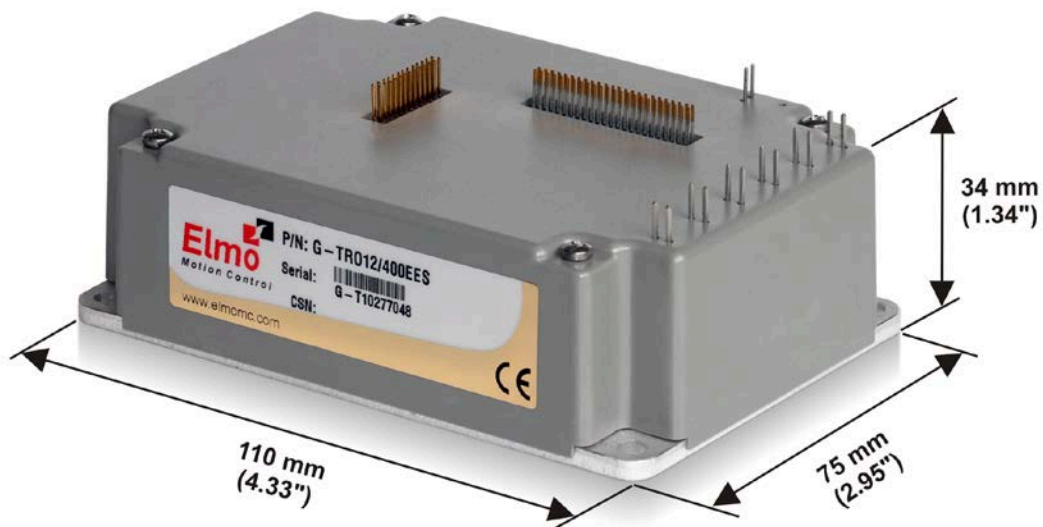


Gold_{Line}

Gold Trombone Digital Servo Drive Installation Guide EtherCAT and CANopen



September 2012 (Ver. 1.6)



www.elmomc.com

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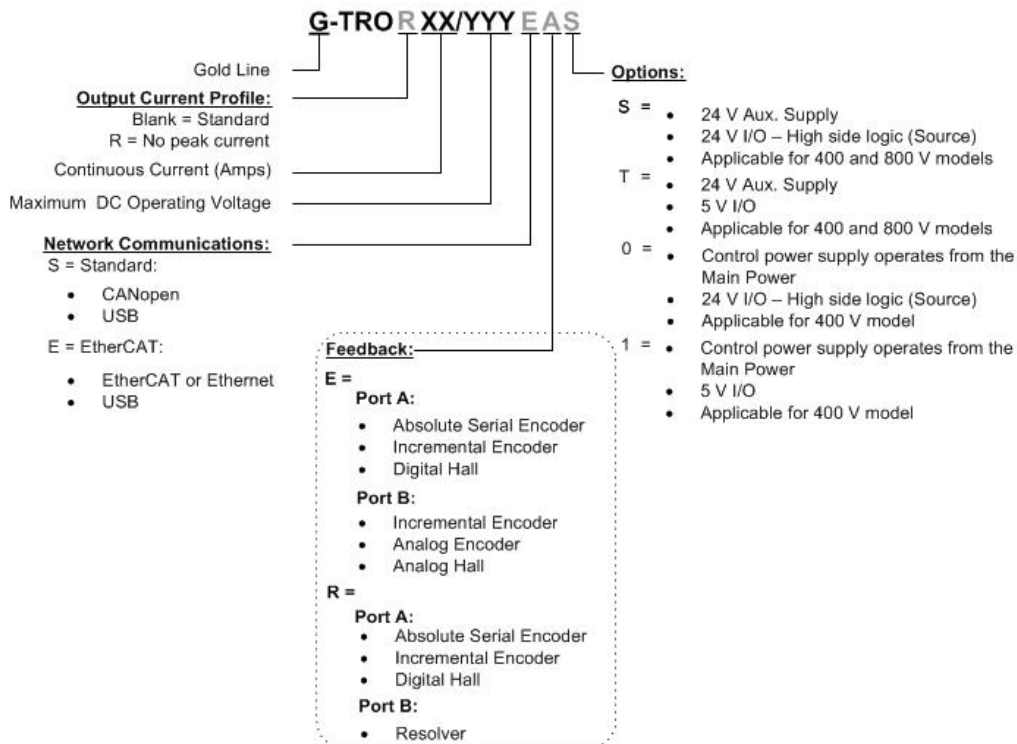
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Catalog Number



Revision History

Version	Details
1.0	Initial Release
1.1	Major updates to Chapter 3
1.2	Several updates throughout the manual
1.3	Sections 4.3 and 4.3.1: Auxiliary Supply Voltage range: 18 V to 30 V
1.4	Wide ranging changes throughout document to include new pinouts. Removal of the RS232 option. Added update P/N details on Feedbacks Absolute - included as standard.
1.5	Change the overvoltage in 800 V mode
1.6	Neutral option removed. Change the overvoltage in 800 V mode, Pin layout, UL recognition, and further optional versions added

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Chapter 1: Safety Information

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

- **Cleaning after soldering.** To avoid damage to the product's acrylic coating, the Gold Trombone must not be cleaned after soldering with soluble solvents or water-based cleaners. For further details see www.elmomc.com/applications/article/Soldering-and-Cleaning_Application-Note.pdf.
- To avoid electric arcing and hazards to personnel and electrical contacts, never connect/disconnect the servo drive while the power source is on.
- Power cables can carry a high voltage, even when the motor is not in motion. Disconnect the Gold Trombone from all voltage sources before it is opened for servicing.
- The Gold 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). Measuring the electrical contact points with a meter, before touching the equipment, is recommended.



1.2. Cautions

- The Gold 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 the Gold Trombone to an approved isolated 18 to 30 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 Gold Trombone, verify that all safety precautions have been observed and that the installation procedures in this manual have been followed.

1.3. Directives and Standards

The Gold 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 Gold 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 Gold 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 Gold 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 time of installation, or 18 months from time of shipment, whichever comes first. No other warranties, expressed or implied — and including a warranty of merchantability and fitness for a particular purpose — extend beyond this warranty.

