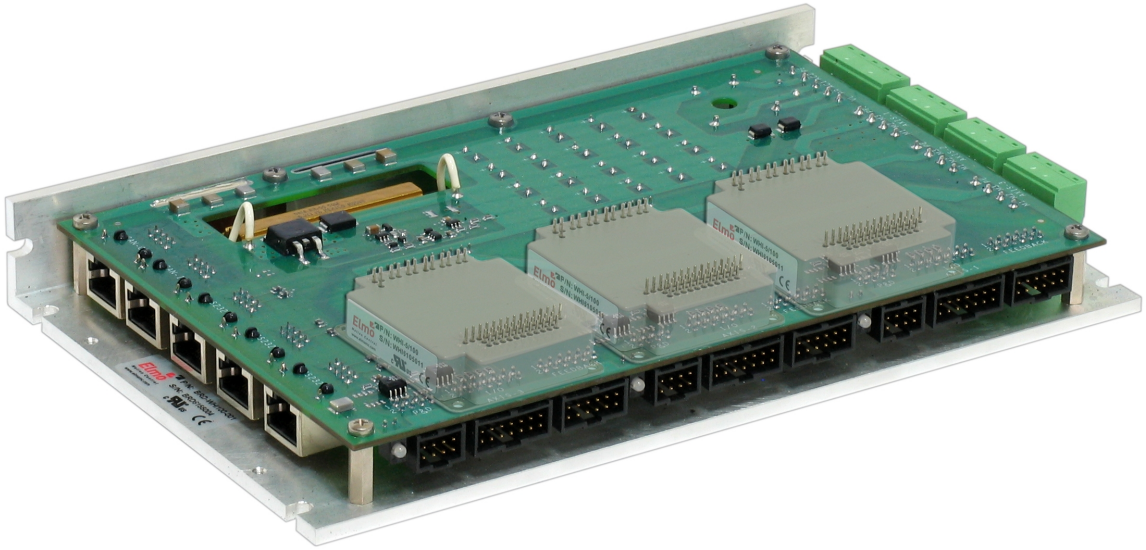
Trio
Installation Guide



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Elmo Motion Control

www.elmomc.com

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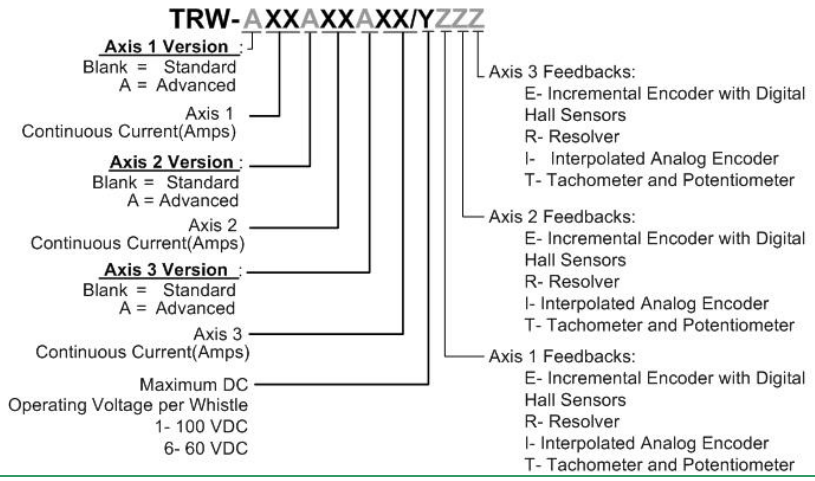
Document No. MAN-TRWIG

Trio Catalog Number:	
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Ver. 1.0	September 2012	Initial release	

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Contents

Safety Information

In order to achieve the optimum, safe operation of the Trio, 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 Trio and accompanying equipment.

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

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

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

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

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

The following safety symbols are used in this manual:

	**Warning:** This information is needed to avoid a safety hazard, which might cause bodily injury.
	**Caution:** This information is necessary for preventing damage to the product or to other equipment.
	**Note:** This is auxiliary information that ensures the correct operation of the equipment.

.1 Warnings

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

.2 Cautions

	The Trio contains hot surfaces and electrically-charged components during operation.
	The maximum AC/DC power supply connected to the instrument must comply with the parameters outlined in this guide. Furthermore, the power supply must be isolated from hazardous live voltages using reinforced or double insulation in accordance to approved safety standards.
	When connecting the Trio to an approved 12 ~ 95 VDC (8.5 ~ 67 VAC) auxiliary power supply, connect it through a line that is isolated from hazardous live voltages using reinforced or double insulation in accordance with approved safety standards.
	Before switching on the Trio, verify that all safety precautions have been observed and that the installation procedures in this manual have been followed.

.3 Directives and Standards

The Trio conforms to the following industry safety standards:

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

The Trio 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.

.4 CE Mark Conformance

The Trio is intended for incorporation in a machine or end product. The actual end product must comply with all safety aspects of the relevant requirements of the European Safety of Machinery Directive 98/37/EC as amended, and with those of the most recent versions of standards EN60204-1 and EN292-2 at the least.

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

.5 Warranty Information

The products covered in this manual are warranted to be free of defects in material and workmanship and conform to the specifications stated either within this document or in the product catalog description. All Elmo drives are warranted for a period of 12 months from the time of installation, or 18 months from time of shipment, whichever comes first. No other warranties, expressed or implied — and including a warranty of merchantability and fitness for a particular purpose — extend beyond this warranty.

Introduction

This installation guide describes the Trio and the steps for its wiring, installation and power-up. Following these guidelines ensures maximum functionality of the product and the system to which it is connected.

.1 Product Description

The Trio was designed to be a very compact product oriented for X, Y, Z applications integrating three servo drives in one package and working under one power supply equipped by a built-in shunt regulator. It is provided with standard terminal blocks for power connections, and header sockets for signal connections.

It operates from an AC/DC power source in current, velocity, position and advanced position modes, in conjunction with permanent-magnet synchronous brushless motors, DC brush motors, linear motors or voice coils. The Trio is designed for use with any type of sinusoidal and trapezoidal commutation, with vector control.

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

Power to the Trio is provided by a 8.5 ~ 62 VAC isolated AC power source (not included with the Trio). A "smart" control-supply algorithm at each Whistle enables the Trio to operate with only one power supply with no need for an auxiliary power supply for the logic.

Optional power to the Trio is by providing a 12 ~ 88VDC isolated DC power source (not included with the Trio).

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

Note: This back-up power supply can operate from any voltage source within the 12 ~ 95 VDC range. This is much more flexible than a standard 24VDC power supply requirement.

The Trio has an integrated shunt regulator, designed for use with high-inertia loads.

The Trio is a basic three servo drives which operate individually in current, velocity and a position mode includes 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 Trio series fully complies with all relevant safety and EMC regulations.

.2 Product Features

.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 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

.2.3 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 rate four times current loop sample time
- Fast event capturing inputs

.2.4 Advanced Position Control

For advanced models 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
- PT and PVT motion modes
- Dual (position/velocity) loop
- Fast output compare (OC)

.2.5 Communication Options

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

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

.2.6 Feedback Options

- Incremental Encoder – up to 20 Mega-Counts (5 Mega-Pulses) per second
- Digital Halls – up to 2 kHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Mega-Counts per second for encoder
- Interpolated Analog Sine/Cosine Encoder – up to 250 kHz (analog signal)
  - Internal Interpolation - up to x4096
  - Automatic Correction of amplitude mismatch, phase mismatch, signals offset
  - Auxiliary emulated, unbuffered, single-ended, encoder output

- Resolver
  - Programmable 10~15 bit resolution
  - Up to 512 Revolution Per Second (RPS)
  - Auxiliary emulated, unbuffered, single-ended, encoder output
- Tachometer, Potentiometer
- Elmo drives provide supply voltage for all the feedback options

.2.7 Fault Protection

The Trio 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

.3 How to Use this Guide

In order to install and operate your Elmo Trio, 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 Trio.

The Appendices list all the drive ratings and specifications as well as information on the relevant cables.

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

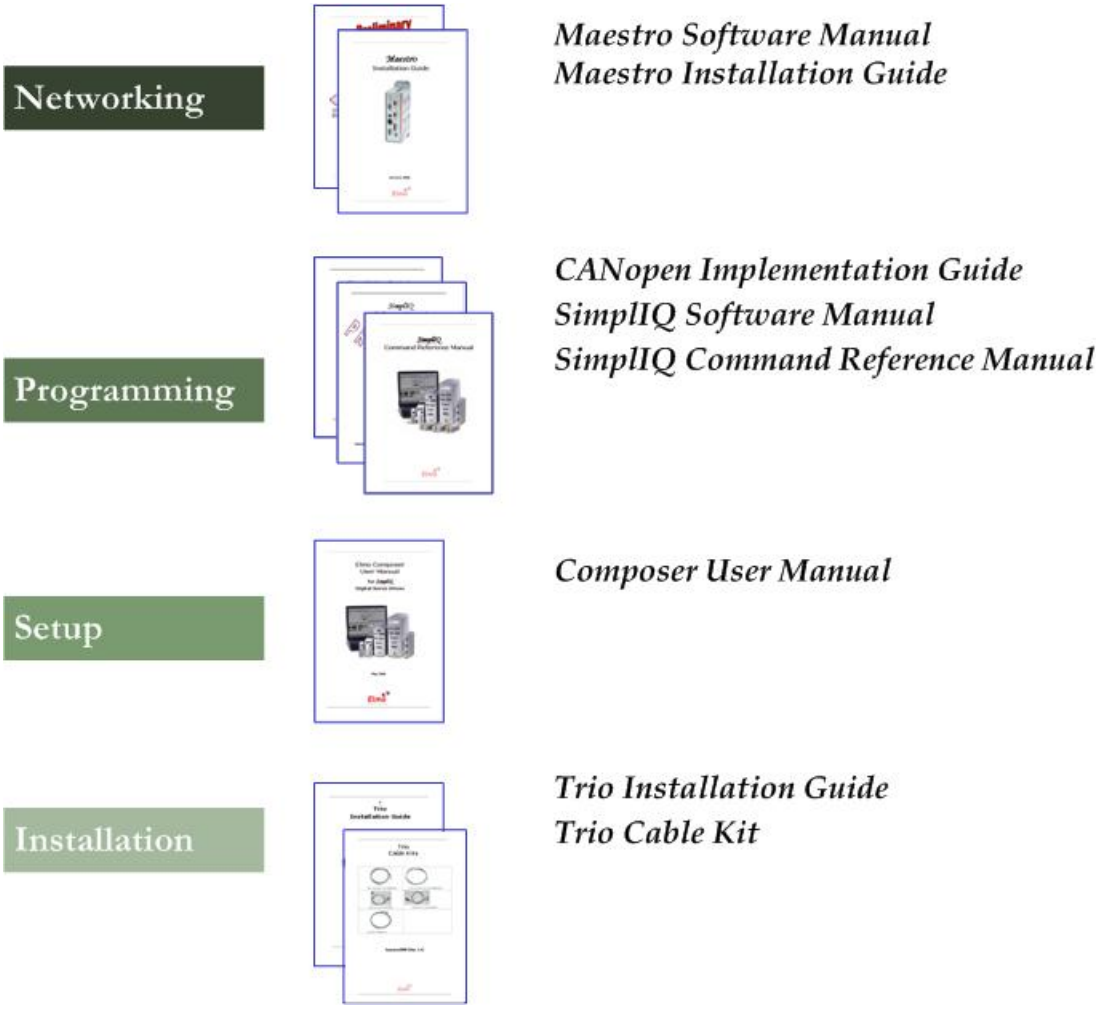


Figure 2-1: ***Elmo Digital Servo Drive Documentation Hierarchy***

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

- The Trio User Guide contains information about how to use the Trio and Cable Kit.
- The Composer *Software Manual,* which includes explanations of all the software tools that are part of Elmo's Composer software environment.
- The *SimplIQ Command Reference Manual,* which describes, in detail, each software command used to manipulate the Whistle motion controllers.
- The *SimplIQ Software Manual,* which describes the comprehensive software used with the Whistles.

Installation

.4 Site Requirements

You can guarantee the safe operation of the Trio 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.	

The Whistle on the Trio dissipates its heat by convection. The maximum operating ambient temperature of 0 °C to 40 °C (32 °F to 104 °F) must not be exceeded. Refer to the Heat Dissipation section of the *Whistle Installation Guide* for more information.

.5 Unpacking the Drive Components

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

- The Trio.
- The Composer software and software manual.

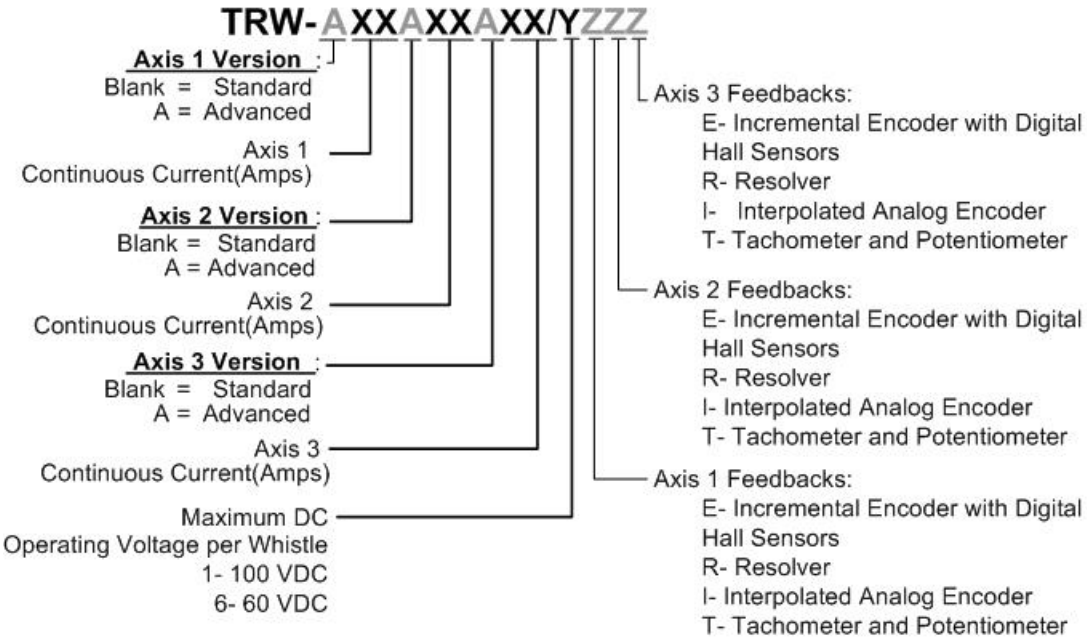
The Trio is shipped in a cardboard box with Styrofoam protection.

To unpack the Trio*:*

1. Carefully remove the Trio from the box and the Styrofoam.
2. Check the Trio 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 Trio.
3. To ensure that the Trio you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Trio. It looks like this:

4.

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



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

.6 Mounting the Trio

The Trio 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 Trio (see the diagram below).

