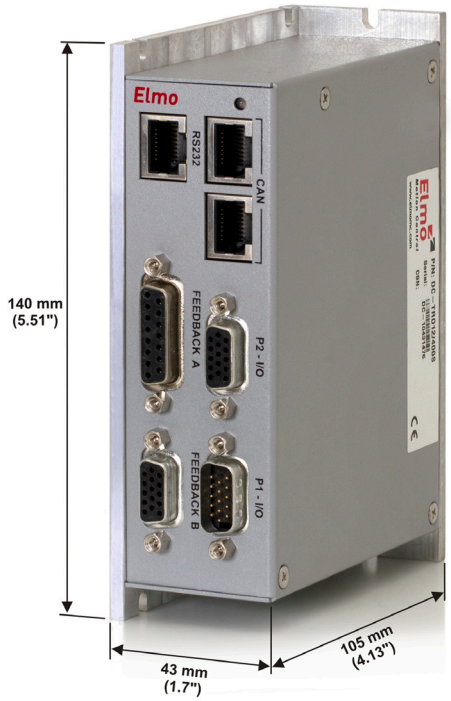
SimpIIQ Line

DC Trombone
Digital Servo Drive
Installation Guide



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Elmo
Motion Control

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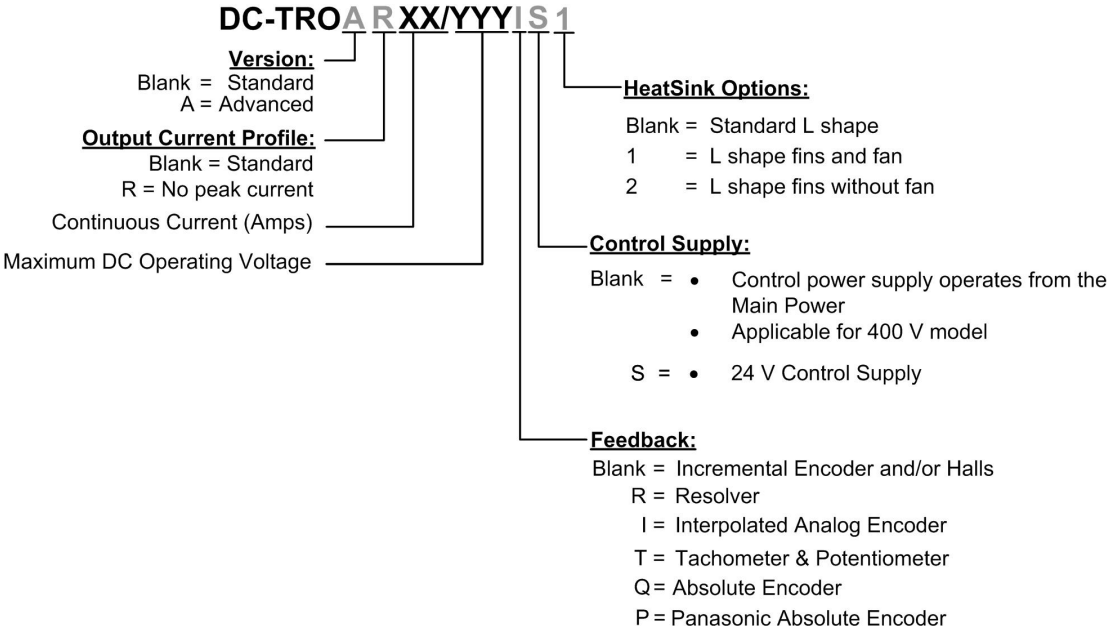

Revision History

Version	Date	Details
Ver. 1.0		Initial release
Ver. 1.1		Updated with new template
Ver. 1.2		Changes and updates to the following sections: 2.1, 2.2.6, 2.2.7, 2.3, 3.0, 3.11, 3.3.1, 3.4, 3.5, 3.5.2, 3.6, 3.7, 3.8, 3.9, 3.10, 4.1, 4.1.7, 4.3, 4.4.1, 4.6, 4.7
Ver. 1.3		Sections 4.3, 4.4.1: Auxiliary supply range: 18 to 30 V
Ver. 1.4	September 2012	Change the overvoltage in 800 V mode, Pin layout, UL recognition, and further optional versions added “Metronome” was replaced by the “Composer” software.
Ver. 1.401	February 2013	Added a caution and recommendation on the type of cleaning solution to use for the Elmo unit.
Ver. 1.500	May 2013	Addition of heat-sink option to lower side of the drive.
Ver. 1.600	June 2014	Manual updated
Ver. 1.601	July 2014	General format updates
Ver. 1602	Oct 2014	Updated the Warranty Information section 1.5 and updated 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 DC 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 DC 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 DC 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

- 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 DC Trombone from all voltage sources before it is opened for servicing.
- The DC 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 DC 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 DC 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 DC 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 DC 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 DC 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 DC 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 DC 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 DC 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: Product Description

This installation guide describes the DC Trombone servo drive and the steps for its wiring, installation and power-up. Following these guidelines ensures optimal performance of the drive and the system to which it is connected.

2.1. Drive Description

The DC Trombone series of digital servo drives are highly resilient and designed to deliver the highest density of power and intelligence. The DC 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 DC 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 DC 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 DC Trombone). Elmo recommends using the Elmo Tambourine Power Supply, which is ideally suited to the Trombone, DC Trombone, and 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 DC 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, DC Trombone models that do *not* have the S option in the catalog number (only for 400 V model) can be used. In these models, a smart control-supply algorithm enables the DC Trombone to operate with only the main power supply VP+ and VN-, with no need for a 24 VDC auxiliary power supply for the logic.

The DC Trombone is available in two versions:

- The Standard DC 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 CAN DS 301, DS 305, DS 402 communications and features a third-generation programming environment. (The catalog number begins DC-TRO but is not followed by an A.)

- The Advanced DC 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 DC-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, DC 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 Encoder
  - Heidenhain 2.1
  - Heidenhain 2.2
  - Panasonic
  - Stegmann

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

2.2.7. Fault Protection

The DC 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

2.2.8. Built-in Protection

- Additional heat-sink options, for demanding applications:
  - External Heat Sink with fins (P/N with suffix 2)
  - External Heat Sink with fins and fan (P/N with suffix 1)

2.3. System Architecture

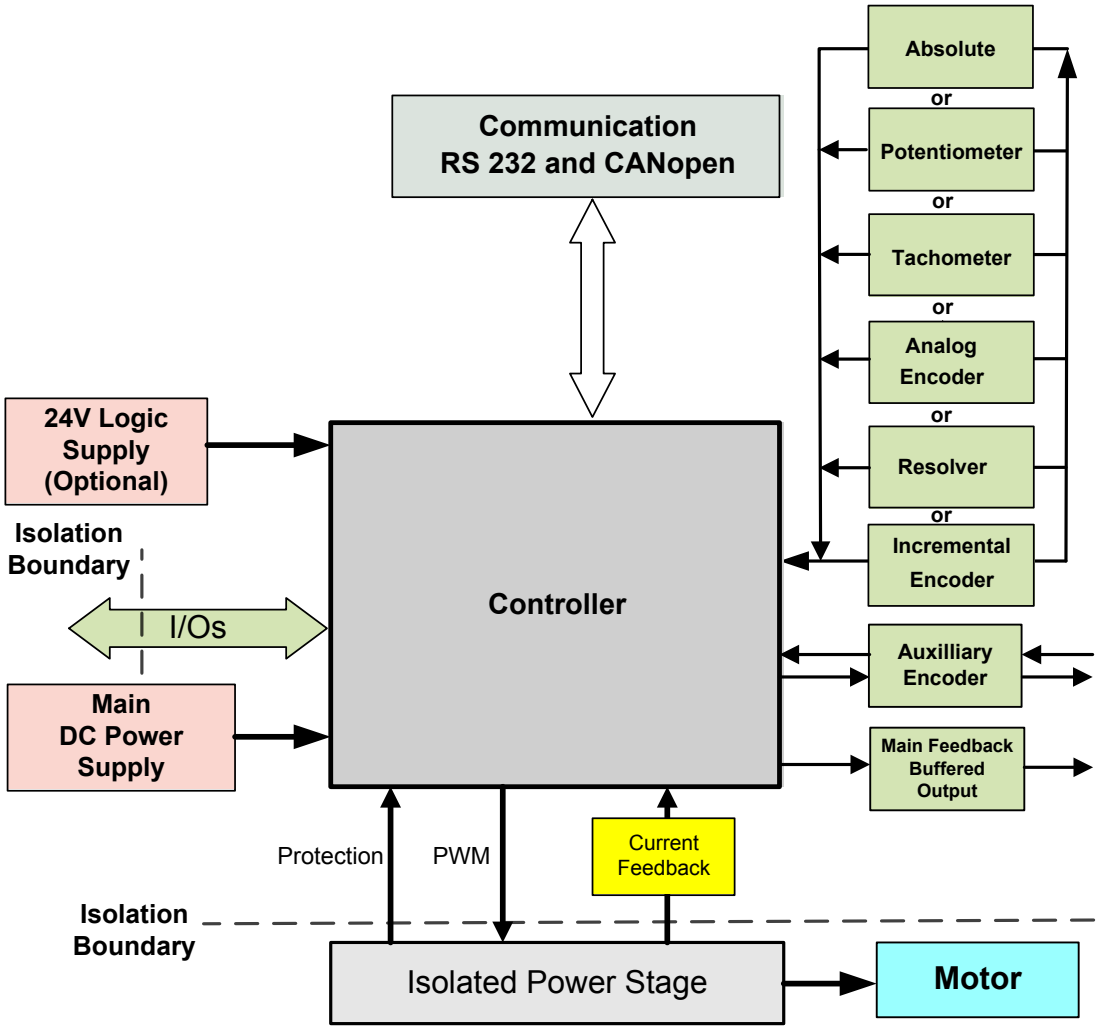


Figure 1: DC Trombone System Block Diagram

2.4. How to Use this Guide

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

Upon completing the instructions in this guide, the DC 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 DC Trombone
- The SimplIQ Command Reference Manual, which describes, in detail, each software command used to manipulate the DC 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

3.1. Before You Begin

3.1.1. Site Requirements

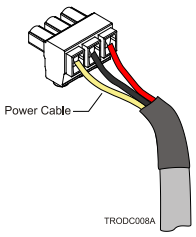
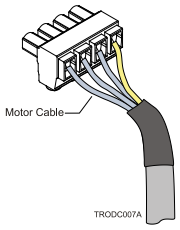
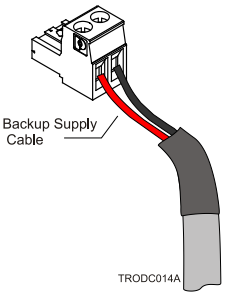
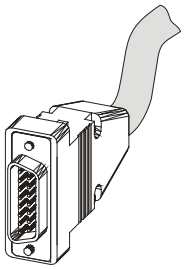
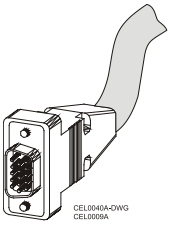
You can guarantee the safe operation of the DC Trombone by ensuring that it is installed in an appropriate environment.

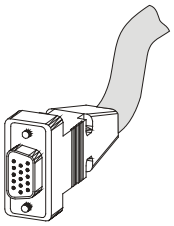
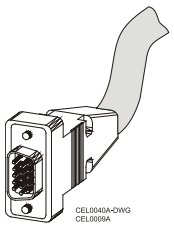
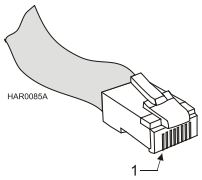
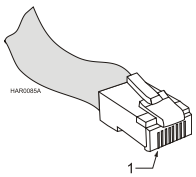
Feature	Value
Ambient operating temperature	0 °C to 40 °C (32 °F to 104 °F)
Maximum Operating Altitude	2,000 m (6562 feet)
Maximum non-condensing humidity	90%
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	

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

3.1.2. Hardware Requirements

The components that you will need to install your DC Trombone are:

Component	Connector	Described in Section	Diagram
Main Power Cable	**PE VN- VP+**	3.6.4	
Motor Cable	**M3 M2 M1 PE**	3.6.3	
Backup Supply Cable (needed for S type drive)	**VL+ VL-**	3.6.7	
Main Feedback Cable	**MAIN FEEDBACK (FEEDBACK A)**	3.7.1	
Auxiliary Feedback Cable (if needed)	**AUX. FEEDBACK (FEEDBACK B)**	3.7.3.2	

Component	Connector	Described in Section	Diagram
Digital I/O Cable (if needed)	**GENERAL I/O P1**	3.8.1	
Digital Inputs and Analog Inputs Cable (if needed)	**GENERAL I/O P2**	3.8.1.2	
RS232 Communication Cable	**RS232**	3.9.1.1	
CAN Communication cable(s) (if needed)	**CAN (in)** **CAN (out)**	3.9.1.2	
PC for drive setup and tuning			
Motor data sheet or manual			

3.2. Unpacking the Drive Components

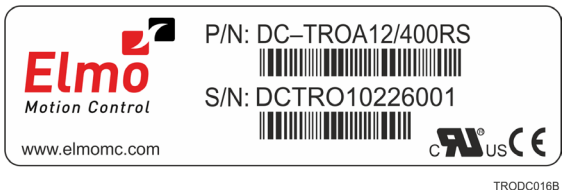
Before you begin working with the DC Trombone system, verify that you have all of its components, as follows:

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

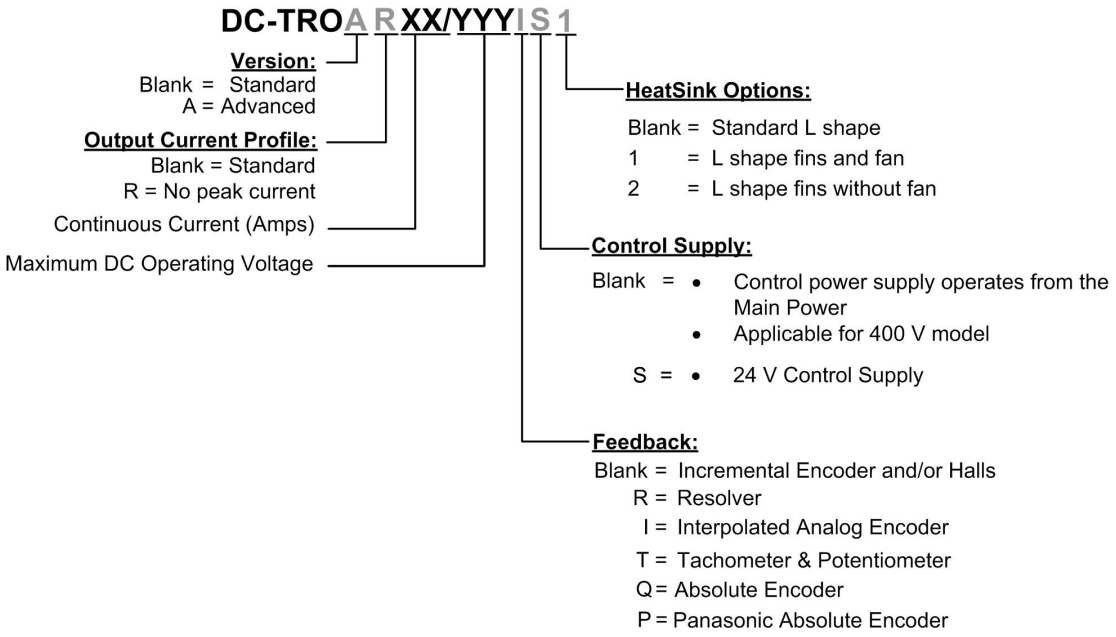
The DC Trombone is shipped in a cardboard box with Styrofoam protection.

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



The P/N number at the top gives the type designation as follows:



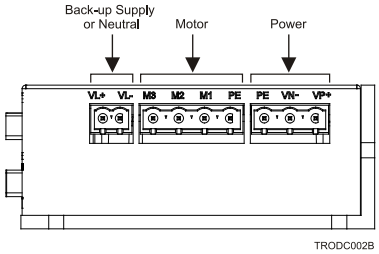
4. Verify that the DC Trombone type is the one that you ordered, and ensure that the voltage meets your specific requirements.

3.3. Connectors

3.3.1. Connector Types

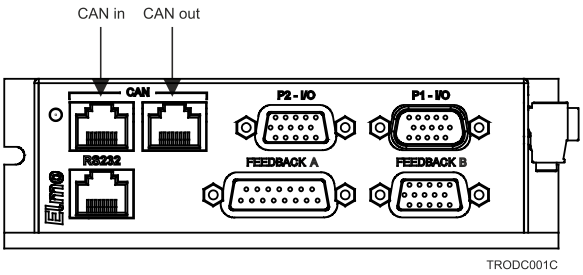
The DC Trombone has the following connectors:

Bottom Connectors



Pins	Type	Function
2	5.08 mm Phoenix high current	Connector for optional backup supply in S type drives
4	7.62 mm Phoenix high current	Motor Connector
3	7.62 mm Phoenix high current	Power Connector

Front Connectors



8	RJ-45	CAN in
8	RJ-45	CAN out
15	High-Density Female D-Sub	P2- I/O
15	High-Density Male D-Sub	P1-I/O
8	RJ-45	RS-232
15	Female D-Sub	Feedback A (Main Feedback)
15	High Density Female D-Sub	Feedback B (Aux. Feedback)

Table 1: Connector Types

3.4. Mounting the DC Trombone

The DC Trombone has been designed for two standard mounting options:

- Wall Mount along the back (can also be mounted horizontally on a metal surface)
- Book Shelf along the side

M4 round head screws, one through each opening in the heat sink, are used to mount the DC Trombone (see the diagram below).

