SimpIIQ Line

Solo Trombone
Digital Servo Drive
Installation Guide

October 2017 (Ver. 1.205)

Elmo
Motion Control

www.elmomc.com

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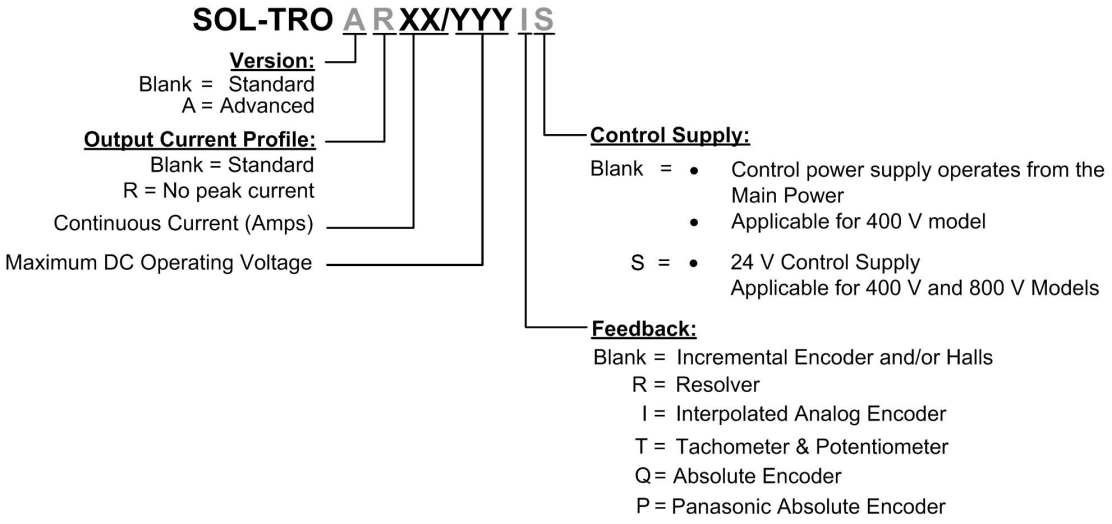
Catalog Number



Revision History

Version		Details
1.0		Initial release
1.1		Update to site requirements. Sections 4.3 and 4.3.1: Auxiliary Supply Voltage range: 18 V to 30 V.
1.2	September 2012	Change the overvoltage in 800 V mode, Pin layout, UL recognition, and further optional versions added Updated the Section 1.3: Directives and Standards and Section 4.11 (Compliance with Standards). “Metronome” was replaced by the “Composer” software.
1.201	February 2013	Added a caution and recommendation on the type of cleaning solution to use for the Elmo unit.
1.202	June 2014	Document update
1.203	July 2014	General document update
1.204	March 2016	General document update
1.205	October 2017	Updated the Warranty Information section 1.5 and the part number label in section 3.2

Elmo Worldwide

Head Office

Elmo Motion Control Ltd.
60 Amal St., P.O. Box 3078, Petach Tikva 4951360
Israel

Tel: +972 (3) 929-2300 • Fax: +972 (3) 929-2322 • info-il@elmomc.com

North America

Elmo Motion Control Inc.
42 Technology Way, Nashua, NH 03060
USA

Tel: +1 (603) 821-9979 • Fax: +1 (603) 821-9943 • info-us@elmomc.com

Europe

Elmo Motion Control GmbH
Hermann-Schwer-Strasse 3, 78048 VS-Villingen
Germany

Tel: +49 (0) 7721-944 7120 • Fax: +49 (0) 7721-944 7130 • info-de@elmomc.com

China

Elmo Motion Control Technology (Shanghai) Co. Ltd.
Room 1414, Huawen Plaza, No. 999 Zhongshan West Road, Shanghai (200051)
China

Tel: +86-21-32516651 • Fax: +86-21-32516652 • info-asia@elmomc.com

Asia Pacific

Elmo Motion Control APAC Ltd.
B-601 Pangyo Innovalley, 621 Sampyeong-dong, Bundang-gu, Seongnam-si, Gyeonggi-do,
South Korea (463-400)

Tel: +82-31-698-2010 • Fax: +82-31-801-8078 • info-asia@elmomc.com

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Chapter 1: Safety Information

In order to operate the Solo Trombone servo drive safely, 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 Trombone and accompanying equipment.

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

Before you start, make sure 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 Trombone 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

Employ the following:

- To avoid electric arcing and hazards to personnel and electrical contacts, never connect/disconnect the servo drive while the power source is on.
- Disconnect the Solo Trombone from all voltage sources before it is opened for servicing.
- The Solo Trombone 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). It is recommended to measure the electrical contact points with a meter before touching the equipment.

1.2. Cautions

- The Solo Trombone 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 to Solo Trombone to an approved isolated 24 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 Trombone, 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 Trombone 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 Trombone conforms 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 Trombone 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 Trombone 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 Trombone 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 Trombone is an integrated solution designed to simply and efficiently connect Elmo's Trombone servo drive directly to the application. The solution consists of the Trombone 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 Trombone servo drive and the steps for its wiring, installation and power-up. Follow these guidelines to ensure maximum functionality of the drive and the system to which it is connected.

2.1. Drive Description

The Solo Trombone series of digital servo drives are highly resilient and designed to deliver the highest density of power and intelligence. The Solo Trombone delivers up to **10 kW of continuous power** or **16 kW of peak power** in a compact package.

The digital drives are based on Elmo's advanced SimplIQ motion control technology. They operate 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. They are designed for use with any type of sinusoidal and trapezoidal commutation, with vector control. The Solo Trombone 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 drives are 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 Trombone, as part of the SimplIQ product line, is fully programmable with Elmo's Composer motion control language.

Power to the drives is provided by a DC power source (not included with the Solo Trombone).

Since the power stage is fully isolated from the control stage, the DC rectifier can be fed directly from the mains, without the need for a bulky and expensive transformer.

If backup functionality is required to store control parameters in the event of a mains power outage, then an S-model Solo Trombone should be used, with an external 24 VDC isolated supply connected to it.

Note: The backup functionality can operate from an isolated voltage source within the range of 18 to 30 VDC.

Whenever backup functionality is not required, Solo Trombone models *without* the catalog number S suffix can be used (only for 400 V model). These models have a smart control-supply algorithm that enables the Solo Trombone to operate with only the main power supply VP+ and VN-, and a 24 VDC auxiliary power supply is unnecessary for the logic.

The Solo Trombone is available in two versions:

- The Standard Solo Trombone is a basic servo drive which operates in current, velocity, and position modes including Follower and 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 catalog number starts SOL-TRO but is not followed by an A.)
- The Advanced Solo Trombone includes all the motion capabilities and communication options included in the Standard model, as well as advanced positioning capabilities: ECAM, Dual Loop and increased program size. (The catalog number starts SOL-TROA.)

Both versions operate with RS-232 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
- Position follower mode for monitoring the motion of the slave axis relative to a master axis, via an auxiliary encoder input
- Pulse-and-direction inputs
- 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

Depending on the application, Solo Trombone users can select from two communication options:

- RS-232 serial communication
- CAN for fast communication in a multi-axis distributed environment

2.2.6. Feedback Options

- Incremental Encoder – up to 20 Megacounts (5 Megapulses) per second
- Digital Halls – up to 2 kHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Megacounts 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
  - Auxiliary emulated, unbuffered, single-ended, encoder output
- Resolver
  - Programmable 10 to 15 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Auxiliary emulated, unbuffered, single-ended, encoder output
- Tachometer, Potentiometer
- Absolute Encoders
  - Heidenhain 2.1
  - Stegmann
  - Panasonic

Note: Elmo drives provide supply voltage for all the feedback options.

2.2.7. Fault Protection

The Solo Trombone 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
- Safe Torque OFF (STO) –optional per customer requirement

2.3. System Architecture

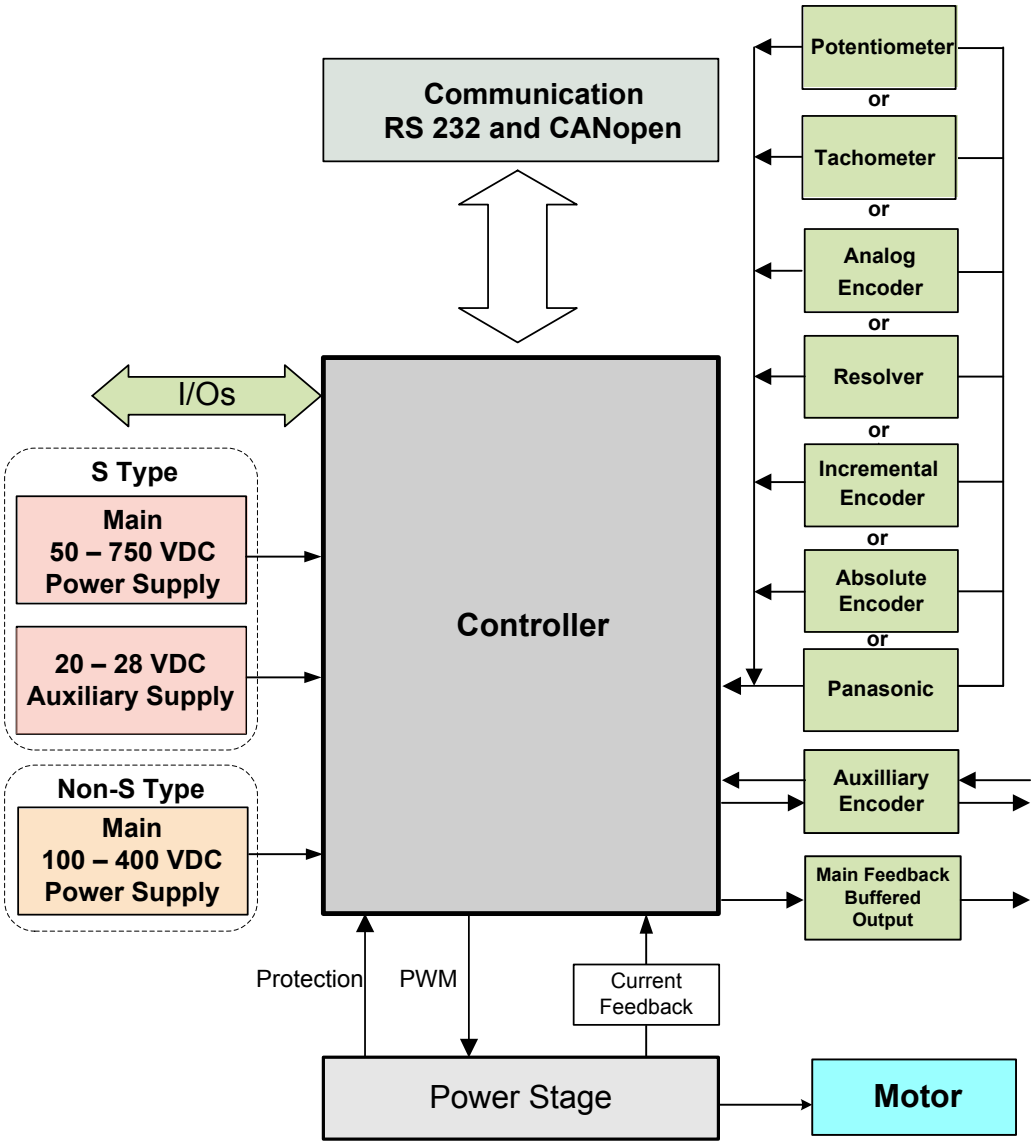


Figure 1: Solo Trombone System Block Diagram

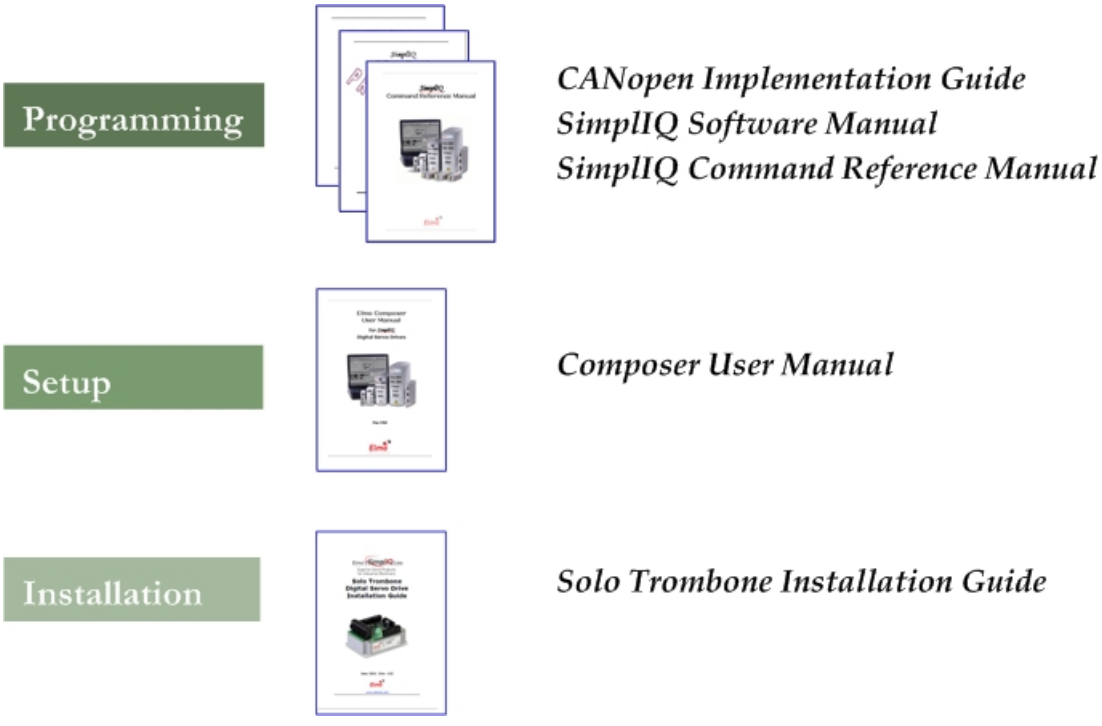
2.4. How to Use this Guide

In order to install and operate the Solo Trombone servo drive, 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 Trombone
- Chapter 4 - *Technical Specifications*, lists all the drive ratings and specifications

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



Chapter 3: Installation

Warning:
The Solo Trombone must be:

- installed in a suitable environment and properly connected to its voltage supplies and the motor.
- mounted and confined within a metal enclosure.

3.1. Before You Begin

3.1.1. Site Requirements

You can guarantee the safe operation of the Solo Trombone 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 operating altitude	2,000 m (6562 feet)
Maximum relative humidity	90% non-condensing
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	

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

3.2. Unpacking the Drive Components

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

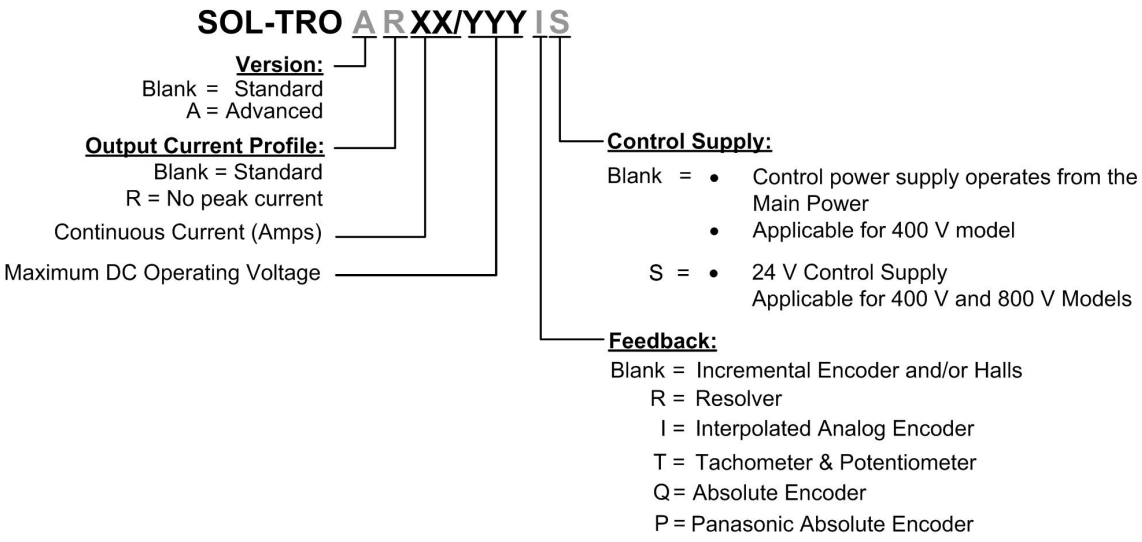
- The Solo Trombone servo drive
- The Composer software and software manual

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

To unpack the Solo Trombone

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 Trombone you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Solo Trombone.
   It looks like this:

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



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

3.3. Pinouts

The Solo Trombone has nine connectors.

3.3.1. Connector Types

The Solo Trombone has the following types of connectors:

No. Pins	Type	Port	Function
2	5.08 mm Pitch	J18	Aux connection
7	8 mm Pitch	J14	Power + Motor Power
4	2.54 mm Pitch	J5	Motor (Brake, PTC)
20	2.54 mm Pitch	J7	I/O
3	2.54 mm Pitch	J22	Not in use
12	2.54 mm Pitch	J3	Communication
16	2.54 mm Pitch	J10	Main Feedback
8	2.54 mm Pitch	J9	Main Feedback Buffered Output
16	2.54 mm Pitch	J6	Auxiliary Feedback
Connector Locations			

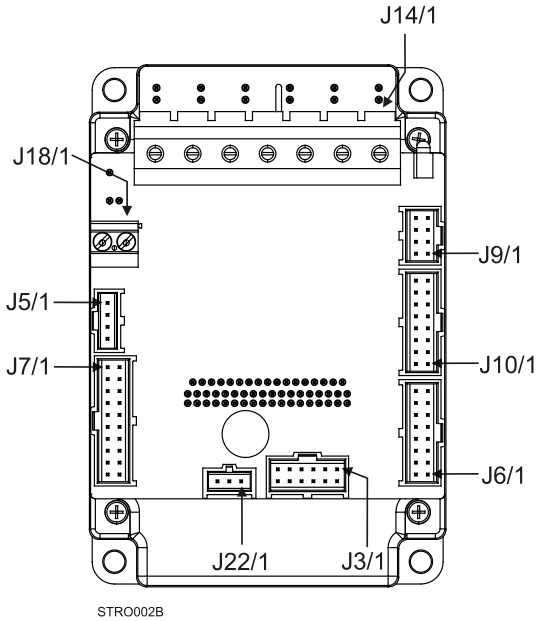


Table 1: Connector Types for the Solo Trombone

3.3.2. Main Power and Motor Power

The Solo Trombone receives power from main and auxiliary supplies and delivers power to the motor.