Chapter 2: Product Description

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

The digital drives are part of Elmo's advanced Gold Line. 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 Gold 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 Application Studio software tools. This Windows-based application enables users to quickly and simply configure the servo drive for optimal use with their motor. The Gold Trombone, as part of the Gold Line, is fully programmable with Elmo's motion control language.

Power to the drives is provided by a DC power source (not included with the Gold 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 or T-model Gold 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, Gold Trombone models that have 0 or 1 suffix (only for 400V models) in the catalog number (see page 21) can be used, i.e., they do not have a 24 V control supply. In these models, a smart control-supply algorithm enables the Gold 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 Gold Trombone is a PCB-mounted device which enables efficient and cost-effective implementation. However, stand-alone integrated products (the Gold DC Trombone and Gold Solo Trombone) are also available, using pluggable connections.



2.2. Product Features

Note: The features described in this chapter relate to the range of Gold Trombone models. Depending on the model you have purchased, not all features are available.

To see the features for your model, look at the product label on the Gold Trombone and use the product catalog number schematic that appears at the beginning of this manual and on page 22 to determine which specific features are available to you.

2.2.1. Servo Control

- Advanced and extremely fast vector control algorithm (current loop bandwidth: 4 kHz)
- Current/Torque sampling rate: up to 20 kHz (50 μ s)
- Velocity sampling rate: up to 10 kHz (100 μ s)
- Position sampling rate: up to 10 kHz (100 μ s)
- Electrical commutation frequency: up to 4 kHz
- Current closed loop bandwidth exceeds 4 kHz
- Position/Velocity/Acceleration command range – full 32 bit
- Position over velocity, with full dual loop support
- Current gain scheduling to compensate for the motor's non-linear characteristics
- Advanced filtering: Low pass, Notch, General Biquad
- Current loop gain scheduling to compensate for bus voltage variations
- Velocity gain scheduling for ultimate velocity loop performance
- Gains and filter scheduling vs. position for mechanical coupling optimization, speed and position tracking errors
- High order filters gain scheduling vs. speed and position
- S-curve Profile Smoothing
- Cogging, BEMF and $\omega \times L$ compensation
- Dual Loop Operation supported by Auto Tuning
- Fast, easy and efficient advanced Auto Tuning
- Incremental encoder frequency of up to 75 Megacounts/sec
- Motion profiler numeric range:
 - Position up to $\pm 2 \times 10^9$ counts
 - Velocity up to 2×10^9 counts/sec
 - Acceleration up to 2×10^9 counts/sec²



2.2.2. Motion Control

- Motion control programming environment
- Motion modes: PTP, PT, PVT, ECAM, Follower
- Full DS-402 motion mode support in the CANopen and CANopen over EtherCAT (CoE) protocols, including Cyclic Position/Velocity modes. Fast (hardware) event capturing inputs, supporting $< 1 \mu\text{s}$ latch latency
- Fast (hardware) Output Compare, with $< 1 \mu\text{s}$ latency
- Output compare repetition rate:
- Fixed Gap: Unlimited
- Table based: 4 kHz
- Motion Commands: Analog, Pulse-Width Modulation (PWM), Software, Pulse and Direction
- Distributed Motion Control
- EAS (Elmo Application Studio) software: an efficient and user friendly auto tuner

2.2.3. Communications

- Fast and efficient EtherCAT and CANopen networking
- EtherCAT Slave per part number:
 - CoE (CANopen over EtherCAT)
 - EoE (Ethernet over EtherCAT)
 - FoE (File over EtherCAT) for firmware download
 - Supports Distributed Clock
 - EtherCAT cyclic modes supported down to a cycle time of $250 \mu\text{s}$
- CANopen (DS-301, DS-305, DS-402) per part number. Refer to the section 4.11 for further details
- Ethernet TCP/IP
 - UDP
 - Telnet
- USB 2.0



2.2.4. Safety

- Approved IEC /EN 61800-5-1, Safety
- Approved IEC/EN 61800-3, EMC
- IEC 61800-5-2, Safe Torque Off (STO) with two STO inputs PLC level which can be configured to 5 V logic (available on request)
- UL 508C recognition
- UL 60950 compliance
- CE EMC compliance

2.2.5. Outputs

- Four high voltage outputs related to VDD and VDDRET:
 - Conforms to IEC 61131-2
 - Up to 30 VDC
 - High side logic (Source)
 - Opto-isolated
 - For S, 0 suffix, Digital Outputs 2,3,4 up to 250 mA
 - For T, 1 suffix, Digital Outputs 2,3,4 up to 7 mA
 - For S, 0 suffix, Digital Output 1 brake output: 500 mA
 - For T, 1 suffix, Digital Output 1: 7 mA
 - Short circuit protection
 - Thermal protection
 - Reverse polarity protection
- The four outputs can be configured to 5 V Logic (available on request)
- Three additional differential outputs can be configured through Port C:
 - EIA-422 differential output line transmitters
 - Response time < 1µs
 - Output current: ± 15 mA

2.2.6. Inputs

- Six Digital Inputs – optically isolated, sharing a single common INRET
- The six digital inputs can be configured to PLC or TTL, depending on the part number definition
- All six inputs are fast capture data <5 µs
- One Analog Input: ±10 V
- Six additional fast differential event capture inputs 5 V logic can be configured through Ports A and B:
 - Via Port A or B (three on each port, depending on model)
 - EIA-422 Differential input line receiver
 - Response time < 1 µs

2.2.7. Feedback Options

There are Port A and Port B feedback input ports that are flexible and configurable. Each port can be programmed to serve as:

- Commutation feedback and/or
- Velocity feedback and/or
- Position feedback

Port A supports the following sensors, depending on the specific model:

- Incremental encoder
- Incremental encoder and digital Hall
- Absolute serial encoder
- Absolute serial encoder and digital Hall (for dual loop).

Port B supports the following sensors, depending on the specific model:

- Incremental encoder
- Analog encoder
- Analog Hall
- Resolver

Port C is a flexible and configurable feedback output port. It supports:

- Encoder emulation outputs of Port A or Port B or internal variables.

Analog input (± 10 V ptp) support:

- Velocity feedback (tachometer)
- Position feedback (potentiometer).

