd	
CAN	Comm	CAN_H, CAN_L, CAN_Gnd	CAN_Shield, CAN_V

2.5.3 Power Connector



Pin	Signal
1	+HV
2	AuxV
3	Pwr_Gnd

This connector supplies the main DC power to the ION module. To minimize the voltage drop between the DC power supply and the ION power connector, ION 3000s should be wired with 14 AWG wire. ION 500s should be wired with 16 AWG wire. ION has a built-in DC/DC converter that derives all required internal voltages from the main DC bus. A separate logic supply is not required. This DC/DC converter also provides IO_5V for powering encoders, limit switches, and other system I/O.

As an additional safety feature, ION provides a separate Auxiliary Voltage (AuxV) input that can be used to power just this DC/DC converter without powering the main DC bus and the output stage. When the AuxV is not connected, power for the DC/DC converter comes from the main +HV input.

A (transformer) isolated power supply should be used for powering ION. The return of this power supply should be grounded. The size of the power supply has to meet the load requirement. If a regulated power supply is used, care should be taken to make sure the power supply can sustain the regenerated power. If a diode is used, the input capacitor should be able to hold the regenerated power without triggering ION into overvoltage protection.

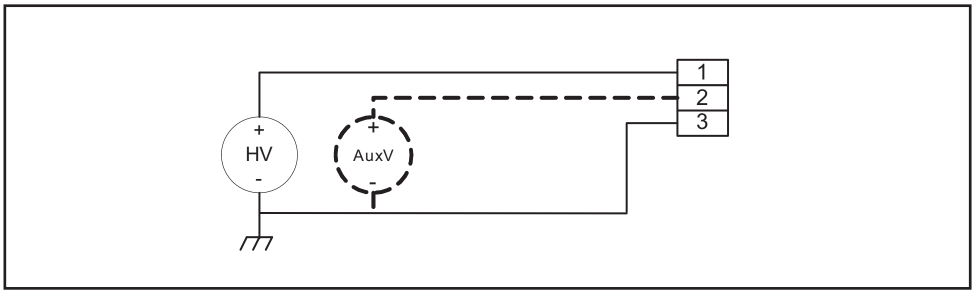
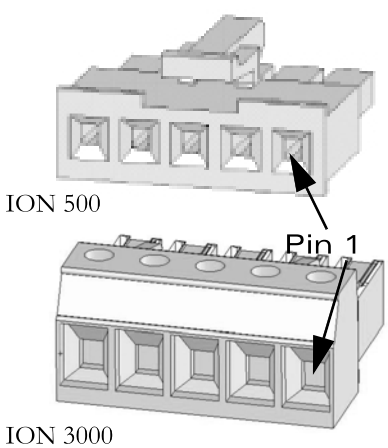


Figure 2-2: Typical power wiring

Pin 3 of the power connector (Pwr_Gnd) should be connected to earth ground as shown in Figure 2-2.

2.5.4 Motor Connector



Pin	DC Brush	Brushless DC	Step
1	Motor+	Motor A (U)	Motor A+
2	Motor- (ION 3000)	Motor B (V)	Motor A-
3	Motor- (ION 500)	Motor C (W)	Motor B+
4	No connect	No connect	Motor B-
5	Case/Shield	Case/Shield	Case/Shield

This connector is used to connect the ION module to the motor. Depending on the type of motor being driven, up to five connections are required. It should be wired with 16 AWG wire (ION 500) or 14 AWG wire (ION 3000) to minimize voltage drops between the ION drive and the motor. The use of shielded cable is recommended to minimize noise.

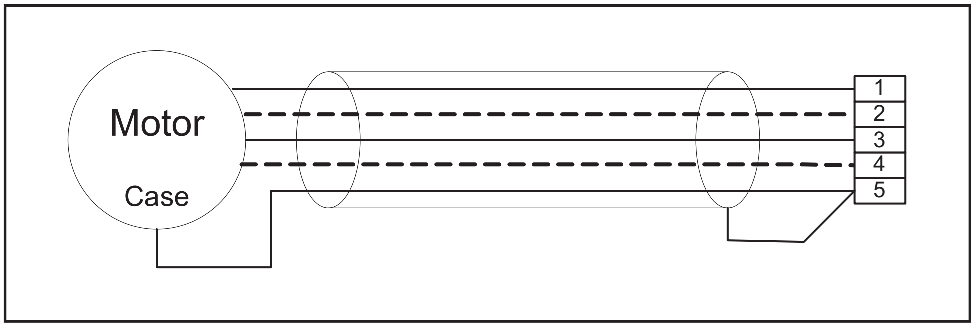
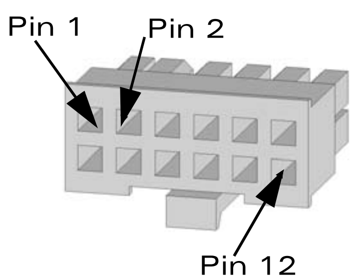


Figure 2-3: Typical motor wiring

For best performance, the case wire should run within the cable shield. If the motor does not come with a case wire or other dedicated case connection, a lug under a motor mounting screw can be used.

The shield drain wire should be connected at the ION module connector end only.

2.5.5 Feedback Connector



Pin	DC Brush	Brushless DC	Step
1	Shield	Shield	Shield
2	IO_Gnd	IO_Gnd	IO_Gnd
3	IO_5V	IO_5V	IO_5V
4	Not used	Hall A	Not used
5	Not used	Hall B	Not used
6	Not used	Hall C	Not used
7	Quad A+	Quad A+	Quad A+
8	Quad A-	Quad A-	Quad A-
9	Quad B+	Quad B+	Quad B+
10	Quad B-	Quad B-	Quad B-
11	Index+	Index+	Index+
12	Index-	Index-	Index-

This connector is used to wire the signals from the main feedback encoder to the ION module. For brushless DC motors, it also connects the Hall Effect signals typically used to commutate the motor. The Halls are not used with DC brush or step motors.

ION directly supports quadrature encoders with single-ended or differential outputs. IO_5V and IO_Gnd are provided to power the encoder and Hall Effect transducers. This connector supports wire gauges from 20 to 30 AWG, depending on the crimp terminal used. Wiring with 22 AWG shielded cable is recommended. For differential encoders, twisted-pair cable should be used.

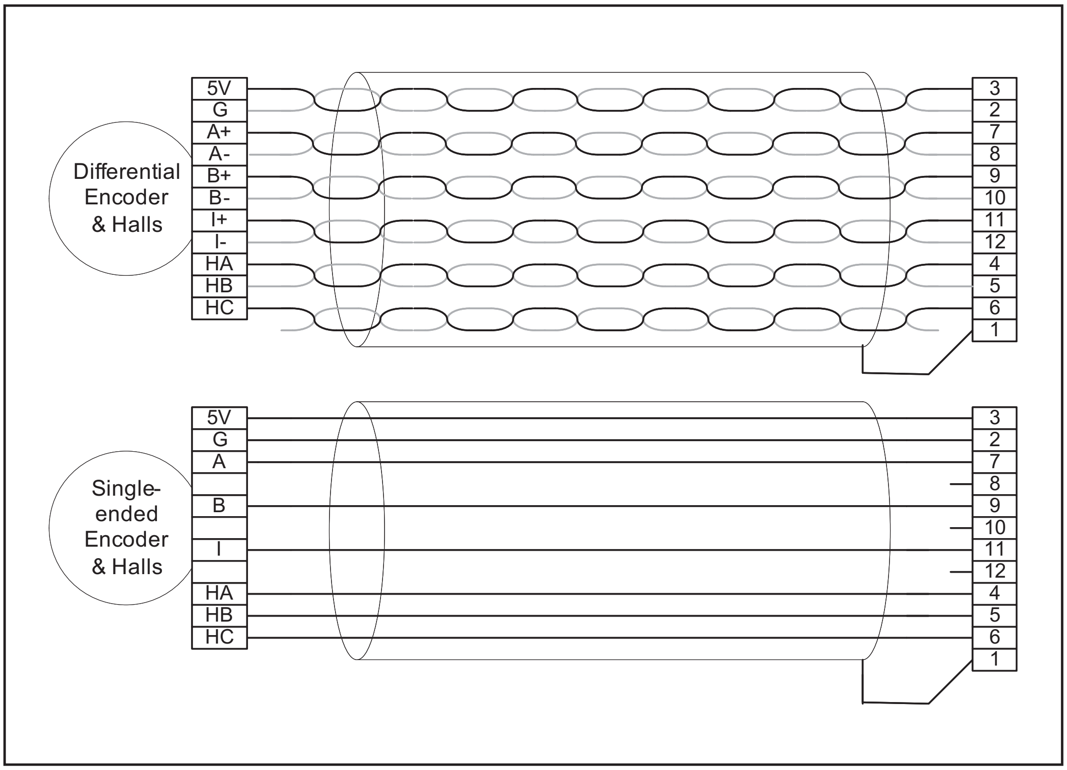
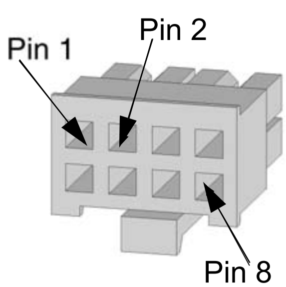


Figure 2-4: Recommended feedback wiring

The shield drain wire should be connected at the ION module connector end only.

2.5.6 Auxiliary Connector



Pin	Signal
1	Shield
2	IO_Gnd
3	IO_5V
4	No connect
5	Quad A+ or Pulse+ (pulse input available on ION 3000 only)
6	Quad A- or Pulse- (pulse input available on ION 3000 only)
7	Quad B+ or Direction+ (direction input available on ION 3000 only)
8	Quad B- or Direction- (direction input available on ION 3000 only)

ION provides a second quadrature encoder port for use as a master in master-slave and electronic gearing applications or, for the ION 3000 only, a pulse and direction input for use in electronic gear applications. As on the main encoder port, ION supports both single-ended and differential signal input. This connector supports wire gauges from 20 to 30 AWG, depending on the crimp terminal used. Wiring with 22 AWG twisted-pair shielded cable is recommended.

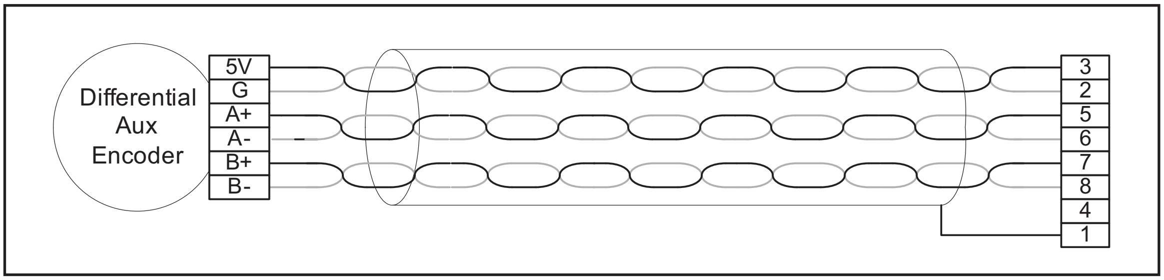


Figure 2-5: Recommended auxiliary encoder wiring

The shield drain wire should be connected at the ION module connector end only.

2.5.6.1 Single Encoder Connections Summary

ION can be connected to feedback encoders in both a single and a dual encoder configuration. Dual encoder input may be useful for general purpose auxiliary encoder position feedback, master/slave electronic gear operation, or dual loop servo filter operation. See the *Magellan Motion Processor User's Guide* for more information on these control modes.

The following diagram and table summarizes the connections for a single encoder.

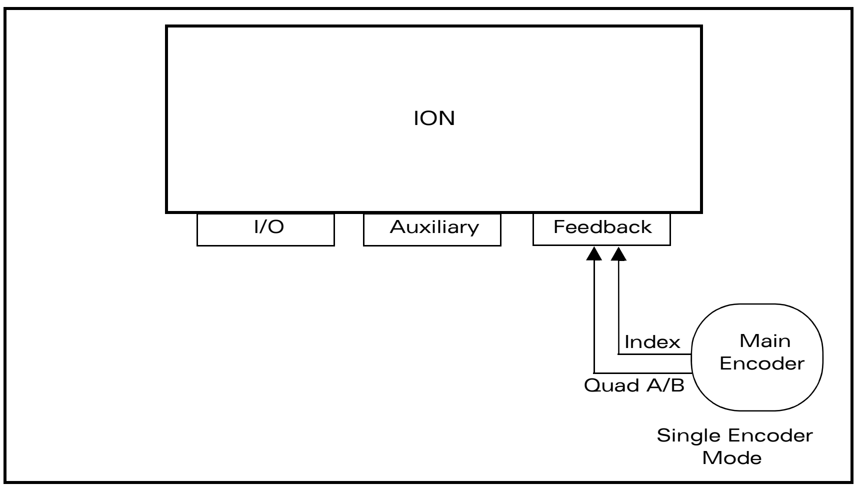


Figure 2-6: Single Encoder Mode connections

Connection from Encoder	ION Connector	Pin	ION Pin
Quadrature A+	Feedback	7	Quad A+
Quadrature A-	Feedback	8	Quad A-
Quadrature B+	Feedback	9	Quad B+
Quadrature B-	Feedback	10	Quad B-
Index+	Feedback	11	Index+
Index-	Feedback	12	Index-
Hall A*	Feedback	4	Hall A
Hall B*	Feedback	5	Hall B
Hall C*	Feedback	6	Hall C

*Brushless DC motors only

2.5.6.2 Dual Encoder Connection Summary

In a two-encoder connection, one encoder measures the load position and is the primary encoder. The second (auxiliary) encoder is located on the motor shaft, measures the motor position, and is used for stabilization. The following diagram and table shows how to connect two encoders to the ION.

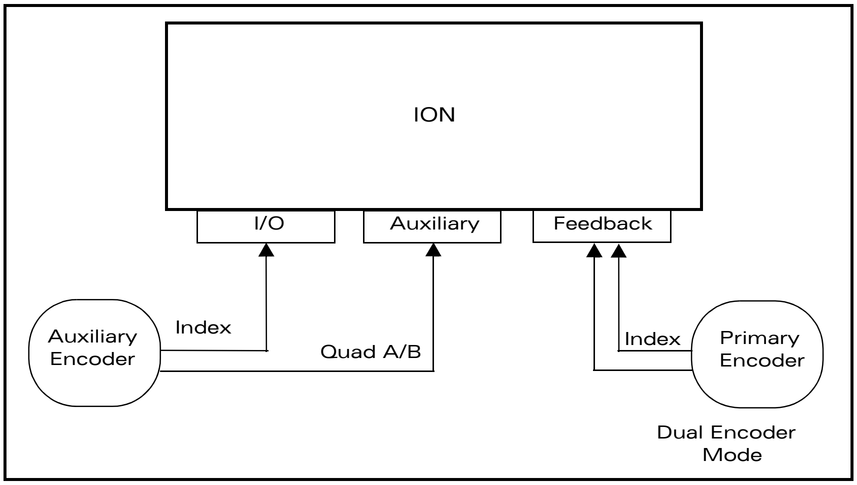


Figure 2-7: Dual Encoder Mode Connections

Connection from Encoder	ION Connector	Pin #	ION Pin
From primary encoder			
Quadrature A+	Feedback	7	Quad A+
Quadrature A-	Feedback	8	Quad A-
Quadrature B+	Feedback	9	Quad B+
Quadrature B-	Feedback	10	Quad B-
Index+	Feedback	11	Index+
Index-	Feedback	12	Index-
From auxiliary encoder			
Quadrature A+	Auxiliary	5	Quad A+
Quadrature A-	Auxiliary	6	Quad A-
Quadrature B+	Auxiliary	7	Quad B+
Quadrature B-	Auxiliary	8	Quad B-
Index+*	I/O	11	High Speed Capture
Hall A**	Feedback	4	Hall A
Hall B**	Feedback	5	Hall B
Hall C**	Feedback	6	Hall C

* For brushless DC motors, an Index signal from the auxiliary encoder is recommended when Hall sensors are not available. For all other configurations, use of the ION's High Speed Capture signal input is optional.