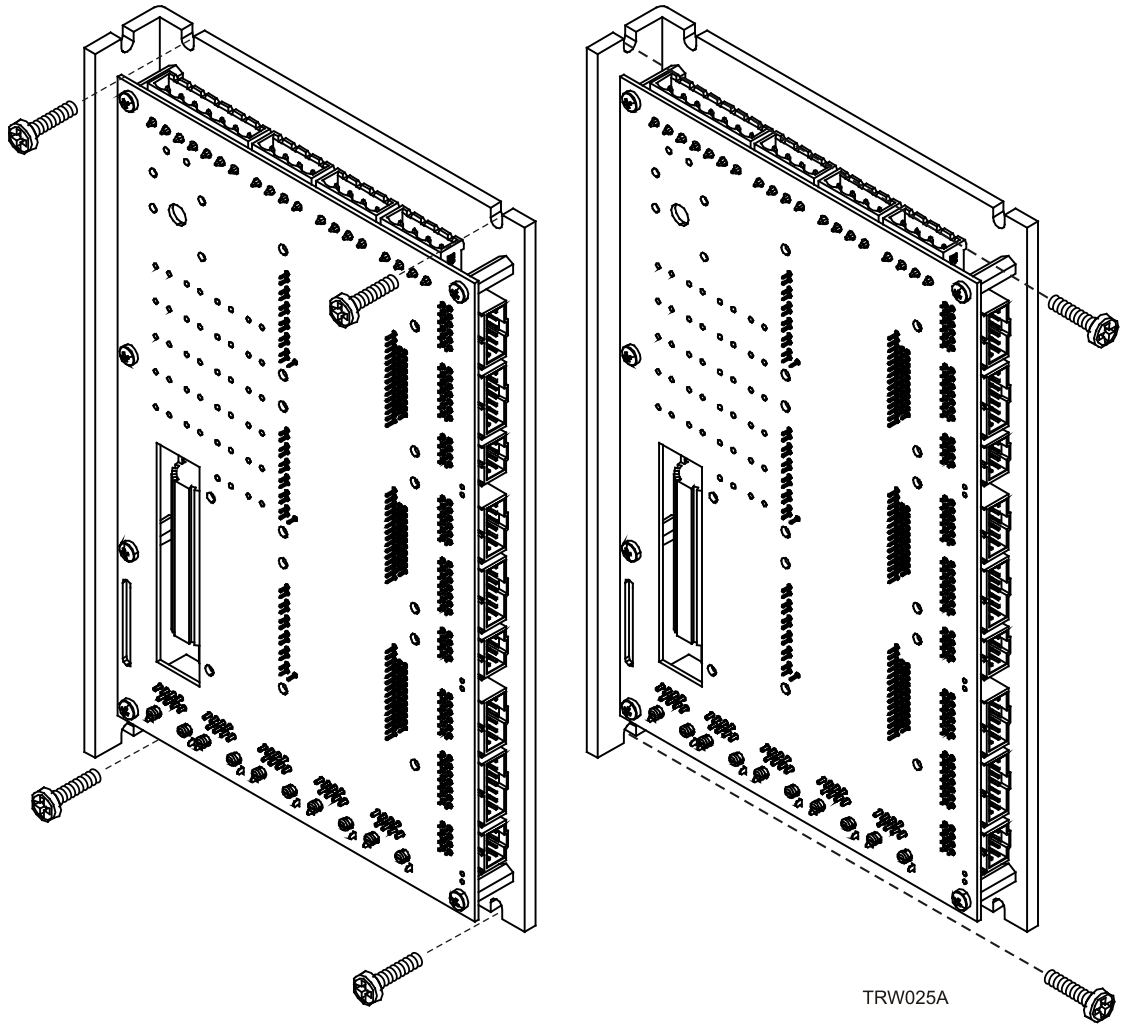


Figure 3-1: ***Mounting the Trio***

.7 Connecting the Cables

.7.1 Wiring the Trio

Once the Trio 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 Trio.

	Follow these instructions to ensure safe and proper wiring

- 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 26 or 28 AWG wire for control and feedback cables is satisfactory although 26 AWG is recommended.
- 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.
- Keep all wires and cables as short as possible.
- Keep the motor wires as far away as possible from the feedback, control and communication cables.
- 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.
- After completing the wiring, carefully inspect all wires to ensure tightness, good solder joints and general safety.

The following connectors are used for wiring the Trio:

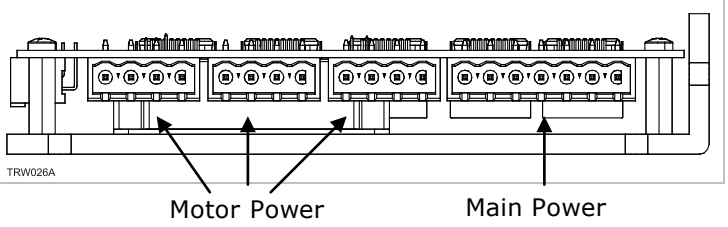
Type	Function	Connector Location
Main Power	PE, AC2, AC1, VP+, PR, PR, VL	
Motor Power	PE, M3, M2, M1	

Table 3-1: **Connectors on the "Bottom" of the Trio**

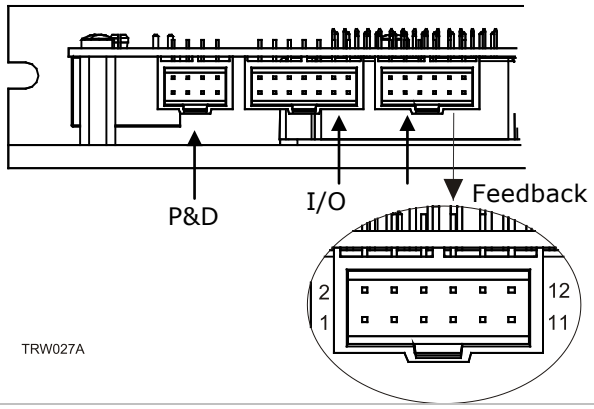
Type	Function	Connector Location
Main Feedback	Feedback	
I/O	I/O	
P&D	P&D	

Table 3-2: **Connectors on the "Front" of the Trio**

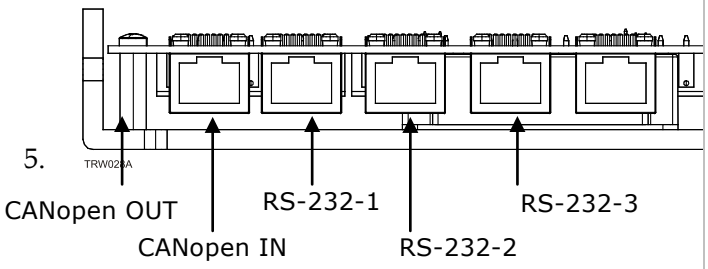
Type	Function	Connector Location
CANopen IN	CANopen IN	
CANopen OUT	CANopen OUT	
RS-232	RS-232-1 RS-232-2 RS-232-3	

Table 3-3: **Connectors on the "Front" of the Trio**

.8 Trio Connector Types

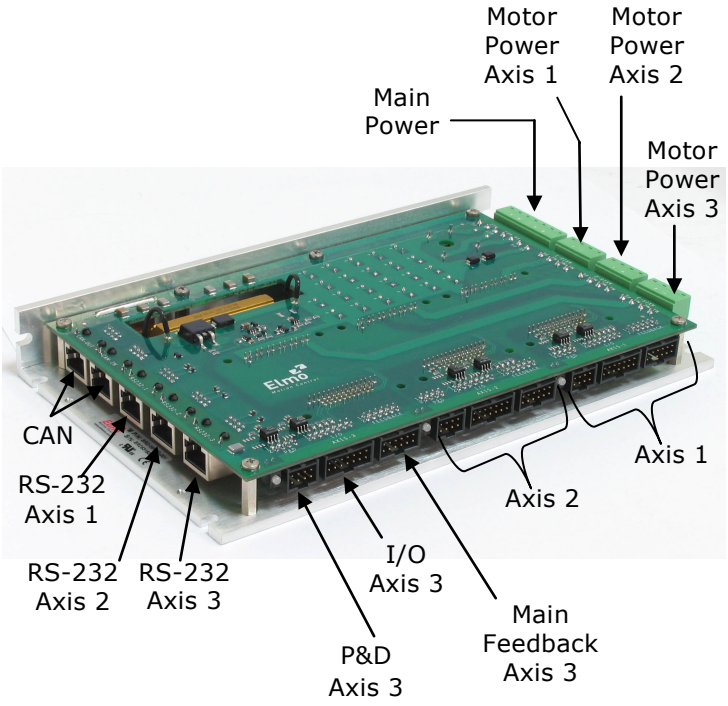
Type	On Board Connector / Mating Connector	Connector Location
Main Power	Phoenix 1x7-pin Header MSTBA 2.5/7-G-5.08/ Phoenix 1x7-pin Plug MSTBT 2.5/7-ST-5.08	
Motor Power	Phoenix 3x4-pin Header MSTBA 2.5/4G-5.08/ Phoenix 3x4-pin Plug MSTBT 2.5/4-ST-5.08	
Main Feedback	3x12-pin Molex Header 90130-3212/3x12-pin Molex Plug 90142-0012 Pin p/n: 90119-2121	
I/O	3x14-pin Molex Header 90130-3214 / 3x14-pin Molex Plug 90142-0014 Pin p/n: 90119-2121	
P&D	3x8-pin Molex Header 90130-3208 / 3x8-pin Molex Plug 90142-0008 Pin p/n: 90119-2121	
CANopen Communication	2x8-pin RJ-45 Socket / 2x8-pin RJ-45 Plug	
RS-232 Communication	3x8-pin RJ-45 Socket / 3x8-pin RJ-45 Plug	

Table 3-4: **Connector Types**

.9 Hardware Requirements

The components that you will need to install your Trio are:

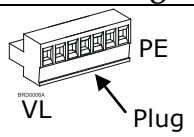
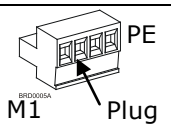
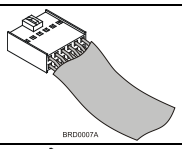
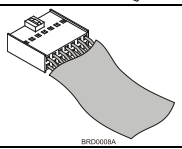
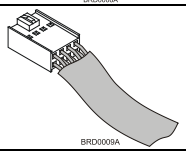
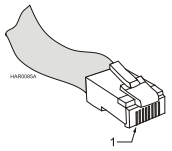
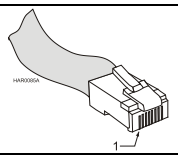
Component	Connector on Board	Function	Described in section	Cable Drawing
Main Power	5.08 mm pitch 1x7-pin Header	PE, AC2, AC1, VP+, PR, PR, VL		
Motor Power	5.08 mm pitch 3x4-pin Header	PE, M3, M2, M1		
Main Feedback	3x12-pin Molex Header	Feedback	B.3	
I/O	3x14-pin Molex Header	I/O	B.5	
P&D	3x8-pin Molex Header	P&D	B.4	
RS-232	3x8-pin RJ-45 Socket	RS-232-1 RS-232-2 RS-232-3	B.6.1	
CANopen Communication	2x8-pin RJ-45 Socket	CANopen IN CANopen OUT	B.6.2	

Table 3-5: **Connector Cross Reference**

.10 Trio Block Diagram

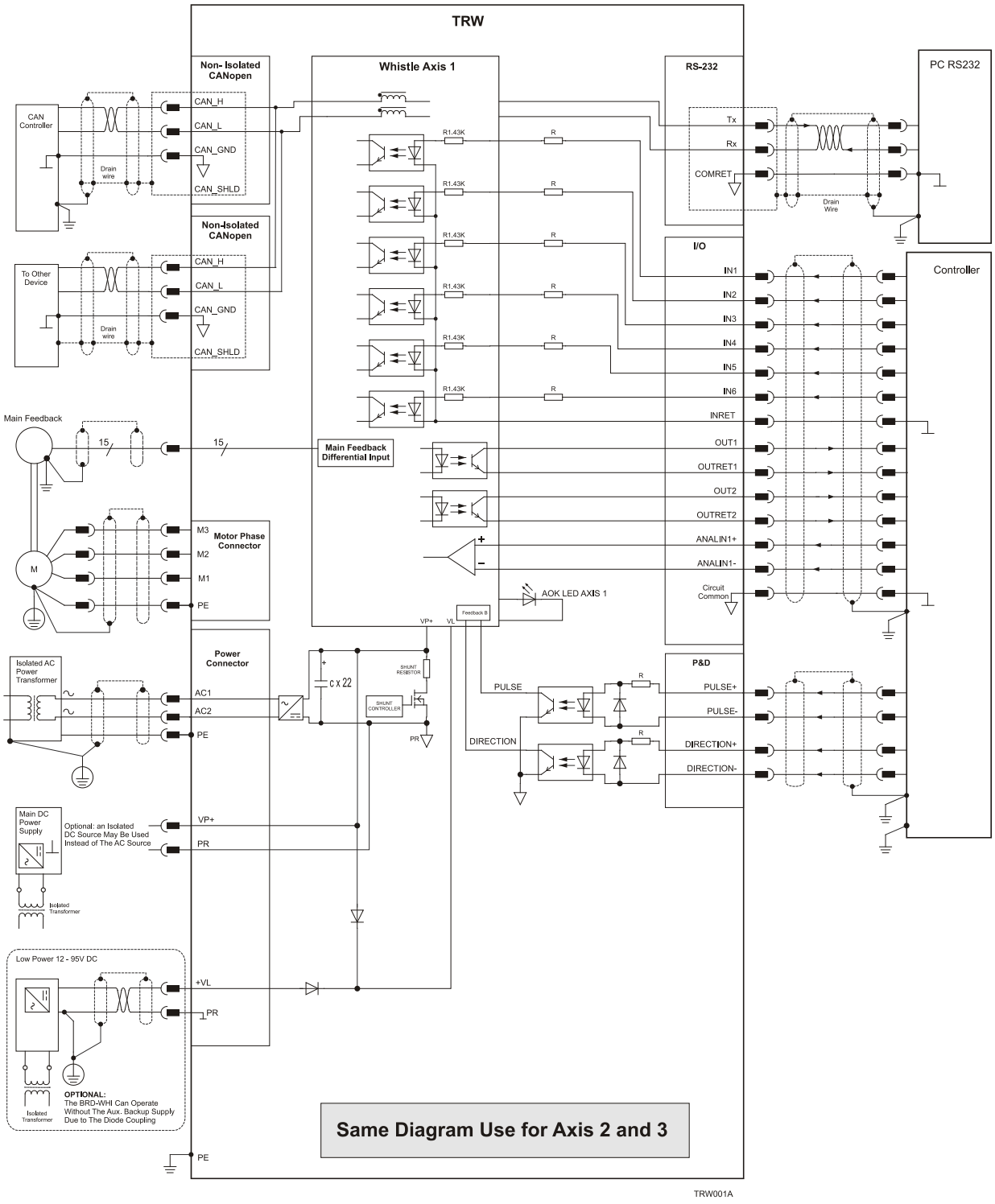


Figure 3-1: **Trio Block Diagram**

.11 The Main Power and Motor Power Connectors

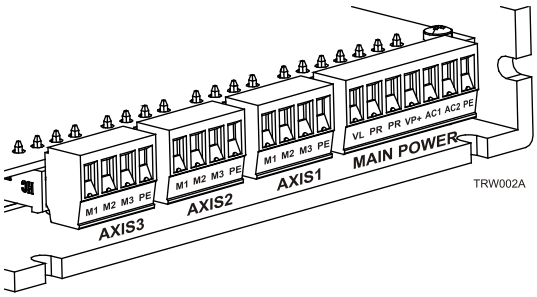
Pin	Function	Cable		Pin Positions
PE	Protective earth	Power		
AC2	Main Voltage Phase 2	Power		
AC1	Main Voltage Phase 1	Power		
VP+	Pos. Power input	Power		
PR	Power return	Power		
PR	Aux. Supply Input Return	Aux		
VL	Aux. Supply Input	Aux		
		AC Motor Cable	**DC Motor Cable**	
PE	Protective earth	Motor	Motor	
M3	Motor phase	Motor	Motor	
M2	Motor phase	Motor	Motor	
M1	Motor phase	Motor	N/C	
	When connecting each Whistle on the Trio to the same kind of motors, all should be wired in an identical manner. This will enable the same ***SimplIQ*** application set-up to run on all drives.			

