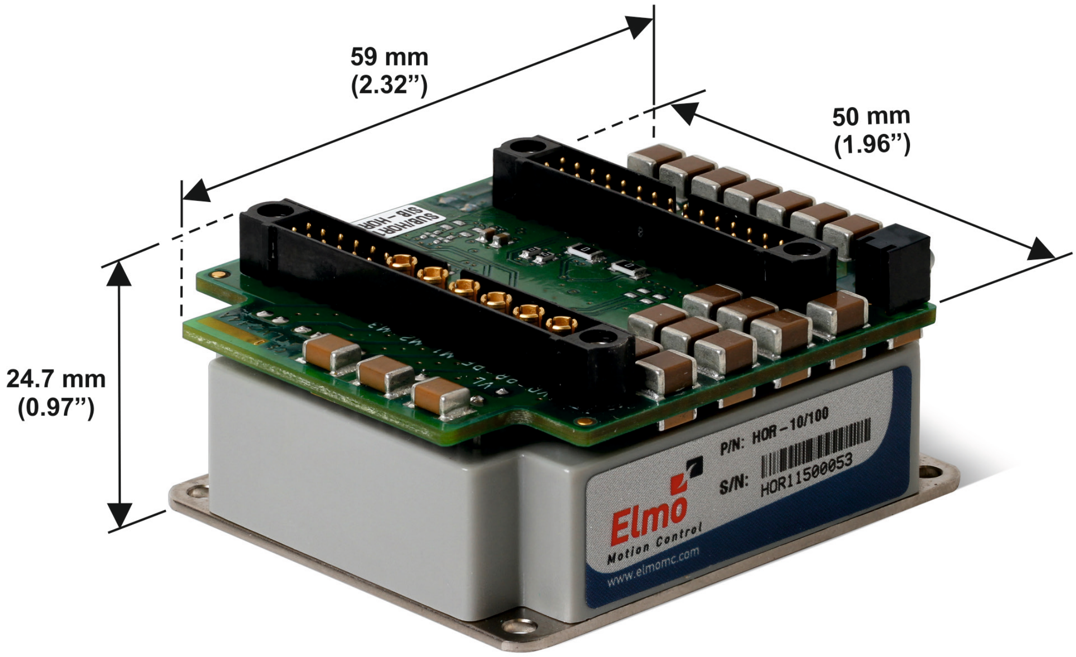
ExtrIQ Line

Solo Hornet Digital Servo Drive Installation Guide



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Elmo Motion Control

www.elmomc.com

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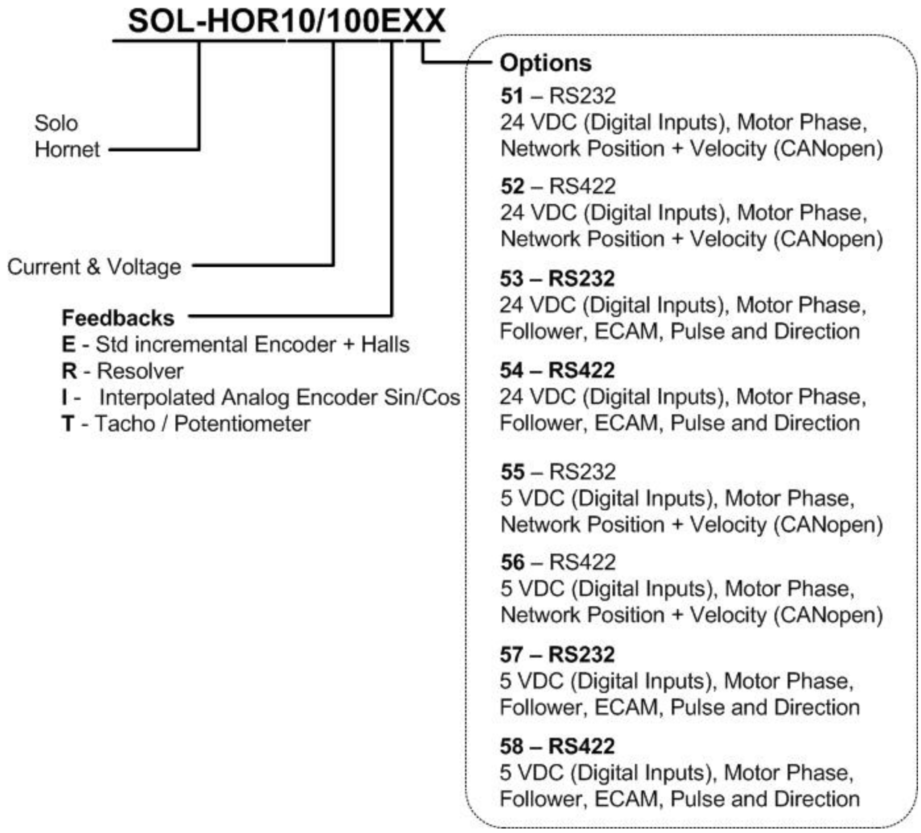

Revision History

Version	Date	Details
1.0	Sep 2012	Initial release
1.001	Jan 2013	Updated the auxiliary voltage value Added a caution and recommendation on the type of cleaning solution to use for the Elmo unit.
1.002	Apr 2013	Small changes to Differential RS-232 Communication
1.003	July 2014	General format update
1.004	Non 2015	Added two mating connectors information
1.005	Oct 2017	Updated the Warranty Information section 1.5 and the part number label in section 4.2.

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Chapter 1: Safety Information

In order to achieve the optimum, safe operation of the Solo Hornet servo drive, it is imperative that you implement the safety procedures included in this installation guide. This information is provided to protect you and to keep your work area safe when operating the Solo Hornet as well as the accompanying equipment.

Please read this chapter carefully before you begin the installation process.

Before you start, ensure that all system components are connected to earth ground. Electrical safety is provided through a low-resistance earth connection.

Only qualified personnel may install, adjust, maintain, and repair the servo drive. A qualified person has the knowledge and authorization to perform tasks such as transporting, assembling, installing, commissioning, and operating motors.

The Solo Hornet servo drive contains electrostatic-sensitive components that can be damaged if handled incorrectly. To prevent any electrostatic damage, avoid contact with highly insulating materials, such as plastic film and synthetic fabrics. Place the product on a conductive surface and ground yourself in order to discharge any possible static electricity build-up.

To avoid any potential hazards that may cause severe personal injury or damage to the product during operation, keep all covers and cabinet doors shut.

The following safety symbols are used in this manual:

Warning:
This information is needed to avoid a safety hazard, which might cause bodily injury.

Caution:
This information is necessary for preventing damage to the product or to other equipment.

1.1. Warnings

- To avoid electric arcing and hazards to personnel and electrical contacts, never connect/disconnect the servo drive while the power source is on.
- Power cables can carry a high voltage, even when the motor is not in motion. Disconnect the Solo Hornet from all voltage sources before it is opened for servicing.
- The Solo Hornet servo drive contains grounding conduits for electric current protection. Any disruption to these conduits may cause the instrument to become hot (live) and dangerous.
- After shutting off the power and removing the power source from your equipment, wait at least 1 minute before touching or disconnecting parts of the equipment that are normally loaded with electrical charges (such as capacitors or contacts). Measuring the electrical contact points with a meter, before touching the equipment, is recommended.

1.2. Cautions

- The Solo Hornet servo drive contains hot surfaces and electrically-charged components during operation.
- The maximum DC power supply connected to the instrument must comply with the parameters outlined in this guide.
- When connecting the Solo Hornet to an approved 11 to 95 VDC auxiliary power supply, connect it through a line that is separated from hazardous live voltages using reinforced or double insulation in accordance with approved safety standards.
- Before switching on the Solo Hornet, verify that all safety precautions have been observed and that the installation procedures in this manual have been followed.
- Do not clean any of the Solo Hornet drive's soldering with solvent cleaning fluids of pH greater than 7 (8 to 14). The solvent corrodes the plastic cover causing cracks and eventual damage to the drive's PCBs.

  Elmo recommends using the cleaning fluid Vigon-EFM which is pH Neutral (7).

  For further technical information on this recommended cleaning fluid, select the link:

  http://www.zestron.com/fileadmin/zestron.com-usa/daten/electronics/Product_TI1s/TI1-VIGON_EFM-US.pdf

1.3. Directives and Standards

The Solo Hornet drives conform to the following industry safety standards:

Safety Standard	Item
Approved **IEC/EN 61800-5-1, Safety**	Adjustable speed electrical power drive systems
Recognized **UL 508C**	Power Conversion Equipment
In compliance with **UL 840**	Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
In compliance with **UL 60950-1** (formerly **UL 1950**)	Safety of Information Technology Equipment Including Electrical Business Equipment
In compliance with **EN 60204-1**	Low Voltage Directive 73/23/EEC

The Solo Hornet servo drive has been developed, produced, tested and documented in accordance with the relevant standards. Elmo Motion Control is not responsible for any deviation from the configuration and installation described in this documentation. Furthermore, Elmo is not responsible for the performance of new measurements or ensuring that regulatory requirements are met.

1.4. CE Marking Conformance

The Solo Hornet servo drive is intended for incorporation in a machine or end product. The actual end product must comply with all safety aspects of the relevant requirements of the European Safety of Machinery Directive 98/37/EC as amended, and with those of the most recent versions of standards **EN 60204-1** and **EN 292-2** at the least.

According to Annex III of Article 13 of Council Directive 93/68/EEC, amending Council Directive 73/23/EEC concerning electrical equipment designed for use within certain voltage limits, the Solo Hornet drive meets the provisions outlined in Council Directive 73/23/EEC. The party responsible for ensuring that the equipment meets the limits required by EMC regulations is the manufacturer of the end product.

1.5. Warranty Information

The products covered in this manual are warranted to be free of defects in material and workmanship and conform to the specifications stated either within this document or in the product catalog description. All Elmo drives are warranted for a period of 12 months from the date of shipment. No other warranties, expressed or implied — and including a warranty of merchantability and fitness for a particular purpose — extend beyond this warranty.

Chapter 2: Introduction

The Solo Hornet is an integrated solution designed to simply and efficiently connect Elmo's Hornet servo drive directly to the application. The solution consists of the Hornet together with a convenient connection interface which either eliminates or reduces development time and resources when designing an application's PCB board.

This installation guide describes the Solo Hornet servo drive and the steps for its wiring, installation and power-up. Following these guidelines ensures maximum functionality of the drive and the systems to which it is connected.

2.1. Drive Description

The Solo Hornet series of digital servo drives is designed to deliver "the highest density of power and intelligence". The Solo Hornet is a lightweight and highly compact solution which can be used whenever reduced size and weight are essential to the application. The Solo Hornet delivers up to **1600 W** of **continuous power** or **3200 W of peak power** in a 72.87 cm^3/4.41 in^3 (59 x 24.7 x 50 mm or 2.32" x 0.97" x 1.96") package.

The Solo Hornet drive is designed for OEMs. It operates from a DC power source in current, velocity, position and advanced position modes, in conjunction with a permanent-magnet synchronous brushless motor, DC brush motor, linear motor or voice coil. It is designed for use with any type of sinusoidal and trapezoidal commutation, with vector control. The Solo Hornet can operate as a stand-alone device or as part of a multi-axis system in a distributed configuration on a real-time network.

The drive is easily set up and tuned using Elmo's *Composer* software tools. This Windows-based application enables users to quickly and simply configure the servo drive for optimal use with their motor. The Solo Hornet, as part of the ExtrIQ product line, is fully programmable with Elmo's *Composer* motion control language.

Power to the drive is provided by an 11 to 95 VDC isolated DC power source (not included with the Solo Hornet). A "smart" control-supply algorithm enables the Solo Hornet to operate with only one power supply with no need for an auxiliary power supply for the logic.

If backup functionality is required for storing control parameters in case of power-loss, an external 11 to 95 VDC isolated supply should be connected via the +VL, providing maximum flexibility and backup functionality when needed.

Note: This backup functionality can operate from any voltage source within the 11 to 95 VDC range. This is much more flexible than to be restricted by only using a standard 24 VDC power supply.

If backup power is not required, two terminals (VP and VL) are shorted so that the main power supply will also power the control/logic supply. In this way there is no need for a separate control/logic supply.

The Solo Hornet drive is available in two models:

- The standard model is a basic servo drive which operates in current, velocity and position modes including PT & PVT. It operates simultaneously via RS-232/RS-422 and CAN DS-301, DS-305, DS-402 communications and features a third-generation programming environment.
- The advanced model includes all the motion capabilities and communication options included in the standard model, as well as advanced positioning capabilities – ECAM, Follower and Dual Loop-and increased program size.

The two models operate with both RS-232/RS-422 and CAN communication.

2.2. Product Features

2.2.1. Current Control

- Fully digital
- Sinusoidal commutation with vector control or trapezoidal commutation with encoder and/or digital Hall sensors
- 12-bit current loop resolution
- Automatic gain scheduling, to compensate for variations in the DC bus power supply

2.2.2. Velocity Control

- Fully digital
- Programmable PI and FFW (feed forward) control filters
- Sample rate two times current loop sample time
- “On-the-fly” gain scheduling
- Automatic, manual and advanced manual tuning and determination of optimal gain and phase margins

2.2.3. Position Control

- Programmable PIP control filter
- Programmable notch and low-pass filters
- Sample time: four times that of the current loop
- Fast event capturing inputs
- PT and PVT motion modes
- Fast output compare (OC)

2.2.4. Advanced Position Control

This relates to the Advanced model only.

- Position-based and time-based ECAM mode that supports a non-linear follower mode, in which the motor tracks the master motion using an ECAM table stored in flash memory
- Dual (position/velocity) loop

2.2.5. Communication Options

Solo Hornet users can use two communication options:

- RS-232 or RS-422 (depending on the catalogue number) serial communication
- CAN for fast communication in a multi-axis distributed environment

2.2.6. Feedback Options

- Incremental Encoder – up to 20 Mega-Counts (5 Mega-Pulse) per second
- Digital Halls – up to 2 kHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Mega-Counts per second for encoder
- Interpolated Analog (Sine/Cosine) Encoder – up to 250 kHz (analog signal)
  - Internal Interpolation - up to x4096
  - Automatic Correction of amplitude mismatch, phase mismatch, signals offset
  - Emulated encoder outputs
- Resolver
  - Programmable 10 to 15 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Emulated encoder outputs
- Tachometer, Potentiometer
- Elmo drives provide supply voltage for all the feedback options

2.2.7. Fault Protection

The Solo Hornet drive includes built-in protection against possible fault conditions, including:

- Software error handling
- Status reporting for a large number of possible fault conditions
- Protection against conditions such as excessive temperature, under/over voltage, loss of commutation signal, short circuits between the motor power outputs and between each output and power input/return
- Recovery from loss of commutation signals and from communication errors

2.3. System Architecture

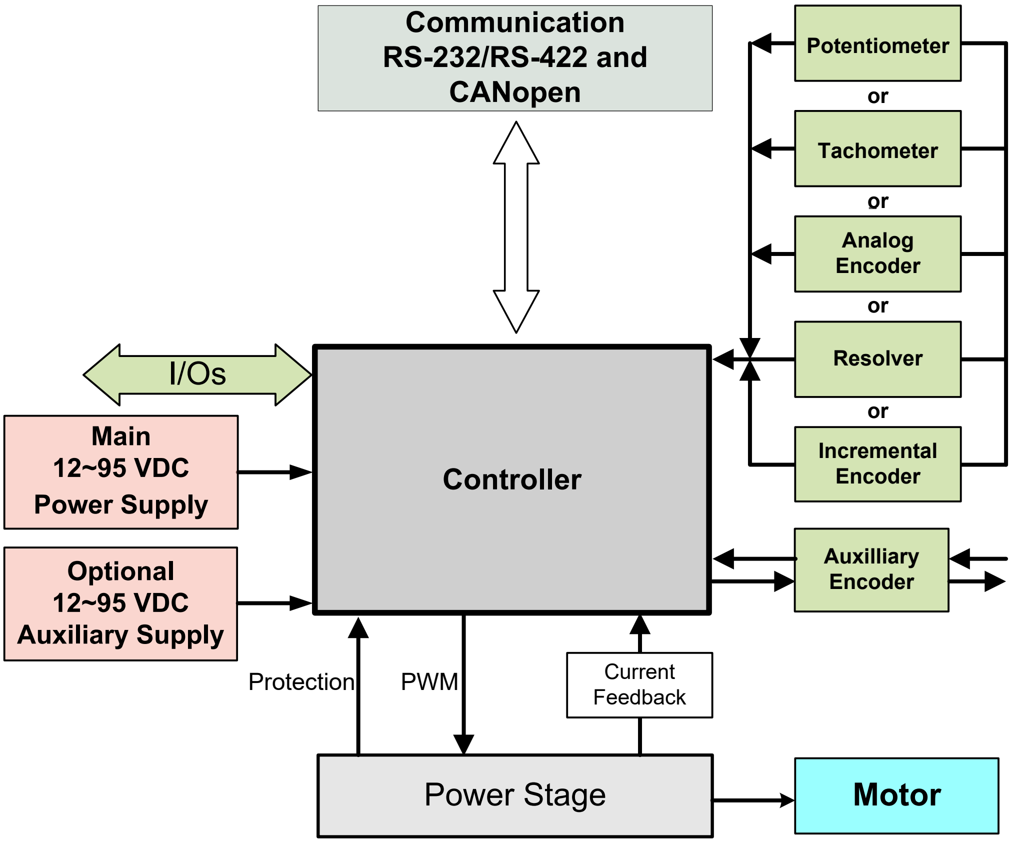


Figure 1: Solo Hornet System Block Diagram

2.4. How to Use this Guide

In order to install and operate your Elmo Solo Hornet servo drive, you will use this manual in conjunction with a set of Elmo documentation. Installation is your first step; after carefully reading the safety instructions in the first chapter, the following chapters provide you with installation instructions as follows:

- Chapter 3, *Installation*, provides step-by-step instructions for unpacking, mounting, connecting and powering up the Solo Hornet.
- Chapter 4, *Technical Specifications,* lists all the drive ratings and specifications.

Upon completing the instructions in this guide, your Solo Hornet servo drive should be successfully mounted and installed. From this stage, you need to consult higher-level Elmo documentation in order to set up and fine-tune the system for optimal operation. The following figure describes the accompanying documentation that you will require.