** Brushless DC motors only

2.5.6.3 Pulse & Direction Input Connection Summary (ION 3000 Only)

With ION 3000, it is possible to command the position of the drive using pulse & direction input signals. This mode can be used with all motor types, DC Brush, Brushless DC, and step motor, and allows the ION to interface to any general purpose motion controller that outputs pulse & direction position information.

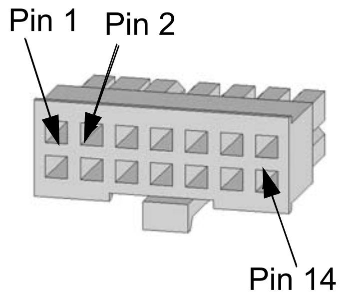
Operation of the ION in pulse & direction input mode is software selectable. To enter this mode the encoder source for axis #2 should be set to pulse & direction, and the profile mode should be set to electronic gear. See the *Magellan Motion Processor User's Guide* for more information.

To connect to the ION in this configuration, use the following connections:

Connection from Encoder	ION Connector	Pin #	ION Pin
Pulse & Direction input			
Pulse+	Auxiliary	5	Pulse+
Pulse-	Auxiliary	6	Pulse-
Direction+	Auxiliary	7	Direction+
Direction-	Auxiliary	8	Direction-
Encoder input (optional if ION is controlling step motor)			
Quadrature A+	Feedback	7	Quad A+
Quadrature A-	Feedback	8	Quad A-
Quadrature B+	Feedback	9	Quad B+
Quadrature B-	Feedback	10	Quad B-
Index+	Feedback	11	Index+
Index-	Feedback	12	Index-
Hall A*	Feedback	4	Hall A
Hall B*	Feedback	5	Hall B
Hall C*	Feedback	6	Hall C

* Brushless DC motors only

2.5.7 I/O Connector



Pin	Signal	Pin	Signal
1	Shield	8	+Limit
2	IO_Gnd	9	-Limit
3	IO_5V	10	Home
4	IO_Gnd	11	High Speed Capture
5	IO_5V	12	AxisIn
6	IO_Gnd	13	AxisOut
7	FaultOut	14	/Enable

This connector is used to wire motion-specific I/O signals such as overtravel limits, home reference, and High Speed Capture input as well as the general purpose AxisIn and AxisOut signals. It also has pins for the master /Enable input and FaultOut signals. Numerous IO_5V and IO_Gnd connections are provided to simplify wiring.

This connector supports wire gauges from 20 to 30 AWG, depending on the crimp terminal used. Wiring with 22 AWG shielded cable is recommended.

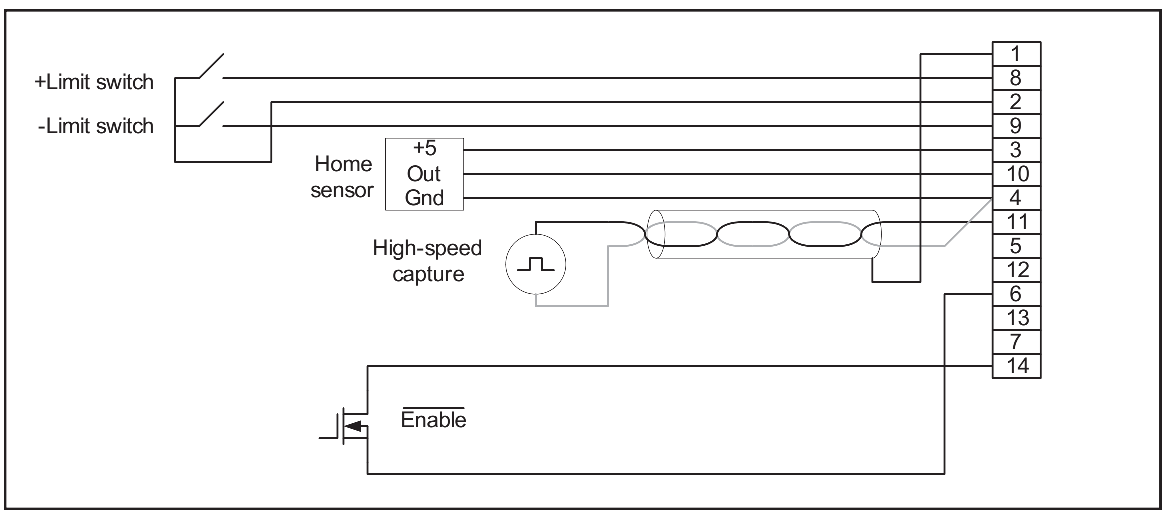
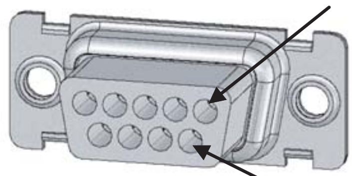


Figure 2-8: Typical I/O wiring

2.5.8 Serial RS232/485 Connector



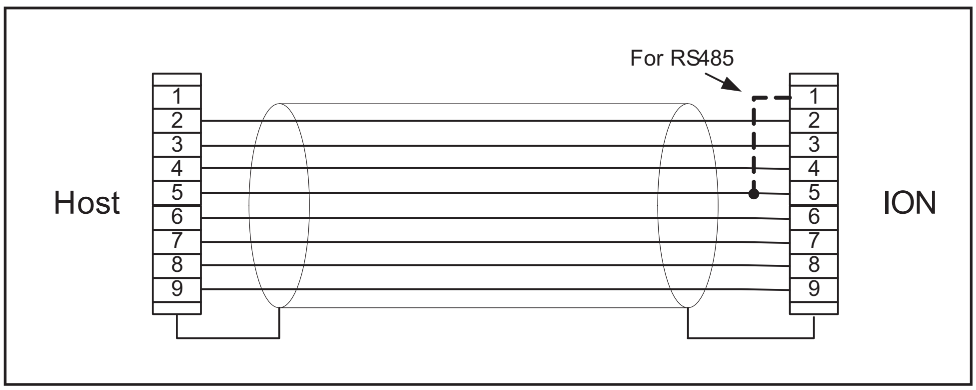
Pin	RS232	RS485
1	Select = float	Select = low
2	Tx	
3	Rx	
4	No connect	No connect
5	IO_Gnd	IO_Gnd
6		Rx+
7		Rx-
8		Tx+
9		Tx-

This DB9M connector has a combination pinout that supports both RS232 and RS485 serial communications. Pin 1 is used to select between the two serial types. For RS232, pin 1 must be left floating. For RS485, pin 1 must be strapped to IO_Gnd.

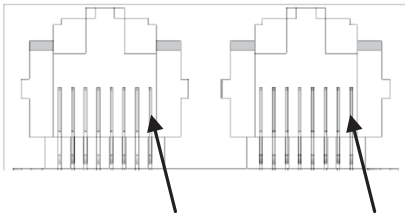
For RS485, ION supports both 4-wire and 2-wire configurations. To use 2-wire network cabling, connect Rx+ to Tx+ and Rx- to Tx- at the ION serial connector.

ION does not have built-in termination for RS485. If a network application requires termination at the ION serial connector, the resistors must be added in the network wiring.

Figure 2-9: RS232/485 wiring



2.5.9 CAN Ports



Pin	Signal
1	CAN_H
2	CAN_L
3	CAN_Gnd
4	Reserved
5	Reserved
6	CAN_Shield
7	CAN_Gnd
8	CAN_V

The CAN version of ION has a dual RJ45 connector to allow daisy-chaining of IONs in a CANbus network. All pins in each port are connected to the corresponding pin the in the other port. CAN_Shield, CAN_V and the two *Reserved* pins are not used by ION but are passed through from one port to the other. When the ION module is the last node of a CANbus network, the network can be terminated by plugging a RJ45 terminator into the unused port.

Standard UTP (unshielded twisted pair) CAT5 Ethernet cabling can be used in most CAN applications. For added noise immunity, shielded cable can be used with the shield routed through the CAN_Shield pins.

2.6 Software Installation

Each ION developer's kit includes a number of powerful software packages for motion system development:

- Pro-Motion, an interactive Windows-based motion system development tool and performance optimizer
- C-Motion, a C-language library designed to simplify integration into C applications
- VB-Motion, an Active X applet providing the features of C-Motion to the Microsoft Visual Basic and similar development environments

Before applying power to the ION drive, locate the Pro-Motion CD and install the Pro-Motion application on the host computer following the instructions in the *Pro-Motion User's Guide.* This software will be used to configure the module and then fully exercise the feature of the ION Digital Drive.

For more information on developing applications in C-Motion and VB-Motion, refer to the *Magellan Motion Processor Programmer's Command Reference.*

PDF versions of this manual, the *Magellan Motion Processor User's Guide,* and the *Magellan Motion Processor Programmer's Command Reference* can be found on the CD included with the ION developer's kit.

The Adobe Acrobat Reader is required for viewing these files. If the Adobe Acrobat Reader is not installed on your computer, you may download it at no cost from http://www.adobe.com.

2.7 Applying Power

> Dangerous voltages, temperatures, and currents exist in all motor drive systems. Do not apply power to the ION module until the motor and system wiring is complete and the ION module and motor are securely mounted. It is best to leave the motor disconnected from its load until after power is applied for the first time and correct operation is verified. The customer must not attempt to service or rewire an ION drive without first shutting down the drive and disconnecting it from its power source. Failure to follow this warning may result in fire, bodily harm, or damage to the product.

Upon power up, ION will be in a reset condition. In this condition, no motor output will be applied and the motor will remain stationary. If the motor does move or jump, remove power from the module and re-check the wiring. If anomalous behavior is still observed, call PMD for application assistance. Complete PMD contact information is listed on the final page of this manual.

2.8 Status LEDs

ION has two bi-color LEDs to indicate the basic operational status of the module and the communications link. The location of these LEDs is shown in Figure 2-1.

2.8.1 Module Status LED

Upon powerup and/or reset, the module Status LED should either be solid green or blinking green, depending on the state of the /Enable input. If enabled, the LED will be solid green.

> The /Enable input is active low.

A Status LED of any other color indicates a fault or unusual condition that must be rectified before going further. See Section 3.6, Operational and Fault Modes, for complete information on ION Operational and Fault modes and the resulting color and blink rate of the Status LED.

2.8.2 Communications Status LED

The Comm Status LED indicates successful packets by blinking green and invalid packets or commands returning an error status by blinking red. A serious fault in the communications port is indicated with solid red. If the LED is solid red, check the cabling and then try cycling power and reconfiguring the communications configuration.

2.9 Communications Configuration

There are a few parameters that must be configured correctly for successful communications between the host computer and the ION module. The Pro-Motion application contains a wizard to make this setup simple—see the *Pro-Motion User's Guide*.

There are two sets of communications parameters. The default set is stored in non-volatile memory while the active set is held in RAM. At powerup (and after every reset) the default set is copied to the active set. The active set can be changed at any time with a software command but will revert to the default set at the next powerup or reset.

The default values for CAN and RS485 parameters can also be changed with a software command. Once programmed, these new default values will be used at the next powerup or reset. Changing the default set does not immediately affect the active parameter set.

For RS232 communications, the situation is deliberately different. The active set can be changed with a software command but there is no way to change the defaults. Upon powerup or reset, the parameters are always reset to the factory defaults. This guarantees that RS232 communications cannot be accidentally put into a state that is incompatible with the host.

2.9.1 Factory Defaults

The following values are pre-programmed into non-volatile memory at the factory.
CAN: Node ID = 0 and Transmission Rate = 20k baud.
RS232/485: 57.6k baud, no parity, 1 stop bit and multi-drop (networking) mode disabled.

See the *Magellan Motion Processor Programmer's Command Reference* for more information on node ID, Transmission Rate, and other serial communications parameters.

> First time communication with an ION can not be done using RS485 half-duplex. In order to configure an ION for RS485 half-duplex (multi-drop), RS232 or RS485 full-duplex (point-to-point) may be used.

2.9.2 RS232/485 Selection

At powerup, ION reads the state of the Select pin to decide which protocol to use and automatically loads the appropriate set of default values from non-volatile memory.

> Changing the state of the Select pin on the fly is not recommended. Doing so will change the hardware configuration without changing the active set of communication parameters and will most likely result in loss of communications.

2.10 Checking Operational Status

Once communications have been established, the ION module is ready for operation. Refer to the *Pro-Motion User's Guide* for a step-by-step system configuration procedure.

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3. Operation

3

In This Chapter

- ION Block Diagram
- PWM Power Stage
- Communications Ports
- Internal Protection and Control Signals
- Operational and Fault Modes
- Trace Buffer
- Operational Scaling Parameters
- Operational Defaults and Limits

3.1 ION Block Diagram

ION combines the function of a motion controller and amplifier. It directly interfaces to a host computer using a serial or CANBus interlace, and connects to all power and feedback signals required to drive a postioning DC Brush, Brushless DC, or step motor.

In addition to the Magellan Motion Processor, ION incorporates several major subsytems including a communications system, a high performance MOSFET-based power stage, a DC Bus conditioning system, and a trace buffer.

The following sections describe these major sections of the ION Digital Drive. For a complete description of the Magellan Motion Processor, see the *Magellan Motion Processor User's Guide* and the *Magellan Programmers Command Reference*.

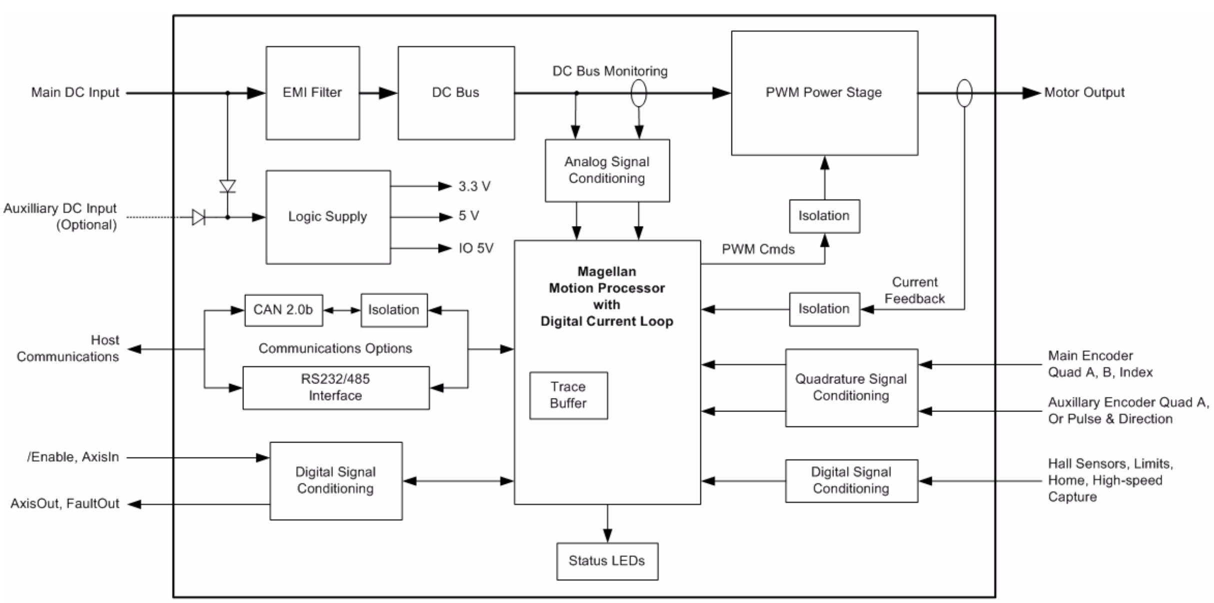

Figure 3-1: ION block diagram

3.2 Communication Port

3.2.1 RS232/485

The serial version of ION supports both the RS232 and RS485 protocols. A simplified transceiver circuit diagram is shown in Figure 3-2. Pin 1 is used to select between RS232 and RS485 operation. For RS232, pin 1 can be tied high to 3.3V or simply left floating. For RS485 operation, pin 1 must be strapped to IO_Gnd.