3.3.2.1. S Type Drives

Pin	Function	Cable	
Auxiliary 24 VDC Control Supply			
VL-	Neg. Aux. input	Control Power	
VL+	Pos. Aux. input	Control Power	
Power			
VP+	Pos. Power input	DC Power	
VN-	Neg. Power input	DC Power	
PE	Protective earth	DC Power	
Motor		**AC**	**DC**
PE	Protective earth	Motor	Motor
M1	Motor phase	Motor	N.C
M2	Motor phase	Motor	Motor
M3	Motor phase	Motor	Motor
Connector Location			

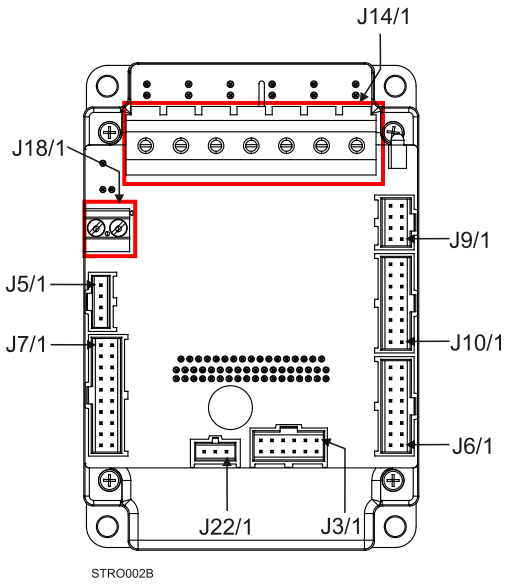


Table 2: Connectors for Main DC Power, Backup Supply and Motor Cable –S Type Drives

Note: When connecting several motors, all the motor phases must be connected in an identical sequence.

3.3.2.2. Non-S 400 VDC Type Drives

Pin	Function	Cable	
Not used			
VL-	N.C.		
VL+	N.C.		
Power			
VP+	Pos. Power input	DC Power	
VN-	Neg. Power input	DC Power	
PE	Protective earth	DC Power	
Motor		**AC**	**DC**
PE	Protective earth	Motor	Motor
M1	Motor phase	Motor	N.C
M2	Motor phase	Motor	Motor
M3	Motor phase	Motor	Motor
Connector Location			

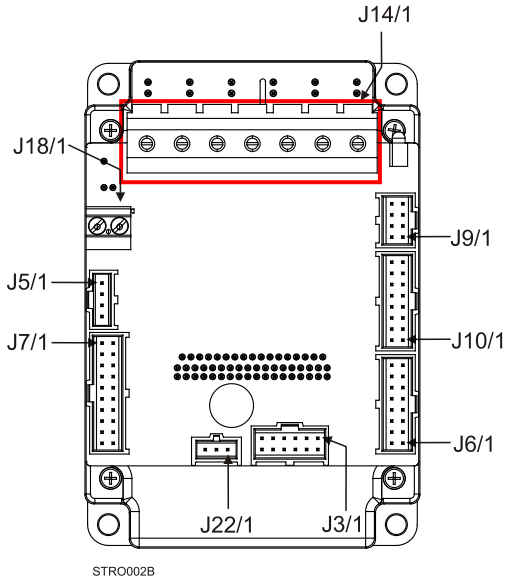


Table 3: Connectors for Main DC Power and Motor Cable – in Non-S 400 VDC type drives

Note: When connecting several motors, all the motor phases must be connected in an identical sequence.

3.3.3. Connecting Motor Power

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

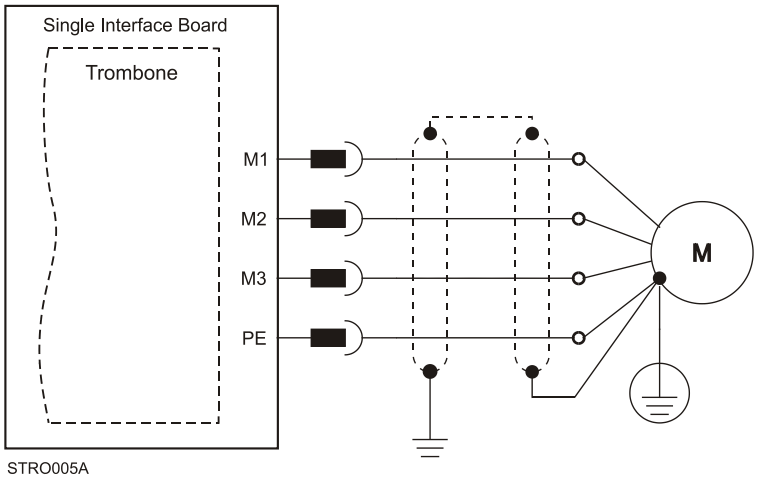


Figure 2: AC Motor Power Connection Diagram

3.3.3.1. Connecting the DC Power

The DC power for the Solo Trombone is delivered from a separated rectifying unit (supplied by the user). The following sections contain topology recommendations for implementing three-phase and a single-phase supply chains. Elmo offers the end-user the option to purchase its Tambourine rectifier, which offers a range of versatile options.

The power stage of the Solo Trombone is fully isolated from the other Solo Trombone sections, such as the control-stage and the heat sink. This isolation allows the user to connect the common of the control section to the PE, a connection that significantly contributes to proper functionality, safety and EMI immunity, leading to better performance of the Solo Trombone.

In addition, this isolation simplifies the requirements of the DC power supply used to power the DC bus of the Solo Trombone, by allowing it to operate with a non-isolated DC power source (a direct-to-mains connection) therefore eliminating the need for a bulky and expensive isolation transformer.

However, as well as operating from a non-isolated/direct-to-mains DC power supply, the Solo Trombone can also operate from an isolated power supply or batteries.

When rectifying an AC voltage source, the AC voltage level must be limited to 270 VAC so as not to exceed the maximum 390 VDC in the case of a 400 VDC drive, or 528 VAC so as not to exceed the maximum 747 VDC in the case of an 800 VDC drive.

If the Solo Trombone is connected to Elmo's Tambourine power supply, the end-user can exploit the Tambourine's options, such as EMI-filtering and shunt-regulator.

3.3.3.2. Direct-to-Mains Power Source (Non-Isolated Rectifier)

This section relates to the configuration of the power supply and drive, which are directly connected to the Mains.

Note for connecting the non-isolated DC power supply:

1. For best immunity, it is highly recommended to use twisted cables for the DC power supply cable. A 3-wire shielded cable should be used. The gauge is determined by the actual current consumption of the motor.
2. Connect both ends of the cable shield to the closest PE connections.
3. Tie one end to the power supply's PE terminal/ heat sink, and tie the other end either to the PE terminal of the Solo Trombone's power-connector, or attach it to one of the four mounting screws of the drive's heat sink.

3.3.3.2.a Three-Phase Direct-to-Mains Connection Topology

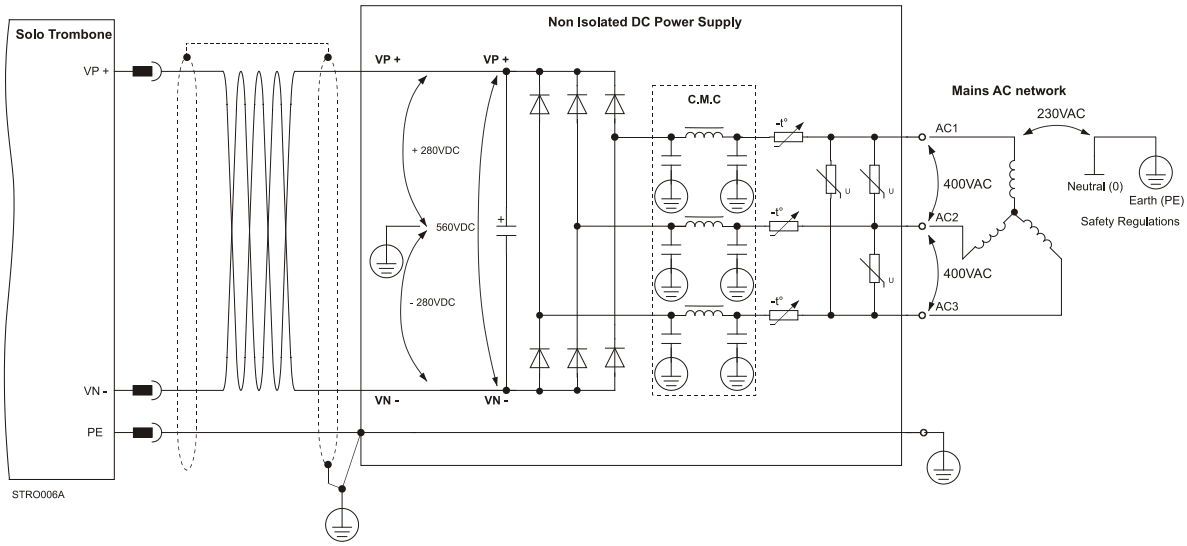


Figure 3: Non-Isolated Three-Phase Connection Topology

Caution:

- Do not connect VN- to PE. **In a direct-to-mains connection the VN- must *not* be connected to the PE,** as this will cause irreparable damage to the system.
- Be careful and note that in a direct-to-mains connection, the Neutral point is *not* the most negative voltage level. It is the mid-point level of the rectified DC bus.

3.3.3.2.b Single-Phase Direct-to-Mains Connection Topology

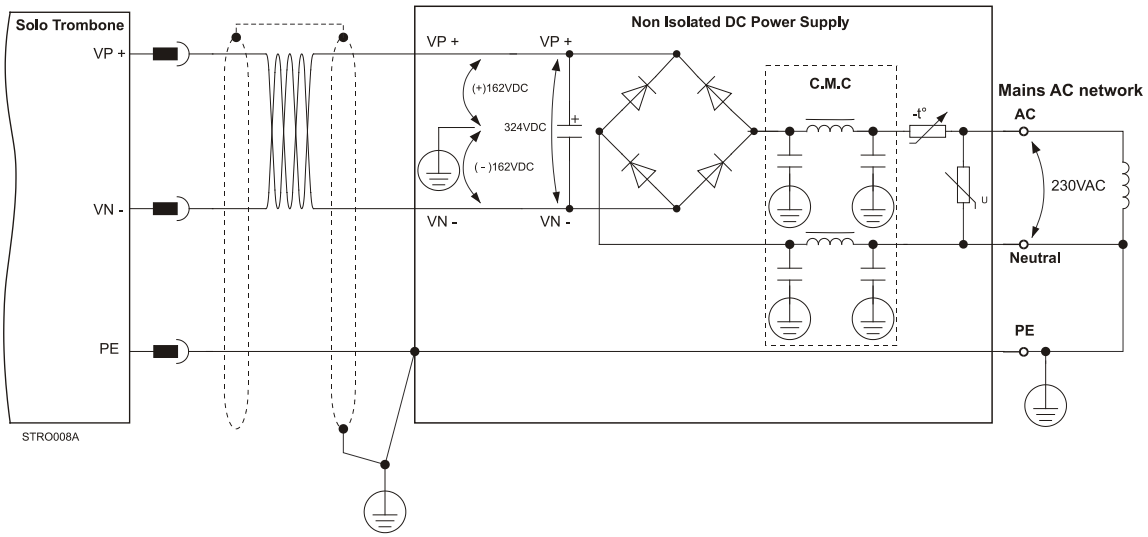


Figure 4: Non-Isolated Single-Phase Connection Topology

The Power Supply is connected directly to the Mains AC line.

Warning:

- Do not connect VN- to PE. **In a direct-to-mains connection the VN- must *not* be connected to the PE.** Connecting the VN- to the PE will cause irreparable damage to the system.
- Be careful and note that in a direct-to-mains connection, the Neutral point is *not* the most negative voltage level. It is the mid-point level of the rectified DC bus.

3.3.3.2.c Multiple Connections Topology

In a multi-axis application, it is likely that a single power supply can feed several drives in parallel.

This topology is rather economic, by reducing the number of power supplies and wiring, but most importantly, it utilizes an "energy-sharing" environment among all the drives that are sharing the same DC bus network.

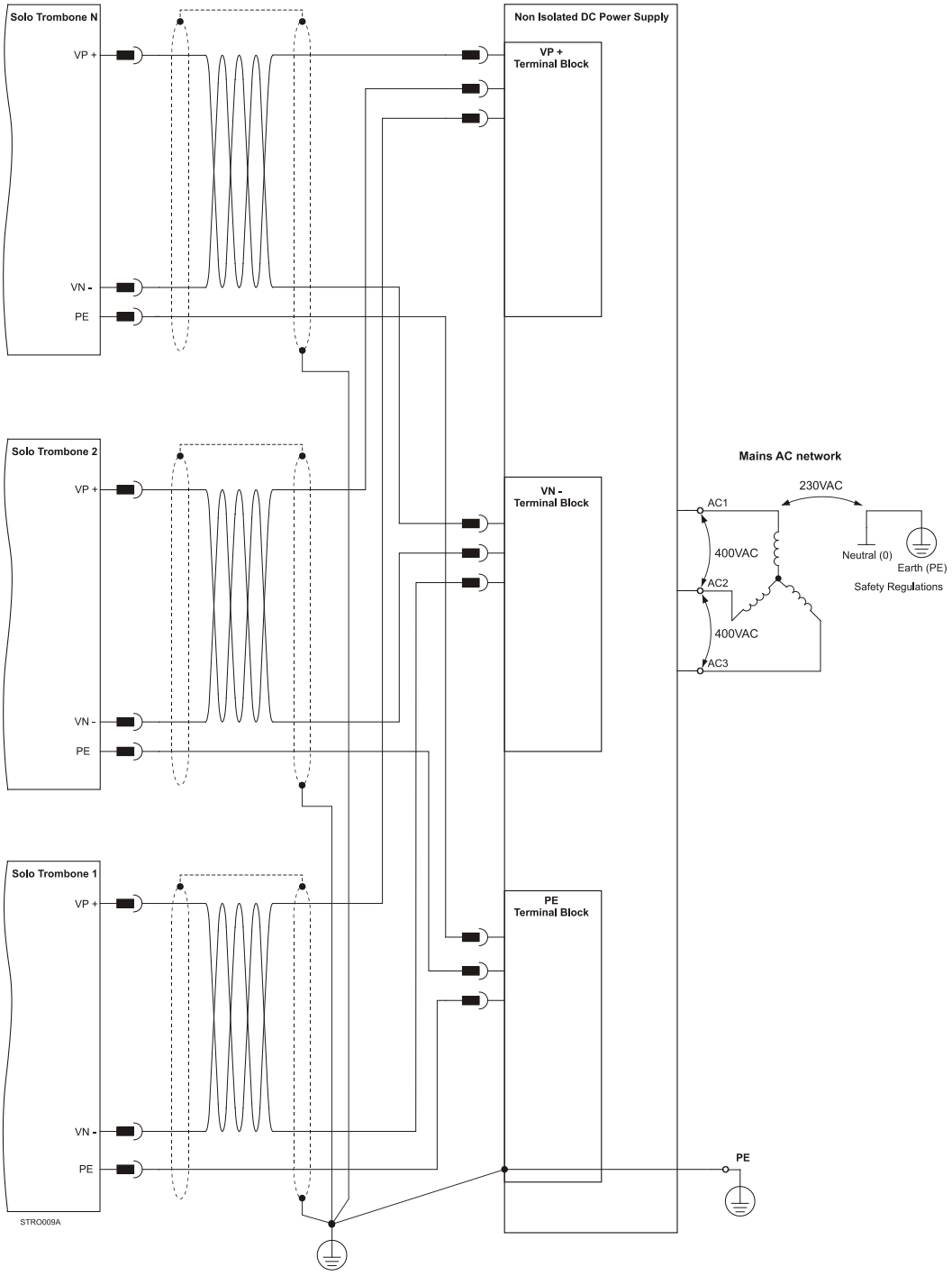


Figure 5: Non-Isolated Three-Phase multiple Connection Topology

The power supply is connected directly to the mains AC line and feeds more than one drive.

3.3.3.3. Battery Power Supply

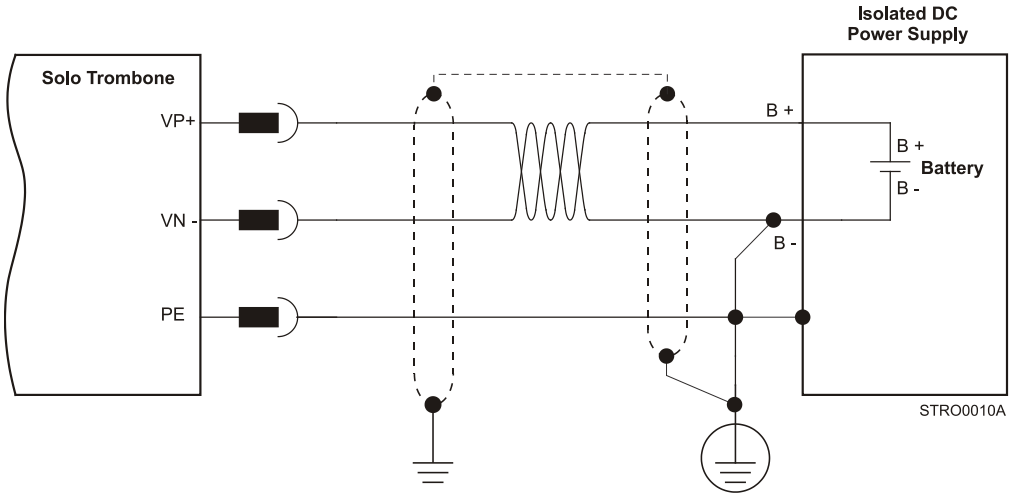


Figure 6: Battery Connection Topology

Caution:

When using batteries, it is recommended to connect the negative pole to the PE.

When doing so, the charger of the battery **must** be isolated from the mains by an isolation transformer.

3.3.4. Connecting the Control and Backup Supply (24 V)

In a non-S type Solo Trombone drive (a drive without the suffix S in its part number), a “smart” control-supply algorithm enables the Solo Trombone to operate with the main power supply only, *with no need for an auxiliary supply voltage for supplying the drive's logic section*.

Note that in such model there is no backup ability at all.

If backup functionality is required to store control parameters in the event of main power outages, then the S type Solo Trombone should be used, with an external 24 VDC isolated power supply connected to it.

Note that the S type Solo Trombone always requires an external 24 VDC power supply, regardless if backup functionality in required or not.

Connect the auxiliary 24 VDC power supply as described below.

Note for 24 VDC backup supply connections:

1. Use a 24 AWG twisted pair shielded cable. The shield should have copper braid.
2. The source of the 24 VDC backup supply must be isolated, by using an isolation transformer.
3. For safety and EMI reasons, connect the return of the 24 VDC backup supply to the closest ground (PE).
4. Connect the cable shield to the closest ground (PE) near the power source.
5. Before applying power, first verify the correct polarity of the connection.