2.2.8. Feedback Sensor Specifications

- Incremental Quadrature Encoder (with or without commutation halls) up to 75 Megacounts per second (18 MHz PPS(Pulses Per Second))
- Digital Hall
 - Up to 4 kHz commutation frequency
 - 5 V logic
 - Input voltage up to 15 VDC
- Incremental encoder and digital Halls
- Analog encoders
 - Supports 1 V PTP Sin/Cos
 - Sin-Cos Frequency: up to 500 kHz
 - Internal Interpolation: up to $\times 8192$
 - Automatic correction of amplitude mismatch, phase mismatch, signal offset



- Analog Hall (commutation & position)
 - One feedback electrical cycle = one motor's electrical cycle
 - Supports 1 V PTP Sin/Cos
 - Sin/Cos Frequency: up to 500 kHz
 - Internal Interpolation: up to $\times 8192$
 - Automatic correction of amplitude mismatch, phase mismatch, signal offset
- Absolute serial encoders:
 - NRZ (Panasonic, Tamagawa, Mitutoyo, etc.)
 - EnDAT 2.2
 - BiSS/SSI
- Resolver up to 512 rps with 14-bit resolution
- Tachometer (available on request)
- Potentiometer (available on request)
- The Gold Trombone provides 5 V supply voltage (5 V, 400 mA max) for the encoders supplies

2.2.9. Protection

Built-in Protection & Diagnostics:

- Software error handling
- Abort
- Extensive status reporting
- Protection against:
 - Shorts between motor power outputs and power return
 - Over temperature
 - Over/under voltage
 - Loss of feedback
 - Motor current
 - Current limits
 - Following errors
 - i^2t motor current
- STO

2.3. System Architecture

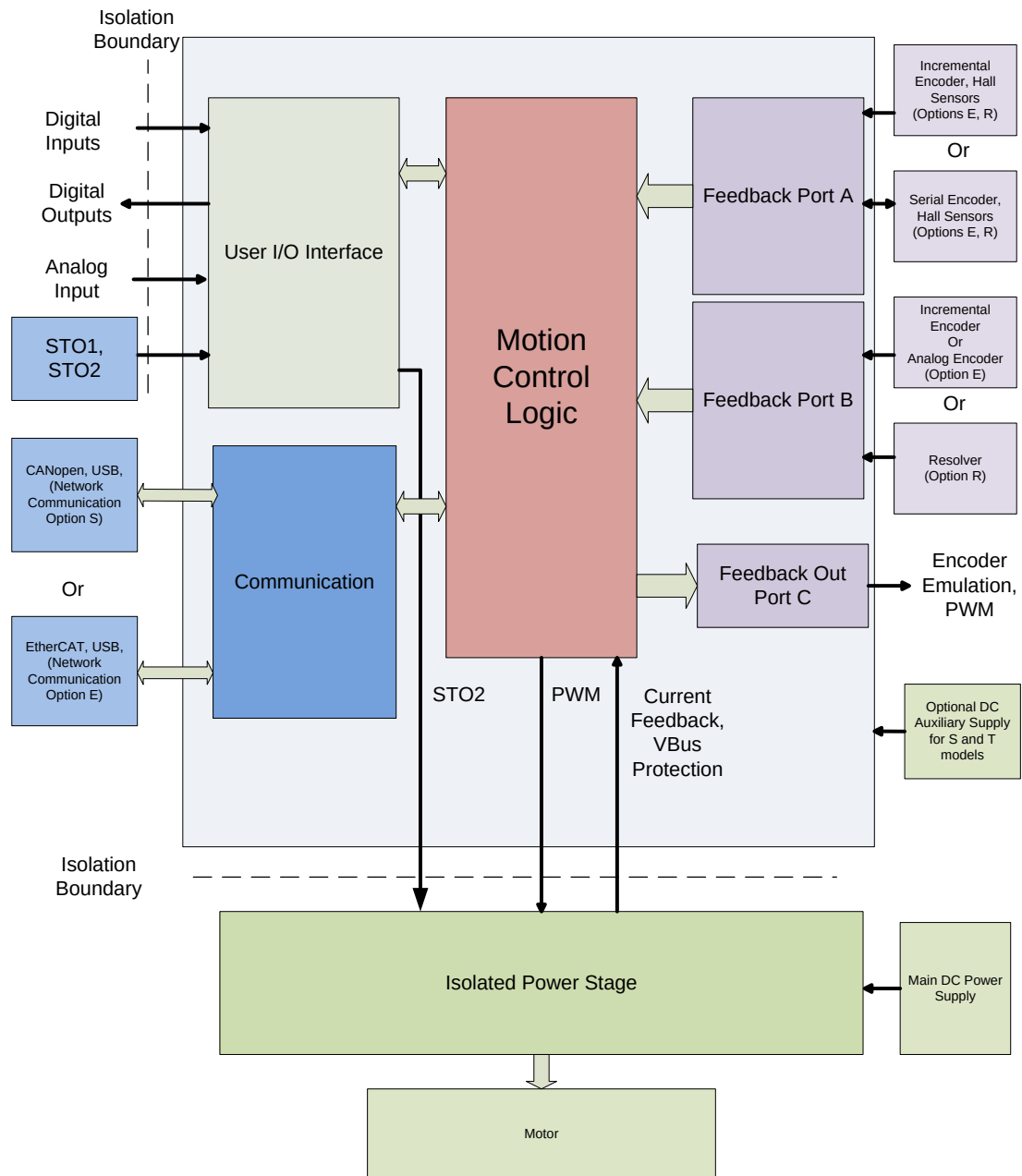


Figure 1: Gold Trombone System Block Diagram



2.4. How to Use this Guide

In order to install and operate your Elmo Gold 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 Gold Trombone.
- [Chapter 4 - Technical Specifications](#), lists all the drive ratings and specifications.