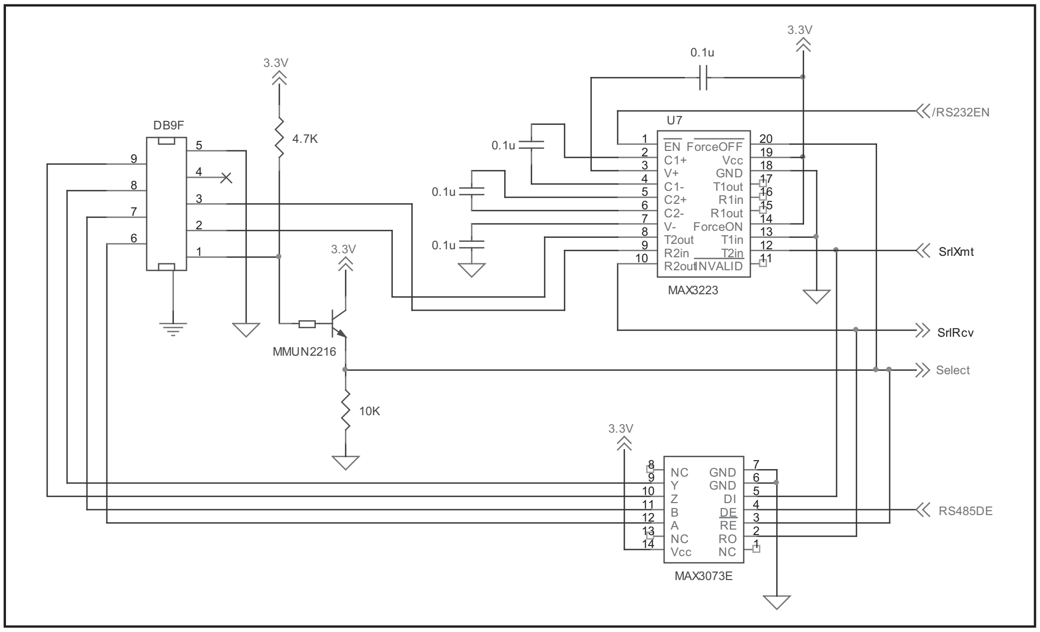

Figure 3-2: Simplified serial transceiver diagram

The **Select** line shown in the simplified circuit diagram is routed to the Magellan Motion Processor to inform the processor of the selected serial mode. ION supports point-to-point and multi-drop networking in RS485 and point-to-point only in RS232.

> The Select line is read only once when the ION comes out of powerup reset. The communications cable must be connected before power is supplied to the ION module.

3.2.2 CAN

The CAN version of ION features a dual RJ45 connector and can use standard UTP Ethernet cabling for implementing a daisy-chain CANbus network. The two jacks are functionally identical. A simplified circuit diagram is shown in Figure 3-3. Note that only the signals used internally are shown. CAN_V, CAN_Shield and the two *Reserved* pins simply pass through to the other RJ45 jack.

To minimize ground loops and noise, the CAN port is isolated from the rest of the ION module and is powered from an isolated winding of the onboard DC/DC converter. The small capacitor between the isolated and non-isolated grounds is required for EMC. The transceiver and signal isolator used support the high speed CAN communications rates of up to 1 M baud.

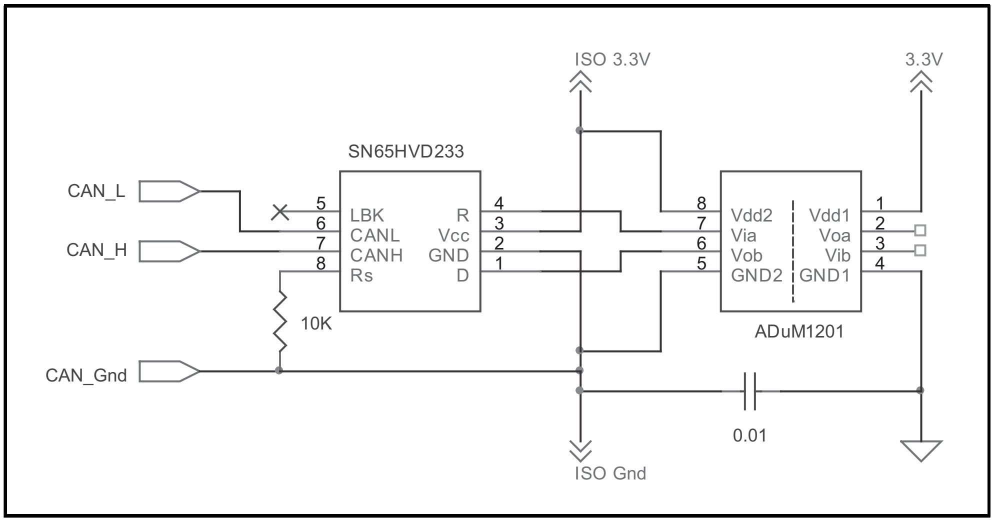

Figure 3-3: Simplified CAN transceiver circuit diagram

3.3 PWM Power Stage

The ION module contains a high-efficiency MOSFET power stage with PWM control and phase current feedback. A slightly different configuration is used for each motor type.

- DC brush motors are driven with an H-Bridge consisting of 4 MOSFETs
- Brushless DC motors are driven with a 3-phase bridge consisting of 6 MOSFETs
- Step motors are driven with two H-Bridges, one for each phase, for a total of 8 MOSFETs

The use of 3-phase and H-Bridge topologies provides full 4-quadrant operation from a single non-isolated DC supply.

ION uses an advanced PWM switching scheme that minimizes the ripple current on the motor windings while maximizing the current loop performance. The PWM frequency is selectable between 20 kHz and 40 kHz to cover a broad range of motor inductance. The fundamental frequency of the ripple current is at twice the PWM frequency and well out of the audible range in all cases.

Two channels of phase current feedback are used for brushless DC and step motor current loops. In the brushless DC version, the third phase is simply calculated as the inverse sum of the other two phase currents. For DC brush motors, only one phase current feedback is used.

By monitoring the DC bus voltage, the DC bus current, and the output phase currents, the ION Digital Drive's output stage is fully protected from overcurrent, overvoltage, and undervoltage faults and line-to-line, line-to-power supply, and line-to-earth/case ground short circuits. The Magellan Motion Processor also implements I^2t peak current foldback and automatic holding current reduction for step motors.

3.3.1 I^2t Current Foldback Protection

ION uses the current feedback to implement I^2t current limiting. This feature protects the drive by controlling its ability to operate above continuous current ratings. This protection feature is active in all operating modes.

When the current loop is enabled and the I^2t energy limit is exceeded, ION will automatically fold back the phase currents to a user programmable continuous current limit value. Alternatively, ION can be configured to fault and disable the output stage when the I^2t energy limit is exceeded.

When the current loop is disabled (ION is operating in voltage control mode only) and the I^2t energy limit is exceeded, ION will always fault and disable the output stage.

3.3.2 Overtemperature Protection

ION uses digital temperature sensors to monitor the operating temperature of the output stage power MOSFETs. The motion processor communicates with the sensors over the built-in SPI bus. If an overtemperature condition is detected, ION shuts down the output stage, indicates the fault with the Module Status LED and optionally activates FaultOut.

The overtemperature threshold is user-settable to any value below the maximum-rated operating temperature of the output stage. See Section 6.4, ION 500 Protection Circuits, for the programmable overtemperature range and the *Magellan Motion Processor Programmer's Command Reference* for more information on setting the temperature threshold.

Refer to the *Magellan Motion Processor User's Guide* and the *Magellan Motion Processor Programmer's Command Reference* for more information on Operating Modes and on setting up these current foldback parameters.

3.3.3 Power Stage Scaling Parameters

To correctly control various ION features via the Magellan Motion Processor it is necessary to know certain drive-specific scale factors. The following tables summarize these values.

3.3.3.1 ION 500 Power Stage Scaling Parameters

Parameter	Commands	Scaling	Example
Current	**GetCurrentLoopValue** **GetFOCValue**	1.296 mA/count	A value of 12,345 from the command **GetCurrentLoopValue** for the ActualCurrent parameter corresponds to a current of 12,345 counts * 1.296 mA/count = 15.999A.
Step motor & Brushless DC*: Continuous RMS Current Limit	**SetCurrentFoldback** **GetCurrentFoldback**	.4587 mA_{RMS}/count	To set a continuous current limit of 5.00A_{RMS} using the **SetCurrentFoldback** command a value of 5,000mA_{RMS}/.4587 mA_{RMS}/count = 10,900 should be used.
DC Brush*: Continuous DC Current Limit	**SetCurrentFoldback** **GetCurrentFoldback**	.5619 mA_{DC}/count	To set a continuous current limit of 5.00A_{DC} using the **SetCurrentFoldback** command a value of 5,000mA_{DC}/.5619 mA_{DC}/count = 8,898 should be used.
Step motor & Brushless DC* I^2t Energy	**SetCurrentFoldback** **GetCurrentFoldback**	.0923 A_{RMS}^2Sec/count	To set a foldback total energy value of 100.0 A_{RMS}^2Sec using the **SetCurrentFoldback** command, a value of 100.0 A_{RMS}^2Sec/.0923 A_{RMS}^2Sec/count = 1,083 should be used.
DC Brush* I^2t Energy	**SetCurrentFoldback** **GetCurrentFoldback**	.1385 A_{DC}^2Sec/count	To set a foldback total energy value of 100.0 A_{DC}^2Sec using the **SetCurrentFoldback** command, a value of 100.0 A_{DC}^2Sec/.1385 $Arms^2$Sec/count = 722 should be used.

*Brushless DC motors used in Hall-based commutation should use the A_{DC} scale factors. All other Brushless DC motor modes should use the A_{RMS} scale factors.

3.3.3.2 ION 3000 Power Stage Scaling Parameters

Parameter	Commands	Scaling	Example
Current	**GetCurrentLoopValue** **GetFOCValue**	2.588 mA/count	A value of 12,345 from the command **GetCurrentLoopValue** for the Actual Current parameter corresponds to a current of 12,345 counts * 2.588 mA/count = 31.949A.
Step motor & Brushless DC*: Continuous RMS Current Limit	**SetCurrentFoldback** **GetCurrentFoldback**	.9152 mA_{RMS}/count	To set a continuous current limit of 10.00A_{RMS} using the **SetCurrentFoldbac**k command a value of 10,000mA_{RMS}/.9152 mA_{RMS}/count = 10,927 should be used.
DC Brush*: Continuous DC Current Limit	**SetCurrentFoldback** **GetCurrentFoldback**	1.121 mA_{DC}/count	To set a continuous current limit of 10.00A_{DC} using the **SetCurrentFoldback** command a value of 10,000mA_{DC}/1.121 mA_{DC}/count = 8,921 should be used.
Step motor & Brushless DC* I^2t Energy	**SetCurrentFoldback** **GetCurrentFoldback**	.3682 A_{RMS}^2Sec/count	To set a foldback total energy value of 1,000.0 A_{RMS}^2Sec using the **SetCurrentFoldback** command, a value of 1,000.0 A_{RMS}^2Sec/.3682 A_{RMS}^2Sec/count = 2,716 should be used.
DC Brush* I^2t Energy	**SetCurrentFoldback** **GetCurrentFoldback**	.5524 A_{DC}^2Sec/count	To set a foldback total energy value of 1,000.0 A_{DC}^2Sec using the **SetCurrentFoldback** command, a value of 1000.0 A_{DC}^2Sec/.5524 $Arms^2$Sec/count = 1,810 should be used.

*Brushless DC motors used in Hall-based commutation should use the A_{DC} scale factors. All other Brushless DC motor modes should use the A_{RMS} scale factors.

3.3.4 Power Stage Defaults and Limits

To correctly control various ION power stage features via the Magellan Motion Processor, it is necessary to know certain drive-specific defaults and limits. The following tables summarize these values.

3.3.4.1 ION 500 Power Stage Defaults and Limits

Parameter	Default value	Limit
Brushless DC model: Foldback Continuous RMS Current	8.073A_{RMS}	Must be <= 8.073A_{RMS}
Brushless DC model: Foldback Total Energy	443.1 A_{RMS}^2sec	Must be <= 443.1 A_{RMS}^2sec
DC Brush model: Foldback Continuous DC Current	9.889A_{DC}	Must be <= 9.889A_{DC}
DC Brush model: Foldback Total Energy	664.7 A_{DC}^2sec	Must be <= 664.7 A_{DC}^2sec
Step motor model: Foldback Continuous RMS Current	5.052A_{RMS}	Must be <= 5.052A_{RMS}
Step motor model: Foldback maximum energy	443.1 A_{RMS}^2sec	Must be <= 443.1 A_{RMS}^2sec

For the ION 500, default values and limits for the Foldback Continuous Current Limit and Foldback Energy Limit are designed to be safe for operation in the drive's highest output mounting option, namely, horizontal to cold plate. See Section 2.4, ION Hardware Configuration and Mounting, for information on ION mounting options.

If the ION 500 drive is being operated at a lower voltage, it may be possible to specify values for Foldback Continuous Current Limit and Foldback Energy Limit that are higher than the default, but lower than or equal to the limit, since the continuous output current rating of the ION 500 drive is higher for lower input voltages. See Section 6.1, ION 500 Drive Ratings, for drive output specifications.

For other mounting configurations, or for use with motors that have lower current and energy limits, it may be useful to set these parameters to values lower than the default values.

It is the responsibility of the user to set the Foldback Continuous Current and Foldback Energy Limit parameters to values that are safe for the specific ION 500 mounting configuration and motor setup being used.

3.3.4.2 ION 3000 Power Stage Defaults and Limits

Parameter	Default value	Limit
Brushless DC model: Foldback Continuous RMS Current	10.60A_{RMS}	Must be <= 15.00A_{RMS}
Brushless DC model: Foldback Total Energy	68A_{RMS}^2sec	Must be <= 101A_{RMS}^2sec
DC Brush model: Foldback Continuous DC Current	15.00A_{DC}	Must be <= 20.00A_{DC}
DC Brush model: Foldback Total Energy	150A_{DC}^2sec	Must be <= 203A_{DC}^2sec
Step motor model: Foldback Continuous RMS Current	5.7A_{RMS}	Must be <= 10.6A_{RMS}
Step motor model: Foldback maximum energy	101A_{RMS}^2sec	Must be <= 125A_{RMS}^2sec

For the ION 3000, default values for the Foldback Continuous Current Limit and Foldback Energy Limit are designed to be safe for operation of the drive in its highest output mounting option and at it highest nominal operating voltage. See Section 2.4, ION Hardware Configuration and Mounting, for information on ION mounting options.

If the ION 3000 drive is being operated at a lower voltage, it may be possible to specify values for Foldback Continuous Current Limit and Foldback Energy Limit that are higher than the default, but lower than or equal to the limit, since the continuous output current rating of the ION 3000 drive is higher for lower input voltages. See Section 6.1, ION 500 Drive Ratings, for drive output specifications.

For other mounting configurations, or for use with motors that have lower current and energy limits, it may be useful to set these parameters to values lower than the default values.