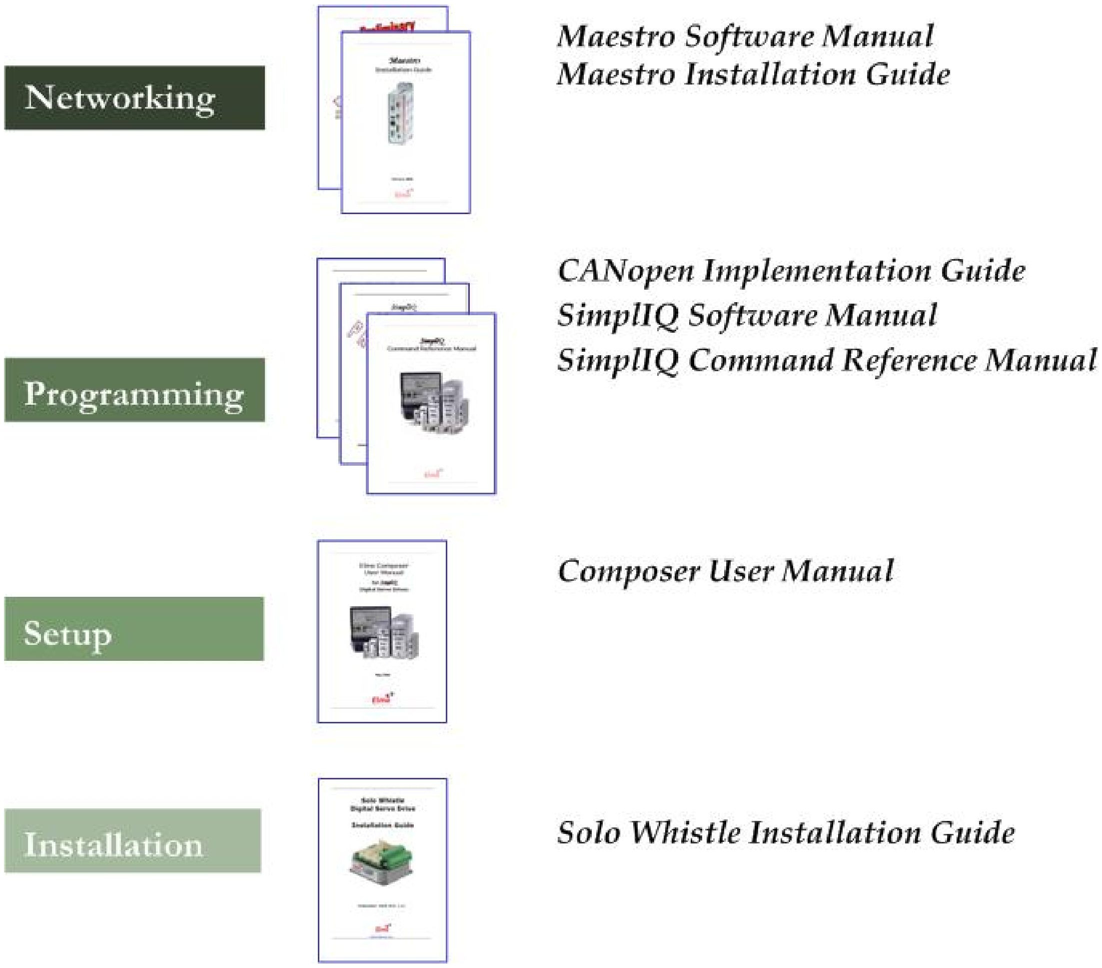


Figure 2: Elmo Digital Servo Drive Documentation Hierarchy

As depicted in the previous figure, this installation guide is an integral part of the Solo Hornet documentation set, comprising:

- The Composer *Software Manual,* which includes explanations of all the software tools that are part of Elmo's Composer software environment.
- The *SimplIQ Command Reference Manual,* which describes, in detail, each software command used to manipulate the Solo Hornet motion controller.
- The *SimplIQ Software Manual,* which describes the comprehensive software used with the Solo Hornet.

Chapter 3: Technical Information

3.1. Technical Data

<table>
<tr><th>Feature</th><th>Units</th><th>15/48</th><th>20/48</th><th>5/60</th><th>10/60</th><th>15/60</th><th>20/60</th><th>2.5/100</th><th>5/100</th><th>15/100</th><th>20/100</th></tr>
<tr><td>Minimum supply voltage</td><td>VDC</td><td colspan="2">6</td><td colspan="4">7.5</td><td colspan="4">12</td></tr>
<tr><td>Nominal supply voltage</td><td>VDC</td><td colspan="2">42</td><td colspan="4">50</td><td colspan="4">85</td></tr>
<tr><td>Maximum supply voltage</td><td>VDC</td><td colspan="2">48</td><td colspan="4">59</td><td colspan="4">95</td></tr>
<tr><td>Maximum continuous power output</td><td>W</td><td>600</td><td>800</td><td>240</td><td>480</td><td>720</td><td>960</td><td>200</td><td>400</td><td>1200</td><td>1600</td></tr>
<tr><td>Efficiency at rated power (at nominal conditions)</td><td>%</td><td colspan="10">> 99</td></tr>
<tr><td>Maximum output voltage</td><td></td><td colspan="10">> 95% of DC bus voltage at f=22 kHz</td></tr>
<tr><td>Auxiliary power supply</td><td>VDC</td><td colspan="10">11 – 95 VDC (up to 2.5 VA inc. 5 V/200 mA for encoder)</td></tr>
<tr><td>Amplitude sinusoidal/DC continuous current</td><td>A</td><td>15</td><td>20</td><td>5</td><td>10</td><td>15</td><td>20</td><td>2.5</td><td>5</td><td>15</td><td>20</td></tr>
<tr><td>Sinusoidal continuous RMS current limit (I_c)</td><td>A</td><td>10.6</td><td>14.1</td><td>3.5</td><td>7</td><td>10.6</td><td>14.1</td><td>1.8</td><td>3.5</td><td>10.6</td><td>14.1</td></tr>
<tr><td>Peak current limit</td><td>A</td><td colspan="10">2 x I_c</td></tr>
<tr><td>Weight</td><td>g (oz)</td><td colspan="10">68.4 g (2.4 oz)</td></tr>
<tr><td>Dimensions</td><td>mm (in)</td><td colspan="10">59 x 24.7 x 50 (2.32" x 0.97" x 1.86")</td></tr>
<tr><td>Digital in/Digital out/Analog in</td><td></td><td colspan="10">6/2/1</td></tr>
</table>

3.1.1. Auxiliary Supply

Feature	Details
Auxiliary power supply	*Isolated DC source only*
Auxiliary supply input voltage	11 VDC to 95 VDC
Auxiliary supply input power	<2.5 VA (this includes the 5 V/200 mA load for the main encoder only)

Chapter 4: Installation

The Solo Hornet must be installed in a suitable environment and properly connected to its voltage supplies and the motor.

4.1. Site Requirements

You can guarantee the safe operation of the Solo Hornet drive by ensuring that it is installed in an appropriate environment.

Feature	Value
Ambient operating temperature	-40 °C to +70 °C (-40 °F to 160 °F)
Maximum operating altitude	12,000 m (39370 feet)
Maximum non-condensing humidity	95%
Operating area atmosphere	No flammable gases or vapors permitted in area

Caution: The Solo Hornet drive dissipates heat by convection. The maximum operating ambient temperature of 0 °C to 40 °C (32 °F to 104° F) must not be exceeded.

4.2. Unpacking the Drive

Before you begin working with the Solo Hornet, verify that you have all of the components, as follows:

- The Solo Hornet servo drive
- The Composer software and software manual

The Solo Hornet is shipped in a cardboard box with Styrofoam protection.

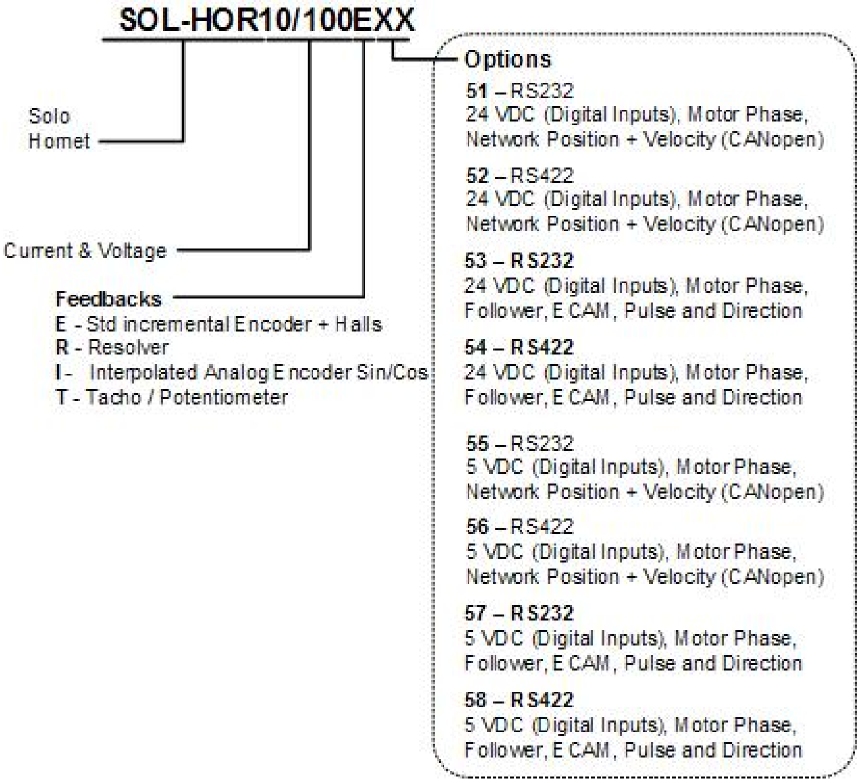
To unpack the Solo Hornet:

1. Carefully remove the servo drive from the box and the Styrofoam.
2. Check the drive to ensure that there is no visible damage to the instrument. If any damage has occurred, report it immediately to the carrier that delivered your drive.

3. To ensure that the Solo Hornet drive you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Solo Hornet.

SOLHO21B

The part number at the top gives the type designation as follows:



4. Verify that the Solo Hornet model is the one that you ordered, and ensure that the voltage meets your specific requirements.

4.3. Connector Types

The Solo Hornet has two connectors (in the connectors version).

Pins	Type	Port	Function
6 2 x 6	Nicomatics CM220 6HP/12 Pins	J1	Motor Power and Main Feedback
2 x 15	Nicomatics CM220 2 x 15 Pins	J2	I/O, Communication and Aux Feedback
Connector Locations			

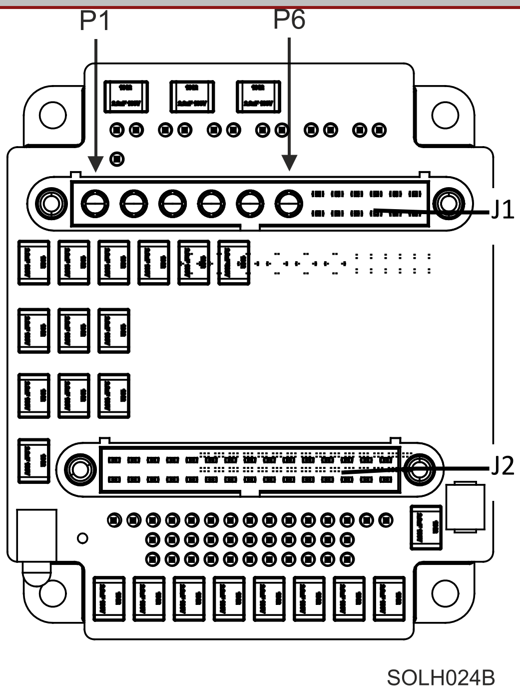


Table 1: Connector Types

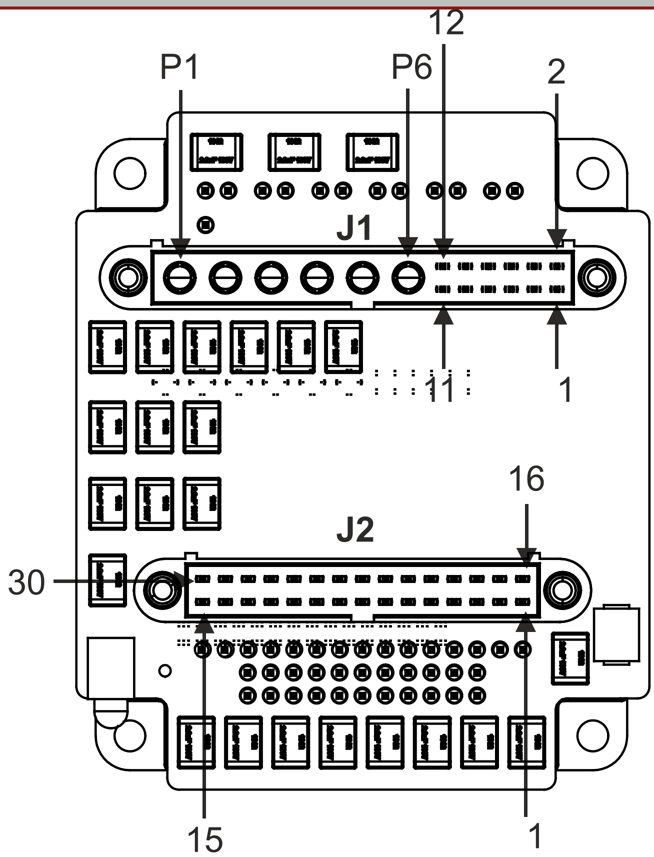
4.4. Mating Connectors

The following table describes the optional female mating connectors for the Solo Hornet. Elmo does not recommend any specific manufacturer.

Connector Description	Nicomatic P/N	Harwin P/N
PLUG CM220 2X15PINS 24-28G FEMALE	222S30M16	M80-4813005
PLUG CM220 6HP/12PINS 24-28G FEMALE	222S12M16-0600-4310	M80-4C11205F2-06-325-00-000

4.5. Main and Motor Power – J1 and J2

Pin (J1)	Signal	Function		
P1	VP+	Pos. power input		
P2	PR	Power return		
P3	PE	Protective earth		
			AC Motor	**DC Motor**
P4	M1	Motor phase	Motor	N/C
P5	M2	Motor phase	Motor	Motor
P6	M3	Motor phase	Motor	Motor
Pin (J2)	**Signal**	**Function**		
1	VL+	Auxiliary supply input		
2	PR	Auxiliary supply input return		
Pin Positions				



SOLH026B

Note: When connecting several drives to several motors, all should be wired in the same motor phases and feedback sequences. This will enable the same ***ExtrIQ*** program to run on

Pin (J1)	Signal	Function
all drives.		

4.5.1. Connecting Main Power

Power to the Solo Hornet is provided by an 11 to 95 VDC source. A smart control-supply algorithm enables the Solo Hornet to operate with the power supply only, with no need for an auxiliary 24 volt supply.

If backup functionality is required (for storing control parameters in case of power-outs) an additional backup supply can be connected by implementing "diode coupling" to the VL+.

Note: The source of the 11 to 95 VDC Main Power Supply must be isolated.

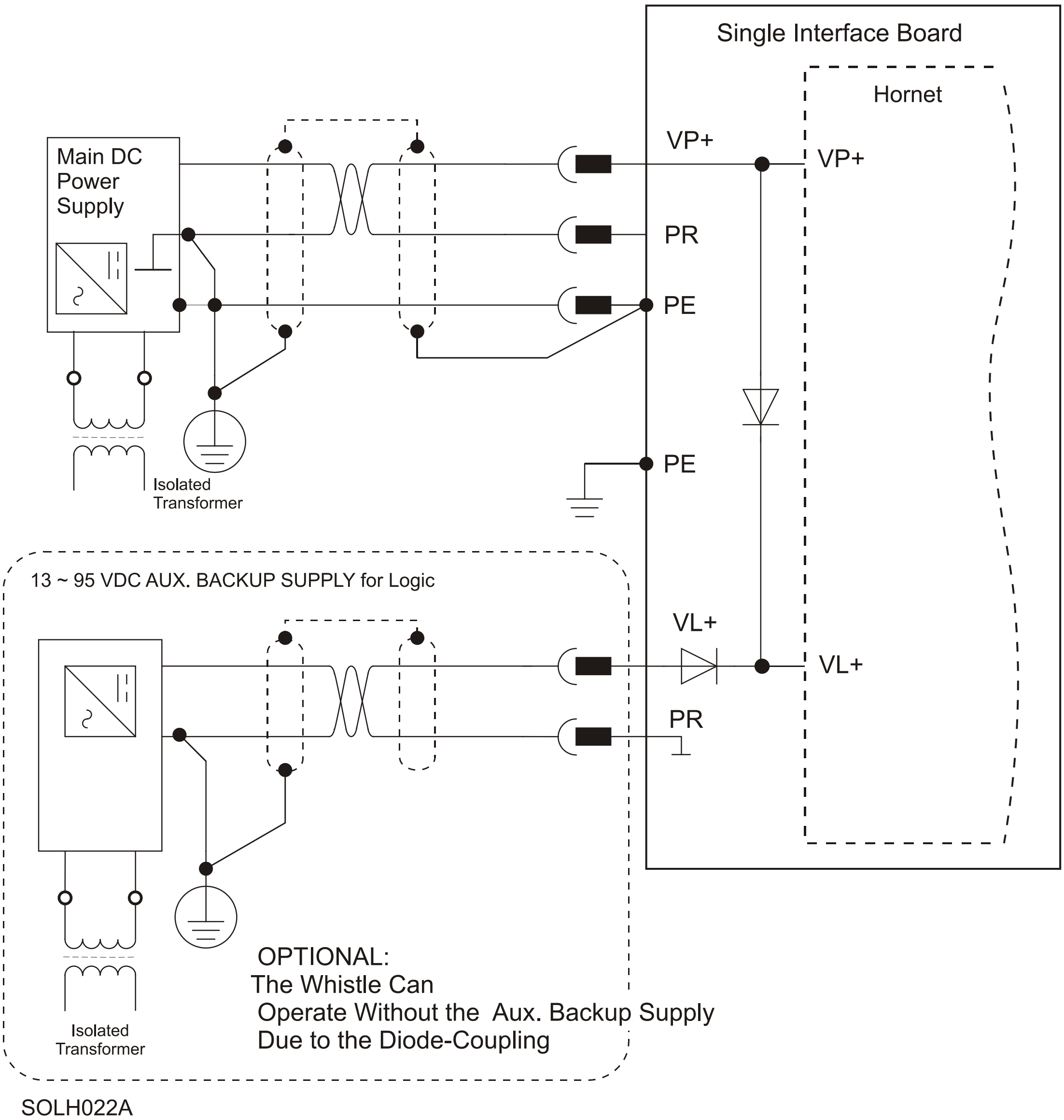


Figure 3: Main Power Supply Connection Diagram

4.6. Motor Power

4.6.1. Connecting Motor Power

Connect the M1, M2, M3 and PE pins on the Solo Hornet. The phase connection is arbitrary as the Composer will establish the proper commutation automatically during setup. However, if you plan to copy the setup to other drives, then the phase order on all copy drives must be the same.

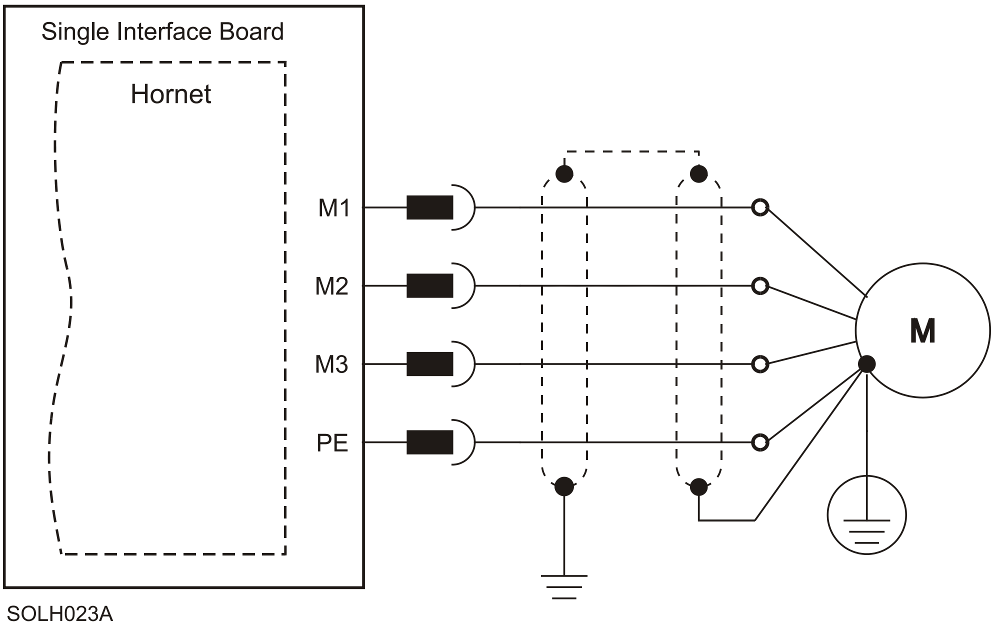


Figure 4: AC Motor Power Connection Diagram

4.7. Main Feedback – J1

The Main Feedback port is used to transfer feedback data from the motor to the drive. In order to copy the setup to other drives, the phase order on all copy drives must be the same.