Table 3-6: **Connectors for Main Power and Motors**

.11.1 Connecting Motor Power

Connect the motor power cable to the M1, M2, and M3 terminals of the relevant axis and the fourth wire to the PE (Protective Earth). The phase connection order is arbitrary because the Composer will establish the proper commutation automatically during setup. If several motor/drive combinations are designed to operate in an identical manner, it is recommended to download the program into all the drives and connecting them in the same way.

Notes for connecting the motor cables:

- For the greatest immunity, it is highly recommended to use a shielded (not twisted) cable for the motor connection. A 4-wire shielded cable should be used. The gauge is determined by the actual current consumption of the motor.
- Connect the shield of the cable to the closest ground connection at the motor end.
- Be sure that the motor chassis is properly grounded.

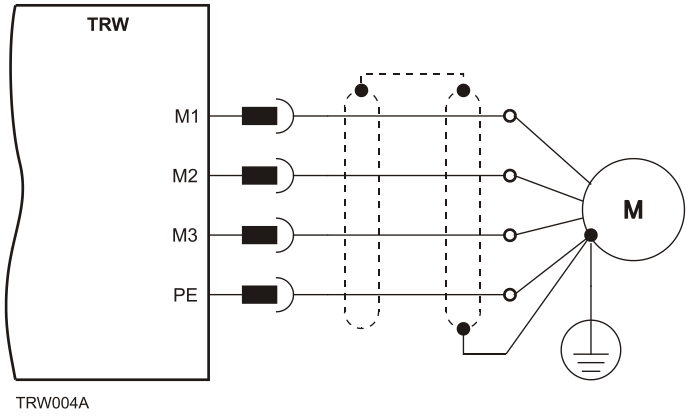


Figure 3-2: **AC Motor Power Connection Diagram for each AXIS.**

.11.2 Connecting Main Power

There are two possibilities for connection:

1. ***AC SOURCE RECOMMENDED***

Connect the AC power supply cable to the AC1, AC2 and PE terminals of the main power connector.

Notes for connecting the AC power cable:

- ***The source of the 0 ~ 62 VAC Power Supply must be isolated.***
- For the greatest immunity, a shielded (not twisted) cable is recommended (not mandatory) for the AC power supply cable. A 3-wire shielded cable should be used. The gauge is determined by the actual current consumption of the motor.
- Connect the two power wires (Neutral and Phase) to the AC power leads of the source.

For safety requirements, the third wire must be used for the protective earth connection (connected to the PE terminal).

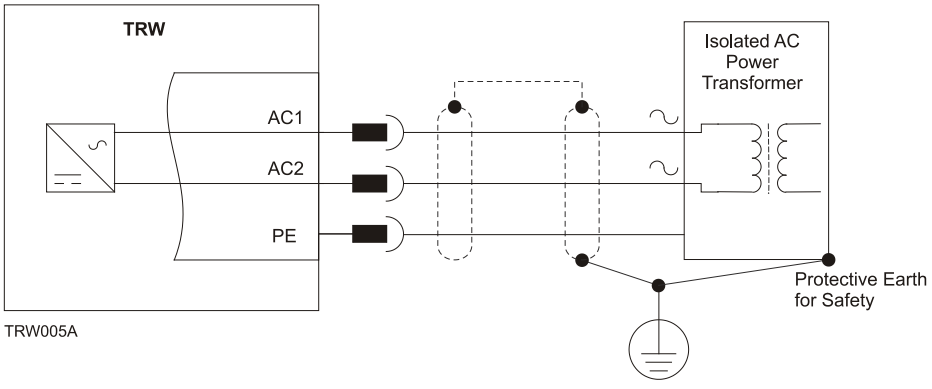


*Figure 3-3**: AC Supply Connection Diagram***

2. ***DC SOURCE OPTIONAL***

Connect the DC power supply cable to the VP+ and PR terminals of the main power connector.

Notes for connecting the DC power supply:

- ***The source of the 0 ~ 88 VDC Power Supply must be isolated.***
- For the greatest immunity, it is highly recommended to use twisted and shielded 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.
- Connect the cable shield to the closest ground connection near the power supply.
- Connect the PE to the closest ground connection near the power supply.
- Connect the PR to the closest ground connection near the power supply.
- Before applying power, first verify the polarity of the connection.

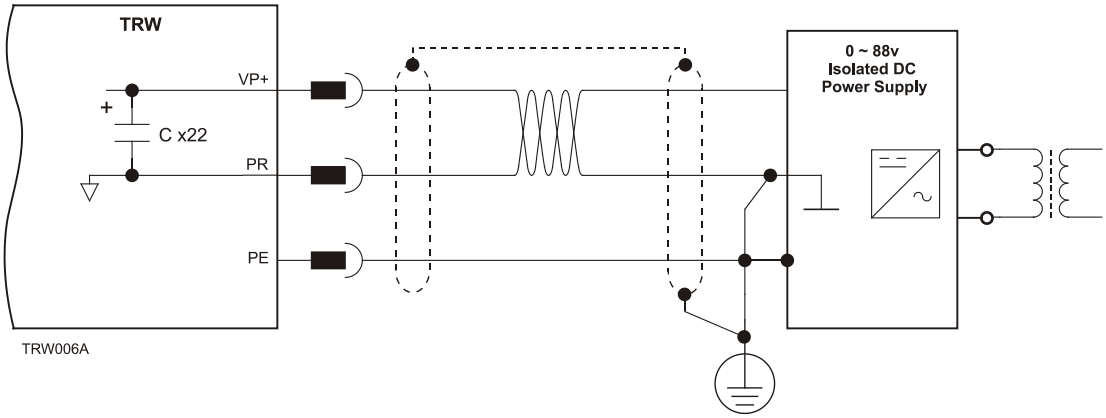


Figure 3-4: **Main Power DC Supply Connection Diagram**

.11.3 Low power Auxiliary Supply (optional)

Notes for 12 ~ 95 VDC Auxiliary Supply connections:

- ***The source of the 12 ~ 95 VDC Auxiliary Supply must be isolated from the main.***
- For safety reasons, connect the return (common) of the Auxiliary Supply source to the closest ground near the Auxiliary Supply source.
- Connect the cable shield to the closest ground near the Auxiliary Supply source.
- Before applying power, first verify the polarity of the connection.

6. **Caution:** Power to each Whistle and motor must come from the Main Supply and **NOT** from the Auxiliary Supply.

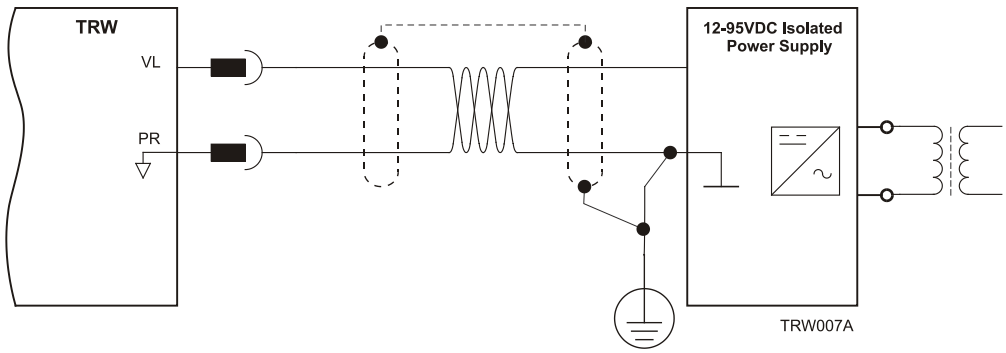


Figure 3-5: **Auxiliary Supply Connection Diagram**

The back-up functionality can be use for storing control parameters in case of power-loss, providing maximum flexibility and backup functionality when needed.

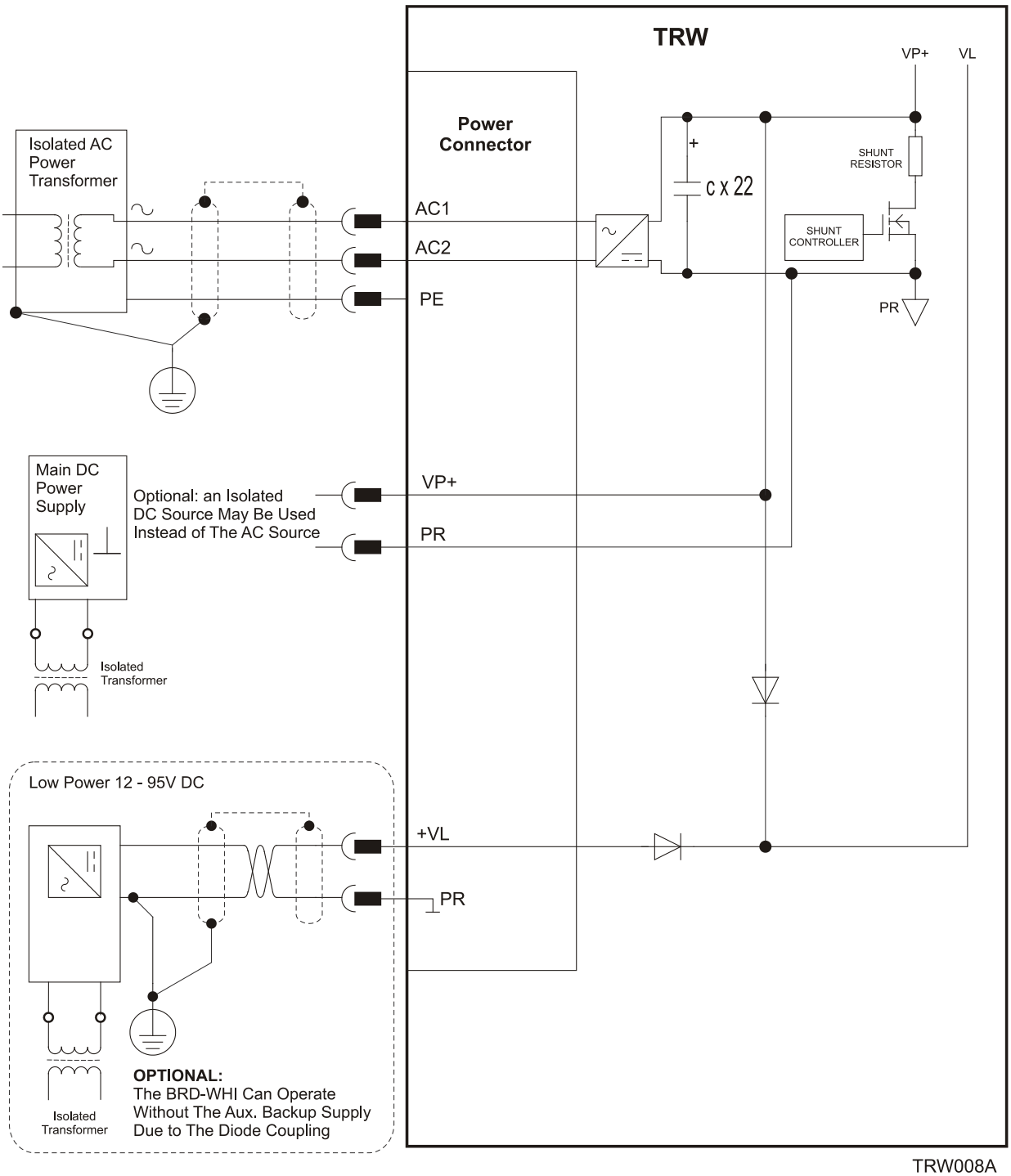


Figure 3-6: **Shared Supply Connection Diagram**

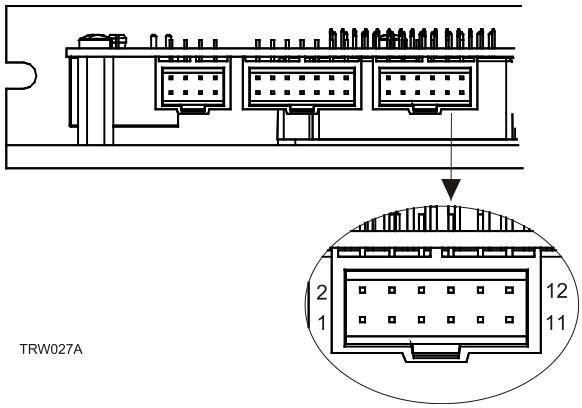
.12 Main Feedback

The Main Feedback port is used to transfer feedback data from the motor to the drive.

The Trio accepts the following 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 and potentiometer (option)

The Main Feedback port on the Trio has a 12-pin Molex Header plug.



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

Table 3-7: **Main Feedback Cable Pin Assignment for Each Axis**

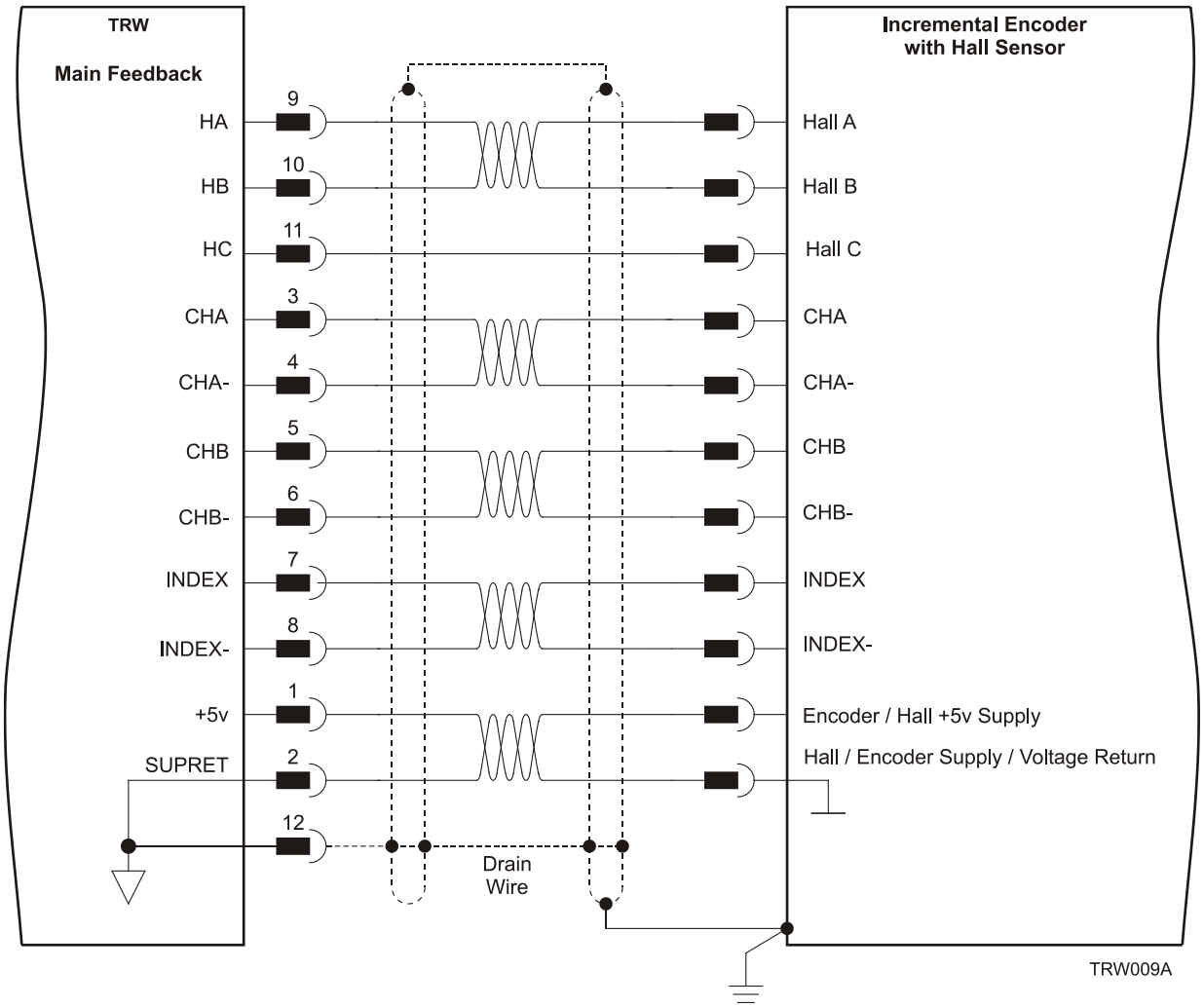


Figure 3-7: **Main Feedback- Incremental Encoder with Digital Halls Sensors Connection Diagram**