> It is the responsibility of the user to set the Foldback Continuous Current and Foldback Energy Limit parameters to values that are safe for the specific ION 3000 input voltage, ION mounting configuration, and motor setup being used.

3.4 DC Bus

3.4.1 DC Bus Current Monitoring

ION monitors both the positive and negative DC bus current to detect overcurrent conditions including: line-to-line, line-to-power supply, and line-to-case-ground short circuits. Both hard short circuits and excessive current conditions are detected. ION can even detect some "ground fault" conditions caused by a partial winding short circuit between winding and case within a motor.

When an overcurrent condition occurs, the output stage is shut down and the ION module goes into the hard fault state. See Section 3.6.1, Hard Fault State, for a description of this state.

3.4.2 DC Bus Overvoltage and Undervoltage

ION monitors the main DC bus voltage for overvoltage and undervoltage conditions. These thresholds are user-settable within the voltage operating range of the drive.

When the DC bus voltage drops below the undervoltage threshold, ION shuts down the output stage, indicates the fault with the Module Status LED, and optionally activates FaultOut.

There are two ways for the DC bus to exceed the overvoltage threshold:

1. The supplied DC power is too high. There is little the ION module can do about this. ION simply turns off the output stage, indicates the fault with the Module Status LED and optionally activates FaultOut.
2. The motor is decelerating at a rate too high for the DC power supply to absorb the regenerated energy and the DC bus "pumps up." ION will protect itself by turning off the output stage. It also indicates the fault with the Module Status LED and optionally activates FaultOut.

In either case, the DC bus voltage must then fall below the threshold before the module exits this fault state and can be re-enabled.

3.4.3 IO_5V Monitor

ION features a separate 5V supply for powering external encoders, Hall sensors, and other I/O devices. This supply is monitored to detect overloading or out-of-tolerance operation and if either condition occurs, ION goes into the hard fault state. See Section 3.6.1, Hard Fault State, for a description of this state.

3.4.4 Motion Processor 3.3V Supply Monitor and Reset Circuit

The 3.3V supply for the motion processor automatically forces the processor into the reset state if the supply voltage falls out of regulation.

3.4.5 DC Bus Scaling Parameters

To correctly control ION DC Bus features via the Magellan Motion Processor it is necessary to know the DC Bus scale factor. The following tables summarize this value.

3.4.5.1 ION 500 DC Bus Scaling Parameters

Parameter	Commands	Scaling	Example
Bus Voltage	**GetBusVoltage** **SetBusVoltageLimits** **GetBusVoltageLimits**	1.361 mV/count	A value of 12,345 from the command **GetBusVoltage** corresponds to a voltage of 12,345 counts * 1.361 mV/counts = 16.801V

3.4.5.2 ION 3000 DC Bus Defaults and Limits

Parameter	Commands	Scaling	Example
Bus Voltage	**GetBusVoltage** **SetBusVoltageLimits** **GetBusVoltageLimits**	5.349 mV/count	A value of 12,345 from the command **GetBusVoltage** corresponds to a voltage of 12,345 counts * 5.349 mV/counts = 66.033V

3.4.6 Undervoltage and Overvoltage Limits

3.4.6.1 ION 500 DC Bus Defaults and Limits

Parameter	Default value	Limit
Undervoltage Limit	9.935V	Must be >= 9.935V and <= 56.00V
Overvoltage Limit	60.02V	Must be <= 60.02V and >= 20.00V

3.4.6.2 ION 3000 DC Bus Defaults and Limits

Parameter	Default value	Limit
Undervoltage Limit	20.00V	Must be >= 20.00V and <= 195.00V
Overvoltage Limit	195.00V	Must be <= 195.00V and >= 20.00V

3.5 Trace Buffer

Trace capture is a powerful feature of the Magellan Motion Processor that allows various parameters and registers to be continuously captured and stored to an internal memory buffer. The captured data may later be downloaded by the host using software commands.

Data traces are useful for optimizing DC brush and brushless DC performance, verifying trajectory behavior, capturing sensor data, or to assist with any type of monitoring where a precise time-based record of the system's behavior is required.

The ION module features 1.5 kB RAM for trace. This will hold up to 384 trace samples. Refer to the *Magellan Motion Processor User's Guide* and the *Magellan Motion Processor Programmer's Command Reference* for complete information on trace configuration and operation.

3.6 Operational and Fault Modes

The ION is commanded by the host controller to perform various motion control functions. During the course of these operations it is possible for the ION to enter various fault states based on operational conditions within the power stage, the motor, the electrical bus, or based on the state of the Enable input signal.

The following tables summarize the operational and fault modes of the ION Digital Drive. More information about these modes can be found in the *Magellan Motion Processor User's Guide*.

Condition	Details	Output Stage	FaultOut	Module Status LED
Enabled	/Enable = low. Normal operation in programmed operating mode	On	Low	Green/solid
Disabled	/Enable = high	Off	Low	Green/blinking (slow)
Overvoltage	DC bus voltage exceeded programmable threshold	Off	Program-mable	Red/blinking (fast)
Undervoltage	DC bus voltage below programmable threshold			
I^2t Current Foldback	Output stage disabled by I^2t foldback protection	Off	Program-mable	Red/blinking (slow)
Overtemperature	Power stage temperature exceeded programmable threshold			

Hard Electrical Fault	Details	Output Stage	FaultOut	Module Status LED
Overcurrent	Short circuit or overload	Off	High	Red/solid
Ground Fault	Excessive current to ground			
IO_5V Fault	Overloaded/out-of-tolerance			
Internal Logic Fault	Internal hardware failure			

The hard electrical faults are serious module or system malfunctions that must be rectified before proceeding.

3.6.1 Hard Fault State

As an additional safety feature, all hard electrical faults put the ION module into the hard fault state. In this state the module is completely dormant with even communications disabled. A power cycle is required before normal operation can resume.

> The ION module should be disabled and disconnected from its power source before any attempt is made to fix a hard fault condition.

The following sequence should be used to recover from the hard fault state:

1. Unless the failure is clearly caused by external circumstances, the ION module should be disconnected from the serial or CANbus network, as well as disconnected from all external hardware such as the motor, motor encoder, power supply, etc.
2. With all external hardware disconnected, restore the module power. If the unit is still in the hard fault state as indicated by the red Module Status LED, the drive is likely to have sustained an unrecoverable failure, and should be considered unusable thereafter. A replacement ION module should be used in the application.
3. If the Module Status LED indicates that a fault is no longer present, the cause can be determined by reconnecting the communications cable, cycling power again, and reading the Drive Fault Status from the ION module. See the *Magellan Motion Processor User's Guide* for more information on reading the Drive Fault Status.
4. Once the nature of the fault is known, it must be corrected. It is always the responsibility of the user to maintain safe operating conditions of the ION module as well as all associated electronics or hardware.
5. With the source of the problem corrected, the ION module can be reinstalled and reconnected. It should now function normally.

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4. Options and Accessories

4

In This Chapter

- Stub Cable Set
- Development Kit Cable and Plug Specifications
- Optional Heatsink (ION 500 Only)
- Optional DIN Rail Adapter (ION 500 only)

4.1 Stub Cable Set

The following tables summarize the cables and other accessories that come with each ION Developer's Kit. See the next section for detailed information on each cable type.

ION 500, Serial

Cable (PMD Part #)	Description
Cable-RS232-03-R	9-pin RS232 Communications Cable
Cable-1002-02-R	Feedback Stub Cable
Cable-1003-02-R	Aux Stub Cable
Cable-1004-02-R	I/O Stub Cable
Cable-1005-02-R	ION 500 DC Bus Stub Cable
Cable-1006-02-R	ION 500 Motor Stub Cable

ION 500, CANBus

Cable (PMD Part #)	Description
Cable-RJ45-02-R	RJ45 CANBus Communications Cable
TRM-RJ45-02-R	RJ45 CANBus terminator
Cable-1002-02-R	Feedback Stub Cable
Cable-1003-02-R	Aux Stub Cable
Cable-1004-02-R	I/O Stub Cable
Cable-1005-02-R	ION 500 DC Bus Stub Cable
Cable-1006-02-R	ION 500 DC Motor Stub Cable

ION 3000, Serial

Cable (PMD Part #)	Description
Cable-RS232-03-R	9-pin RS232 Communications Cable
Cable-1002-02-R	Feedback Stub Cable
Cable-1003-02-R	Aux Stub Cable
Cable-1004-02-R	I/O Stub Cable
Plug-1007-01-R	ION 3000 DC Bus Plug
Plug-1008-01-R	ION 3000 DC Motor Plug

ION 3000, CANBus

Cable (PMD Part #)	Description
Cable-RJ45-02-R	RJ45 CANBus Communications Cable
TRM-RJ45-02-R	RJ45 CANBus terminator
Cable-1002-02-R	Feedback Stub Cable
Cable-1003-02-R	Aux Stub Cable
Cable-1004-02-R	I/O Stub Cable
Plug-1007-01-R	ION 3000 DC Bus Plug
Plug-1008-01-R	ION 3000 DC Motor Plug

4.2 Development Kit Cable and Plug Specifications

PMD Part #: Cable-RS23203-R
Description: RS232 Comm cable
Length: 2m
Cable: 4P, 24AWG, foil shield, Alpha 5474C, or equiv.

Notes: Shield connected to shells at both ends.
*Grounded jumper wire included inside DB9M backshell to use for Select.

Pin	Signal	Pairing	Color
1	Select	None	Blk*
2	Tx	P2	Wht
3	Rx	P1	Red
4	No connect		
5	Gnd	P1	Blk
6	Rx+	P3	Grn
7	Rx-	P3	Blk
8	Tx+	P4	Blu
9	Tx-	P4	Blk

PMD Part #: Cable-RJ45-02-R
Description: CAN Comm cable
Length: 2m
Cable: 4P, 24AWG, UTP, Cat5

Pin	Signal	Pairing	Color
1	CAN_H	P1	Org/Wht
2	CAN_L	P1	Org
3	CAN_Gnd	P2	Grn/Wht
4	Reserved	P3	Blu
5	Reserved	P3	Blu/Wht
6	CAN_Shield	P2	Grn
7	CAN_Gnd	P4	Brn/Wht
8	CAN_V	P4	Brn

PMD Part #: Cable-1002-02-R
Description: Feedback stub cable
Length: 2m
Cable: 6P, 22AWG, foil shield, Alpha 2216C or equiv.

Pin	Signal	Pairing	Color
1	Drain		
2	IO_Gnd	P1	Blk
3	IO_5V	P1	Red
4	Hall A	P5	Brn
5	Hall B	P5	Blk
6	Hall C	P6	Yel
7	A+	P2	Wht
8	A-	P2	Blk
9	B+	P3	Grn
10	B-	P3	Blk
11	Z+	P4	Blu
12	Z-	P4	Blk

PMD Part #: Cable-1003-02-R
Description: Auxiliary stub cable
Length: 2m
Cable: 3P, 22AWG, foil shield, Alpha 2213C or equiv.

Pin	Signal	Pairing	Color
1	Drain		
2	IO_Gnd	P1	Blk
3	IO_5V	P1	Red
4	No connect		
5	A+	P2	Wht
6	A-	P2	Blk
7	B+	P3	Grn
8	B-	P3	Blk

PMD Part #: Cable-1004-02-R
Description: I/O stub cable
Length: 2m
Cable: 13C, 22AWG, foil shield, Alpha 1299C/15 or equiv.

Pin	Signal	Color
1	Drain	
2	IO_Gnd	Blk
3	IO_5V	Red
4	IO_Gnd	Blu
5	IO_5V	Red/Yel
6	IO_Gnd	Brn
7	FaultOut	Pnk
8	+Limit	Wht
9	-Limit	Grn
10	Home	Org
11	HSI	Yel
12	AxisIn	Vio
13	AxisOut	Gry
14	/Enable	Tan

PMD Part #: Cable-1005-02-R
Description: ION 500 DC bus stub cable
Length: 2m
Cable: 3C,16AWG, foil shield, Alpha 5363C or equiv.

Note: Drain and PGnd spliced together at Pin 3.

Pin	Signal	Color
1	HV	Red
2	AuxV	Wht
3	PGnd	Blk

PMD Part #: Cable-1006-02-R
Description: ION 500 Motor stub cable
Length: 2m
Cable: 6C,16AWG, foil shield, Alpha 5366C or equiv.

Note: Drain and PGnd spliced together at Pin 5.

Pin	Signal	Color
1	A+ (U, M+)	Wht
2	A- (V)	Grn
3	B+ (W, M-)	Org
4	B-	Blu
5	PGnd	Blk

PMD Part #: Plug-1007-01-R
Description: ION 3000 DC bus plug

Cable: Phoenix, p/n 1804917

Pin	Signal	Color
1	HV	--
2	AuxV	--
3	PGnd	--
		--

PMD Part #: Plug-1008-01-R
Description: ION 3000 Motor Plug

Cable: Phoenix, p/n 1804933

Pin	Signal	Color
1	A+ (U, M+)	--
2	A- (V, M-)	--
3	B+ (W)	--
4	B-	--
5	PGnd	--

4.3 Optional Heatsink (ION 500 Only)

The optional heatsink, available for ION 500 models only, can be used to increase the continuous output current and power in applications where the ION module is not cold-plate mounted or is operating in high ambient environments. It is especially effective when forced air cooling is available. See Section 6.9, “ION 500 Thermal Operating Curves,” for the ION specifications with and without the heatsink attached.

To enhance thermal conductivity, the heatsink has a thermal pad permanently attached to its mounting surface. The heatsink attaches to the ION enclosure base using the four mounting holes and four (4), M3x10 cross-head screws (supplied).

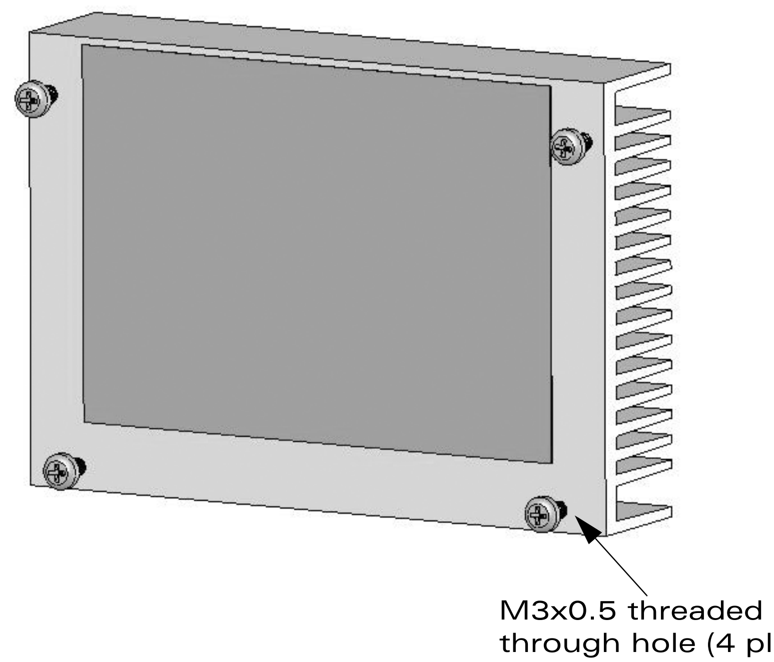

Figure 4-1: ION 500 heatsink

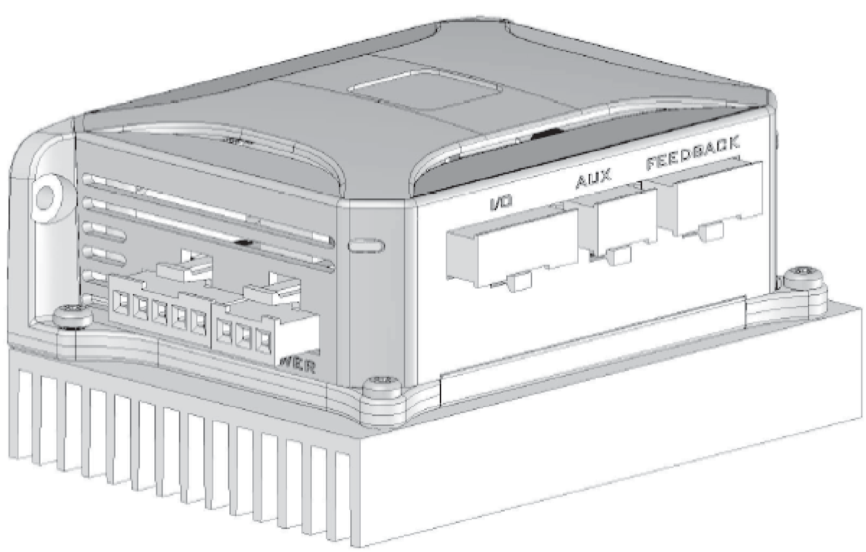

Figure 4-2: ION 500 with heatsink attached

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4.4 Optional DIN Rail Adapter (ION 500 Only)

The optional DIN rail adapter fits on the back of the ION module and allows ION to be mounted to a standard 35mm DIN rail. To install the adapter, place the tab into the large hole in the enclosure and rotate the adapter clockwise as shown in Figure 4-3. The recommended insertion orientation is indicated. When subsequently mounted on a horizontal DIN rail, the Communications connector will be up and the adapter release tab down.