The Solo Hornet can accept any one of the following devices as a main feedback mechanism:

- Incremental encoder only
- Incremental encoder with digital Hall sensors
- Digital Hall sensors only
- Incremental Analog (Sine/Cosine) encoder (option)
- Resolver (option)
- Tachometer (option)
- Potentiometer (option)

	Incremental Encoder		Interpolated Analog Encoder		Resolver		Tachometer and Potentiometer	
	SOL-HORXX/YYYEZZ		SOL-HORXX/YYYIZZ		SOL-HORXX/YYYRZZ		SOL-HORXX/YYYTZZ	
Pin (J1)	**Signal**	**Function**	**Signal**	**Function**	**Signal**	**Function**	**Signal**	**Function**
1	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply
2	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return
3	HC	Hall sensor C input	HC	Hall sensor C input	NC	-	HC	Hall sensor C input
4	HB	Hall sensor B input	HB	Hall sensor B input	NC	-	HB	Hall sensor B input
5	HA	Hall sensor A input	HA	Hall sensor A input	NC	-	HA	Hall sensor A input
6	PE	Protective Earth	PE	Protective Earth	PE	Protective Earth	PE	Protective Earth
7	CHA-	Channel A complement	A-	Sine A complement	S3	Sine A complement	Tac 1-	Tacho Input 1 Neg. (20 V max)
8	CHA	Channel A	A+	Sine A	S1	Sine A	Tac 1+	Tacho Input 1 Pos. (20 V max)
9	CHB-	Channel B complement	B-	Cosine B complement	S4	Cosine B complement	Tac 2-	Tacho Input 2 Neg. (50 V max)
10	CHB	Channel B	B+	Cosine B	S2	Cosine B	Tac 2+	Tacho Input 2 Pos. (50 V max)
11	INDEX-	Index complement	R-	Reference complement	R2	Vref complement f= 1/TS, 50 mA Maximum	NC	-
12	INDEX	Index	R+	Reference	R1	Vref f=1/TS, 50 mA Max.	POT	Potentiometer Input (5 V Max)

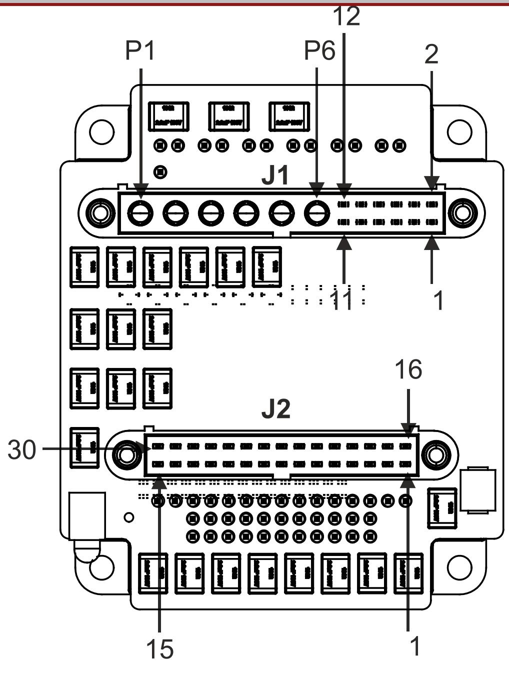
Incremental Encoder	Interpolated Analog Encoder	Resolver	Tachometer and Potentiometer
Pin Positions			
			

Table 2: Main Feedback Pin Assignments

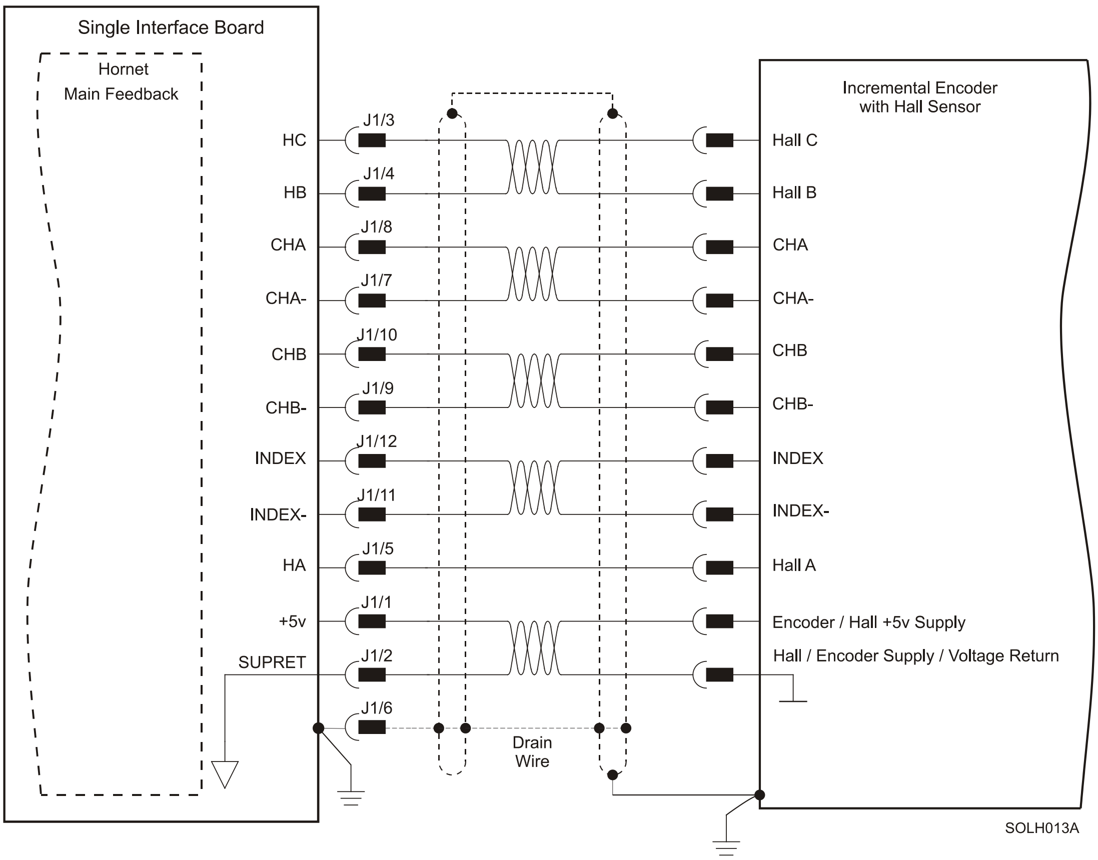


Figure 5: Main Feedback- Incremental Encoder with *Digital Hall Sensor* Connection Diagram

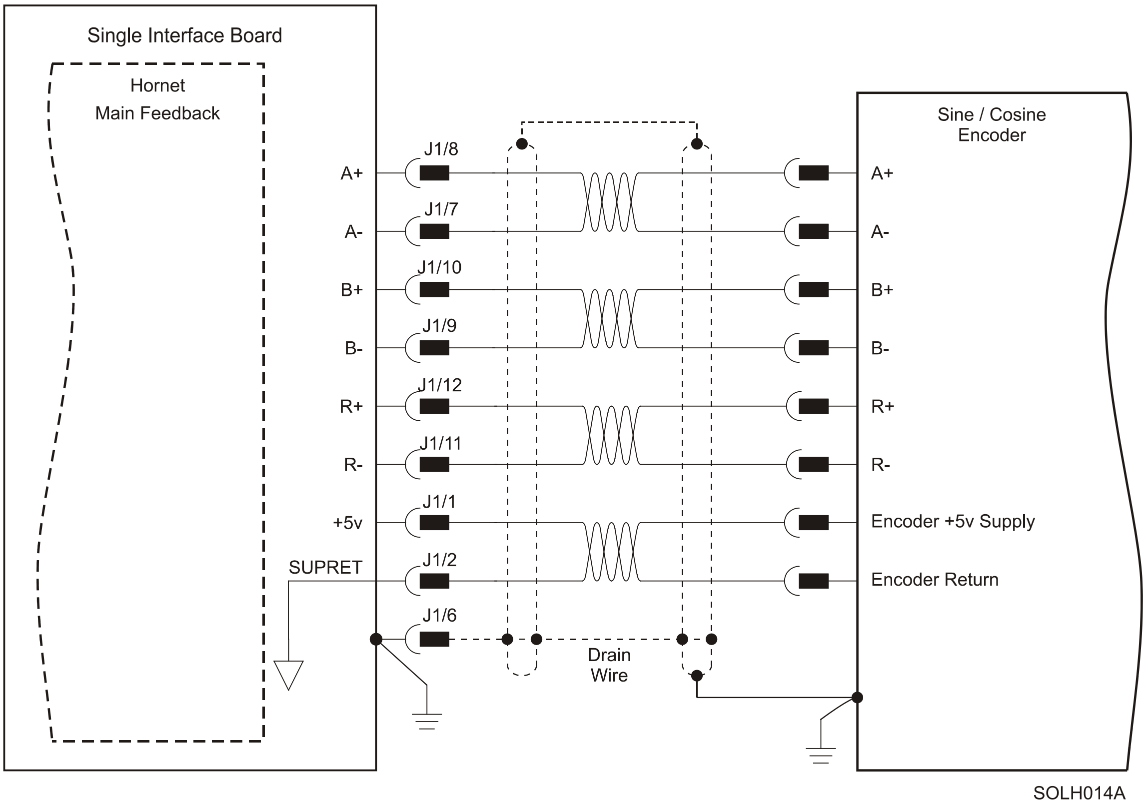


Figure 6: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder Connection Diagram

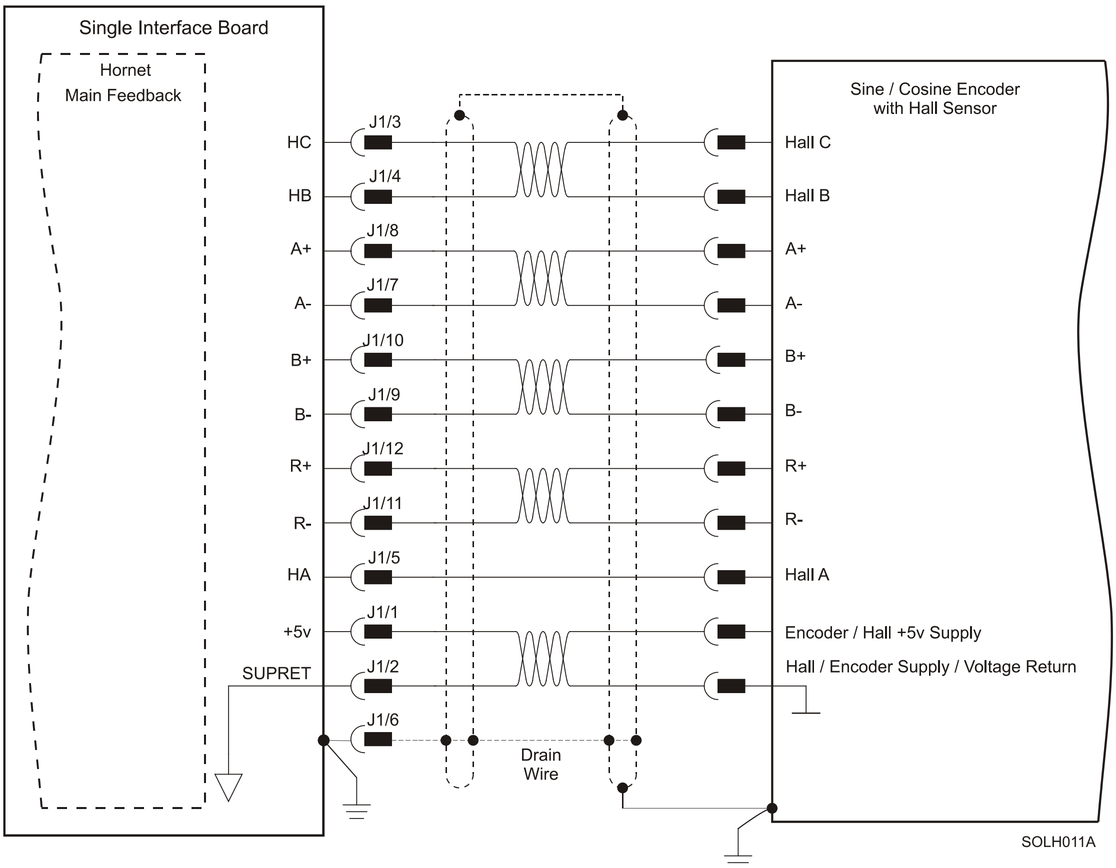


Figure 7: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder with Digital Hall Sensor Connection Diagram

