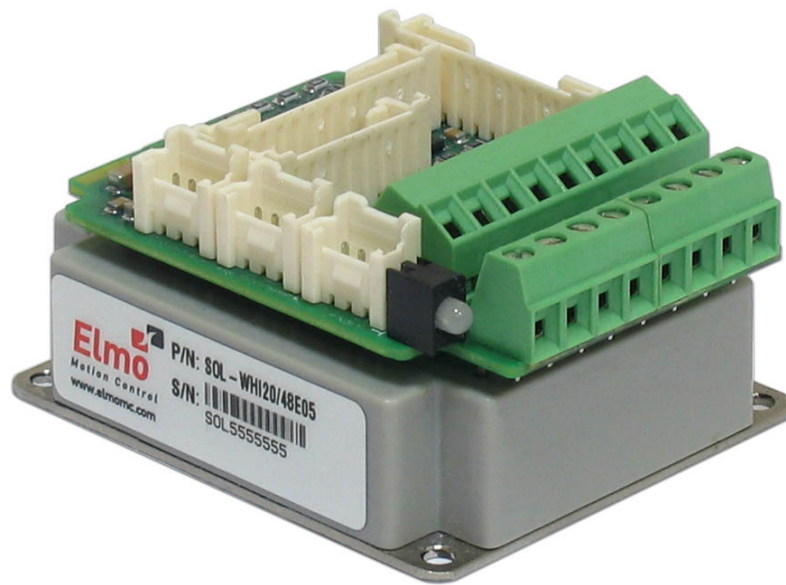

Solo Whistle Digital Servo Drive Installation Guide



February 2009 (Ver. 1.2)



www.elmomc.com

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Solo Whistle Catalog Numbers:	SOL-WHI A15/100R01	
	Whistle+ Interface Board Whistle [] - Standard A - Advanced Current & Voltage Feedbacks E - Std incremental Encoder + Halls R - Resolver I - Interpolated Analog Encoder Sin/Cos T - Tacho / Potentiometer	01 - 24 VDC (Digital Inputs), Motor Phase Connector, Network Position + Velocity (CANOpen) 02 - 24 VDC (Digital Inputs), Motor Phase Wires, Network Position + Velocity (CANOpen) 03 - 5 VDC (Digital Inputs), Motor Phase Connector, Network Position + Velocity (CANOpen) 04 - 5 VDC (Digital Inputs), Motor Phase Wires, Network Position + Velocity (CANOpen) 05 - 24 VDC (Digital Inputs), Motor Phase Connector, Follower, ECAM, Pulse and Direction 06 - 24 VDC (Digital Inputs), Motor Phase Wires, Follower, ECAM, Pulse and Direction 07 - 5 VDC (Digital Inputs), Motor Phase Connector, Follower, ECAM, Pulse and Direction 08 - 5 VDC (Digital Inputs), Motor Phase Wires, Follower, ECAM, Pulse and Direction

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Ver. 1.2	February 2009	MTCR 01-009-39: Section 3.7.1: Advanced not mandatory therefore in Mode 1 catalog number, "A" was removed.

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Chapter 1: Safety Information

In order to achieve the optimum, safe operation of the Solo Whistle 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 Whistle 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 Whistle 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.
	Note: This is auxiliary information that ensures the correct operation of the equipment.

1.1 Warnings

	Cleaning after soldering To avoid damage to the product's acrylic coating, the Solo Whistle drive must not be cleaned after soldering with soluble solvents or water-based cleaners. For further details see: www.elmomc.com/applications/article/Soldering-and-Cleaning_Application-Note.pdf
	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 Whistle from all voltage sources before it is opened for servicing.
	The Solo Whistle 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 Whistle 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 Whistle to an approved 12~95 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 Whistle, verify that all safety precautions have been observed and that the installation procedures in this manual have been followed.

1.3 Directives and Standards

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

Safety Standard	Item
In compliance with UL508c	Power Conversion Equipment
In compliance with UL840	Insulation Coordination, Including Clearance and Creepage Distances of Electrical Equipment
In compliance with UL60950-1 (formerly UL1950)	Safety of Information Technology Equipment, Including Electrical Business Equipment
In compliance with EN60204-1	Low Voltage Directive, 73/23/EEC

The Solo Whistle 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 Mark Conformance

The Solo Whistle 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 EN60204-1 and EN292-2 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 Whistle drive meets the provisions outlined in Council Directive 73/23/EEC. The party responsible for ensuring that the equipment meet 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 time of installation, or 18 months from time of shipment, whichever comes first. 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 is an integrated solution designed to simply and efficiently connect Elmo's Whistle servo drive directly to the application. The solution consists of the Whistle 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 Whistle 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 Whistle series of digital servo drives is designed to deliver "the highest density of power and intelligence". The Solo Whistle is a lightweight and highly compact solution which can be used whenever reduced size and weight are essential to the application. The Solo Whistle delivers up to **1600 W of continuous power** or **3200 W of peak power** in a 77.19cc/4.55 in³ (58.25 x 28.5 x 46.5 mm or 2.3" x 1.1" x 1.8") package.

The Solo Whistle 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 Whistle 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 Whistle, as part of the *SimplIQ* product line, is fully programmable with Elmo's *Metronome* motion control language.

Power to the drive is provided by a 12 ~ 95 VDC isolated DC power source (not included with the Solo Whistle). A "smart" control-supply algorithm enables the Solo Whistle to operate with only one power supply with no need for an auxiliary power supply for the logic.

If back-up functionality is required for storing control parameters in case of power-loss, an external 12 ~ 95 VDC isolated supply should be connected (via the +VL terminal on the Solo Whistle) providing maximum flexibility and backup functionality when needed.

Note: This back-up functionality can operate from any voltage source within the 12 ~ 95 VDC range. This is much more flexible than to be restricted by only using a standard 24VDC power supply.

If back-up power is not needed, 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 Whistle 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 and CANopen 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 and CANopen 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 Whistle users can use two communication options:

- RS-232 serial communication
- CANopen 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)
 - o Internal Interpolation - up to x4096
 - o Automatic Correction of amplitude mismatch, phase mismatch, signals offset
 - o Emulated encoder outputs
- Resolver
 - o Programmable 10~15 bit resolution
 - o Up to 512 revolutions per second (RPS)
 - o Emulated encoder outputs
- Tachometer, Potentiometer
- Elmo drives provide supply voltage for all the feedback options

2.2.7 Fault Protection

The Solo Whistle 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

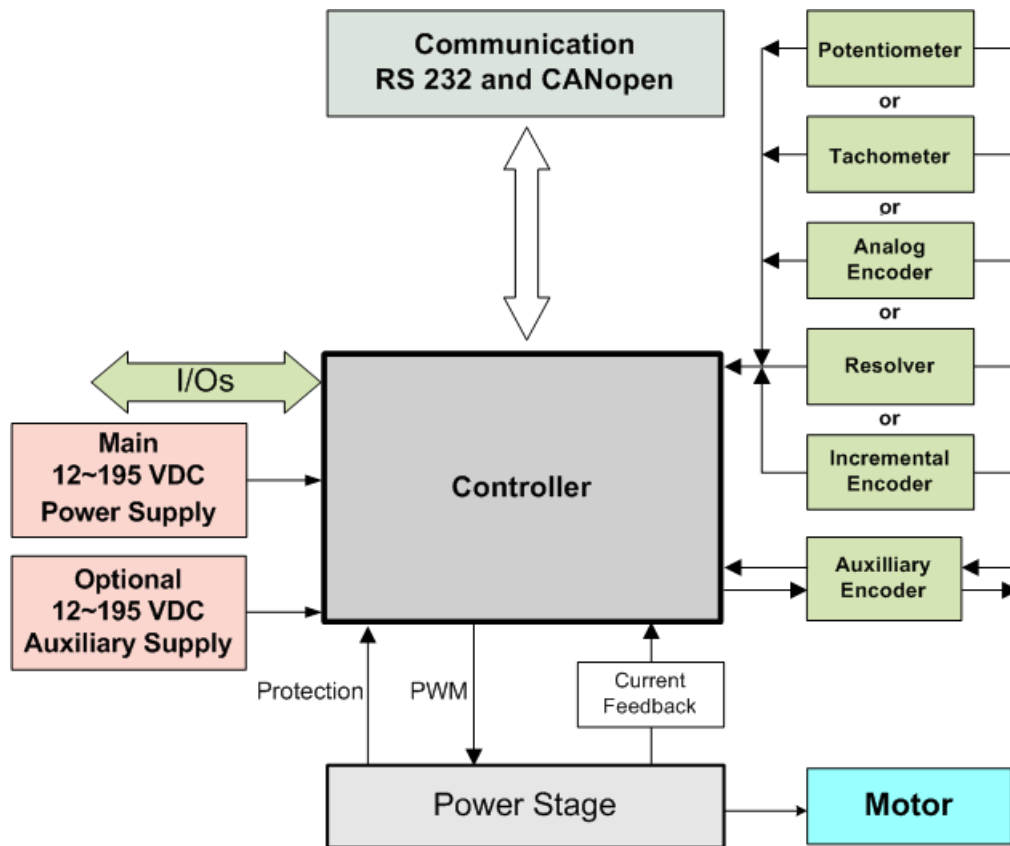


Figure 2-1: Solo Whistle System Block Diagram

2.4 How to Use this Guide

In order to install and operate your Elmo Solo Whistle 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 Whistle.

The [Appendix, Technical Specifications](#), lists all the drive ratings and specifications.

Upon completing the instructions in this guide, your Solo Whistle 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.

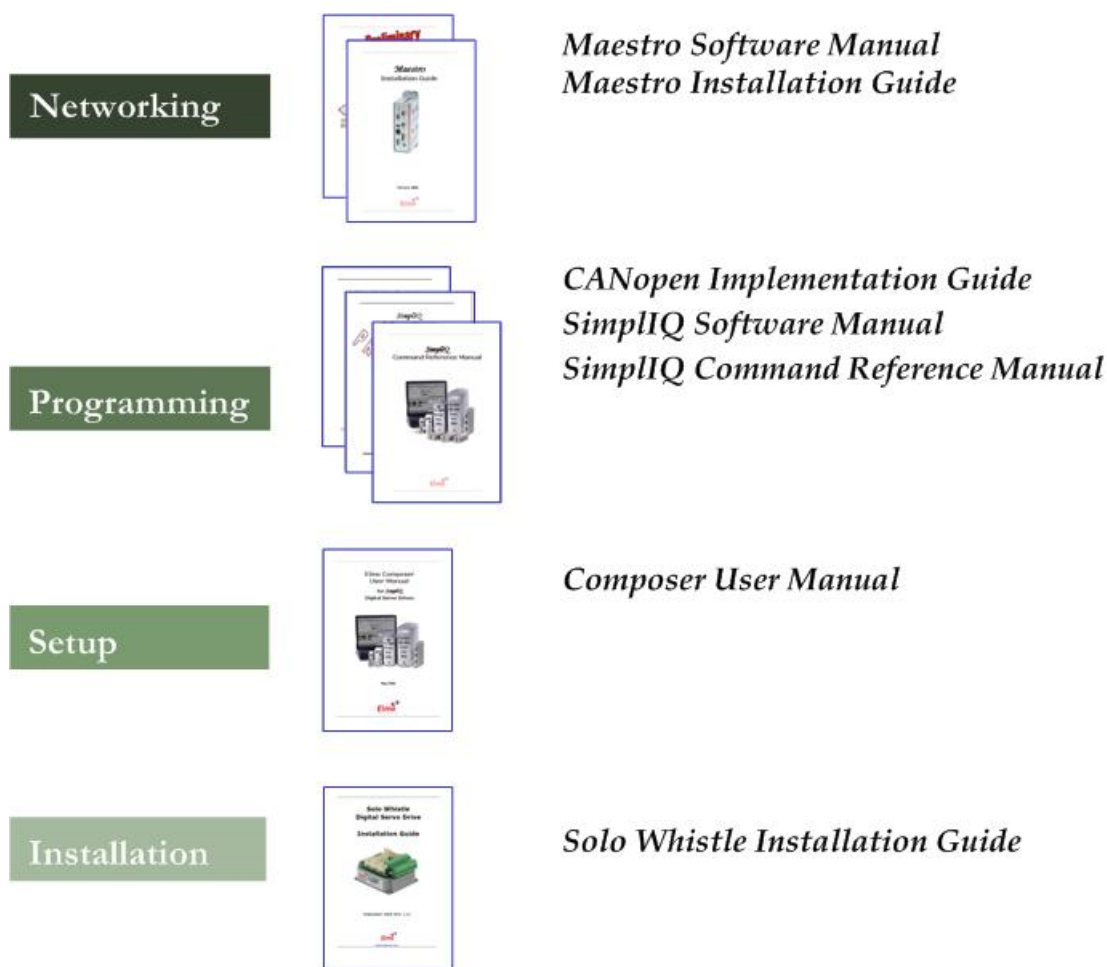


Figure 2-2: Elmo Digital Servo Drive Documentation Hierarchy

As depicted in the previous figure, this installation guide is an integral part of the Solo Whistle 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 Whistle motion controller.
- The *SimplIQ Software Manual*, which describes the comprehensive software used with the Solo Whistle.

Chapter 3: Installation

3.1 Site Requirements

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

Feature	Value
Ambient operating temperature	0 °C to 40 °C (32 °F to 104 °F)
Maximum relative humidity	90% non-condensing
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	



The Solo Whistle 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.

3.2 Unpacking the Drive

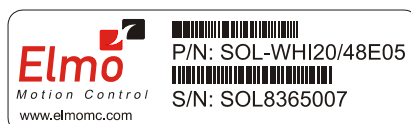
Before you begin working with the Solo Whistle, verify that you have all of the components, as follows:

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

The Solo Whistle is shipped in a cardboard box with styrofoam protection.

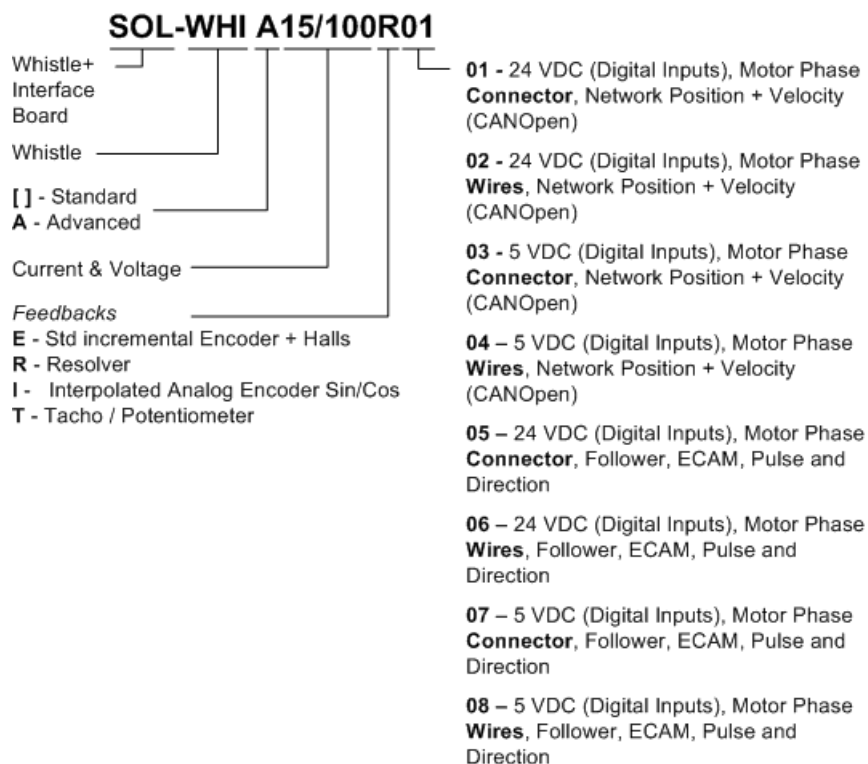
To unpack the Solo Whistle:

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 Whistle drive you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Solo Whistle.