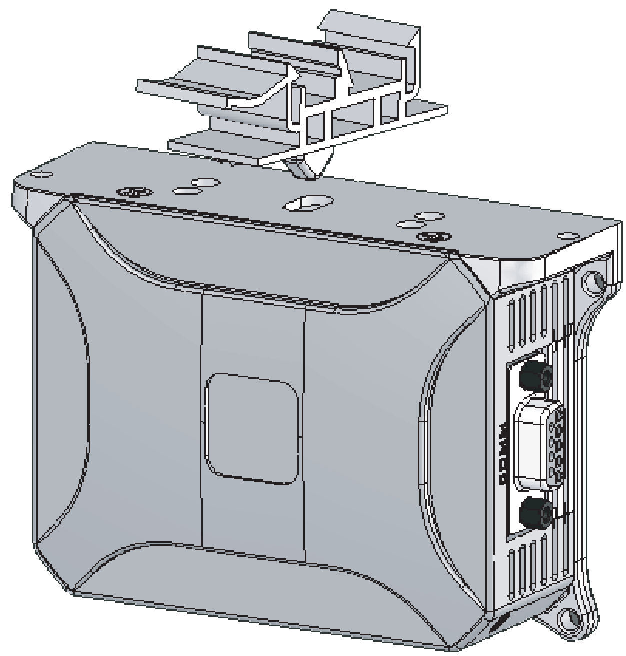


Figure 4-3: Attaching the optional DIN rail adapter

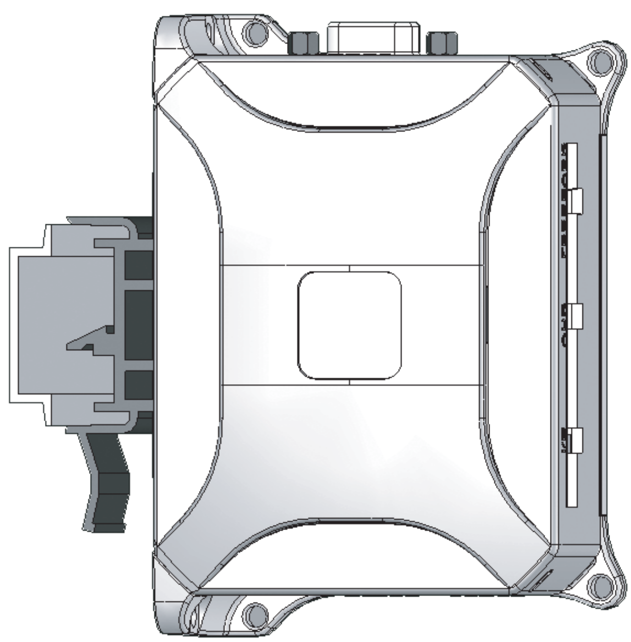


Figure 4-4: ION mounted on DIN rail

To remove the adapter, pry up the two ends while applying rotation force. A flat blade screwdriver may be required.

5. Electrical Signal Interfacing

In This Chapter

- Motor Feedback
- Auxiliary Position Input
- Limit and Home Inputs
- Position Capture Sources
- AxisIn and AxisOut Signals
- /Enable and FaultOut Signals

5.1 Motor Feedback

The Feedback connector contains the main encoder signals as well as Hall commutation signals. These signals are buffered and filtered in the Quadrature Signal Conditioning and Digital Signal Conditioning blocks, respectively, as shown in the block diagram. ION supports incremental quadrature encoders with count rates up to 10 Mcounts per second, and for the ION 3000 module Pulse & Direction input on the auxiliary position input at up to 10 Mpulses per second.

5.1.1 Main Encoder Inputs

The differential input circuitry for the main encoder A, B and Index signals is shown in Figure 5-1. This circuit accepts both differential and single-ended signals in the range of 0 – 5 V. For single-ended operation, the unused input should be left floating.

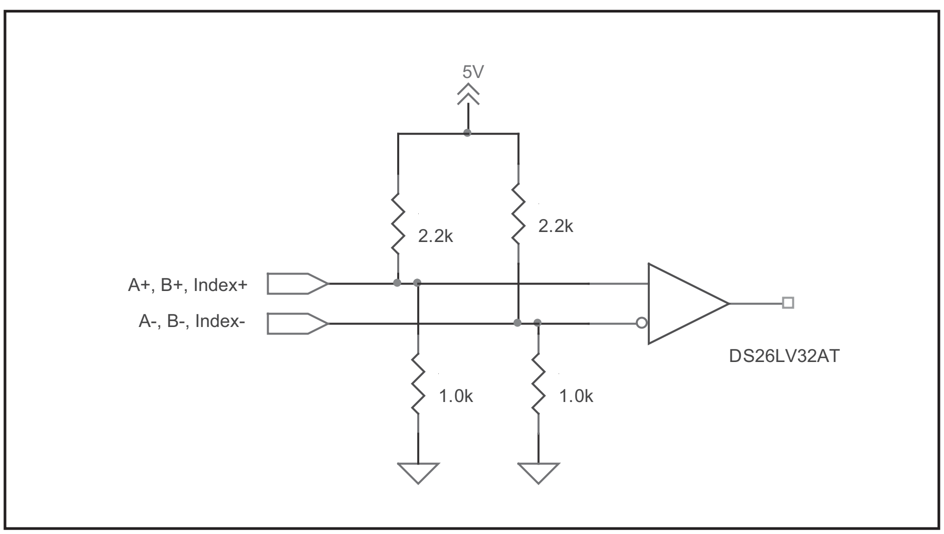
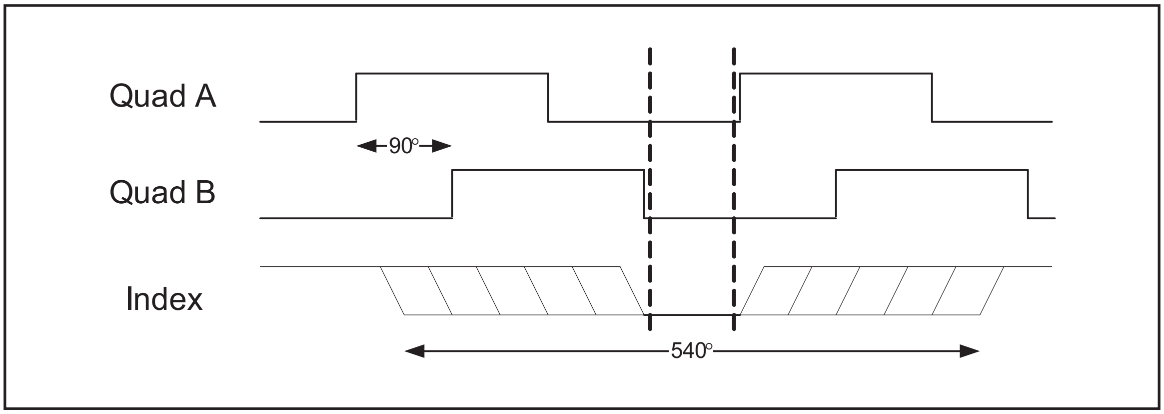


Figure 5-1: Main encoder input circuits

For full functionality, ION requires a three channel (with Index) incremental encoder for the main feedback. The required index alignment is shown in Figure 5-2. ION qualifies the Index with the A and B quadrature inputs and recognizes an Index event when all signals (A, B and Index) are low.

Figure 5-2: Encoder phasing diagram



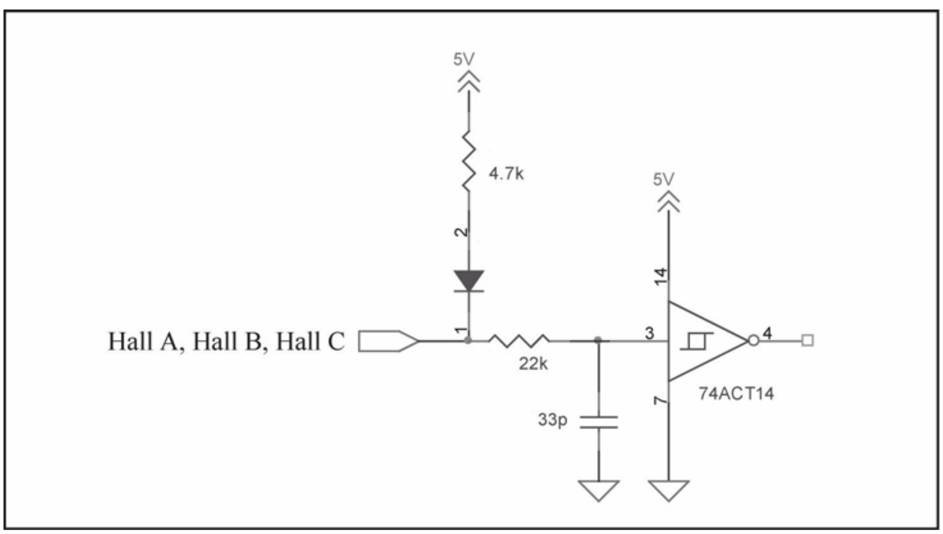
Correct Index phasing and polarity is required for the ION to operate properly. The A & B channels can be swapped and the quadrature signals inverted as required at the differential inputs to achieve the above phasing alignment.

While the motion processor has the ability to invert the polarity of the A, B and Index signals with a software command, this command cannot be used to alter the index alignment because the inversion takes effect after index qualification.

5.1.2 Hall Inputs

The input buffer for the Hall A, B and C signals is shown in Figure 5-3. This circuit accepts signals in the range of 0 – 24 V and has TTL compatible, Schmidt trigger thresholds. It has a pull-up to 5V to allow direct interfacing to open collector sources without the need for an external pull-up resistor and an R-C low pass filter to reject noise.

Figure 5-3: Hall input circuits



The Hall signals are only used with brushless DC motors. They are used to directly commutate the motor in 6-step commutation mode or to provide an absolute phase reference for sinusoidal commutation.

5.2 Auxiliary Position Input

The differential input circuitry for the auxiliary position input signals is shown in Figure 5-4. This circuit accepts both differential and single-ended signals in the range of 0 – 5 V. For single-ended operation, the unused input should be left floating.

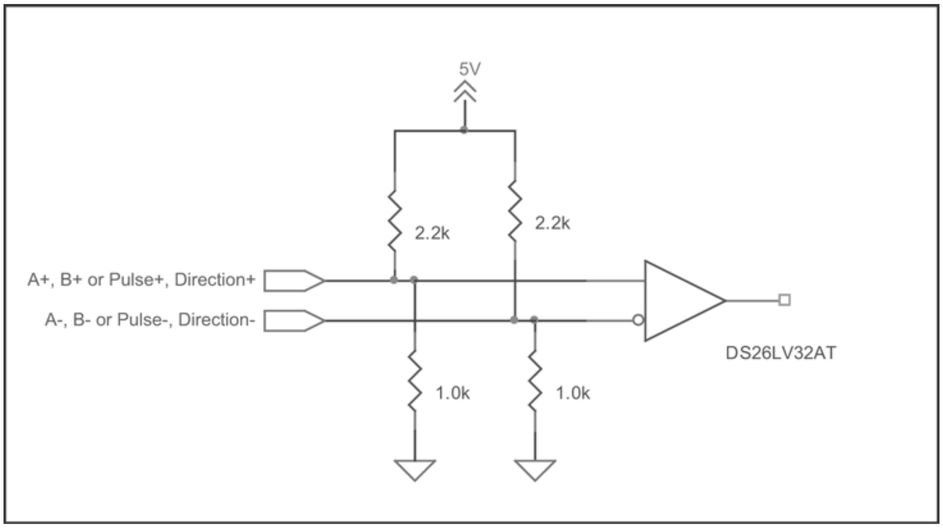


Figure 5-4: Auxiliary encoder input circuits

Auxiliary encoder input is optional and can be used for general-purpose position feedback, as the master in electronic gearing applications, or as part of a dual-loop filter compensation scheme. See the *Magellan Motion Processor User's Manual* for information on these operational modes.

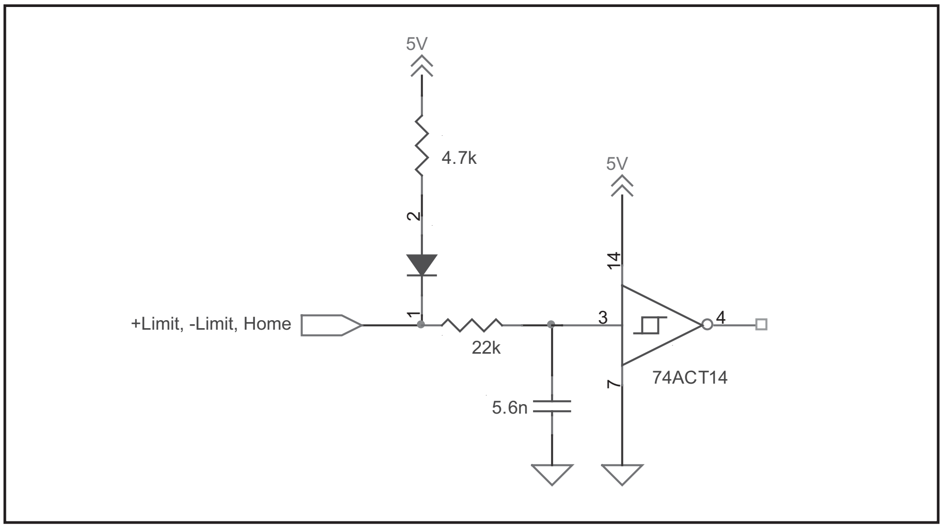
Pulse & direction input (available on ION 3000 only) is optional and can be used for either general purpose position feedback or as the master in electronic gearing applications. To select pulse & direction as the input format for the auxiliary position input, use the Magellan command Set Encoder Source with axis #2 selected. See the *Magellan Motion Processor User's Manual* for more information.

There is no index pulse input on the auxiliary position input.

5.3 Limit and Home Inputs

The input buffer for the end-of-travel limit and home signals is shown in Figure 5-5. This circuit accepts signals in the range of 0–24 V and has TTL compatible, Schmidt trigger thresholds. It has a pull-up to 5V to allow direct interfacing to open collector sources without the need for an external pull-up resistor and a 1.3 kHz R-C low pass filter to reject noise.