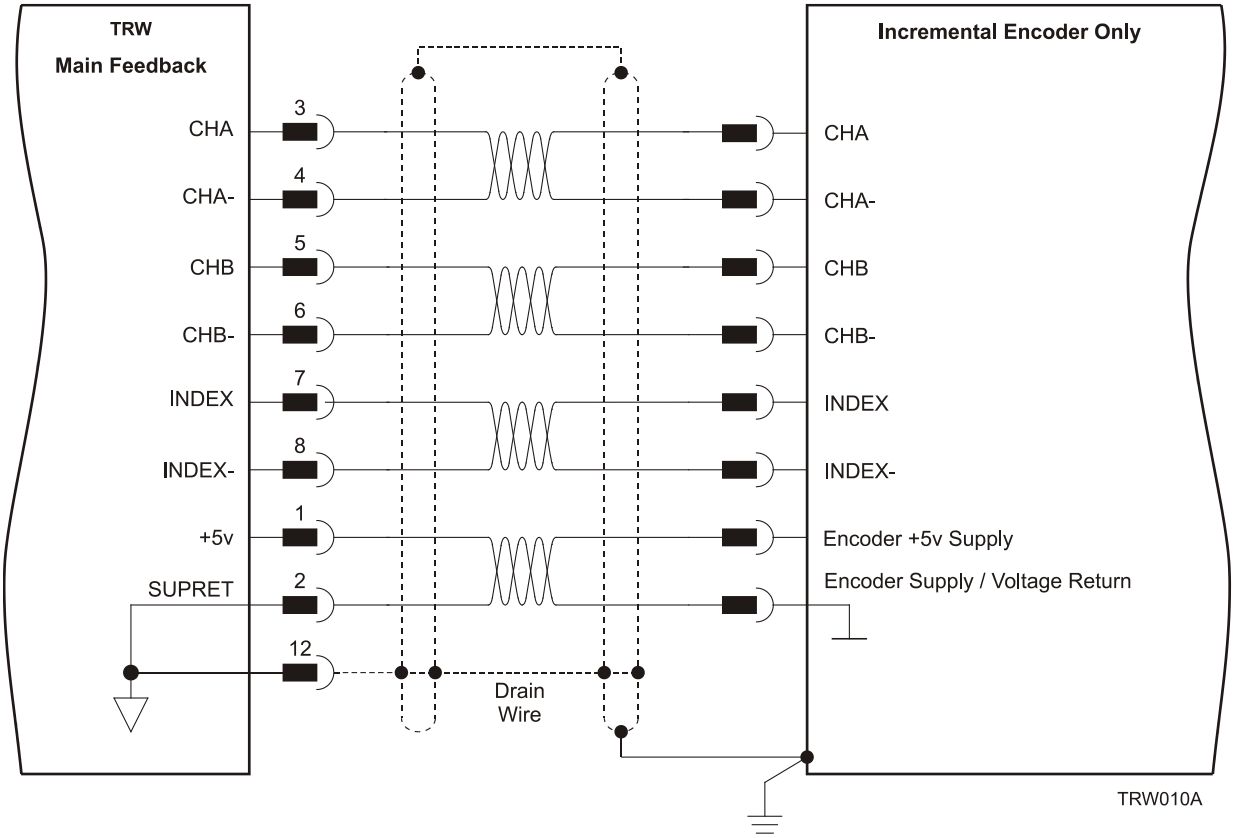


Figure 3-8: **Main Feedback- Incremental Encoder Only Connection Diagram**

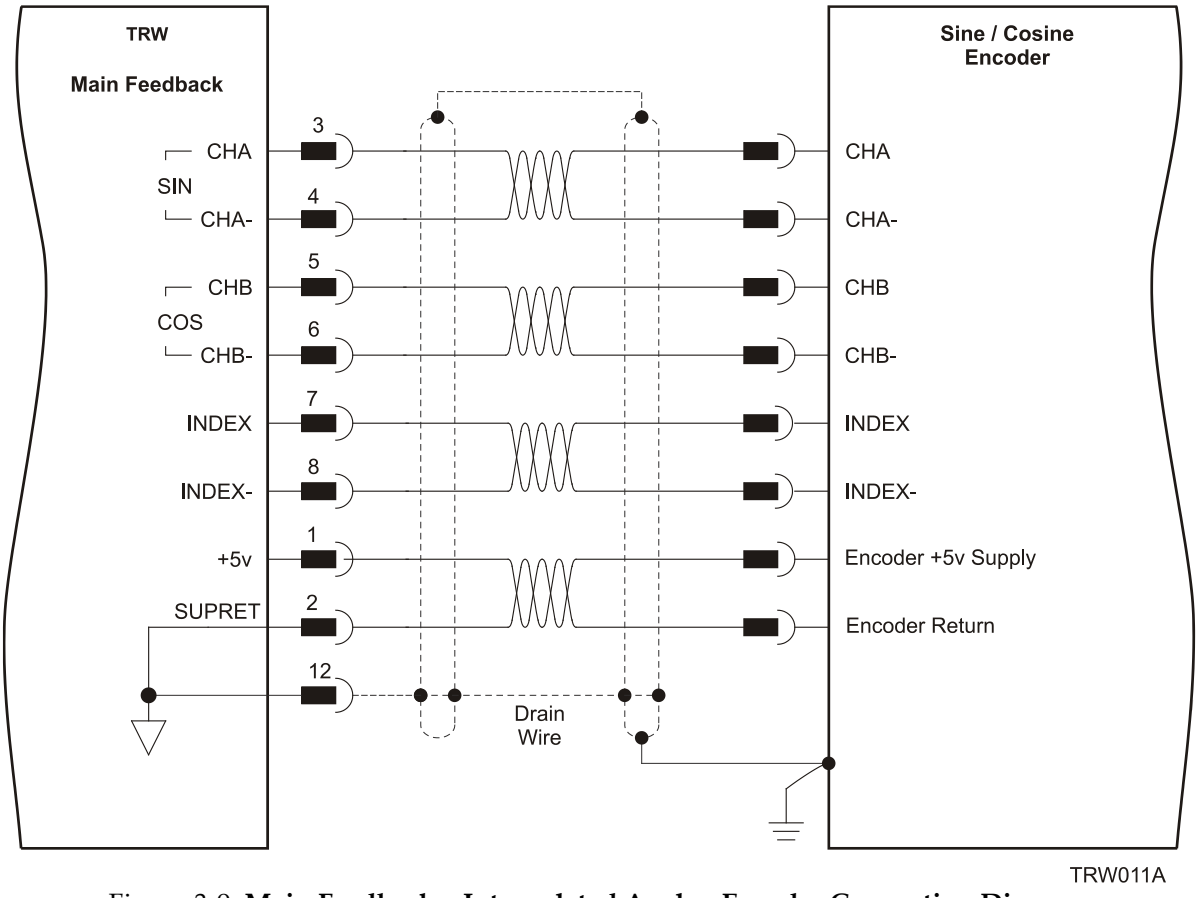


Figure 3-9: **Main Feedback – Interpolated Analog Encoder Connection Diagram**

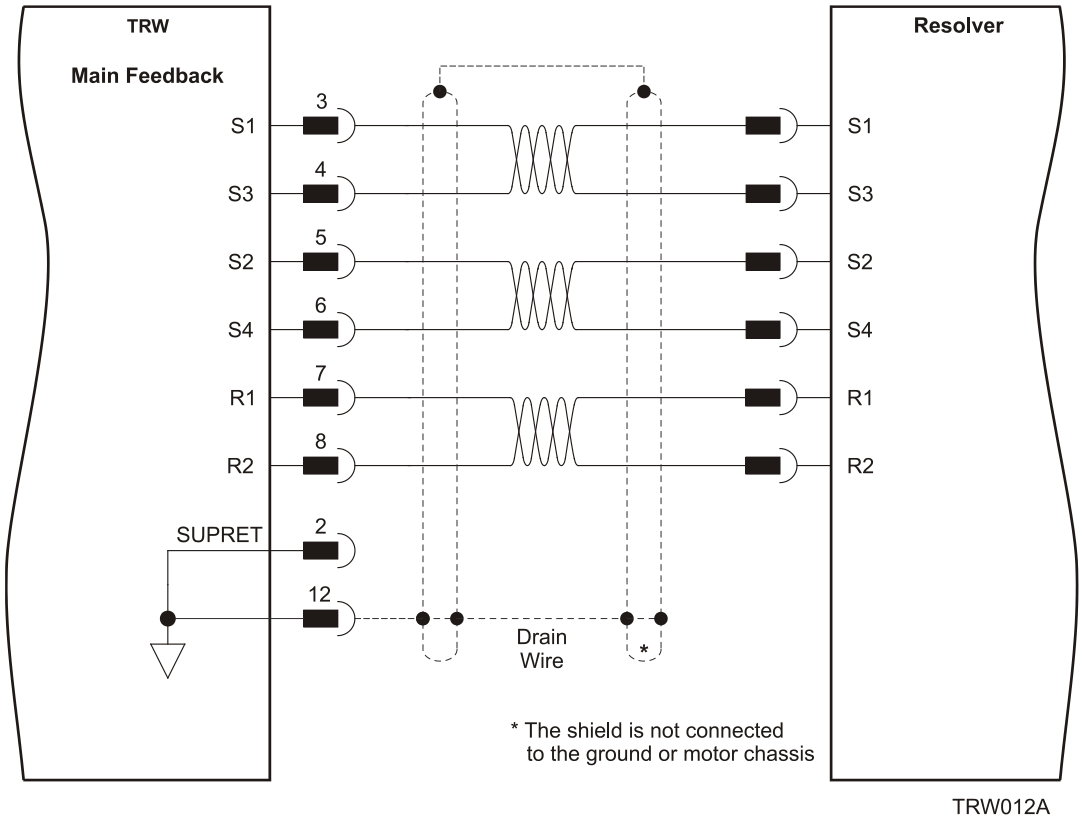


Figure 3-10: ***Main Feedback– Resolver Connection Diagram***

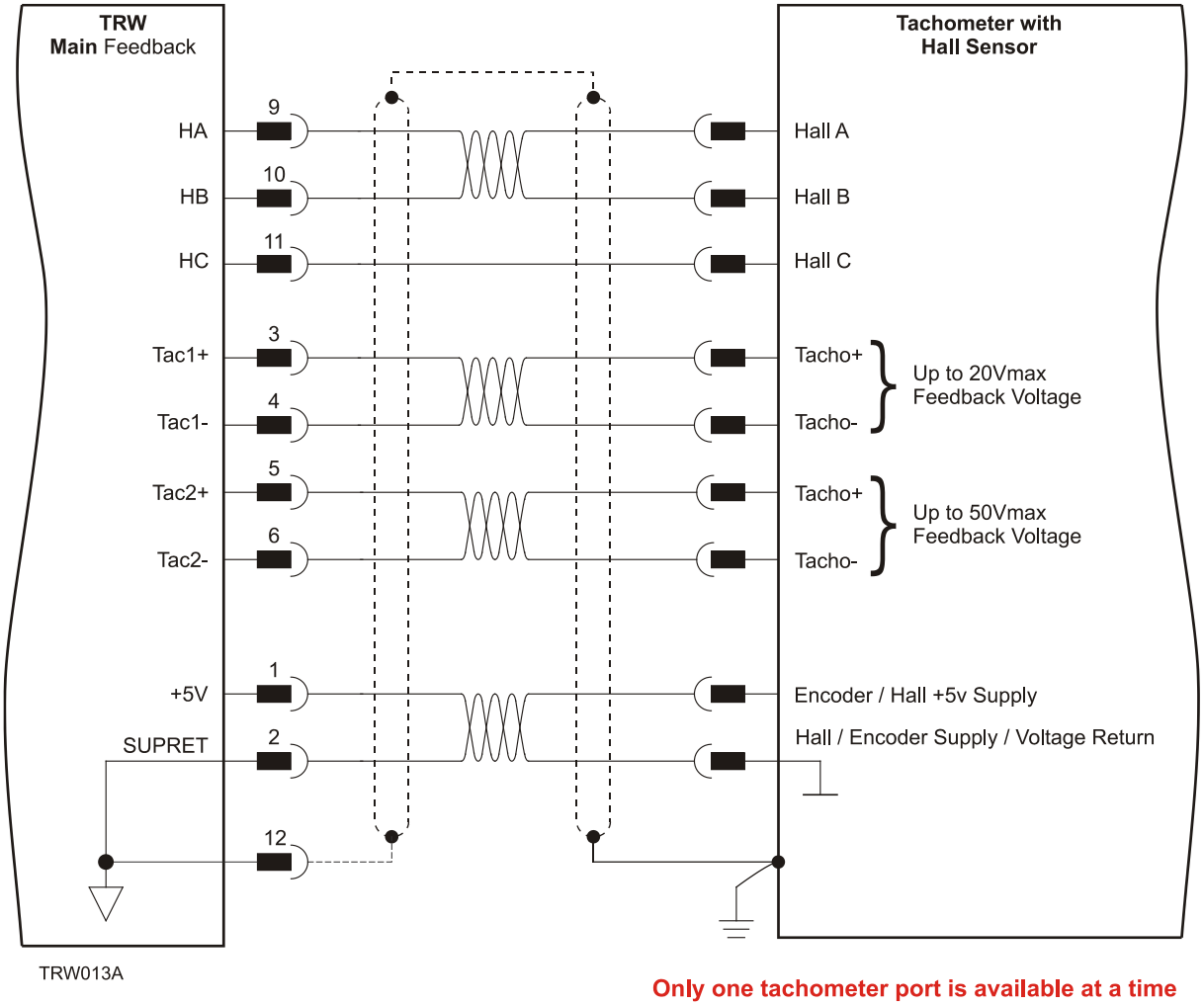


Figure 3-11: ***Main Feedback – Tachometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors***