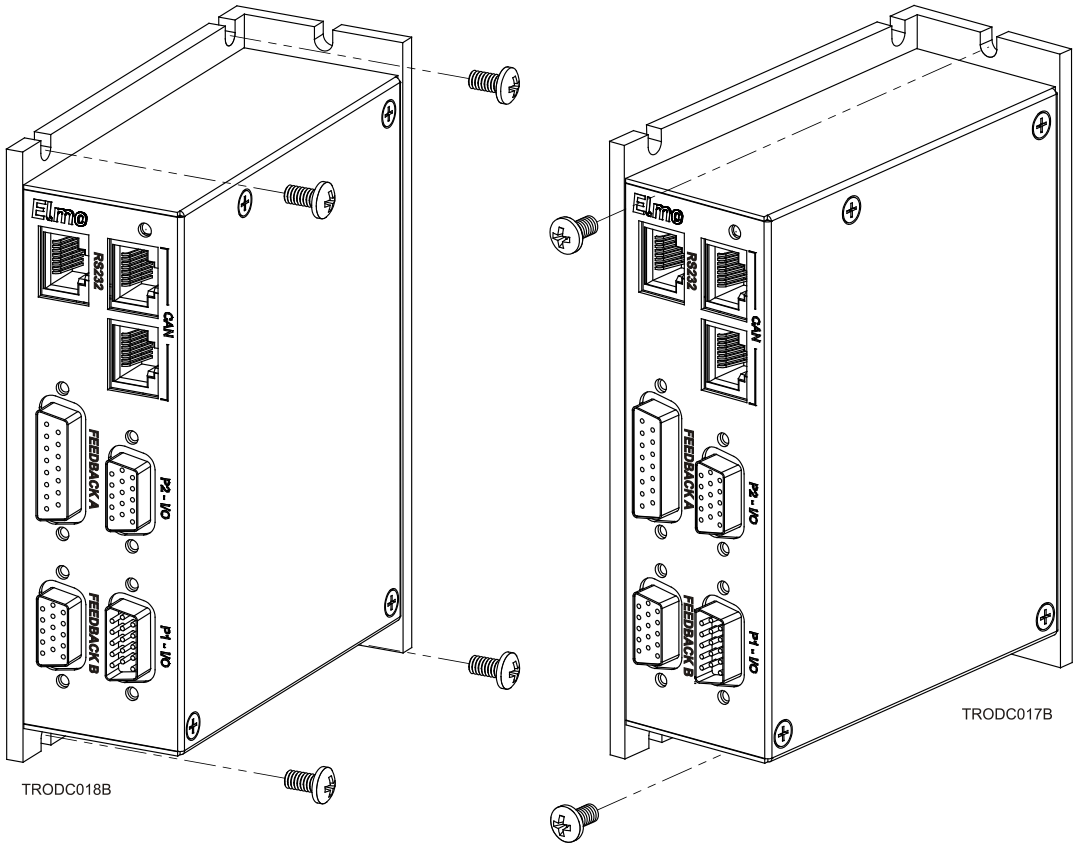


Figure 2: Mounting the DC Trombone with L-shaped Heat-sink

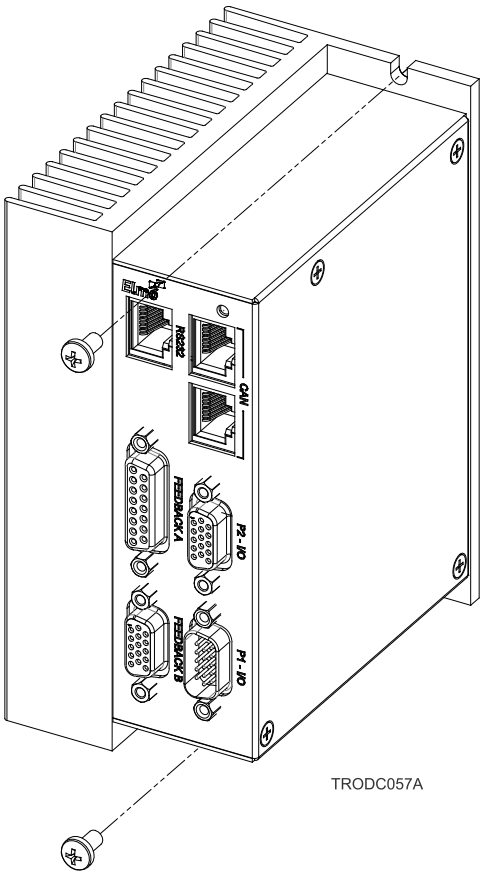


Figure 3: Mounting the DC Trombone with Heat-Sink Fan and Fins

3.5. Connections

3.5.1. Wiring the DC Trombone

Once the DC Trombone is mounted, you are ready to wire the device. Proper wiring, grounding and shielding are essential for ensuring safe, immune and optimal servo performance of the DC Trombone.

Caution:
Perform the following instructions to ensure safe and proper wiring.

1. Use twisted pair shielded cables for control, feedback and communication connections. For best results, the cable should have an aluminum foil shield covered by copper braid, and should contain a drain wire.
   The drain wire is a non-insulated wire that is in contact with parts of the cable, usually the shield. It is used to terminate the shield and as a grounding connection.

   The impedance of the wire must be as low as possible. The size of the wire must be thicker than actually required by the carrying current. A 24, 26 or 28 AWG wire for control and feedback cables is satisfactory although 24 AWG is recommended.
2. Use shielded wires for motor connections as well. If the wires are long, ensure that the capacitance between the wires is not too high: C < 30 nF is satisfactory for most applications.
3. Keep all wires and cables as short as possible.
4. Keep the motor wires as far away as possible from the feedback, control and communication cables.
5. Ensure that in normal operating conditions, the shielded wires and drain *carry no current.* The only time these conductors carry current is under abnormal conditions, when electrical equipment has become a potential shock or fire hazard while conducting external EMI interferences directly to ground, in order to prevent them from affecting the drive. Failing to meet this requirement can result in drive/controller/host failure.
6. After completing the wiring, carefully inspect all wires to ensure tightness, good solder joints and general safety.

3.5.2. Connection Diagrams

The following two connection diagrams (Figure 4, Figure 5) show the three different ways of connecting the servo drive:

- 400 V and 800 V S models (the catalog number has an S option) that feature backup functionality and require an auxiliary 24 V backup supply. The drive will not be operative without the external 24 VDC supply.
- 400 V model without backup functionality. The drive's internal DC/DC converter is fed from the VP+ and VN- of the internal drive's bus line.

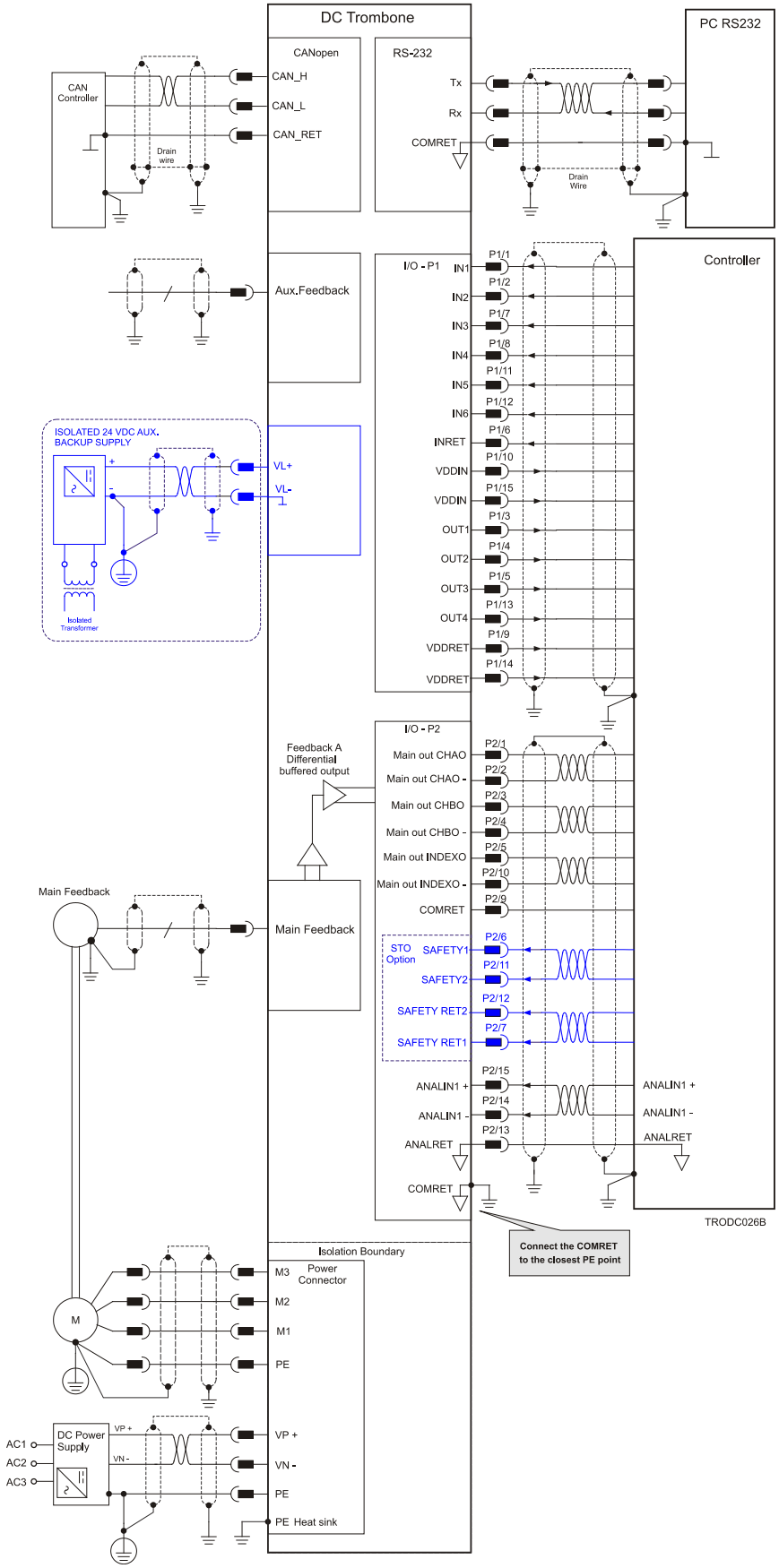


Figure 4: DC Trombone Connection Diagram – with Backup Functionality (S Type Drive)

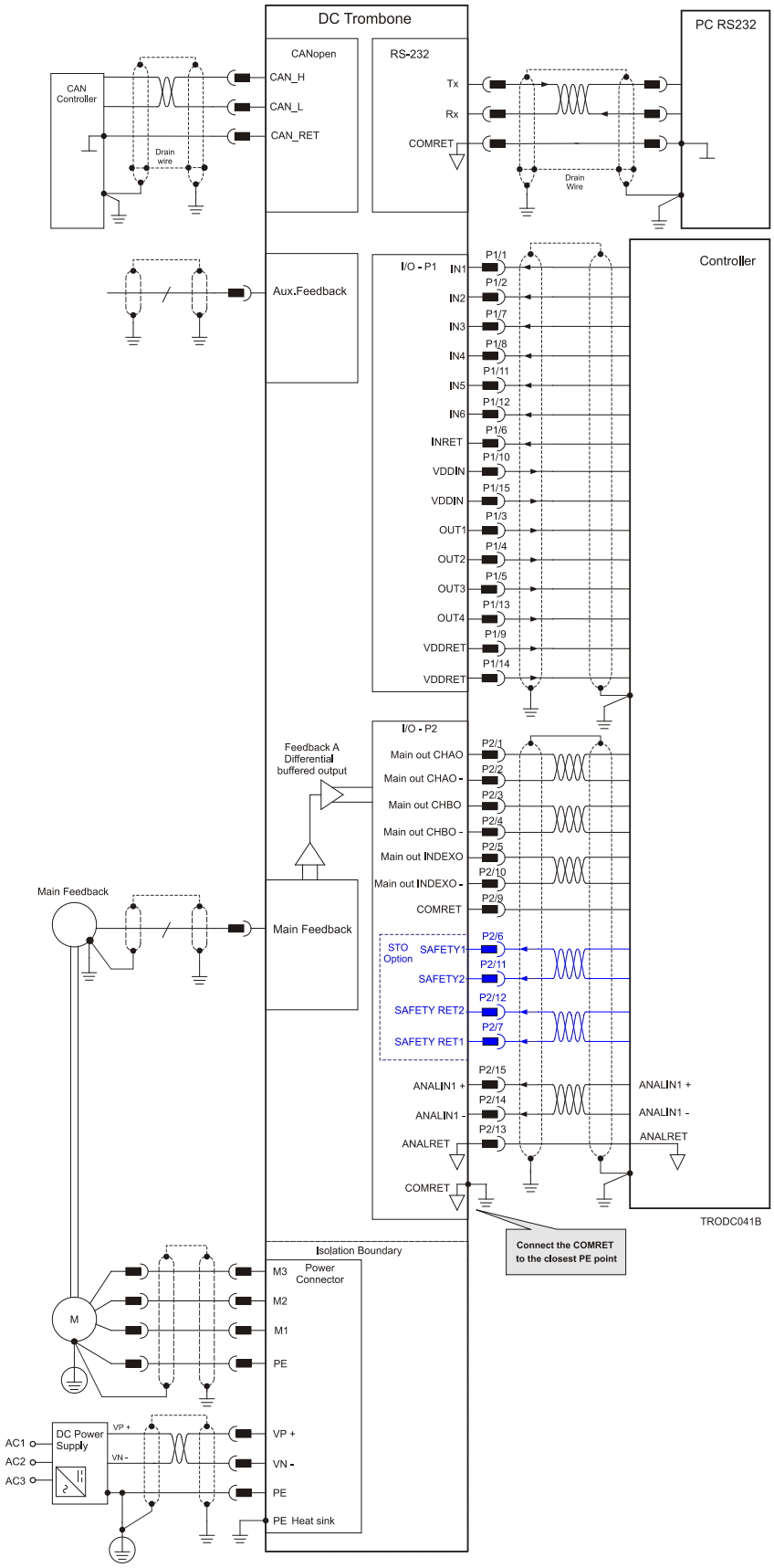


Figure 5: DC-DC Trombone Connection Diagram – 400 V without Backup Functionality

3.6. Connecting the Power Cables

The power connectors are located at the bottom of the DC Trombone, as follows:

3.6.1. For S type drives

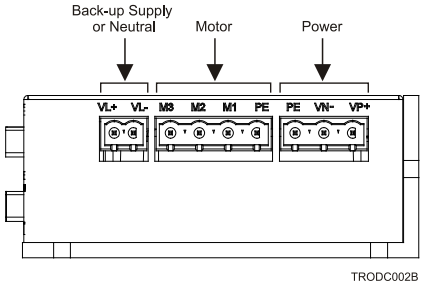
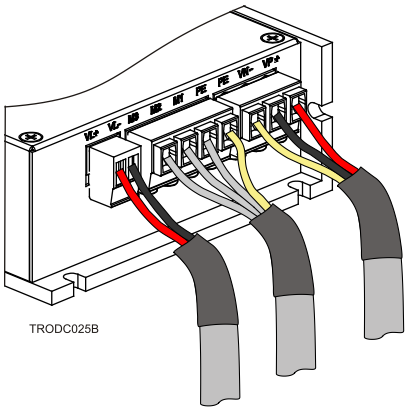
Pin	Function	Cable	
Power			
VP+	Positive Power input	DC Power	
VN-	Negative Power input	DC Power	
PE	Protective earth	DC Power	
Motor		**AC**	**DC**
PE	Protective earth	Motor	Motor
M1	Motor phase	Motor	N/C
M2	Motor phase	Motor	Motor
M3	Motor phase	Motor	Motor
Auxiliary 24 VDC Backup Supply			
VL-	Negative Auxiliary input	Backup Power	
VL+	Positive Auxiliary input	Backup Power	
Connector Location		**Cable Connector**	
 **Pin Positions**			

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

3.6.2. For Non-S 400 VDC Type Drives

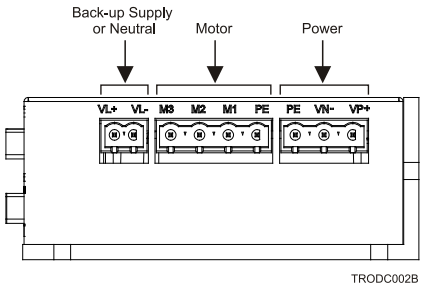
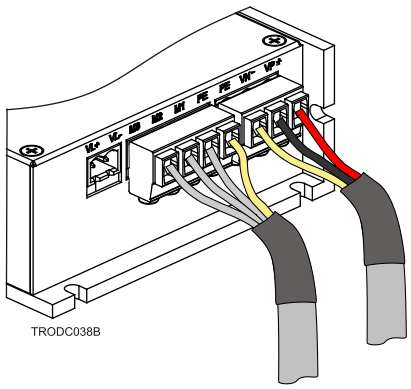
Pin	Function	Cable	
Power			
VP+	Positive Power input	DC Power	
VN-	Negative Power input	DC Power	
PE	Protective earth	DC Power	
Motor		**AC**	**DC**
PE	Protective earth	Motor	Motor
M1	Motor phase	Motor	N/C
M2	Motor phase	Motor	Motor
M3	Motor phase	Motor	Motor
Not Used			
VL-	N.C.		
VL+	N.C.		
Connector Location		**Cable Connector**	
 **Pin Positions**			

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

3.6.3. Connecting the Motor Cable

Connect the motor power cable to the M3, M2, M1 and the PE (Motor chassis) terminals of the motor connector (see diagram below). The phase connection order is arbitrary because the Composer will establish the proper commutation automatically during setup. However, if you are willing to avoid from tuning each drive separately, and you plan to copy this setup file to other drives – then, the motor-phase order, on all copy drives, must be kept the same as in the first drive.

Note for connecting the motor cables:

1. For best immunity, it is highly recommended to use a shielded (not twisted) cable for the motor connection. A shielded cable consisting of four wires should be used. The gauge is determined by the actual current consumption of the motor.
2. Connect the shield of the cable to the closest ground connection at the motor end.
3. Connect the shield of the cable to the PE terminal in the drive's motor-connector.
4. Make sure that the motor chassis is properly grounded.

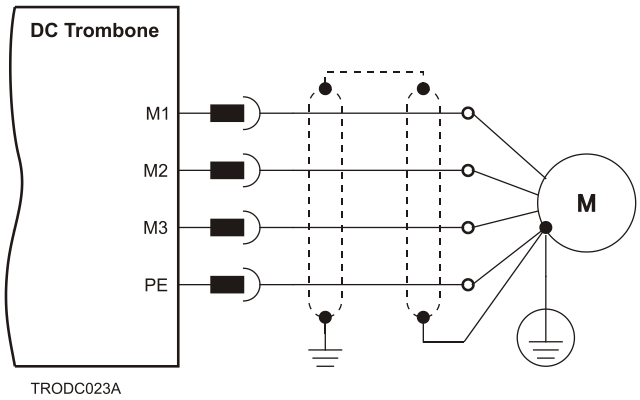


Figure 6: AC Motor Power Connection Diagram

3.6.4. Connecting the DC Power

The DC power to the DC 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 DC Trombone is fully isolated from other sections of the DC Trombone, 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 which significantly contributes to proper functionality, safety and EMI immunity, leading to a better performance of the DC Trombone.