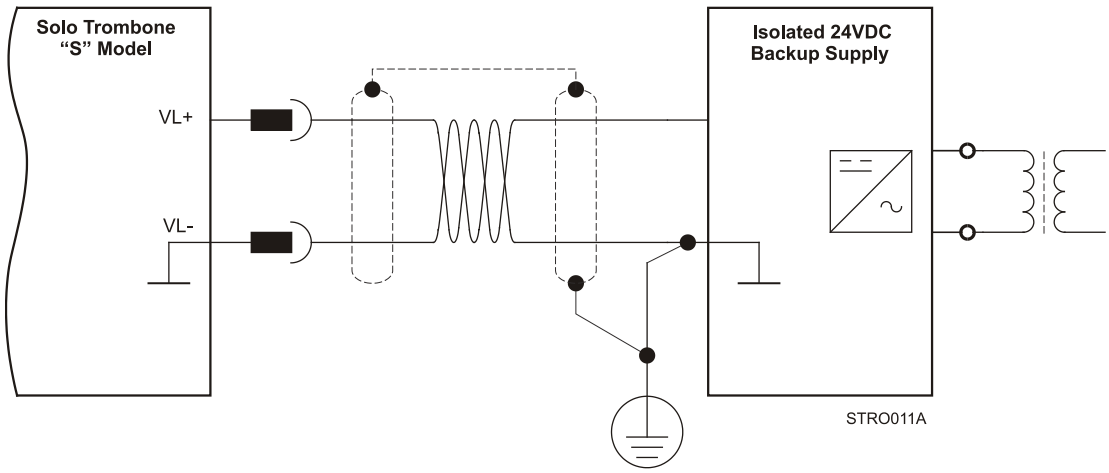


Figure 7: Auxiliary 24 VDC Backup Supply Connection Diagram

3.3.5. Motor (Brake, PTC)

Pin (J5)	Signal	Function
1	BRAKE -	Brake (-) (coming from the motor)
2	BRAKE +	Brake (+) (coming from the motor)
3	PTC	Motor Protection Sensor (coming from the motor)
4	PTC	Motor Protection Sensor (coming from the motor)
Pin Positions		

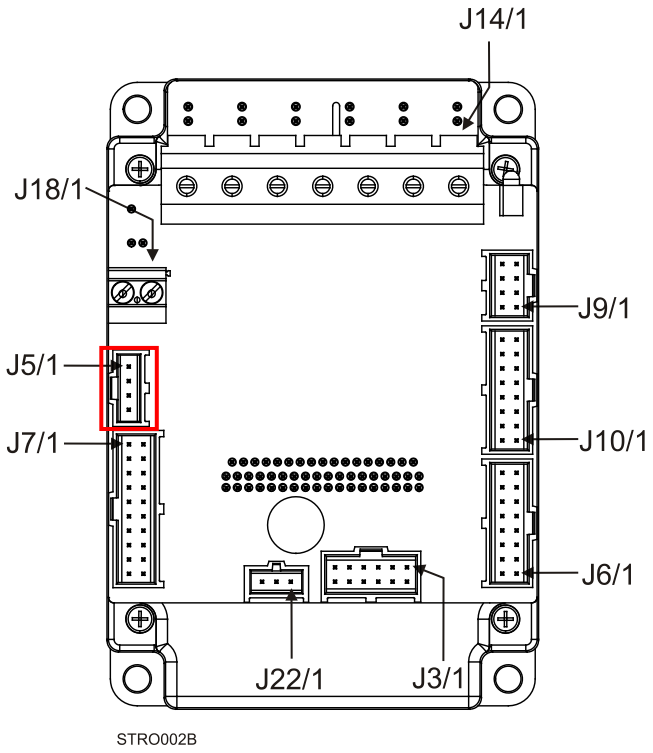


Table 4: The Motor Brake and PTC Connector

3.3.6. Main Feedback

The main feedback cable is used to transfer feedback data from the motor to the drive.

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

- Incremental encoder only
- Incremental encoder with digital Hall sensors
- Digital Hall sensors only
- Interpolated Analog (Sine/Cosine) encoder (option)
- Resolver (option)
- Tachometer (option)
- Potentiometer (option)
- Absolute Encoder (Heidenhain 2.1 or Stegmann)
- Panasonic absolute encoder

	Incremental Encoder		Interpolated Analog Encoder		Resolver		Tachometer and Potentiometer	
	SOL-ARTROXX/YYY_		SOL -ARTROXX/YYYI		SOL -ARTROXX/YYYR		SOL -ARTROXX/YYYT	
Pin (J10)	Signal	Function	Signal	Function	Signal	Function	Signal	Function
14	HC	Hall sensor C input	HC	Hall sensor C input	NC	-	HC	Hall sensor C input
12	HA	Hall sensor A input	HA	Hall sensor A input	NC	-	HA	Hall sensor A input
15	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return
2	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply
4	CHA-	Channel A complement	A-	Sine A complement	S3	Sine A complement	Tac 1-	Tacho Input 1 Neg. (20 V max)
3	CHA	Channel A	A+	Sine A	S1	Sine A	Tac 1+	Tacho Input 1 Pos. (20 V max)
8	INDEX-	Index complement	R-	Reference complement	R2	Vref complement f= 1/TS, 50 mA Maximum	NC	-
7	INDEX	Index	R+	Reference	R1	Vref f=1/TS, 50 mA Max.	POT	Potentiometer Input
1	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return
11	HB	Hall sensor B input	HB	Hall sensor B input	NC	-	HB	Hall sensor B input
6	CHB-	Channel B complement	B-	Cosine B complement	S4	Cosine B complement	Tac 2-	Tacho Input 2 Neg. (50 V max)
5	CHB	Channel B	B+	Cosine B	S2	Cosine B	Tac 2+	Tacho Input 2 Pos. (50 V max)

Table 5: Main Feedback Cable Pin Assignments (Part A)

Absolute Encoders				
	SOL -ARTROXX/YYYQ			SOL -ARTROXX/YYYP
Pin (J10)	**Signal**	**Heidenhain**	**Stegmann**	**Panasonic**
14	HC	Hall C	Hall C	Hall C
12	HA	Hall A	Hall A	Hall A
15	SUPRET	Supply return	Supply return	Supply return
2	+5V	EnDat (Heidenhain) Encoder +5 supply	Halls supply +5V	Encoder +5 supply
4	A-	Sine A complement	Sine A	Sine A complement
3	A+	Sine A	Sine A complement	Sine A
8	DATA-	Data complement	Data complement	Data complement
7	DATA+	DATA	DATA	DATA
1	SUPRET	Supply return	Supply return	Supply return
11	HB	Hall B	Hall B	Hall B
10	CLK-	CLOCK complement	-	-
16	+8V	-	Stegmann Encoder +8V supply 8 V @90 mA maximum	-
9	CLK+	CLOCK	-	-
6	B-	Cosine B complement	Cosine B complement	Cosine B complement
5	B+	Cosine B	Cosine B	Cosine B
Pin Positions				

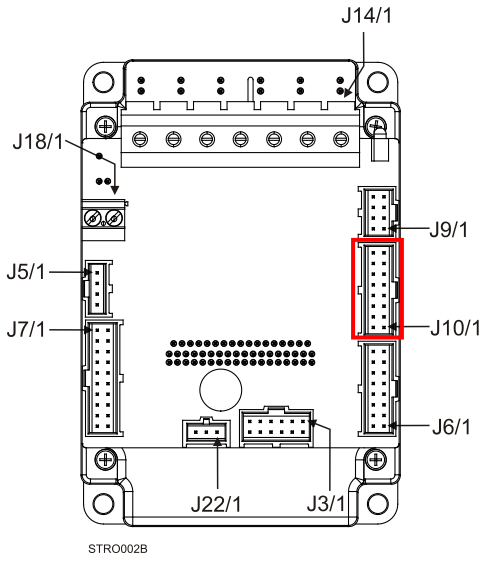


Table 6: Main Feedback Cable Pin Assignments (Part B)

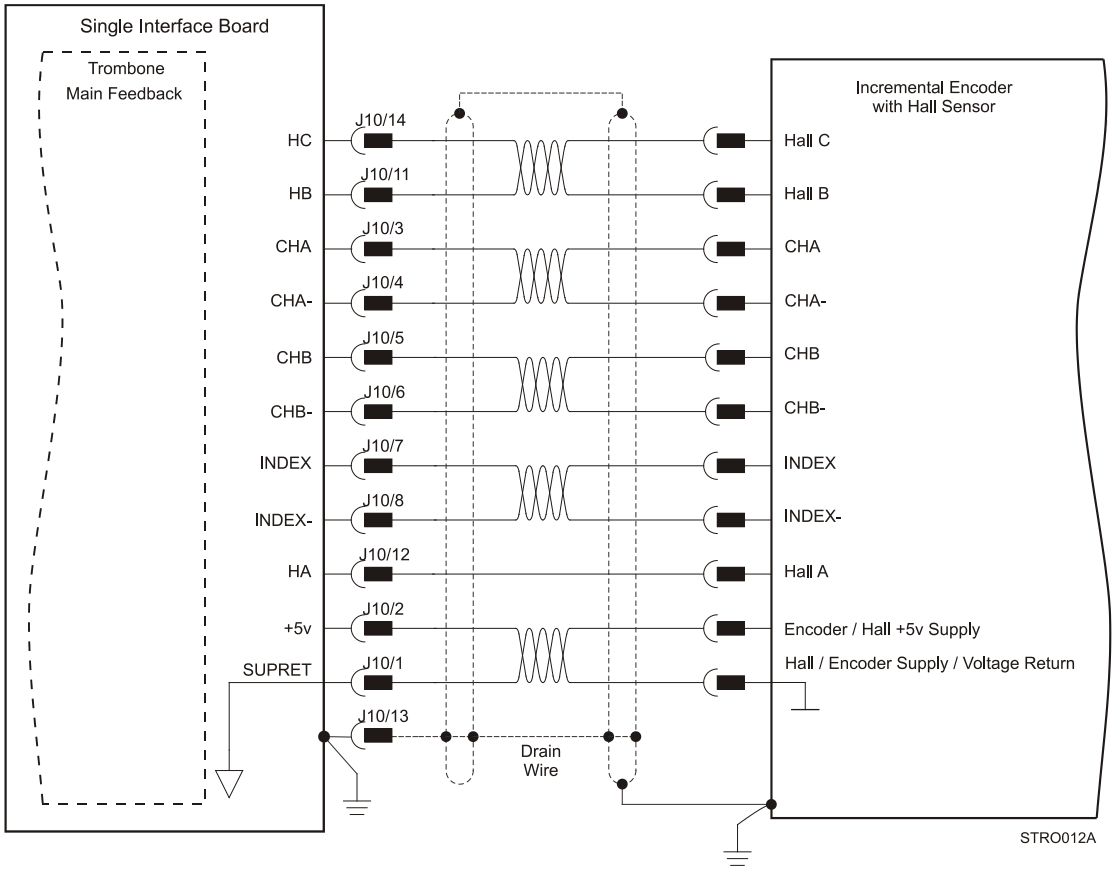


Figure 8: Main Feedback – Incremental Encoder with Digital Hall Sensors Connection Diagram

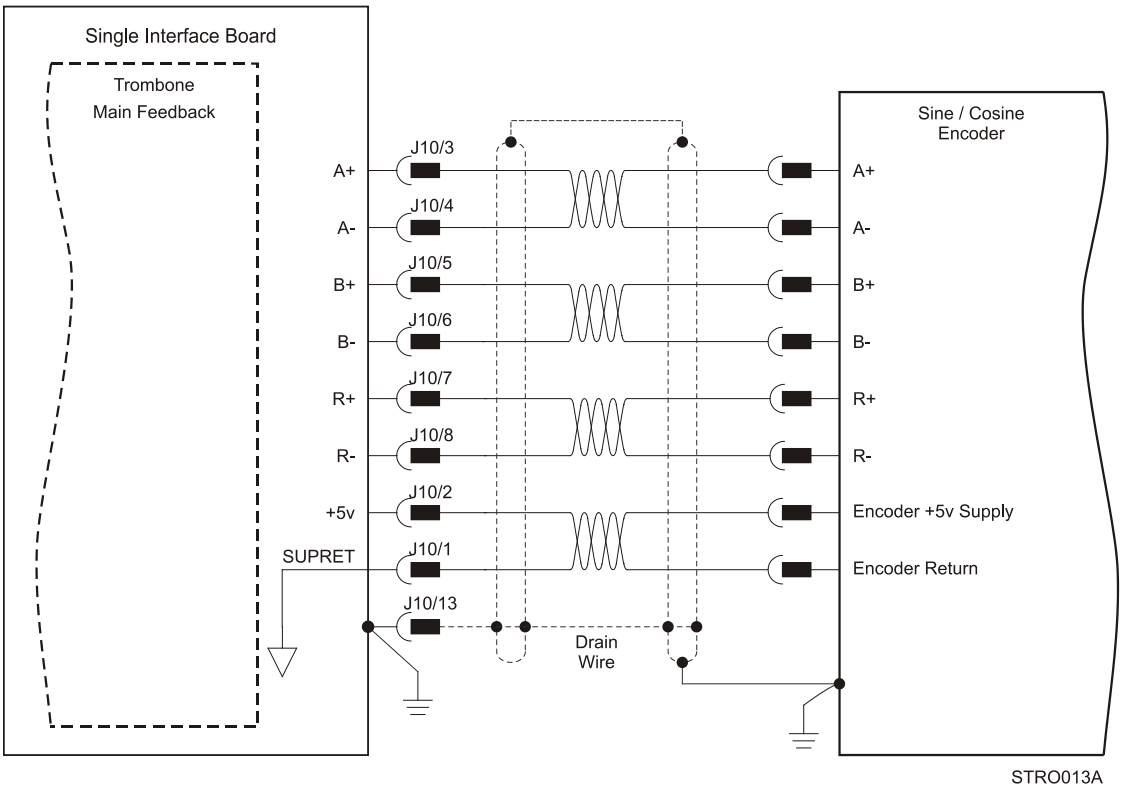


Figure 9: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder Connection Diagram

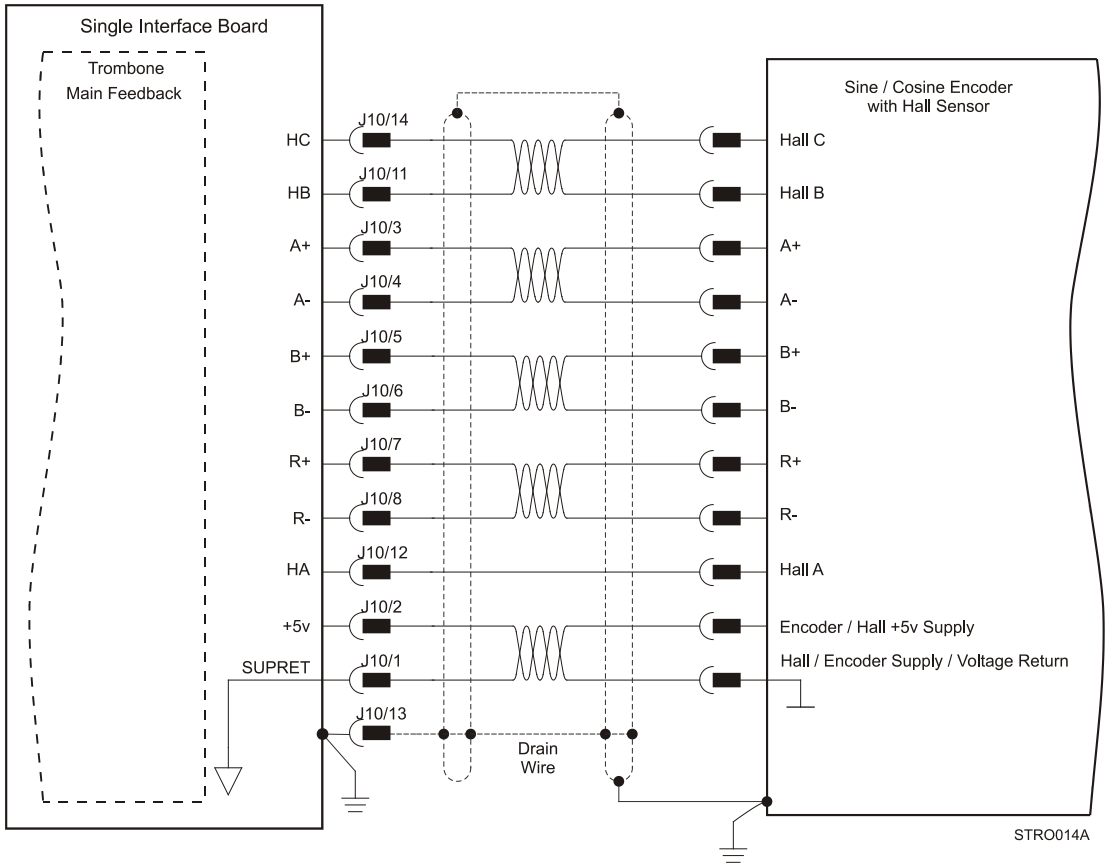


Figure 10: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder with Digital Hall Sensors Connection Diagram