SOLW036A

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



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

3.3 Connector Types

No. Pins	Type	Port	Function
9	3.5 mm Pitch	J1	Power Connector
12	2 mm Pitch	J2	I/O
8	2 mm Pitch	J3	Auxiliary Feedback
12	2 mm Pitch	J4	Main Feedback
3	2 mm Pitch	J5	RS232
3	2 mm Pitch	J6	CANIN
3	2 mm Pitch	J7	CANOUT
8	3.81mm Pitch/16-18 AWG Wires	J8	Motor Connection

Connector Locations

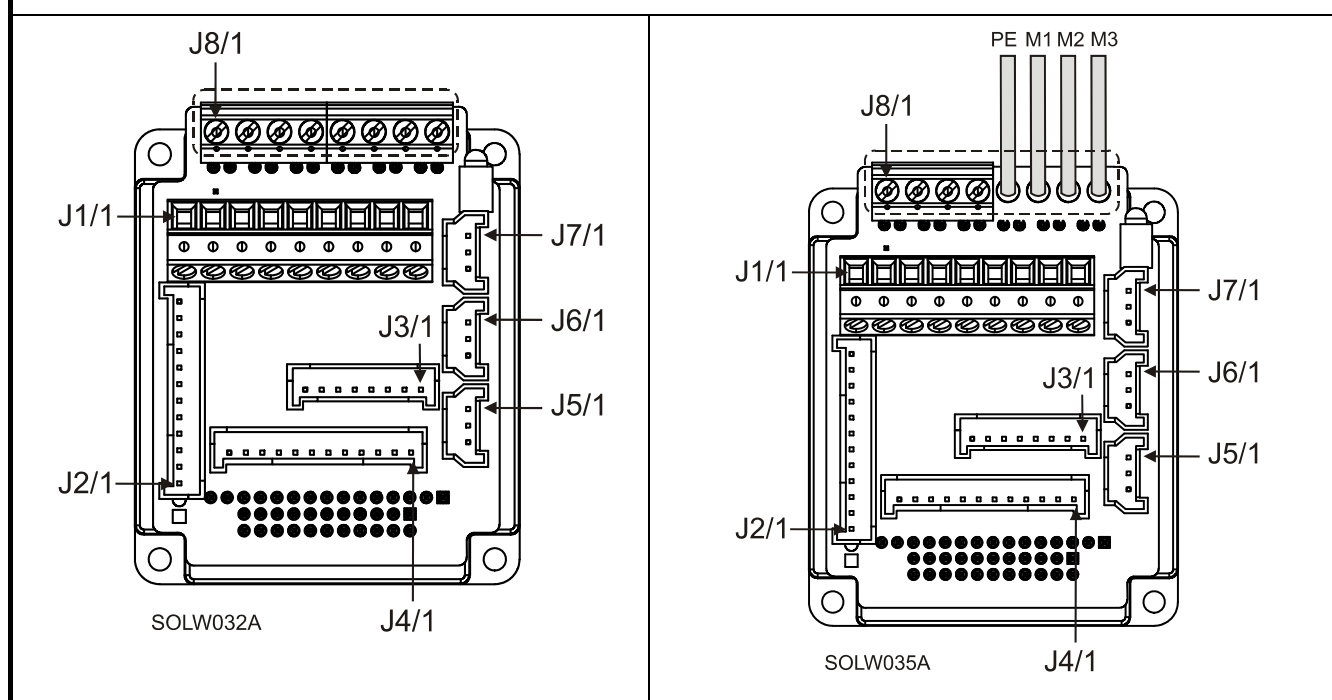


Table 3-1: Connector Types

3.4 Motor Power – J8

Pin	Signal	Function		
J8/1	PTC	Positive Temperature Coefficient		
J8/2	PTC	Positive Temperature Coefficient		
J8/3	N/C	Not Connected		
J8/4	N/C	Not Connected		
			AC Motor	DC Motor
J8/5	PE	Protective earth	Motor	Motor
J8/6	M1	Motor phase	Motor	N/C
J8/7	M2	Motor phase	Motor	Motor
J8/8	M3	Motor phase	Motor	Motor

Pin Positions	
SOLW032A	SOLW035A

	When connecting several drives to several motors, all should be wired in the same motor phases and feedback sequences. This will enable the same <i>SimplIQ</i> program to run on all drives.
--	--

3.4.1 Connecting Motor Power

Connect the M1, M2, M3 and PE pins on the Solo Whistle. 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.

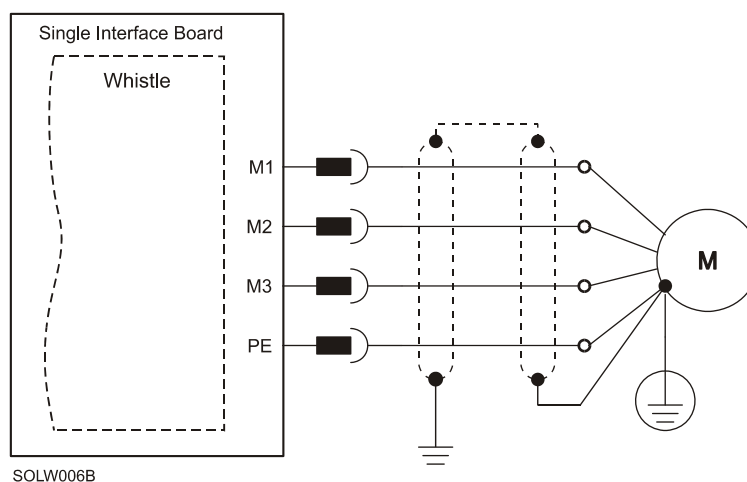
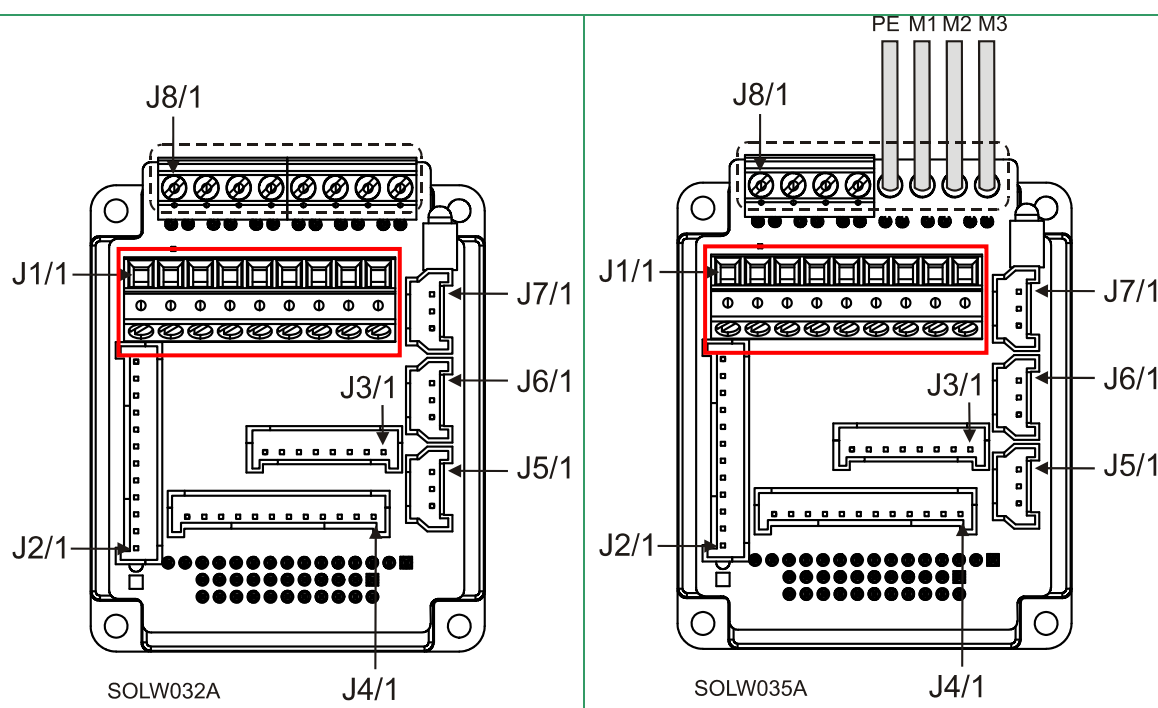


Figure 3-1: AC Motor Power Connection Diagram

3.5 Main Power – J1

Pin	Signal	Function
J1/1	VL+	Auxiliary supply Input
J1/2	VL-	Auxiliary supply Input Return
J1/3	VP+	Pos. power input
J1/4	VP+	Pos. power input
J1/5	PR	Power return
J1/6	PR	Power return
J1/7	PE	Protective earth
J1/8	N/C	Not connected
J1/9	N/C	Not connected

Pin Positions



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

3.5.1 Connecting Main Power

Power to the Solo Whistle is provided by a 12 to 95 VDC source. A smart control-supply algorithm enables the Solo Whistle 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+.

- **The source of the 12 ~ 95 VDC Main Power Supply must be isolated.**

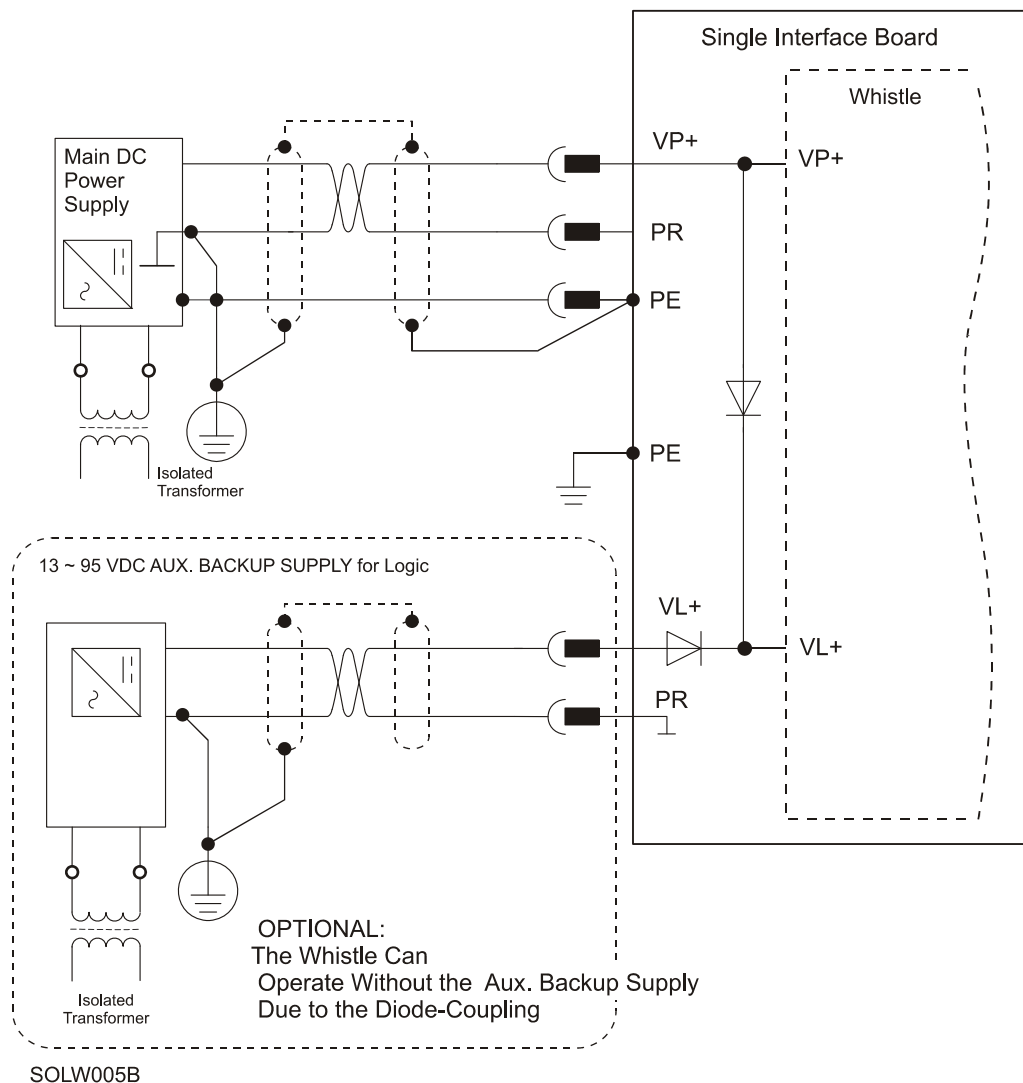


Figure 3-2: Main Power Supply Connection Diagram

3.6 Main Feedback

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 Whistle 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-WHIAXX/YYEZZ		SOL-WHIAXX/YYYIZZ		SOL-WHIAXX/YYYRZZ		SOL-WHIAXX/YYTZZ	
Pin	Signal	Function	Signal	Function	Signal	Function	Signal	Function
J4/1	HC	Hall sensor C input	HC	Hall sensor C input	NC	-	HC	Hall sensor C input
J4/3	HA	Hall sensor A input	HA	Hall sensor A input	NC	-	HA	Hall sensor A input
J4/4	PE	Protective Earth	PE	Protective Earth	PE	Protective Earth	PE	Protective Earth
J4/5	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return
J4/6	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply
J4/11	CHA-	Channel A complement	A-	Sine A complement	S3	Sine A complement	Tac 1-	Tacho Input 1 Neg. (20 V max)
J4/12	CHA	Channel A	A+	Sine A	S1	Sine A	Tac 1+	Tacho Input 1 Pos. (20 V max)
J4/7	INDEX-	Index complement	R-	Reference complement	R2	Vref complement $f = 1/TS, 50mA$ Maximum	NC	-
J4/8	INDEX	Index	R+	Reference	R1	Vref $f = 1/TS, 50mA$ Max.	POT	Potentiometer Input (5 V Max)
J4/2	HB	Hall sensor B input	HB	Hall sensor B input	NC	-	HB	Hall sensor B input
J4/9	CHB-	Channel B complement	B-	Cosine B complement	S4	Cosine B complement	Tac 2-	Tacho Input 2 Neg. (50 V max)
J4/10	CHB	Channel B	B+	Cosine B	S2	Cosine B	Tac 2+	Tacho Input 2 Pos. (50 V max)

Table 3-2: Main Feedback Pin Assignments

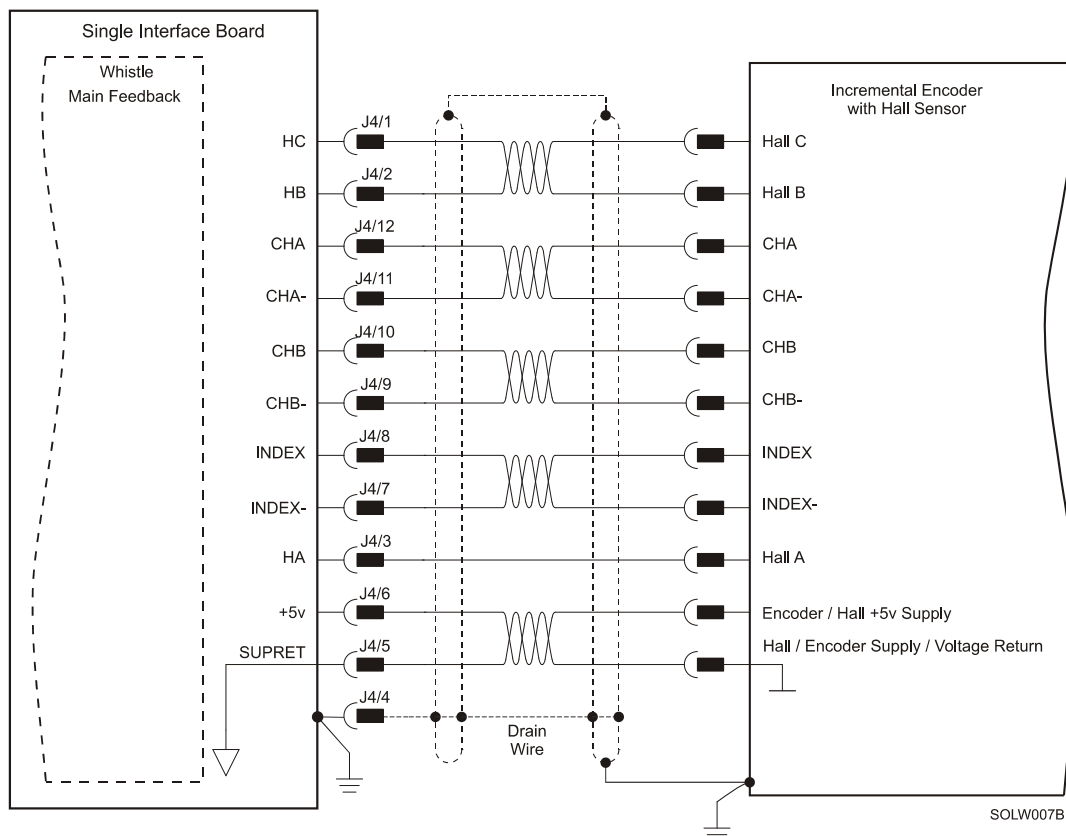


Figure 3-3: Main Feedback- Incremental Encoder with Digital Hall Sensor Connection Diagram