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

However, the DC Trombone can operate from a non-isolated/direct-to-mains DC power supply, an isolated DC 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 Trombone is connected to Elmo's Tambourine power supply, then the end-user can exploit the Tambourine's options, such as EMI-filtering and shunt-regulator.

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

This section relates to the configuration of the power supply and drive, which are connected directly to the mains (Figure 7, Figure 8, Figure 9).

Recommended connection of 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 DC Trombone's power-connector, or attach it to one of the 6 mounting screws of the drive's heat sink.

3.6.5.1. Three-Phase Direct-to-Mains Connection Topology

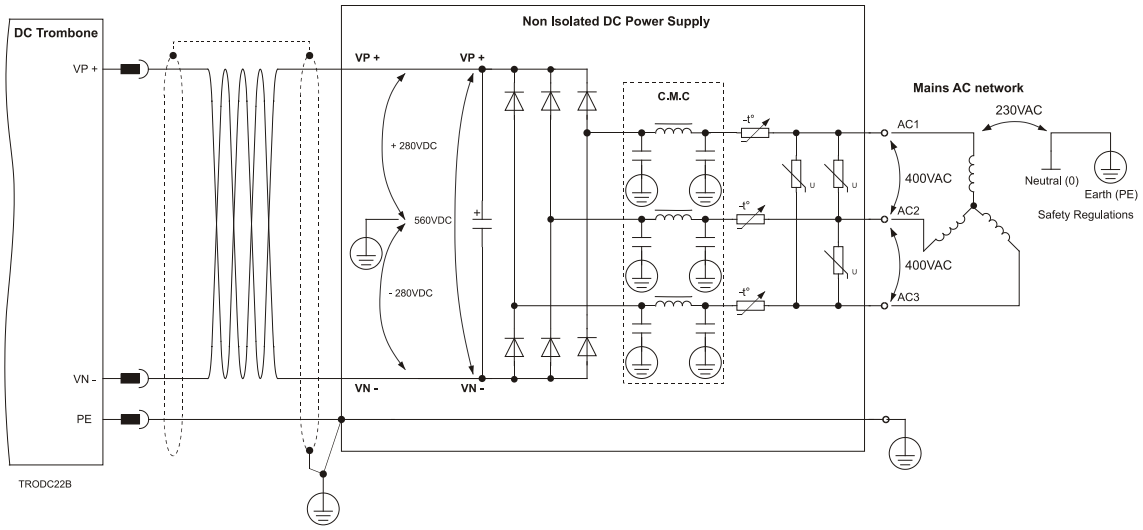


Figure 7: Non-Isolated Three-Phase Connection Topology

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.

Take care to 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.

3.6.5.2. Single-Phase Direct-to-Mains Connection Topology

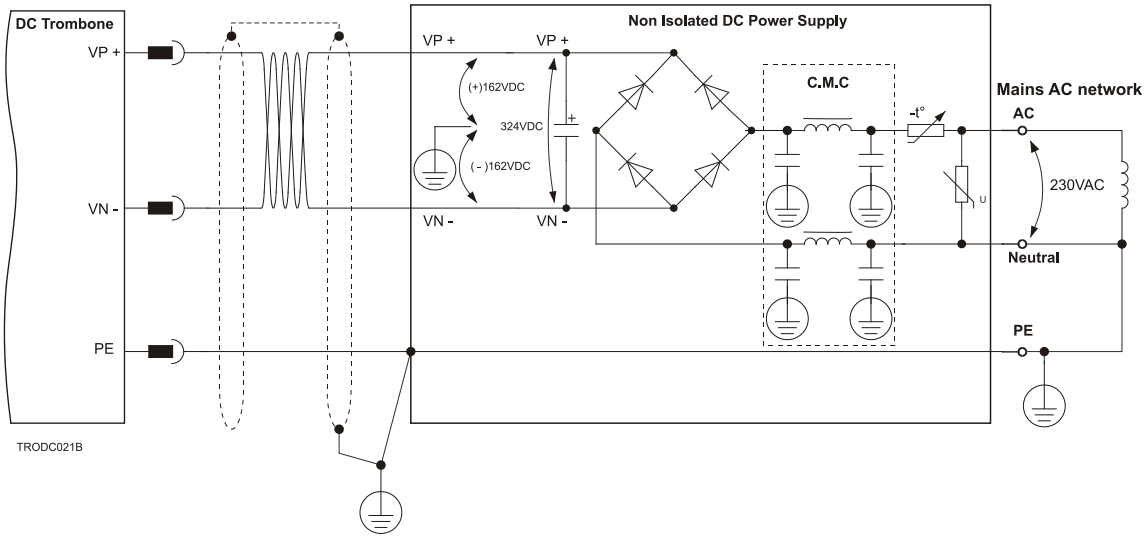


Figure 8: Non-Isolated Single-Phase Connection Topology

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, as this will cause irreparable damage to the system.

Take care 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.

3.6.5.3. Multiple Connections Topology

When applied in a multi-axis arrangement, it is likely that a single power supply can feed several drives in parallel.

This topology is efficient and cost saving, reducing the number of power supplies and the amount of wiring. More importantly, it utilizes an energy-sharing environment among all the drives that share the same DC bus network.

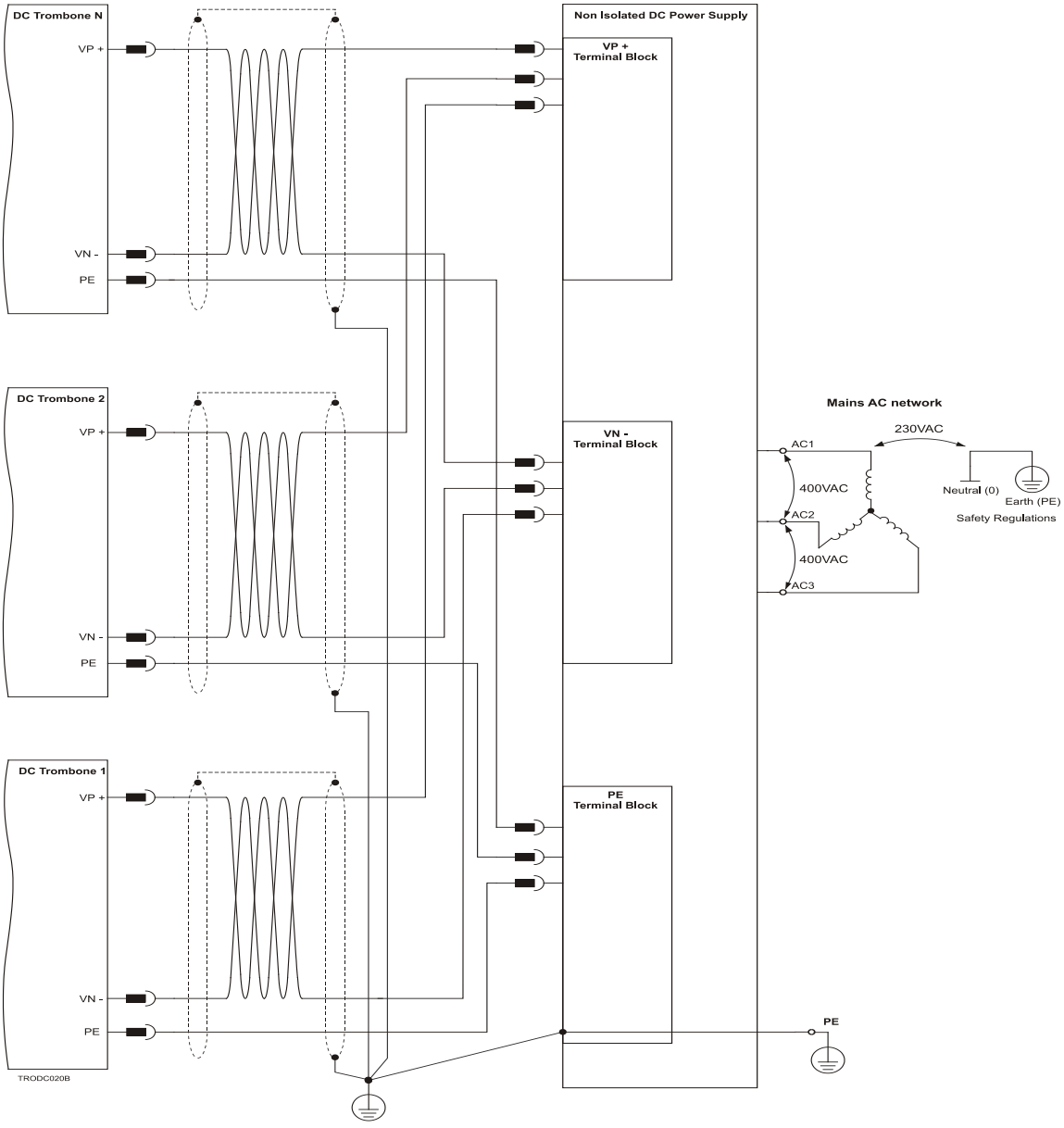


Figure 9: Non-Isolated Three-Phase multiple Connection Topology

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

3.6.6. Battery Power Supply

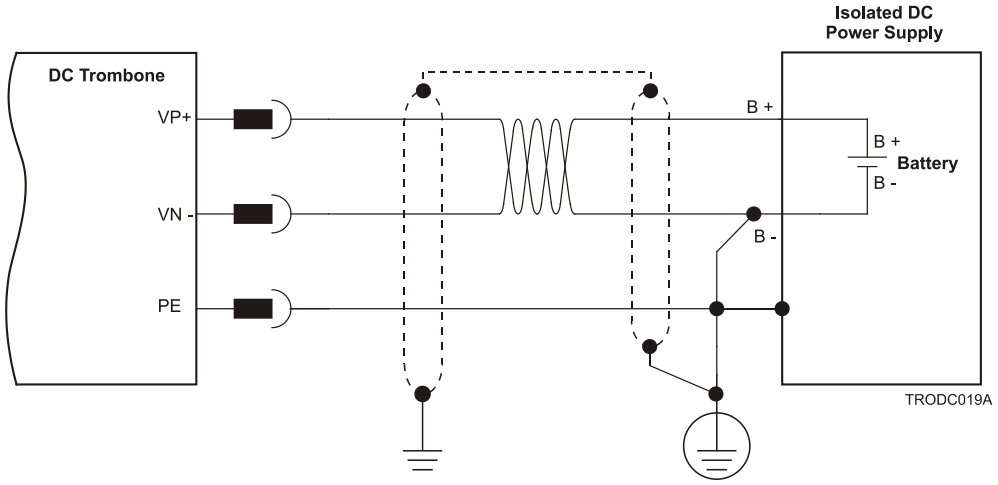


Figure 10: Battery Connection Topology

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.

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

In non-S type DC Trombone drive (a drive without having the option S in its part number), a "smart" control-supply algorithm enables the DC 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: In models without the S option, 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 DC Trombone should be used, with an external 24 VDC isolated power supply connected to it.

Note: The S-model DC Trombone always requires an external 24 VDC power supply, regardless of whether or not backup functionality is required.

Connect the auxiliary 24 VDC power supply as described below.

Notes 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.

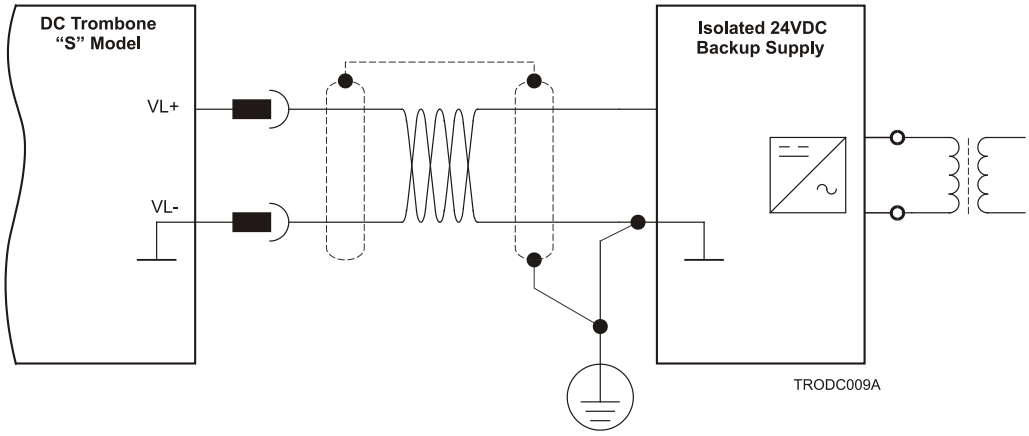


Figure 11: Auxiliary 24 VDC Backup Supply Connection Diagram

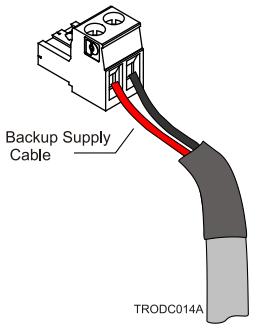
Pin	Signal	Function	Cable
VL+	+24VDC	+24 VDC backup supply Input Positive	 **2-Pin Phoenix Plug-in Connector**
VL-	24VDC RET	Return (common) of the 24 VDC backup supply	

Table 4: Backup Cable Plug

3.7. Feedback and Control Cable Assemblies

The DC Trombone features easy-to-use D-Sub type connections for all Control and Feedback cables. Below are instructions and diagrams describing how to assemble those cables.

1. Use 24, 26 or 28 AWG twisted-pair shielded cables (24 AWG cable is recommended). For best results, the shield should have aluminum foil covered by copper braid.
2. Use only a D-Sub connector with a **metal housing**.
3. Ideally, solder the shield drain wire to the connector body as shown in Figure 12. However, the shield may also be attached without soldering, as long as the braid shield is in tight contact with the metal housing of the D-type connector.
4. On the motor side connections, ground the shield to the motor chassis.
5. On controller side connections, follow the controller manufacturer's recommendations concerning the shield.

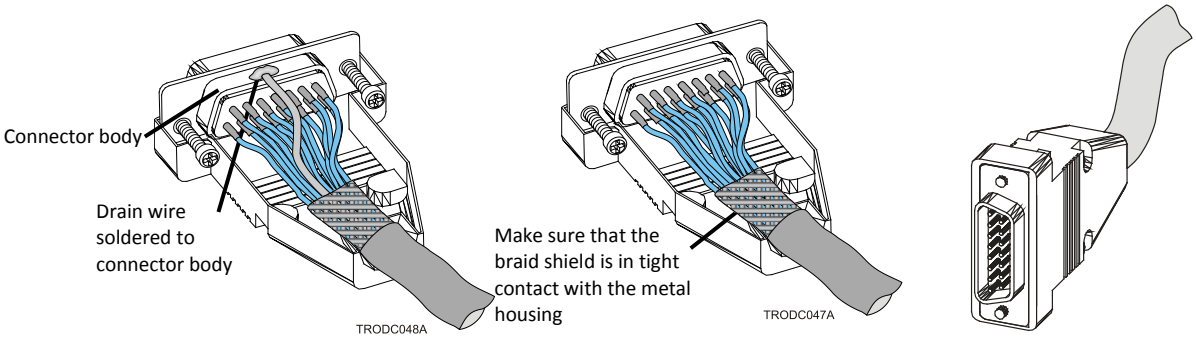


Figure 12: Feedback and Control Cable Assemblies

Note: All D-Sub type connectors, used with the DC Trombone, should be assembled in this way.

3.7.1. Main Feedback Cable (FEEDBACK A)

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

The DC Trombone 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)
- Absolute Encoder

FEEDBACK A on the “front” of the DC Trombone has a 15-pin D-Sub socket.

Connect the Main Feedback cable from the motor to FEEDBACK A using a 15-pin, D-Sub plug with a metal housing. When assembling the Main Feedback cable, follow the instructions in Section 3.7 (Feedback and Control Cable Assemblies).

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

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

Table 6: Main Feedback Cable Pin Assignments

Note: Connect the common from the control section to the closest PE point.