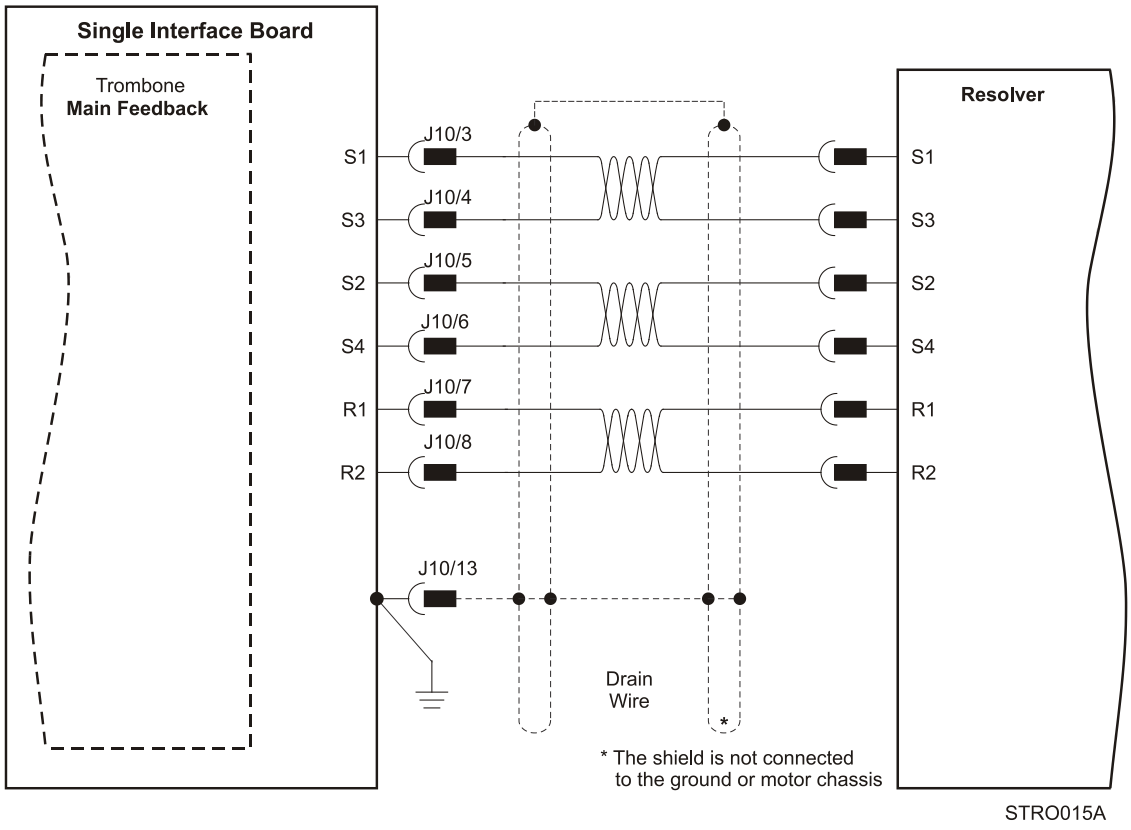


Figure 11: Main Feedback – Resolver Connection Diagram

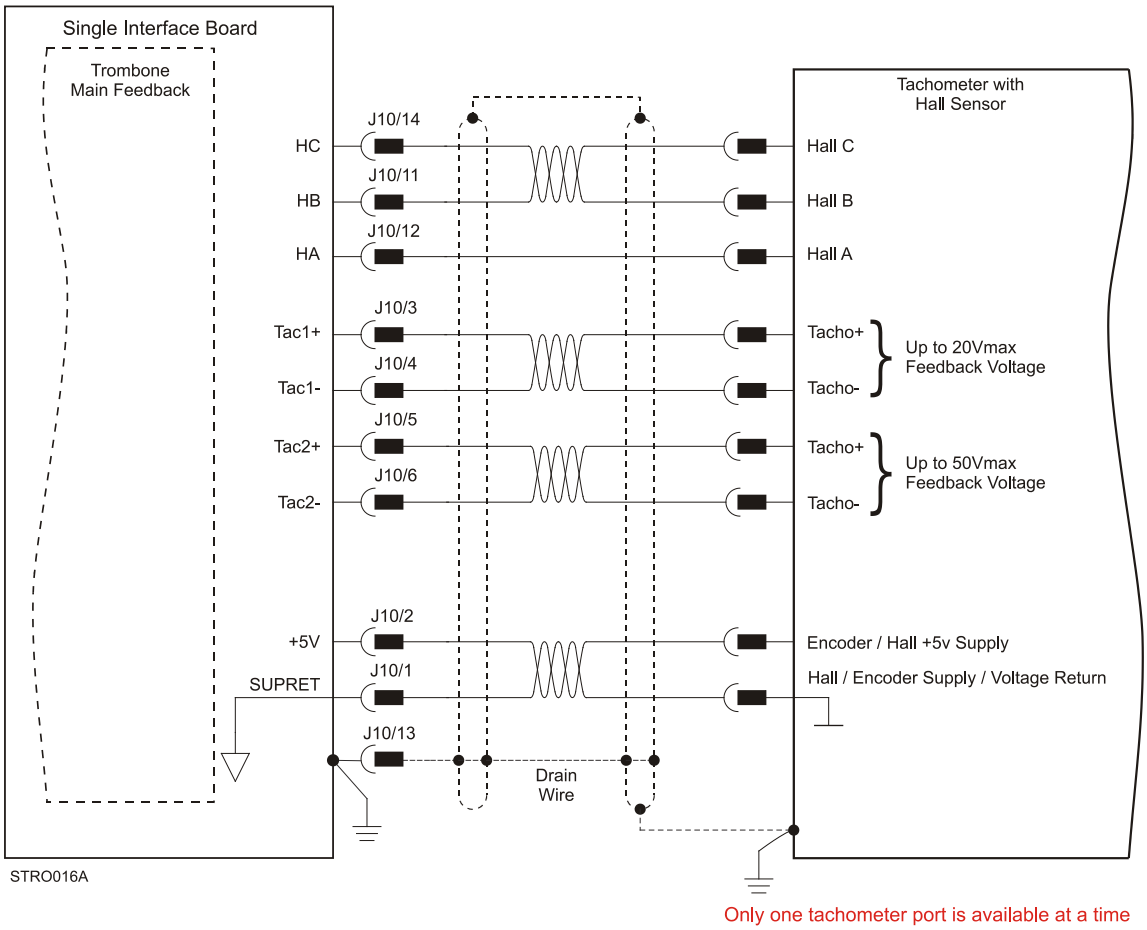


Figure 12: Main Feedback – Tachometer Feedback with Digital Hall Sensors Connection Diagram for Brushless Motors

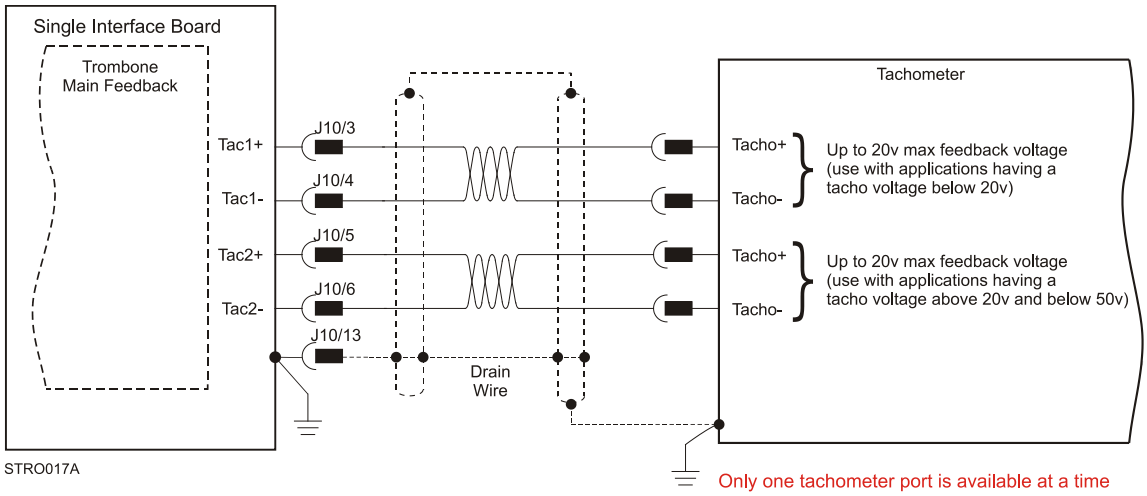


Figure 13: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors

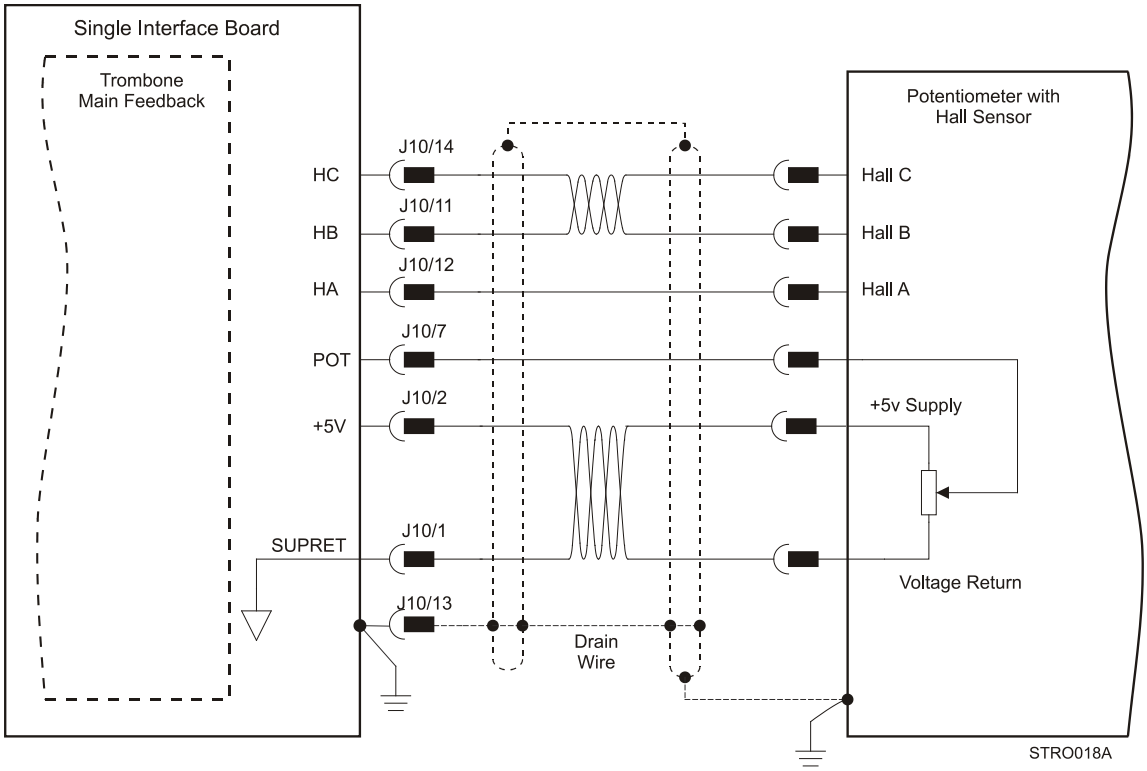


Figure 14: Main Feedback – Potentiometer Feedback with Digital Hall Sensors Connection Diagram for Brushless Motors

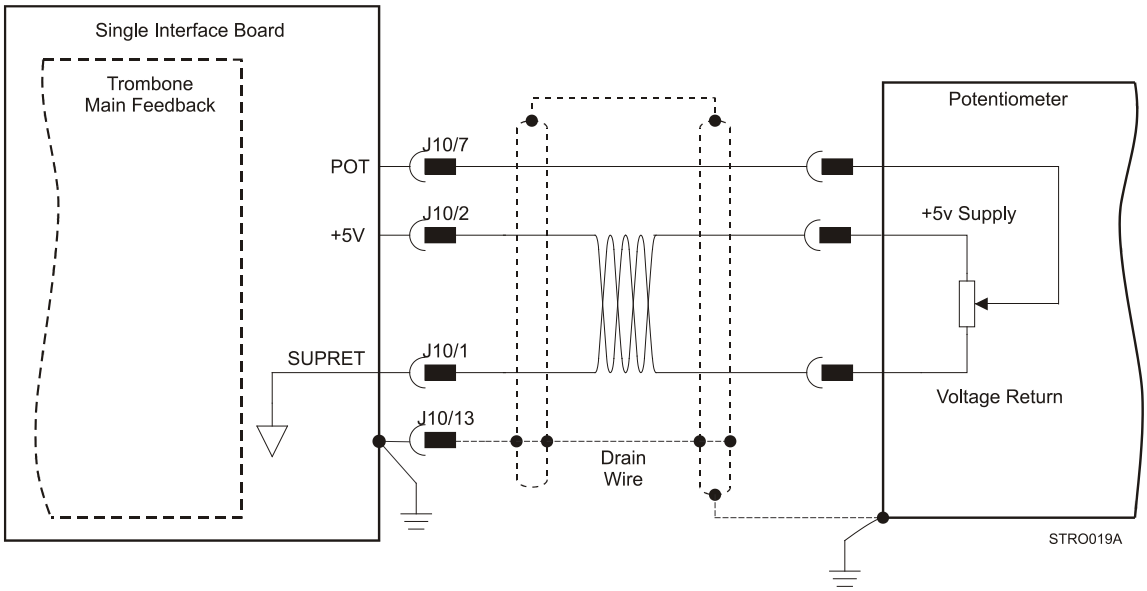


Figure 15: Main Feedback –
Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils

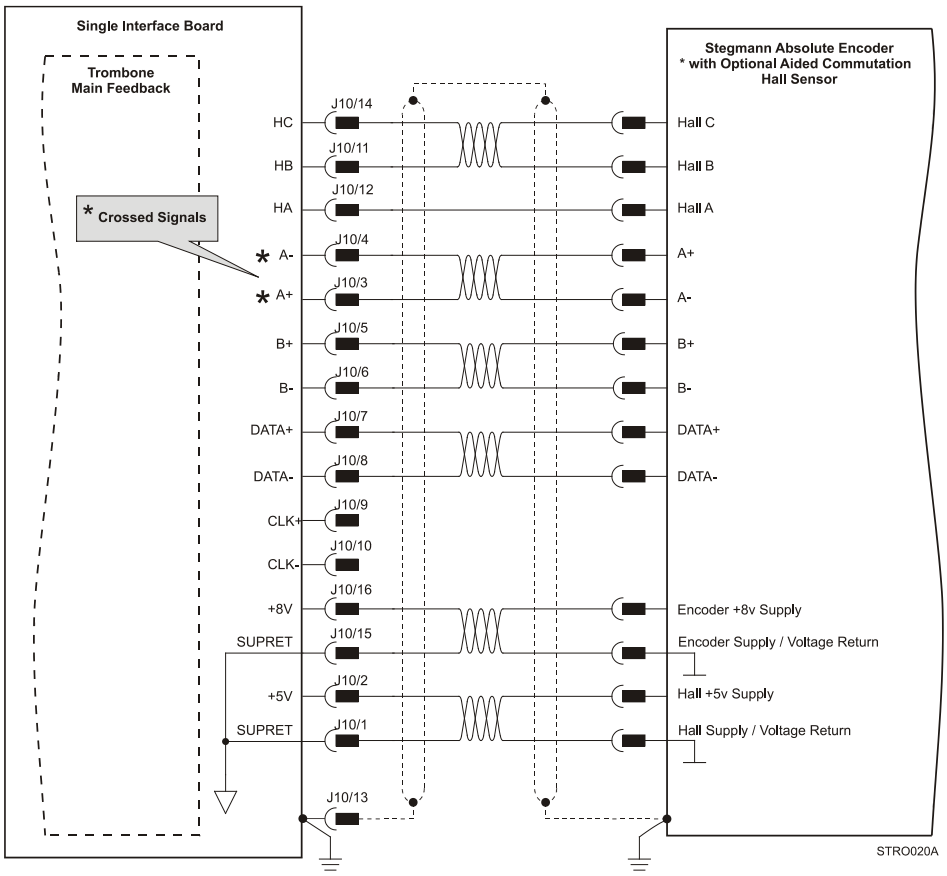


Figure 16: Main Feedback – Stegmann Feedback Connection Diagram

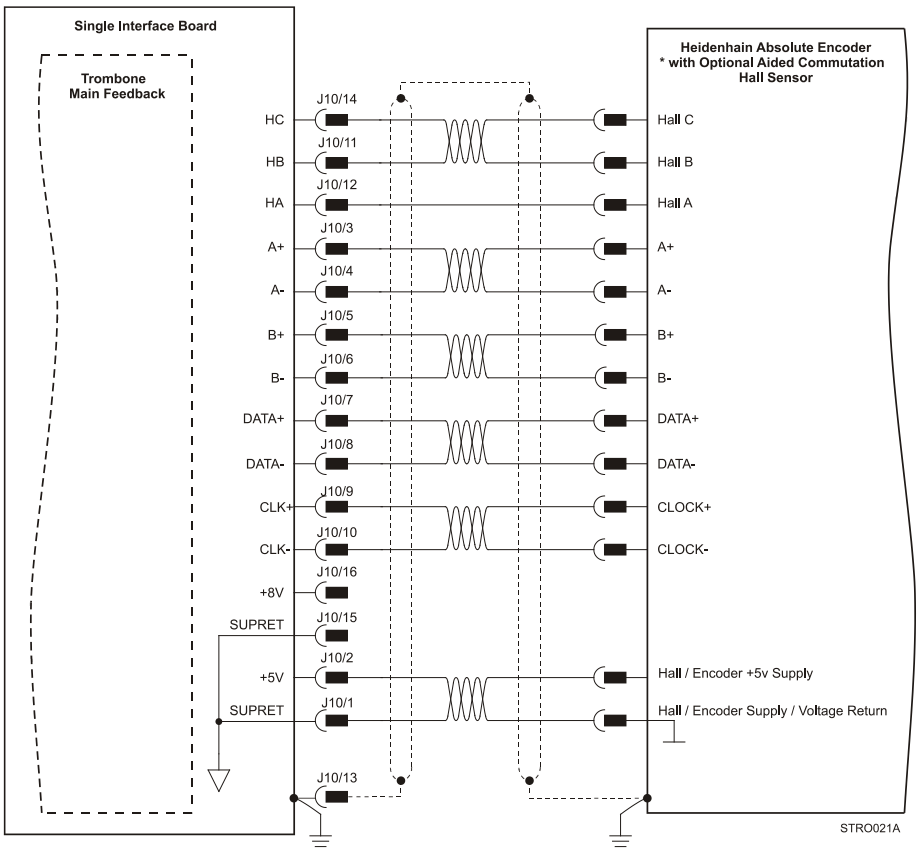


Figure 17: Main Feedback – Heidenhain Feedback Connection Diagram

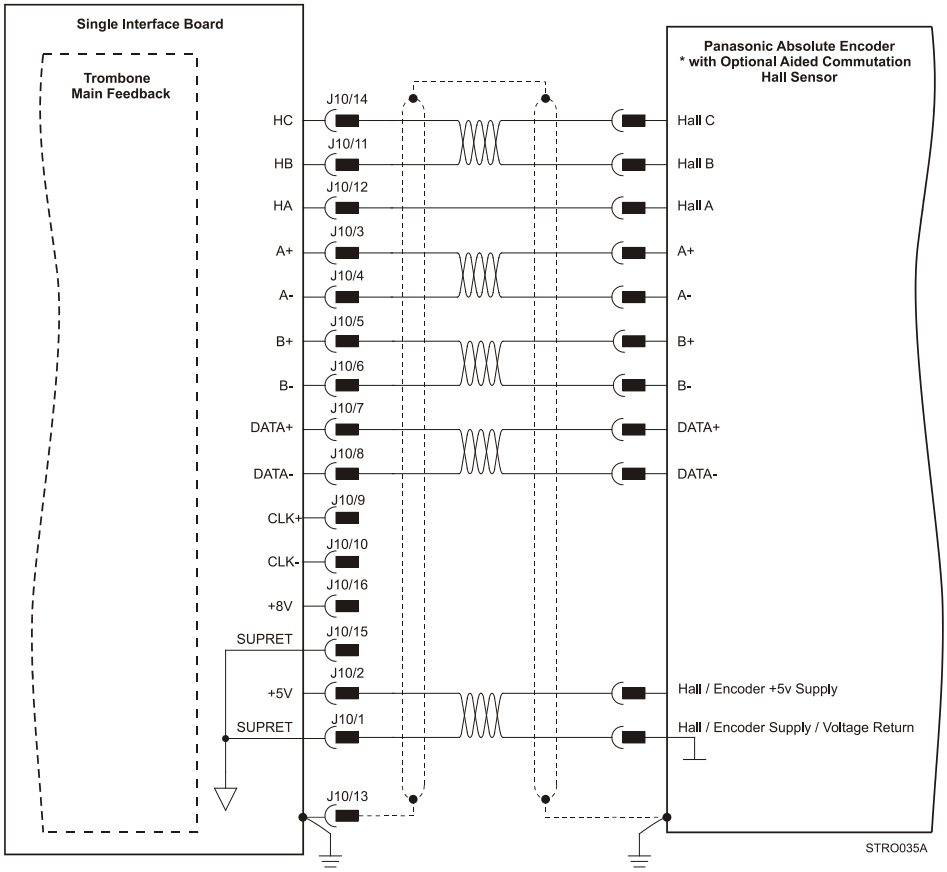


Figure 18: Main Feedback – Panasonic Feedback Connection Diagram

3.4. Main Buffered Output Port

This port provides Differential Buffered Outputs (of the Main Feedback) for another axis.