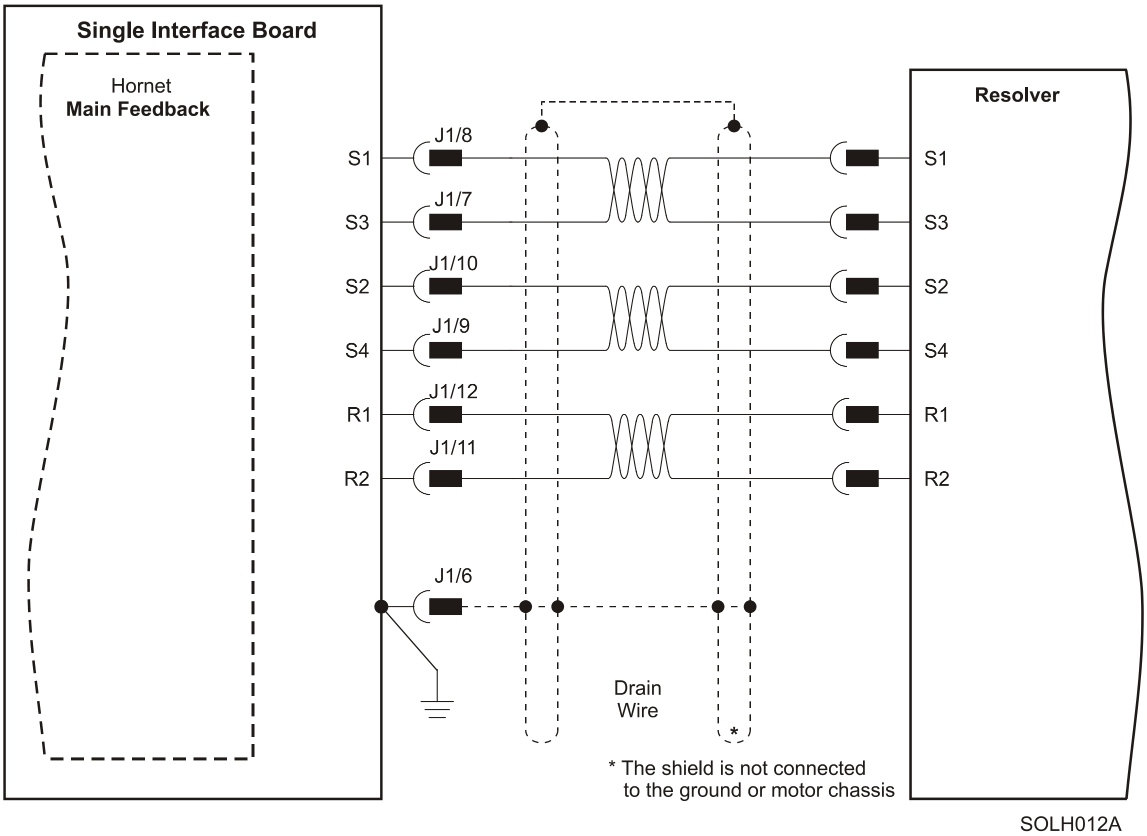


Figure 8: Main Feedback – Resolver Connection Diagram

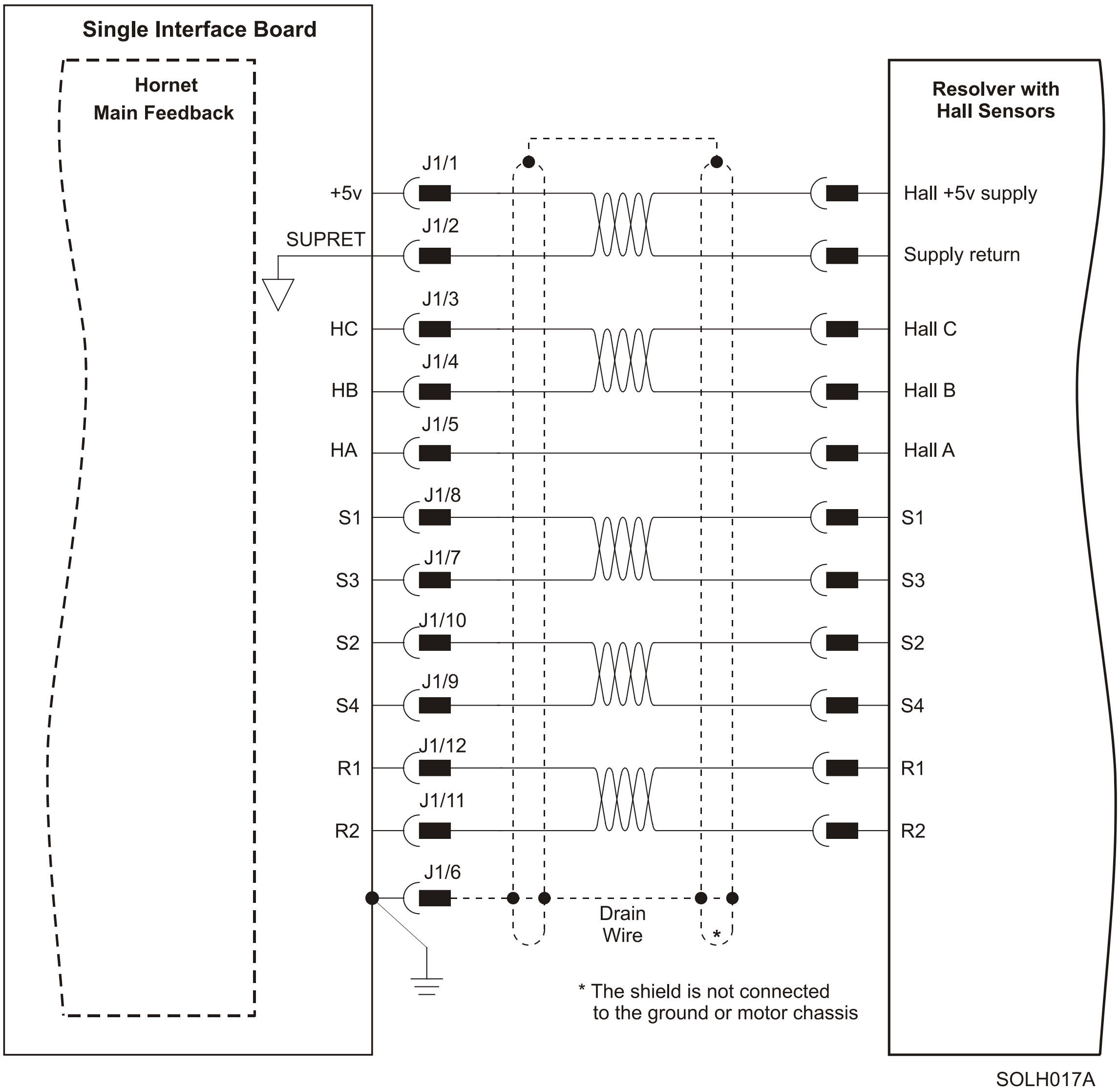


Figure 9: Main Feedback – Resolver with Digital Hall Sensor Connection Diagram

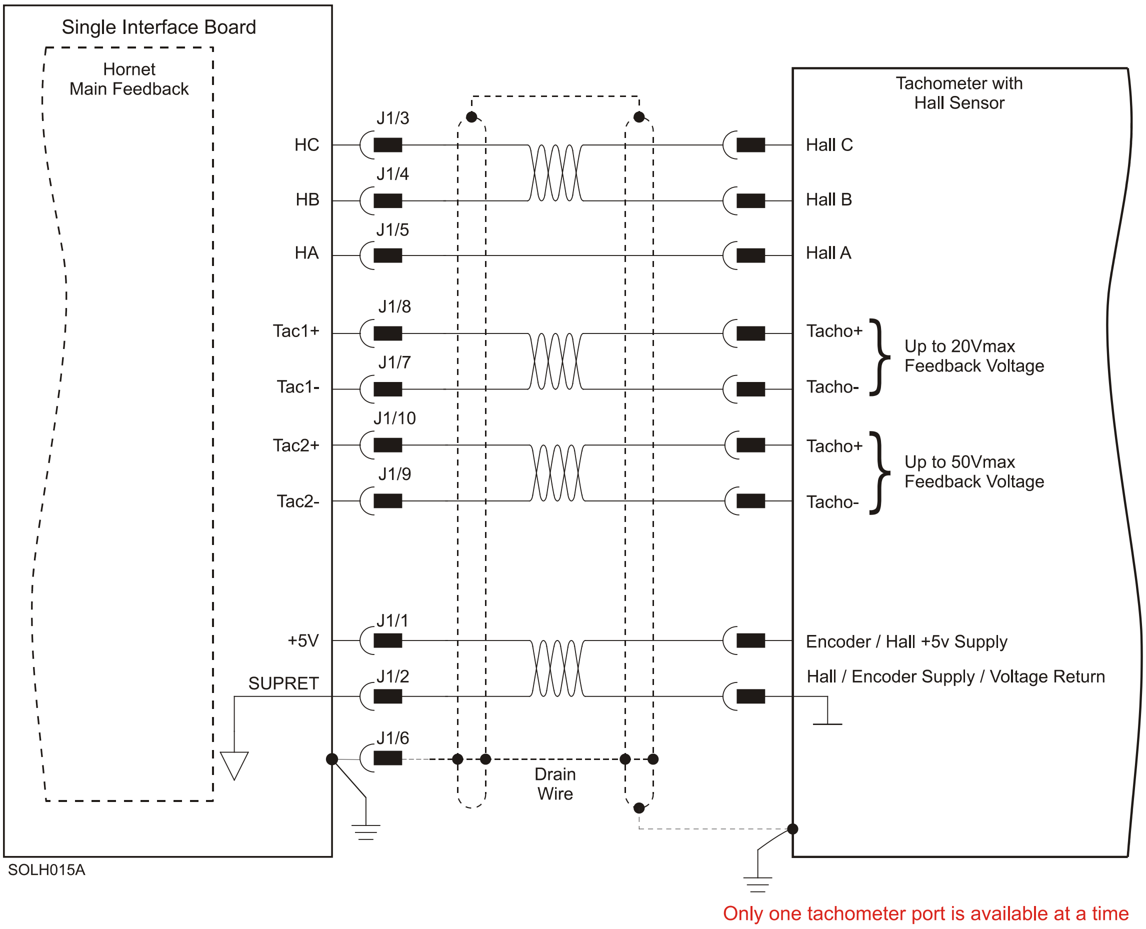


Figure 10: Main Feedback – Tachometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

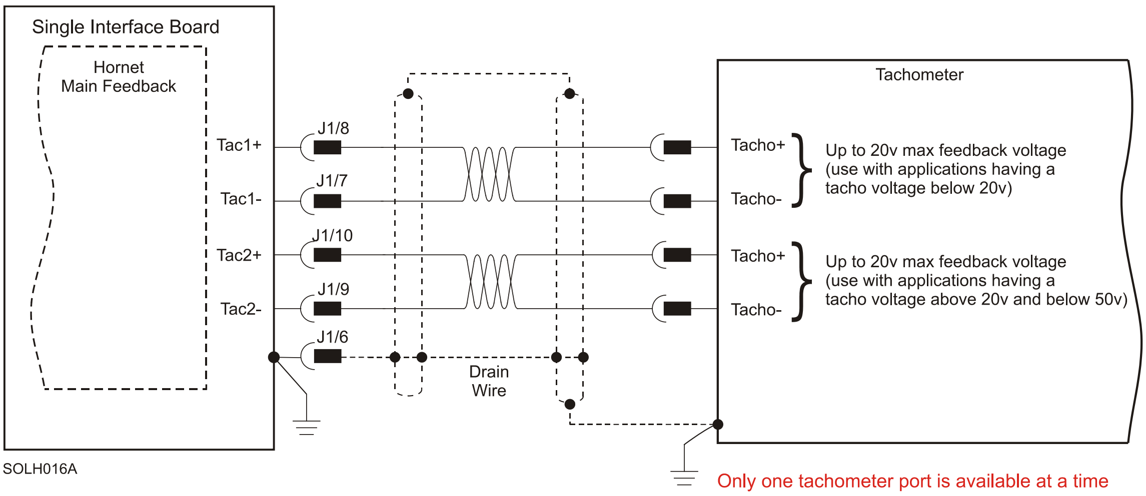


Figure 11: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors

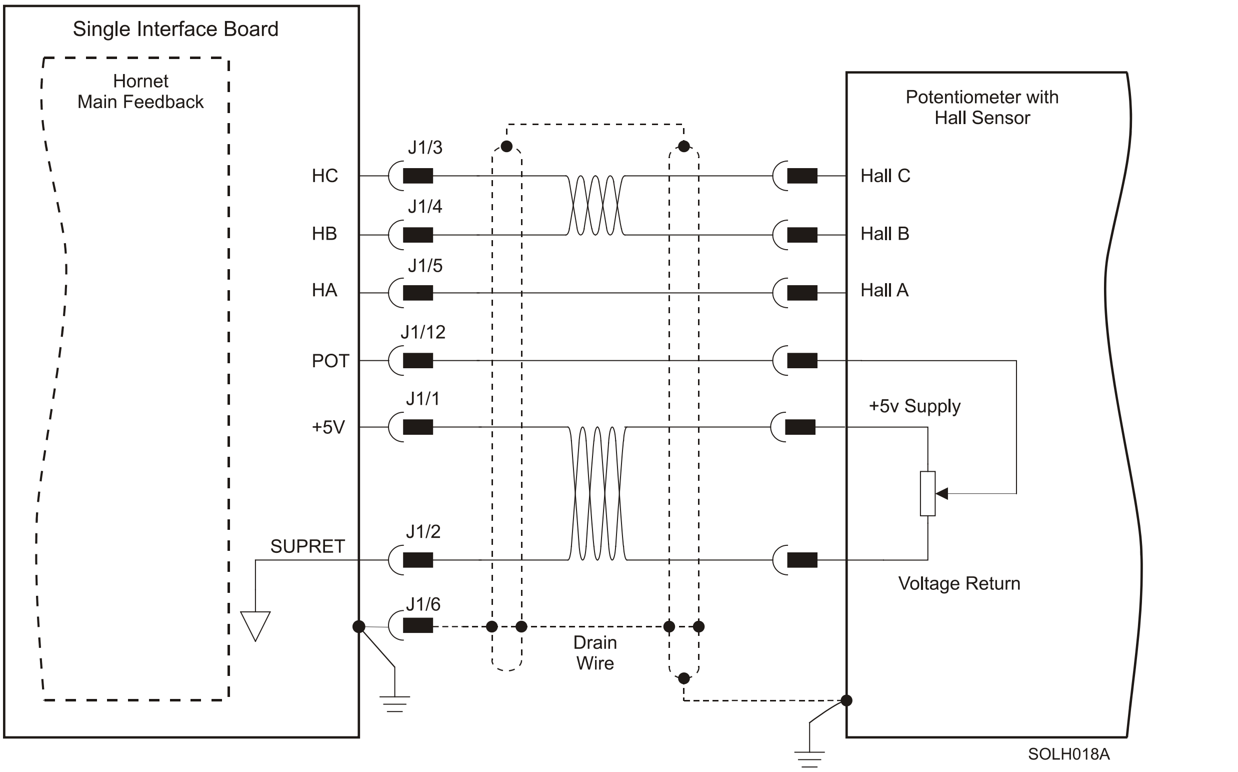


Figure 12: Main Feedback,
Potentiometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

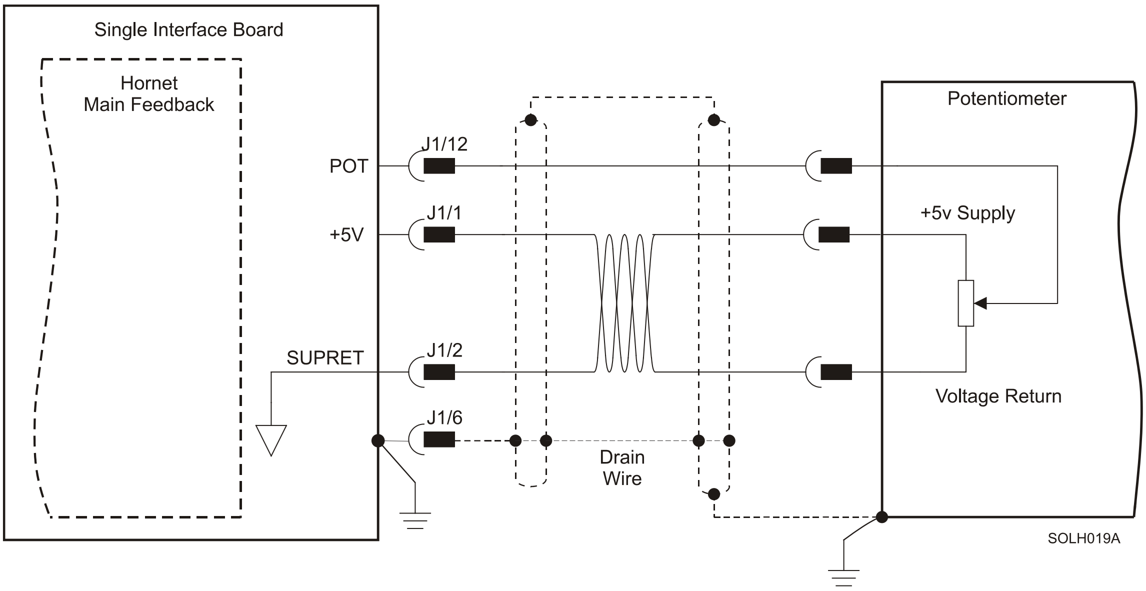


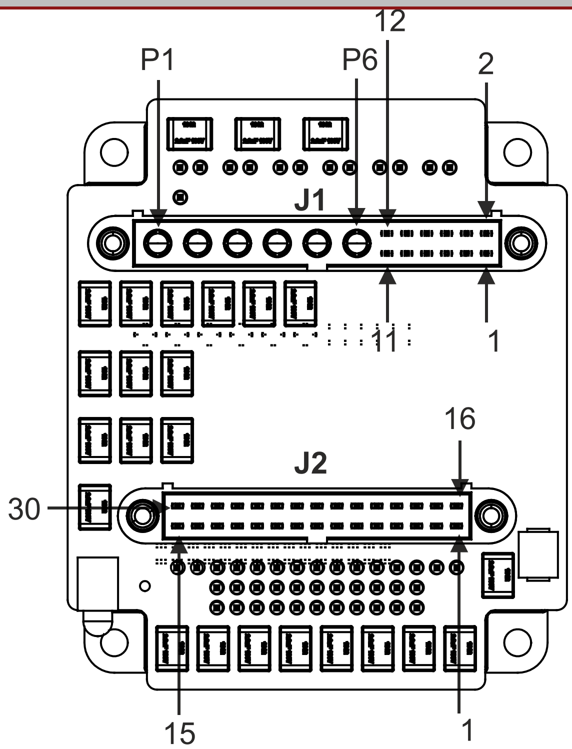
Figure 13: Main Feedback,
Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils

4.8. Auxiliary Feedback – J2

Pin (J2)	Signal	Function
1	VL+	Auxiliary Power Supply
2	PR	Auxiliary Power Supply RET
3	PE	Protective Earth
4	CHAO-	Buffered Channel A complement output
5	CHAO	Buffered Channel A output
6	IN6	Hi-Speed Programmable input 6 (event capture, Main Home, general purpose, RLS, FLS, INH)
7	IN_RET	Programmable input return
8	INDEXO	Buffered Index output
9	INDEXO-	Buffered Index complement output
10	OUT1	Programmable digital output 1
11	OUT_RET1	Programmable digital output return 1
12	OUT2	Programmable digital output 2
13	OUT_RET2	Programmable digital output return 2
14	IN1	Programmable input 1 (general purpose, RLS, FLS, INH)
15	IN2	Programmable input 2 (general purpose, RLS, FLS, INH)
16	IN3	Programmable input 3 (general purpose, RLS, FLS, INH)
17	IN4	Programmable input 4 (general purpose, RLS, FLS, INH)
18	IN5	Hi-Speed Programmable input 5 (event capture, Main Home, general purpose, RLS, FLS, INH)
19	CHBO	Buffered Channel B output
20	CHBO-	Buffered Channel B complement output
21	ANLRET	Analog Return
22	ANLIN1+	Analog input 1+

Pin (J2)	Signal	Function
23	ANLIN1-	Analog input 1-
24	COMRET	Common Return
25	RS422_RX+	RS-422 Receive+
26	RS422_RX-	RS-422 Receive-
27	RS232_TX/ RS422_TX+	RS-232 Transmit or RS422 Transmit +
28	RS232_RX/ RS422_TX-	RS-232 Receive or RS422 Transmit -
29	CAN_L	CAN_L busline (dominant low)
30	CAN_H	CAN_H busline (dominant low)

Pin Positions



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When using one of the Auxiliary Feedback options, the relevant functionality of the Auxiliary Feedback's ports are software- and hardware-selected for that option. Refer to the *SimplIQ Command Reference Manual* for detailed information about Auxiliary Feedback setup.

4.8.1. Auxiliary Feedback Operation Modes

There are two modes of operation for the Solo Hornet:

- **Mode 1**: Auxiliary output (Composer command: YA[4]=4) – see Section 4.8.2
  For SOL-HORXXX/YYYY51 to SOL-HORXXX/YYYY52
  And SOL-HORXXX/YYYY55 to SOL-HORXXX/YYYY56

Differential emulated encoder outputs are used to provide emulated encoder signals to another controller or drive. The emulated encoder output option is only available when using a resolver or analog encoder as the main feedback device.

This option can be used when the Solo Hornet is used:

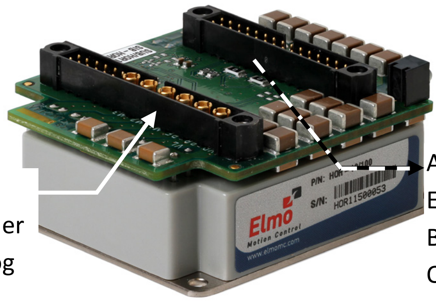
- As a current amplifier to provide position data to the position controller.
- In velocity mode to provide position data to the position controller.
- As a master in follower or ECAM mode.

- **Mode 2**: Auxiliary input (Composer command: YA[4]=2 or YA[4]=0) - see Sections 4.8.3 and 4.8.4
  For SOL-HORXXX/YYYY53 to SOL-HORXXX/YYYY54
  And SOL-HORXXX/YYYY57 to SOL-HORXXX/YYYY58

Differential auxiliary inputs, for the input of position data of the master encoder in follower or ECAM mode. This mode can also be used for differential pulse-and-direction position commands.

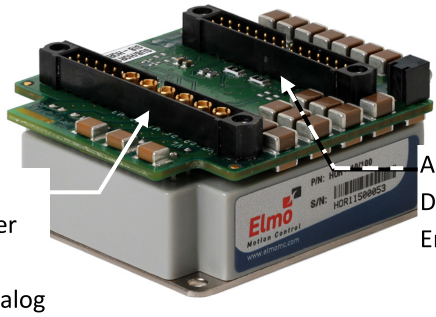
4.8.2. Main and Auxiliary Feedback Combinations

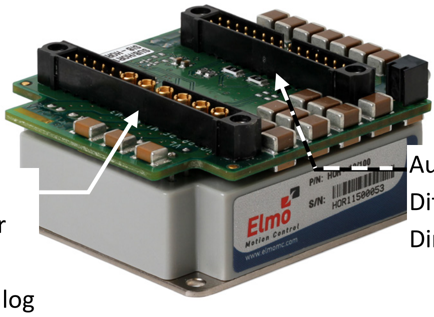
The Main Feedback is always used in motion control devices whereas Auxiliary Feedback is often, but not always used. The Auxiliary Feedback connector on the Solo Hornet has three bi-directional pins (CHA, CHB and INDEX). When used in combination with Main Feedback, the Auxiliary Feedback can be set, by software, as follows:

<table>
<tr><th>Main Feedback</th><th>Auxiliary Feedback: Output</th></tr>
<tr><td>Software Setting</td><td>YA[4] = 4
(Auxiliary Feedback: output)</td></tr>
<tr><td>Incremental Encoder Input</td><td rowspan="4">Main Feedback:
Incremental Encoder
Interpolated Analog
(Sin/Cos) Encoder
OR Resolver
OR Potentiometer
OR Tachometer

Auxiliary Feedback:
Emulated Differential
Buffered Encoder
Output</td></tr>
<tr><td>✦Interpolated Analog (Sine/Cosine) Encoder Input</td></tr>
<tr><td>★Resolver Input</td></tr>
<tr><td>✶Potentiometer/ Tachometer Input</td></tr>
<tr><td>Typical Applications</td><td>Analog Encoder applications where position data is required, in the Encoder's quadrature format, for other purposes such as position controllers and/or other drives.

Resolver applications where position data is required in the Encoder's quadrature format, for other purposes such as position controllers and/or other drives.

Potentiometer and Tachometer applications where position data is required, in the Encoder's quadrature format, for other purposes such as position controllers and/or other drives.</td></tr>
</table>

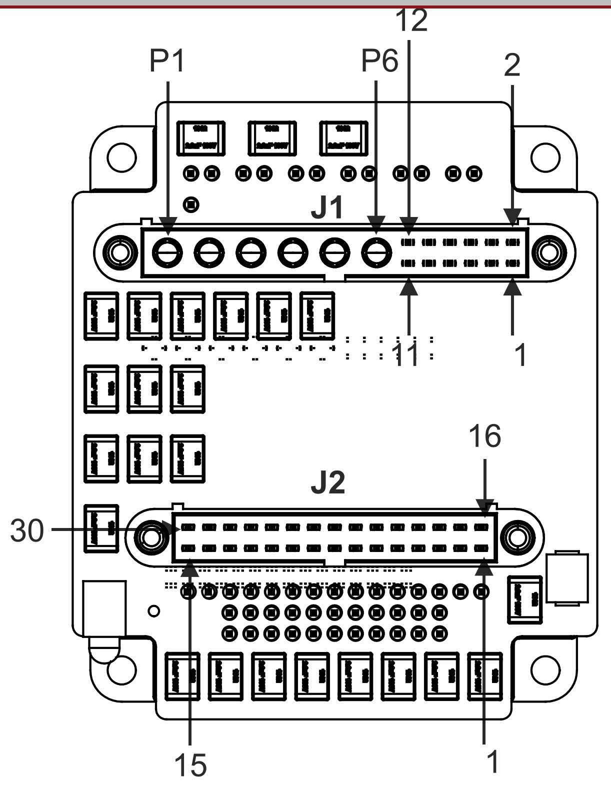
Main Feedback	Auxiliary Feedback: Input
Software Setting	**YA[4] = 2** (Auxiliary Feedback: input)
Incremental Encoder Input	
Interpolated Analog (Sine/Cosine) Encoder Input	
Resolver Input	
Potentiometer Tachometer Input	
Typical Applications	Any application where two Feedbacks are used by the drive. The Auxiliary Feedback port serves as an input for the Auxiliary incremental encoder. For applications such as Follower, ECAM, or Dual Loop.