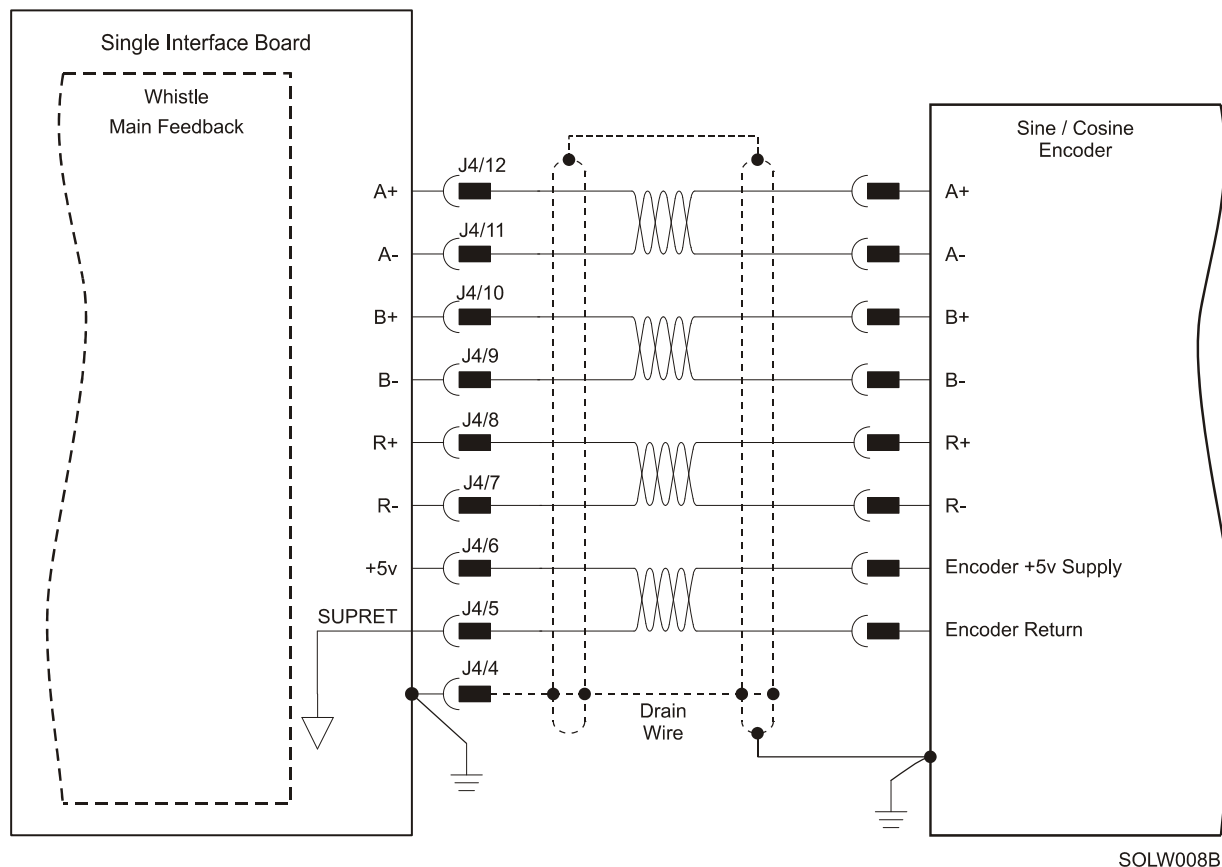


Figure 3-4: Main Feedback - Interpolated Analog Encoder Connection Diagram

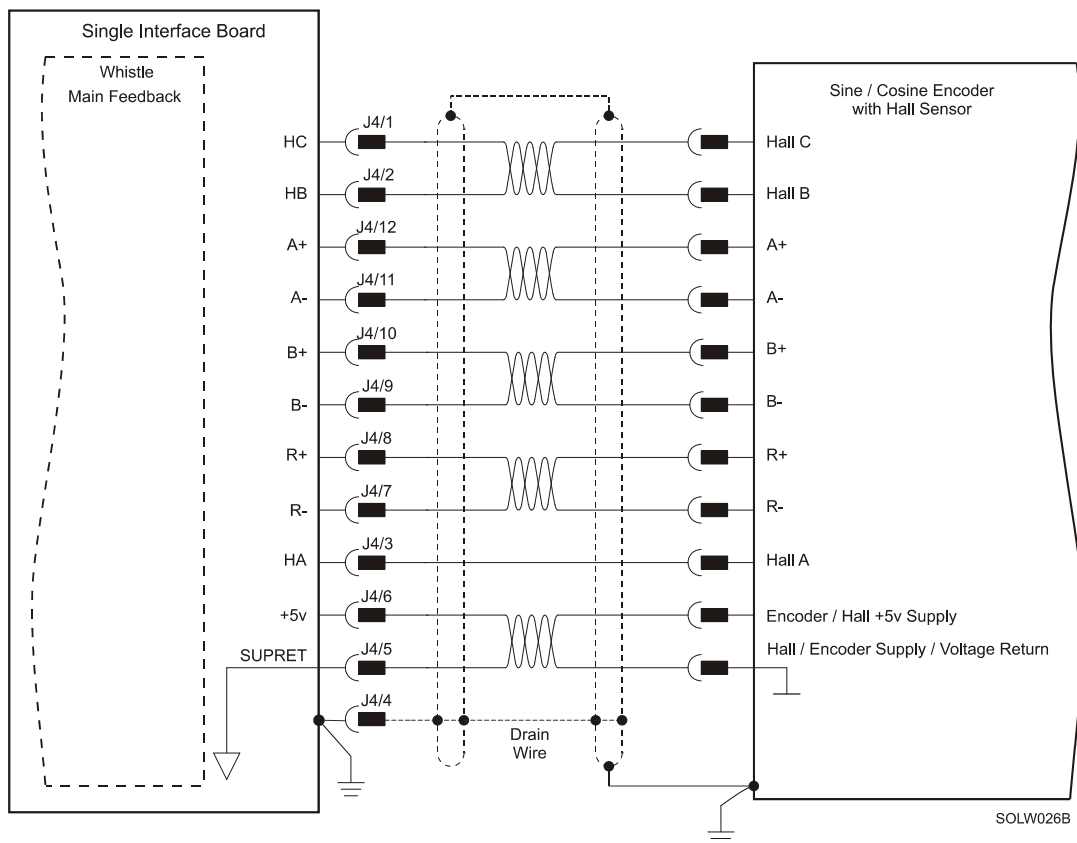


Figure 3-5: Main Feedback - Interpolated Analog Encoder with Digital Hall Sensor Connection Diagram

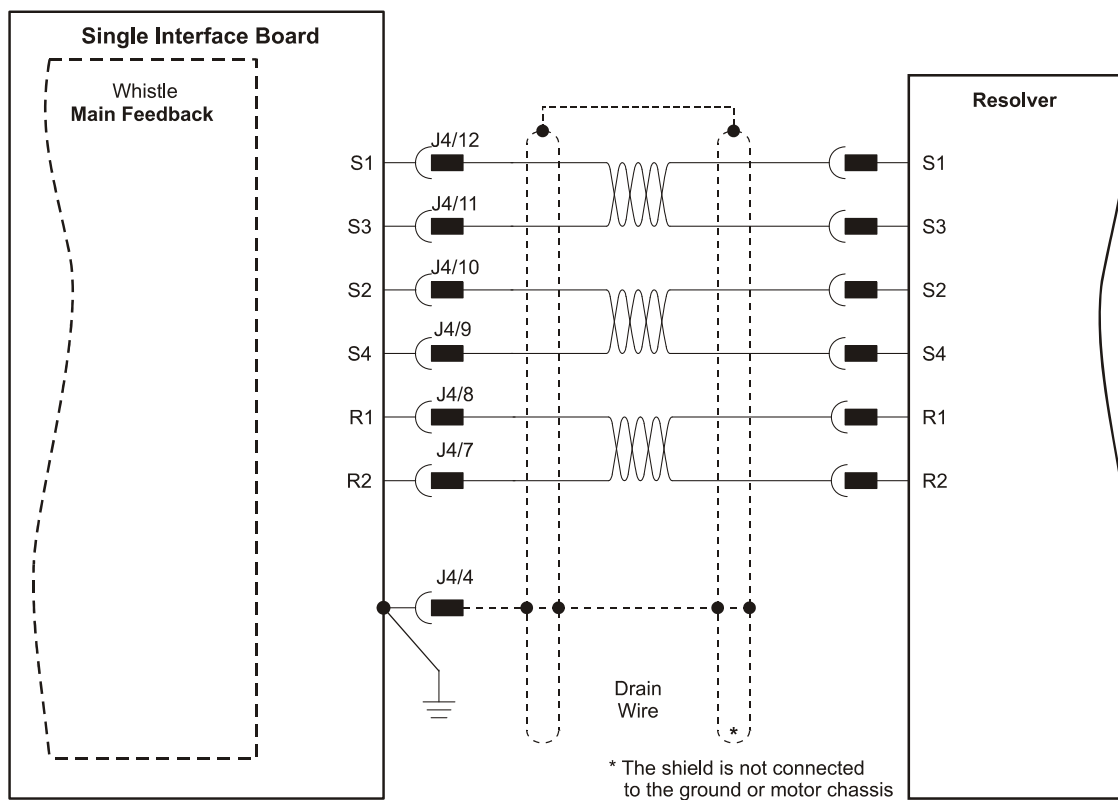
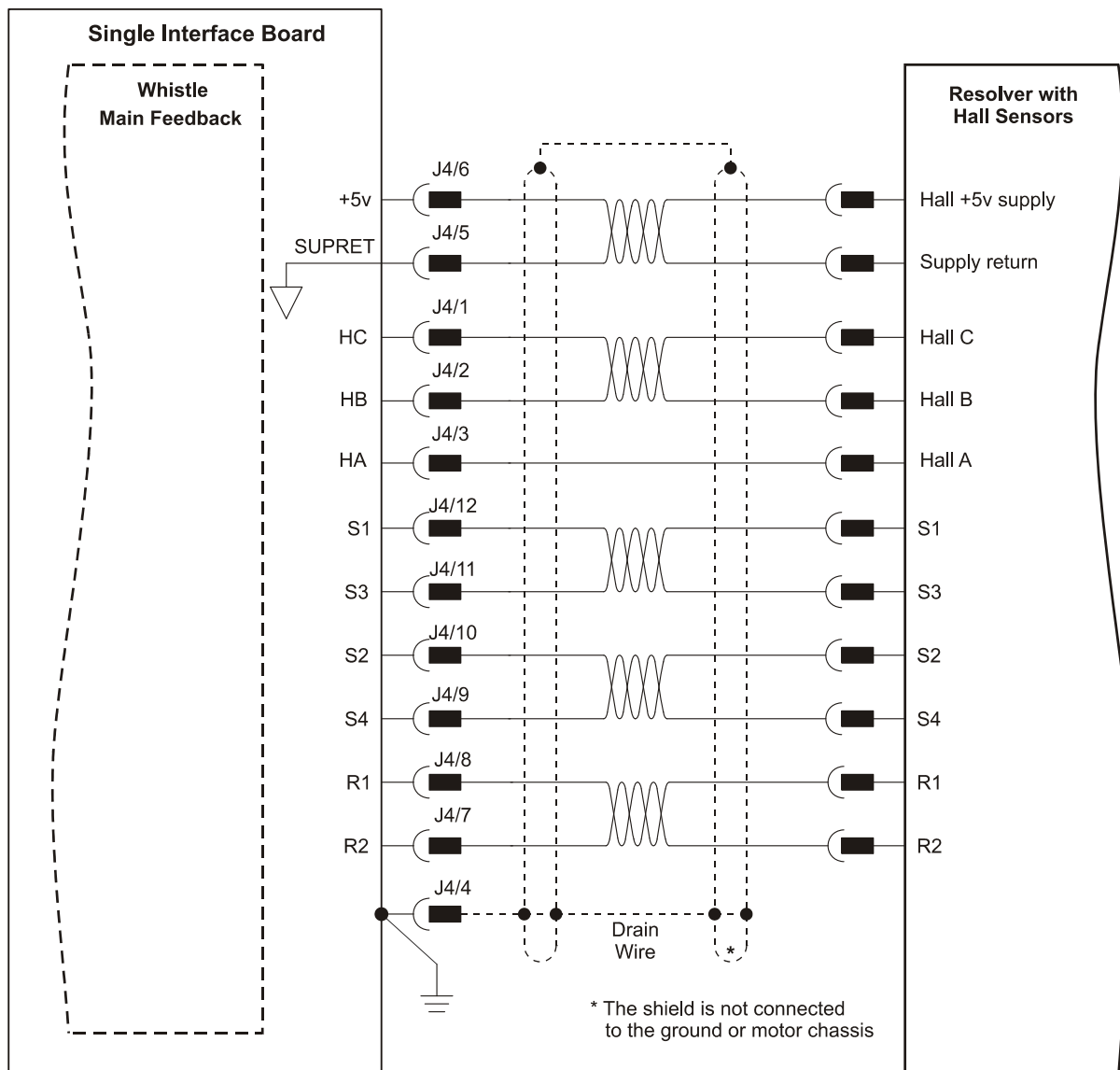


Figure 3-6: Main Feedback - Resolver Connection Diagram



SOLW027B

Figure 3-7: Main Feedback - Resolver with Digital Hall Sensor Connection Diagram

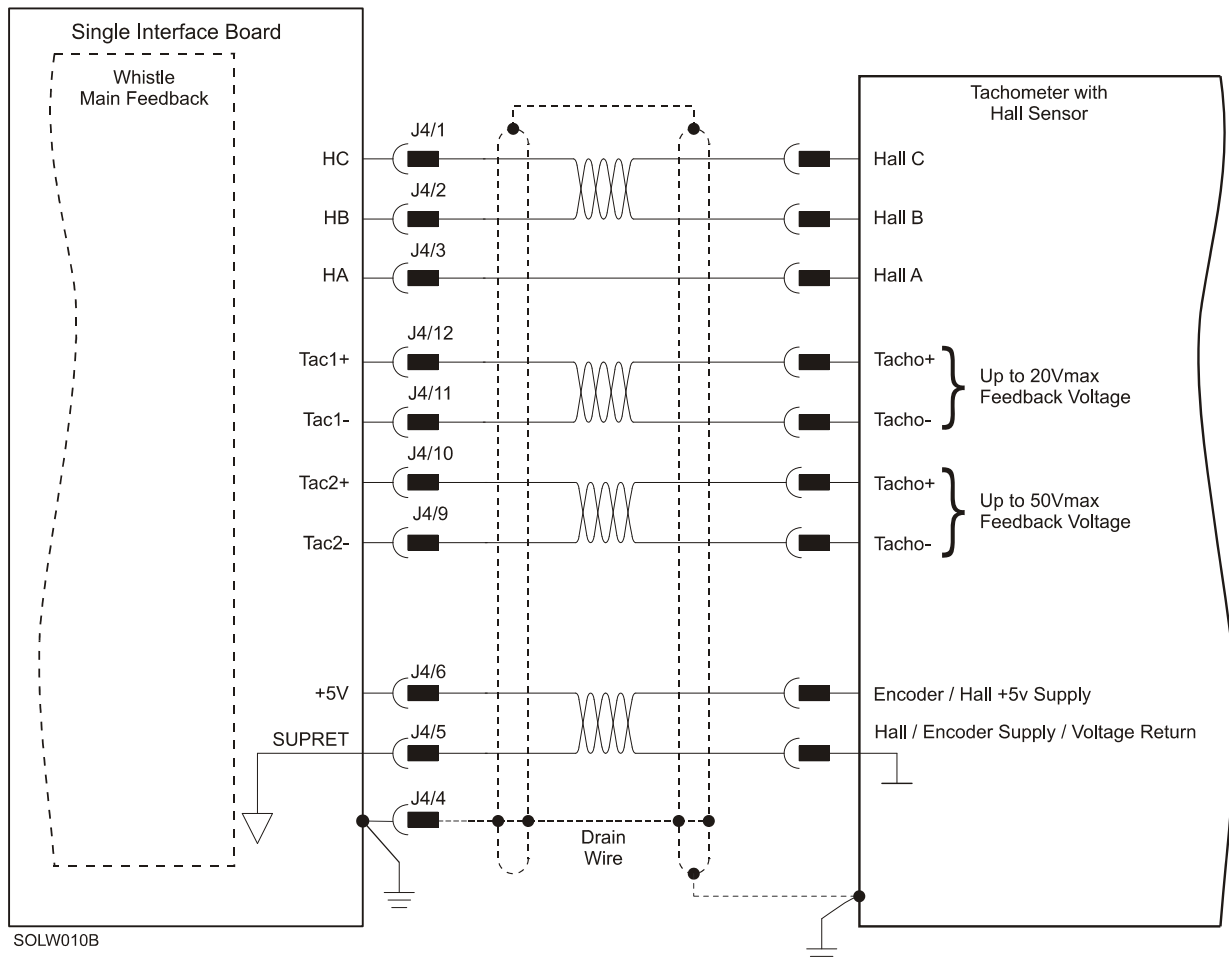


Figure 3-8: Main Feedback - Tachometer Feedback with Digital Hall Sensor
Connection Diagram for Brushless Motors