Pin (J9)	Signal	Function
1	CHAO	Buffered Channel A output
2	CHAO-	Buffered Channel A complement output
3	CHBO	Buffered Channel B output
4	CHBO-	Buffered Channel B complement output
5	INDEXO	Buffered Index output
6	INDEXO-	Buffered Index complement output
7	COMRET	Common return
8	PE	Protective Earth
Pin Positions		

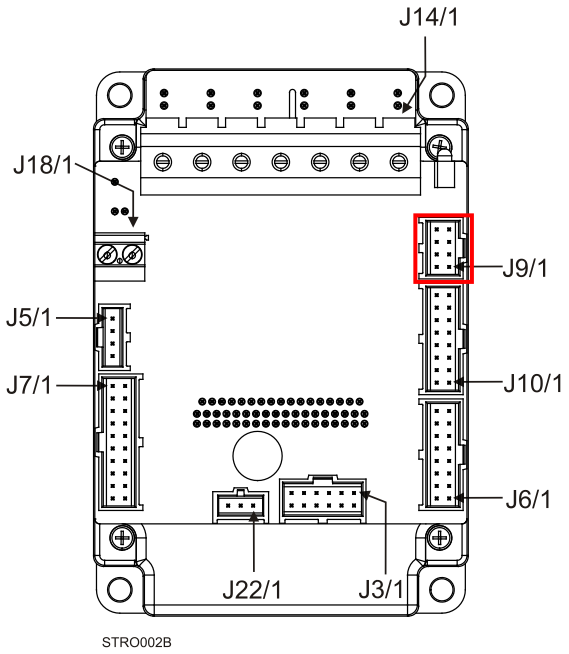


Table 7: Main Buffered Output Port - Pin Assignments

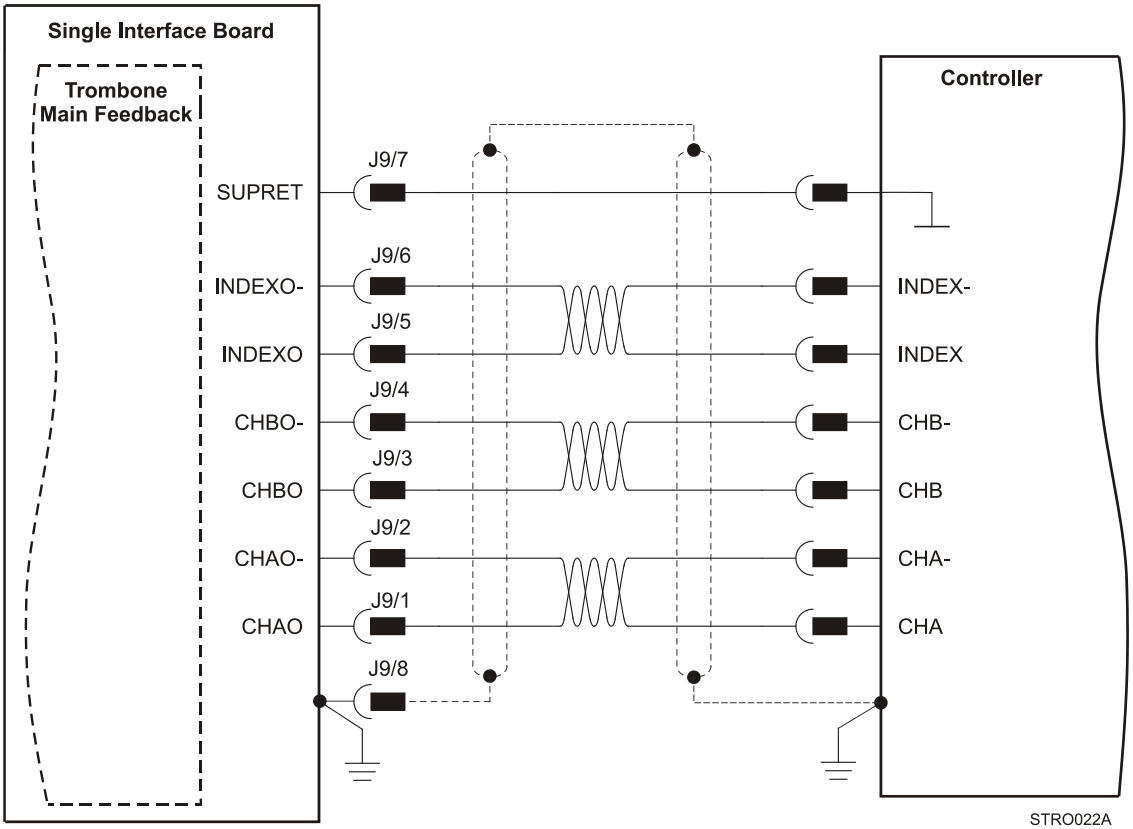


Figure 19: Main Buffered Output Port (Differential Main Feedback Output) – Connection Diagram

3.5. Auxiliary Feedback (Bi-Directional)

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

The Auxiliary Feedback connector has two ports: B1 and B2.

- **Port B1** has three pairs of differential buffered inputs.
- **Port B2** has three pairs of differential buffered outputs.

There are two modes of operation for this interface:

- Mode 1 (Composer Command: YA[4]=4) – see Section 3.5.2

  When the Auxiliary port of the Solo Trombone is set by the software to act as an emulated encoder output.
  This is practical only when using the following Main Feedbacks:
  Resolver
  Interpolated Analog Encoder
  Potentiometer and Tachometer
  Absolute Encoder (Stegmann, Heidenhain or Panasonic)

  - B1 input becomes inactive.
  - B2 presents emulated differential buffered encoder output signals of the Main Feedback.
- Mode 2 (Composer Command: YA[4]=2 or YA[4]=0) – Refer to Sections 3.5.3, and 3.5.4.
  When the Auxiliary port of the Solo Trombone is set by software to act as an input

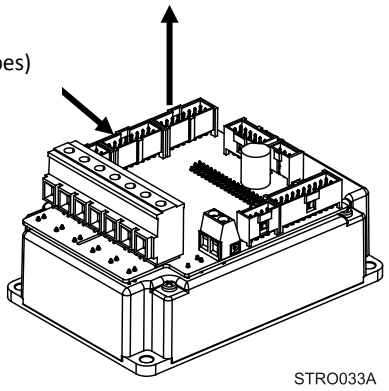
  - B1 becomes an active differential buffered input.
  - B2 presents differential buffered encoder output signals of B1.

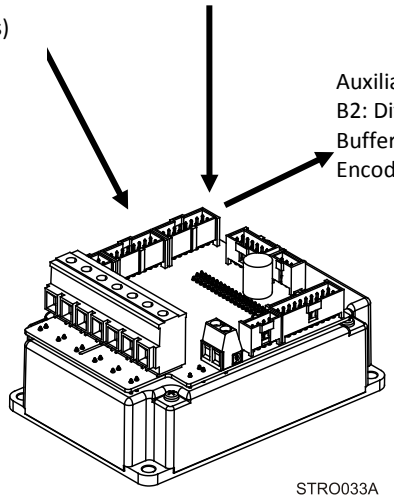
3.5.1. Main and Auxiliary Feedback Combinations

The Main Feedback is always used in motion control devices, whereas the Auxiliary Feedback is often, but not always used. The Auxiliary Feedback connector on the Solo Trombone, AUX. FEEDBACK, has two ports, Port B1 and Port B2. When used in combination with the MAIN FEEDBACK, these ports can be set, by the 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>Auxiliary Feedback:</td></tr>
<tr><td>Interpolated Analog (Sine/Cosine) Encoder Input✶</td><td rowspan="4">Main Feedback:
Interpolated Analog (Sin/Cos) Encoder
OR Resolver
OR Potentiometer
OR Tachometer
OR Absolute (all types)

Auxiliary Feedback:
B2: Emulated Differential Buffered Encoder Output
B1: NA

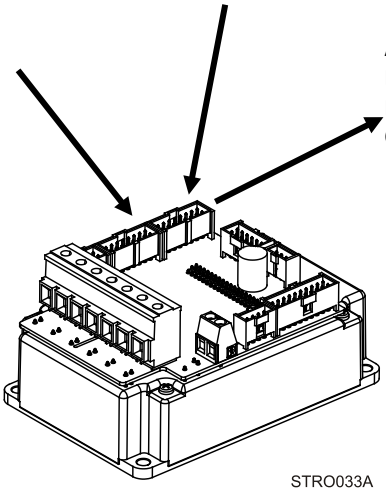
 
STRO033A</td></tr>
<tr><td>Resolver Input✸</td></tr>
<tr><td>Potentiometer Tachometer Input✹</td></tr>
<tr><td>Absolute Encoder Input (All types) ◊</td></tr>
<tr><td>Typical Applications</td><td>✶ Analog Encoder applications where position data is required, in the Encoder’s quadrature format, for other 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.
◊ Absolute 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** **Absolute Encoder Input** **(All types)**	Main Feedback: Incremental Encoder OR Interpolated Analog (Sin/Cos) Encoder OR Resolver OR Potentiometer OR Tachometer OR Absolute (all types) Auxiliary Feedback: B1: Differential Auxiliary Encoder Input Auxiliary Feedback: B2: Differential Buffered Encoder Output of B1  STRO033A
Typical Applications	Any application where two Feedbacks are used by the drive. The B1 Auxiliary Feedback port serves as an input port for the B2 Auxiliary incremental encoder. For applications such as Follower, ECAM, or Dual Loop.

<table>
<tr><th>Main Feedback</th><th>Auxiliary Feedback: Input</th></tr>
<tr><td>Software Setting</td><td>YA[4] = 0
(Auxiliary Feedback: input)</td></tr>
<tr><td>Incremental Encoder Input</td><td rowspan="5">Main Feedback:
Incremental Encoder
OR Interpolated
Analog (Sin/Cos) Encoder
OR Resolver
OR Potentiometer
OR Tachometer
OR Absolute (all types)

Auxiliary Feedback:
B1: Differential
Pulse & Direction
Commands Input

Auxiliary Feedback:
B2: Differential Buffered
Pulse & Direction
Commands Output of B1

 
STRO033A</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>Absolute Encoder Input (All types)</td></tr>
<tr><td>Typical Applications</td><td>Any application where two Feedbacks are used by the drive.
The Auxiliary Feedback ports serve as an input and output for Pulse & Direction Commands.</td></tr>
</table>

3.5.2. Solo Trombone Auxiliary Feedback – Differential Buffered Encoder Output (YA[4]=4)

The Auxiliary Feedback's B2 port can provide **emulated encoder signals** to other controllers or drives. This option can be used when:

- A Resolver, Interpolated Analog Encoder, Absolute Encoder (Stegmann, Heidenhain or Panasonic), or Potentiometer and Tachometer is used as a Main Feedback device.
- The Solo Trombone is used as a current amplifier to provide position data to the position controller.
- The Solo Trombone is used in velocity mode, to provide position data to the position controller.
- The Solo Trombone is used as a master in Follower or ECAM mode.

Below are the signals on the Auxiliary Feedback ports when the Solo Trombone Auxiliary Feedback port is set up for emulated output of the Main Feedback device (Resolver or Analog Incremental Encoder only).

Port	Pin (J6)	Signal	Function
PWR	1	COMRET	Common return
PWR	2	+5V	Encoder supply voltage
B1	3	NA	When YA[4]=4 the B1 port is not available
B1	4	NA	When YA[4]=4 the B1 port is not available
B1	5	NA	When YA[4]=4 the B1 port is not available
B1	6	NA	When YA[4]=4 the B1 port is not available
B1	7	NA	When YA[4]=4 the B1 port is not available
B1	8	NA	When YA[4]=4 the B1 port is not available
B2	9	CHAO	Buffered Channel A output
B2	10	CHAO-	Buffered Channel A complement output
B2	11	CHBO	Buffered channel B output
B2	12	CHBO-	Buffered channel B complement output
B2	13	INDEXO	Buffered Index output
B2	14	INDEXO-	Buffered Index complement output
PWR	15	PE	Protective Earth
PWR	16	COMRET	Common return

Pin Positions

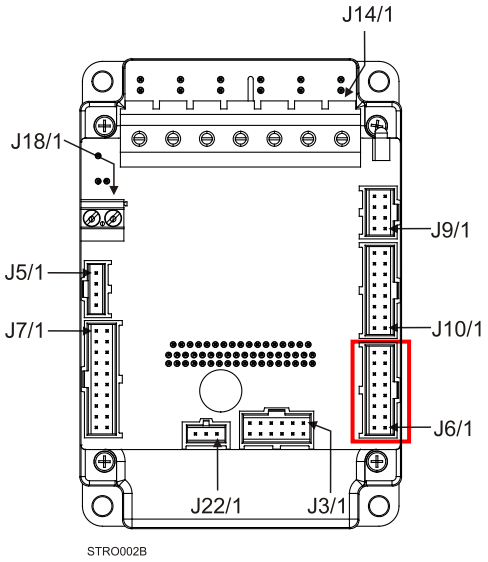


Table 8: Emulated Encoder Output on the Auxiliary Feedback Port B2 - Pin Assignments

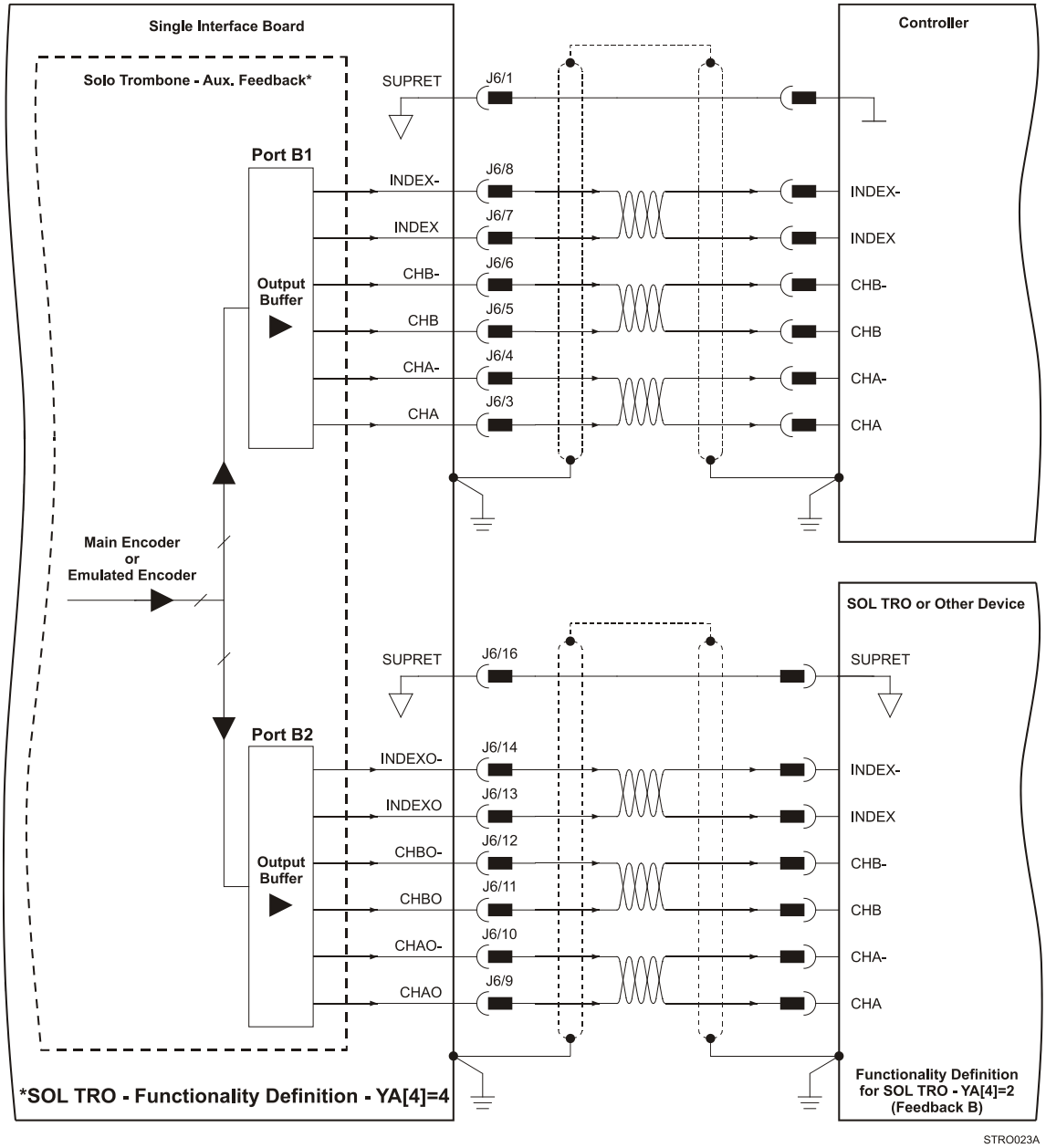


Figure 20: Emulated Encoder Direct Output – Acceptable Connection Diagram

3.5.3. Auxiliary Feedback - Differential Encoder Input Option (YA[4]=2)

The Solo Trombone can be used as a slave by receiving the position data (on Port B1) of the master encoder in Follower or ECAM mode. In this mode, Port B2 provides **differential buffered Auxiliary outputs of B1** for the next slave axis in Follower or ECAM mode.