Upon completing the instructions in this guide, your Gold 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 Gold Product Line Software Manual, which describes the comprehensive software used with the Gold Trombone
- The Gold Product Line Command Reference Manual, which describes, in detail, each software command used to manipulate the Gold Trombone motion controller
- The Elmo Application Studio Software Manual, which includes explanations of all the software tools that are part of the Elmo Application Studio software environment

Chapter 3: Technical Information

3.1. Technical Data

Feature	Units	12/400	16/400	R17/400	R22/400	8/800	12/800	R11/800	R16/800
Minimum supply voltage	VDC	*For S or T type = 50 For 0 or 1 suffix type = 100				*For S or T type = 95			
Nominal supply voltage	VDC	325				560 for 400 VAC 680 for 480 VAC			
Maximum supply voltage	VDC	400				780			
Maximum continuous power output	W	Up to 10 kW of continuous qualitative power							
Efficiency at rated power (at nominal conditions)	%	> 98							
Auxiliary supply voltage option	VDC	18 to 30 VDC (only in S or T type)							
Auxiliary power supply	VA	≤5 VA without external loading ≤8 VA with full external loading							
Continuous current limit (Ic) Amplitude sinusoidal/DC trapezoidal commutation	A	12	16	17	22	8	12	11	16
Sinusoidal continuous RMS current limit (Ic)	A	8.5	11.3	12	15.5	5.7	8.5	7.8	11.3
Peak current limit	A	2 x Ic		No peak		2 x Ic		No peak	
Weight	g (oz)	300 g (10.6 oz)							
Dimensions	mm (in)	111 x 76 x 34 (4.37" x 3" x 1.34")							
Digital in/Digital out/ Analog in		6/4/1							
Mounting method		PCB Mounted							

*See page 21 for details on the part number. The S or T suffix appears in models where there is a 24 V control supply. If there is an 0 or 1 suffix, the control power supply operates from the main power.



Note on current ratings: The current ratings of the Gold 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.

3.1.1. Auxiliary Supply

Feature	Details
Auxiliary power supply	<i>Isolated DC source only</i>
Auxiliary supply input voltage	18 VDC to 30 VDC
Auxiliary supply input power	< 4 VA (this includes the 5 V/200 mA load for the main encoder only) < 5.5 VA (this includes the 5 V/400 mA load on the main encoder and feedback B)

Chapter 4: Installation

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

4.1. Site Requirements

You can guarantee the safe operation of the Gold 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 non-condensing humidity	90%
Maximum altitude	10,000 m
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	



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

4.2. Unpacking the Drive Components

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

- The Gold Trombone servo drive
- The Elmo Application Studio (EAS) software and software manual

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

To unpack the Gold 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.

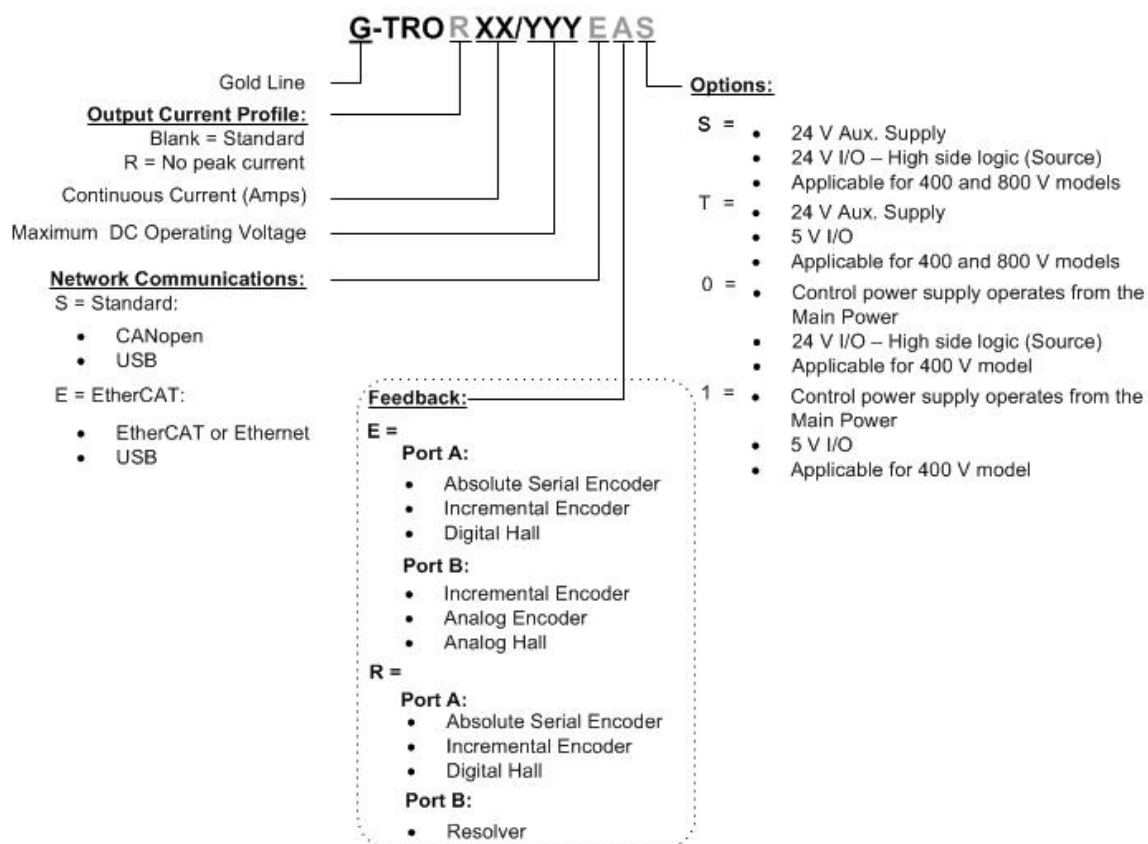
- To ensure that the Gold Trombone you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Gold Trombone. It looks like this:



GTR000BA

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

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



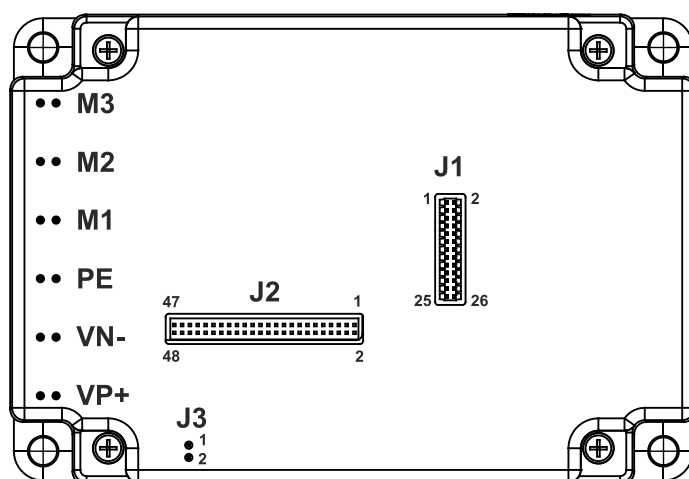
4.3. Connectors

The Gold Trombone has 9 connectors.