Main Feedback	Auxiliary Feedback: Input
Software Setting	**YA[4] = 0** (Auxiliary Feedback: input)
Incremental Encoder Input	 Main Feedback: Incremental Encoder Input OR Interpolated Analog (Sin/Cos) Encoder Input OR Resolver OR Potentiometer OR Tachometer Auxiliary Feedback: Differential Pulse & Direction Input
Interpolated Analog (Sine/Cosine) Encoder Input	
Resolver Input	
Potentiometer Tachometer Input	
Typical Applications	Any application where two Feedbacks are used by the drive. The Auxiliary Feedback port serves as an input for Pulse & Direction Commands.

4.8.3. Auxiliary Feedback: Emulated Encoder Output Option (YA[4]=4)

Pin (J2)	Signal	Function
3	PE	Protective Earth
24	COMRET	Common Return
5	CHA	Buffered Channel A output
4	CHA-	Buffered Channel A complement output
19	CHB	Buffered Channel B output
20	CHB-	Buffered Channel B complement output
8	INDEX	Buffered Index output
9	INDEX-	Buffered Index complement output

Pin Positions



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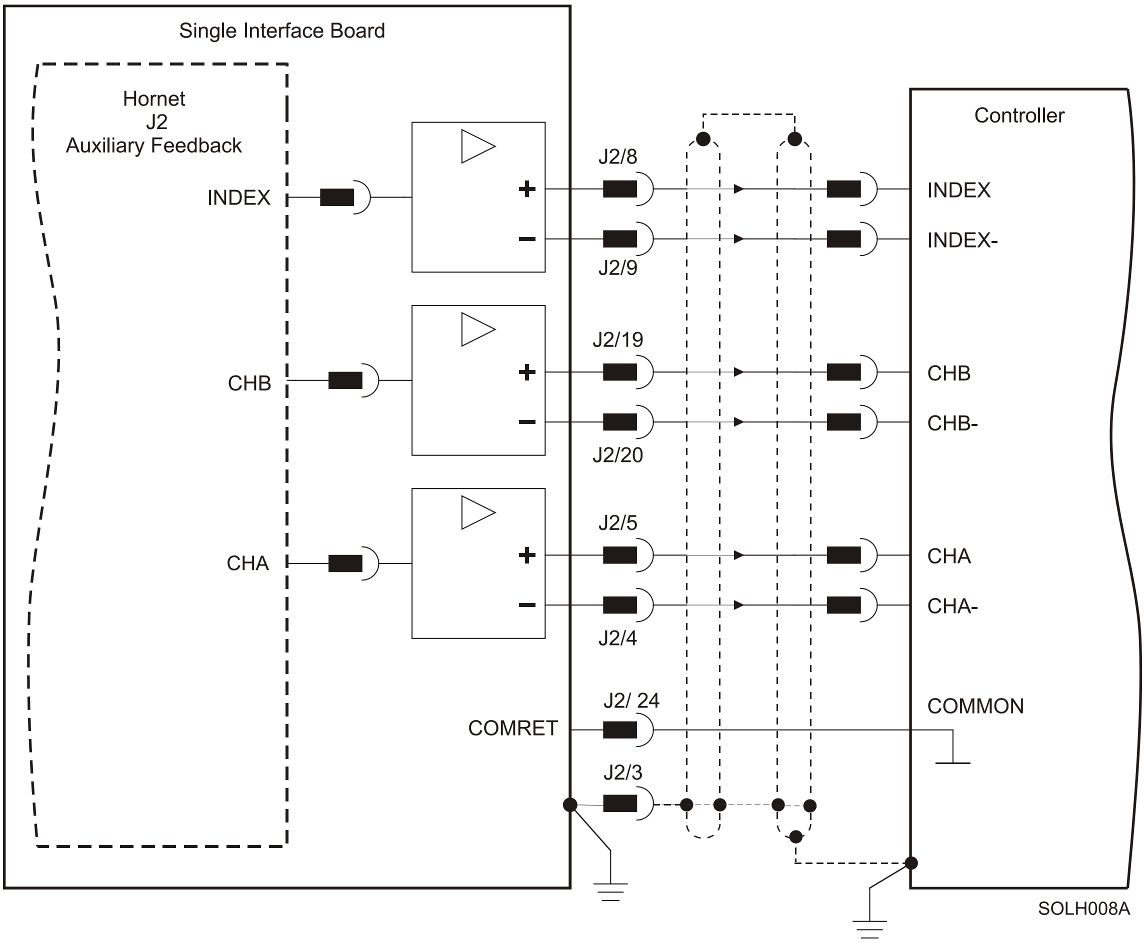
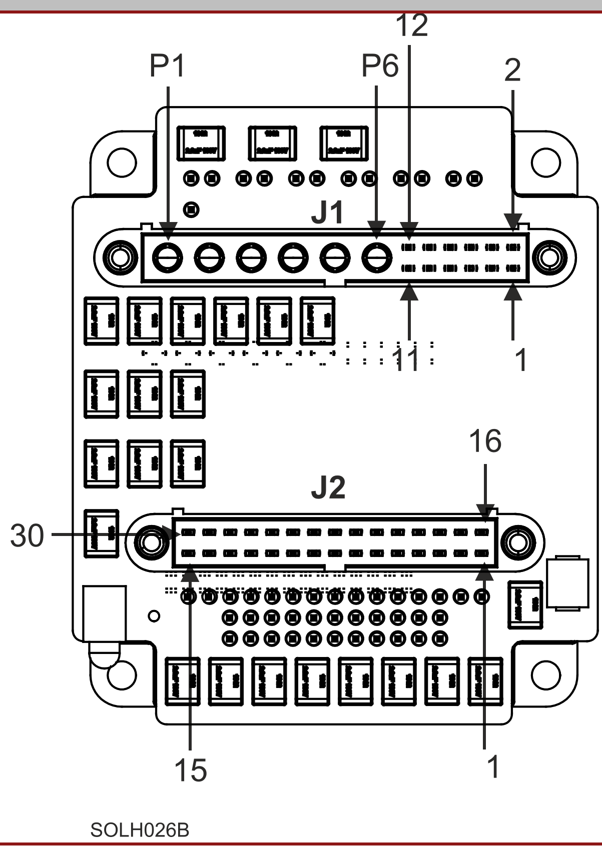


Figure 14: Emulated Encoder Differential Output Diagram

4.8.4. Auxiliary Feedback: Differential Encoder Input Option (YA[4]=2)

Pin (J2)	Signal	Function
3	PE	Protective Earth
24	COMRET	Common Return
5	CHA	Auxiliary channel A Input
4	CHA-	Auxiliary channel A complement input
19	CHB	Auxiliary channel B input
20	CHB-	Auxiliary channel B complement input
8	INDEX	Auxiliary Index input
9	INDEX-	Auxiliary Index complement Input

Pin Positions



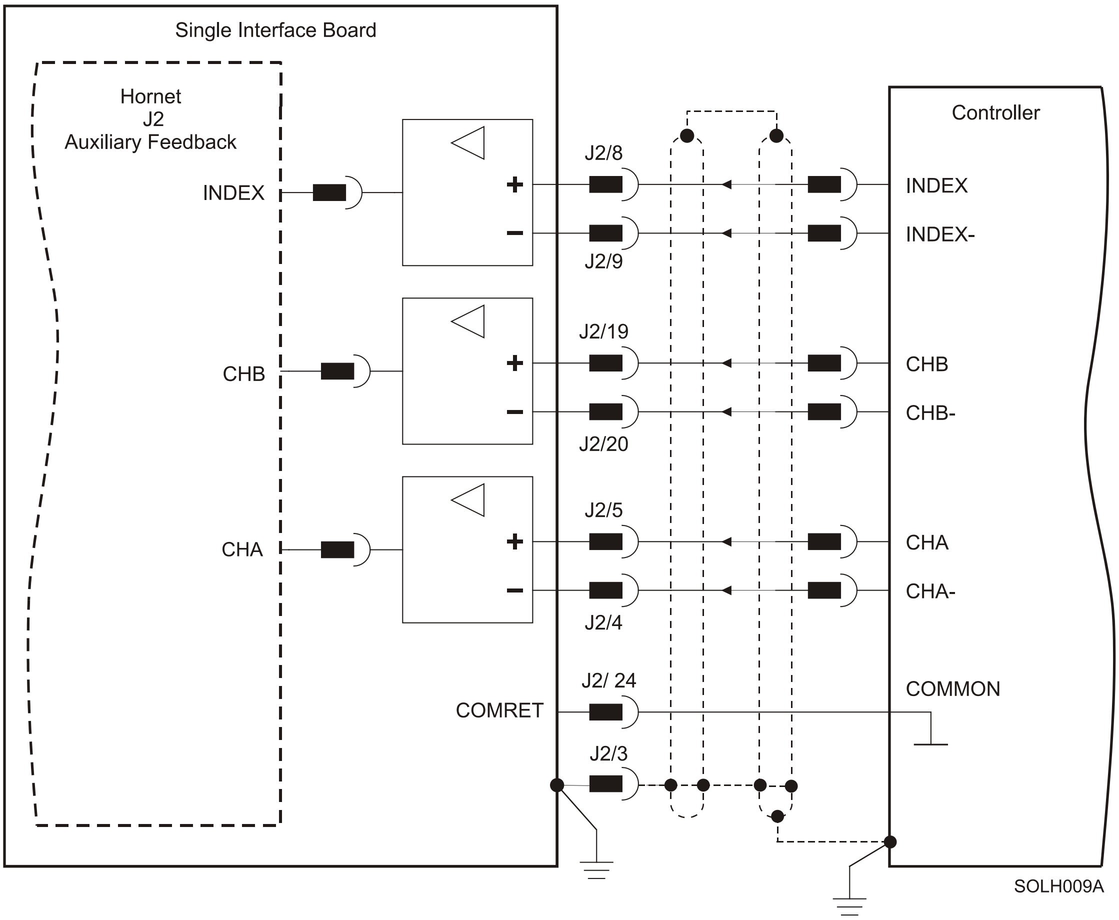


Figure 15: Differential Auxiliary (Controller) Encoder Input Option Diagram

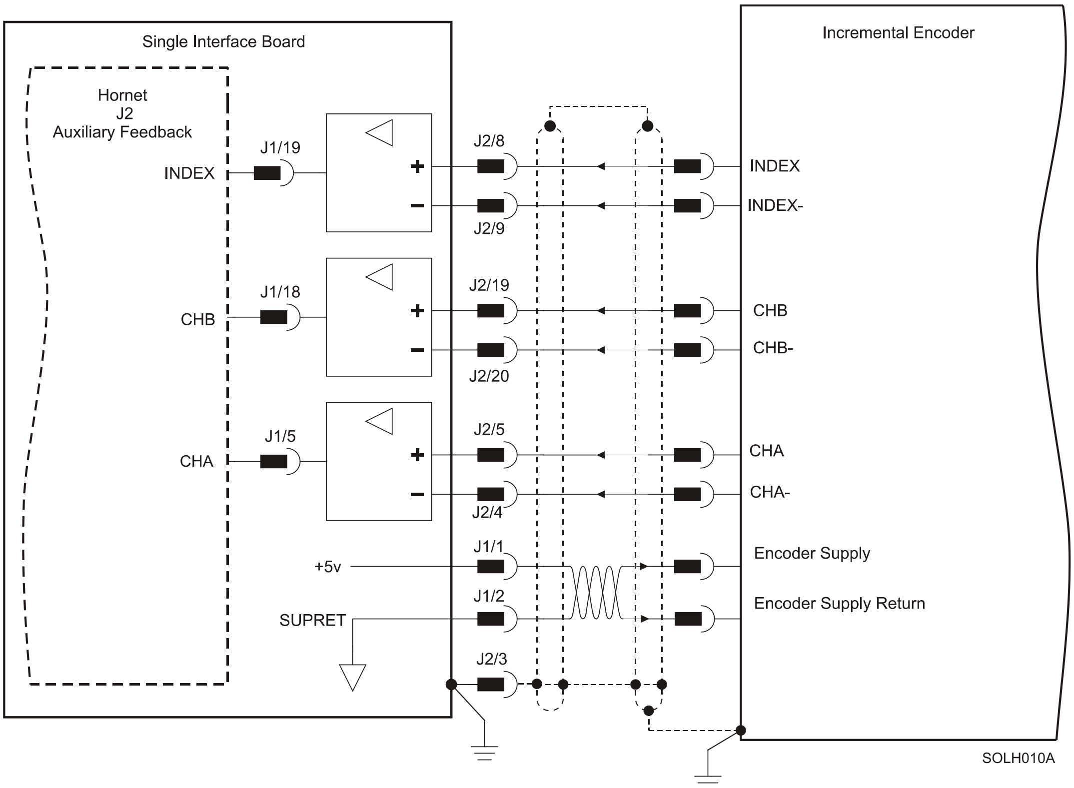
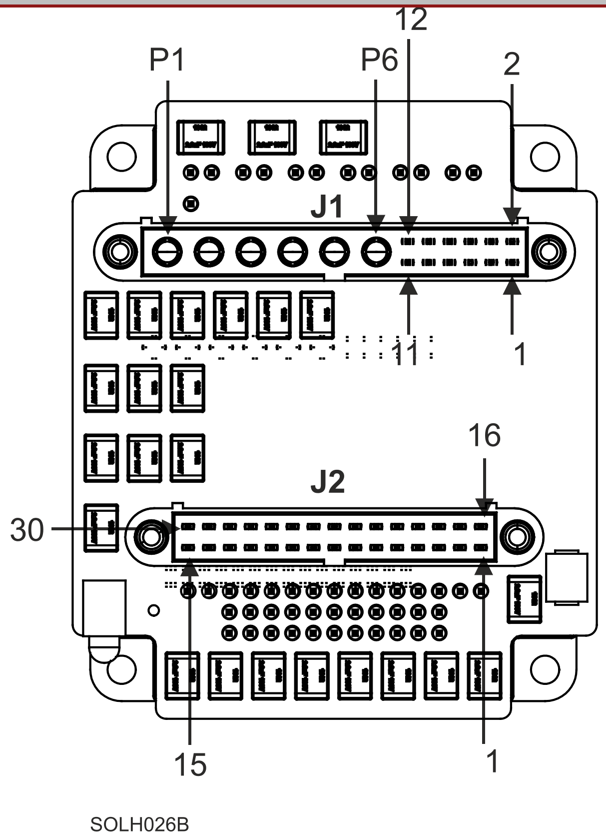


Figure 16: Differential Auxiliary (Incremental) Encoder Input Option Diagram

4.8.5. Auxiliary Feedback: Differential Pulse-and-Direction Input Option (YA[4]=0)

Pin (J2)	Signal	Function
3	PE	Protective Earth
24	COMRET	Common Return
5	CHA	Auxiliary Pulse *input*
4	CHA-	Auxiliary Pulse complement *input*
19	CHB	Auxiliary Direction *input*
20	CHB-	Auxiliary Direction complement *input*
8	INDEX	NA
9	INDEX-	NA

Pin Positions



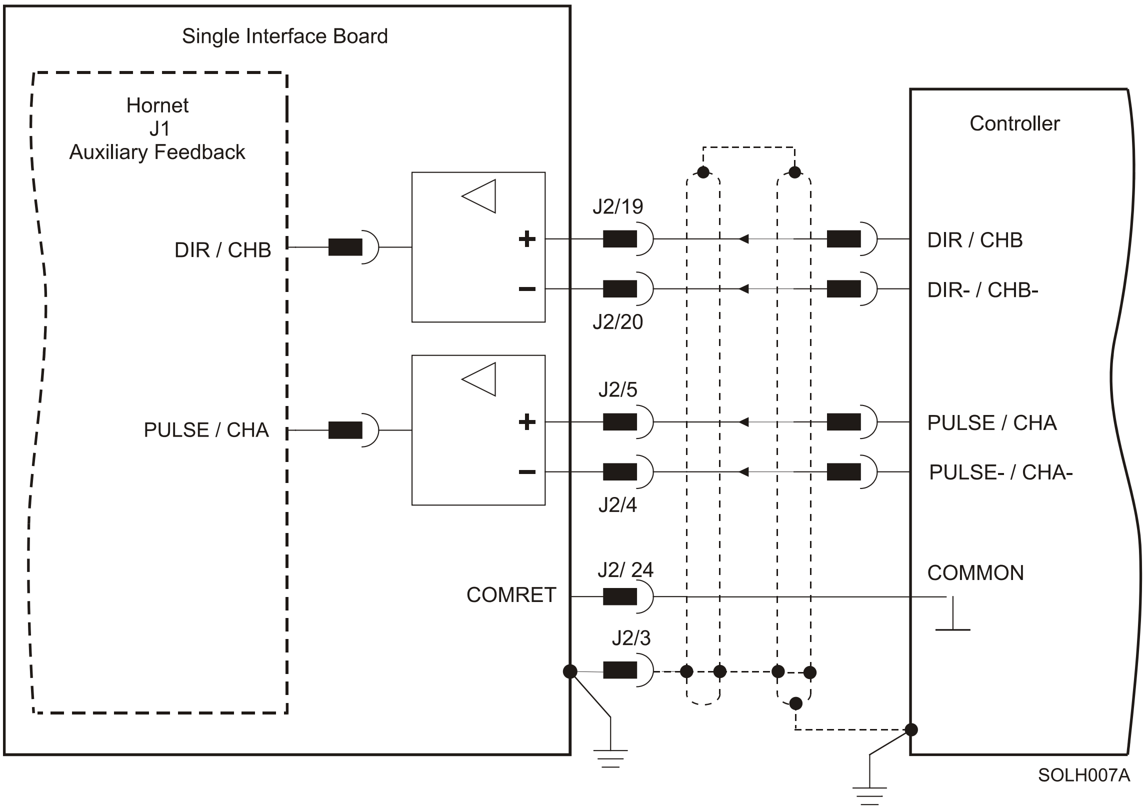


Figure 17: Pulse-and-Direction Diagram

4.9. I/Os

The Solo Hornet has four digital inputs, two digital outputs and one analog input.

4.9.1. Digital Input (J2)

The digital input level signal can be 5 V (TTL).