Below are the signals on the Auxiliary Feedback ports when the Solo Trombone Auxiliary Feedback port is set up to run as a differential Auxiliary input:

Port	Pin (J6)	Signal	Function
PWR	1	COMRET	Common return
PWR	2	+5V	Encoder supply voltage
B1	3	CHA	Auxiliary channel A input
B1	4	CHA-	Auxiliary channel A complement input
B1	5	CHB	Auxiliary channel B input
B1	6	CHB-	Auxiliary channel B complement input
B1	7	INDEX	Auxiliary Index input
B1	8	INDEX-	Auxiliary Index complement input
B2	9	CHAO	Buffered Channel A output
B2	10	CHAO-	Buffered channel A complement output
B2	11	CHBO	Buffered channel B output
B2	12	CHBO-	Buffered channel B complement output
B2	13	INDEXO	Buffered Index output
B2	14	INDEXO-	Buffered Index complement output
PWR	15	PE	Protective Earth
PWR	16	COMRET	Common return

Pin Positions

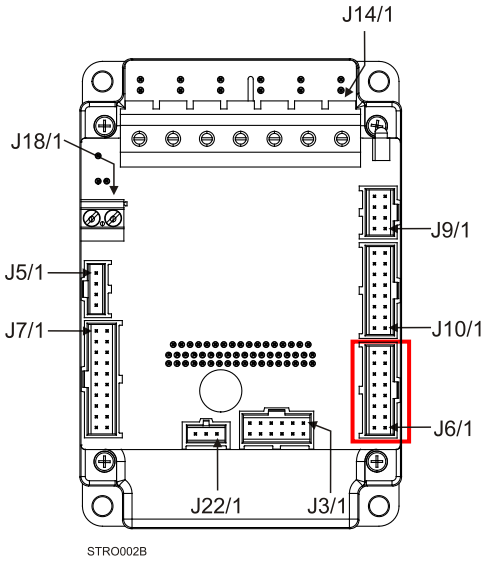


Table 9: Differential Auxiliary Encoder Input Option along with Differential Encoder Outputs on Auxiliary Feedback - Pin Assignments

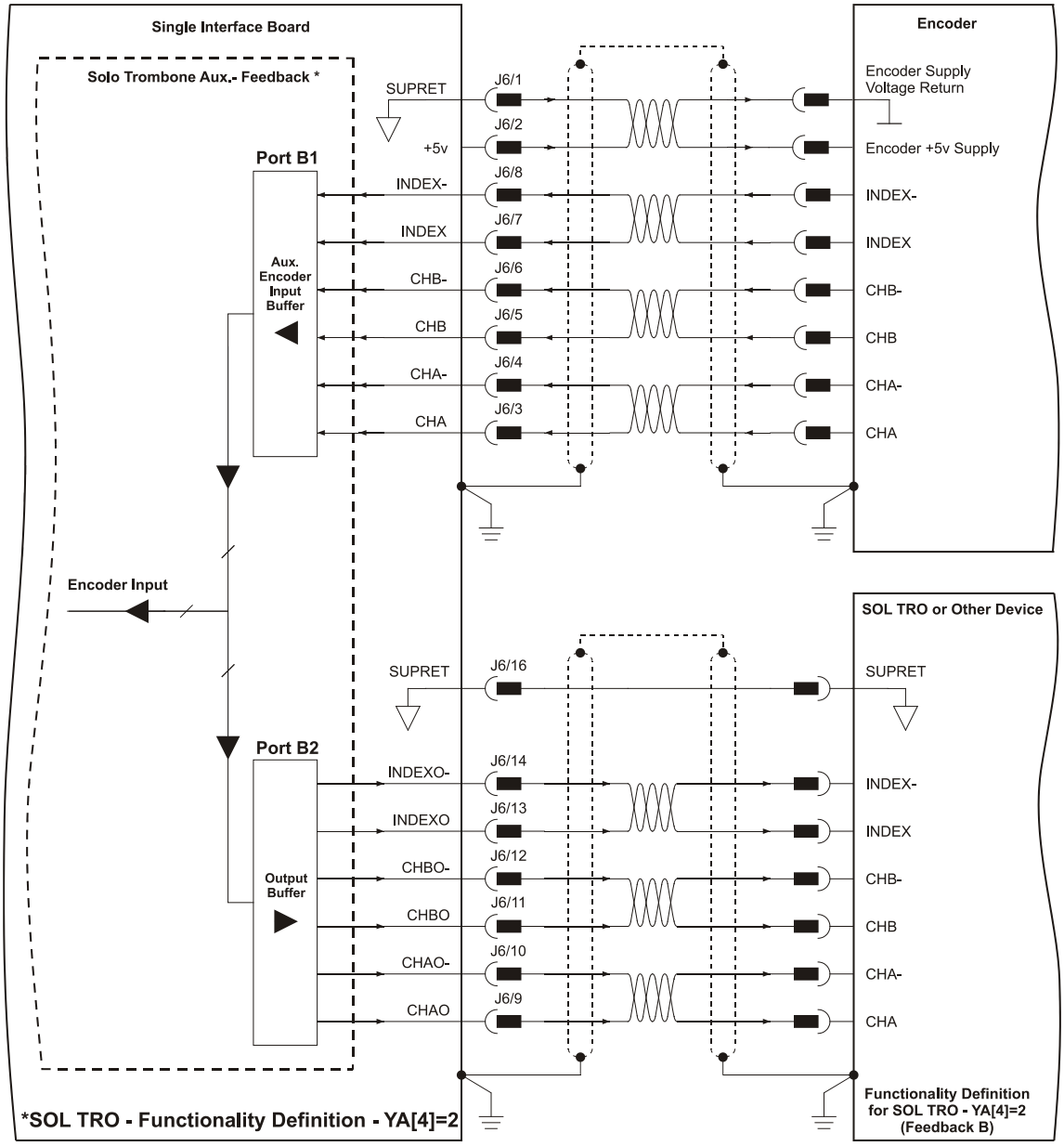


Figure 21: Differential Auxiliary Input Option on Auxiliary Feedback - Connection Diagram

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

This mode is used for input of differential pulse-and-direction position commands on Port B1. In this mode Port B2 provides **differential buffered pulse-and-direction outputs of B1** for another axis.

Below are the signals on the Auxiliary Feedback ports when set up to run as a differential pulse-and-direction input:

Port	Pin (J6)	Signal	Function
PWR	1	COMRET	Common return
PWR	2	+5V	Encoder supply voltage
B1	3	CHA	Auxiliary pulse input
B1	4	CHA-	Auxiliary pulse complement input
B1	5	CHB	Auxiliary direction input
B1	6	CHB-	Auxiliary direction complement input
B1	7	NA	Do not connect this pin
B1	8	NA	Do not connect this pin
B2	9	CHAO	Buffered pulse output
B2	10	CHAO-	Buffered pulse complement output
B2	11	CHBO	Buffered direction output
B2	12	CHBO-	Buffered direction complement output
B2	13	NA	Do not connect this pin
B2	14	NA	Do not connect this pin
PWR	15	PE	Protective Earth
PWR	16	COMRET	Common return

Pin Positions

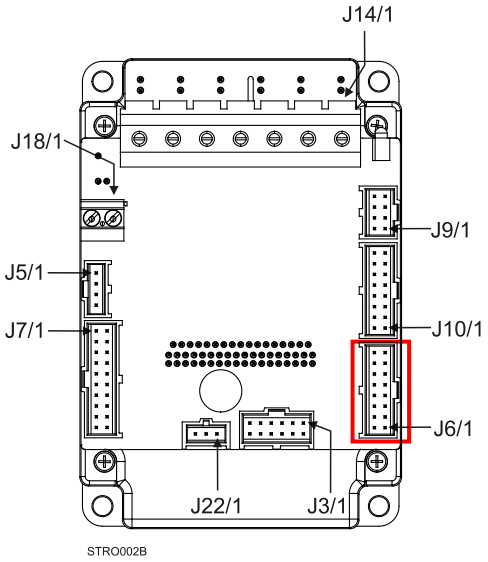


Table 10: Pulse-and-Direction Pin Assignments on Auxiliary Feedback

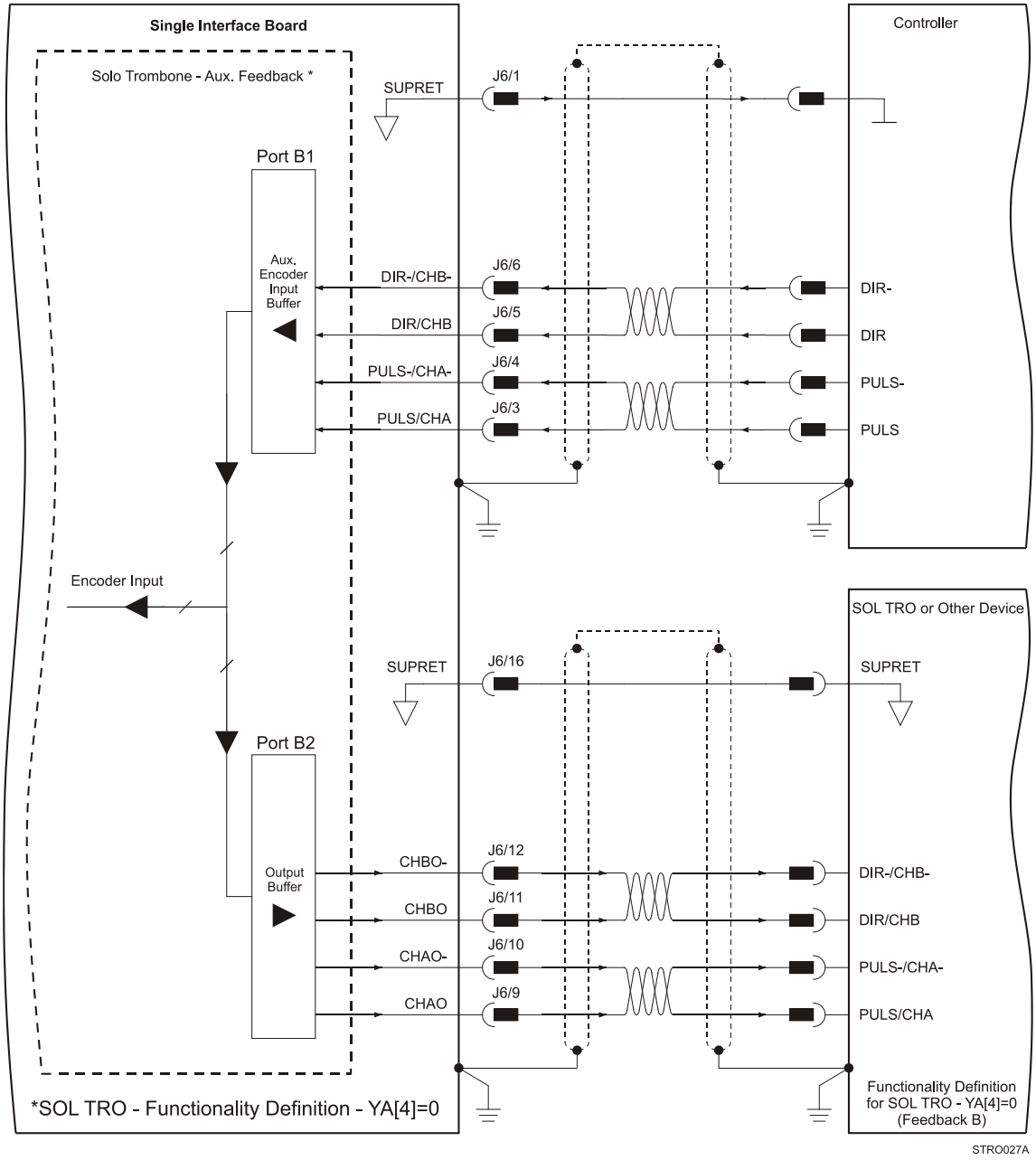


Figure 22: Pulse-and-Direction Input Option on Auxiliary Feedback - Connection Diagram

3.5.5. I/Os

The Solo Trombone has 6 Digital Inputs, 4 Digital Outputs and 1 Analog Input.

3.5.5.1. Digital Input

Each of the pins below can function as an independent input.

Pin (J7)	Signal	Function
1	IN2	Programmable input 2 (general purpose, RLS, FLS, INH)
2	INRET2	Programmable input 2 return
3	IN4	Programmable input 4 (general purpose, RLS, FLS, INH)
4	IN3	Programmable input 3 (general purpose, RLS, FLS, INH)
5	IN5	Hi-Speed Programmable input 5 (event capture, Main Home, general purpose, RLS, FLS, INH)
6	INRET	Programmable input return
7	IN6	Hi-Speed Programmable input 6 (event capture, Auxiliary Home, general purpose, RLS, FLS, INH)
8	INRET	Programmable input return
Pin Positions		

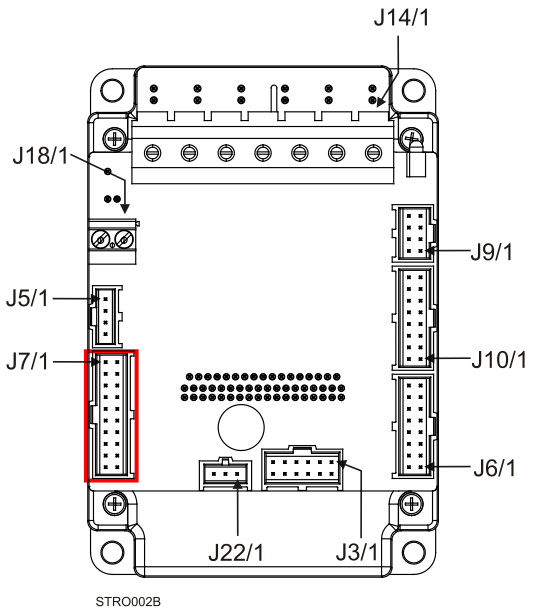


Table 11: Digital Input Pin Assignments

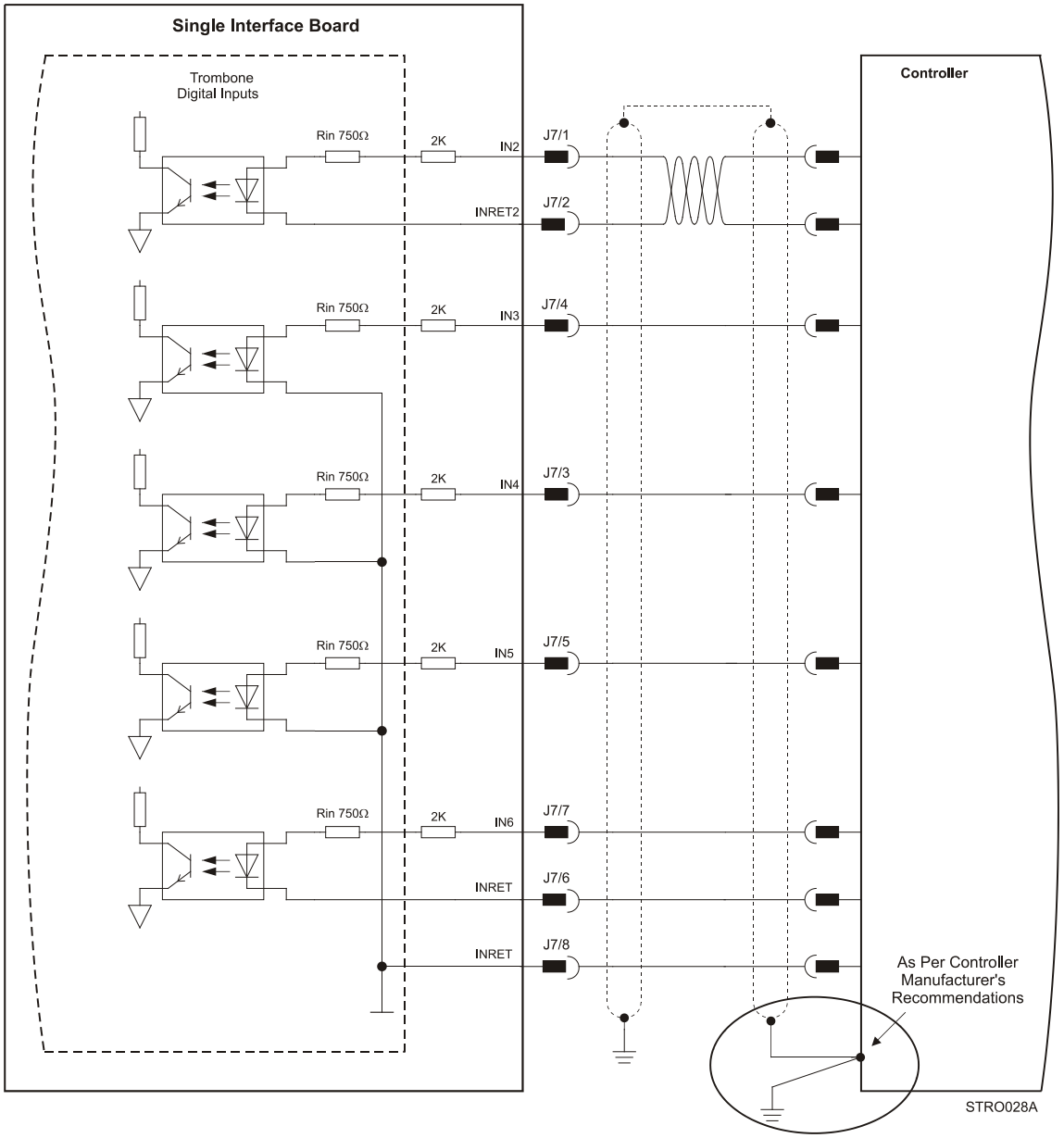


Figure 23: Digital Input Connection Diagram

3.5.6. Digital Output

Pin (J7)	Signal	Function
9	VDDIN	Digital output supply
10	OUT1	Programmable digital output 1
11	VDDIN	Digital output supply
12	OUT2	Programmable digital output 2
13	VDDRET	Digital output supply return
14	OUT3	Programmable digital output 3
15	VDDRET	Digital output supply return
16	OUT4	Programmable digital output 4

Pin Positions

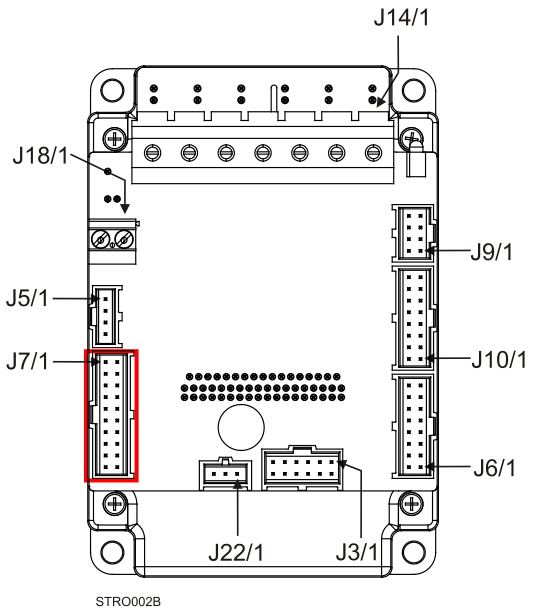


Table 12: Digital Output Pin Assignments

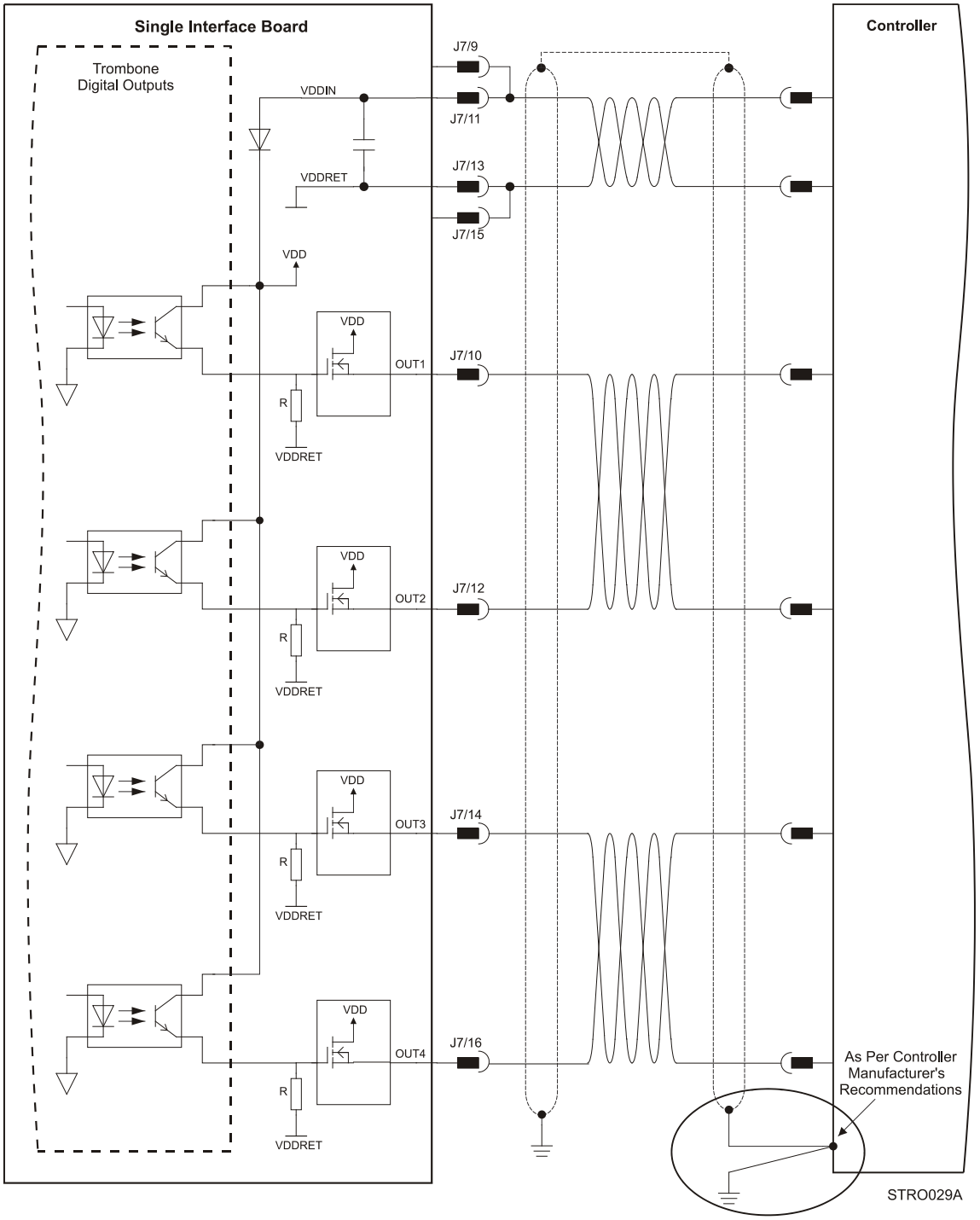


Figure 24: Digital Output Connection Diagram

3.5.7. Analog Input

Pin (J7)	Signal	Function
18	ANLIN1+	Analog input 1+
20	ANLIN1-	Analog input 1-
17	ANLRET	Analog return
Pin Positions		