Figure 5-5: Limit and Home input circuits



5.4 Position Capture Sources

The Magellan Motion Processor has the ability to capture the instantaneous position of the main feedback encoder when a trigger is received from a hardware input. The ION module supports three trigger sources: Encoder Index, Home and High-Speed Capture input. The choice of trigger source is selectable through software. The input circuits for Index and Home are described in sections 5.1.1 and 5.3, respectively.

5.4.1 High Speed Capture Input

This dedicated input is specifically designed for high speed signals. It is similar to the Home input with the exception that the R-C low pass filter bandwidth has been increased to 1.2 MHz. This value is a compromise between noise rejection and trigger latency.

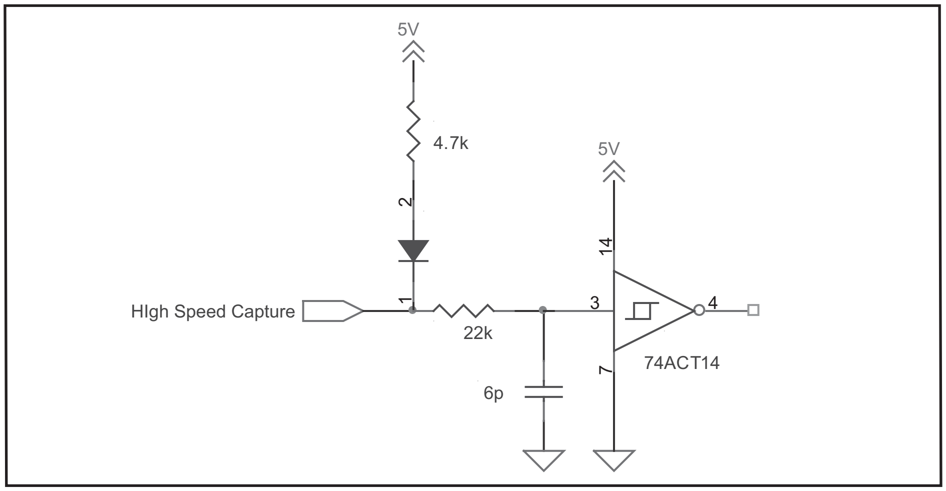


Figure 5-6: High Speed Capture circuit

5.5 AxisIn and AxisOut Signals

The input buffer for the AxisIn signal is shown in Figure 5-7. This circuit accepts signals in the range of 0 – 24 V and has TTL compatible, Schmidt trigger thresholds. It has a pull-up to 5V to allow direct interfacing to open collector sources without the need for an external pull-up resistor and a 13 kHz R-C low pass filter to reject noise.

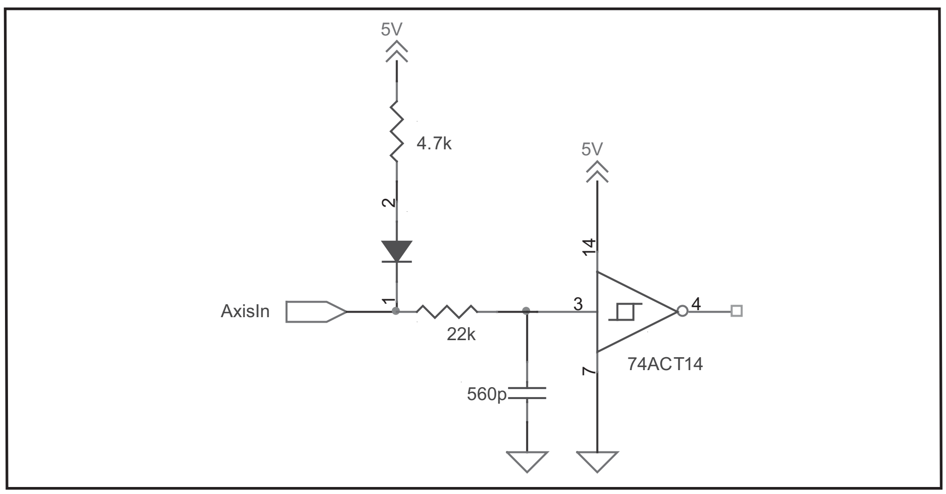


Figure 5-7: AxisIn circuit

The output driver for the AxisOut signal is shown in Figure 5-8. This circuit can continuously sink over 100 mA and source 4mA from a pull-up resistor to 5V. The diode in series with the pull-up resistor allows loads powered from up to 24 VDC to be switched. The FET driver is internally protected from shorts up to 30 V.

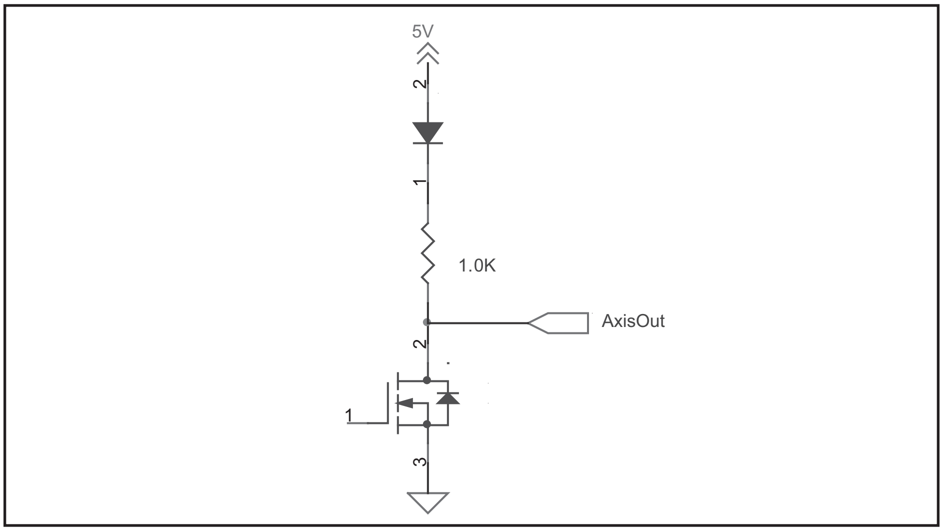


Figure 5-8: AxisOut circuit

AxisIn and AxisOut are versatile I/O signals. They are not dedicated to any particular motion control function but can be programmed to implement a wide array of system integration functions. See the *Magellan Motion Processor User's Guide* for more information on configuring and programming these signals.

5.6 /Enable and FaultOut Signals

These dedicated signals are typically used to implement a safety interlock between the ION module and other control portions of the system. /Enable is an active-low input that must be tied or driven low for the ION output stage to be active. Similarly, FaultOut indicates any serious problem by going high. When ION is operating properly, FaultOut is low. The polarity of these signals is fixed and cannot be changed via software.

The input buffer for the /Enable input is shown in Figure 5-9. This circuit accepts signals in the range of 0 – 24 V and has TTL compatible, Schmidt trigger thresholds. It has a pull-up to 5V to allow direct interfacing to open collector enable sources without the need for an external pull-up resistor and a 1.3 kHz R-C low pass filter to reject noise.

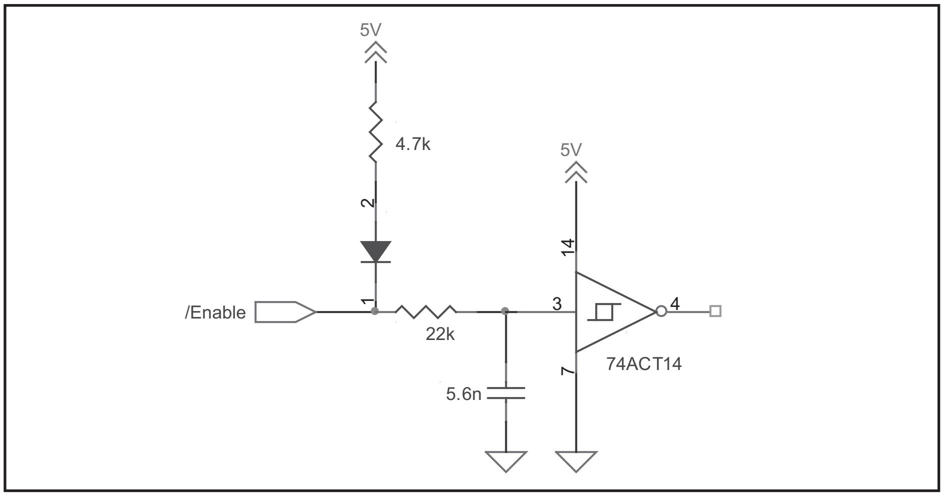


Figure 5-9: /Enable input circuit

The output driver for FaultOut is shown in Figure 5-10. This circuit can continuously sink over 100 mA and source 4mA from a pull-up resistor to 5V. The diode in series with the pull-up resistor allows loads powered from up to 24 VDC to be switched. The FET driver is internally protected from shorts up to 30 V.

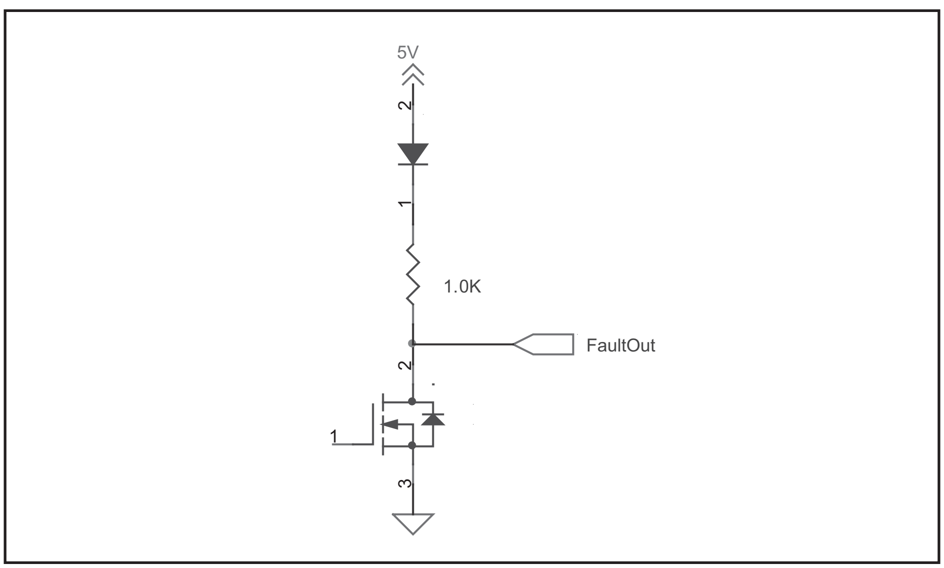


Figure 5-10: FaultOut circuit

When the ION is powered off, FaultOut is effectively high impedance and unable to sink current. This state should be interpreted as “Fault” by the receiving circuit.

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6. ION 500 Specifications

In This Chapter

6.1 ION 500 Drive Ratings

	Motor Model		
Specification	**DC Brush**	**Brushless DC**	**Step**
Nominal supply voltage	48 VDC	48 VDC	48 VDC
Supply voltage range transformer isolated power supply	12 – 56 VDC	12 – 56 VDC	12 – 56 VDC
Output current (per phase) - Continuous, DIN rail mount, w/heat sink, free air @ 25 C - Continuous, coldplate mount, Tbp<50 C - Peak (2 sec)	 6 ADC 9.8 ADC 21.2 ADC	 6 Arms (8.5 ADC) 8 Arms (11.3 ADC) 15 Arms (21.2 ADC)	 5 Arms (7.1 ADC) 5 Arms (7.1 ADC) 15 Arms (21.2 ADC)
Maximum continuous output power - Coldplate mount, Tbp<50 C	 450 W	 500 W	 350 W

6.2 ION 500 Controller Performance

Supported motor types: DC brush, brushless DC, step motor.

Communications options: RS232/485 and CANbus. Both RS485 and CAN versions are networkable.

Profile modes:

S-curve point-to-point: Position, velocity, acceleration, deceleration, jerk.
Trapezoidal point-to-point: Position, velocity, acceleration, deceleration.
Velocity-contouring: Velocity, acceleration, deceleration.
Electronic gearing: Using auxiliary encoder.

Position loop filter parameters: Scalable PID with Velocity and Acceleration feedforward, integration limit, offset bias, dual biquad filter, and settable derivative sampling time. Also supports dual encoder feedback.

Position error tracking:

Motion error window: Allows axis to be stopped upon exceeding programmable window.
Tracking window: Allows flag to be set if axis exceeds a programmable position window.

Configurable loop modes:

DC brush and brushless DC motor versions: Position, torque/current and voltage.
Step motor version: Open loop with stall detection, current, and voltage.

Digital current loop:

Filter parameters: Scalable PI with integration limit and torque/current limit.
Configuration: Standard phase A/B control or FOC with state-vector PWM (user selectable).
Current feedback scaling: 100% full scale equals 21.2 A.

Current foldback:

DC brush and brushless DC motor versions: Programmable I^2t peak limiting.
Step motor version: Programmable automatic holding current reduction.

Brushless DC commutation modes: Sinusoidal and 6-step (Hall) commutation**.**

Microstepping resolution: Up to 256 microsteps per step.

Maximum encoder rate: 10 Mcounts per second.

PWM frequency: 20 kHz or 40 kHz (user selectable).

Loop rates:

Commutation & current loop: 51.2 µsec.

Position loop & trajectory generator: 102.4 µsec to 1.67 sec, selectable in multiples of 51.2 µsec from n = 2 to 2^{15}-1.

6.3 ION 500 Electrical

AuxV input voltage range: 12 – 56 VDC.
AuxV Maximum Current: 0.5A.
IO_5V supply output: 5V +/- 2%, 300 mA (total max.), short circuit protected.

Differential/single-ended encoder inputs:

Signals: Main encoder (A+, A-, B+, B-, Index+, Index-), Auxiliary encoder (A+, A-, B+, B-).
Voltage range: 0 – 5 VDC.
Logic threshold: RS422 compatible.
Max. frequency: 2.5 MHz.
Phasing: A leads B by 90°±20°. Index low must align with the A low and B low states and be low for less than 540° total. See Figure 3-3.

Digital inputs:

Signals: Hall A, Hall B, Hall C, Home, +Limit, -Limit, AxisIn, High-speed Capture, /Enable.
Voltage range: 0 – 24 VDC.
Logic threshold: TTL compatible.

Digital outputs:

Signals: AxisOut, FaultOut.
Voltage range: 0 – 24 VDC.
Output current: 4mA source, 100 mA sink, short circuit protected to 30V.

RS232/485 Communications:

Baud Rates: 1200, 2400, 9600, 19.2k, 57.6k, 115k, 230k, 460k. Default is 57.6k. 460k support for RS485 only.
Isolation: None.
Termination: None.

CAN Communications:

Compatibility: CAN 2.0b.
Baud Rates: 10k, 20k, 50k, 125k, 250k, 500k, 800k, 1M. Default baud rate is 20k.
Isolation: Optocoupled.
Termination: External 121 Ohm RJ45 terminator.

6.4 ION 500 Protection Circuits

Overtemperature: User programmable between 0 C and 70 C.
Overvoltage: User programmable between 20 V and 60 V.
Undervoltage: User programmable between 10 V and 56 V.
Overcurrent: Fixed at <= 200% of drive peak rating.
Short circuit protection: Line-to-line, line-to-power supply, and line-to-case ground.