To connect the control common to the PE, use any one of the following available pins:

- P2/9
- FEEDBACK-B / 9, or 15
- FEDBACK A / 9, or 11, or 13

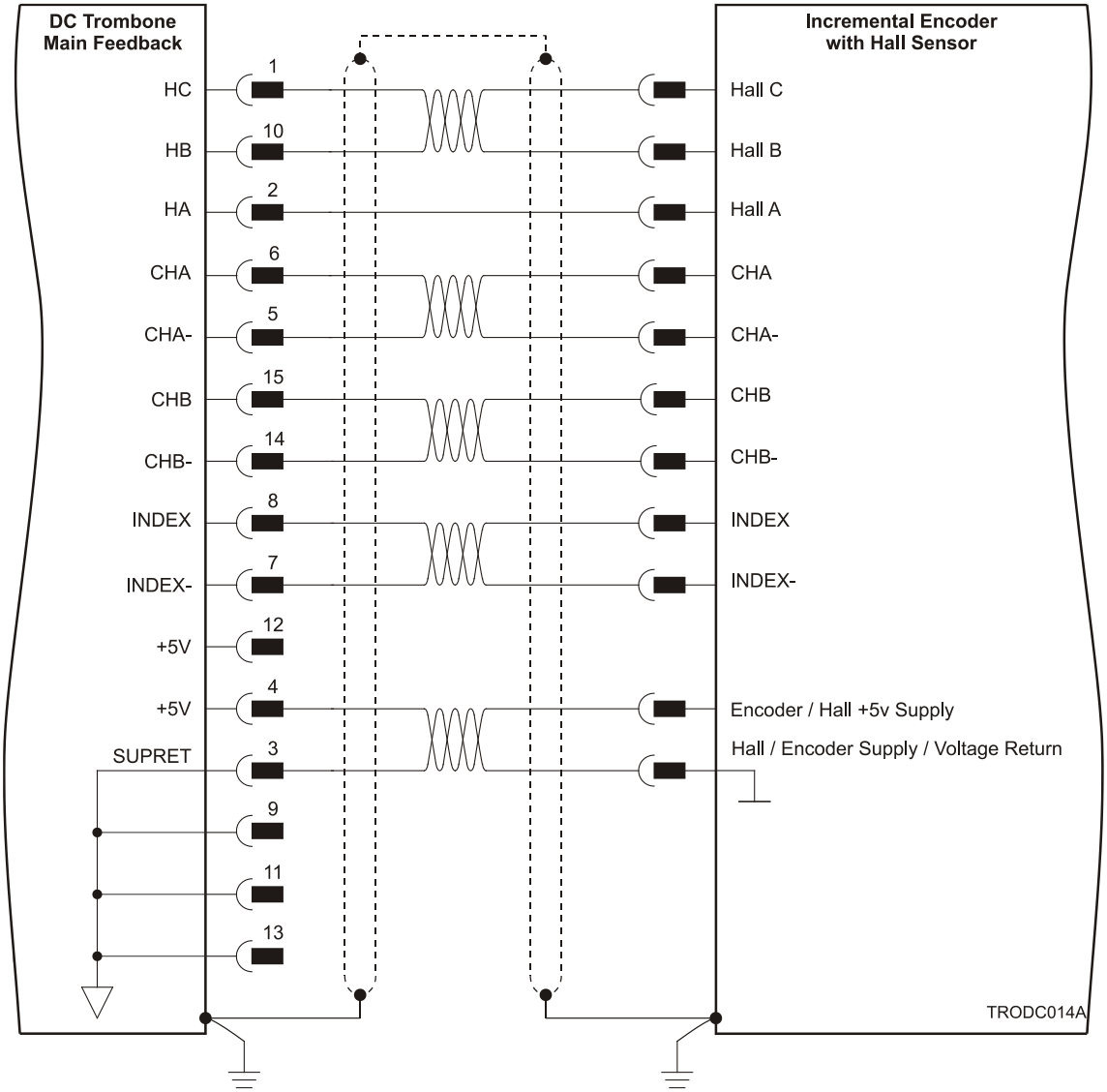


Figure 13: Main Feedback- Incremental Encoder Connection Diagram

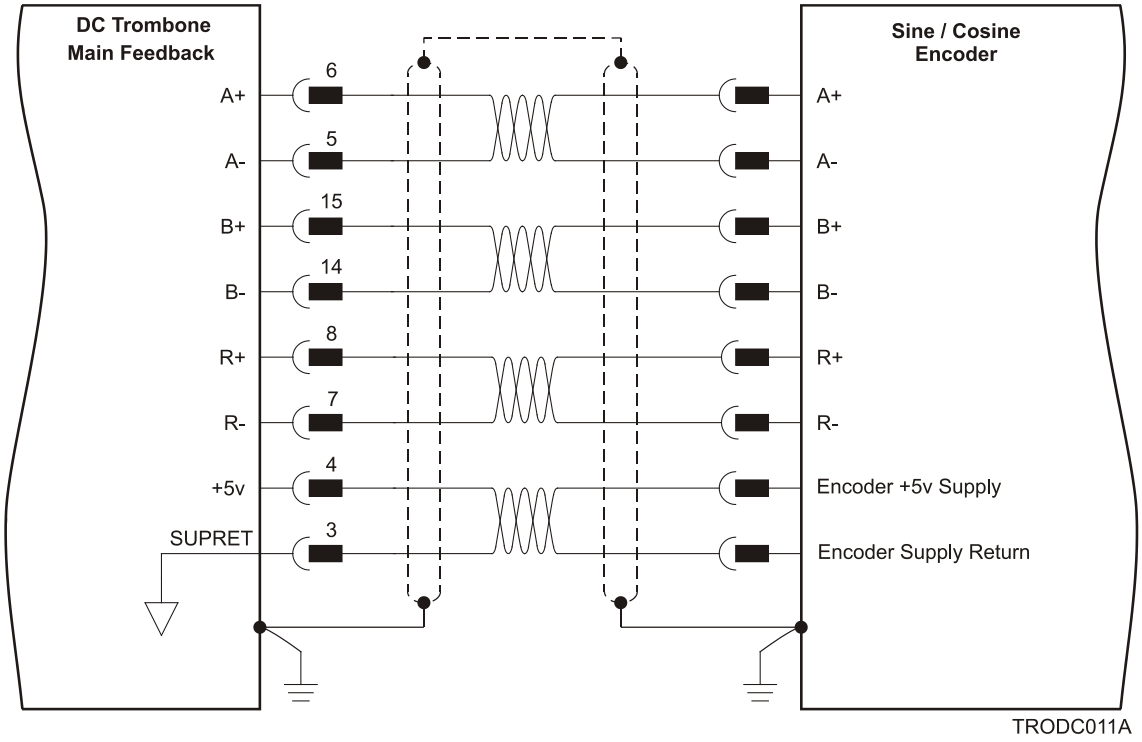


Figure 14: Main Feedback – Interpolated Analog Encoder Connection Diagram

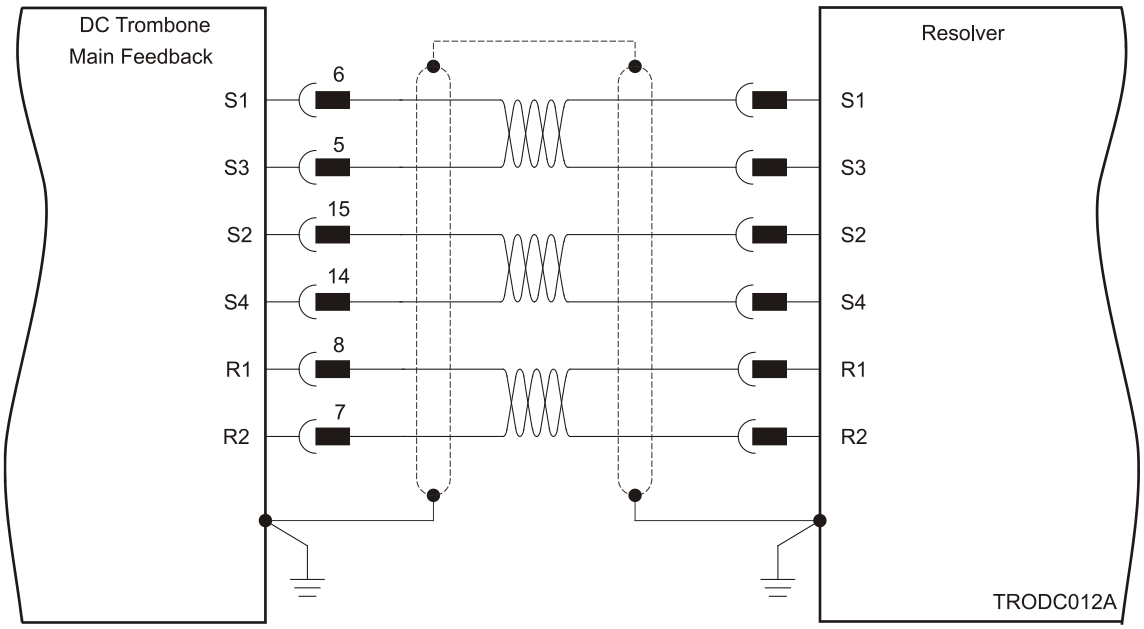


Figure 15: Main Feedback – Resolver Connection Diagram

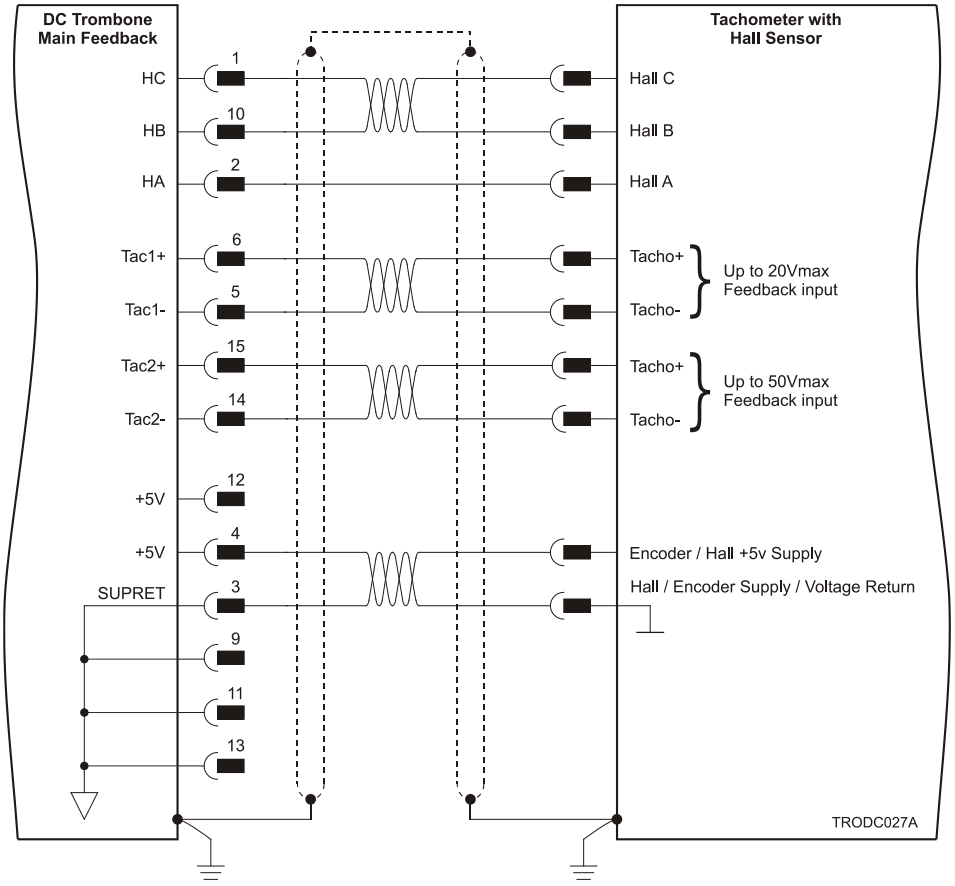


Figure 16: Main Feedback – Tachometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

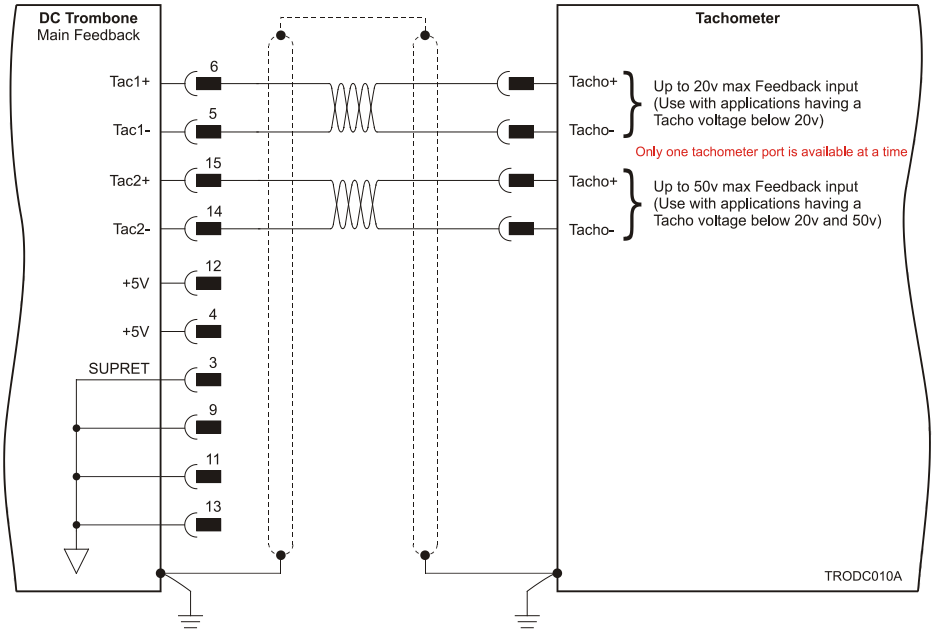


Figure 17: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors

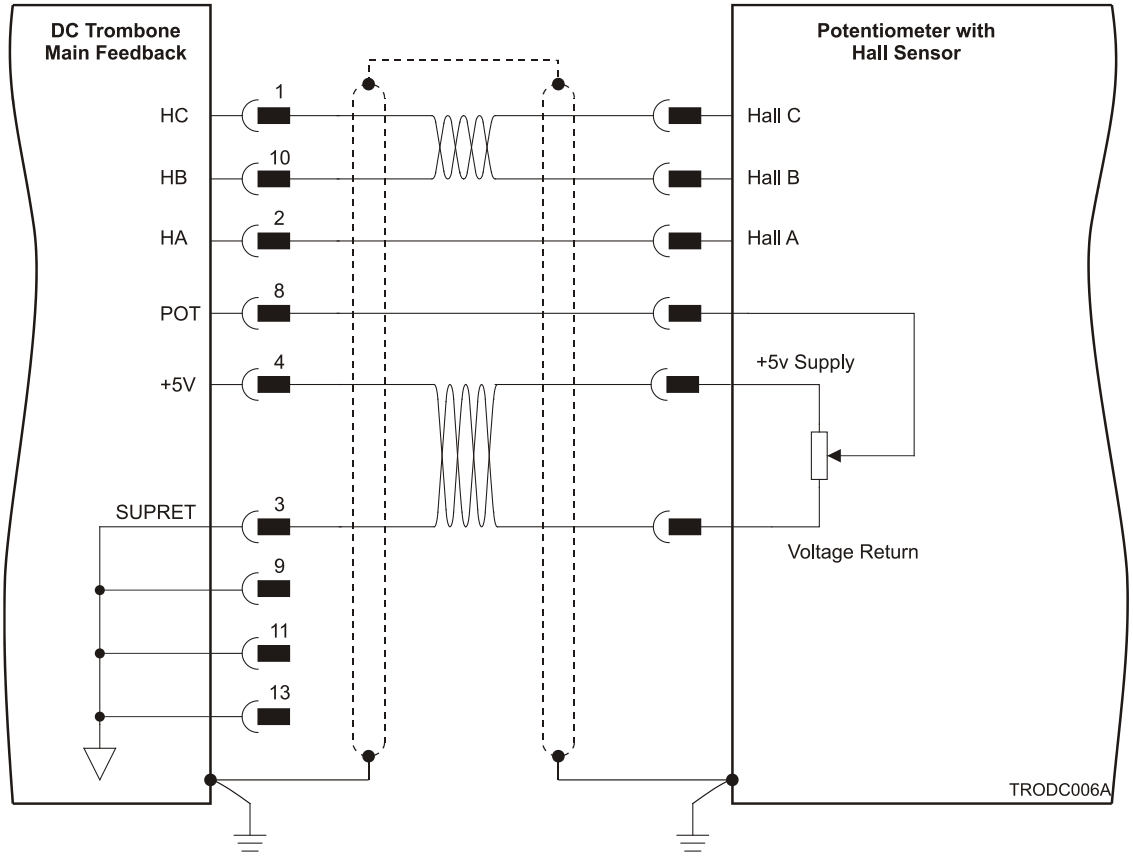


Figure 18: Main Feedback – Potentiometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

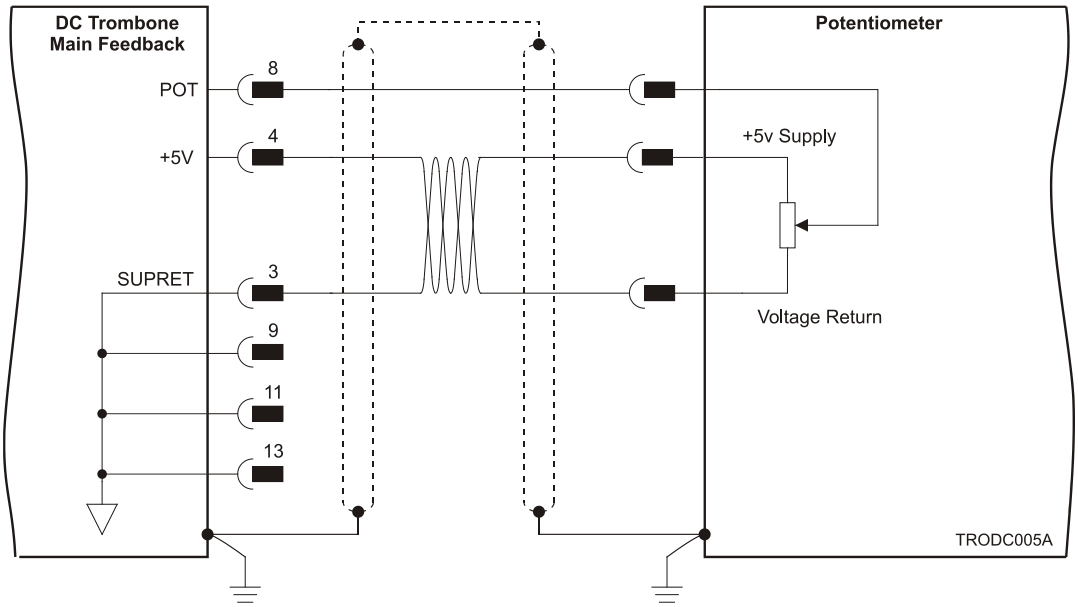


Figure 19: Main Feedback –
Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils

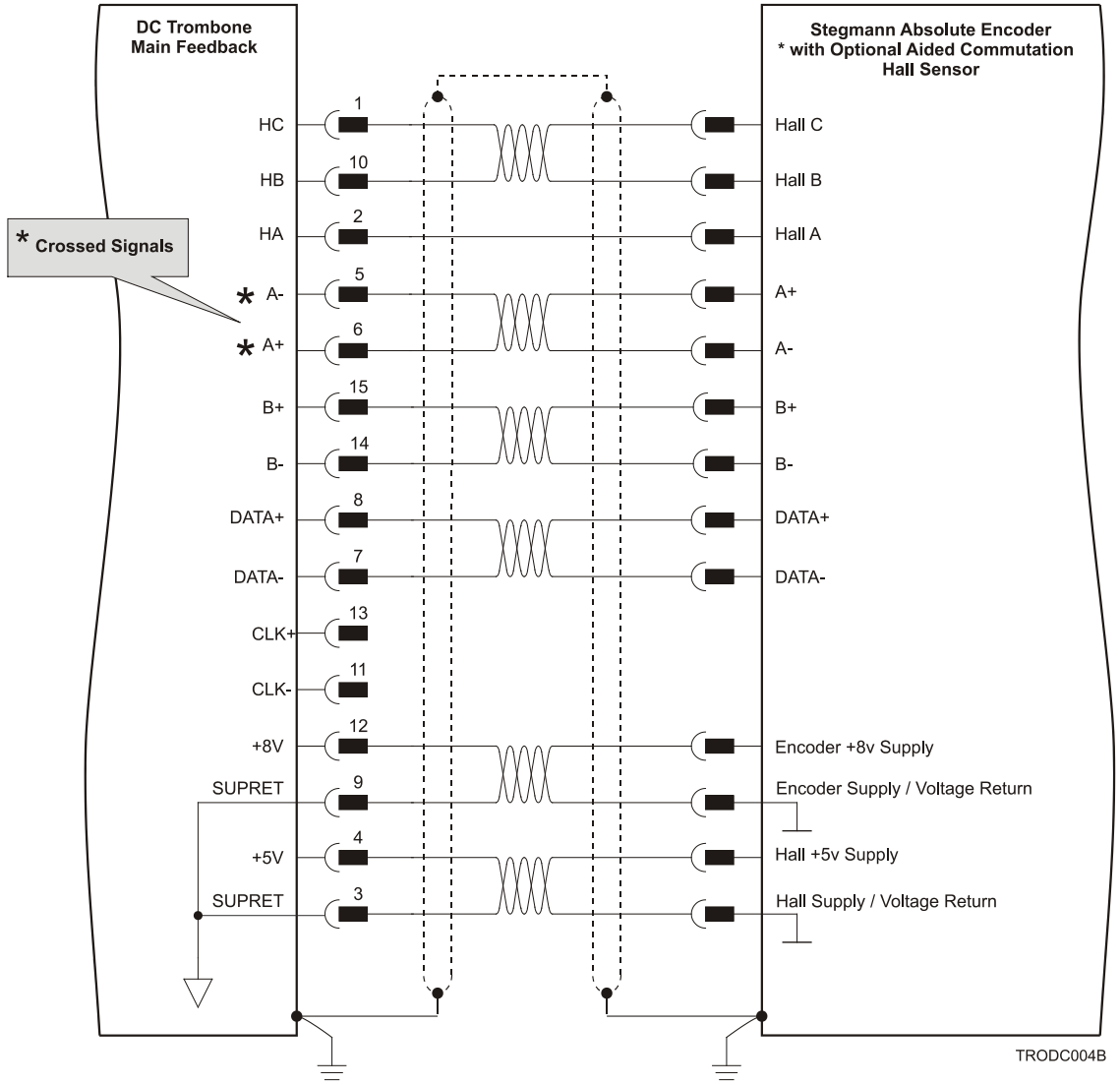


Figure 20: Main Feedback – Stegmann Feedback Connection Diagram

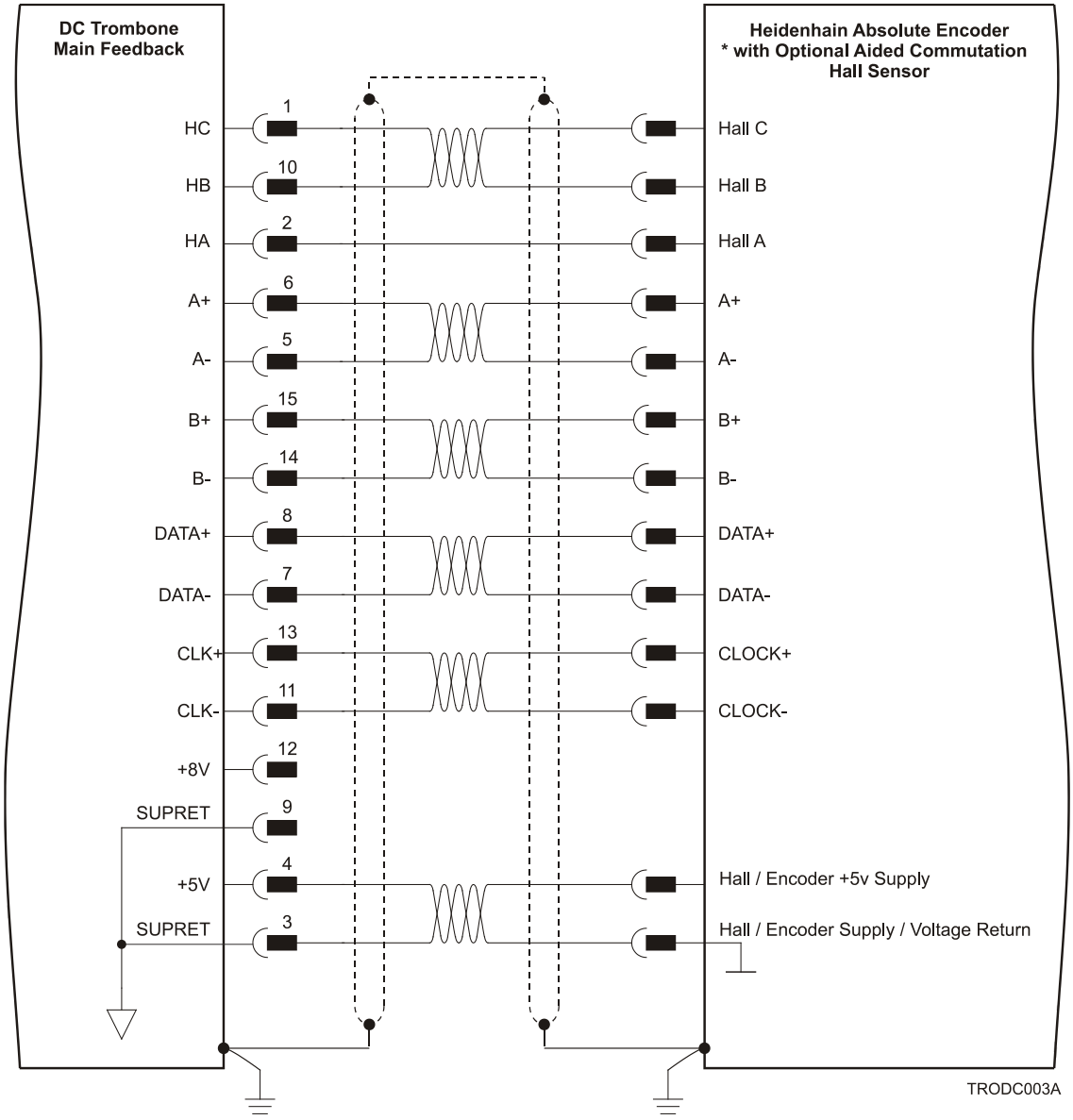
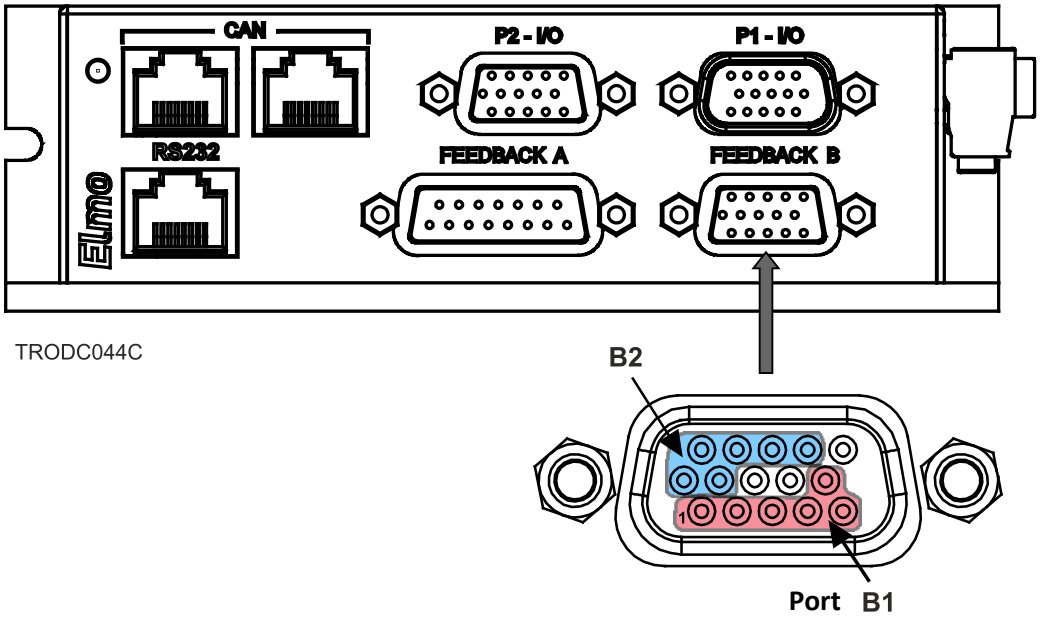


Figure 21: Main Feedback – Heidenhain Feedback Connection Diagram

3.7.2. Main and Auxiliary Feedback Combinations

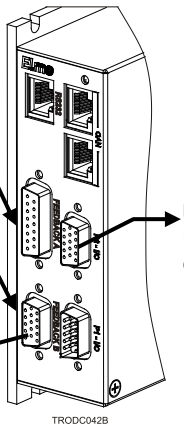
The Main Feedback is always used in motion control devices, whereas the Auxiliary Feedback is often, but not always used. The Auxiliary Feedback connector on the DC Trombone, FEEDBACK B, has two ports, Port B1 and Port B2. When used in combination with the FEEDBACK A, these ports can be set, by the software, as follows:



<table>
<tr><th>MAIN FEEDBACK</th><th>AUX. FEEDBACK Ports B1 and B2</th></tr>
<tr><td>Software Setting</td><td>YA[4] = 4</td></tr>
<tr><td>Incremental Encoder Input</td><td>Feedback A (Main Feedback):
Digital Encoder

Feedback B (Auxiliary Feedback)
B1 Input:
N/A

Feedback B (Auxiliary Feedback)
B2 Output:
N/A

Main Buffered Output via P2:
Differential and buffered main encoder signals</td></tr>
<tr><td>Interpolated Analog (sin/cos) Encoder Input

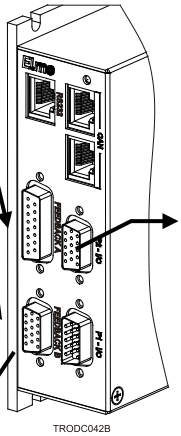
Resolver Input

Potentiometer and Tachometer Input

Absolute Encoder Input (All Types)</td><td>Feedback A (Main Feedback):
Interpolated Analog Encoder
Or Resolver
Or Potentiomer and Tachometer
Or Absolute Encoder (all types)

Feedback B (Auxiliary Feedback)
B1 Input:
N/A

Feedback B (Auxiliary Feedback)
B2 Output:
Differential and buffered emulated encoder signal of Feedback A

Main Buffered Output via P2:
N/A</td></tr>
</table>

<table>
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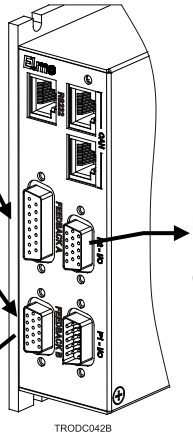
<tr><td>Software Setting</td><td>YA[4] = 2</td></tr>
<tr><td>Incremental Encoder Input</td><td>Feedback A (Main Feedback):
Digital Encoder

Feedback B (Auxiliary Feedback) B1 Input:
Differential Incremental Encoder

Feedback B (Auxiliary Feedback) B2 Output:
Output same as B1

 
TRODC042B

Main Buffered Output via P2:
Differential and buffered main encoder signals</td></tr>
<tr><td>Interpolated Analog (sin/cos) Encoder Input

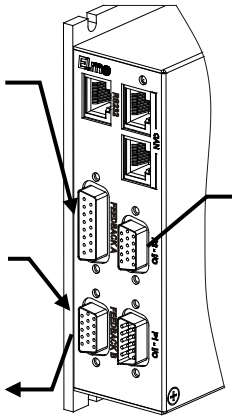
Resolver Input

Potentiometer and Tachometer Input

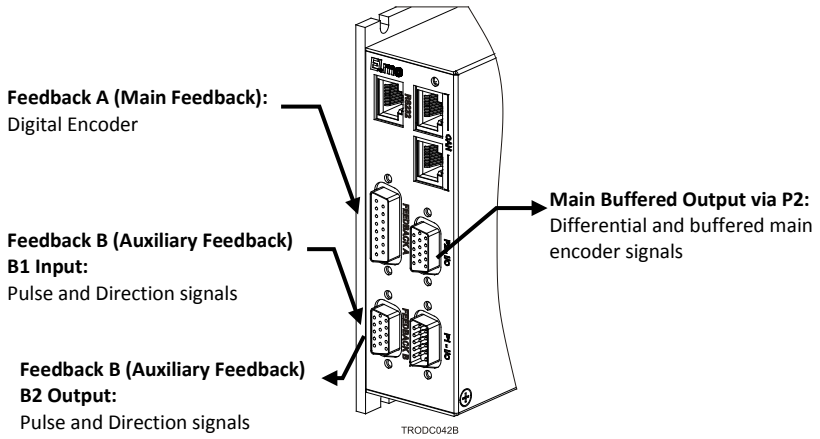
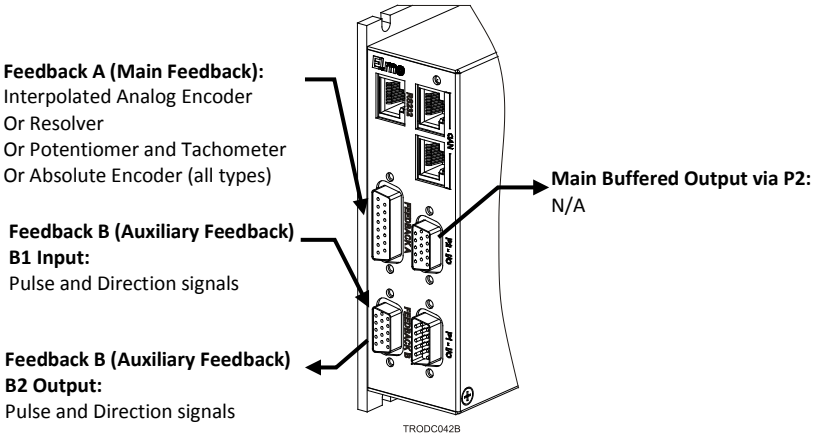
Absolute Encoder Input (All Types)</td><td>Feedback A (Main Feedback):
Interpolated Analog Encoder
Or Resolver
Or Potentiomer and Tachometer
Or Absolute Encoder (all types)

Feedback B (Auxiliary Feedback) B1 Input:
Differential Incremental Encoder

Feedback B (Auxiliary Feedback) B2 Output:
Output same as B1

 
TRODC042B

Main Buffered Output via P2:
N/A</td></tr>
</table>

MAIN FEEDBACK	AUX. FEEDBACK Ports B1 and B2
Software Setting	**YA[4] = 0**
Incremental Encoder Input	
Interpolated Analog (sin/cos) Encoder Input **Resolver Input** **Potentiometer and Tachometer Input** **Absolute Encoder Input (All Types)**	

3.7.3. FEEDBACK B (Auxiliary Feedback)

When using one of the auxiliary feedback options, the relevant functionality of the AUX. FEEDBACK ports are software selected for that option. Refer to the *SimplIQ Command Reference Manual* for detailed information about FEEDBACK B setup.

3.7.3.1. Emulated Encoder Outputs Option on FEEDBACK B (YA[4]=4)

Note: This mode is not applicable when an incremental encoder is employed as the Main Feedback A. When an incremental encoder is employed as Feedback A, the buffered main output is transmitted via P2 to an upper controller or other drive.

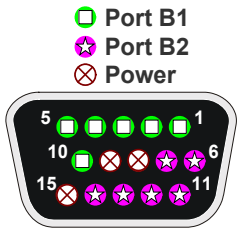
Through FEEDBACK B (Port B2) the DC Trombone can provide **a simultaneous emulated encoder signal** to other controllers or drives. This option can be used when the DC Trombone:

- Is used as a current amplifier to provide position data to the position controller.
- Is used in velocity mode, to provide position data to the position controller.
- Is used as a master in Follower or ECAM mode.

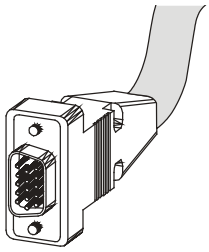
Below are the signals on the Auxiliary Feedback ports when set up to run as buffered emulated outputs of the following main encoders(on FEEDBACK A):

- Interpolated Analog Encoder
- Resolver
- Tachometer and Potentiometer
- Absolute Encoder (all types)

Port	Pin	Signal	Function
B1	1	CHA	Not in use in this mode
B1	2	CHA-	Not in use in this mode
B1	3	CHB	Not in use in this mode
B1	4	CHB-	Not in use in this mode
B1	5	INDEX	Not in use in this mode
B2	6	CHAO	Emulated buffered channel A output
B2	7	CHAO-	Emulated buffered channel A complement output
PWR	8	+5V	Encoder supply voltage
PWR	9	SUPRET	Encoder supply voltage return
B1	10	INDEX-	Not in use in this mode
B2	11	CHBO	Emulated buffered channel B output
B2	12	CHBO-	Emulated buffered channel B complement output
B2	13	INDEXO	Emulated buffered Index output
B2	14	INDEXO-	Emulated buffered Index complement output
PWR	15	SUPRET	Supply return
Pin Positions			



15-Pin High Density D-Sub Socket



15-Pin High Density D-Sub Plug

Table 7: Emulated Encoder Outputs on FEEDBACK B - Pin Assignments

FEEDBACK B on the DC Trombone has a 15-pin high density D-Sub socket.

Connect the Auxiliary Feedback cable, from the controller or other device, to FEEDBACK B using a 15-pin, high density D-Sub plug with a metal housing. When assembling the Auxiliary Feedback cable, follow the instructions in Section 3.7 (Feedback and Control Cable Assemblies).