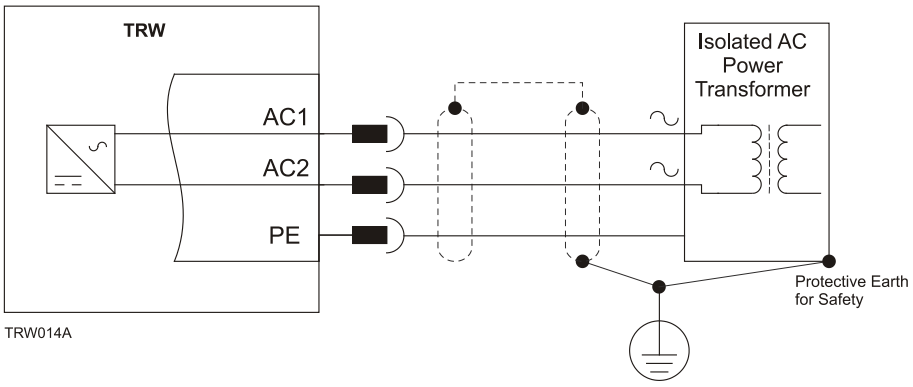


Figure 3-12: ***Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors***

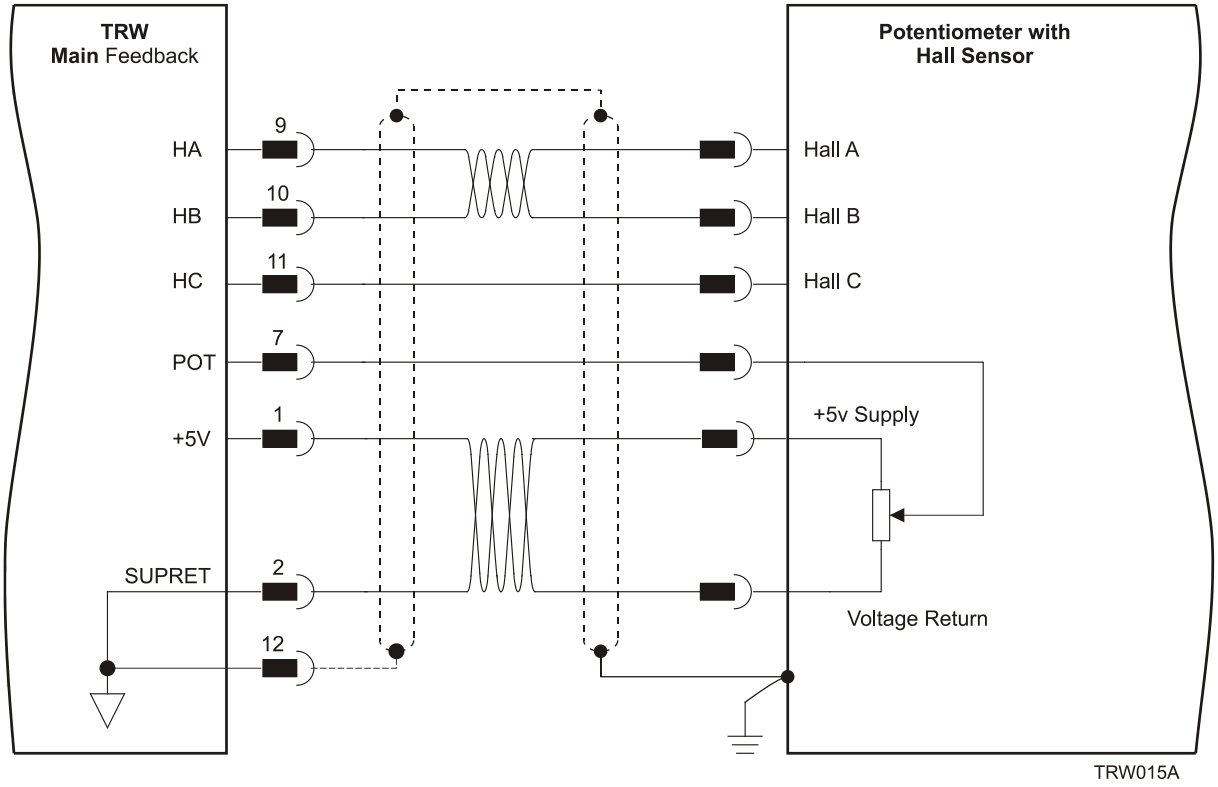


Figure 3-13: ***Main Feedback – Potentiometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors***

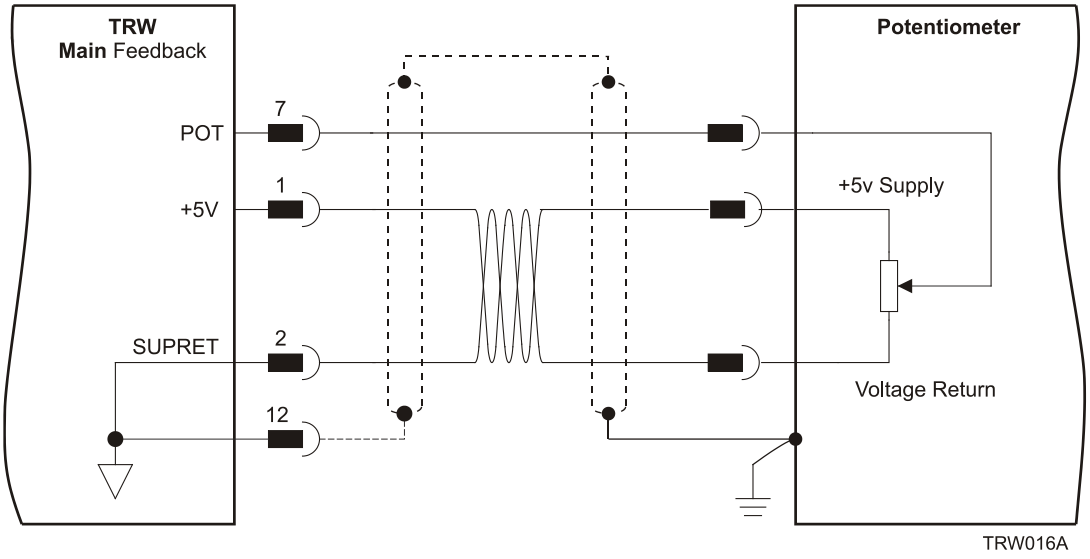


Figure 3-14: ***Main Feedback – Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils***

.13 Pulse and Direction (YA[4]=0)

The P/D port has an 8-pin Molex Header plug with the following pin-outs.

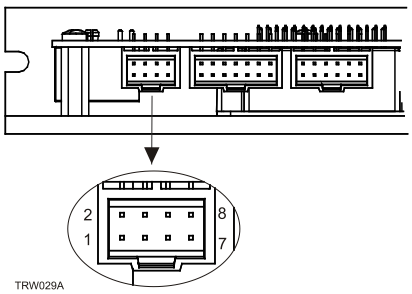
Pin	Signal	Function	Pin Position
1	PULSE+	Pulse input	
2	PULSE-	Pulse complement input	
3	DIRECTION+	Direction input	
4	DIRECTION-	Direction complement input	
5	+5V	+5V supply voltage	
6	PULSE-	Pulse complement input	
7	+5V	+5V supply voltage	
8	SUPRET	Supply return	