4.3.1. Connector Types

Port	Pins	Type	Function
J1	2x13	1.27 mm pitch 0.41 mm sq	Analog Input, Feedback
J2	2x24		Communications
J3/1	1	2 mm pitch 0.51 mm sq	24 VDC Auxiliary power input positive (Only in Trombones with the S or T suffix)
J3/2	1		24 VDC Auxiliary supply input return (Only in Trombones with the S or T suffix)
VP+	2	2.54 mm pitch 0.64 mm sq	Positive DC power input
VN-	2		Negative DC power input
PE	2		Protective earth
M1	2		Motor power output 1
M2	2		Motor power output 2
M3	2		Motor power output 3

Connector Location



GTRO032C

Table 1: Connector Types

4.3.2. Pinouts

The pinouts in this section describe the function of each pin in the Gold Trombone connectors that are listed in Table 1.

4.3.2.1. Motor Power

For full details about connecting motor power see Section 4.7.1.

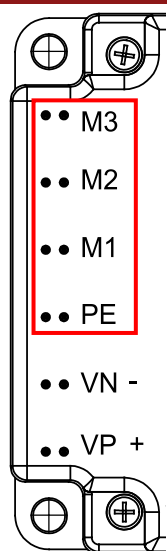
Pin	Function	Cable		Pin Positions
		Brushless Motor	Brushed DC Motor	
M3	Motor phase	Motor	Motor	
M2	Motor phase	Motor	Motor	
M1	Motor phase	Motor	N/C	
PE	Protective Earth	Power and Motor		
Connector Type: 2.54 mm pitch 0.64 mm sq				

Table 2: Connector for Motor

4.3.2.2. Main Power

For full details about connecting main power see Section 4.7.2.

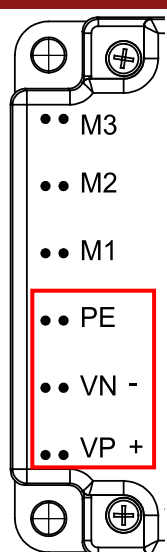
Pin	Function	Cable	Pin Positions
PE	Protective Earth	Power and Motor	
VN-	DC Negative Power input	Power	
VP+	DC Positive Power input	Power	
Connector Type: 2.54 mm pitch 0.64 mm sq			

Table 3: Connector for Main Power

4.3.2.3. Auxiliary Power Connector (J3)

For full details about connecting auxiliary power see Section 4.7.3.

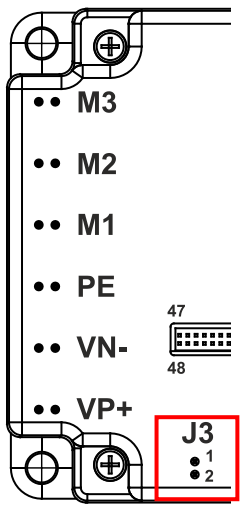
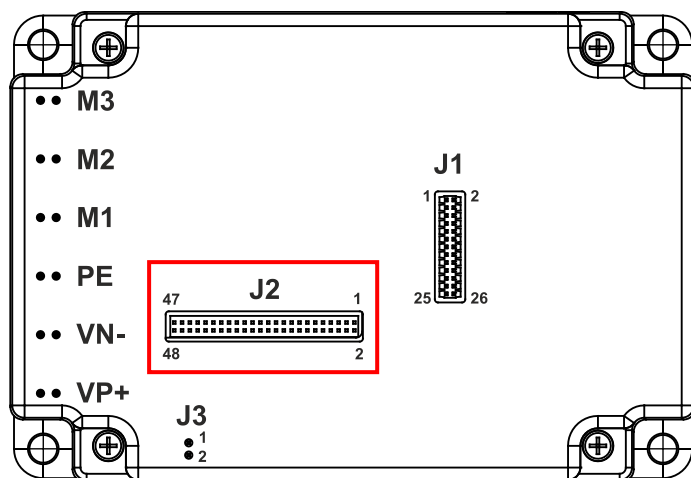
Pin (J3)	Function	Pin Positions
1	+24 V Auxiliary Supply Input Positive	
2	24 V RET Auxiliary Supply Input Return	
Connector Type: 2 mm pitch 0.51 mm sq		

Table 4: Auxiliary 24 VDC Backup Supply Pins and Polarity

4.3.2.4. Connector J2



GTR0032C

Feedback, Analog input, communications

Connector Type: 1.27 mm pitch
0.41 mm sq

For full details about connecting feedback port A see Section 4.9.1.

For full details about connecting feedback port B see Section 4.9.2.

For full details about connecting feedback port C see Section 4.9.3.

For full details about connecting analog input see Section 4.10.3.

For full details about connecting communication see Section 4.11.

Note regarding the EtherCAT and CAN communication options:

The J2 Connector exports all supported communication links. However, note that CAN and EtherCAT are not available in the same version of the Gold Trombone and are thus not operational simultaneously. See the part number diagram in Section 4.2 above for the different Gold Trombone configurations.