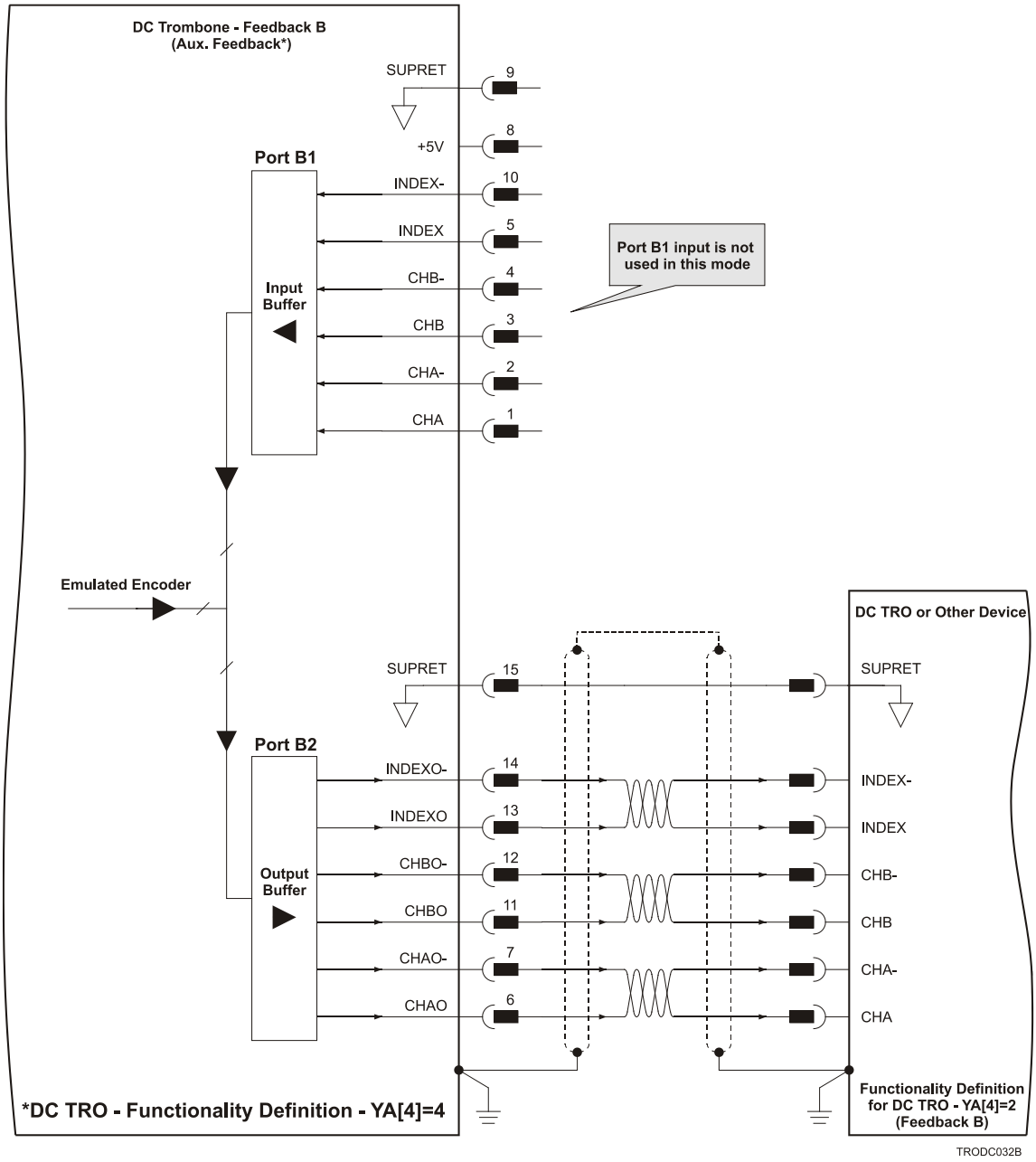


Figure 22: Emulated Encoder Output on FEEDBACK B - Connection Diagram

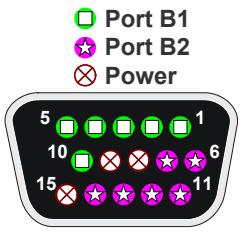
Note: When using digital incremental encoder as the main Feedback A, buffered main encoder signals are conveyed through the P2-I/O connector.

3.7.3.2. Differential Auxiliary Encoder Input Option on FEEDBACK B (YA[4]=2)

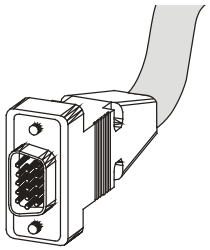
The DC Trombone can be used as a slave by receiving the position of the master encoder data (on Port B1) in Follower or ECAM mode. In this mode Port B2 provides **differential buffered auxiliary outputs of Port B1** for the next slave axis in follower or ECAM mode.

Below are the signals on the Auxiliary Feedback port when set up to run as a differential auxiliary encoder input:

Port	Pin	Signal	Function
B1	1	CHA	Auxiliary channel A high *input*
B1	2	CHA-	Auxiliary channel A low *input*
B1	3	CHB	Auxiliary channel B high *input*
B1	4	CHB-	Auxiliary channel B low *input*
B1	5	INDEX	Auxiliary Index high *input*
B2	6	CHAO	Buffered channel A output
B2	7	CHAO-	Buffered channel A complement output
PWR	8	+5V	Encoder supply voltage
PWR	9	SUPRET	Encoder supply voltage return
B1	10	INDEX-	Auxiliary Index low *input*
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	SUPRET	Supply return
Pin Positions			



15-Pin High Density D-Sub Socket



15-Pin High Density D-Sub Plug

Table 8: Differential Auxiliary Encoder Input Option on FEEDBACK B - Pin Assignments

FEEDBACK B on the DC Trombone has a 15-pin high density D-Sub socket.
Connect the Auxiliary Feedback cable from the feedback device to FEEDBACK B using a 15-pin, high density D-Sub plug with a metal housing.
When assembling the Auxiliary Feedback cable, follow the instructions in Section 3.7 (Feedback and Control Cable Assemblies).

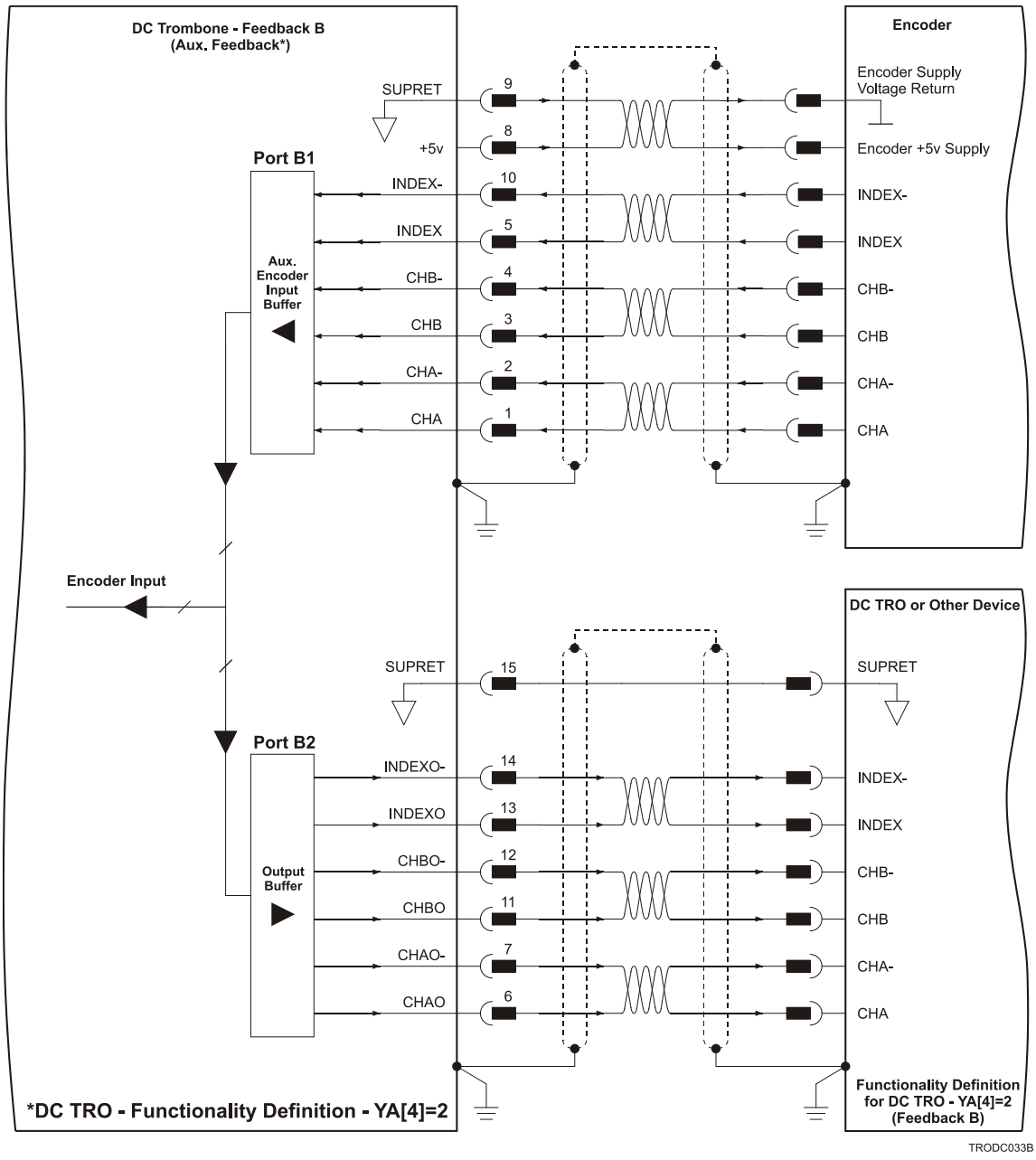


Figure 23: Differential Auxiliary Encoder Input Option on FEEDBACK B - Connection Diagram

3.7.3.3. Differential Pulse-and-Direction Input Option on FEEDBACK B (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 Port B1** for another axis.

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

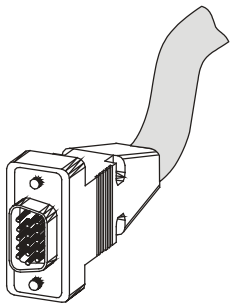
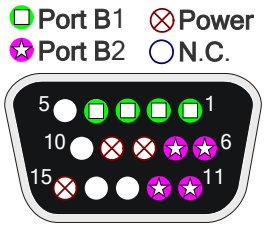
Port	Pin	Signal	Function	Pin Positions
B1	1	PULS/CHA	Pulse/Auxiliary channel A high *input*	 15-Pin D-Sub Plug
B1	2	PULS-/CHA-	Pulse-/Auxiliary channel A low *input*	
B1	3	DIR/CHB	Direction/Auxiliary channel B high *input*	
B1	4	DIR-/CHB-	Direction-/Auxiliary channel B low *input*	
	5	NC	Do not connect this pin	
B2	6	CHAO	Channel A output	
B2	7	CHAO-	Channel A complement output	
PWR	8	+5V	Encoder supply voltage	
PWR	9	SUPRET	Encoder supply voltage return	 15-Pin D-Sub Socket
	10	NC	Do not connect this pin	
B2	11	CHBO	Channel B output.	
B2	12	CHBO-	Channel B complement output	
	13	NC	Do not connect this pin	
	14	NC	Do not connect this pin	
PWR	15	SUPRET	Supply return	

Table 9: Differential Pulse-and-Direction Auxiliary Encoder Pin Assignment on FEEDBACK B

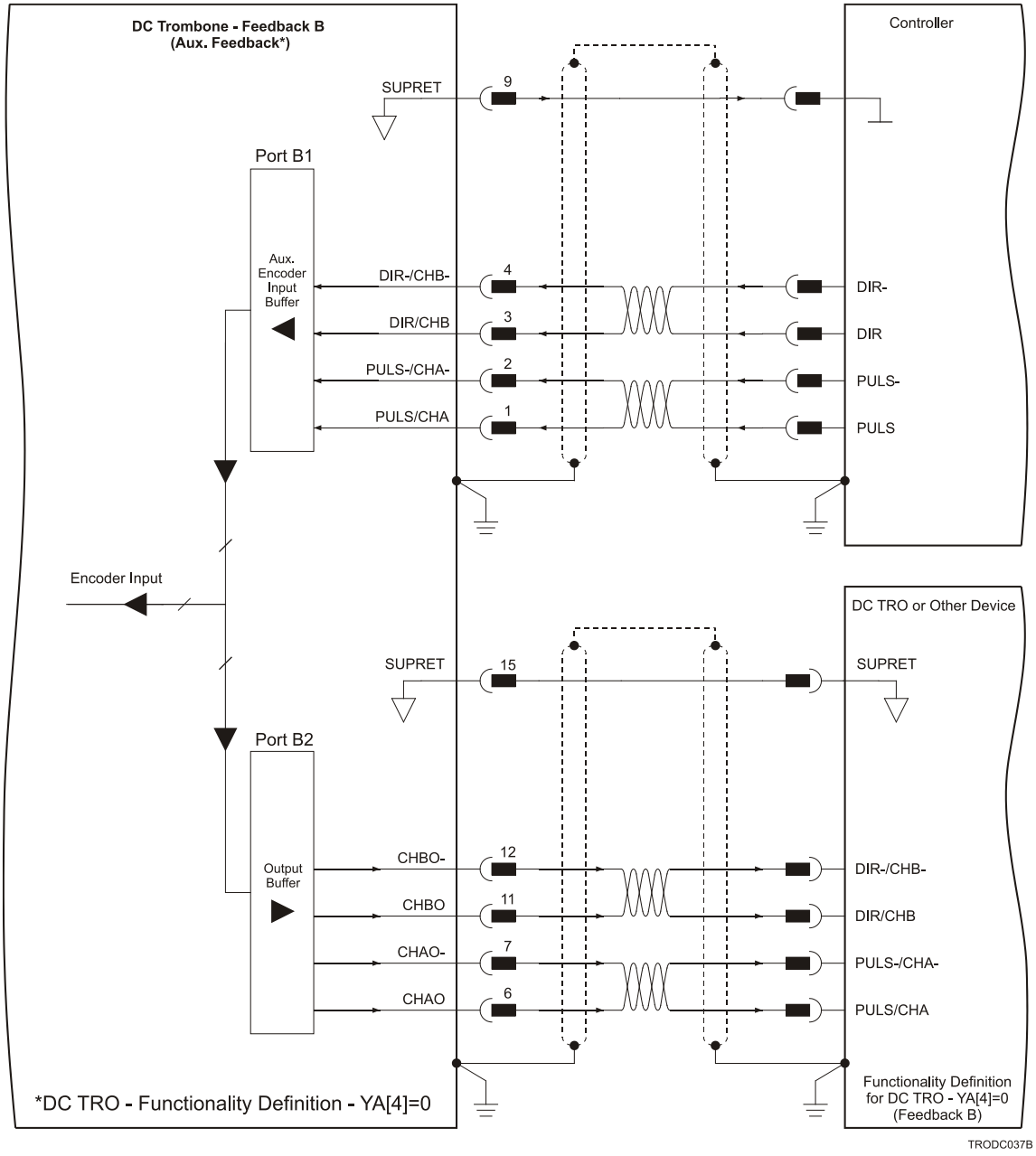


Figure 24: Differential Pulse-and-Direction Input Option on FEEDBACK B - Connection Diagram

3.8. I/O Cables

The DC Trombone has two I/O ports, P1 and P2. P1 is a general I/O which can be used to connect 6 digital inputs and 4 digital outputs. P2 has 1 analog input port, and buffered encoder signals that are derived from the main feedback:

I/O	P1 Port	P2 Port
Digital Input	6	-
Digital Output	4	-
Analog Input	-	1

3.8.1. General I/O Port (P1)

Port P1 has a 15-pin high density D-Sub plug. When assembling this I/O cable, follow the instructions in Section 3.7 (Feedback and Control Cable Assemblies) using a 15-pin high density metal case D-Sub female connector (socket).

The I/Os for Port P1 detailed below; Digital Output (as Source Configuration) & Input (as Sink Configuration) are defaults, although several options are available (upon request).

Note: The digital input interface is suitable for both TTL-level (5V) and PLC-level (24V).

3.8.1.1. Digital Output (as Source Configuration) & Input (as Sink Configuration)

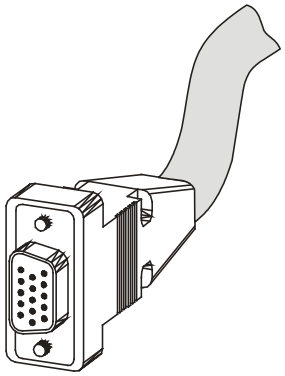
Pin	Signal	Function	Pin Positions
1	IN1	Programmable input 1	
2	IN2	Programmable input 2	
3	OUT1	Programmable output 1 up to 0.5 A	
4	OUT2	Programmable output 2 up to 0.5 A	
5	OUT3	Programmable output 3 up to 0.5 A	
6	INRET	General input return 1 to 6/ “Common Cathode”	
7	IN3	Programmable input 3	
8	IN4	Programmable input 4	
9	VDDRET	External 24 VDC supply return	
10	VDDIN	External 24 VDC supply pos. input	
11	IN5	Programmable input 5	
12	IN6	Programmable input 6	
13	OUT4	Programmable output 4 up to 0.5 A	
14	VDDRET	External 24 VDC supply return	
15	VDDIN	External 24 VDC supply pos. input	

Table 10: Digital Output (as Source Configuration) & Input (as Sink Configuration) P1 Cable - Pin Assignments

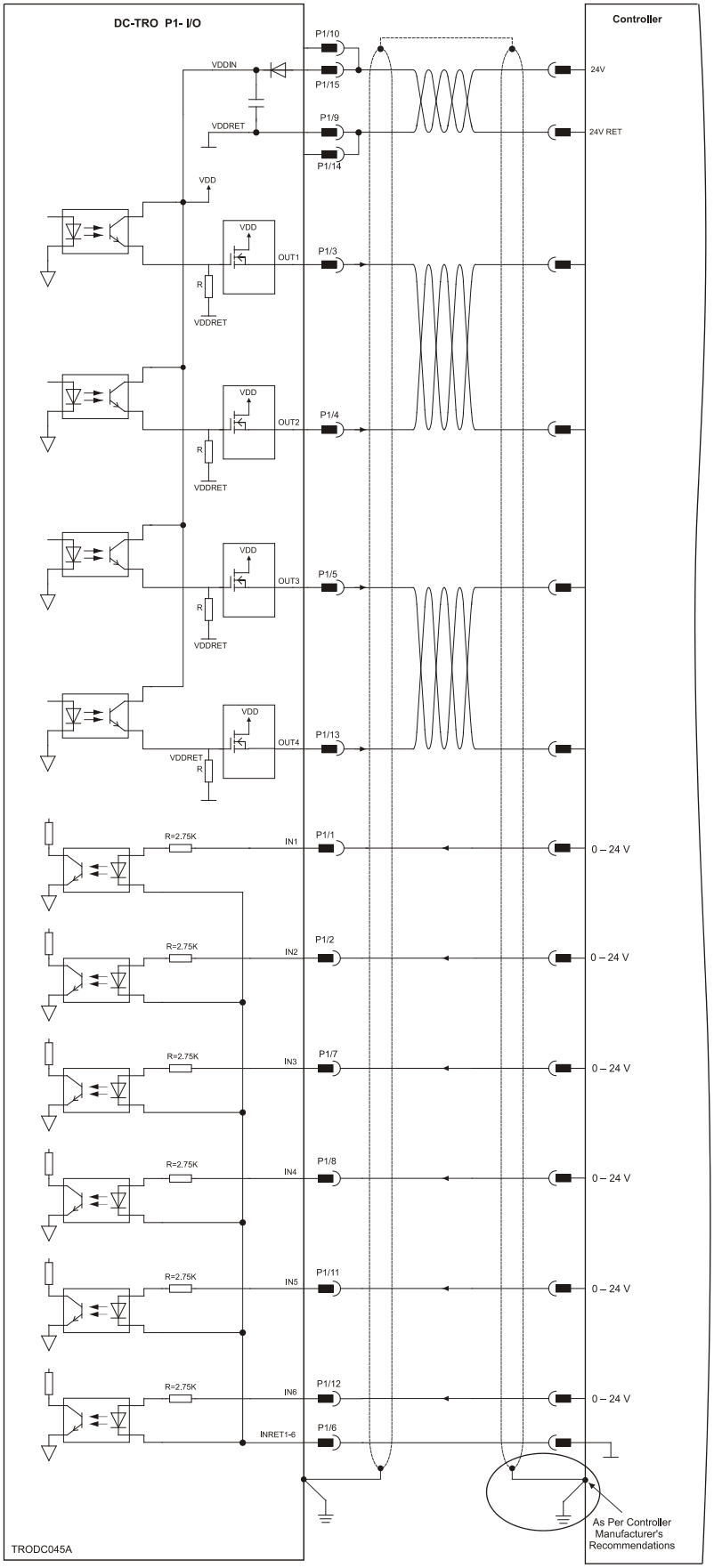


Figure 25: Digital Output (as Source Configuration) & Input (as Sink Configuration) P1 - Connection Diagram