Pin (J2)	Signal	Function
14	IN1	Programmable input 1 (general purpose, RLS, FLS, INH)
15	IN2	Programmable input 2 (general purpose, RLS, FLS, INH)
16	IN3	Programmable input 3 (general purpose, RLS, FLS, INH)
17	IN4	Programmable input 4 (general purpose, RLS, FLS, INH)
18	IN5	Hi-Speed Programmable input 5 (event capture, Main Home, general purpose, RLS, FLS, INH)
6	IN6	Hi-Speed Programmable input 6 (event capture, Auxiliary Home, general purpose, RLS, FLS, INH)
7	INRET	Programmable input return
Pin Positions		

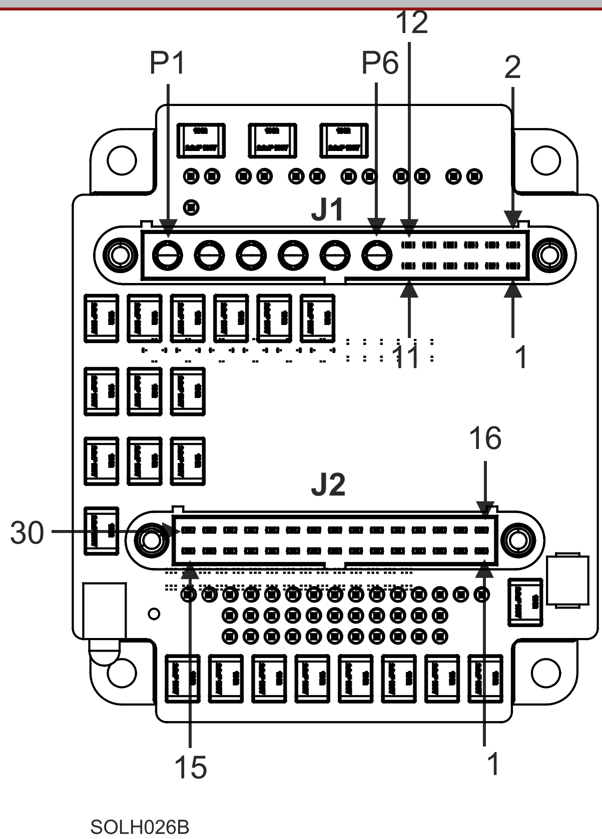


Table 3: Digital Input Pin Assignments

4.9.1.1. Digital Input 5 V (TTL)

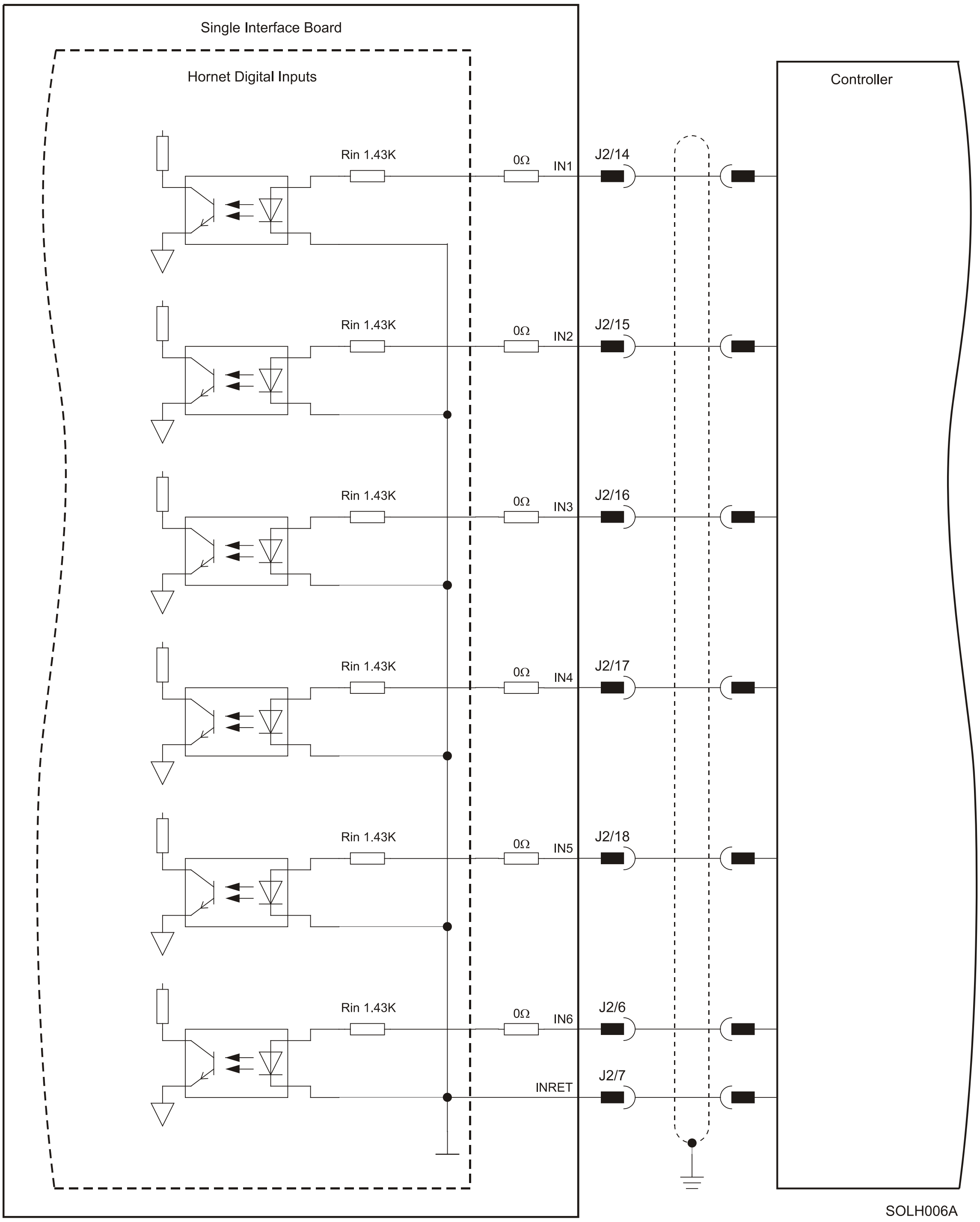


Figure 18: Digital Input 5 V Connection Diagram

4.9.1.2. Digital Input 24 V (PLC)

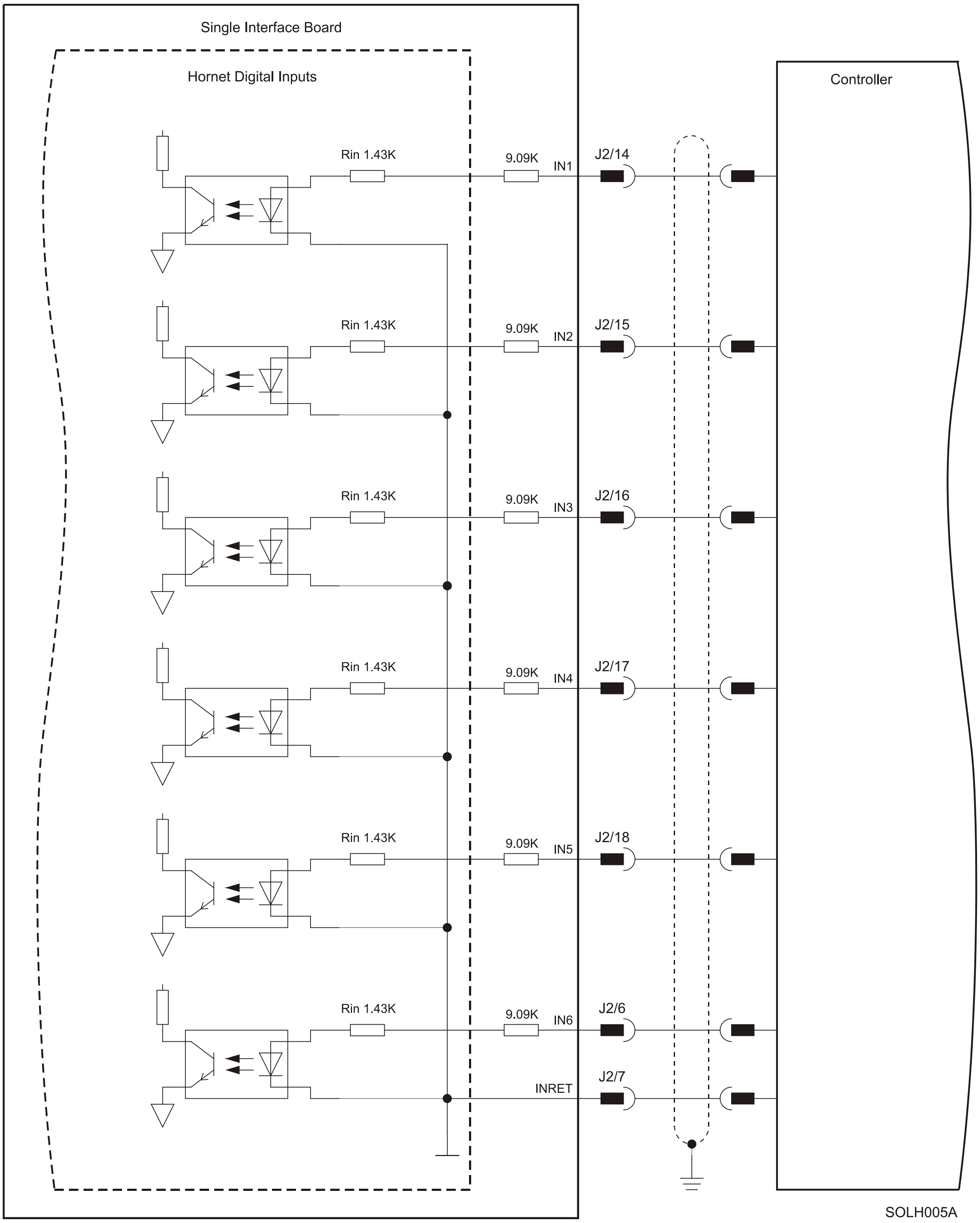


Figure 19: Digital Input 24 Connection Diagram

4.9.2. Digital Output

Pin (J2)	Signal	Function
10	OUT1	Programmable digital output 1
11	OUTRET1	Programmable digital output return 1
12	OUT2	Programmable digital output 2
13	OUTRET2	Programmable digital output return 2
Pin Positions		

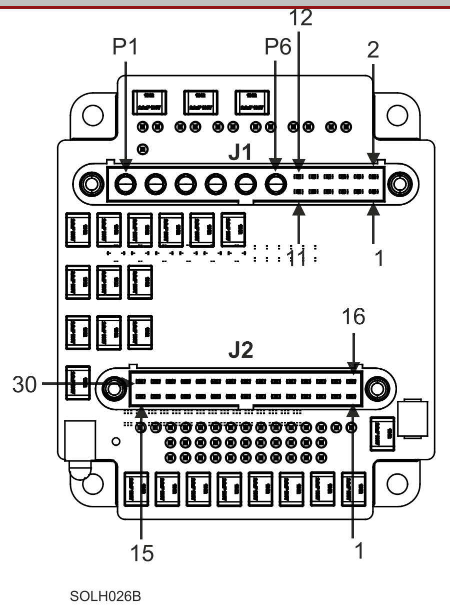


Table 4: Digital Output Pin Assignment

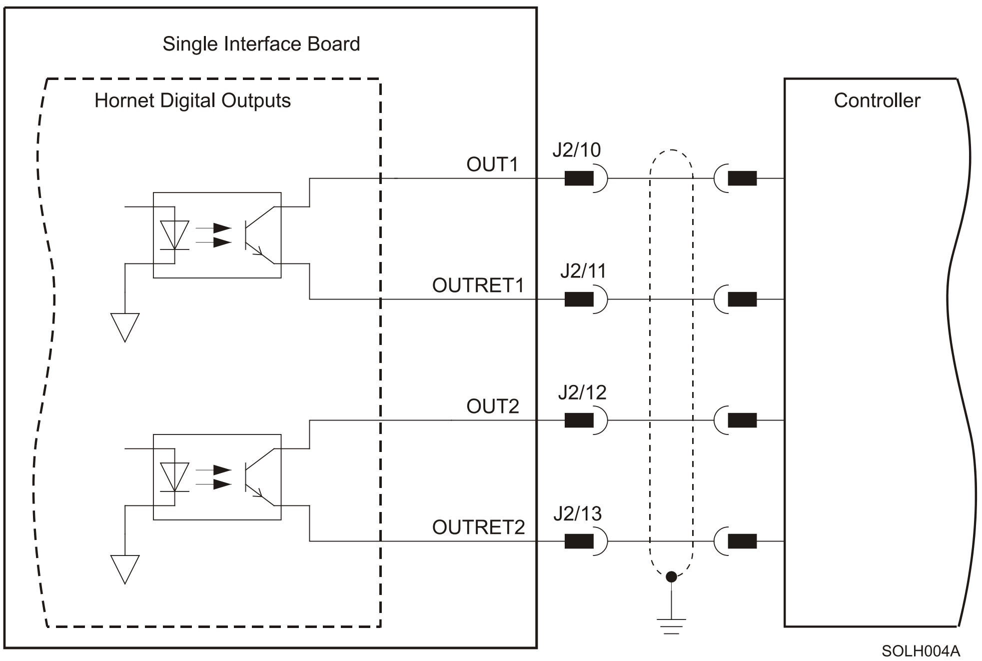


Figure 20: Digital Output Connection Diagram

4.9.3. Analog Input

Pin (J2)	Signal	Function
22	ANLIN1+	Analog input 1+
23	ANLIN1-	Analog input 1-
21	ANLRET	Analog return

Pin Positions

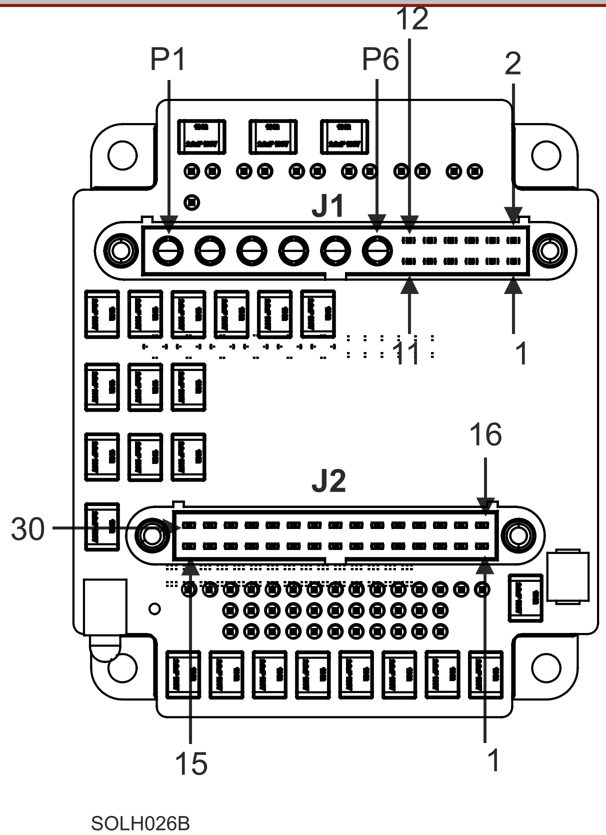


Table 5: Analog Input Pin Assignments

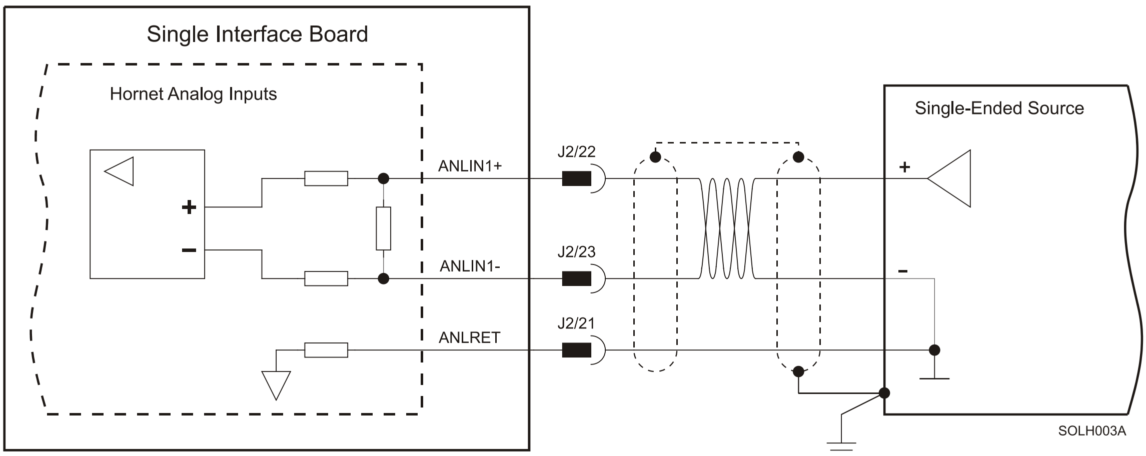


Figure 21: Analog Input with Single-Ended Source

4.10. Communications

The communication interface may differ according to the user's hardware. The Solo Hornet can communicate using the following options:

a. RS-232, full duplex

b. RS-422, Differential RS-232

c. CAN

RS-232 communication requires a standard, commercial 3-core null-modem cable connected from the Solo Hornet to a serial interface on the PC. The interface is selected and set up in the Composer software.

Differential RS-232 (RS-422)communication requires four wires connected from the Solo Hornet to a controller . The RS-232 interface is selected and set up in the Composer software.

In order to benefit from **CAN** communication, the user must have an understanding of the basic programming and timing issues of a CAN network.

For ease of setup and diagnostics of CAN communication, RS-232 and CAN can be used simultaneously.

4.10.1. RS-232 Communication (J2)

Notes for connecting the RS-232 communication cable:

- Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.
- The RS-232 communication port is **non-isolated**.

Pin (J2)	Signal	Function
28	RS232_Rx	RS-232 receive
27	RS232_Tx	RS-232 transmit
24	COMRET	Common Return
Pin Positions		

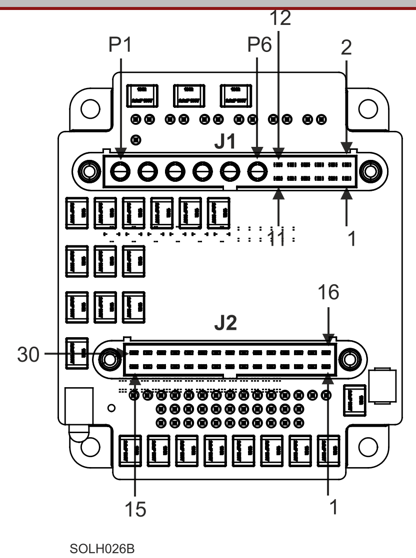


Table 6: RS-232 Pin Assignments

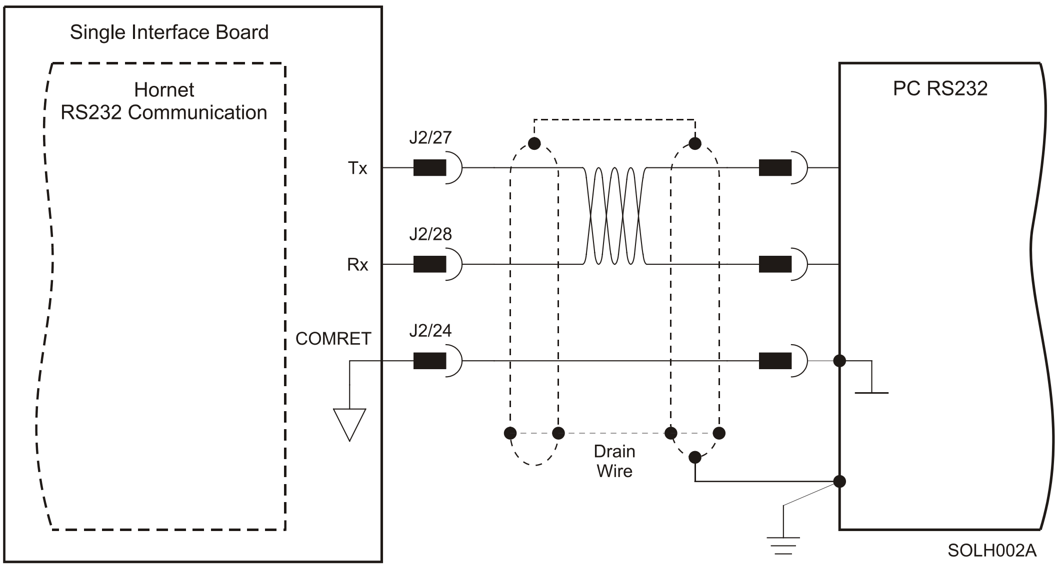


Figure 22: RS-232 Connection Diagram

4.10.2. Differential RS-232 Communication (RS-422) – J2

Note for connecting the RS-232 communication cable:

- This is Differential RS-232 Communication based on RS-422. Connect the shield to the ground of the Controller. Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.