Pin (J2)	Signal	Function
1	PortA_ENC_A+ /ABS_CLK+	Port A- channel A/ Absolute encoder clock+
2	PortC_ENCO_A-	Port C- channel A complement output
3	PortA_ENC_A-/ABS_CLK-	Port A- channel A complement / Absolute encoder clock-
4	PortC_ENCO_A+	Port C- channel A output
5	PortA_ENC_B+/ABS_DATA+	Port A - channel B/ Absolute encoder Data+
6	PortC_ENCO_B-	Port C - channel B complement output
7	PortA_ENC_B-/ABS_DATA-	Port A - channel B complement / Absolute encoder Data-
8	PortCENCO_B+	Port C - channel B output
9	PortA_ENC_INDEX+	Port A – index
10	PortC_ENCO_INDEX-	Port C - index complement output



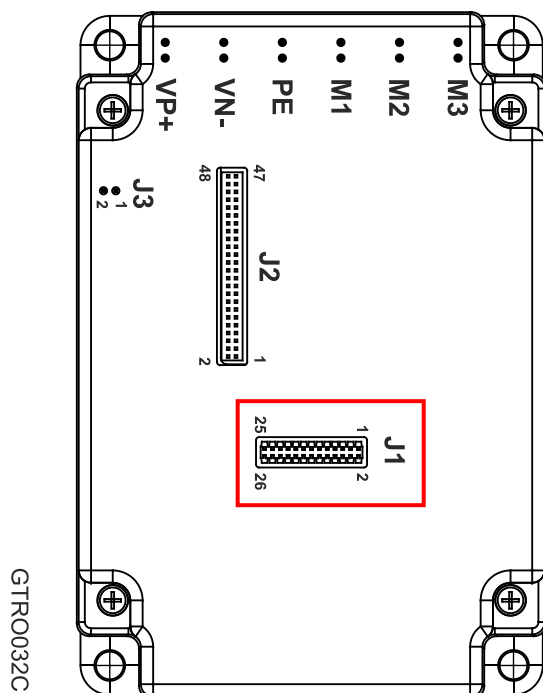
Pin (J2)	Signal	Function
11	PortA_ENC_INDEX-	Port A - index complement
12	PortC_ENCO_INDEX+	Port C - index output
13	PortB_ENC_A+/SIN+	Port B - channel A
14	HC	Hall sensor C input
15	PortB_ENC_A-/SIN-	Port B - channel A complement
16	HB	Hall sensor B input
17	PortB_ENC_B+/COS+	Port B - channel B
18	HA	Hall sensor A input
19	PortB_ENC_B-/COS-	Port B - channel B complement
20	ANLRET	Analog return
21	PortB_ENC_INDEX+/ANALOG_I+	Port B – index
	RESOLVER_OUT+	Vref complement f= 1/TS, 50 mA Maximum
22	ANALOG1+	Analog input 2
23	PortB_ENC_INDEX-/ANALOG_I-	Port B – index complement
	RESOLVER_OUT-	Vref complement f= 1/TS, 50 mA Maximum
24	ANALOG1-	Analog input 1 complement
25	SUPRET	Supply return
26	+3.3V	3.3 V supply voltage for EtherCAT LEDs
27	PHY_IN_RX+	EtherCAT In receive
28	EtherCAT: PHY_OUT_RX+	EtherCAT Out receive
29	PHY_IN_RX-	EtherCAT In receive complement
30	EtherCAT: PHY_OUT_RX-	EtherCAT Out receive complement
31	PHY_IN_COMRET	EtherCAT In Communication return
	CAN: CAN_COMRET	CAN Communication Return
32	EtherCAT: PHY_OUT_COMRET	EtherCAT Out Communication
	CAN: CAN_COMRET	CAN Communication Return
33	PHY_IN_TX+	EtherCAT In transmit



Pin (J2)	Signal	Function
34	EtherCAT: PHY_OUT_TX+	EtherCAT Out transmit complement
35	PHY_IN_TX-	EtherCAT In transmit complement
36	EtherCAT: PHY_OUT_TX-	EtherCAT Out transmit complement
37	PHY_IN_LINK_ACT	EtherCAT In active LED
38	EtherCAT: PHY_OUT_LINK_ACT	EtherCAT Out active LED
	CAN: CAN_L	CAN_L bus line (dominant low)
39	PHY_IN_SPEED	EtherCAT In LED2
40	EtherCAT: PHY_OUT_SPEED	EtherCAT Out LED2
	CAN: CAN_H	CAN_H bus line (dominant high)
41	USBD-	USB data complement
42	USBD+	USB data
43	USB_COMRET	USB_COMRET
44	USB_VBUS	USB VBUS 5V
45	N/A	N/A – Not in use, keep unconnected
46	COMRET	Common return
47	N/A	N/A – Not in use, keep unconnected
48	N/A	N/A – Not in use, keep unconnected

Table 5: Connector J2 – Feedback and Analog Input

4.3.2.5. Connector J1



Digital Inputs, Digital Outputs, STO, Amplifier and Communication LEDs, Encoder Supply

Connector Type: 1.27 mm pitch 0.41 mm sq

For full details about connecting digital input see Section 4.10.3.

For full details about connecting digital output see Section 4.10.2.

Pin (J1)	Signal	Function
1	SUPRET	Supply Return
2	+5VE	Encoder +5V supply
3	N/A	N/A
4	N/A	N/A
5	INRET1_6	Programmable digital inputs 1–6 return
6	IN1	Programmable digital input 1
7	IN2	Programmable digital input 2
8	IN3	Programmable digital input 3
9	IN4	Programmable digital input 4
10	IN5	Programmable digital input 5
11	IN6	Programmable digital input 6
12	STO_RET	Safety signal return
13	STO2	Safety 2 input (default 24 V)
14	STO1	Safety 1 input (default 24 V)
15	LED_ET_ERR	Communication error LED output (Cathode)
16	LED_ET_RUN	Communication OK LED output (Cathode)



Pin (J1)	Signal	Function
17	LED2	Bi-color amplifier OK LED output (Cathode)
18	LED1	Bi-color amplifier error LED output (Cathode)
19	COMRET	Common return
20	N/A	N/A
21	OUT2	Programmable output 2
22	OUT1	Programmable output 1
23	OUT4	Programmable output 4
24	OUT3	Programmable output 3
25	VDDRET	VDD Supply Return
26	VDD	VDD Supply (5V up to 30V)

Table 6: Connector J1 – Communication

4.4. Mounting the Gold Trombone

The Gold Trombone is designed for mounting on a printed circuit board (PCB). It is connected by 1.27 mm pitch 0.41 mm square pins and 2.54 mm pitch 0.64 mm square pins. When integrating the Gold Trombone into a PCB, be sure to leave about 1 cm (0.4") outward from the heatsink to enable free convection of the air around the Gold Trombone. We recommend that the Gold Trombone be soldered directly to the board. Alternatively, though this is not recommended, the Gold Trombone can be attached to socket connectors mounted on the PCB. However, if the PCB is enclosed in a metal chassis, we recommend that the Gold Trombone be screw-mounted to it as well to help with heat dissipation. The Gold Trombone has screw-mount holes on each corner of the heatsink for this purpose.