3.8.1.2. Digital Output (as Sink Configuration) & Input (as Source Configuration)

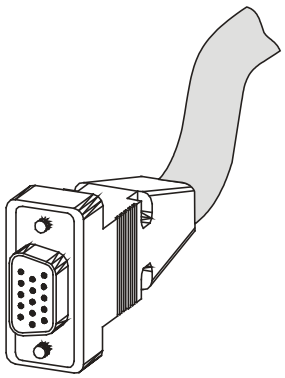
Pin	Signal	Function	Pin Positions
1	IN1	Programmable input 1 return	
2	IN2	Programmable input 2 return	
3	OUT1	Programmable output 1 up to 50 mA	
4	OUT2	Programmable output 2 up to 50 mA	
5	OUT3	Programmable output 3 up to 50 mA	
6	INRET	General input for positive connection / “Common Anode”	
7	IN3	Programmable input 3 return	
8	IN4	Programmable input 4 return	
9	VDDRET	External 24 VDC supply return	
10	VDDIN	External 24 VDC supply pos. input	
11	IN5	Programmable input 5 return	
12	IN6	Programmable input 6 return	
13	OUT4	Programmable output 4 up to 50 mA	
14	VDDRET	External 24 VDC supply return	
15	VDDIN	External 24 VDC supply pos. input	

Table 11: Digital Output (as Sink Configuration) & Input (as Source Configuration) P1 Cable - Pin Assignments

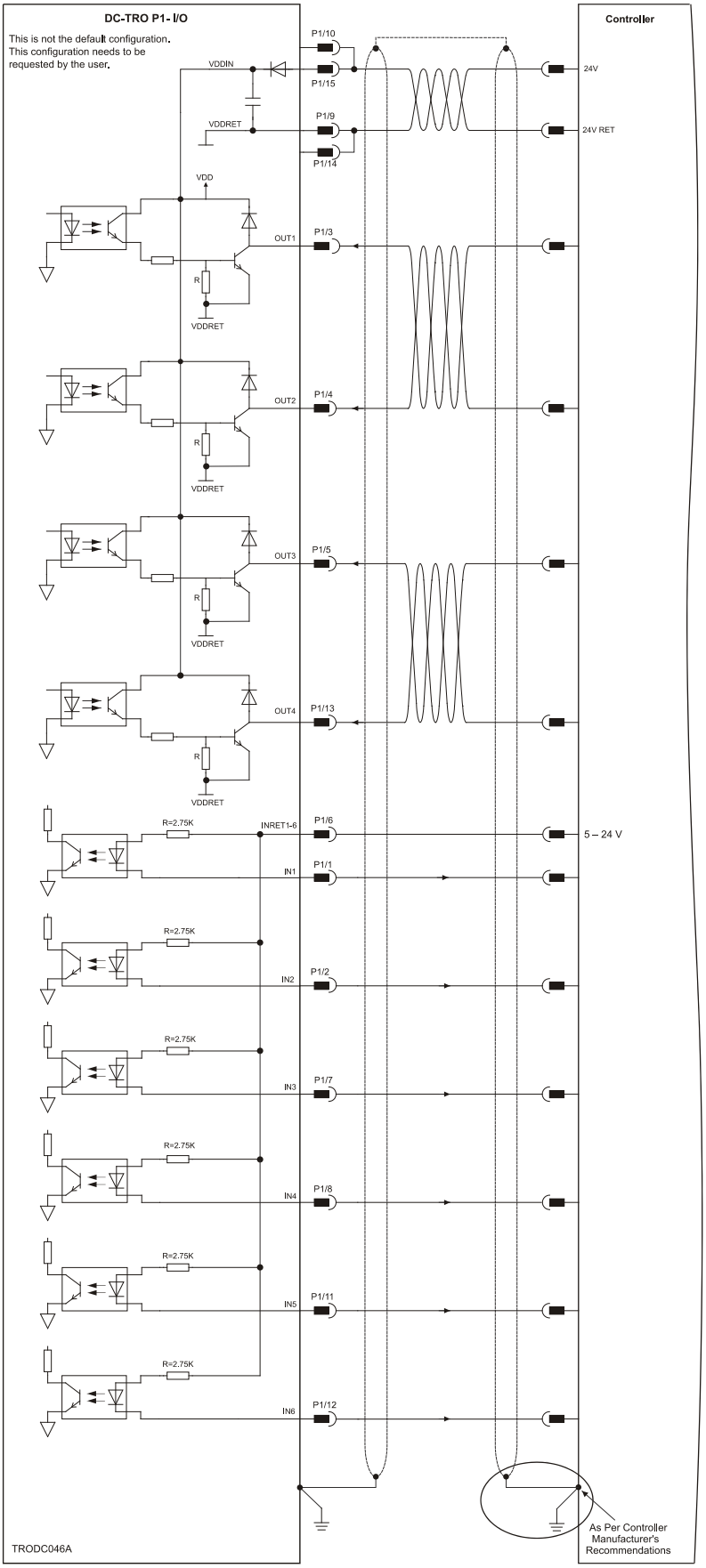


Figure 26: Digital Output (as Sink Configuration) & Input (as Source Configuration) P1 - Connection Diagram

3.8.2. General I/O Port (P2)

Port P2 has a 15-pin high density D-Sub socket. When assembling this I/O cable, follow the instructions in Section 3.7 (Feedback and Control Cable Assemblies) using a 15-pin high density metal case D-Sub male connector (plug).

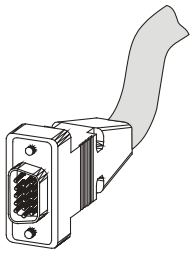
Pin	Signal	Function	Pin Positions
1	MAIN_OUT_CHAO	Buffered output of main FB Channel A	
2	MAIN_OUT_CHAO-	Buffered output of main FB Channel A complement	
3	MAIN_OUT_CHBO	Buffered output of main FB Channel B	
4	MAIN_OUT_CHBO-	Buffered output of main FB Channel B complement	
5	MAIN_OUT_INDEXO	Buffered output of main FB index	
6	SAFETY 1	Safety input 1	
7	SAFETY_RET	Safety input 1 Return (optionally connected to P2/12)	
8	Not connected	Empty pin	
9	COMRET	Circuit common	
10	MAIN_OUT_INDEXO-	Buffered output of main FB index complement	
11	SAFETY 2	Safety input 2	
12	SAFETY_RET	Safety input 2 Return (optionally connected to P2/7)	
13	ANLRET	Analog input return	
14	ANLIN1-	Analog input 1 negative	
15	ANLIN1+	Analog input 1 positive	

Table 12: General I/O P2 Cable - Pin Assignments

Note: The main feedback buffered output signals are only available when Main Feedback A is a digital incremental encoder type.

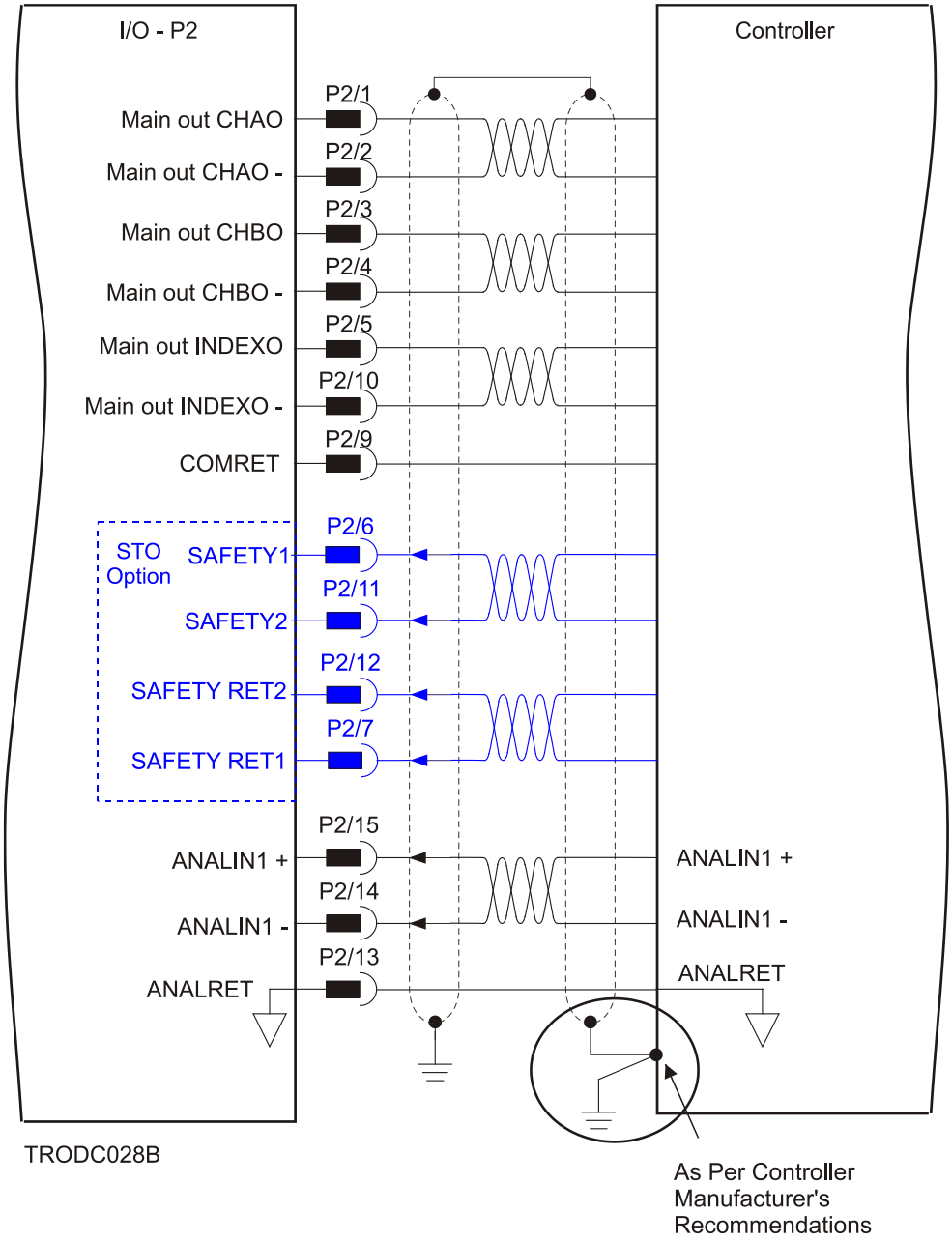


Figure 27: General I/O P2 - Connection Diagram

3.9. Communication Cables

The communication cables use an 8-pin RJ-45 plug that connect to the RS-232 and CAN ports of the DC Trombone.

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

a. RS-232, full duplex

b. CAN

RS-232 communication requires a standard, commercial 3-core null-modem cable connected from the DC 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.

3.9.1.1. RS-232 Communication

Notes for connecting the RS-232 communication cable:

- Use a 26 or 28 AWG twisted pair shielded cable. The shield should have aluminum foil covered by copper braid with a drain wire.
- 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 male RJ plug must have a shield cover.
- Ensure that the shield of the cable is connected to the shield of the RJ plug. The drain wire can be used to facilitate the connection.

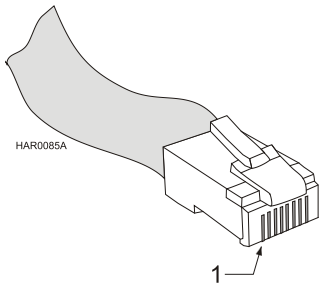
Pin	Signal	Function	Pin Location
1, 2	N/A	—	
3	RS232_Tx	RS-232 transmit	
4	N/A	—	
5	COMRET	Communication return	
6	RS232_Rx	RS-232 receive	
7, 8	N/A	—	

Table 13: RS-232 Cable - Pin Assignments

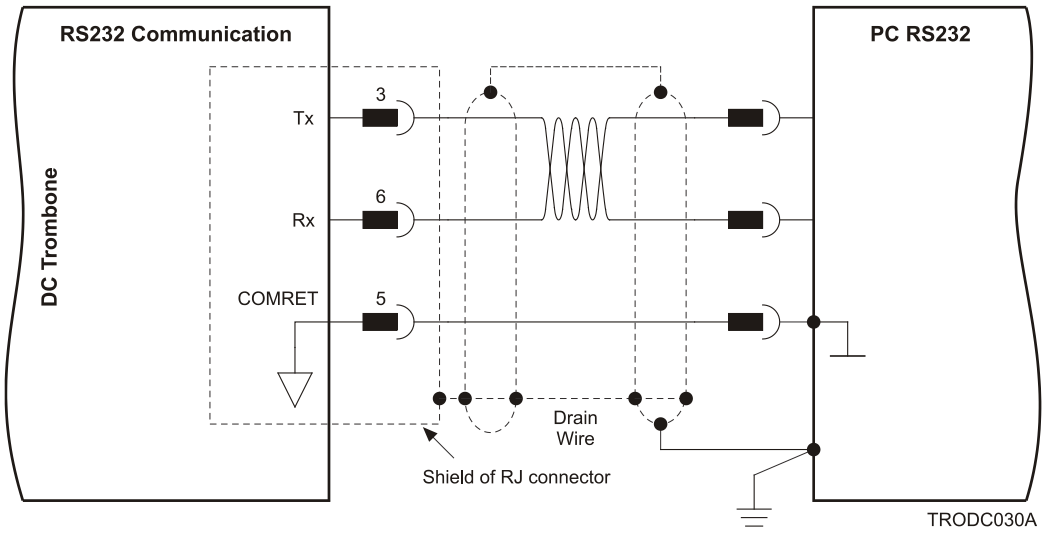


Figure 28: RS-232 Connection Diagram

3.9.1.2. CAN Communication

Notes for connecting the CAN communication cable:

- Use 26 or 28 AWG twisted pair shielded cables. For best results, the shield should have aluminum foil and covered by copper braid with a drain wire
- 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 male RJ plug must have a shield cover.
- Ensure that the shield of the cable is connected to the shield of the RJ plug. The drain wire can be used to facilitate the connection.
- Connect a termination 120-Ohms resistor at each of the two ends of the network cable.

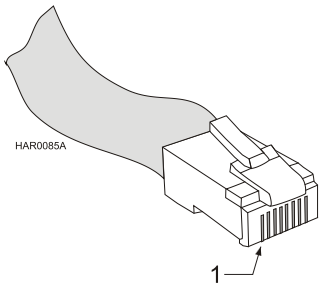
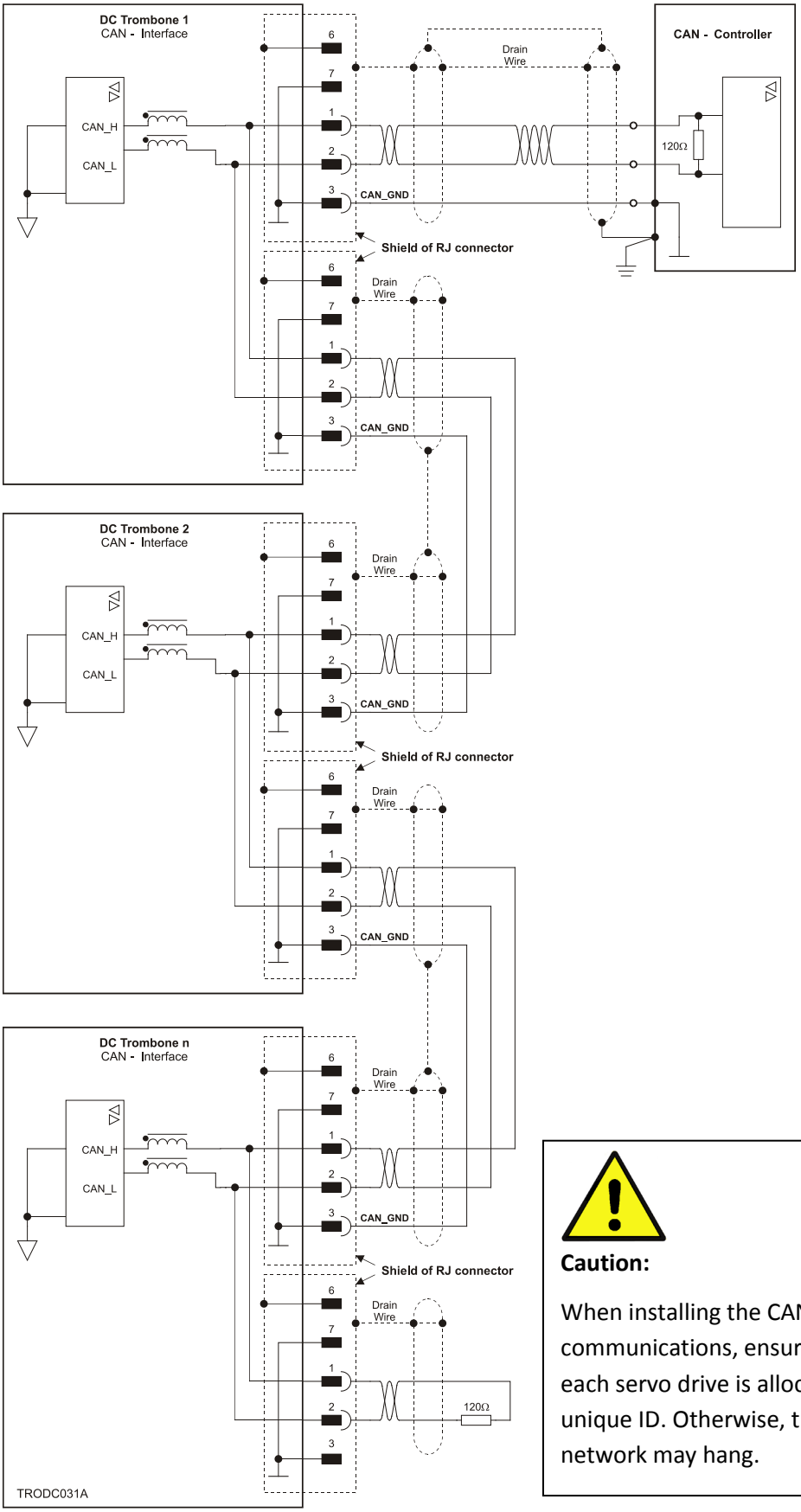
Pin	Signal	Function	Pin Positions
1	CAN_H	CAN_H bus line (dominant high)	
2	CAN_L	CAN_L bus line (dominant low)	
3	CAN_RET	CAN Return	
4, 5	N/A	—	
6	CAN_SHLD	Shield, connected to the RJ plug cover	
7	CAN_RET	CAN Return	
8	N/A	—	

Table 14: CAN Cable - Pin Assignments



Caution:

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

Figure 29: CAN - Connection Diagram

3.10. Powering Up

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

The DC 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 DC Trombone and that the proper plus-minus connections are in order.