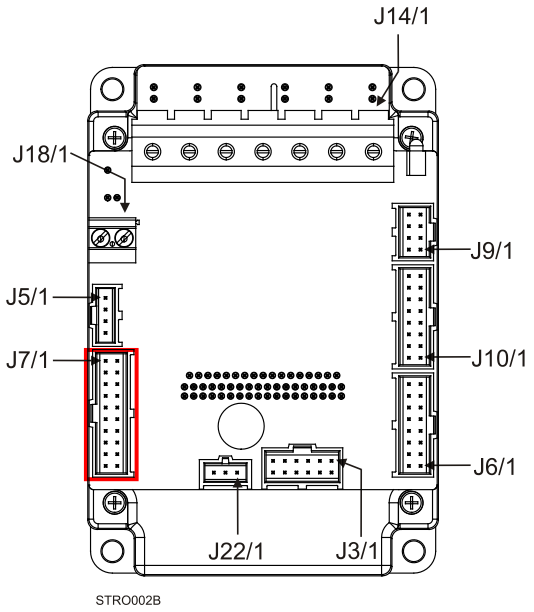


Table 13: Analog Input Pin Assignments

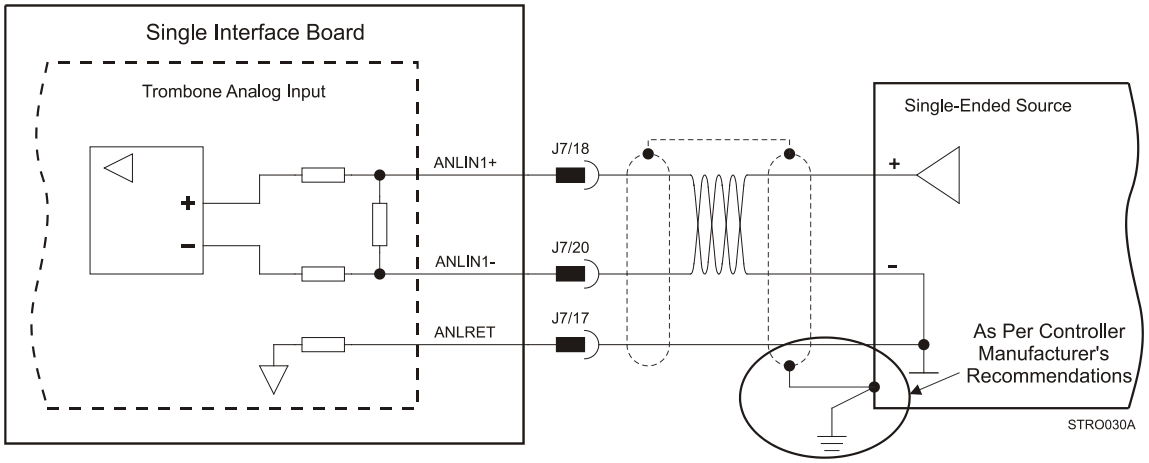


Figure 25: Analog Input with Single-Ended Source

3.5.8. Communication

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

- RS-232, full duplex
- CAN

RS-232 communication requires a standard, commercial 3-core null-modem cable connected from the Solo Trombone to a serial interface on the PC. The 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.

The CAN interface is not isolated.

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

3.5.8.1. RS-232 Communication

To connect the RS-232 communication cable

1. 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.
2. The RS-232 communication port is non-isolated.

Pin (J3)	Signal	Function
9	RS232_Tx	RS-232 transmit
10	RS232_Rx	RS-232 receive
11	RS232_COMRET	Communication return
Pin Positions		

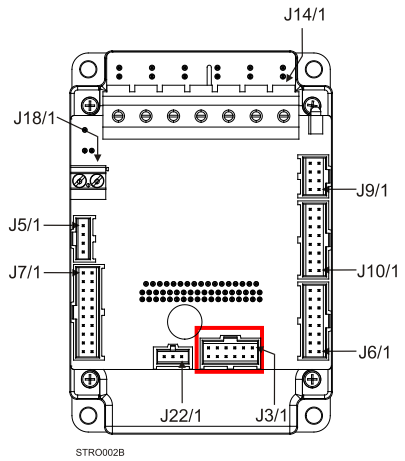


Table 14: RS-232 Pin Assignments

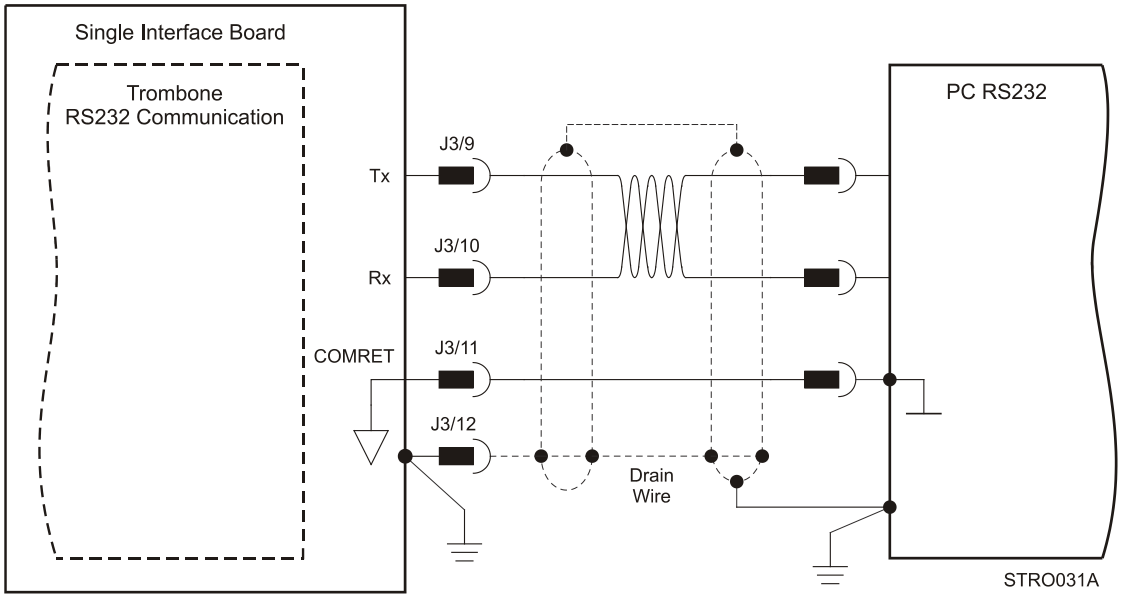


Figure 26: RS-232 Connection Diagram

3.5.8.2. CAN Communication

To connect the CAN communication cable

1. 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.
2. Make sure to have a 120-Ω resistor termination at each of the two ends of the network cable.
3. Note that the Solo Trombone's CAN port is **non-isolated**.

Pin (J3) CANIN	Pin (J3) CANOUT	Signal	Function
1	5	CAN_L	CAN_L busline (dominant low)
2	6	CAN_H	CAN_H busline (dominant high)
3	7	CAN_GND	CAN ground
Pin Positions			

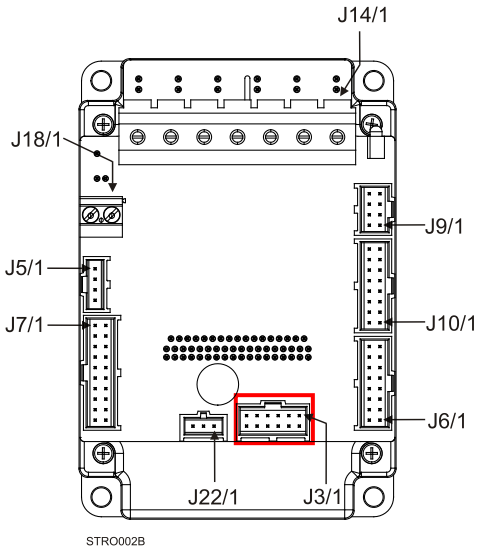


Table 15: CAN - Pin Assignments

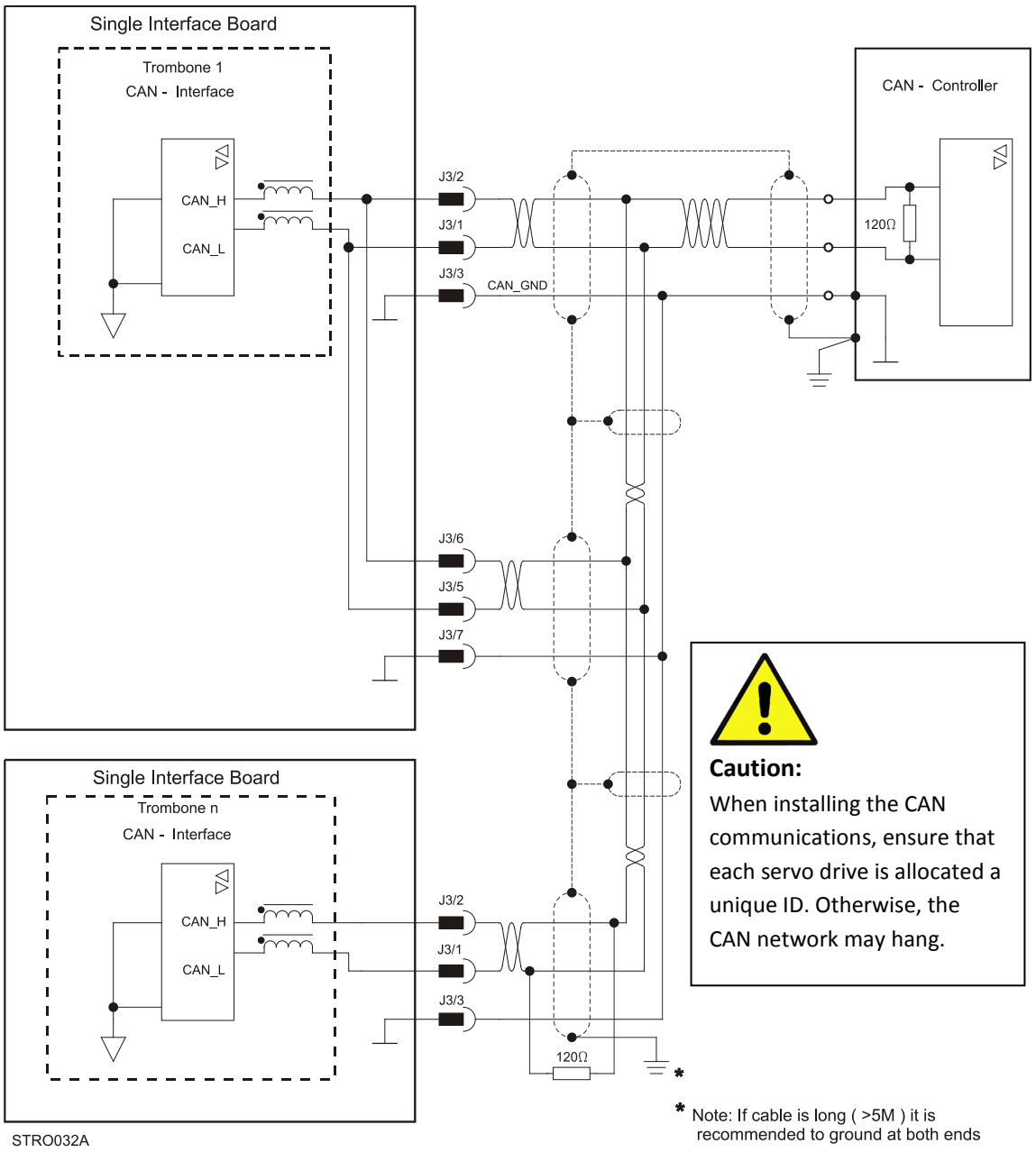


Figure 27: CAN - Connection Diagram

3.6. Powering Up

After the Solo Trombone has been mounted, check that the cables are intact.

The Solo Trombone servo drive is then ready to be powered up.

Caution:
Before applying power, ensure that the DC supply is within the range specified for your specific type of Solo Trombone and that the proper plus-minus connections are in order.

3.7. Initializing the System

After the Solo Trombone 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*.

3.8. Heat Dissipation

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

3.8.1. Solo Trombone Thermal Data

- Heat dissipation capability (θ): Approximately 5.5 °C/W
- Thermal time constant: Approximately 600 seconds (thermal time constant means that the Solo Trombone will reach 2/3 of its final temperature after 10 minutes)
- Shut-off temperature: 86 °C to 88 °C (measured on the heatsink)

3.8.2. Heat Dissipation Data

Heat Dissipation is shown graphically below:

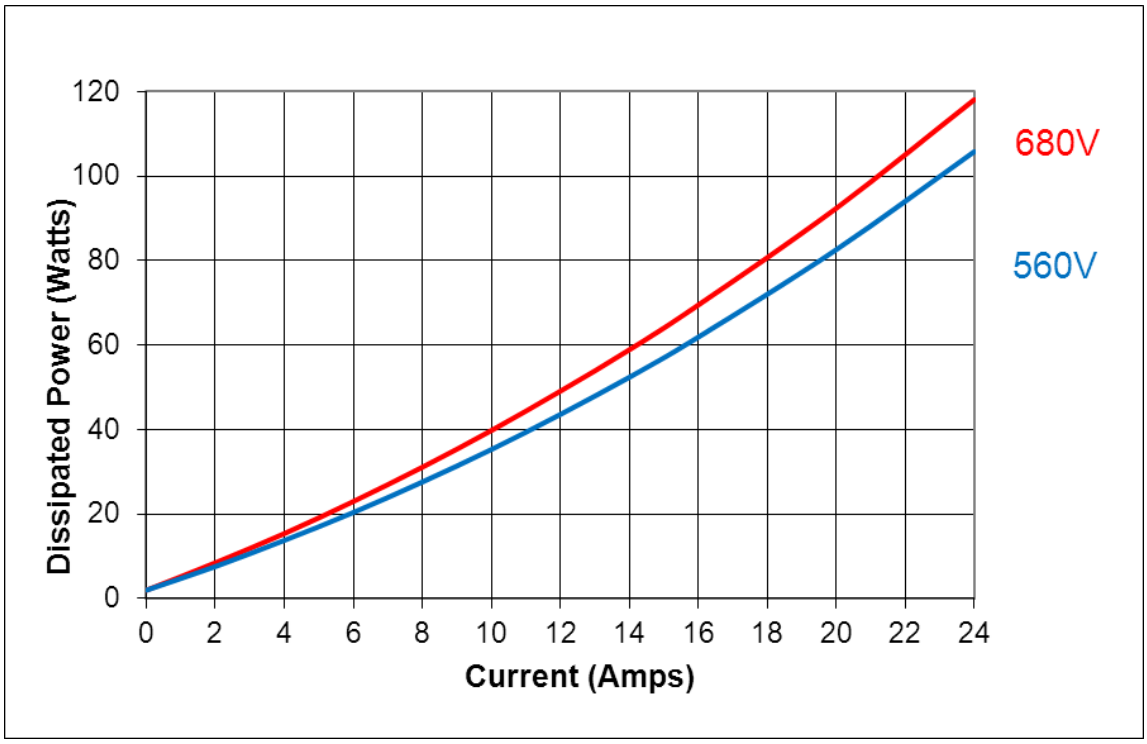


Figure 28: Dissipation versus Current Graph for 560 and 680 VDC

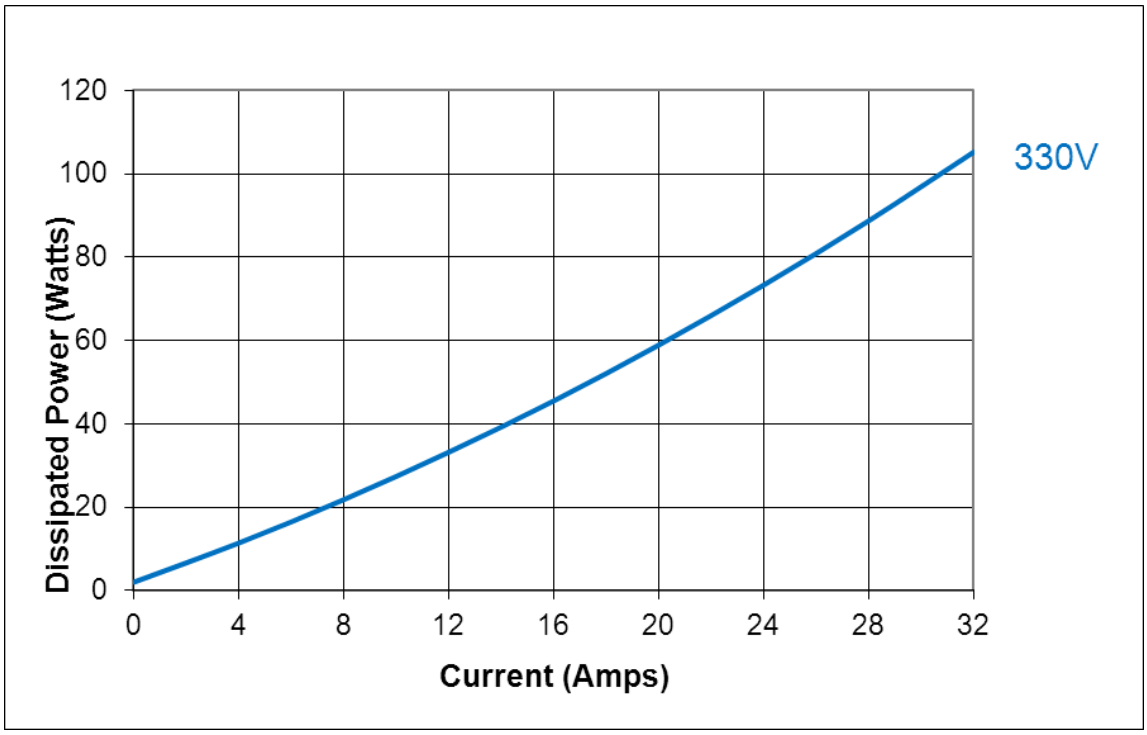


Figure 29: Dissipation versus Current Graph for 330 VDC

3.8.3. 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 (shunt down is 6 °C to 8 °C higher).
2. Determine the ambient operating temperature of the Solo Trombone as ≤ 40 °C.
3. Calculate the allowable temperature increase according to the following example: For an ambient temperature of 40 °C, ΔT = 80 to 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.