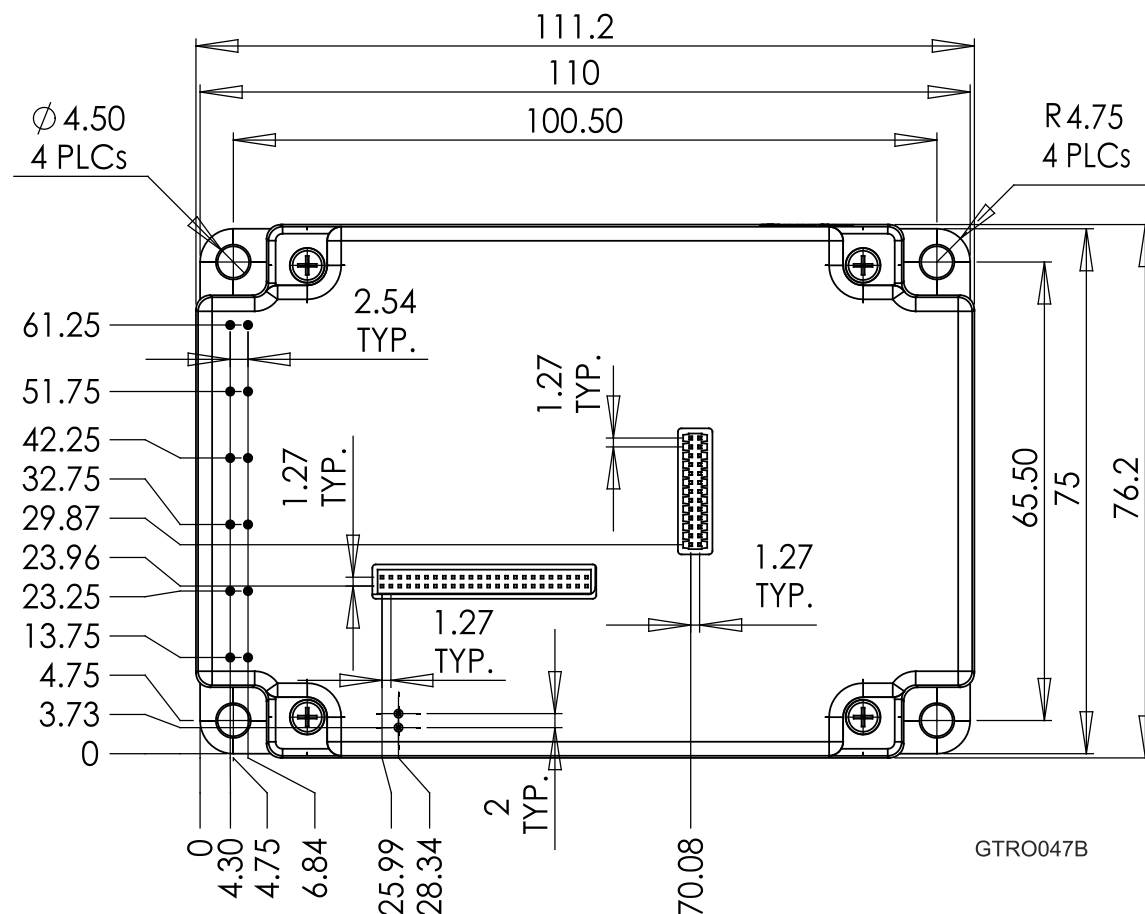


Figure 2: Gold Trombone Footprint

4.5. Integrating the Gold Trombone on a PCB

The Gold Trombone is designed to be mounted on a PCB, either by soldering its pins directly to the PCB or by using suitable socket connectors. In both cases the following rules apply:

4.5.1. Traces

- The size of the traces on the PCB (thickness and width) is determined by the current carrying capacity required by the application.
 - The rated continuous current limit (I_c) of the Gold Trombone is the current used for sizing the motor traces (M1, M2, M3 and PE) and power traces (VP+, VN- and PE).
 - For control, feedbacks and I/O conductors the actual current is very small, but “generous” thickness and width of the conductors will contribute to better performance and lower interference.
- The traces should be as short as possible to minimize EMI and to minimize the heat generated by the conductors.
- The spacing between the high voltage conductors (VP+, VN-, M1, M2, M3) must be at least:

		400 V Drives	800 V Drives
Surface layer	Non-coated	2.4 mm	4.2 mm
	Coated	1.0 mm	2.4 mm
Internal layer		0.5 mm	1.0 mm

- The spacing between the high voltage conductors (VP+, VN-, M1, M2, M3) and the logic part of the drive must be at least:

		400 V Drives	800 V Drives
Surface layer	Non-coated	4.8 mm	8.4 mm
	Coated	2.0 mm	3.8 mm
Internal layer		0.5 mm	1.0 mm

- The spacing between any voltage conductors and the PE part of the drive, must be at least:

		400 V Drives	800 V Drives
Surface layer	Non-coated	2.4 mm	4.2 mm
	Coated	1.0 mm	1.8 mm
Internal layer		0.5 mm	1.0 mm

Complying with the rules above will help satisfy UL safety standards, MIL-STD-275 and the IPC-D-275 standard for non-coated conductors, operating at voltages lower than 800 VDC and at “unlimited altitudes” (above 10,000 meters [30,000 feet]).

4.5.2. Grounds and Returns

The “Returns” of the Gold Trombone are structured internally in a star configuration. The returns in each functional block are listed below:

Functional Block	Return Pin
CAN Communications	CAN_COMRET (J2/31, 32)
USB Communications	USB_COMRET (J2/43)
PHY_IN communication return	PHY_IN_COMRET (J2/31)
PHY OUT communication return	PHY_OUT_COMRET (J2/32)
Analog input return	ANLRET (J2/20)
Common return	COMRET (J1/19, J2/46)
Supply return	SUPRET (J1/1, J2/25)

Table 7: Grounds and Returns

The returns above are all shorted within the control section of the Gold Trombone in a topology that results in optimum performance.