Table 3-8: **Pulse-and-Direction Pin Assignment for Each Axis**

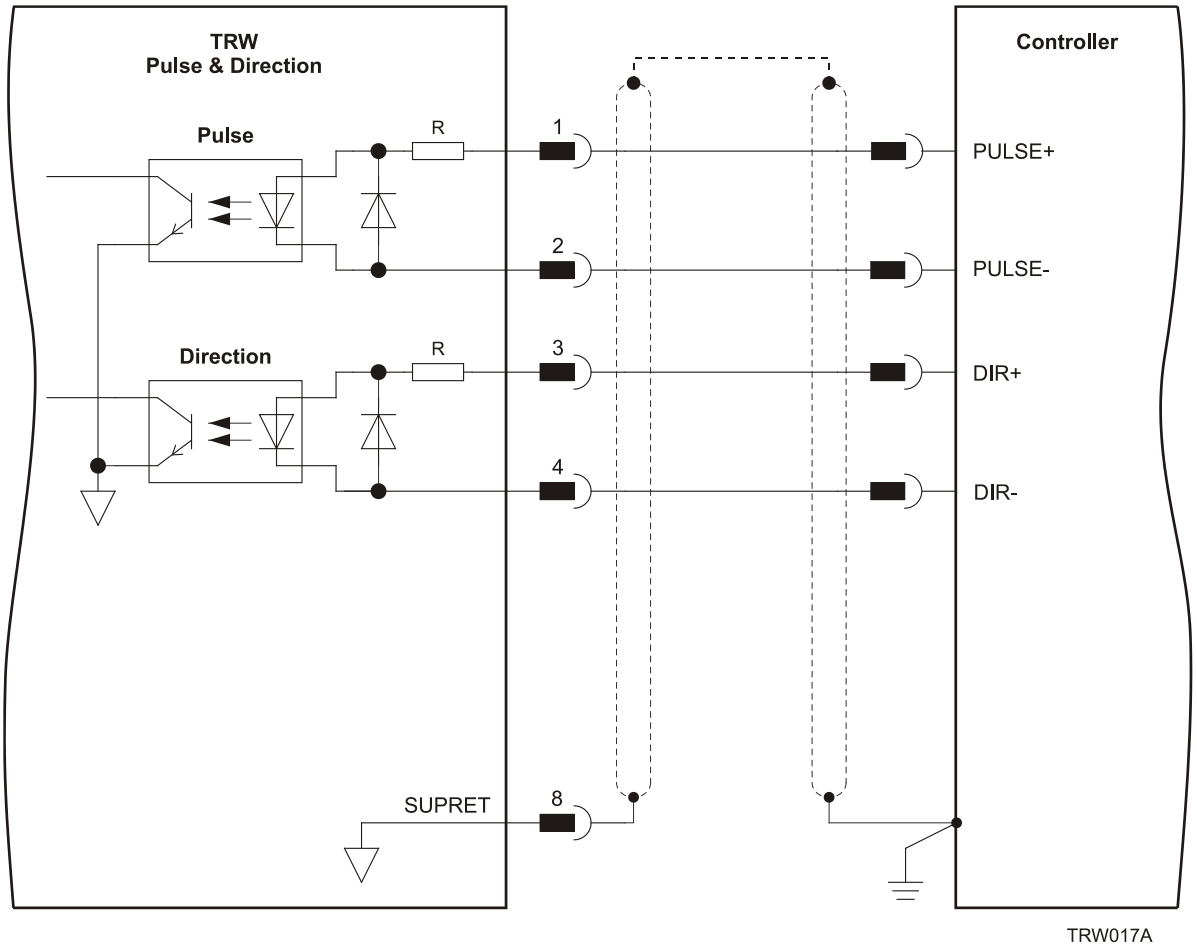


Figure 3-15: **Isolated differential Pulse-and-Direction – Connection Diagram**

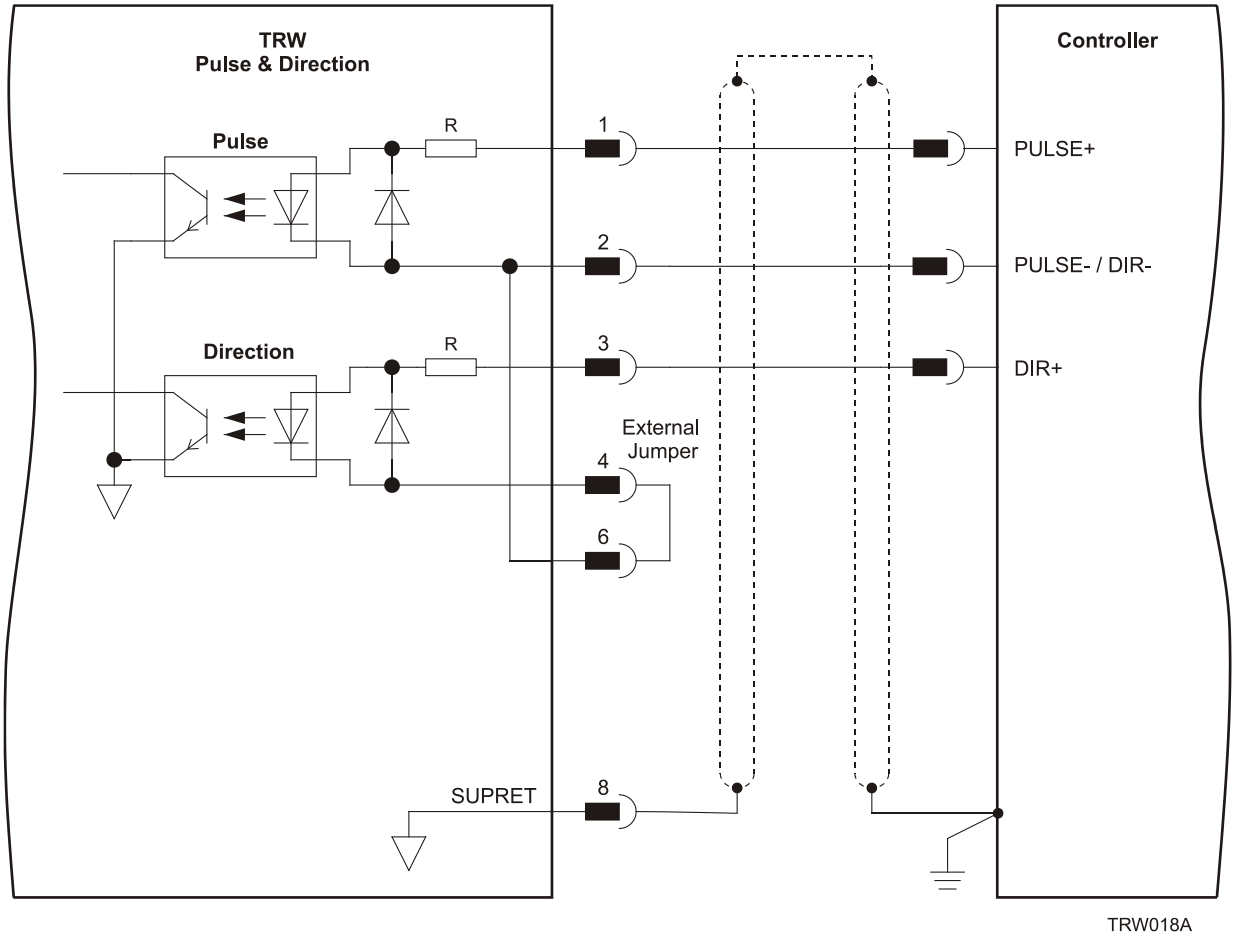


Figure 3-16: **Isolated single ended Pulse-and-Direction – Connection Diagram**

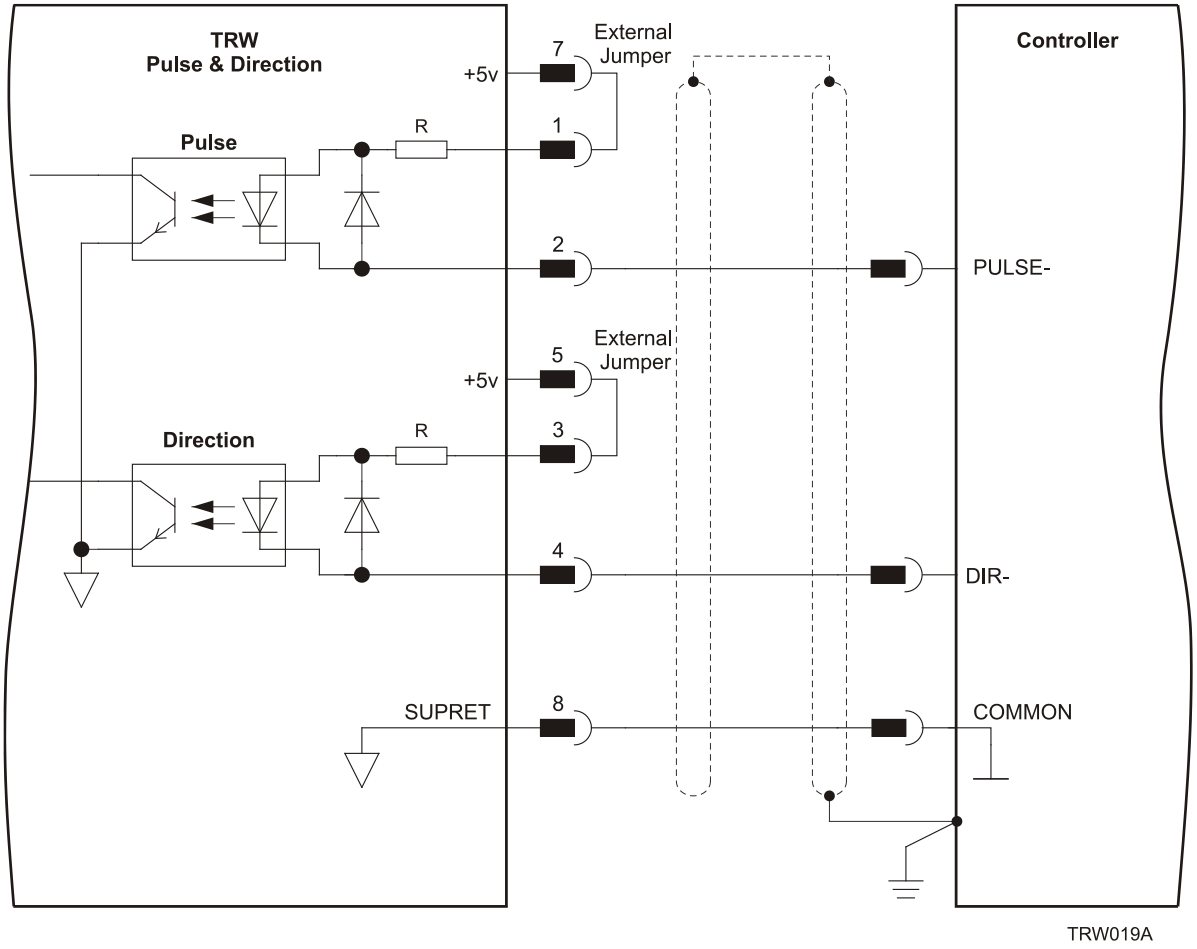


Figure 3-17: **Non Isolated Pulse-and-Direction – Connection Diagram**

.14 I/O

Each Whistle on the Trio has 6 digital inputs, 2 digital outputs and a single analog input.

The I/O port has a 14-pin Molex Header plug with the following pin-outs.

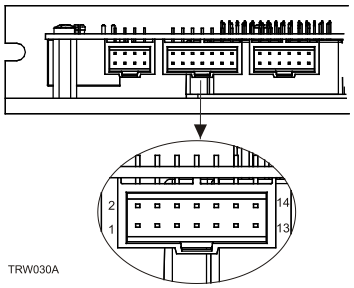
Pin	Signal	Function	Pin Position
1	OUT1	Programmable Digital output 1	
2	OUTRET1	Programmable Digital output 1 return	
3	OUT2	Programmable Digital output 2	
4	OUTRET2	Programmable Digital output 2 return	
5	IN1	Programmable Digital input 1	
6	IN2	Programmable Digital input 2	
7	IN3	Programmable Digital input 3	
8	IN4	Programmable Digital input 4	
9	IN5	Programmable Digital input 5	
10	IN6	Programmable Digital input 6	
11	INRET	Programmable Digital input return	
12	COMRET	Common return	
13	ANALIN1+	Analog input 1+	
14	ANALIN1-	Analog input 1-	

Table 3-9: **I/O Port and Cable - Pin Assignment for Each Axis**

.14.1 Digital Input

Digital input can be configured in one of two ways:

- When the controller's signal level is ~24 V.

- When the controller's signal level is ~5 V.

The Default Digital Input level Signal is 5 V.

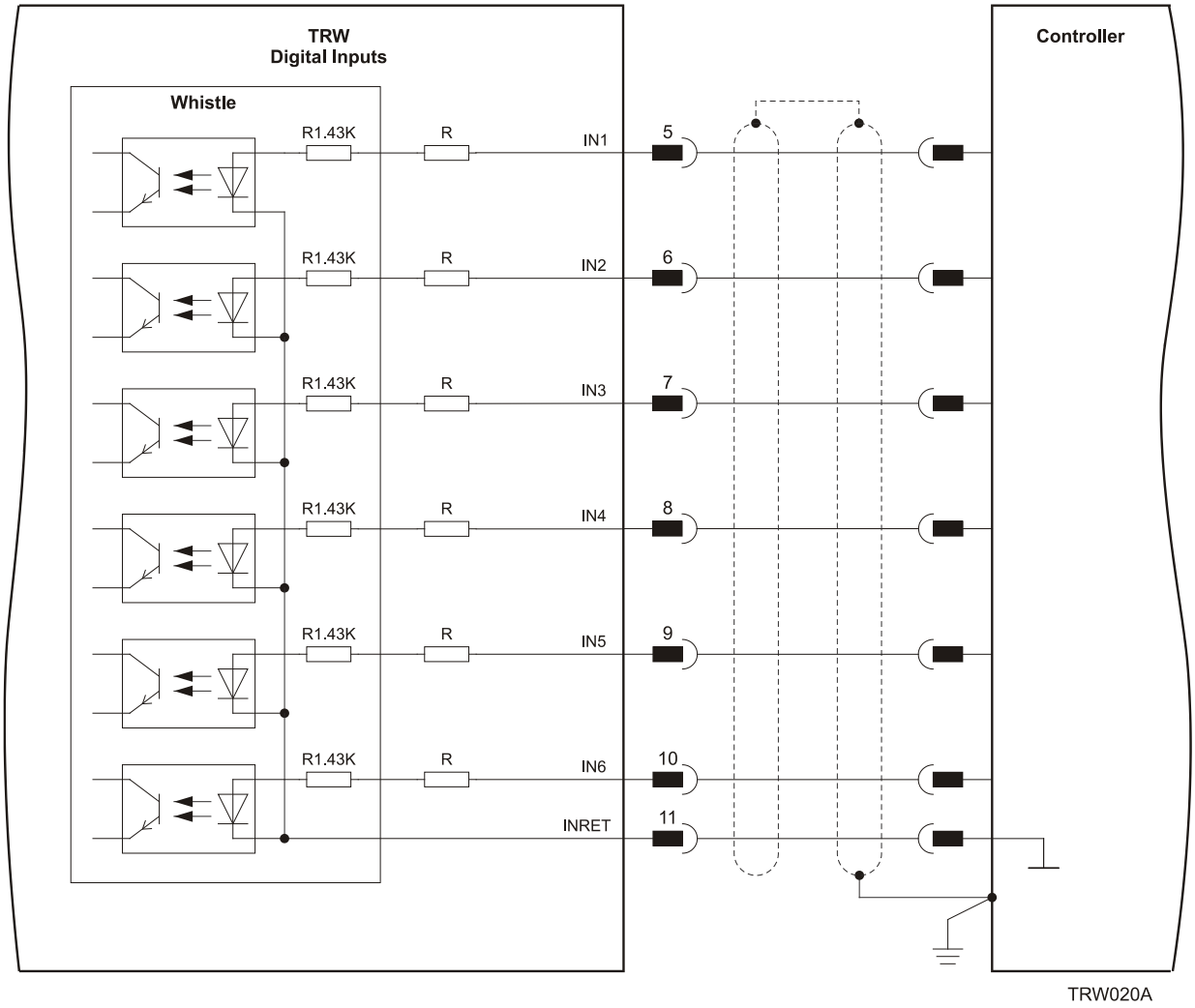


Figure 3-18: **Digital Input Connection Diagram**

.14.2 Digital Output

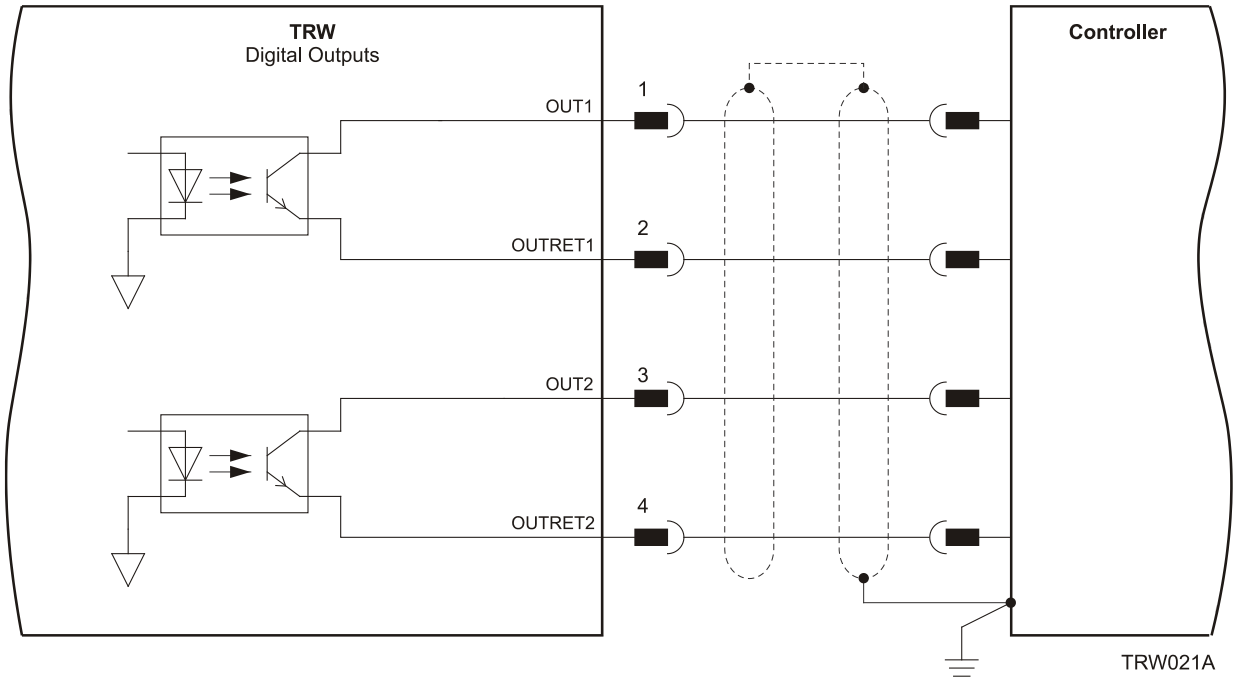


Figure 3-19: **Digital Output Connection Diagram**

.14.3 Analog Input

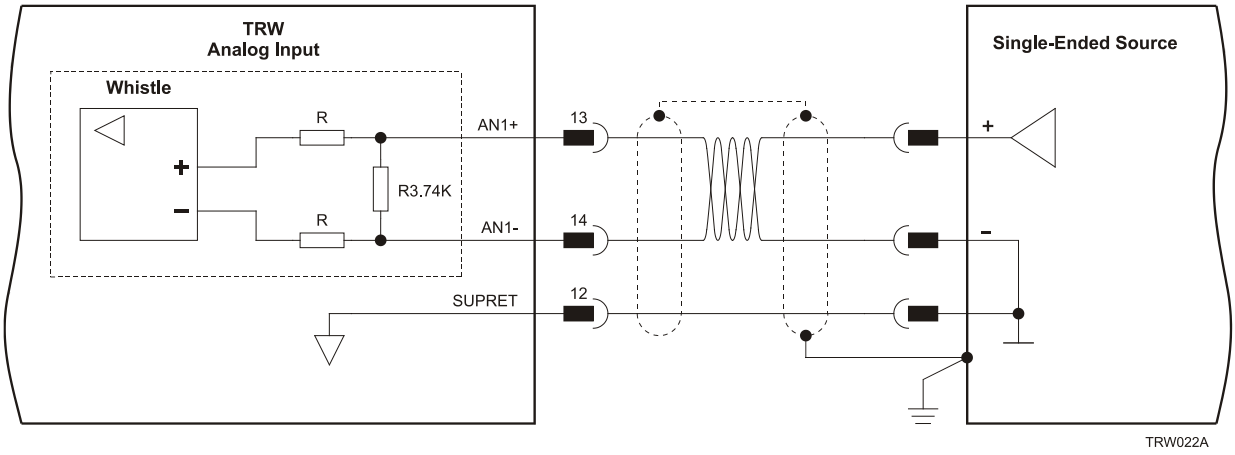


Figure 3-20: **Analog Input with Single-ended Source**

.15 Communications

The communication cables use an 8-pin RJ-45 plug that connect to the RS-232 and CANopen ports on the Trio.

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

1. RS-232, full duplex
2. CANopen

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

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

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

.15.1 RS-232 Communication

Notes for connecting the RS-232 communication cable:

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

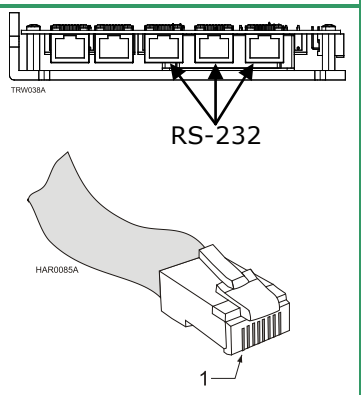
Pin	Signal	Function	Pin Position
1	–	–	
2	–	–	
3	Tx	RS-232 transmit	
4	–	–	
5	COMRET	Communication return	
6	Rx	RS-232 receive	
7	–	–	
8	–	–	
body	Drain Wire	shield	

Table 3-10: **RS-232 Cable - Pin Assignments**

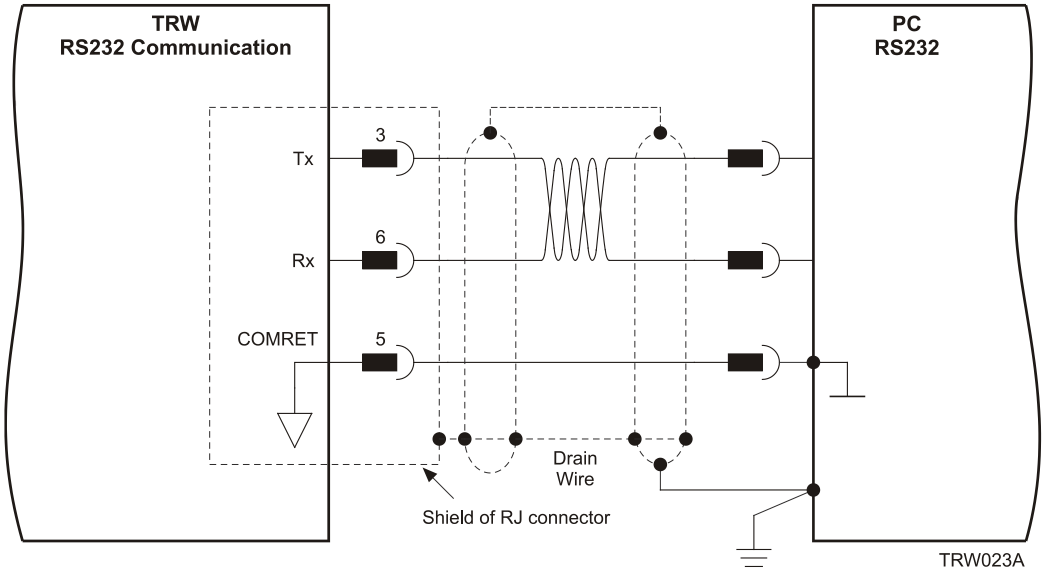


Figure 3-21: **RS-232 Connection Diagram**

.15.2 CANopen Communication

Notes for connecting the CANopen communication cable:

- For "daisy-chain" connections, use 26 or 28 AWG twisted pair shielded cables. For best results, the shield should have aluminum foil and be 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 CANopen communication port is **non-isolated**.
- 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-Ohm resistor at each of the two ends of the network cable.