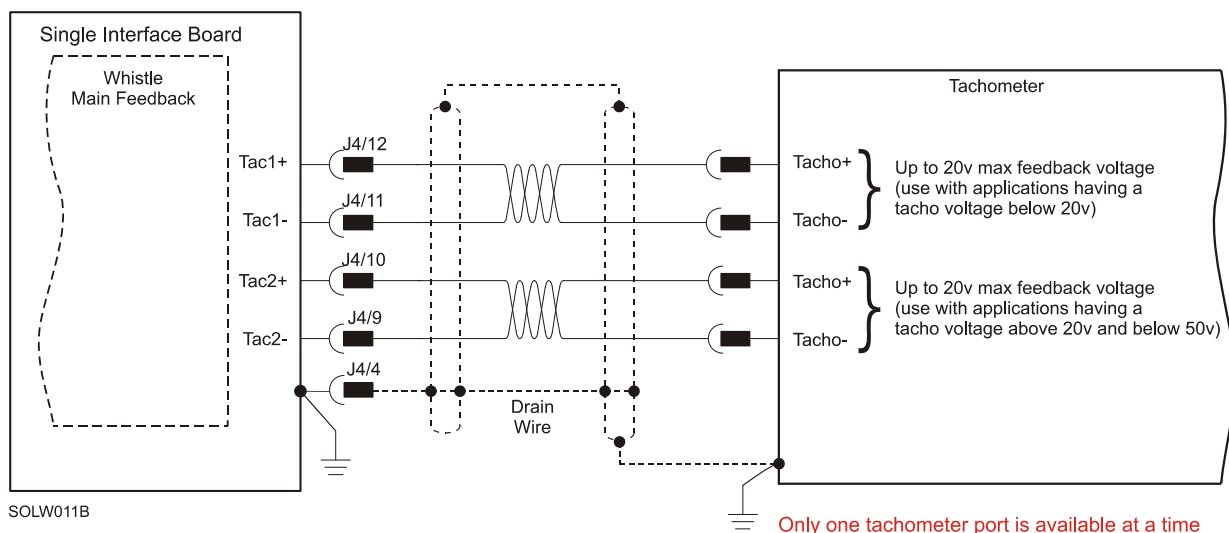


Figure 3-9: Main Feedback - Tachometer Feedback Connection Diagram for Brush Motors

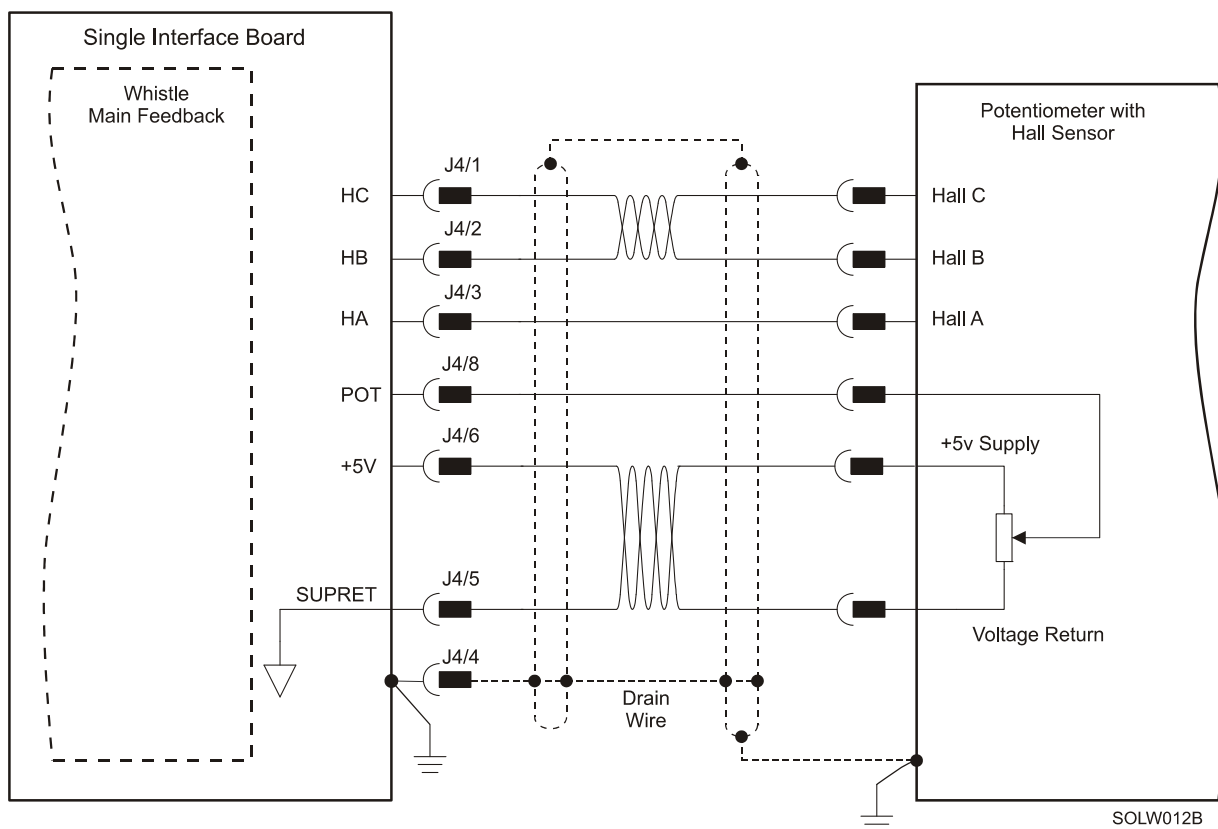


Figure 3-10: Main Feedback - Potentiometer Feedback with Digital Hall Sensor
Connection Diagram for Brushless Motors

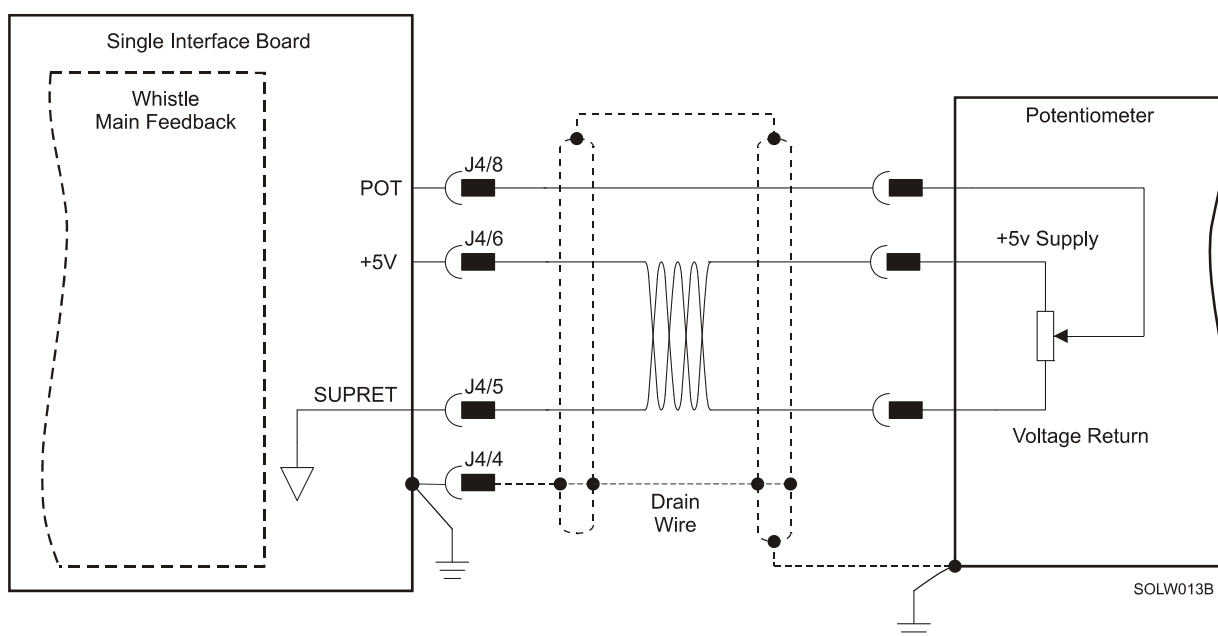


Figure 3-11: Main Feedback - Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils

3.7 Auxiliary Feedback

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.

3.7.1 Auxiliary Feedback Operation Modes

There are two modes of operation for the Solo Whistle:

- **Mode 1:** Auxiliary output (Composer command: YA[4]=4) – see section 3.7.2
Only for SOL-WHIXXX/YYYY01 - SOL-WHIXXX/YYYY04

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.

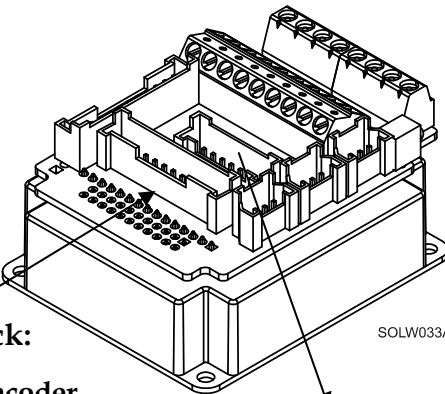
This option can be used when:

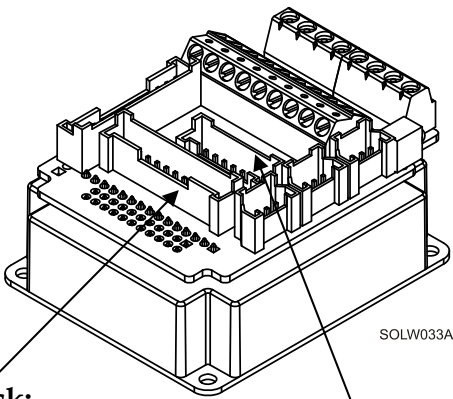
- The Solo Whistle is used as a current amplifier to provide position data to the position controller.
 - The Solo Whistle is used in velocity mode to provide position data to the position controller.
 - The Solo Whistle is used as a master in follower or ECAM mode.
- **Mode 2:** Auxiliary input (Composer command: YA[4]=2 or YA[4]=0) - see section 3.7.3 & 3.7.4
Only for SOL-WHIAXXX/YYYY05 - SOL-WHIAXXX/YYYY08

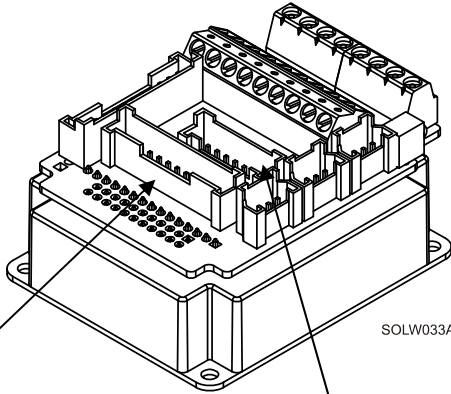
Differential auxiliary inputs, for the input of position data of the master encoder in follower or ECAM mode. This mode can also be used for differential pulse-and-direction position commands.

3.7.2 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 Whistle 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:

<i>SW Setting</i> Main Feedback	Auxiliary Feedback: Output YA[4] = 4 (Auxiliary Feedback: output)
Incremental Encoder Input	 SOLW033A Main Feedback: Incremental Encoder Interpolated Analog (Sin/Cos) Encoder OR Resolver OR Potentiometer OR Tachometer Auxiliary Feedback: Emulated Differential Buffered Encoder Output.
✦ Interpolated Analog (Sin/Cos) Encoder Input	
★ Resolver Input	
★ Potentiometer/Tachometer Input	
Typical Applications	✦ 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.

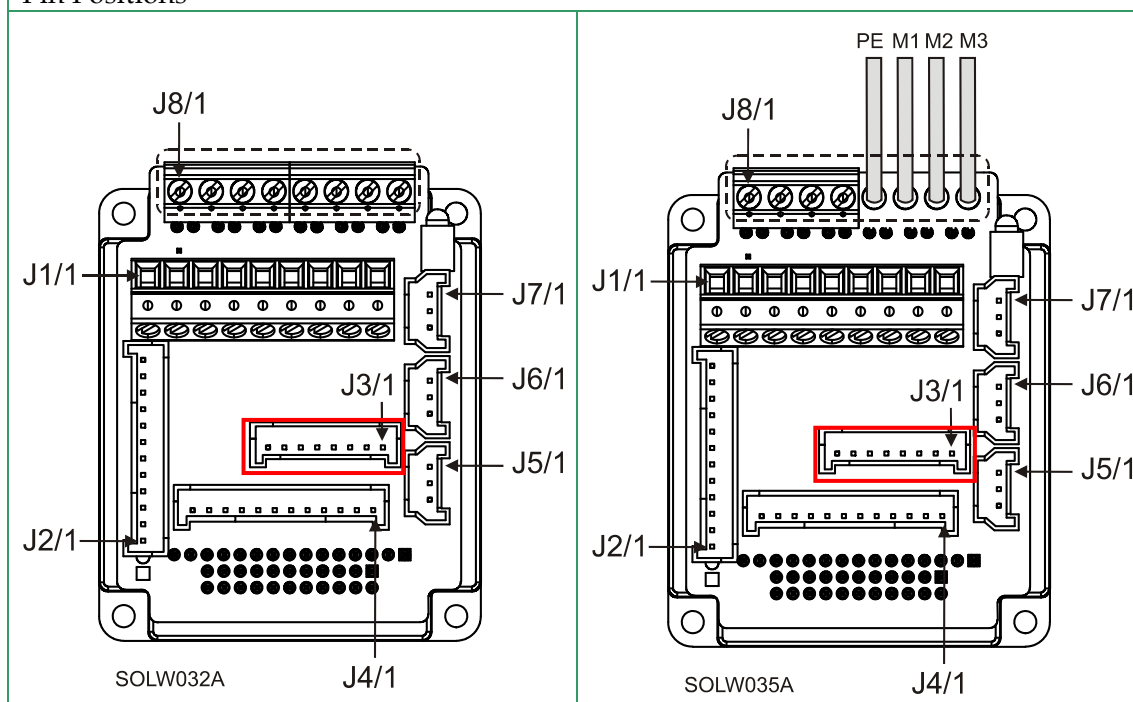
SW Setting Main Feedback	Auxiliary Feedback: Input YA[4] = 2 (Auxiliary Feedback: input)
Incremental Encoder Input	 SOLW033A Main Feedback: Incremental Encoder Input OR Interpolated Analog (Sin/Cos) Encoder Input OR Resolver OR Potentiometer OR Tachometer Auxiliary Feedback: Differential Auxiliary Encoder Input
Interpolated Analog (Sin/Cos) 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.

SW Setting Main Feedback	Auxiliary Feedback: Input YA[4] = 0 (Auxiliary Feedback: input)
Incremental Encoder Input	 SOLW033A Main Feedback: Incremental Encoder Input OR Interpolated Analog (Sin/Cos) Encoder Input OR Resolver OR Potentiometer OR Tachometer Auxiliary Feedback: Differential Pulse & Direction Commands Input
Interpolated Analog (Sin/Cos) 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.