Pin (J2)	Signal	Function
27	Differential RS422_Tx +	Differential RS-232/RS-422 Transmit +
28	Differential RS422_Tx -	Differential RS-233/RS-422 Transmit -
25	Differential RS422_Rx +	Differential RS-232/RS-422 Receive +
26	Differential RS422_Rx -	Differential RS-232/RS-422 Receive -
24	COMRET	Common Return

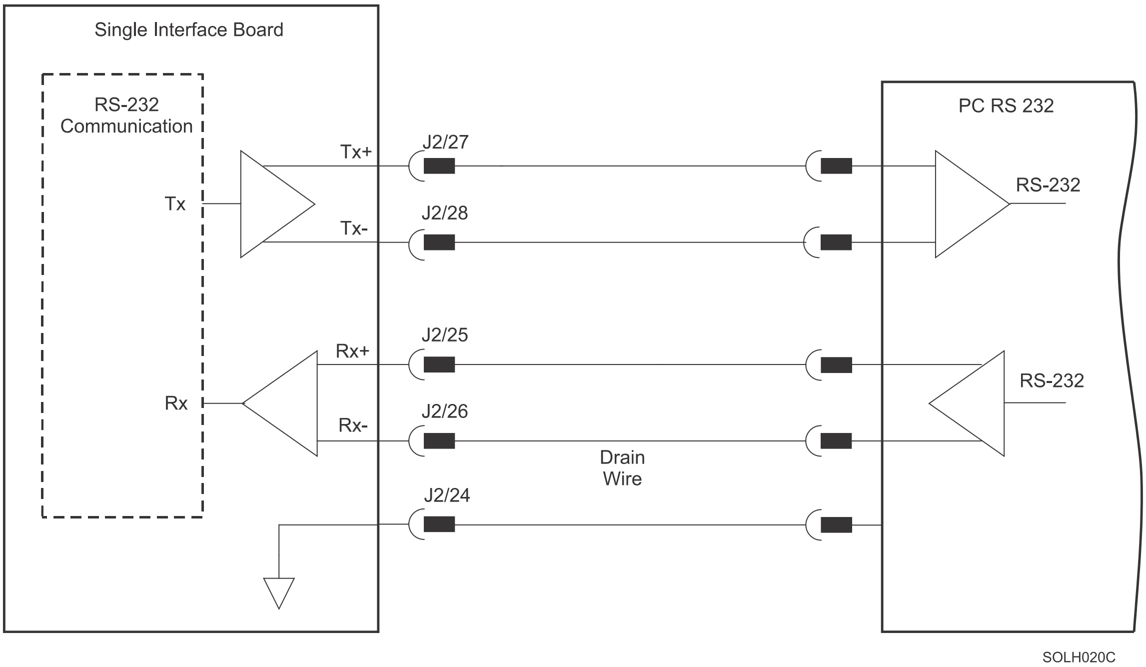


Figure 23: Differential RS-232 Communication

4.10.3. CAN Communication (J2)

Notes for connecting the CAN communication cable:

- Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.
- Make sure to have a 120-Ω resistor termination at each of the two ends of the network cable.
- The Solo Hornet's CAN ports are **non-isolated**.

Pin (J2)	Signal	Function
24	COM-RET	Common Return
29	CAN_L	CAN_L busline (dominant low)
30	CAN_H	CAN_H busline (dominant high)

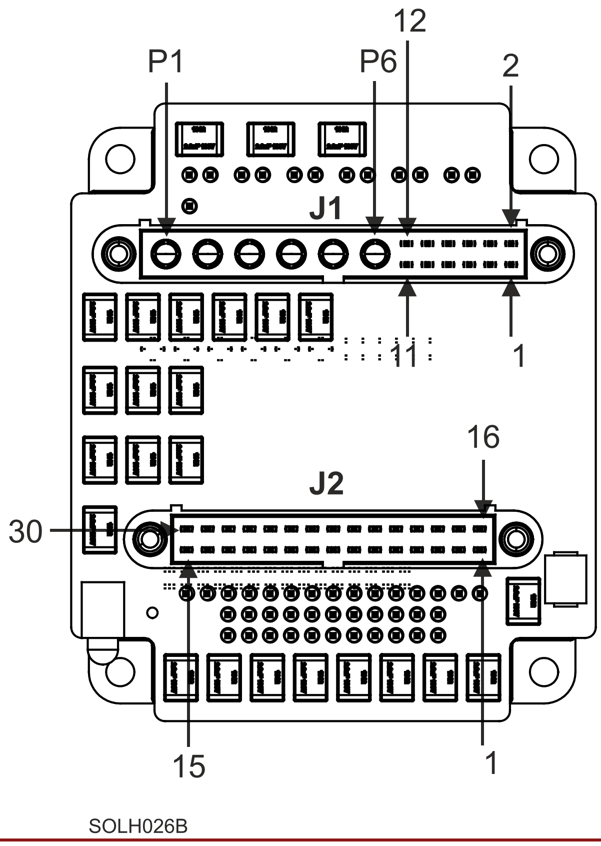


Table 7: CAN - Pin Assignments

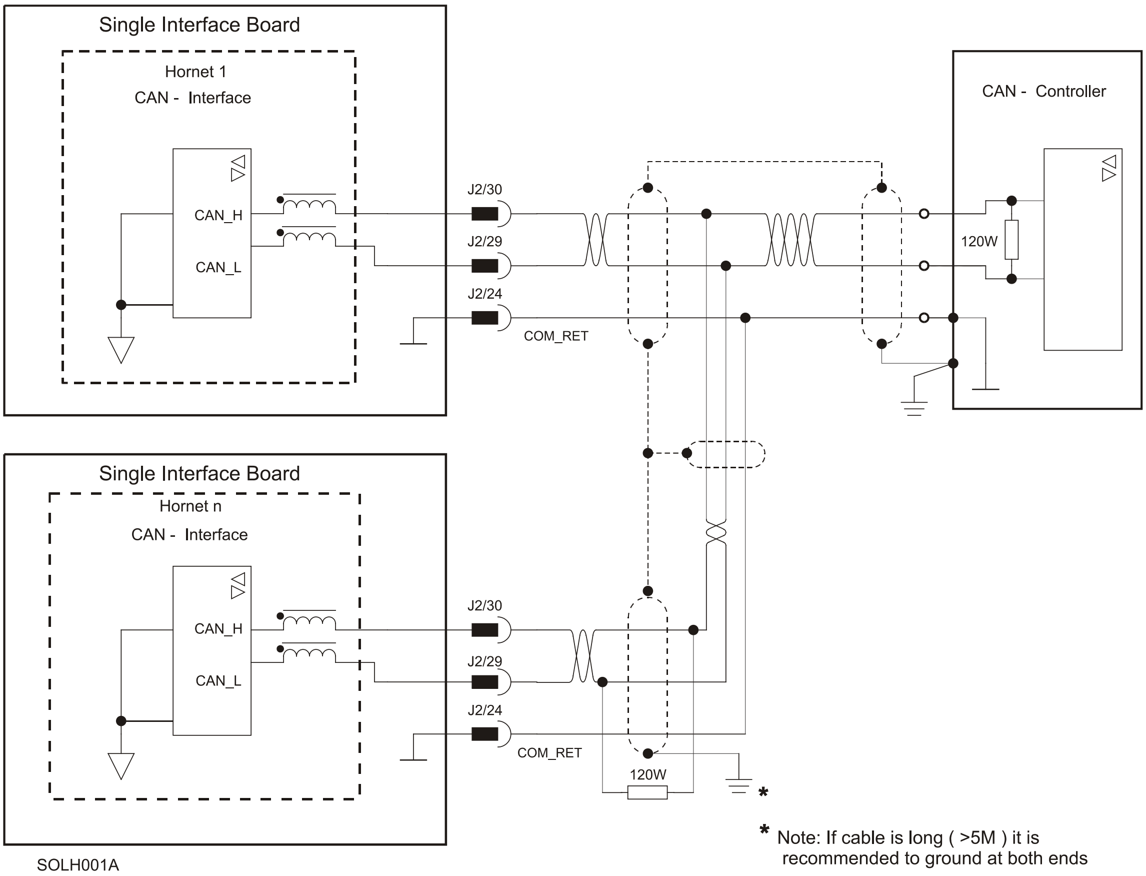


Figure 24: CAN Network Diagram

Caution: When installing CAN communication, ensure that each servo drive is allocated a unique ID. Otherwise, the CAN network may hang.

4.11. Powering Up

After the Solo Hornet is connected to its device, it is ready to be powered up.

Caution: Before applying power, ensure that the DC supply is within the specified range and that the proper plus-minus connections are in order.

4.12. Initializing the System

After the Solo Hornet has been connected and mounted, the system must be set up and initialized. This is accomplished using the *Composer*, Elmo's Windows-based software application. Install the application and then perform setup and initialization according to the directions in the *Composer Software Manual*.

4.13. Heat Dissipation

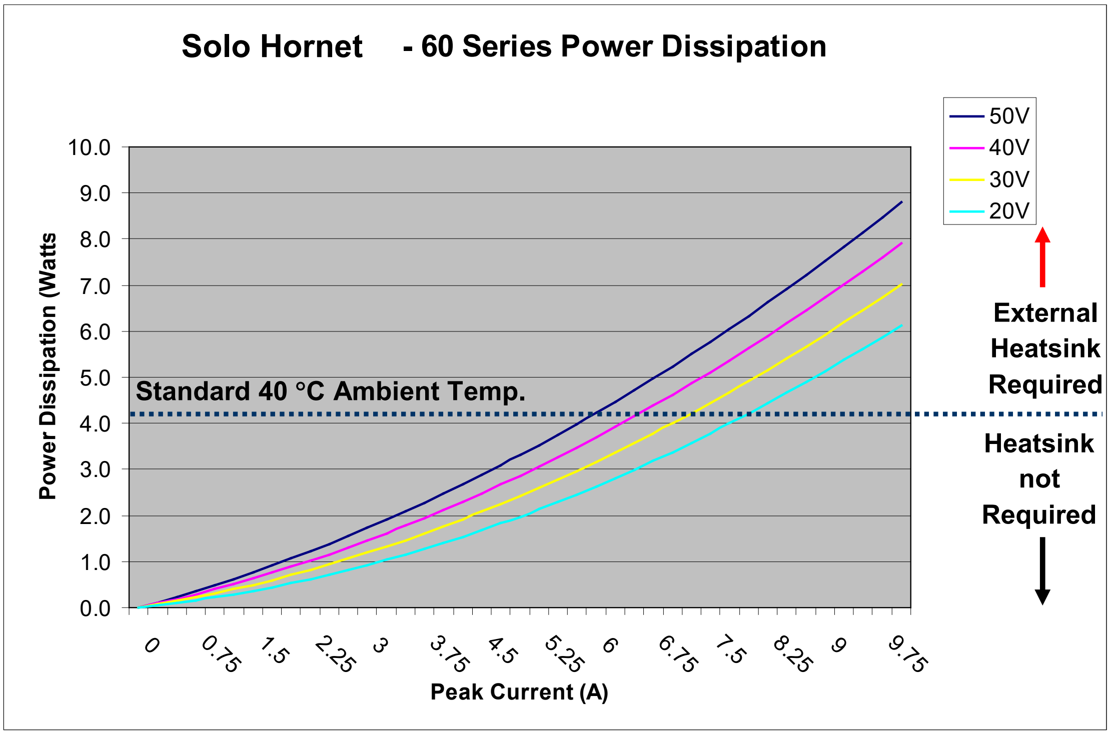
The best way to dissipate heat from the Solo Hornet is to mount it so that its heat sink faces up. For best results leave approximately 10 mm of space between the Solo Hornet's heat sink and any other assembly.

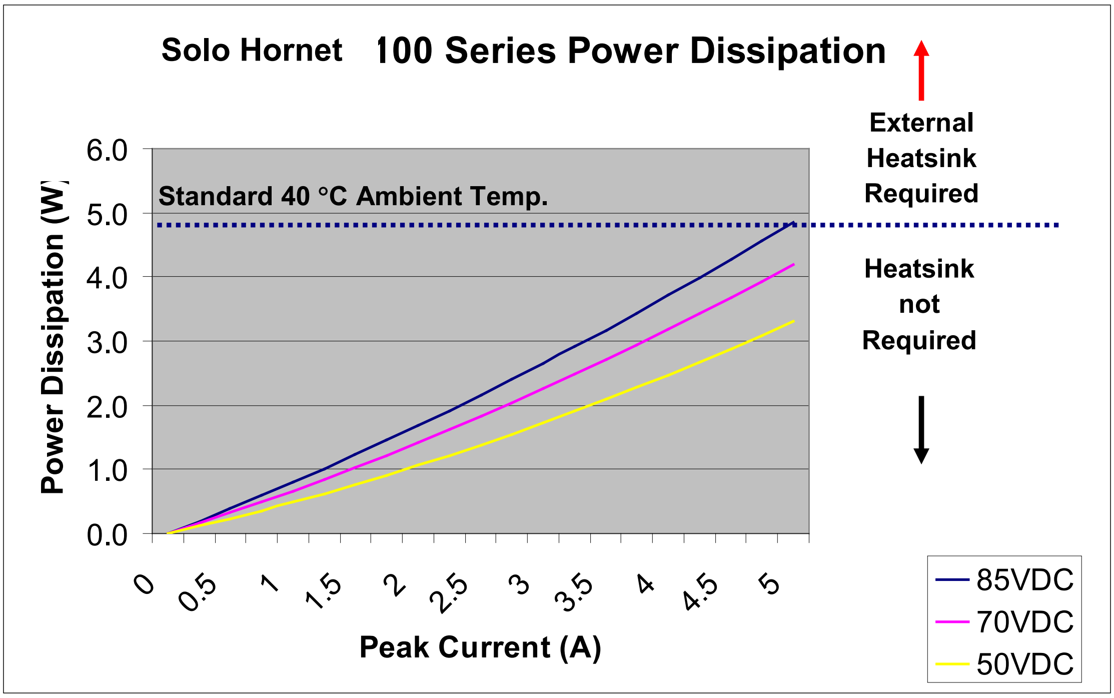
4.13.1. Solo Hornet Thermal Data

- Heat dissipation capability (θ): Approximately 10 °C/W.
- Thermal time constant: Approximately 240 seconds (thermal time constant means that the Solo Hornet will reach 2/3 of its final temperature after 4 minutes).
- Shut-off temperature: 86 °C to 88 °C (measured on the heat sink)

4.13.2. Heat Dissipation Data

Heat dissipation is shown in graphically below:





4.13.3. How to Use the Charts

The charts above are based upon theoretical worst-case conditions. Actual test results show 30% to 50% better power dissipation.

To determine if your application needs a heat sink:

1. Allow maximum heat sink temperature to be 80 °C or less.
2. Determine the ambient operating temperature of the Solo Hornet.
3. Calculate the allowable temperature increase as follows:
   - For an ambient temperature of 40 °C , ΔT= 80°C – 40 °C = 40 °C
4. Use the chart to find the actual dissipation power of the drive. Follow the voltage curve to the desired output current and then find the dissipated power.
5. If the dissipated power is below 4 W the Solo Hornet will need no additional cooling.

Note: The chart above shows that no heat sink is needed when the heat sink temperature is 80 °C, ambient temperature is 40 °C and heat dissipated is 4 Watts.

Chapter 5: Technical Specifications

This chapter provides detailed technical information regarding the Solo Hornet. This includes its dimensions, power ratings, the environmental conditions under which it can be used, the standards to which it complies and other specifications.

5.1. Features

The Solo Hornet's features determine how it controls motion, as well as how it processes host commands, feedback and other input.

5.1.1. Motion Control Modes

- Current/Torque - up to 14 kHz sampling rate
- Velocity - up to 7 kHz sampling rate
- Position - up to 3.5 kHz sampling rate

5.1.2. Advanced Positioning Control Modes

- PTP, PT, PVT, ECAM, Follower, Dual Loop, Current Follower
- Fast event capturing inputs
- Fast output compare (OC)
- Motion Commands: Analog current and velocity, pulse-width modulation (PWM) current and velocity

5.1.3. Advanced Filters and Gain Scheduling

- “On-the-fly” gain scheduling of current and velocity
- Velocity and position with “1-2-4” PIP controllers
- Automatic commutation alignment
- Automatic motor phase sequencing

5.1.4. Fully Programmable

- Third generation programming structure with motion commands – “Composer”
- Event capturing interrupts
- Event triggered programming

5.1.5. Feedback Options

- Incremental Encoder – up to 20 Mega-Counts (5 Mega-Pulse) per second
- Digital Halls – up to 2 kHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Mega-Counts per second for encoder
- Interpolated Analog (Sine/Cosine) Encoder – up to 250 kHz (analog signal)
  - Internal Interpolation - up to x4096
  - Automatic Correction of amplitude mismatch, phase mismatch, signal offset
  - Emulated encoder outputs
- Analog Hall Sensor
- Resolver
  - Programmable 10 to 15 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Emulated encoder outputs
- Tachometer & Potentiometer
- Provide power (5 V, 200 mA max) for one Encoder, Resolver or Hall.