3.11. Initializing the System

After the DC 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*.

Chapter 4: Technical Specifications

4.1. Features

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
- 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 DC 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 default output-current configuration of 0.5 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. Dimensions

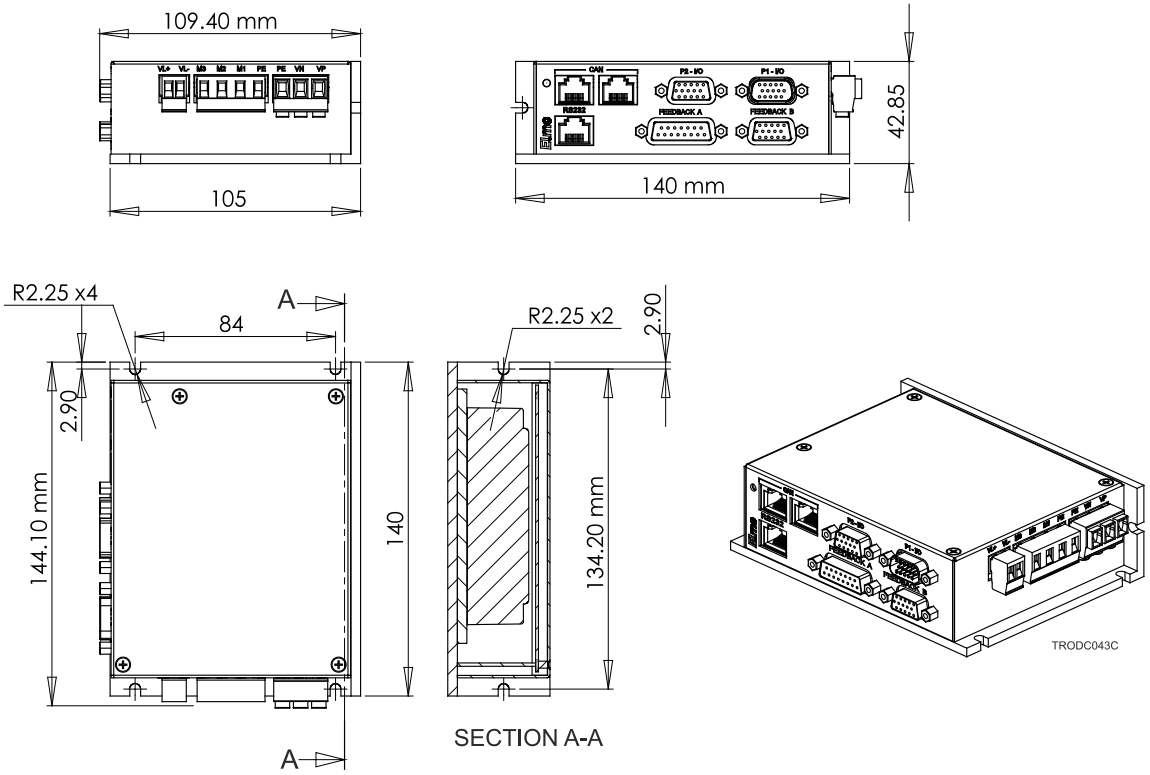


Figure 30: DC Trombone with L-shaped Heat-Sink

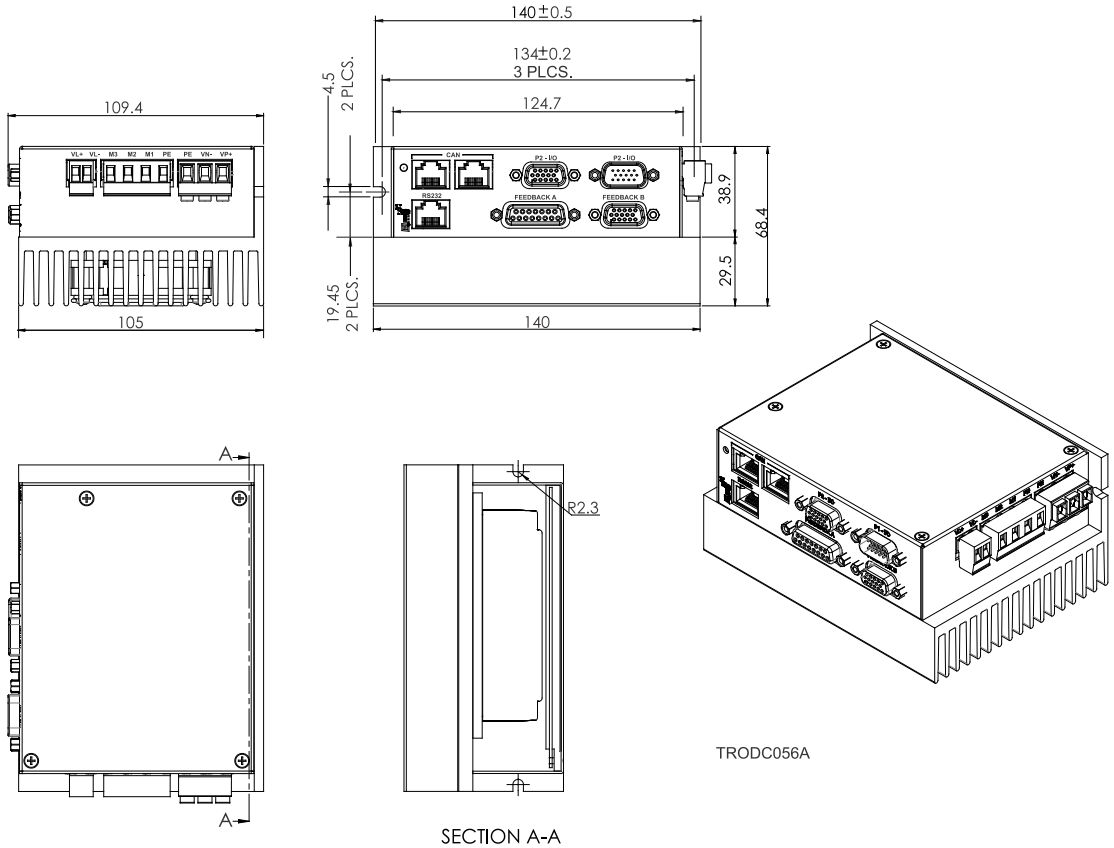


Figure 31: DC Trombone with Heat-Sink Fan and Fins

4.3. Power Ratings for the 400 V Type

Feature	Units	6/400	12/400	16/400	R17/400	R22/400
Minimum supply voltage	VDC	S option in P/N: 50 No S option in P/N: 100				
Nominal supply voltage	VDC	325				
Maximum supply voltage	VDC	400				
Maximum continuous power output	kW	2	4	5	5.5	7
Efficiency at rated power (at nominal conditions)	%	> 98				
Auxiliary supply voltage option	VDC	18 V to 30 V Only for Control Supply S option Model				
Auxiliary power supply	VA	≤5 VA without external loading ≤7 VA with full external loading				
Continuous current limit (Ic) Amplitude sinusoidal/DC trapezoidal commutation	A	6	12	16	17	22
Sinusoidal continuous RMS current limit (Ic)	A	4.2	8.5	11.3	12	15.5
Peak current limit	A	2 x Ic			No peak	
Weight	g (oz)	650 g (22.9 oz) for standard L shape 1100 g (38.8 oz) for L shape fins and fan				
Dimensions	mm (in)	140 x 105 x 43 (5.51" x 4.13" x 1.7") for standard L shape				
Digital in/Digital out/ Analog in		6/4/1				
Mounting method		Panel / Wall Mounted				

4.4. Power Ratings for the 800 V Type

Feature	Units	8/800	12/800	R11/800	R16/800
Minimum supply voltage	VDC	S option in P/N: 95+			
Nominal supply voltage	VDC	560 for 400 VAC 680 for 480 VAC			
Maximum supply voltage	VDC	780			
Maximum continuous power output	kW	5	7.5	7	10
Efficiency at rated power (at nominal conditions)	%	> 98			
Auxiliary supply voltage option	VDC	18 V to 30 V Only for Control Supply S option Model			
Auxiliary power supply	VA	≤5 VA without external loading ≤7 VA with full external loading			
Continuous current limit (Ic) Amplitude sinusoidal/DC trapezoidal commutation	A	8	12	11	16
Sinusoidal continuous RMS current limit (Ic)	A	5.7	8.5	7.8	11.3
Peak current limit	A	2 x Ic		No peak	
Weight	g (oz)	650 g (22.9 oz) for standard L shape 1100 g (38.8 oz) for L shape fins and fan			
Dimensions	mm (in)	140 x 105 x 43 (5.51" x 4.13" x 1.7") for standard L shape			
Digital in/Digital out/ Analog in		6/4/1			
Mounting method		Panel / Wall Mounted			

The following note applies to Power Ratings of both the 400 and 800 V drive types.

Note: **Current rating**: The current ratings of the DC 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.

4.4.1. Auxiliary Supply (only for S Type Drive)

Feature	Details
Auxiliary power supply	*Isolated DC source only*
Auxiliary supply input voltage	18 VDC to 30 VDC
Auxiliary supply input power	< 5 VA (this includes the 5 V/200 mA load for the main encoder only) < 7 VA (this includes the 5 V/400 mA load on the main encoder and feedback B)

Note: An S type drive will not be operative if not having the Aux. supply (Mandatory).

4.5. 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

4.6. Control Specifications

4.6.1. 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

4.6.2. 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 (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 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.

4.6.3. 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

4.7. Feedbacks

4.7.1. Feedback Supply Voltage

The DC Trombone has two feedback ports (Main and Auxiliary). The DC Trombone supplies voltage to the main feedback device and to the auxiliary feedback device if needed.

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

4.7.2. Main Feedback Options

4.7.2.1. 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

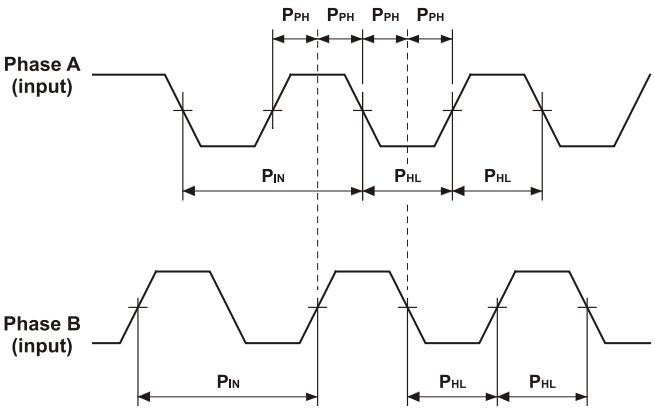


Figure 32: Main Feedback - Encoder Phase Diagram

4.7.2.2. 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

4.7.2.3. Absolute Encoder

Feature	Details
Encoder format	• NRZ (Panasonic) • EnDAT 2.21 (with analogue Sin/Cos) • 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

4.7.2.4. Interpolated Analog Encoder (Sine/Cosine)

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 (4.7.3)

4.7.2.5. 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 DC Trombone
Reference current	up to ±50 mA
Encoder outputs	See Auxiliary Encoder Output specifications (4.7.3)

4.7.2.6. 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.

4.7.2.7. Potentiometer

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

4.7.3. Main Encoder Buffered Output

The main encoder buffered output is only functioning when Feedback A is a Digital Incremental Encoder.

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

4.7.4. 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 analog encoder • Emulated encoder outputs of the resolver • Emulated encoder outputs of the tachometer • Emulated encoder outputs of the potentiometer
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

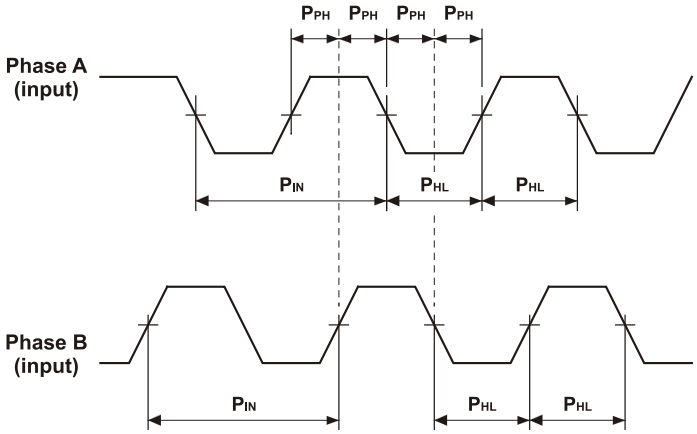


Figure 33: Auxiliary Feedback - Encoder Phase Diagram

4.7.5. 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

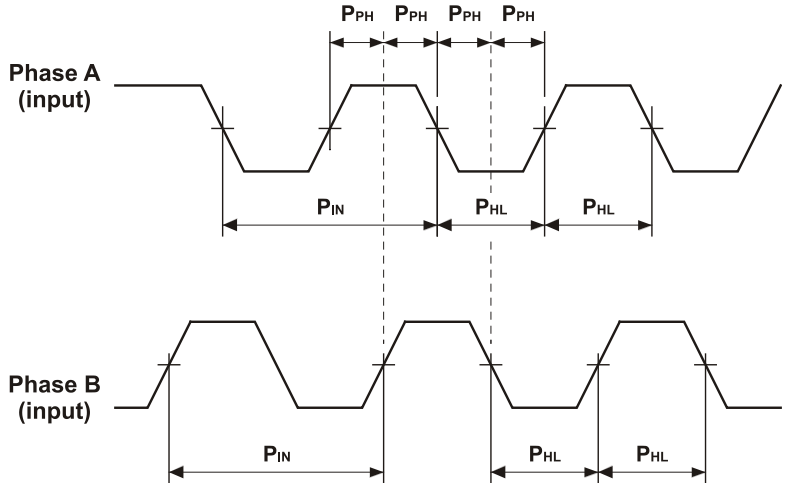


Figure 34: Auxiliary Feedback - Encoder Phase Diagram

4.8. I/Os

The DC Trombone has:

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

4.8.1. 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.

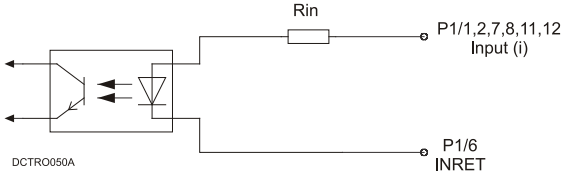


Figure 35: Digital Input Schematic when configured as Common Cathode

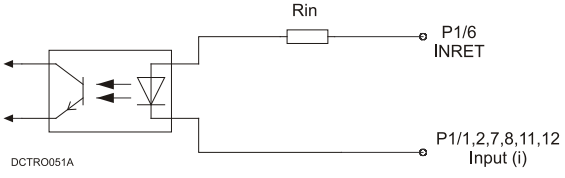


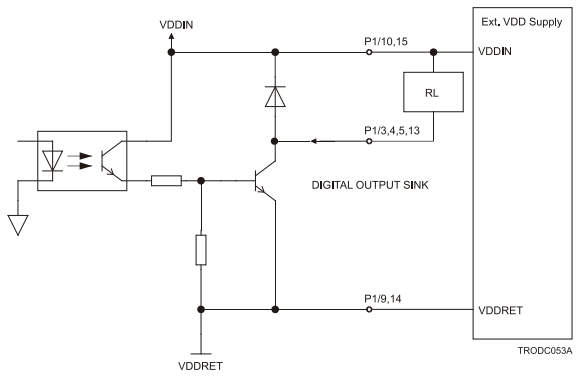
Figure 36: Digital Input Schematic when configured as Common Anode

4.8.2. Digital Output Interface

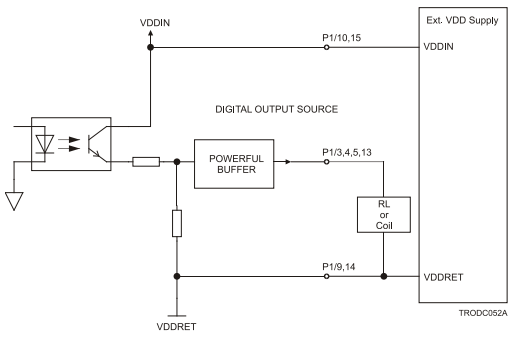
Feature	Details
Type of output	• Optically isolated • Powerful Source capability
Maximum supply output (VDD)	30 V
Max. output current I_{out} (max) (V_{out} = Low)	I_{out} (max) ≤ 500 mA for output 4 I_{out}(max) ≤ 250 mA for outputs 1 to 3
VOH at maximum output voltage Source mode	VDO ≥ VOH ≥ VDO – 1.25 VOH at 250 mA
VOL at maximum output voltage Sink mode	0 V ≤ VOL ≤ 1.25 VOL at 250 mA
R_L	The external resistor R_L must be selected to limit the output current to no more than 500 mA (output 4) or 200 mA (outputs 1 to 3). $R_L = \frac{VDD - VOL}{I_{out}(max)}$
Executable time	If output is set to one of the built-in functions — Home flag, Brake or AOK — execution is immediate upon detection: 0 < T < 4 x TS If output is set to General output and is executed from a program, the typical time is approximately 0.5 msec.

Schematic Diagram

SINK



SOURCE



4.8.3. 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

4.9. 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

4.10. 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)

4.11. 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

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)