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

Pin	Signal	Function
J3/1	PE	Protective Earth
J3/2	COMRET	Common Return
J3/3	INDEXO-	Buffered Index complement output
J3/4	INDEXO	Buffered Index output
J3/5	CHBO-	Buffered Channel B complement output
J3/6	CHBO	Buffered Channel B output
J3/7	CHAO-	Buffered Channel A complement output
J3/8	CHAO	Buffered Channel A output

Pin Positions



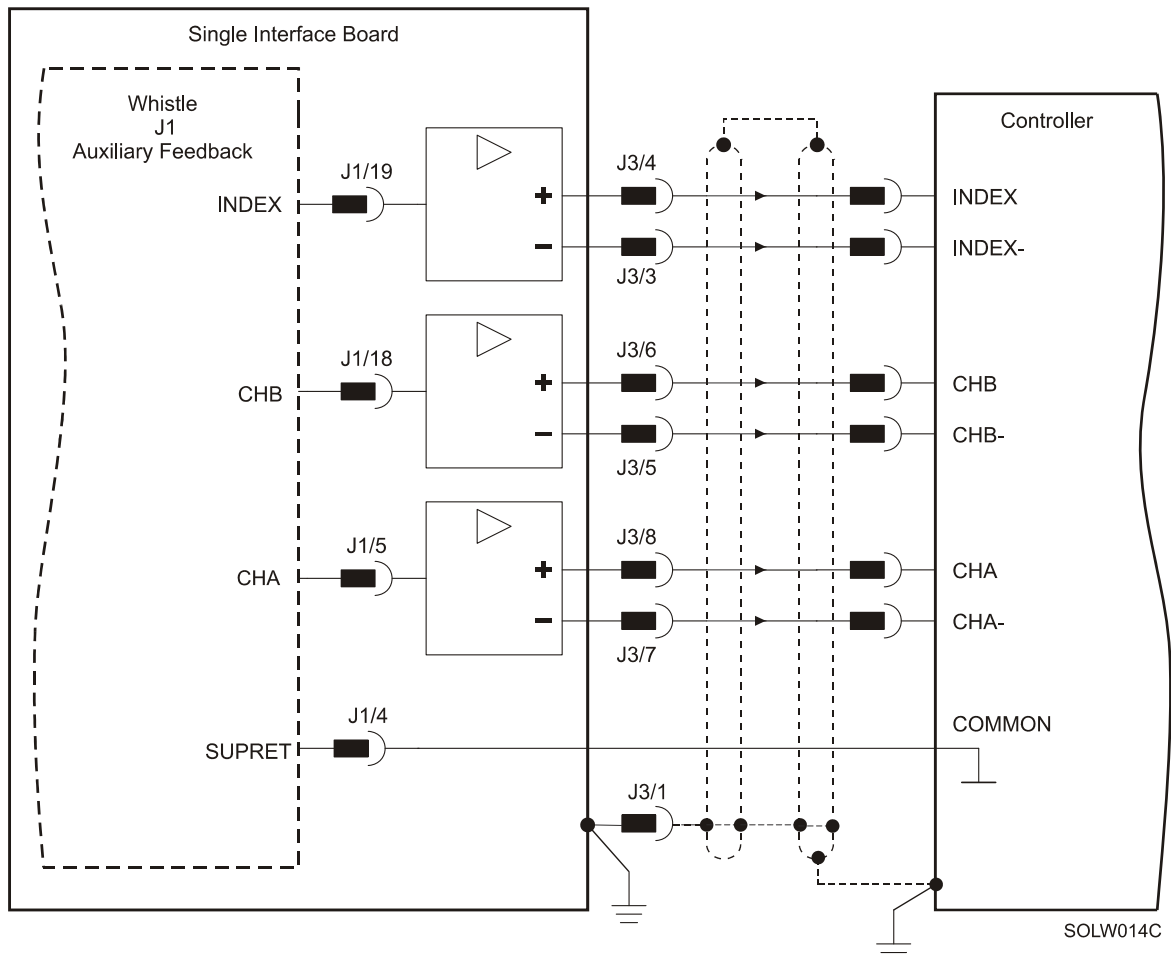
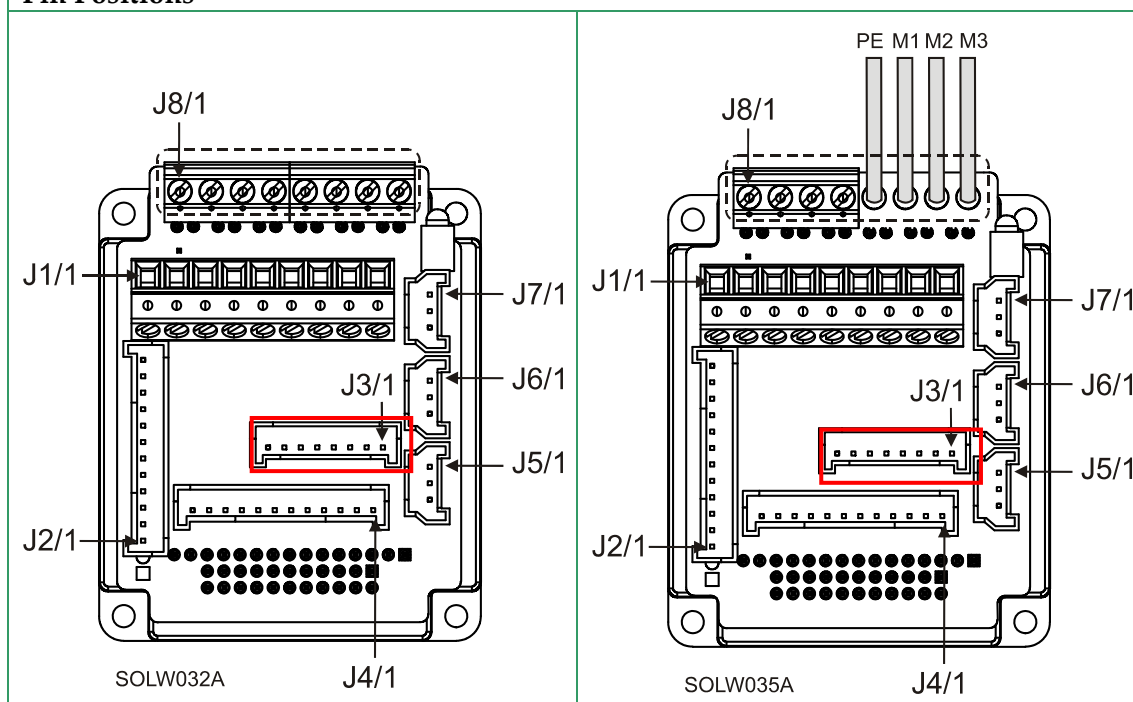


Figure 3-12: Emulated Encoder Differential Output Diagram

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

Pin	Signal	Function
J3/1	PE	Protective Earth
J3/2	COMRET	Common Return
J3/3	INDEX-	Auxiliary Index complement Input
J3/4	INDEX	Auxiliary Index Input
J3/5	CHB-	Auxiliary channel B complement input
J3/6	CHB	Auxiliary channel B <i>input</i>
J3/7	CHA-	Auxiliary channel A complement input
J3/8	CHA	Auxiliary channel A <i>input</i>

Pin Positions



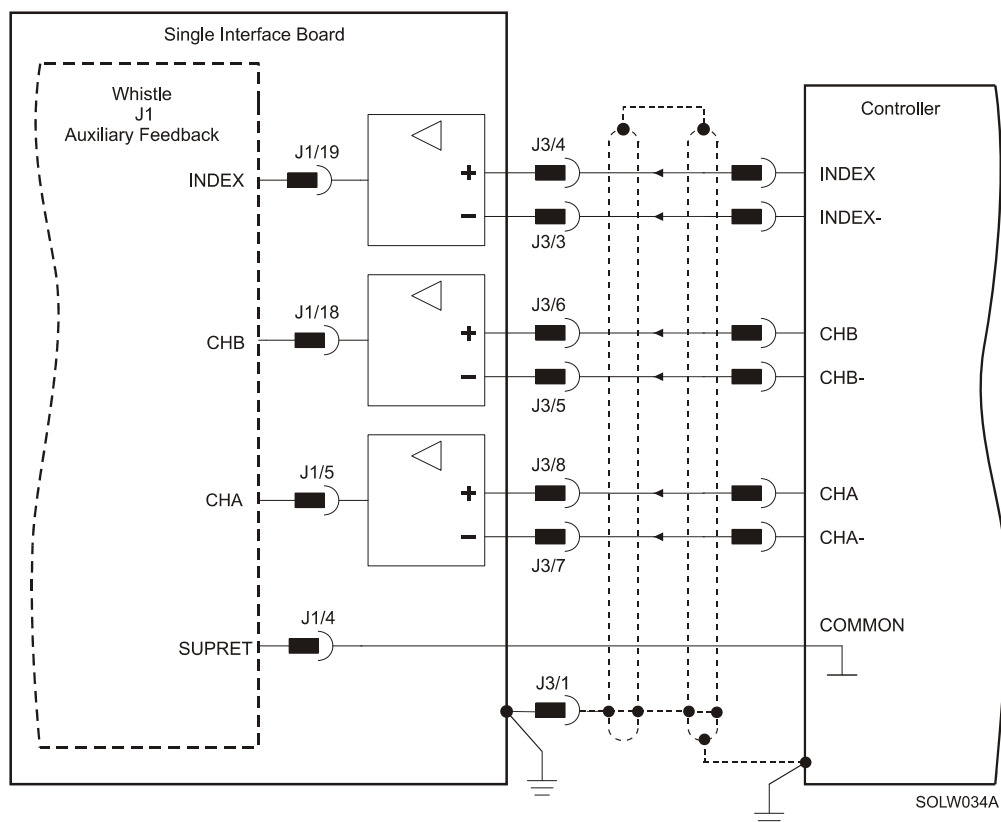


Figure 3-13: Differential Auxiliary Encoder Input Option Diagram

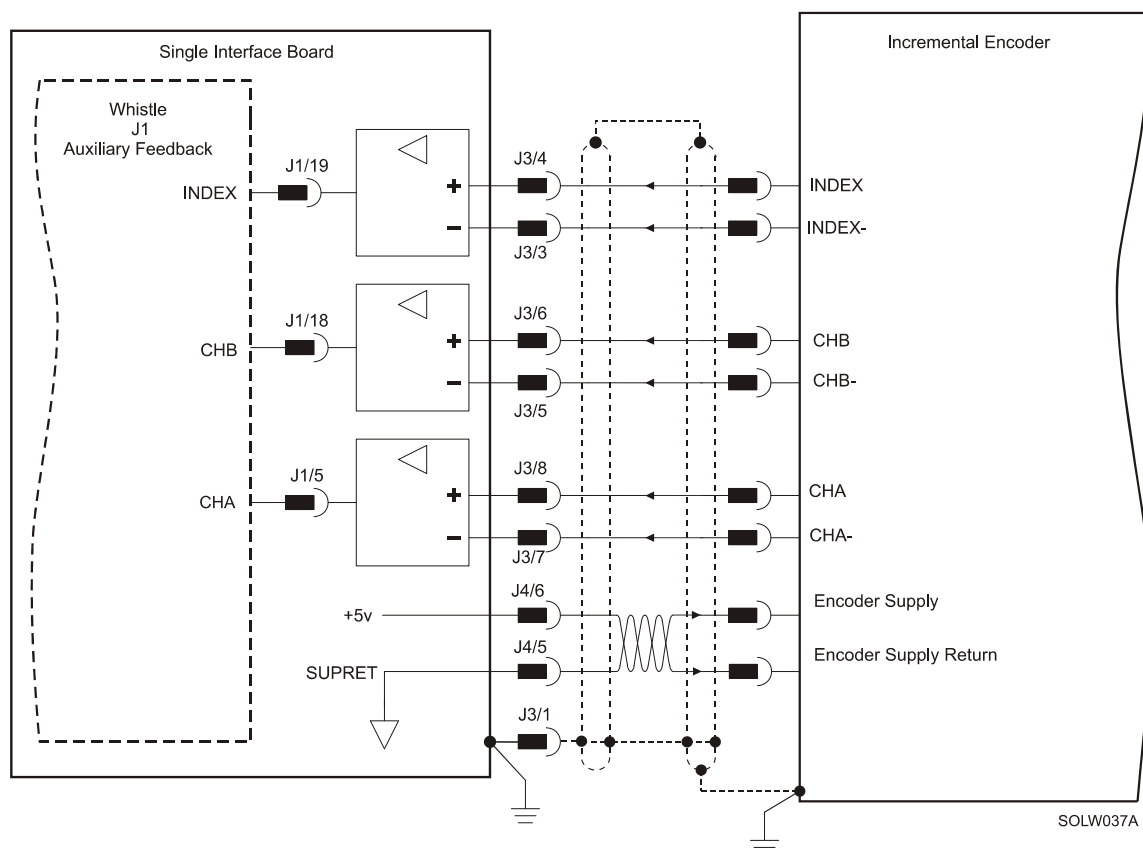
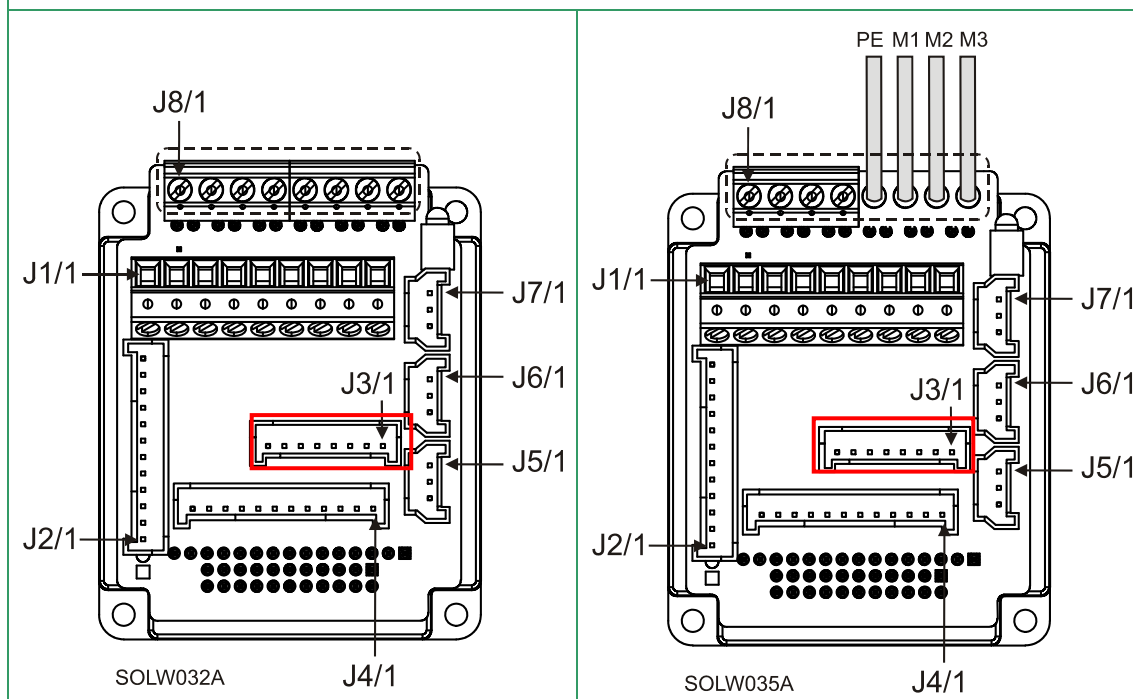


Figure 3-14: Differential Auxiliary Encoder Input Option Diagram

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

Pin	Signal	Function
J3/1	PE	Protective Earth
J3/2	COMRET	Common Return
J3/3	NA	Do not connect this pin
J3/4	NA	Do not connect this pin
J3/5	CHB-	Auxiliary Direction complement <i>input</i>
J3/6	CHB	Auxiliary Direction <i>input</i>
J3/7	CHA-	Auxiliary Pulse complement <i>input</i>
J3/8	CHA	Auxiliary Pulse <i>input</i>