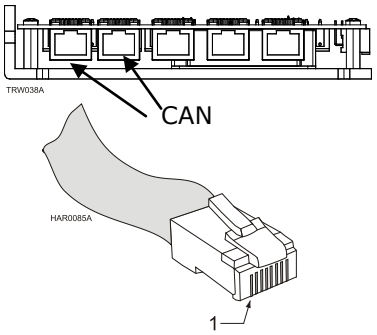
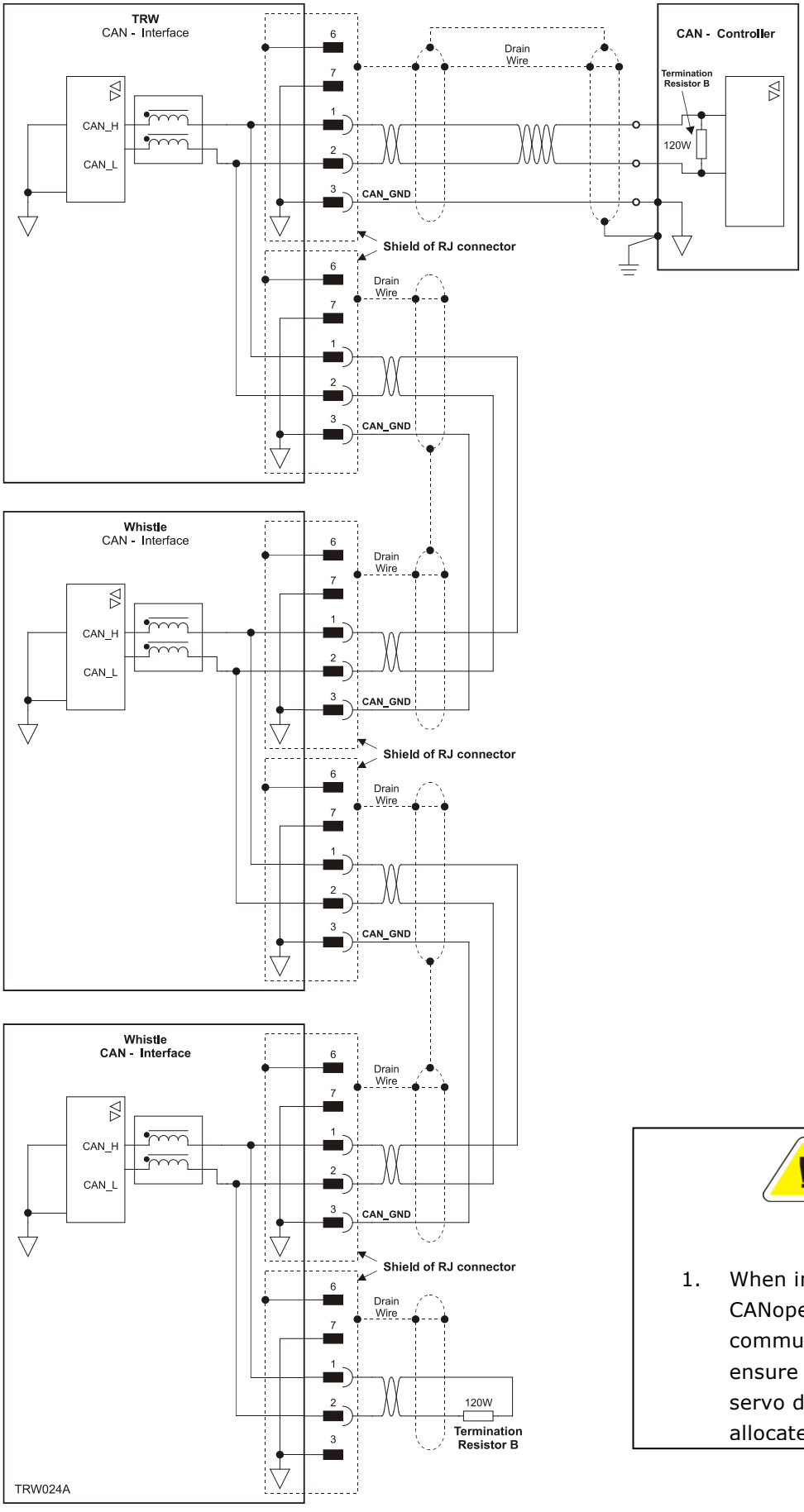
Pin	Signal	Function	Pin Position
1	CAN_H	CAN_H busline (dominant high)	
2	CAN_L	CAN_L busline (dominant low)	
3	CAN_GND	CAN ground	
4	–	–	
5	–	–	
6	CAN_SHLD	Shield, connected to the RJ plug cover	
7	CAN_GND	CAN Ground	
8	–	–	
body	Drain Wire	shield	

Table 3-11: **CANopen Cable - Pin Assignments**



1. When installing CANopen communications, ensure that each servo drive is allocated a unique ID.

Figure 3-22: **CANopen Connection Diagram**

.16 Powering Up

After the cables have been connected to their devices, the Trio is ready to be powered up.

1. Before applying power, ensure that the AC/DC supply are both isolated and within the specified range.
2. When using a DC supply, ensure that the proper plus-minus connections are in order.

.17 Initializing the System

After the Trio 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*.

Technical Specifications

.18 Features

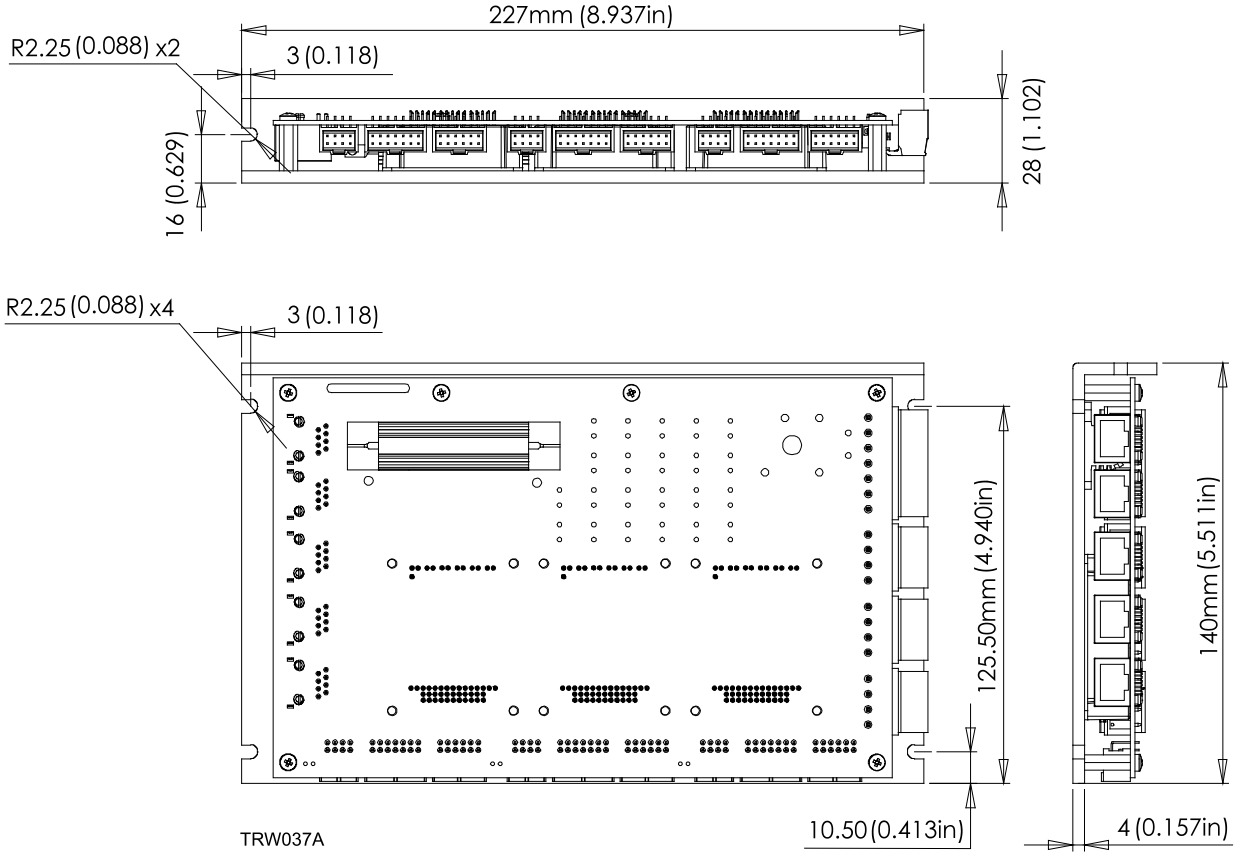
- Operating power
  - AC power supply: 8.5 - 62 VAC source
- DC BUS
  - Rectified AC voltage: 12 – 88 VDC
- Control supply
  - A separate DC power supply serves as both the auxiliary supply *and* the backup supply (Option)
- Operating modes
  - Current, velocity and position
- Commutation alternatives
  - Sinusoidal vector control
  - Trapezoidal
  - DC brush
- Feedback alternatives
  - Incremental encoder + digital Halls
  - Incremental encoder only
  - Digital Halls
  - Resolver
  - Sin/Cos
  - Analog Halls
  - Tacho
  - Potentiometer
- Communication
  - Simultaneous operation of RS-232 and CANopen DS 402 User programming
- User Programming
  - Third-generation programming environment (language and Elmo Studio)
- Encoder Inputs
  - One

- Event capturing inputs
- Event triggered programming structure
- Analog inputs
    - 1 differential inputs with 12-bit resolution
- Enable input, limit switches and emergency stop handling
- Smart multi-purpose inputs
    - Programmable as Enable, Forward and Reverse Limit Switches, Home, Capture
- Uncommitted programmable inputs
    - 6 inputs sharing one single common
- Uncommitted, programmable outputs
    - 2 separated outputs
- Storage memory
    - Large, non-volatile storage of controller parameters and user programs
- Setup, startup and tuning software
    - Windows-based Composer
- Automatic analysis of kinematics
- Status indication
    - Bi-color LED
- 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
- Motion modes
    - Point-to-point (PTP)
    - Jogging
    - Position-Velocity-Time (PVT)
    - Position-Time (PT)
    - Pulse-and-direction

.19 Built-In Protection

- Software error handling
    - Software-based
- Status reporting
    - Available for a large number of fault conditions
- Protection against:
    - Short circuit between motor power outputs
    - Short circuit between each motor power output and DC bus return
    - Failure of internal power supply
    - Heatsink over-temperature
    - Under/over voltage
    - Loss of commutation signals
    - Loss of velocity feedback
    - “Bad” commutation
    - Communication error

.20 Trio Dimensions



.21 Power Ratings

Feature	Unit	1/60	2.5/60	5/60	10/60	1/100	2.5/100	5/100	10/100
Minimum supply voltage	VAC	5.5				8.5			
Nominal supply voltage	VAC	34				60			
Maximum supply voltage	VDC	48				88			
Max. output power from the drive without heatsink	W	50	120	240	480	75	180	400	500
Efficiency at rate power	%	> 99							
Output Voltage	%	> 95% of supply VDC at f=22 kHz							
DC and Trapezoidal Commutation Continuous Current Limit (Ic)	A	1	2.5	5	10	1	2.5	5	10
Sinusoidal Commutation Continuous RMS Current Limit (Ic)	A	0.7	1.8	3.6	7	0.7	1.8	3.6	7
Peak current limit (RMS)	A	2 x Ic							
PWM Switching Frequency	kHz	22 +/-5% default on the motor							
Switching Method		Advanced Unipolar PWM							
Digital In/Digital Out /Analog In		6 / 2 / 1							

Note:

- **Current rating:** The current ratings of the Trio 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.

.22 Control Specifications

.22.1 Current Loop

Feature	Details
Controller type	Vector, digital
Current sampling time	70 - 100 μsec
Current loop bandwidth	1400 - 2500 Hz
Compensation for bus voltage variations	Gain scheduling
Motor types	▪ AC brushless (sinusoidal) ▪ DC brushless (trapezoidal) ▪ DC brush
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 step response (including settling time)	300 - 400 μsec
Current rise time	150 - 200 μsec

.22.2 Velocity Loop

Feature	Details
Controller type	PI
Speed sampling time	140 - 200 µsec (x2 current loop sample time)
Velocity loop bandwidth	
Velocity control	▪ Fully digital ▪ Programmable PI and FFW control filters ▪ On-the-fly gain scheduling ▪ Automatic, manual and advanced manual tuning
Velocity and position feedback options	▪ Incremental encoder + digital Halls ▪ Incremental encoder only ▪ Digital Halls ▪ Resolver ▪ Sin/Cos ▪ Analog Halls ▪ Tacho ▪ Potentiometer **Note:** With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).
Velocity command options	▪ Analog ▪ Internally calculated by either jogging or step **Note:** All software-calculated profiles support on-the-fly changes.