Chapter 4: Technical Specifications

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

4.1. Features

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

4.1.1. 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

4.1.2. Advanced Positioning Control Modes

- PTP, PT, PVT, ECAM, Follower, Dual Loop, Current Follower
- Fast event capturing inputs
- Fast output compare (OC)
- Motion Commands: Analog, PWM, digital (SW) and Pulse and Direction

4.1.3. 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

4.1.4. Fully Programmable

- Third generation programming structure with motion commands – “Composer”
- Event capturing interrupts
- Event triggered programming
- 32 KB memory in "A" (Advanced) type

4.1.5. Feedback Options

- Incremental Encoder – up to 20 Megacounts (5 Megapulses) per second
- Digital Halls – up to 2 kHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Megacounts 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, differential, buffered of the Analog encoder
- Absolute Encoder
- Panasonic
- Analog Hall Sensor
- Resolver
  - Programmable 10 to 15 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Emulated encoder outputs, differential, buffered of the Resolver
- Auxiliary Encoder inputs (ECAM, follower, etc.) differential, buffered
- Tachometer & Potentiometer
- The Solo Trombone can provide power (5 V, 2x200 mA max) for Encoders, Resolver or Halls.

4.1.6. Input/Output

- 1 **Analog Input** – up to 14-bit resolution
- 6 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
- 4 programmable **Digital Outputs**:
  - Brake Control with output-current of 0.25 A
  - Amplifier fault indication
  - General-purpose
  - Servo enable indication

- Buffered and differential outputs of the main encoder with up to 5 MHz pulses
- Buffered and differential outputs of the auxiliary encoder
- Emulated Buffered and differential outputs of resolver or analog encoder
- Pulse and Direction inputs (Differential)
- PWM current command output for torque and velocity

4.1.7. 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 outputs and power input/return
  - Failure of internal power supplies
  - Over-heating
  - Continuous temperature measurement. Temperature can be read on the fly; a warning can be initiated x degrees before temperature disable is activated.
  - Over/Under voltage
  - Loss of feedback
  - Following error
  - Current limits

4.1.8. Accessories

- Heat sinks (TBD)

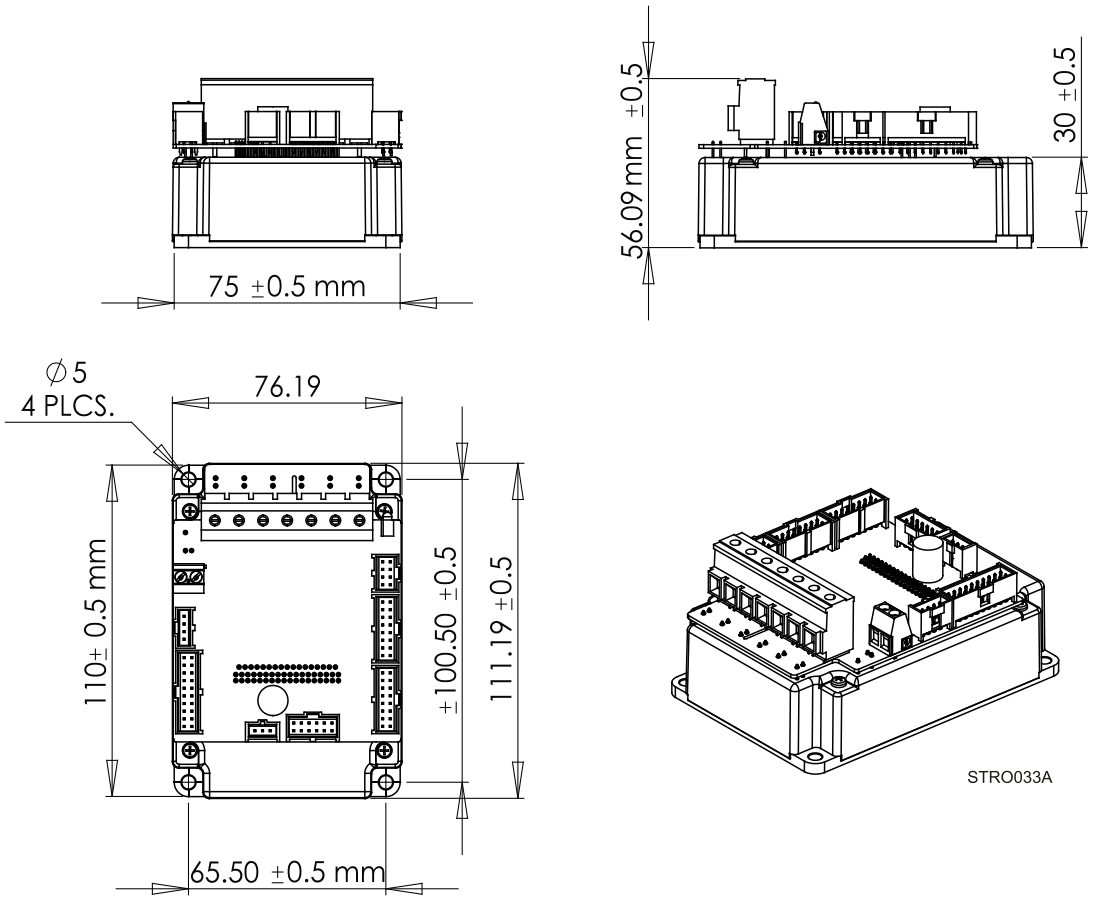
4.1.9. Status Indication

- Bi-color LED

4.1.10. 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

4.2. Solo Trombone Dimensions



4.3. Power Ratings

Feature	Units	12/400	16/400	R17/400	R22/400	8/800	12/800	R11/800	R16/800
Minimum supply voltage	VDC	S suffix in P/N*: 50 No S suffix in P/N: 100				S suffix in P/N*: 95+			
Nominal supply voltage	VDC	325				560 for 400 VAC 680 for 480 VAC			
Maximum supply voltage	VDC	400				780			
Maximum continuous power output	W	Up to 10 kW of continuous qualitative power							
Efficiency at rated power (at nominal conditions)	%	> 98							
Auxiliary supply voltage option	VDC	18 V to 30 V Only for Control Supply S suffix Model							
Auxiliary power supply	VA	≤5 VA without external loading ≤8 VA with full external loading							
Continuous current limit (Ic) Amplitude sinusoidal/DC trapezoidal commutation	A	12	16	17	22	8	12	11	16
Sinusoidal continuous RMS current limit (Ic)	A	8.5	11.3	12	15.5	5.7	8.5	7.8	11.3
Peak current limit	A	2 x Ic		No peak		2 x Ic		No peak	
Weight	g (oz)	350 g (12.3 oz)							
Dimensions	mm (in)	111 x 76 x 56 (4.37" x 2.99" x 2.21")							
Digital in/Digital out/ Analog in		6/4/1							
Mounting method		Panel / Wall Mounted							

*See page 17 for details on the part number. The S suffix appears in models where there is a 24 V control supply. If there is no S suffix, the control power supply operates from the main power.

Note on current ratings: The current ratings of the Solo Trombone are given in units of DC amperes (ratings that are used for trapezoidal commutation or DC motors). The RMS (sinusoidal commutation) value is the DC value divided by 1.41.

4.3.1. Auxiliary Supply

This table applies only to the models with an S suffix. See page 17 for further details on the part number.

Feature	Details
Auxiliary power supply	*Isolated DC source only*
Auxiliary supply input voltage	18 to 30 VDC
Auxiliary supply input power	< 8 VA (this includes the 5 V/2x200 mA load for the main and auxiliary encoders)

Note: An S-type drive will not operate unless it has the Aux. supply (**Mandatory**).

4.4. Environmental Conditions

Feature	Details
Operating ambient temperature according to IEC60068-2-2	0 °C to 40 °C (32 °F to 104 °F)
Storage temperature	-20 °C to +85 °C (-4 °F to +185 °F)
Maximum non-condensing humidity according to IEC60068-2-78	95%
Maximum Operating Altitude	2,000 m (6562 feet)
Mechanical Shock according to IEC60068-2-27	15g / 11ms Half Sine
Vibration according to IEC60068-2-6	5 Hz ≤ f ≤ 10 Hz: ±10mm 10 Hz ≤ f ≤ 57 Hz: 4G 57 Hz ≤ f ≤ 500 Hz:5G

4.5. Control Specifications

4.5.1. 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 sampling time	Programmable 100 to 200 µsec
Current sampling rate	Default 10 kHz

4.5.2. 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 • Absolute encoder (optional) • 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 sampling time	140 to 200 µsec (2x current loop sample time)
Velocity 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.

4.5.3. 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 sampling time	280 to 400 µsec (4x current loop sample time)
Position sampling rate	Up to 4 kHz; default 2.75 kHz

4.6. Feedbacks

4.6.1. Feedback Supply Voltage

The DC supply voltage of the Solo Trombone has two feedback ports (Main and Auxiliary). This DC voltage supplies voltage only to the main feedback device and to the auxiliary feedback device if necessary.

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

4.6.2. Main Feedback Options

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

4.6.2.1. Incremental Encoder Input

Feature	Details
Encoder format	• A, B and Index • Differential • Quadrature
Interface	RS-422
Input resistance	Differential: 120 Ω
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

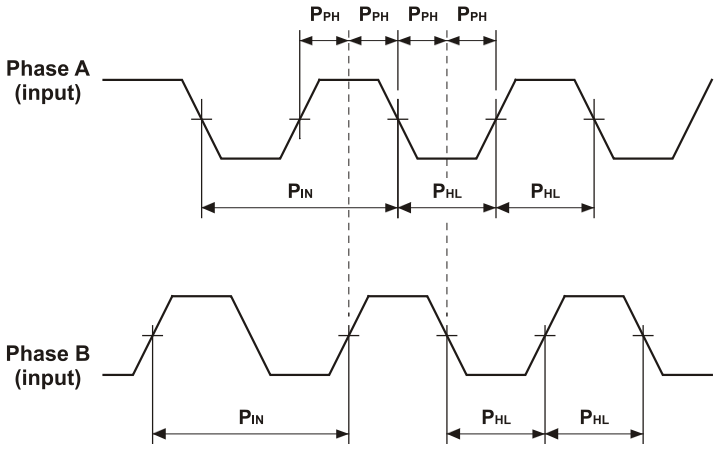


Figure 30: Main Feedback - Encoder Phase Diagram

4.6.2.2. 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): 5 mA
Maximum frequency	f_{MAX} : 2 kHz

4.6.2.3. Absolute Serial Encoder

Feature	Details
Encoder format	• NRZ (Panasonic) • EnDAT 2.21 (with analog Sine/Cosine) • Stegmann in DC-TRO/SOL-TRO
Interface	• RS-485 • Clock – Differential output line • Data – Differential bidirectional line
Input Resistance	Differential 120 Ω
Transmission Rate	Up to 2.5 MHz

4.6.2.4. 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 Megacounts/sec “internally”
Automatic errors correction	Signal amplitudes mismatch Signal phase shift Signal offsets
Encoder outputs	See Auxiliary Encoder Outputs specifications (4.6.3)

4.6.2.5. 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 Trombone
Reference current	up to ±50 mA
Encoder outputs	See Auxiliary Encoder Output specifications (4.6.3)

4.6.2.6. 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.

4.6.2.7. Potentiometer

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

4.6.3. Main Encoder Buffered Output

Feature	Details
Main encoder 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
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

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

Feature	Details
Emulated output	• A, B, Index • Differential outputs
Output current capability	Maximum output current: I_{OH} (max) = 2 mA High level output voltage: V_{OH} > 3.0 V Minimum output current: I_{OL} = 2 mA Low level output voltage: V_{OL} < 0.4 V
Available as options	• Emulated encoder outputs of: • Resolver • Analog Encoder • Absolute Encoder (Stegmann, Heidenhain or Panasonic), • Potentiometer and Tachometer
Maximum frequency	f_{MAX}: 5 MHz pulses/output
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

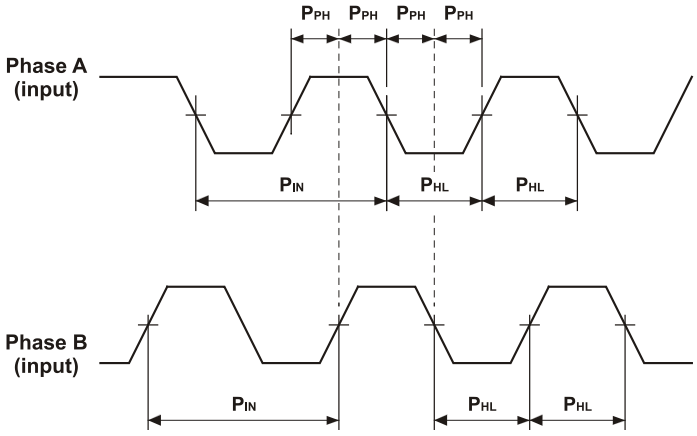


Figure 31: Auxiliary Feedback – Encoder Phase Diagram

4.6.5. 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

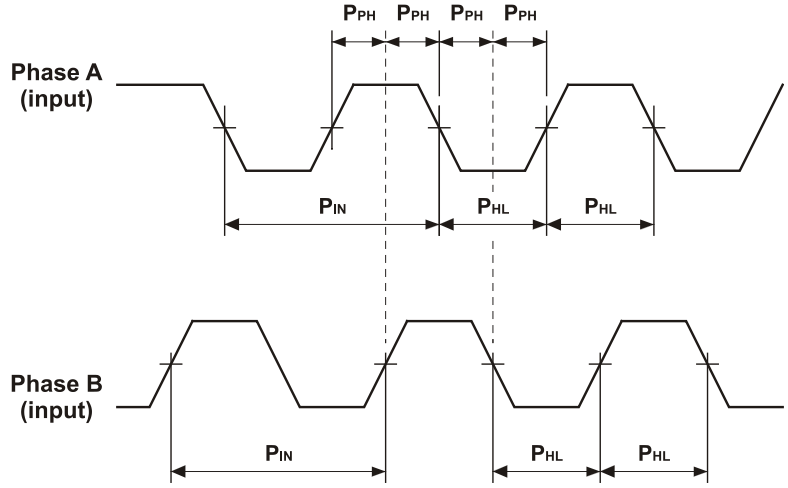


Figure 32: Auxiliary Feedback - Encoder Phase Diagram

4.7. I/Os

The Solo Trombone has

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

4.7.1. Digital Input Interfaces

Feature	Details
Type of input	Optically isolated
Input current for all inputs	Rin=3.43K, Iin = 1.2 mA @ Vin = 5 V Rin=3.43K, Iin = 6.7 mA @ Vin = 24 V
High-level input voltage	5 V < Vin < 24 V
Low-level input voltage	0 V < Vin < 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 < 4 x TS 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.

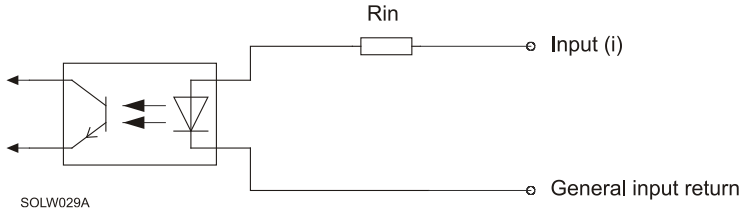
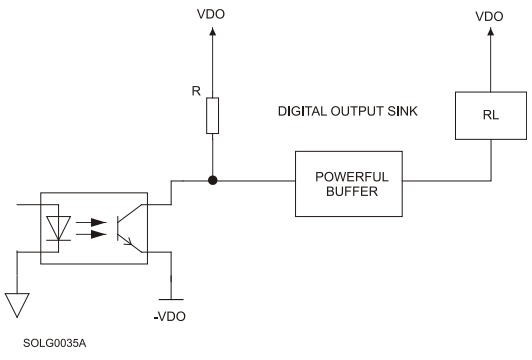


Figure 33: Digital Input Schematic

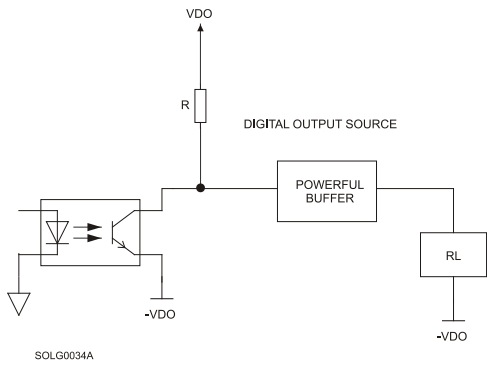
4.7.2. Powerful Digital Output Interface

Feature	Details
Type of output	• Optically isolated • Powerful Sink/Source capability
Maximum supply output (Vdd)	30 V
Max. output current Iout (max) (Vout = Low)	Iout (max) ≤ 250 mA
VOH at maximum output voltage Source mode	VDO ≥ VOH ≥ VDO-1.25 VOH @ 250 mA
VOL at maximum output voltage Sink mode	0 V ≤ VOL ≤ 1.25 VOL @ 250 mA
RL	The external RL must be selected to limit output current to no more than 250 mA. $RL=\frac{VDO-Ix5}{I}$
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.

SINK



SOURCE



4.7.3. 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

4.8. 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.
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

4.9. 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)

4.10. Brake

The brake can be controlled by **Digital Output 1**, which should be set to Brake.

Feature	Details
Rated voltage	24 V +10%
Rated current	0.5 A
Input power	12 W

4.11. 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)