Pin Positions



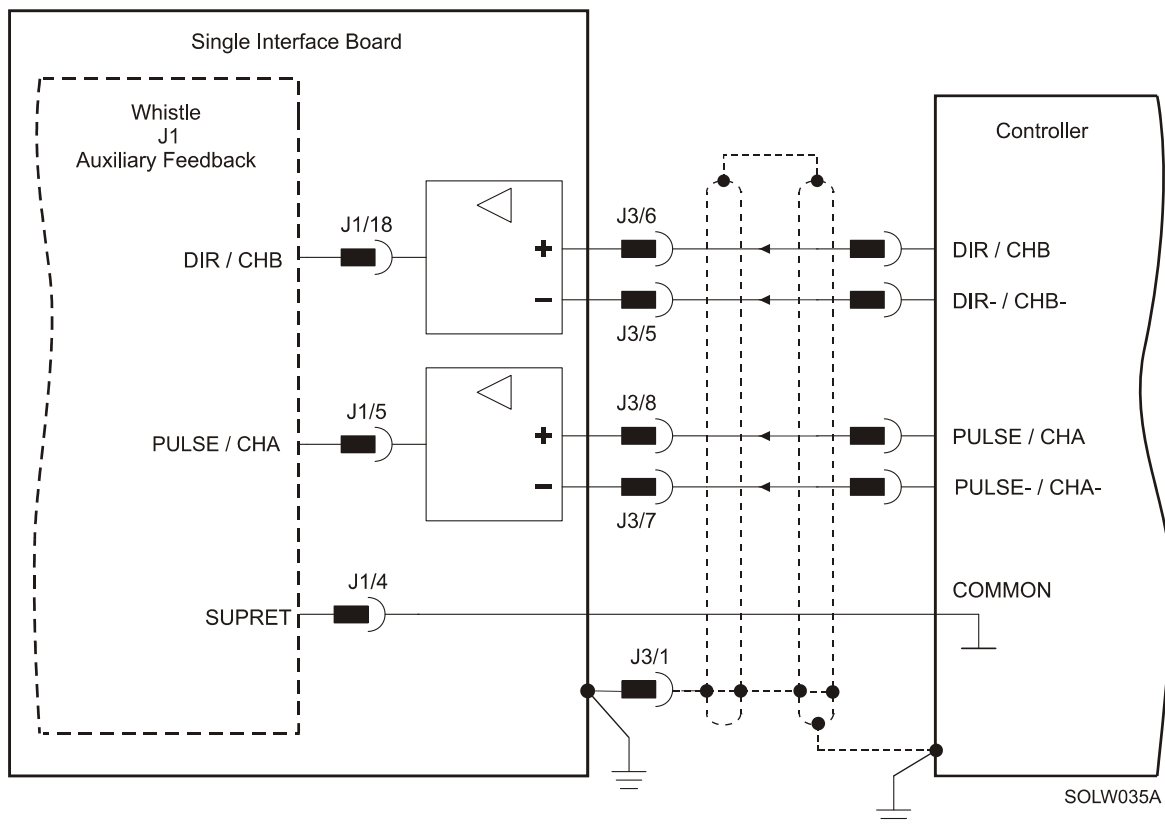


Figure 3-15: Pulse-and-Direction Diagram

3.8 I/Os

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

3.8.1 Digital Input

The digital input level signal can be 5 V (TTL) or 24 V (PLC).

Pin	Signal	Function
J2/1	IN3	Programmable input 3 (general purpose, RLS, FLS, INH)
J2/2	IN4	Programmable input 4 (general purpose, RLS, FLS, INH)
J2/3	IN5	Hi-Speed Programmable input 5 (event capture, Main Home, general purpose, RLS, FLS, INH)
J2/4	IN6	Hi-Speed Programmable input 6 (event capture, Auxiliary Home, general purpose, RLS, FLS, INH)
J2/5	INRET	Programmable input return

Pin Positions	
SOLW032A	SOLW035A

Table 3-3: Digital Input Pin Assignments

3.8.1.1 Digital Input 5 V (TTL)

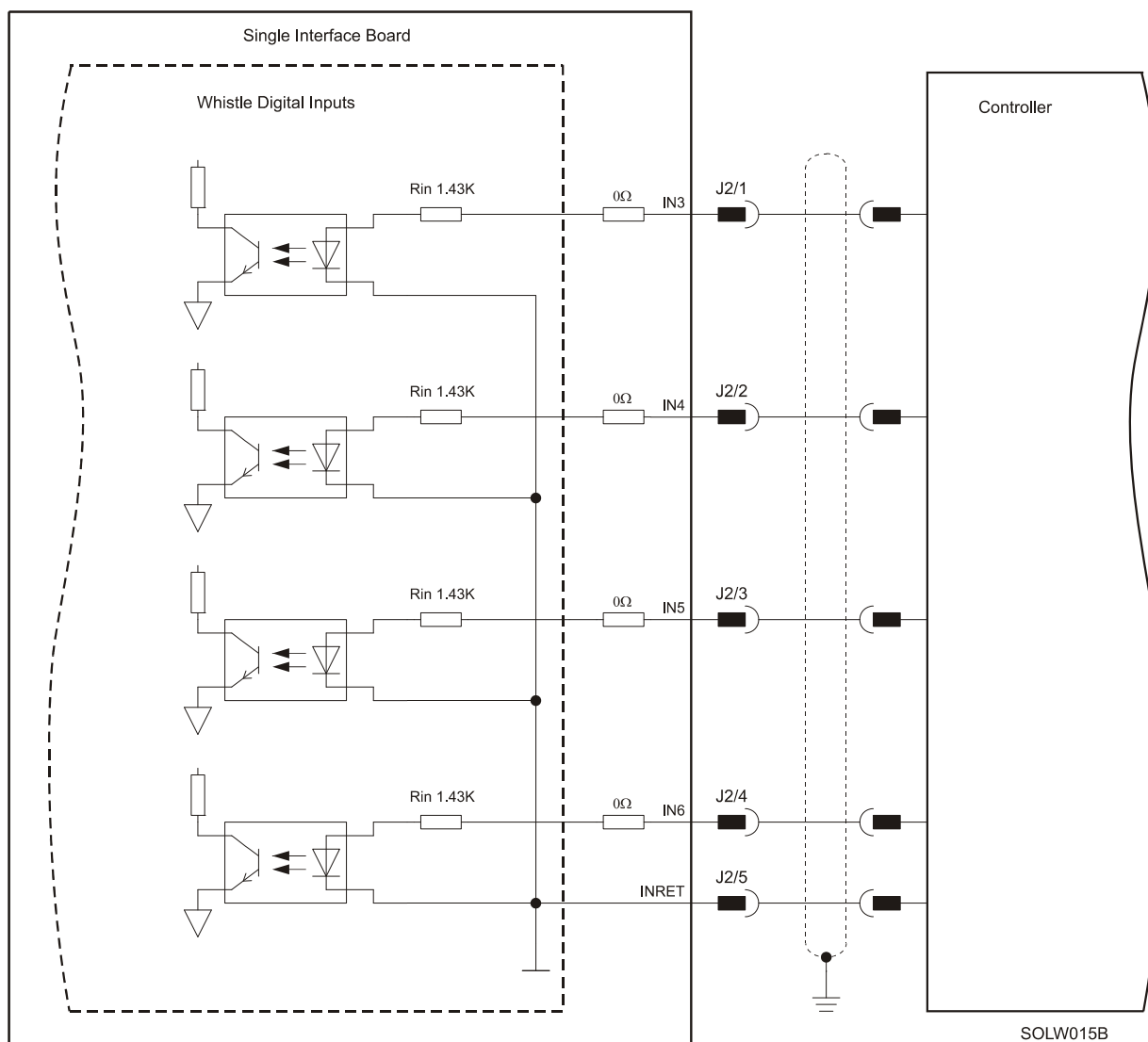


Figure 3-16: Digital Input 5 V Connection Diagram

3.8.1.2 Digital Input 24 V (PLC)

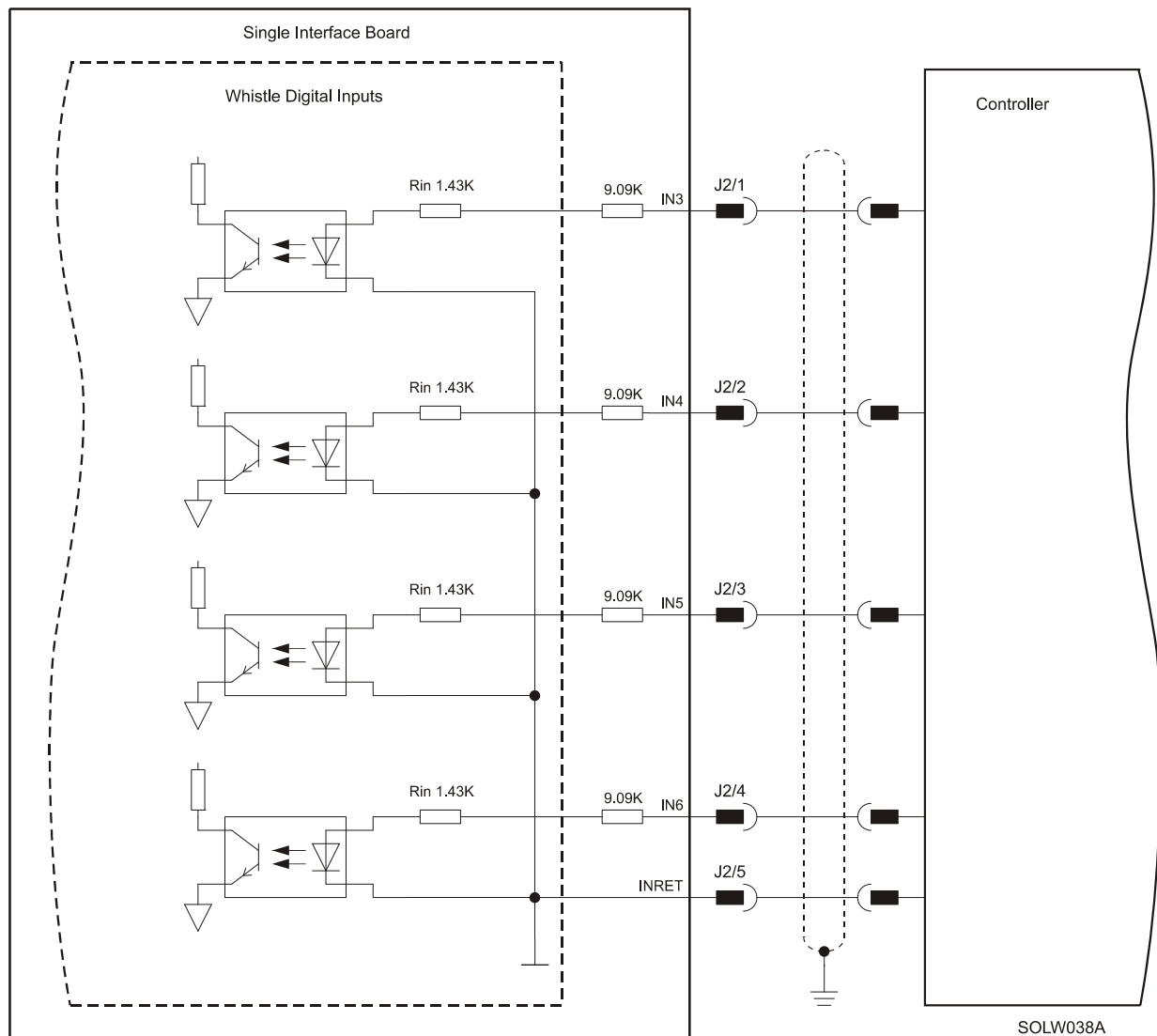


Figure 3-17: Digital Input 24 Connection Diagram

3.8.2 Digital Output

Pin	Signal	Function
J2/8	OUT1	Programmable digital output 1
J2/9	OUTRET1	Programmable digital output return 1
J2/6	OUT2	Programmable digital output 2
J2/7	OUTRET2	Programmable digital output return 2

Pin Positions	
	SOLW032A
	J4/1
	SOLW035A
	J4/1

Table 3-4: Digital Output Pin Assignment

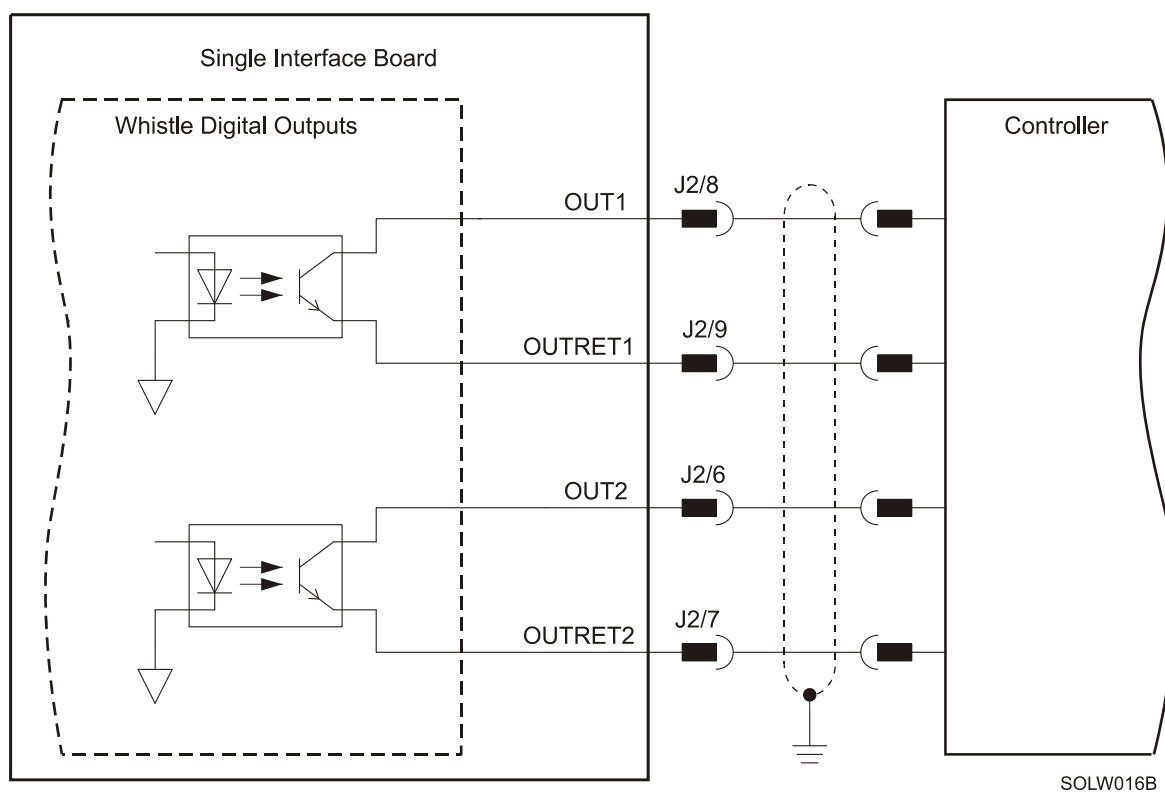


Figure 3-18: Digital Output Connection Diagram

3.8.3 Analog Input

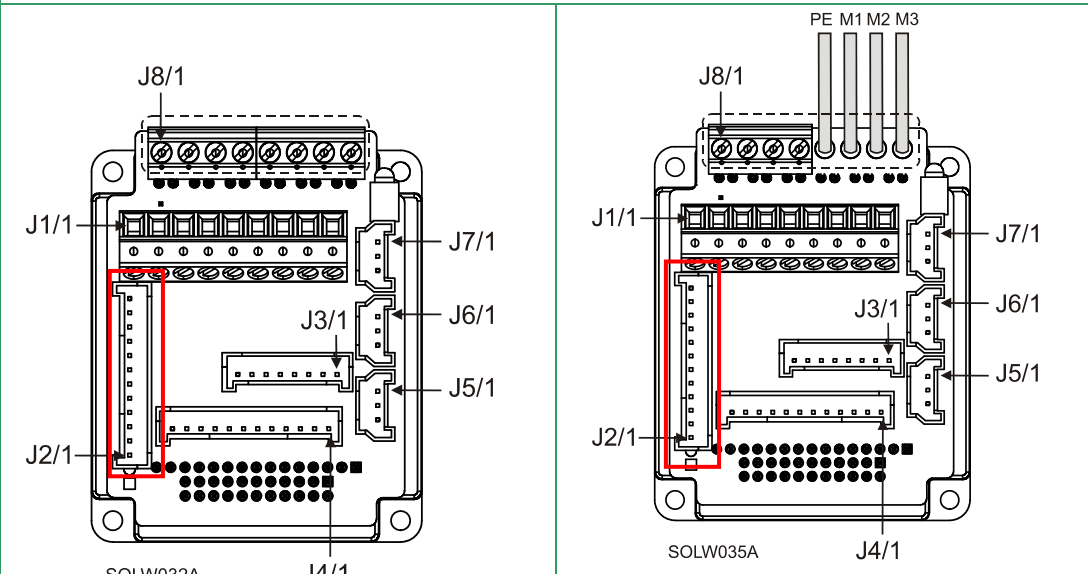
Pin	Signal	Function
J2/10	ANLIN1+	Analog input 1+
J2/11	ANLIN1-	Analog input 1-
J2/12	ANLRET	Analog return
Pin Positions		
		