.22.3 Position Loop

Feature	Details
Controller type	124 PIP
Position sampling time	280 - 400 µsec (x 4 current loop sample time)
Analog input command resolution	12-bit inputs
PWM resolution	12-bit
PWM switching frequency on the load	2/ Ts (factory default 22 kHz on the motor)

Control inputs	PLC or +5V level

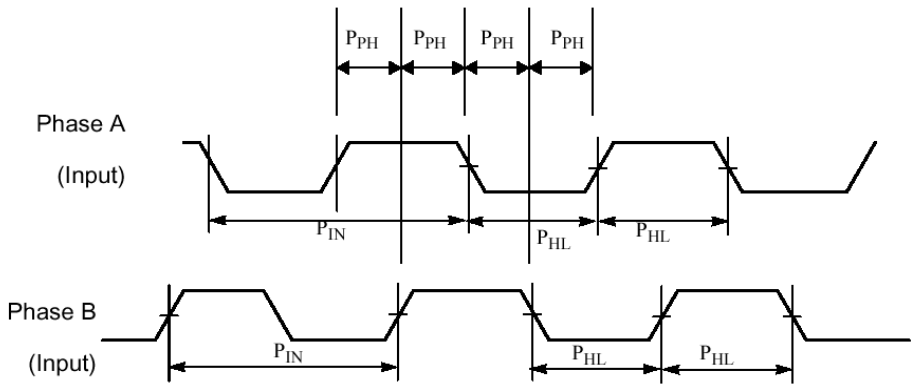
.23 Feedbacks

.23.1 Incremental Encoder

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 single, 20 MHz quadrature
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

.23.2 Feedback Supply Voltage

Feature	Details
Encoder/Hall supply voltage	5 V +5%
Maximum encoder supply current	200 mA (For the main encoder only)



.23.3 Digital Halls

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

.23.4 Interpolated Analog Encoder (Sine/Cosine)

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

.23.5 Resolver

Feature	Details
Resolver format	▪ Sine/Cosine ▪ Differential
Input resistance	Differential 2.49 kΩ
Resolution	Programmable: 10 ~ 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 Whistle
Reference current	Up to ±50 mA

.23.6 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

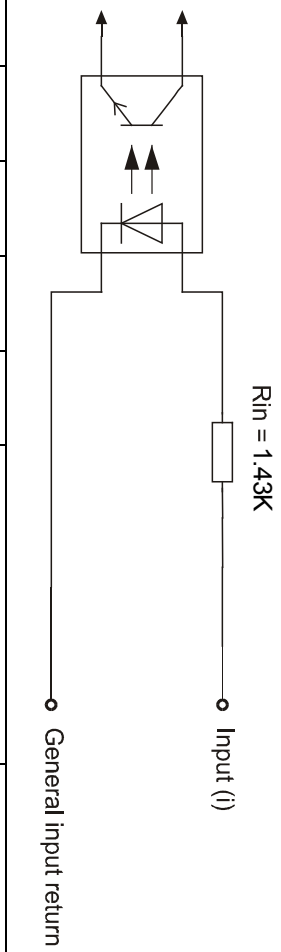
* Only one Tachometer port can be used at a time (either TAC1+/TAC1- or TAC2+/TAC2-).
TAC1+/TAC1- is used in applications with having a Tachometer of less than 20 V.
TAC2+/TAC2- is used in applications with having a Tachometer of between 20 V and 50 V.

.23.7 Potentiometer

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

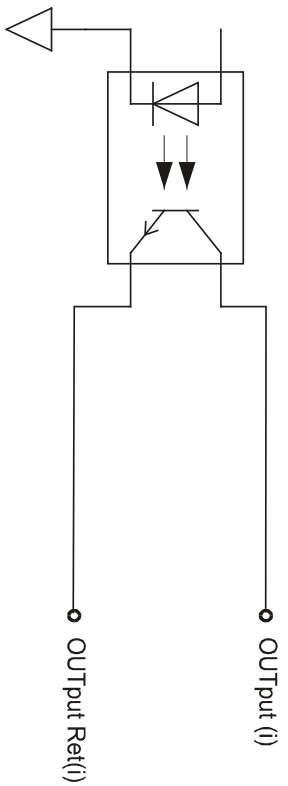
.24 I/Os

.24.1 Digital Input Interface

Feature	Details	Connector Location
Type of input	▪ Optically isolated ▪ All six inputs share one signal return line	 *Digital Input Schematic*
Input current for all inputs	Iin = 2.4 mA @ Vin = 5 V	
High-level input voltage	2.5 V < Vin < 10 V, 5 V typical	
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<4xTS If input is set to General input, execution depends on program. Typical execution time: ≅ 0.5 msec.	
High-speed inputs – 5 & 6 minimum pulse width, in high-speed mode	T < 5 µsec **Notes:** ▪ Home mode is high-speed mode and can be used for fast capture and precise homing. ▪ High speed input has a digital filter set to same value as digital filter (EF) of main encoder. ▪ Highest speed is achieved when turning on optocouplers.	

The Default Digital Input Level is 5 V. 24 V Level is also available.

.24.2 Digital Output Interface

Feature	Details	Connector Location
Type of output	▪ Optically isolated ▪ Open collector and open emitter	 *Digital Output Schematic*
Maximum supply output (Vcc)	30 V	
Max. output current Iout (max) (Vout = Low)	Iout (max) ≤ 10 mA	
VOL at maximum output voltage (low level)	Vout (on) ≤ 0.3 V	
RL	External resistor RL must be selected to limit output current to no more than 10 mA. $R_L = \frac{Vcc - VOL}{Io(\max)}$	
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.	

.24.3 Analog Inputs

Feature	Details
Analog input - maximum differential mode voltage	+ 20 V
Analog input - maximum common mode voltage	+ 10 V
Input resistance	3.74 kΩ

.25 Mechanical Specifications

Feature	Details
Mounting	The Trio will be 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
Overall dimensions	220 x 140 x 30 mm
Weight	~ 815 g

.26 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

.27 Compliance Standards

Specification	Details
ISO9001	Quality Assurance

.27.1 Design

Specification	Details
MIL-HDBK- 217F	Reliability prediction of electronic equipment (rating, de-rating, stress and so on)
▪ IPC-D-275	Printed wiring for electronic equipment

▪ IPC-SM-782 ▪ IPC-CM-770 ▪ UL508c ▪ UL840	(clearance, creepage, spacing, conductor sizing and so on)
In compliance with **VDE0160 -7**	Type testing

.27.2 Safety

Specification	**Details**
Recognized **UL508c**	Power conversion equipment
In compliance with **UL840**	Insulation coordination, including clearance and creepage distances of electrical equipment
In compliance with **UL60950**	Safety of information technology equipment, including electrical business equipment
In compliance with **EN60204-1**	Low voltage directive, 73/23/EEC

.27.3 EMC

Specification	**Details**
In compliance with IEC 1800-3, Part 3: 1996 (Adjustable speed electrical power-drive systems - EMC products standard, including specific test methods)	Electromagnetic compatibility (EMC)

Cables (Optional)

.28 Cable Photos

Main Feedback: CBL- HDRFB-001

Pulse and Direction: CBL- HDRPD-001

I/O: CBL- HDRIO-001

RS-232 Com.: CBL-RJ452321

CAN Com.: CBL-RJ45CAN1

.29 Cable Kits

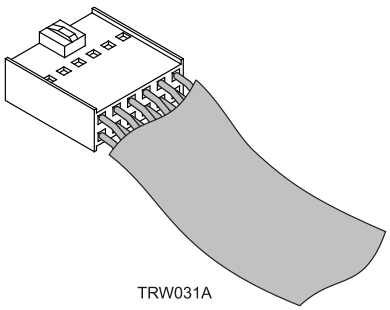
The cables are all 2 m in length. Each set contains the cables listed below. Additional cable kits and individual cables (individually or in multiples of 10 each) are available from Elmo.

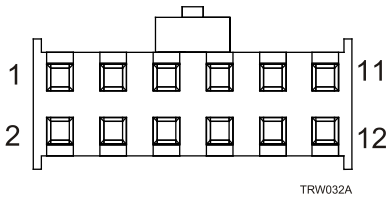
Cable Application	Cable Part. No.	QTY
Main Feedback	CBL-HDRFB-001	3
Pulse and Direction	CBL-HDRPD-001	3
I/O	CBL-HDRIO-001	3
RS-232 Communications	CBL-RJ452321	1
CAN Communications	CBL-RJ45CAN1	1

.30 Main Feedback Cable (CBL-HDRFB-001)

The Main Feedback cable (CBL-HDRFB-001) is made of a 24-AWG shielded cable with a 12-pin Molex Header socket. It connects to the FEEDBACK port on the Trio. It is open on its other side so that it can be connected to customer-specific controller connectors.

Pin No.	Color	Pairs	
1	Brown	pair	12 pin Molex Header Socket
2	White		
3	Cyan	pair	
4	Orange		
5	Purple	pair	
6	Black		
7	Red	pair	
8	Blue		
9	Green	pair	
10	Yellow		
11	Pink	pair	
12	Drain wire		





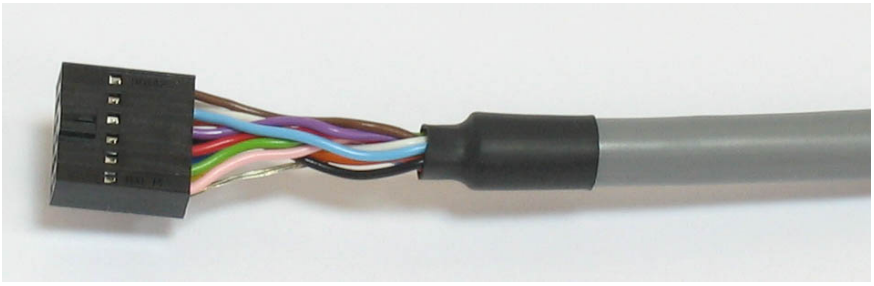
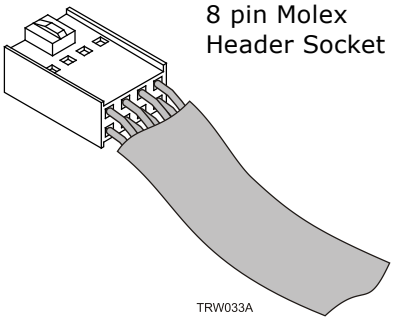
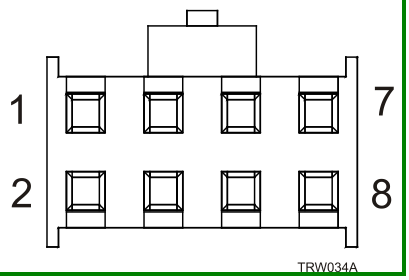


Figure A-6: **Single-sided Main Feedback Cable** (Part No. CBL-HDRFB-001)

.31 Pulse and Direction (CBL-HDRPD-001)

The Pulse and Direction cable (CBL-HDRPD-001) is made of a 24-AWG shielded cable with an 8-pin Molex Header socket. It connects to the Pulse and Direction port on the Trio.

Pin No.	Color	Pairs	
1	Green	pair	
2	Yellow		
3	Pink	pair	
4	Gray		
5	Red	pair	
6	Blue		
7	Brown	pair	
8	White		

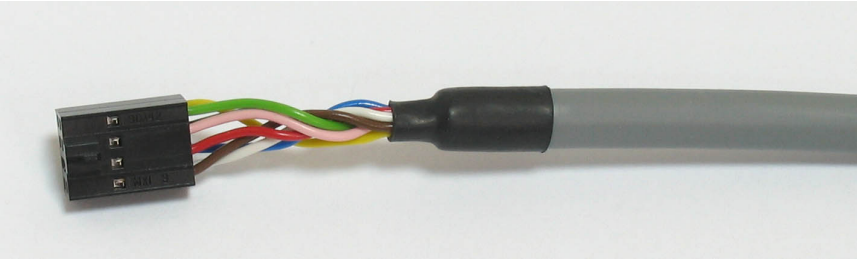
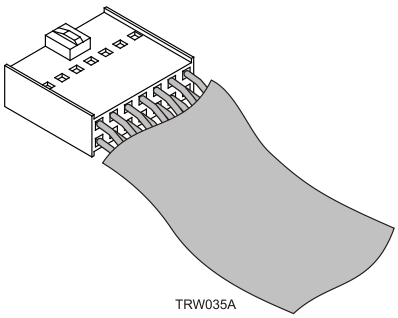


Figure A-2: **Single-sided Pulse and Direction Cable** (Part No. CBL-HDRPD-001)

.32 I/O (CBL-HDRIO-001)

The I/O cable (CBL-HDRIO-001) is made of a 24-AWG shielded cable with a 14-pin Molex Header socket. It connects to the I/O port on the Trio.

Pin No.	Color	Pairs	
1	Orange	pair	14 pin Molex Header Socket 
2	Cyan		
3	Black	pair	
4	Purple		
5	Brown	pair	
6	White		
7	Green	pair	
8	Yellow		
9	Gray	pair	
10	Pink		
11	Blue	pair	

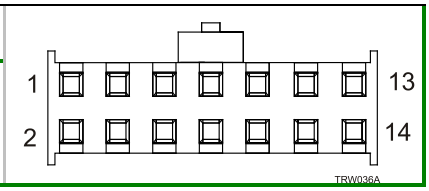
12	Red		
13	White-Black	pair	
14	White-Red		

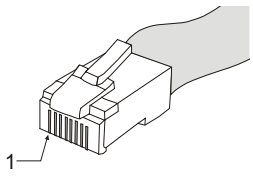
Figure A-7: **Single-sided I/O Cable** (Part No. CBL-HDRIO-001)

.33 Communication Cables

The communication cables use 26-AWG twisted pair shielded cable. They are connected using an 8-pin RJ-45 plug. Elmo drives can communicate using the following options:

- RS-232 full duplex
- CANopen

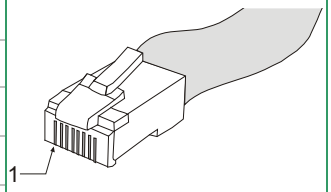
.33.1 RS-232 Option (CBL-RJ452321)

RJ45 Pin No.	Color	D-type Female Pin No.	Signal	Description	
3	Brown	2	Tx	RS-232 transmit	
5	White	5	COMRET	Communication return	
6	Green	3	Rx	RS-232 receive	
body	Drain Wire	body	shield	cable shield	

The shields of the RJ-45 and D-type plugs are connected to each other through the cable braid.

Figure A-4: **RS-232 Communications Cable** (Part No. CBL-RJ452321)

.33.2 CAN Option (CBL-RJ45CAN1)

RJ45 Pin No.	Color	D-type Female Pin No.	Signal	Description	
1	Green	7	CAN-H	CAN_H bus line	
2	Yellow	2	CAN_L	CAN_L bus line	
3	White	3	CAN_GND	CAN ground	
4	–	–	–	–	
5	–	–	–	–	
7	–	–	–	–	
8	–	–	–	–	
body	Drain Wire	body	shield	cable shield	

The shields of the RJ-45 and D-type plugs are connected to each other through the cable braid.

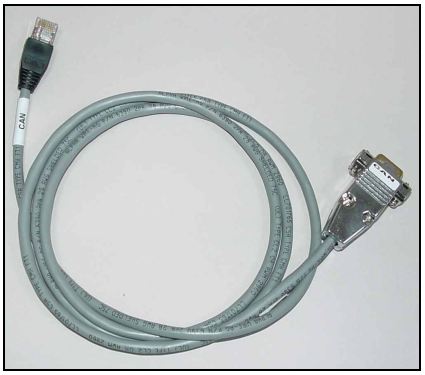


Figure A-5: ***CAN Cable*** *(Part No. CBL-RJ45CAN1)*

.34 Guidelines for Making Your Own Cables

Proper wiring, grounding and shielding are essential for ensuring safe, immune and optimal servo performance of the Trio. If you do not plan to use cables provided by Elmo, follow the instructions below carefully.

Follow these instructions to ensure safe and proper wiring:

- Use twisted pair shielded cables for control, feedback and communication connections. For best results, the cable should have an aluminum foil shield covered by a 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.
- 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.
- Keep all wires and cables as short as possible.
- Keep the motor wires as far away as possible from the feedback, control and communication cables.
- 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.
- After completing the wiring, carefully inspect all wires to ensure tightness, good solder joints and general safety.

.34.1 Recommended Wire Cross Sections

Function	**Connection**	**Details**
Motor	PE, M1, M2, M3	14 AWG
Feedback and Control	Main FEEDBACK PULSE & DIRECTION I/O	24 AWG twisted pair shielded cables
Communications	RS-232 CANopen	26 AWG twisted pair shielded cables