6.5 ION 500 Connectors and Pinouts

6.5.1 High Power Connectors

Connector: Power	Pin	Signal
Mating connector mfg/type: Molex MiniFit Jr. plug	1	+HV
Mating connector P/N: 39-01-4031	2	AuxV
Wire range, AWG: 16	3	Pwr_Gnd
Recommended crimp terminal: 44476-3112		

Connector: Motor	Pin	Signal
Mating connector mfg/type: Molex MiniFit Jr. plug	1	Motor+, Motor A, Motor A+
Mating connector P/N: 39-01-4051	2	Motor B, Motor A-
Wire range, AWG: 16	3	Motor-, Motor C, Motor B+
Recommended crimp terminal: 44476-3112	4	Motor B-
	5	Case/Shield

6.5.2 Signal Connectors

Connector: Feedback
Mating connector mfg/type: Molex MicroFit 3.0 plug
Mating connector P/N: 43025-1200
Wire range, AWG: 20-24
Recommended crimp terminal: 43030-0009
Alternate wire range, AWG: 26-30
Alternate crimp terminal: 43030-0012

Pin	Signal
1	Shield
2	IO_Gnd
3	IO_5V
4	Hall A
5	Hall B
6	Hall C
7	Quad A+
8	Quad A-
9	Quad B+
10	Quad B-
11	Index+
12	Index-

Connector: Auxiliary
Mating connector mfg/type: Molex MicroFit 3.0 plug
Mating connector P/N: 43025-0800
Wire range, AWG: 20-24
Recommended crimp terminal: 43030-0009
Alternate wire range, AWG: 26-30
Alternate crimp terminal: 43030-0012

Pin	Signal
1	Shield
2	IO_Gnd
3	IO_5V
4	No connect
5	Quad A+
6	Quad A-
7	Quad B+
8	Quad B-

Connector: I/O
Mating connector mfg/type: Molex MicroFit 3.0 plug
Mating connector P/N: 43025-1400
Wire range, AWG: 20-24
Recommended crimp terminal: 43030-0009
Alternate wire range, AWG: 26-30
Alternate crimp terminal: 43030-0012

Pin	Signal
1	Shield
2	IO_Gnd
3	IO_5V
4	IO_Gnd
5	IO_5V
6	IO_Gnd
7	FaultOut
8	+Limit
9	-Limit
10	Home
11	High Speed Capture
12	AxisIn
13	AxisOut
14	/Enable

6.5.3 Communications Connectors

Connector: RS232/485
Mating connector mfg/type: Generic DB9M

Pin	Signal
1	Select
2	Tx (RS232)
3	Rx (RS232)
4	No connect
5	IO_Gnd
6	Rx+ (RS485)
7	Rx- (RS485)
8	Tx+ (RS485)
9	Tx- (RS485)

Connector: CAN
Mating connector mfg/type: Generic RJ45 8P8C

*The dual RJ45 jacks are fully connected in parallel. CAN_V, CAN_Shield and the *Reserved* pins are not connected internally and simply pass the signals through to the other jack.

Pin	Signal
1	CAN_H
2	CAN_L
3	CAN_Gnd
4	*Reserved**
5	*Reserved**
6	CAN_Shield*
7	CAN_Gnd
8	CAN_V*

6.6 ION 500 Mechanical

Specification	Value
Dimensions	See Figure 6-1
Weight - without heatsink - with heatsink	 0.6 lb [0.28 kg] 1.1 lb [0.5 kg]
Enclosure materials	Aluminum base and molded plastic cover
Mounting options	Coldplate, panel, and DIN rail
Recommended mounting screws	#6, M3, or M3.5
Protection class	IP20

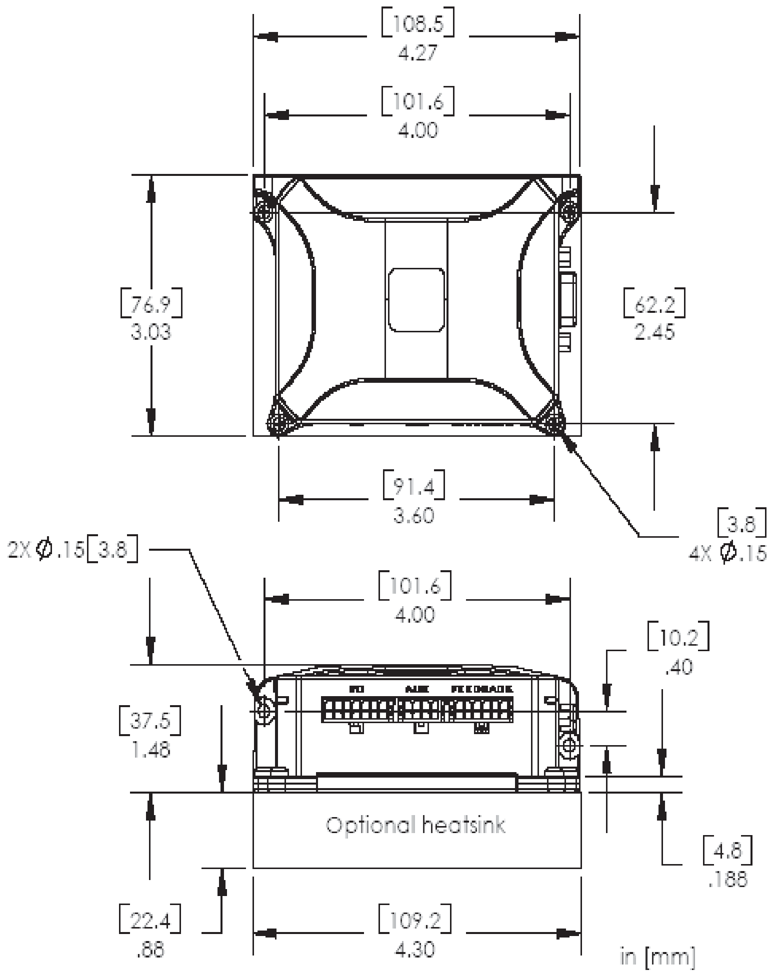


Figure 6-1: ION 500 dimensions

6.7 ION 500 Environmental

Specification	Value
Operating ambient temperature	0 to 60 C
Maximum base plate temperature	70 C
Storage temperature	-20 to 85 C
Humidity	0 to 95%, non-condensing
Altitude	Up to 2000 meters without derating
Contamination	Pollution Degree 2

6.8 ION 500 Safety and Compliance

Specification	Standards
CE	LVD: EN60204-1 EMC-D: EN61000-6-1, EN61000-6-3, EN55011
Electrical safety	Designed to UL508c, UL840, and EN60204-1
Hazardous materials	RoHS compliant
Flammability	UL 94-V2 or V0
Enclosure	IP20

6.9 ION 500 Thermal Operating Curves

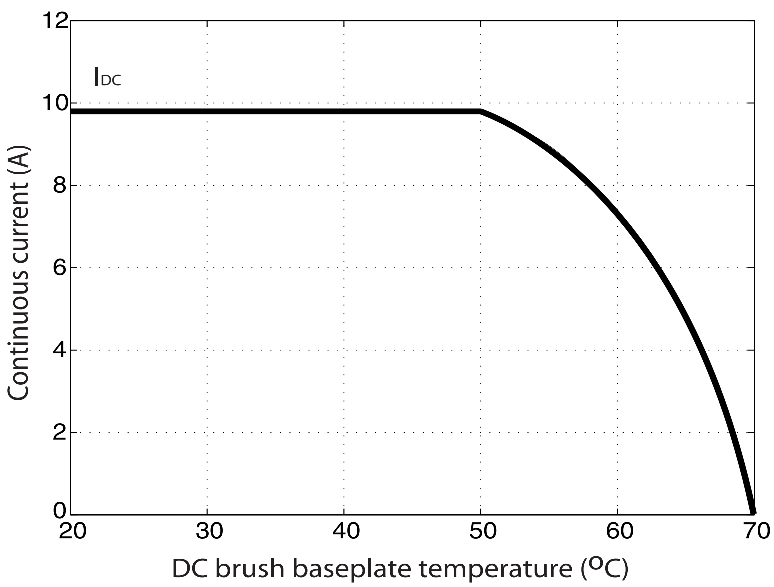
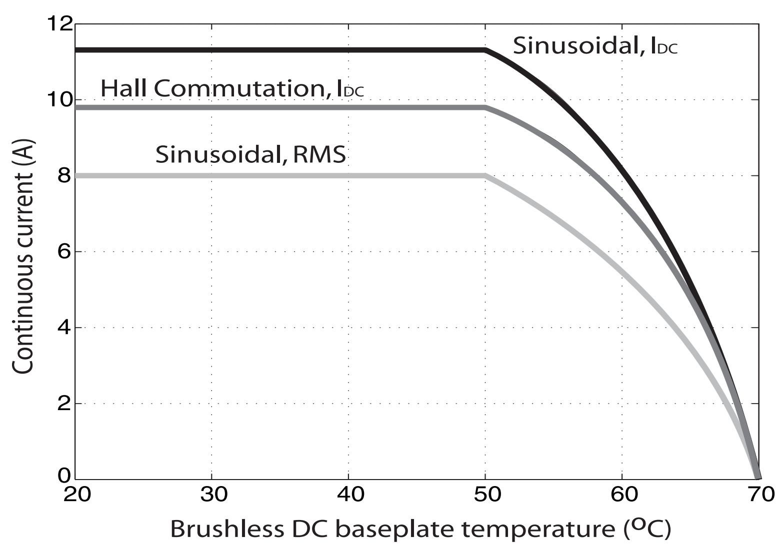


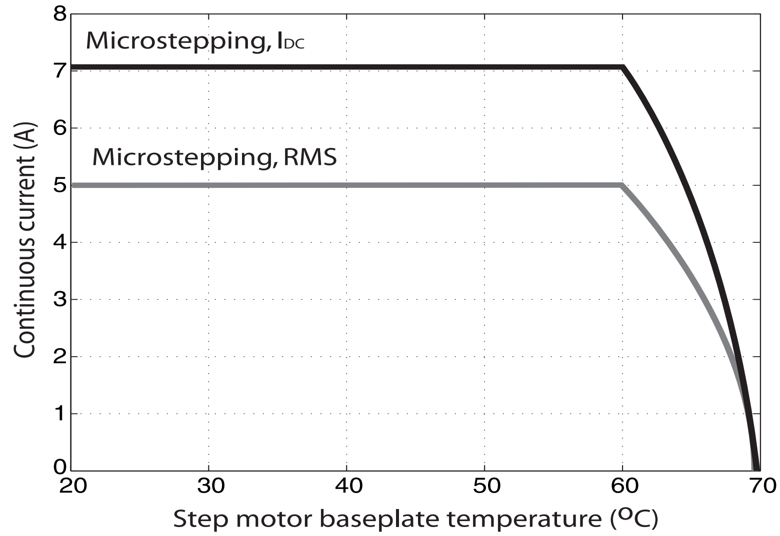
Figure 6-2: ION 500 Derating curve for DC brush module



Note: $I_{DC} = 1.414 * I_{RMS}$

Figure 6-3: ION 500 Derating curves for brushless DC module

Figure 6-4: ION 500 Derating curves for step motor module



Note: $I_{DC} = 1.414 * I_{RMS}$

7. ION 3000 Specifications

In This Chapter

- ION 3000 Drive Ratings
- ION 3000 Controller Performance
- ION 3000 Electrical
- ION 3000 Protection Circuits
- ION 3000 Connectors and Pinouts
- ION 3000 Mechanical
- ION 3000 Environmental
- ION 3000 Safety and Compliance
- ION 3000 Thermal Operating Curves

7.1 ION 3000 Drive Ratings

	Motor Model		
Specification	**DC Brush**	**Brushless DC**	**Step**
Supply voltage range transformer isolated power supply	20-195 VDC	20-195 VDC	20-195 VDC
Output current (per phase) at 48V nominal voltage			
- Continuous, coldplate mount, Tbp<40 C	20 ADC	15 Arms	10.6 Arms
- Peak (per phase)	30 A	30 A	30 A
Maximum continuous output power at 48V nominal voltage	960 W	882 W	650 W
Output current (per phase) at 180V nominal voltage			
- Continuous, coldplate mount, Tbp<40 C	15 ADC	10.6 Arms	5.7 Arms
- Peak (per phase)	30 A	30 A	30 A
Max continuous output power at 180V nominal voltage	2700 W	2336 W	1310 W

7.2 ION 3000 Controller Performance

Supported motor types: DC brush, brushless DC, step motor.

Communications options: RS232/485 and CANbus. Both RS485 and CAN versions are networkable.

Profile modes:

S-curve point-to-point: Position, velocity, acceleration, deceleration, jerk.
Trapezoidal point-to-point: Position, velocity, acceleration, deceleration.
Velocity-contouring: Velocity, acceleration, deceleration.
Electronic gearing: Using auxiliary encoder or pulse and direction.

Position loop filter parameters: Scalable PID with Velocity and Acceleration feedforward, integration limit, offset bias, dual biquad filter, and settable derivative sampling time. Also supports dual encoder feedback.

Position error tracking:
Motion error window: Allows axis to be stopped upon exceeding programmable window.
Tracking window: Allows flag to be set if axis exceeds a programmable position window.

Configurable loop modes:
DC brush and brushless DC motor versions: Position, torque/current and voltage.
Step motor version: Open loop with stall detection, current, and voltage.

Digital current loop:
Filter parameters: Scalable PI with integration limit and torque/current limit.
Configuration: Standard phase A/B control or FOC with state-vector PWM (user selectable).
Current feedback scaling: 100% full scale equals 42.4 A.

Current foldback:
DC brush and brushless DC motor versions: Programmable I^2t peak limiting.
Step motor version: Programmable automatic holding current reduction.

Brushless DC commutation modes: Sinusoidal and 6-step (Hall) commutation**.**

Microstepping resolution: Up to 256 microsteps per step.

Maximum encoder rate: 10 Mcounts per second.

PWM frequency: 20 kHz or 40 kHz (user selectable).

Loop rates:
Commutation & current loop: 51.2 µsec.

Position loop & trajectory generator: 102.4 µsec to 1.67 sec, selectable in multiples of 51.2 µsec from n = 2 to 2^{15}-1.

7.3 ION 3000 Electrical

AuxV input voltage range: 20 – 195 VDC.
AuxV Maximum Current: 0.5 A.
IO_5V supply output: 5V +/- 2%, 300 mA (total max.), short circuit protected.

Differential/single-ended encoder inputs:
Signals: Main encoder (A+, A-, B+, B-, Index+, Index-), Auxiliary encoder (A+, A-, B+, B-) or Pulse+, Pulse-, Direction+, Direction-.
Voltage range: 0 – 5 VDC.
Logic threshold: RS422 compatible.
Max. frequency: 2.5 MHz.
Phasing: A leads B by 90°±20°. Index low must align with the A low and B low states and be low for less than 540° total.

Digital inputs:
Signals: Hall A, Hall B, Hall C, Home, +Limit, -Limit, AxisIn, High-speed Capture, /Enable.
Voltage range: 0 – 24 VDC.
Logic threshold: TTL compatible.

Digital outputs:

Signals: AxisOut, FaultOut.
Voltage range: 0 – 24 VDC.
Output current: 4mA source, 100 mA sink, short circuit protected to 30V.

RS232/485 Communications:

Baud Rates: 1200, 2400, 9600, 19.2k, 57.6k, 115k, 230k, 460k. Default is 57.6k. 460k support for RS485 only.
Isolation: None.
Termination: None.

CAN Communications:

Compatibility: CAN 2.0b.
Baud Rates: 10k, 20k, 50k, 125k, 250k, 500k, 800k, 1M. Default baud rate is 20k.
Isolation: Optocoupled.
Termination: External 121 Ohm RJ45 terminator.

7.4 ION 3000 Protection Circuits

Overtemperature: User programmable between 0 C and 80 C.
Overvoltage: User programmable between 20 V and 195 V.
Undervoltage: User programmable between 20 V and 195 V.
Overcurrent: Fixed at >50 A.
Short circuit protection: Line-to-line, line-to-power supply, and line-to-case ground.