Table 3-5: Analog Input Pin Assignments

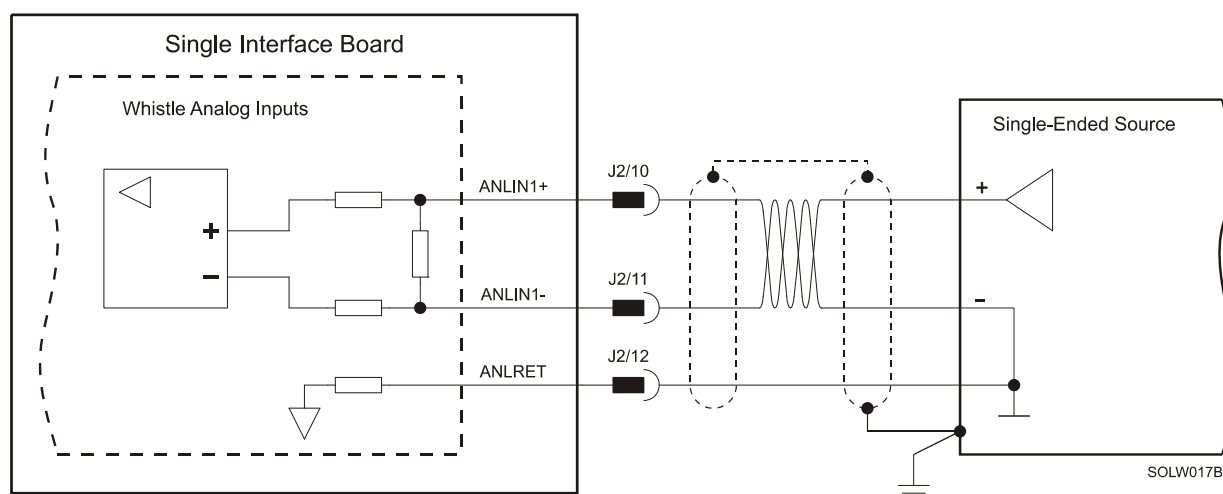


Figure 3-19: Analog Input with Single-ended Source

3.9 Communications

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

- RS-232, full duplex
- CANopen

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

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

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

3.9.1 RS-232 Communication



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	Signal	Function
J5/1	RS232_Rx	RS-232 receive
J5/2	RS232_Tx	RS-232 transmit
J5/3	RS232_COMRET	Communication return

Pin Positions	

Table 3-6: RS-232 Pin Assignments

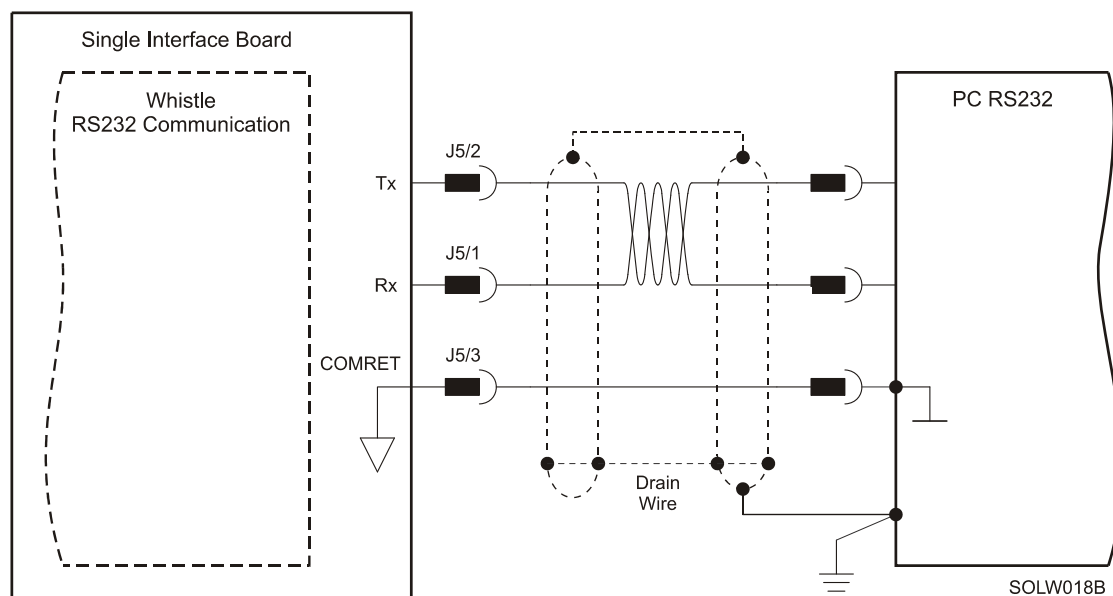


Figure 3-20: RS-232 Connection Diagram

3.9.2 CANopen Communication



Notes for connecting the CANopen 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-Ohm resistor termination at each of the two ends of the network cable.
- The Solo Whistle's CAN ports are **non-isolated**.

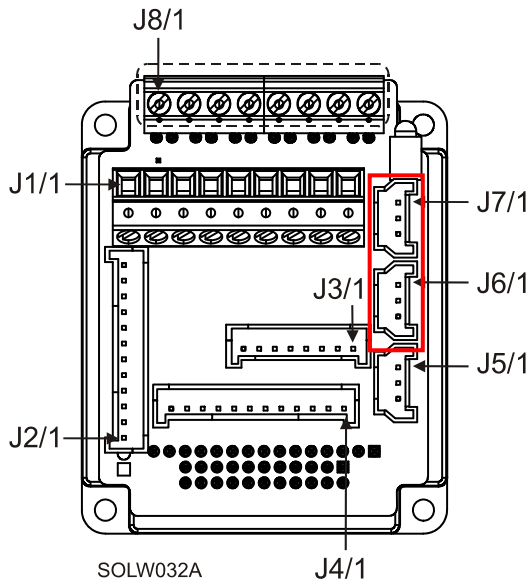
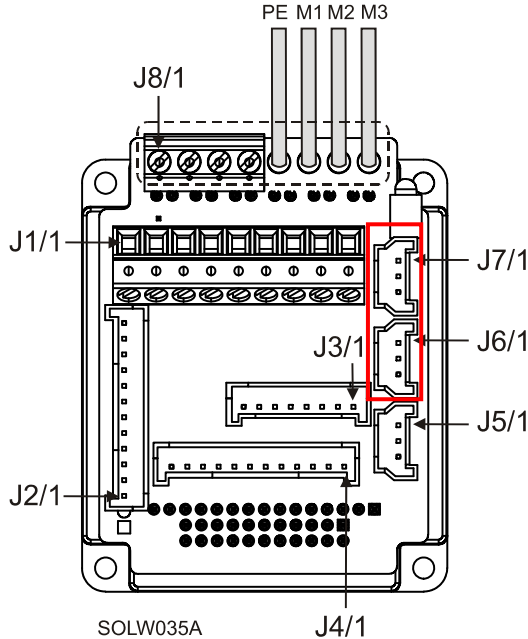
Pin CANIN	Pin CANOUT	Signal	Function
J6/1	J7/1	CAN_GND	CAN ground
J6/2	J7/2	CAN_L	CAN_L busline (dominant low)
J6/3	J7/3	CAN_H	CAN_H busline (dominant high)
Pin Positions			
 SOLW032A		 SOLW035A	

Table 3-7: CANopen - Pin Assignments

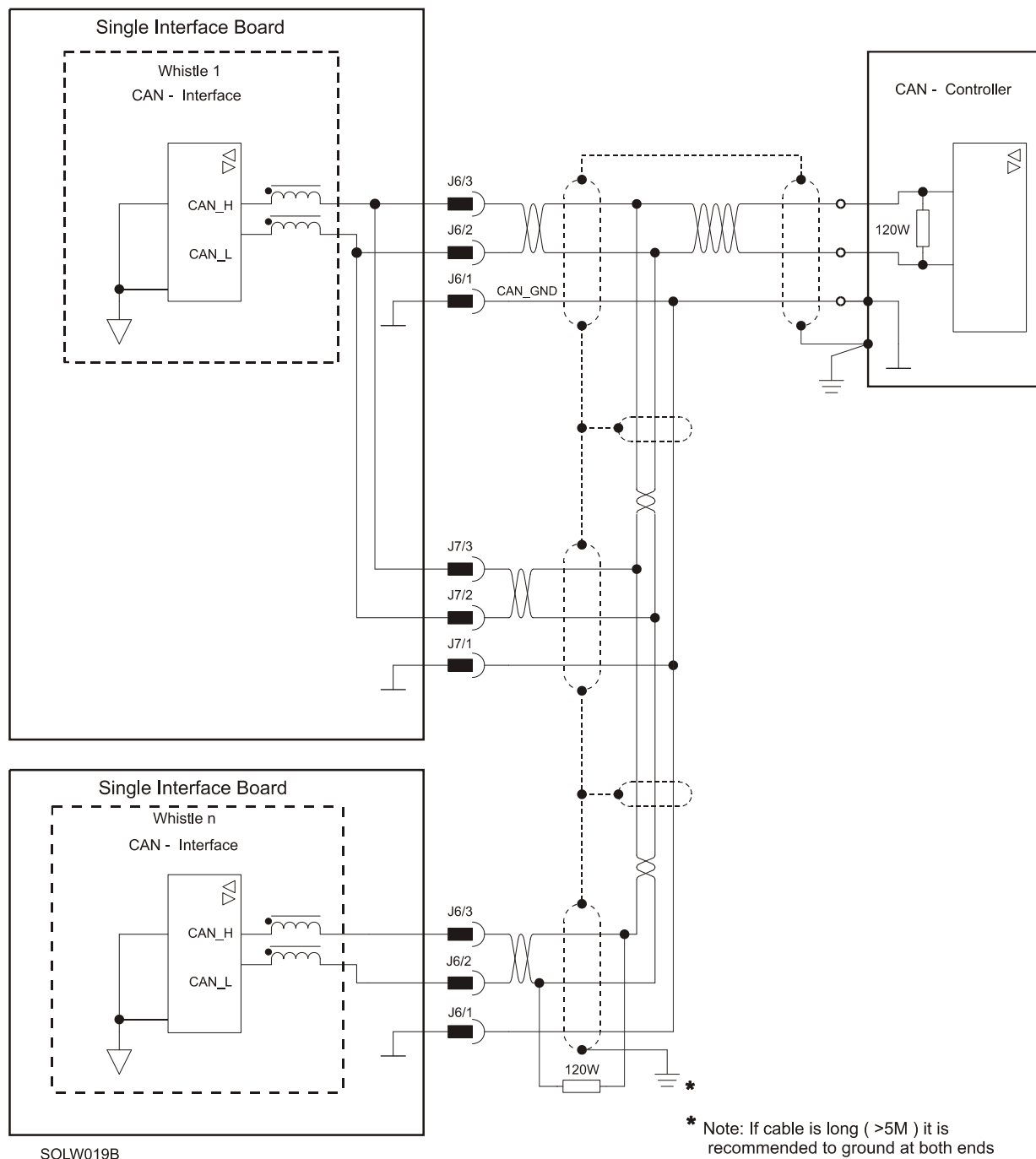


Figure 3-21: CANopen Network Diagram

**Caution:**

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

3.10 Powering Up

After the Solo Whistle 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.

3.11 Initializing the System

After the Solo Whistle 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*.

3.12 Heat Dissipation

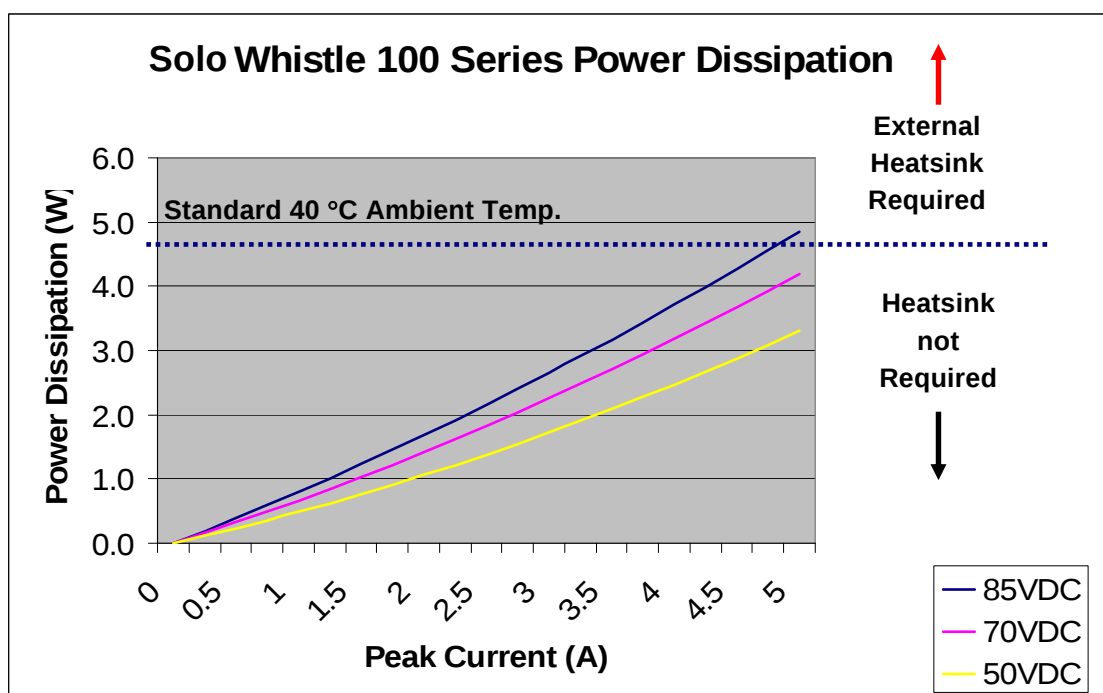
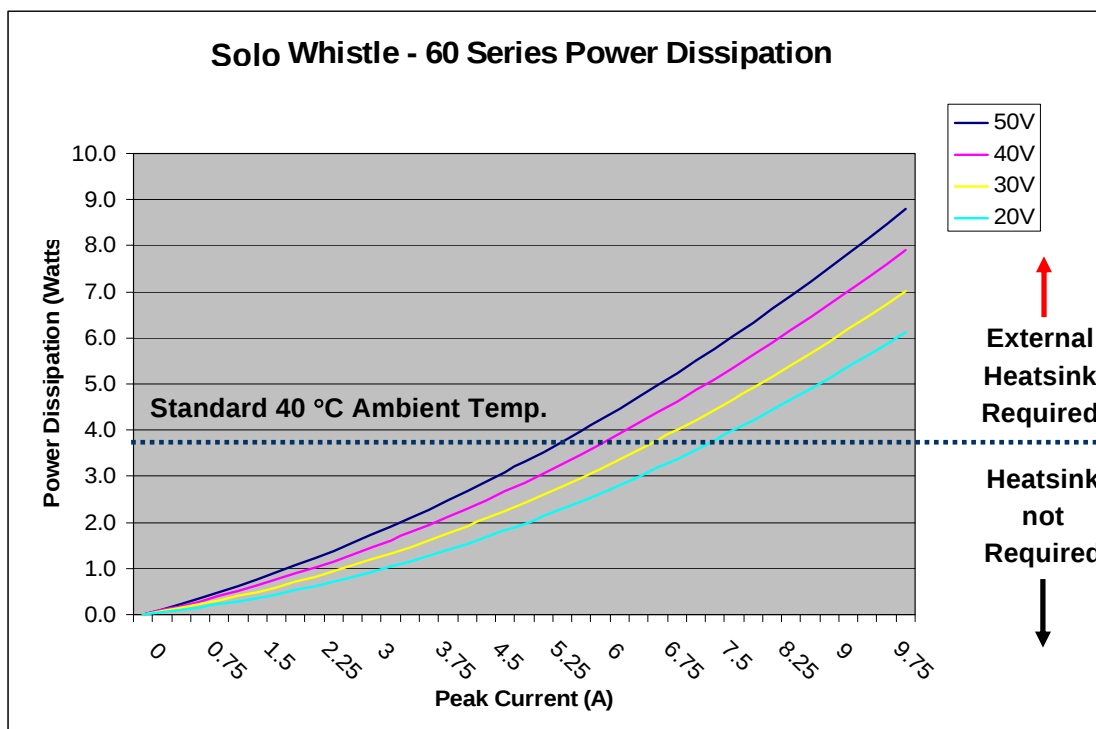
The best way to dissipate heat from the Solo Whistle is to mount it so that its heat sink faces up. For best results leave approximately 10 mm of space between the Solo Whistle's heat sink and any other assembly.