5.1.6. Input/Output

- One **Analog Input** – up to 14-bit resolution
- Six programmable **Digital Inputs**, optically isolated (two of which are fast event capture inputs).
  - Inhibit/Enable motion
  - Software and analog reference stop
  - Motion limit switches
  - Begin on input
  - Abort motion
  - Homing
  - General-purpose
- Two programmable **Digital Outputs**, optically isolated (open collector) one with fast output compare (OC)
  - Brake Control
  - Amplifier fault indication
  - General-purpose
  - Servo enable indication
- PWM current command output for torque and velocity

5.1.7. Built-In Protection

- Software error handling
- Abort (hard stops and soft stops)
- Status reporting
- Protection against:
  - Shorts between motor power outputs
  - Shorts between motor power output and power input/return
  - Failure of internal power supplies
  - Over temperature
  - Continuous temperature measurement; temperature can be read on the fly; warning can be initiated x degrees before temp disable is activated.
  - Over/Under voltage
  - Loss of feedback
  - Following error
  - Current limits

5.1.8. Accessories

- Heat sinks

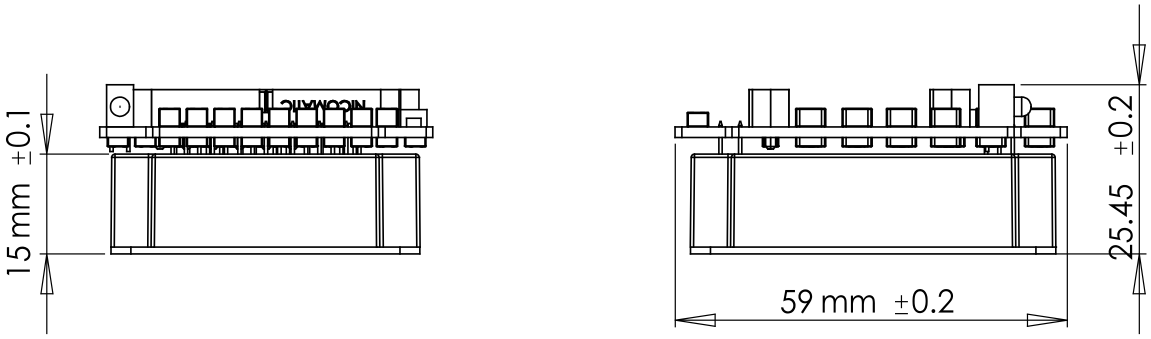
5.1.9. Status Indication

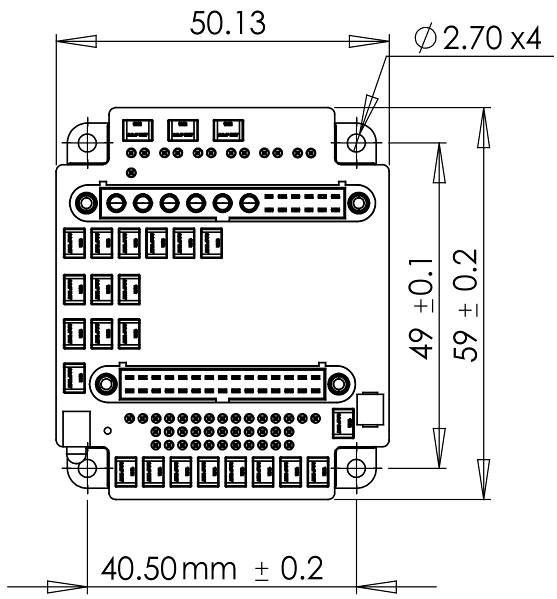
- Output for a bi-color LED

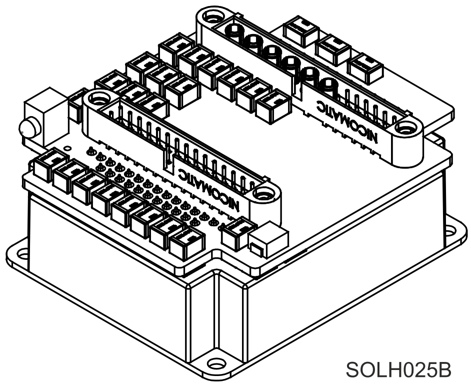
5.1.10. Automatic Procedures

- Commutation alignment
- Phase sequencing
- Current loop offset adjustment
- Current loop gain tuning
- Current gain scheduling
- Velocity loop offset adjustment
- Velocity gain tuning
- Velocity gain scheduling
- Position gain tuning

5.2. Solo Hornet Dimensions







5.3. Environmental Conditions

Feature	Operation Conditions	Range
Ambient Temperature Range	Non-operating conditions	-50 °C to +100 °C (-58 °F to 212 °F)
	Operating conditions	-40 °C to +70 °C (-40 °F to 160 °F)
Temperature Shock	Non-operating conditions	-40 °C to +70 °C (-40 °F to 160 °F) within 3 min.
Altitude	Non-operating conditions	Unlimited
	Operating conditions	-400 m to 12,000 m (-1312 to 39370 feet)
Maximum Humidity	Non-operating conditions	Up to 95% relative humidity non-condensing at 35 °C (95 °F)
	Operating conditions	Up to 95% relative humidity non-condensing at 25 °C (77 °F), up to 90% relative humidity non-condensing at 42 °C (108 °F)
Vibration	Operating conditions	20 Hz to 2,000 Hz, 14.6 GRMS
Mechanical Shock	Non-operating conditions	±40g; Half sine, 11 msec
	Operating conditions	±20g; Half sine, 11 msec

5.4. Control Specifications

5.4.1. Current Loop

Feature	Details
Controller type	Vector, digital
Compensation for bus voltage variations	"On-the-fly" automatic gain scheduling
Motor types	• AC brushless (sinusoidal) • DC brushless (trapezoidal) • DC brush • Linear motors • "Voice" coils
Current control	• Fully digital • Sinusoidal with vector control • Programmable PI control filter based on a pair of PI controls of AC current signals and constant power at high speed
Current loop bandwidth	< 2.5 kHz
Current loop sampling time	Programmable 70 to 120 μsec
Current sampling rate	Up to 6 kHz; default 11 kHz

5.4.2. Velocity Loop

Feature	Details
Controller type	PI
Velocity control	• Fully digital • Programmable PI and FFW control filters • "On-the-fly" gain scheduling • Automatic, manual and advanced manual tuning
Velocity and position feedback options	• Incremental Encoder • Digital Halls • Interpolated Analog (Sine/Cosine) Encoder (optional) • Resolver (optional) • Tachometer and Potentiometer (optional) **Note:** With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).
Velocity loop bandwidth	<350 Hz
Velocity loop sampling time	140 to 240 μsec (2x current loop sample time)
Velocity loop sampling rate	Up to 8 kHz; default 5.5 kHz
Velocity command options	• Analog • Internally calculated by either jogging or step **Note:** All software-calculated profiles support on-the-fly changes.

5.4.3. Position Loop

Feature	Details
Controller type	"1-2-4" PIP
Position command options	• Software • Pulse and Direction • Analog Potentiometer
Position loop bandwidth	<80 Hz
Position loop sampling time	280 to 480 μsec (4x current loop sample time)
Position loop sampling rate	Up to 4 kHz; default 2.75 kHz

5.5. Feedbacks

5.5.1. Feedback Supply Voltage

The Solo Hornet has two feedback ports (Main and Auxiliary). The drive supplies voltage to the main feedback device only.

Feature	Details
Main encoder supply voltage	5 V ±5% @ 200 mA maximum

5.5.2. Main Feedback Options

The Solo Hornet can receive and process feedback input from diverse types of devices.

5.5.2.1. Incremental Encoder Input

Feature	Details
Encoder format	• A, B and Index • Differential • Quadrature
Interface	RS-422
Input resistance	Differential: 120 Ω (TBD)
Maximum incremental encoder frequency	Maximum absolute: 5 MHz pulses
Minimum quadrature input period (P_{IN})	112 nsec
Minimum quadrature input high/low period (P_{HL})	56 nsec
Minimum quadrature phase period (P_{PH})	28 nsec
Maximum encoder input voltage range	Common mode: ±7 V Differential mode: ±7 V

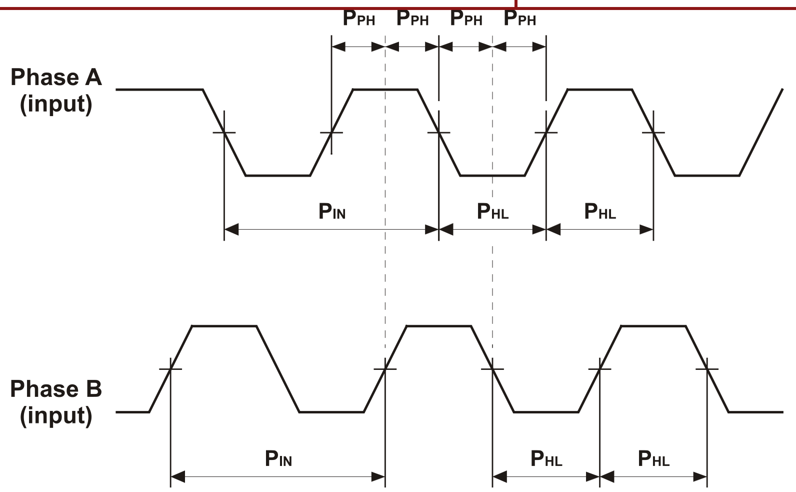


Figure 25: Main Feedback - Encoder Phase Diagram

5.5.2.2. Digital Halls

Feature	Details
Halls inputs	• H_A, H_B, H_C. • Single ended inputs • Built in hysteresis of 1 V for noise immunity
Input voltage	Nominal operating range: 0 V < V_{In_Hall} < 5 V Maximum absolute: -1 V < V_{In_Hall} < 15 V High level input voltage: V_{InHigh} > 2.5 V Low level input voltage: V_{InLow} < 1 V
Input current	Sink current (when input pulled to the common): 3 mA Source current: 1.5 mA (designed to also support open collector Halls)
Maximum frequency	f_{MAX} : 2 kHz

5.5.2.3. Interpolated Analog (Sine/Cosine) Encoder

Feature	Details
Analog encoder format	Sine and Cosine signals
Analog input signal level	• Offset voltage: 2.2 V to 2.8 V • Differential, 1 V peak to peak
Input resistance	Differential 120 Ω
Maximum analog signal frequency	f_{MAX} : 250 kHz
Interpolation multipliers	Programmable: x4 to x4096
Maximum “counts” frequency	80 mega-counts/sec “internally”
Automatic errors correction	Signal amplitudes mismatch Signal phase shift Signal offsets
Encoder outputs	See Auxiliary Encoder Outputs specifications (5.5.3)

5.5.2.4. Resolver

Feature	Details
Resolver format	• Sine/Cosine • Differential
Input resistance	Differential 2.49 kΩ
Resolution	Programmable: 10 to 15 bits
Maximum electrical frequency (RPS)	512 revolutions/sec
Resolver transfer ratio	0.5
Reference frequency	1/Ts (Ts = sample time in seconds)
Reference voltage	Supplied by the Solo Hornet
Reference current	Up to ±50 mA
Encoder outputs	See Auxiliary Encoder Output specifications (5.5.3)

5.5.2.5. Tachometer*

Feature	Details
Tachometer format	Differential
Maximum operating differential voltage for TAC1+, TAC1-	±20 V
Maximum absolute differential input voltage for TAC1+, TAC1-	±25 V
Maximum operating differential voltage for TAC2+, TAC2-	±50 V
Maximum absolute differential input voltage for TAC2+, TAC2-	±60 V
Input resistance for TAC1+, TAC1-	46 kΩ
Input resistance for TAC2+, TAC2-	100 kΩ
Resolution	14 bit

***** Only one Tachometer port can be used at a time (either TAC1+/TAC1- or TAC2+/TAC2-).
TAC1+/TAC1- is used in applications with having a Tachometer of less than 20 V.
TAC2+/TAC2- is used in applications with having a Tachometer of between 20 V and 50 V.

5.5.2.6. Potentiometer

Feature	Details
Potentiometer Format	Single-ended
Operating Voltage Range	0 to 5 V supplied by the Solo Hornet
Potentiometer Resistance	100 Ω to 1 kΩ above this range, linearity is affected detrimentally
Input Resistance	100 kΩ
Resolution	14 bit

5.5.3. Auxiliary Feedback Port (output mode YA[4]= 4)

Feature	Details
Encoder output and main buffered output	• A, B, Index • Differential outputs • Quadrature
Interface	RS-422
Output current capability	Driving differential loads of 200 Ω on INDEX/INDEX-, CHB/CHB- and CHA/CHA- pairs
Available as options	• Simultaneous buffered outputs of main-incremental encoder input • Simultaneous emulated encoder outputs of analog encoder input • Simultaneous emulated encoder outputs of resolver input
Maximum frequency	f_{MAX} : 5 MHz pulses/output
Index (marker)	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

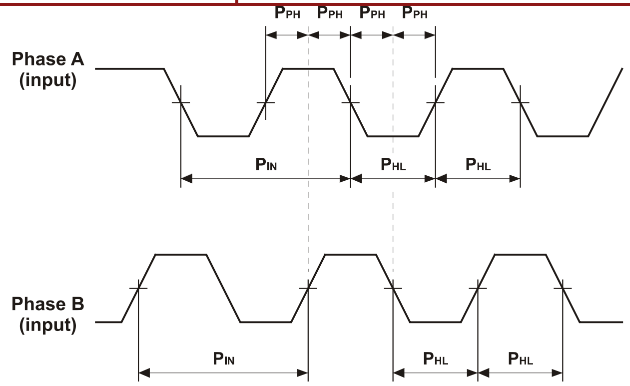


Figure 26: Auxiliary Feedback - Encoder Phase Diagram

5.5.4. Auxiliary Feedback Port (input mode YA[4]= 2, 0)

Feature	Details
Encoder input, pulse and direction input	• A, B, Index • Differential
Input voltage	V_{in} Low: 0 V < V_{IL} < 0.8 V V_{in} High: 2 V < V_{IH} < 5 V Maximum absolute voltage: 0 < V_{in} < 5.5 V Input current: ±1 μA
Available as options	• Differential Buffered Encoder inputs • Differential Buffered Pulse and Direction inputs
Edge separation between A & B	Programmable number of clocks to allow adequate noise filtering at remote receiver of emulated encoder signals
Index (marker):	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

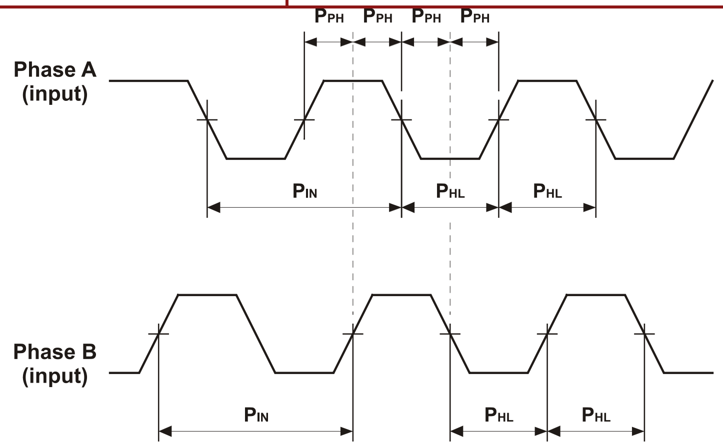


Figure 27: Auxiliary Feedback - Encoder Phase Diagram

5.6. I/Os

The Solo Hornet has:

- 4 Digital Inputs
- 2 Digital Outputs
- 1 Analog Input

5.6.1. Digital Input Interfaces

Feature	Details
Type of input	• Optically isolated • All four inputs share one signal return line
Input current for 5 V DI level	R_{in}=1.43K, I_{in} = 2.8 mA @ V_{in} = 5 V
Input current for 24 V DI level	R_{in}=10.52k, I_{in} = 2.2 mA @ V_{in} = 24 V
High-level input voltage	5 V < V_{in} < 24 V
Low-level input voltage	0 V < V_{in} < 1 V
Minimum pulse width	> 4 x TS, where TS is sampling time
Execution time (all inputs): the time from application of voltage on input until execution is complete	If input is set to one of the built-in functions — Home, Inhibit, Hard Stop, Soft Stop, Hard and Soft Stop, Forward Limit, Reverse Limit or Begin — execution is immediate upon detection: 0<T<4xTS If input is set to General input, execution depends on program. Typical execution time: ≅ 0.5 msec.
High-speed inputs – 5 & 6 minimum pulse width, in high-speed mode	T < 5 μsec **Notes:** • Home mode is high-speed mode and can be used for fast capture and precise homing. • High speed input has a digital filter set to same value as digital filter (EF) of main encoder. • Highest speed is achieved when turning on optocouplers.

Feature	Details

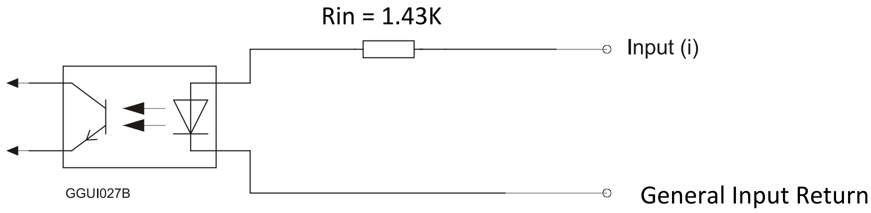


Figure 28: Digital Input Schematic

5.6.2. Digital Output Interface

Feature	Details
Type of output	• Optically isolated • Open collector and open emitter
Maximum supply output (VCC)	30 V
Max. output current I_{out} (max) (V_{out} = Low)	I_{out} (max) ≤ 10 mA
VOL at maximum output voltage (low level)	V_{out} (on) ≤ 0.3 V
R_L	The external resistor R_L must be selected to limit the output current to no more than 10 mA. $R_L = \frac{VCC - VOL}{I_{out}(max)}$
Executable time	If output is set to one of the built-in functions -Home flag, Brake or AOK — execution is immediate upon detection: 0 < T < 4 x TS If output is set to General output and is executed from a program, the typical time is approximately 0.5 msec.

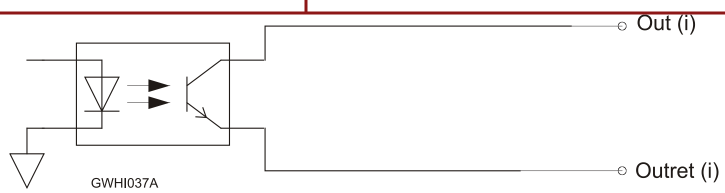


Figure 29: Digital Output Schematic

5.6.3. Analog Input

Feature	Details
Maximum operating differential voltage	± 10 V
Maximum absolute differential input voltage	± 16 V
Differential input resistance	3.74 kΩ
Analog input command resolution	14-bit

5.7. Communications

Specification	Details
RS-232	**Signals:** • RxD , TxD , GND • Full duplex, serial communication for setup and control. • Baud Rate of 9,600 to 57,600 bit/sec.
Differential RS-232 **(RS-422)**	**Signals:** • RxD , TxD , GND • Full duplex, serial communication for setup and control. • Baud Rate of 9,600 to 57,600 bit/sec.
CAN	**CAN bus Signals:** • CAN_H, CAN_L, CAN_GND • Maximum Baud Rate of 1 Mbit/sec. **Version:** • DS 301 V4.01 **Layer Setting Service and Protocol Support:** • DS 305 **Device Profile** (drive and motion control)**:** • DS 402

5.8. Pulse-Width Modulation (PWM)

Feature	Details
PWM resolution	12-bit
PWM switching frequency on the load	2/Ts (factory default 22 kHz on the motor)

5.9. Compliance with Standards

Specification	Details
Quality Assurance	
ISO 9001:2008	Quality Management
Design	
Approved **IEC/EN 61800-5-1, Safety**	Printed wiring for electronic equipment (clearance, creepage, spacing, conductors sizing, etc.)
MIL-HDBK- 217F	Reliability prediction of electronic equipment (rating, de-rating, stress, etc.)
• **UL 60950** • **IPC-D-275** • **IPC-SM-782** • **IPC-CM-770** • **UL 508C** • **UL 840**	Printed wiring for electronic equipment (clearance, creepage, spacing, conductors sizing, etc.)
In compliance with **VDE0160-7 (IEC 68)**	Type testing
Safety	
Recognized **UL 508C**	Power Conversion Equipment
In compliance with **UL 840**	Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
In compliance with **UL 60950**	Safety of Information Technology Equipment Including Electrical Business Equipment
Approved **IEC/EN 61800-5-1, Safety**	Adjustable speed electrical power drive systems
In compliance with **EN 60204-1**	Low Voltage Directive 73/23/EEC

Specification	Details
EMC	
Approved **IEC/EN 61800-3, EMC**	Adjustable speed electrical power drive systems
In compliance with **EN 55011** Class A with **EN 61000-6-2**: Immunity for industrial environment, according to: **IEC 61000-4-2** / criteria B **IEC 61000-4-3** / criteria A **IEC 61000-4-4** / criteria B **IEC 61000-4-5** / criteria B **IEC 61000-4-6** / criteria A **IEC 61000-4-8** / criteria A **IEC 61000-4-11** / criteria B/C	Electromagnetic compatibility (EMC)
Workmanship	
In compliance with **IPC-A-610**, level 3	Acceptability of electronic assemblies
PCB	
In compliance with **IPC-A-600**, level 2	Acceptability of printed circuit boards
Packing	
In compliance with **EN 100015**	Protection of electrostatic sensitive devices
Environmental	
In compliance with **2002/96/EC**	Waste Electrical and Electronic Equipment regulations (WEEE) **Note:** Out-of-service Elmo drives should be sent to the nearest Elmo sales office.
In compliance with **2002/95/EC** (effective July 2006)	Restrictions on Application of Hazardous Substances in Electric and Electronic Equipment (RoHS)