7.5 ION 3000 Connectors and Pinouts

7.5.1 High Power Connectors

Connector: Power
Mating connector mfg/type: Phoenix
Mating connector P/N: 1804917
Wire range, AWG: 14

Pin	Signal
1	+HV
2	AuxV
3	Pwr_Gnd

Connector: Motor
Mating connector mfg/type: Phoenix
Mating connector P/N: 1804933
Wire range, AWG: 14

Pin	Signal
1	Motor+, Motor A, Motor A+
2	Motor-, Motor B, Motor A-
3	Motor C, Motor B+
4	Motor B-
5	Case/Shield

7.5.2 Signal Connectors

Connector: Feedback
Mating connector mfg/type: Molex MicroFit 3.0 plug
Mating connector P/N: 43025-1200
Wire range, AWG: 20-24
Recommended crimp terminal: 43030-0009
Alternate wire range, AWG: 26-30
Alternate crimp terminal: 43030-0012

Pin	Signal
1	Shield
2	IO_Gnd
3	IO_5V
4	Hall A
5	Hall B
6	Hall C
7	Quad A+
8	Quad A-
9	Quad B+
10	Quad B-
11	Index+
12	Index-

Connector: Auxiliary
Mating connector mfg/type: Molex MicroFit 3.0 plug
Mating connector P/N: 43025-0800
Wire range, AWG: 20-24
Recommended crimp terminal: 43030-0009
Alternate wire range, AWG: 26-30
Alternate crimp terminal: 43030-0012

Pin	Signal
1	Shield
2	IO_Gnd
3	IO_5V
4	No connect
5	Quad A+ or Pulse+
6	Quad A- or Pulse-
7	Quad B+ or Direction+
8	Quad B- or Direction-

Connector: I/O
Mating connector mfg/type: Molex MicroFit 3.0 plug
Mating connector P/N: 43025-1400
Wire range, AWG: 20-24
Recommended crimp terminal: 43030-0009
Alternate wire range, AWG: 26-30
Alternate crimp terminal: 43030-0012

Pin	Signal
1	Shield
2	IO_Gnd
3	IO_5V
4	IO_Gnd
5	IO_5V
6	IO_Gnd
7	FaultOut
8	+Limit
9	-Limit
10	Home
11	High Speed Capture
12	AxisIn
13	AxisOut
14	/Enable

7.5.3 Communications Connectors

Connector: RS232/485 **Mating connector mfg/type:** Generic DB9M	Pin	Signal
	1	Select
	2	Tx (RS232)
	3	Rx (RS232)
	4	No connect
	5	IO_Gnd
	6	Rx+ (RS485)
	7	Rx- (RS485)
	8	Tx+ (RS485)
	9	Tx- (RS485)

Connector: CAN **Mating connector mfg/type:** Generic RJ45 8P8C *The dual RJ45 jacks are fully connected in parallel. CAN_V, CAN_Shield and the *Reserved* pins are not connected internally and simply pass the signals through to the other jack.	Pin	Signal
	1	CAN_H
	2	CAN_L
	3	CAN_Gnd
	4	Reserved*
	5	Reserved*
	6	CAN_Shield*
	7	CAN_Gnd
	8	CAN_V*

7.6 ION 3000 Mechanical

Specification	Value
Dimensions	See Figure 7-1
Weight	1lb 1 oz [0.50 kg]
Enclosure materials	Aluminum base and molded plastic cover
Mounting options	Coldplate and panel
Recommended mounting screws	#6, M3, or M3.5
Protection class	IP20

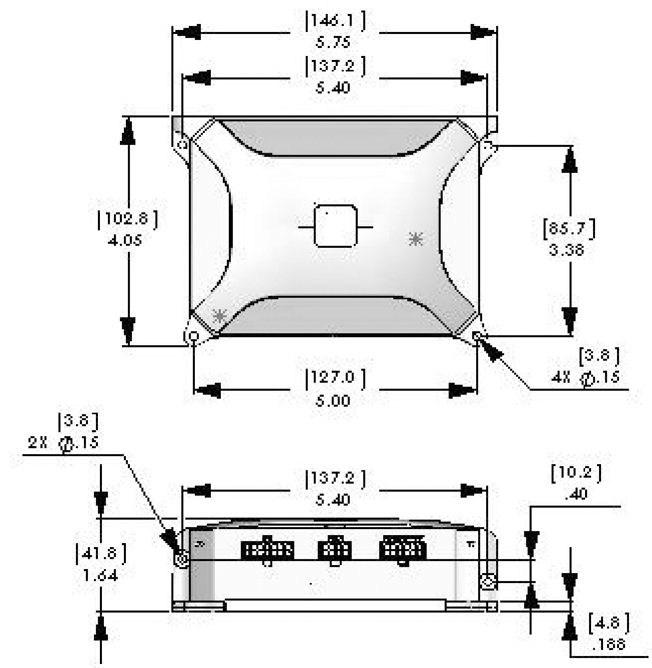


Figure 7-1: ION 3000 dimensions

7.7 ION 3000 Environmental

Specification	Value
Operating ambient temperature	0 to 40 C
Maximum base plate temperature	70 C
Storage temperature	-20 to 85 C
Humidity	0 to 95%, non-condensing
Altitude	Up to 2000 meters without derating
Contamination	Pollution Degree 2

7.8 ION 3000 Safety and Compliance

Specification	Standards
CE	LVD: EN60204-1 EMC-D: EN61000-6-1, EN61000-6-3, EN55011
safety	UL recognized
Hazardous materials	RoHS compliant
Flammability	UL 94-V2 or V0
Enclosure	IP20

7.9 ION 3000 Thermal Operating Curves

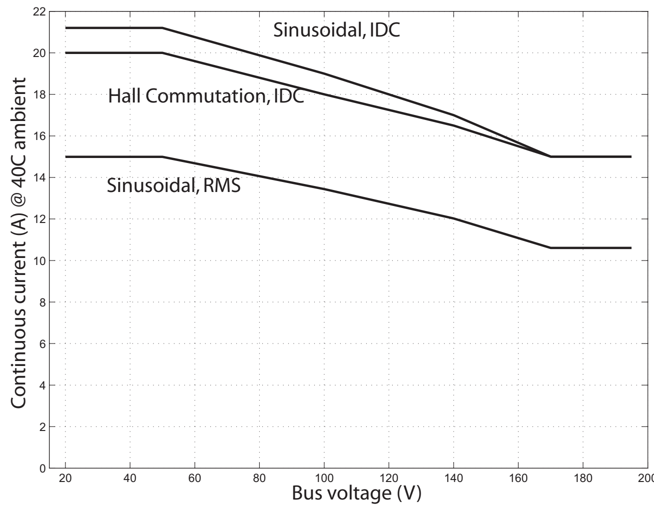


Figure 7.2: BLDC output current vs bus voltage at 40^0C ambient

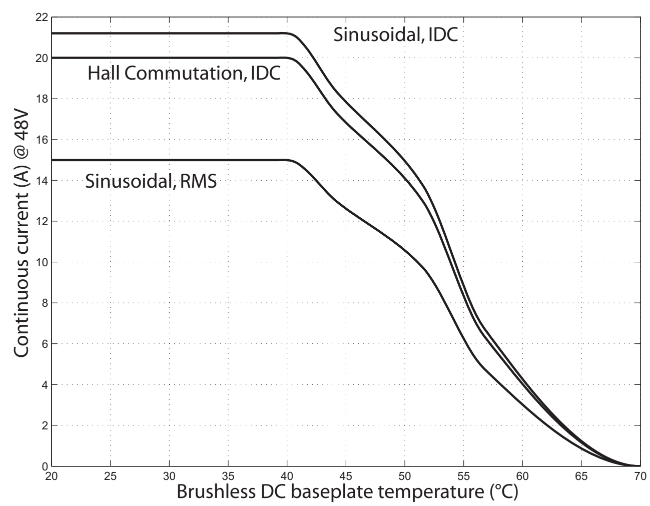


Figure 7.3: BLDC output current vs temperature with 48V input

Figure 7.4: BLDC output current vs temperature with 180V input

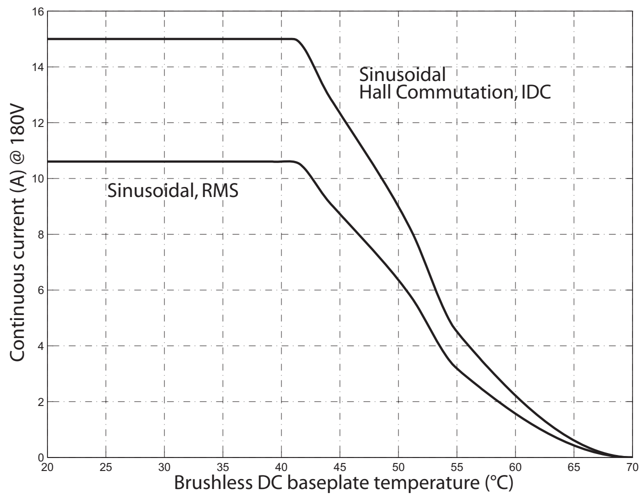
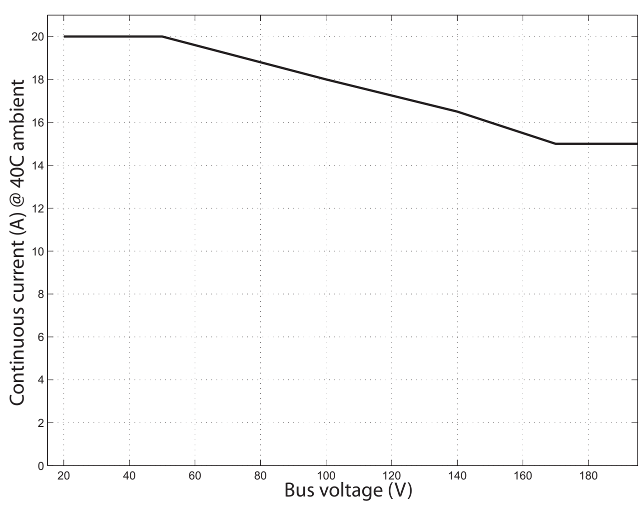


Figure 7-5: DC brush output current vs bus voltage at 40°C ambient



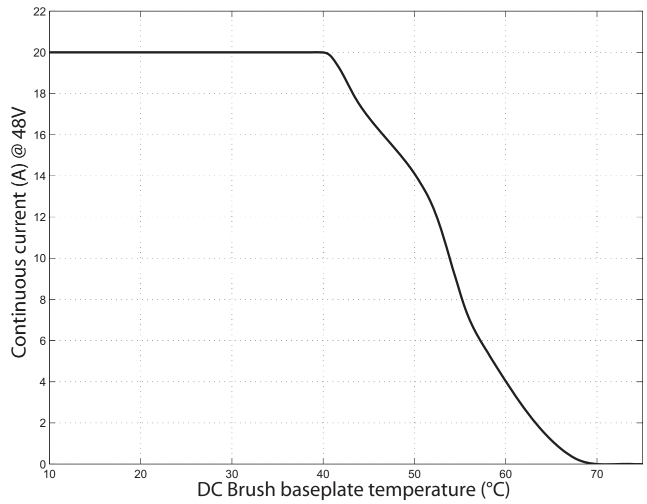


Figure 7-6: DC brush output current vs temperature with 48V input

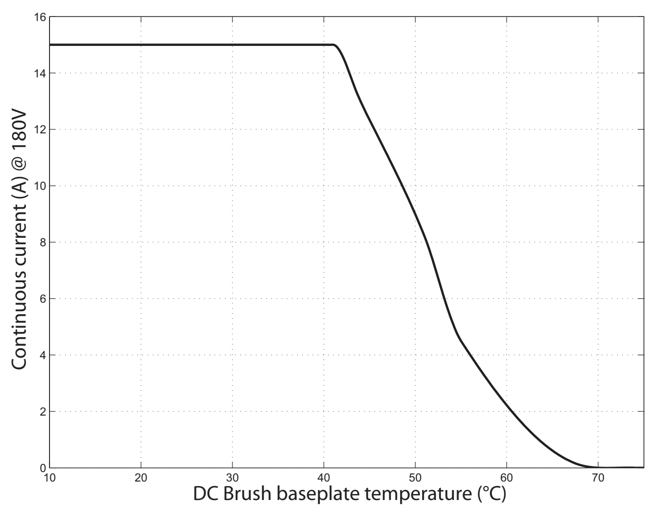


Figure 7-7: DC brush output current vs temperature with 180V input

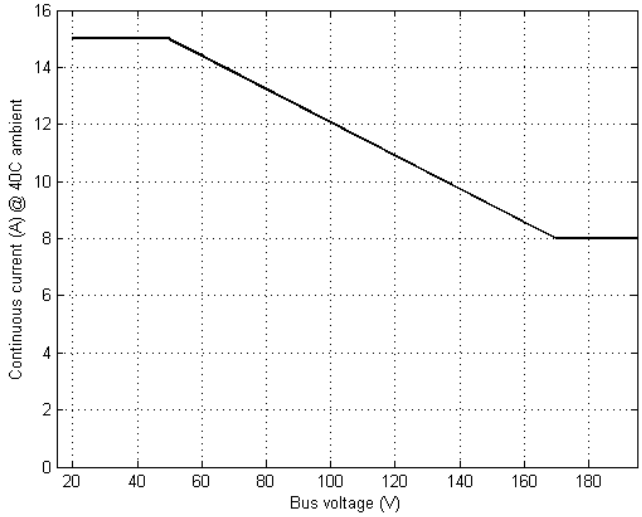


Figure 7-8: Microstepping output current vs bus voltage at 40°C ambient

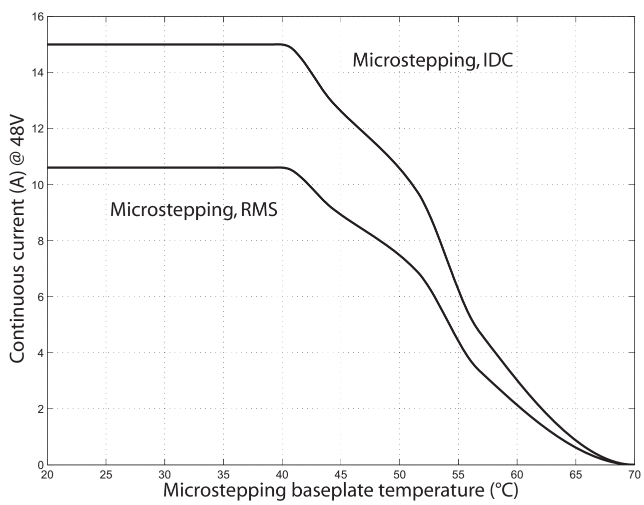


Figure 7-9: Microstepping output current vs temperature with 48V input

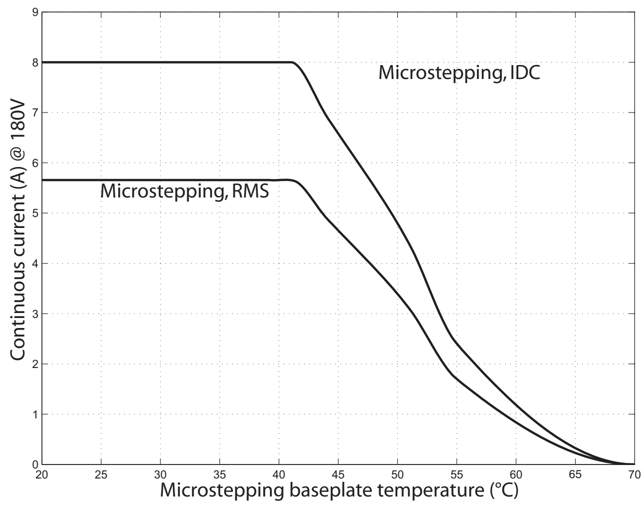


Figure 7-10: Microstepping output current vs temperature with 180V input

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