3.12.1 Solo Whistle Thermal Data

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

3.12.2 Heat Dissipation Data

Heat dissipation is shown in graphically below:



3.12.3 How to Use the Charts

The charts above are based upon theoretical worst-case conditions. Actual test results show 30% - 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 Whistle.
3. Calculate the allowable temperature increase as follows:
 - For an ambient temperature of 40 °C , $\Delta T = 80^{\circ}\text{C} - 40^{\circ}\text{C} = 40^{\circ}\text{C}$
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 Whistle 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.

Appendix: Solo Whistle Technical Specifications

A.1 Features

A.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

A.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, PWM current and velocity

A.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

A.1.4 Fully Programmable

- Third generation programming structure with motion commands - "Metronome"
- Event capturing interrupts
- Event triggered programming

A.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 10~15 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.

A.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

A.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

A.1.8 Accessories

- Heat sinks

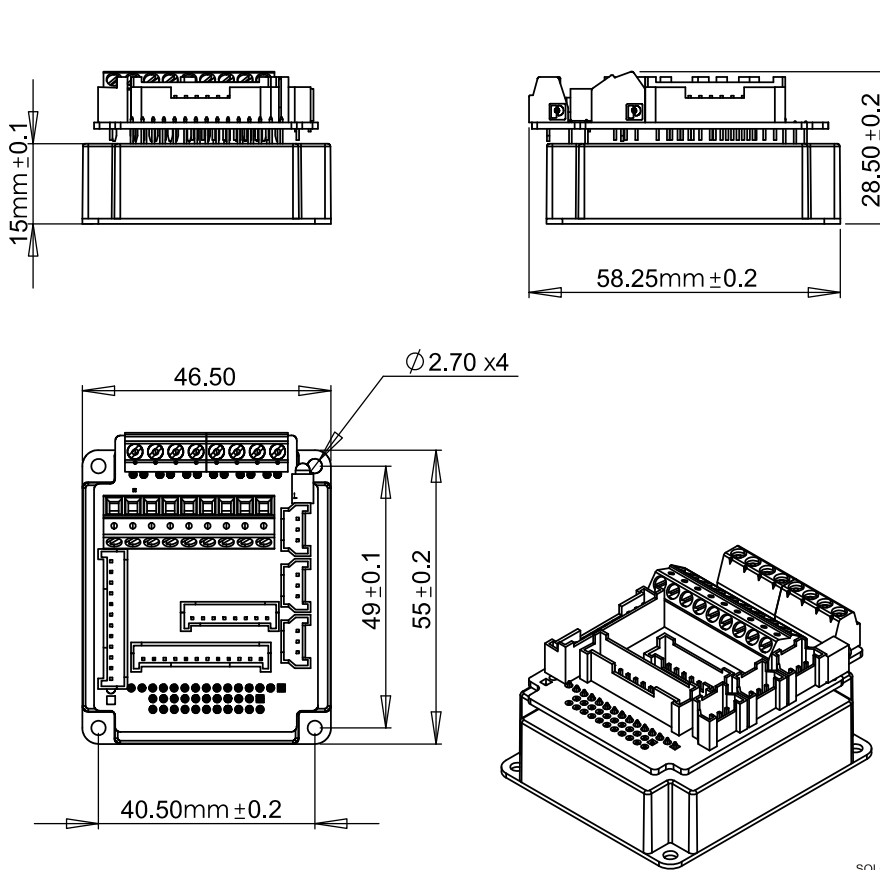
A.1.9 Status Indication

- Output for a bi-color LED

A.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

A.2 Solo Whistle Dimensions



SOL006A.SLDDRW
SOLW030A

Feature	Units	15/48	20/48	1/60	2.5/60	5/60	10/60	15/60	20/60	1/100	2.5/100	5/100	10/100	15/100	20/100
Minimum supply voltage	VDC	6													
Nominal supply voltage	VDC	42													
Maximum supply voltage	VDC	48													
Maximum continuous power output	W	600	800	50	120	240	480	720	960	80	200	400	800	1200	1600
Efficiency at rated power (at nominal conditions)	%	> 99													
Maximum output voltage		> 95% of DC bus voltage at f=22 kHz													
Auxiliary power supply	VDC	11 – 95 VDC (up to 2.5 VA inc. 5 V/200 mA for encoder)													
Amplitude sinusoidal/DC continuous current	A	15	20	1	2.5	5	10	15	20	1	2.5	5	10	15	20
Sinusoidal continuous RMS current limit (I _c)	A	10.6	14.1	0.7	1.8	3.5	7	10.6	14.1	0.7	1.8	3.5	7	10.6	14.1
Peak current limit	A	2 x I _c													
Weight	g (oz)	68.4 g (2.4 oz)													
Dimensions	mm (in)	58.25 x 28.5 x 46.5 (2.3" x 1.1" x 1.8")													
Digital in/Digital out/ Analog in		4/2/1													

A.3 Environmental Conditions

Feature	Details
Ambient operating temperature	0 °C ~ 40 °C (32 °F ~ 104 °F)
Storage temperature	-20 °C ~ +85° C (-4 °F ~ +185 °F)
Maximum humidity	90% non-condensing
Maximum operating altitude	Up to 10,000 m (30,000 ft)
Protection level	

A.3.1 Auxiliary Supply

Feature	Details
Auxiliary power supply	<i>Isolated DC source only</i>
Auxiliary supply input voltage	12 VDC ~ 95 VDC
Auxiliary supply input power	< 2.5 VA (this includes the 5 V/200 mA load for the main encoder only)

A.4 Control Specifications

A.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 - 120 µsec
Current sampling rate	Up to 16 kHz; default 11 kHz

A.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 (sin/cos) 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 - 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.

A.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 - 480 µsec (4x current loop sample time)
Position loop sampling rate	Up to 4 kHz; default 2.75 kHz

A.5 Feedbacks

A.5.1 Feedback Supply Voltage

The Solo Whistle 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 $\pm 5\%$ @ 200 mA maximum

A.5.2 Main Feedback Options

A.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

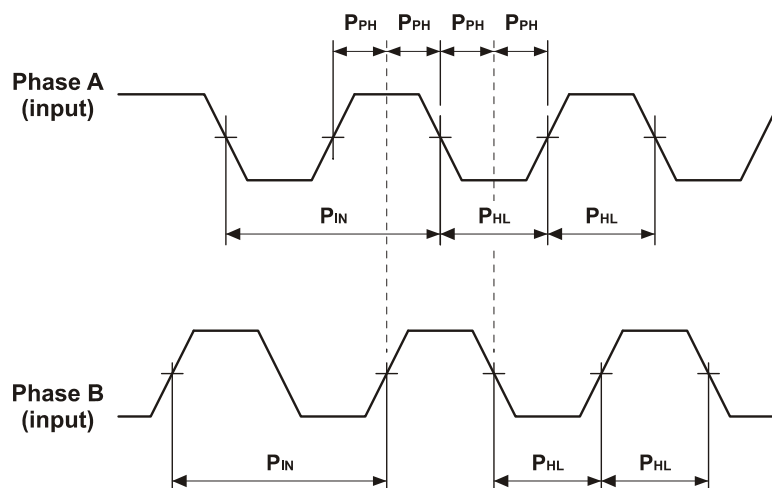


Figure A-1: Main Feedback - Encoder Phase Diagram

A.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: $0\text{ V} < V_{\text{In_Hall}} < 5\text{ V}$ Maximum absolute: $-1\text{ V} < V_{\text{In_Hall}} < 15\text{ V}$ High level input voltage: $V_{\text{InHigh}} > 2.5\text{ V}$ Low level input voltage: $V_{\text{InLow}} < 1\text{ V}$
Input current	Sink current (when input pulled to the common): 3mA Source current: 1.5 mA (designed to also support open collector Halls)
Maximum frequency	$f_{\text{MAX}} : 2\text{ kHz}$

A.5.2.3 Interpolated Analog Encoder (Sine / Cosine)

Feature	Details
Analog encoder format	Sine and Cosine signals
Analog input signal level	▪ Offset voltage: 2.2 V – 2.8 V ▪ Differential, 1 V peak to peak
Input resistance	Differential 120 Ω
Maximum analog signal frequency	$f_{\text{MAX}} : 250\text{ kHz}$
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 (A.5.3)

A.5.2.4 Resolver

Feature	Details
Resolver format	▪ Sine/Cosine ▪ Differential
Input resistance	Differential 2.49 k Ω
Resolution	Programmable: 10 ~ 15 bits

Feature	Details
Maximum electrical frequency (RPS)	512 revolutions/sec
Resolver transfer ratio	0.5
Reference frequency	$1/T_s$ (T_s = sample time in seconds)
Reference voltage	Supplied by the Solo Whistle
Reference current	Up to ± 50 mA
Encoder outputs	See Auxiliary Encoder Output specifications (A.5.3)

A.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 k Ω
Input resistance for TAC2+, TAC2-	100 k Ω
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.

A.5.2.6 Potentiometer

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

A.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

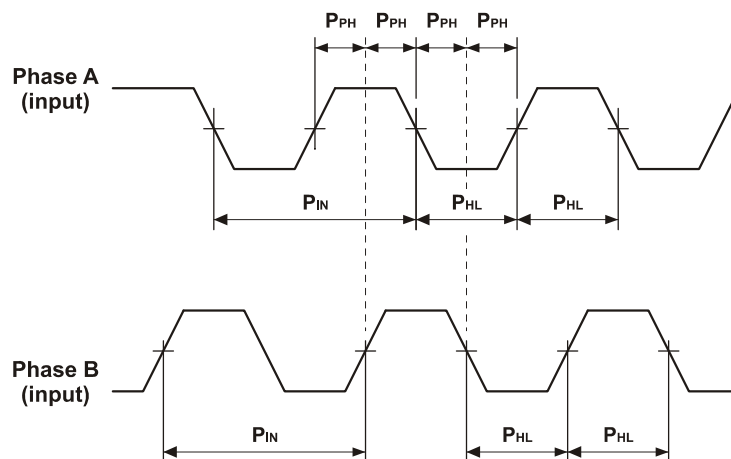


Figure A-2: Auxiliary Feedback - Encoder Phase Diagram

A.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	$V_{in} \text{ Low: } 0 \text{ V} < V_{IL} < 0.8 \text{ V}$ $V_{in} \text{ High: } 2 \text{ V} < V_{IH} < 5 \text{ V}$ Maximum absolute voltage: $0 < V_{in} < 5.5 \text{ V}$ Input current: $\pm 1 \mu\text{A}$
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

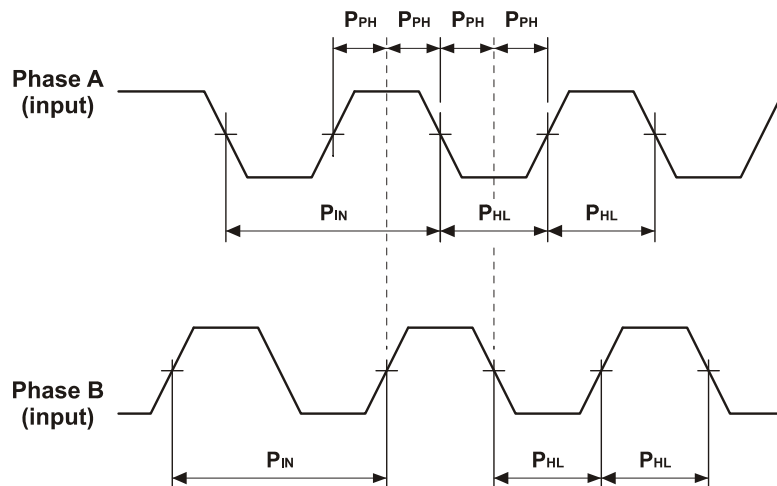


Figure A-3: Auxiliary Feedback - Encoder Phase Diagram

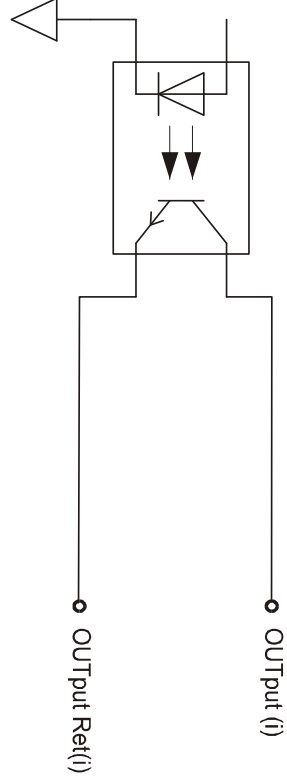
A.6 I/Os

The Solo Whistle has 4 Digital Inputs, 2 Digital Outputs and 1 Analog Input.

A.6.1 Digital Input Interfaces

Feature	Details	Schematic Diagram
Type of input	- Optically isolated - All four inputs share one signal return line	Digital Input Schematic
Input current for 5V DI level	$R_{in}=1.43K, I_{in} = 2.8 \text{ mA} @ V_{in} = 5 \text{ V}$	
Input current for 24V DI level	$R_{in}=10.52k, I_{in} = 2.2 \text{ mA} @ V_{in} = 24 \text{ V}$	
High-level input voltage	$5 \text{ V} < V_{in} < 24 \text{ V}$	
Low-level input voltage	$0 \text{ V} < V_{in} < 1 \text{ V}$	
Minimum pulse width	$> 4 \times TS$, 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: $0 < T < 4 \times TS$ If input is set to General input, execution depends on program. Typical execution time: $\cong 0.5 \text{ msec}$.	
High-speed inputs – 5 & 6 minimum pulse width, in high-speed mode	$T < 5 \mu\text{sec}$ 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.	

A.6.2 Digital Output Interface

Feature	Details	Connector Location
Type of output	- Optically isolated - Open collector and open emitter	 <i>Digital Output Schematic</i>
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	
RL	External resistor RL must be selected to limit output current to no more than 10 mA. $R_L = \frac{V_{cc} - VOL}{I_o(max)}$	
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.	

A.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

A.7 Communications

Specification	Details
RS-232	Signals: - RxD , TxD , Gnd - Full duplex, serial communication for setup and control. - Baud Rate of 9,600 ~ 57,600 bit/sec.
CANopen	CANbus 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

A.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)

A.9 Standards Compliance

A.9.1 Quality Assurance

Specification	Description
ISO 9001:2000	Quality Management

A.9.2 Design

Specification	Description
MIL-HDBK- 217F	Reliability prediction of electronic equipment (rating, de-rating, stress, etc.)
- IPC-D-275 - IPC-SM-782 - IPC-CM-770 - UL508c - UL840	Reliability prediction of electronic equipment (rating, de-rating, stress, etc.) Printed wiring for electronic equipment (clearance, creepage, spacing, conductors sizing, etc.)
In compliance with VDE0160-7 (IEC68)	Type testing

A.9.3 Safety

Specification	Description
In compliance with UL508c	Power conversion equipment
In compliance with UL840	Insulation coordination, including clearance and creepage distances of electrical equipment
In compliance with UL60950	Safety of information technology equipment, including electrical business equipment
In compliance with EN60204-1	Low voltage directive, 72/23/EEC

A.9.4 EMC

Specification	Description
In compliance with EN55011 and EN61000	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment. Electromagnetic compatibility (EMC)

A.9.5 Workmanship

Specification	Description
In compliance with IPC-A-610 , level 3	Acceptability of electronic assemblies

A.9.6 PCB

Specification	Description
In compliance with IPC-A-600 , level 2	Acceptability of printed circuit boards

A.9.7 Packing

Specification	Description
In compliance with EN100015	Protection of electrostatic sensitive devices

A.9.8 WEEE *

Specification	Description
In compliance with 2002/96/EC	Waste Electrical and Electronic Equipment regulations

* Please send out-of-service Elmo drives to the nearest Elmo sales office.

A.9.9 RoHS

Specification	Description
In compliance with 2002/95/EC (effective July 2006)	Restrictions on Application of Hazardous Substances in Electric and Electronic Equipment

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