Caution: Follow these instructions to ensure safe and proper implementation. Failure to meet any of the below-mentioned requirements can result in drive/controller/host failure.

1. When wiring the traces of the above functions, on the Integration Board, the **Returns** of each function must be **wired separately** to its designated terminal on the Gold Trombone. **DO NOT USE A COMMON GROUND PLANE.** Shorting the commons on the Integration Board may cause performance degradation (ground loops, etc).
2. **Inputs:** The 6 digital inputs are optically isolated from the other parts of the Gold Trombone. All six inputs share one return line, INRET1_6. To retain isolation, the Input Return pin and all other conductors on the input circuit, must be laid out separately.
3. **Outputs:** The 4 digital outputs are optically isolated from the other parts of the Gold Trombone. Each output is related to VDDRET that is also optically isolated. To retain isolation, all the output circuit conductors must be laid out separately.
4. **Return Traces:** The return traces should be as large as possible, but without shorting each other, and with minimal cross-overs.
5. **Main Power Supply and Motor Traces:** The power traces must be kept as far away as possible from the feedback, control and communication traces.
6. **PE Terminal:** The PE (Protective Earth) terminal is connected directly to the Gold Trombone’s heat-sink. The heat-sink serves as an EMI common plane. The PE terminal should be connected to the system's Protective Earth. Any other metallic parts (such as the chassis) of the assembly should be connected to the Protective Earth as well.



7. Under normal operating conditions, the PE trace carries no current. The only time these traces carry current is under abnormal conditions (such as when the device has become a potential shock or fire hazard while conducting external EMI interferences directly to ground). When connected properly the PE trace prevents these hazards from affecting the drive.

4.6. Connection Diagrams

There are two connection diagrams for EtherCAT and two for CAN that show the two different ways of connecting the power supply:

- 400 V and 800 V S or T -models (the catalog number has an S or T suffix) 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 (0 or 1 suffix). The drive's internal DC/DC converter is fed from the VP+ and VN- of the internal drive's bus line.

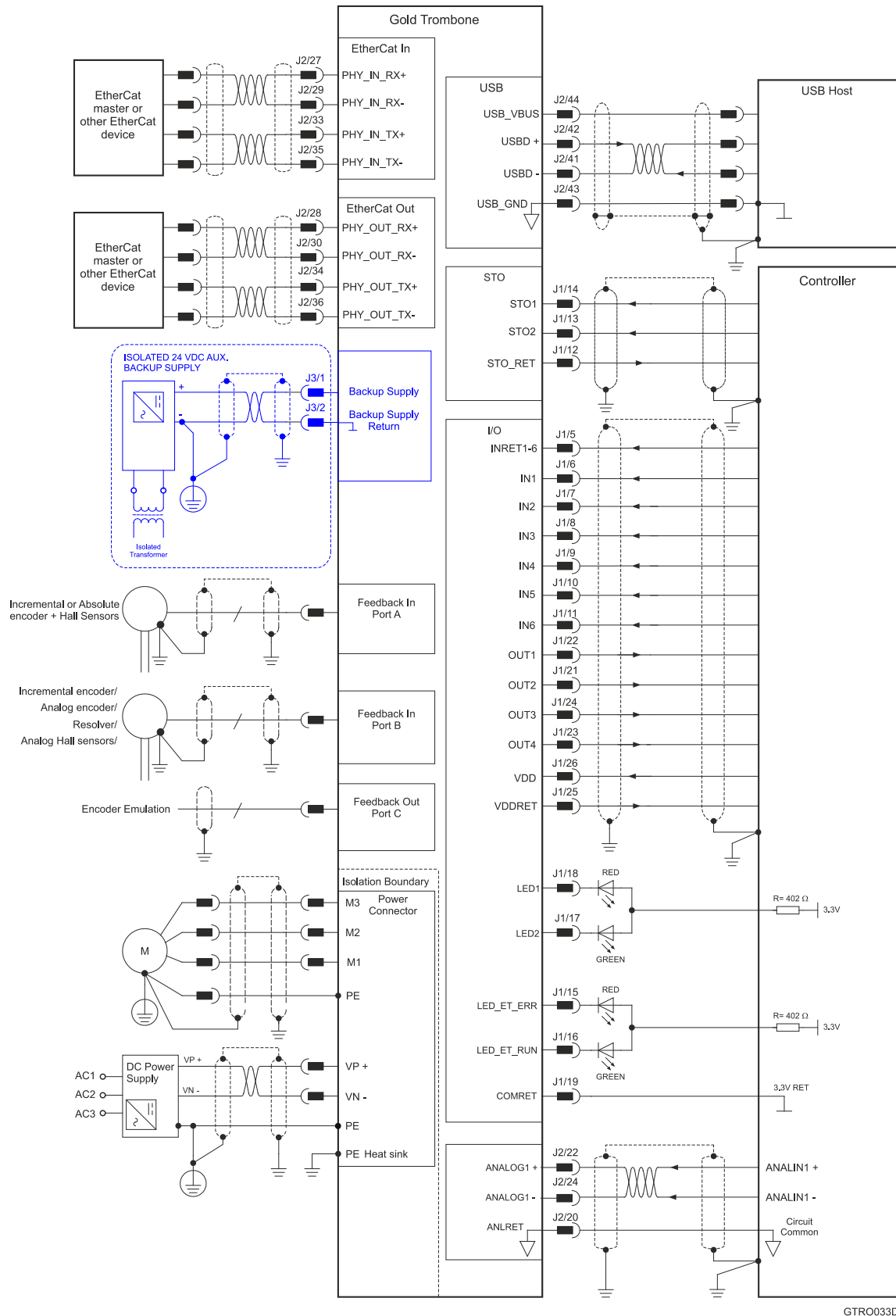


Figure 3: Gold Trombone Connection Diagram for EtherCAT – with Backup Functionality (S or T Model Drive)

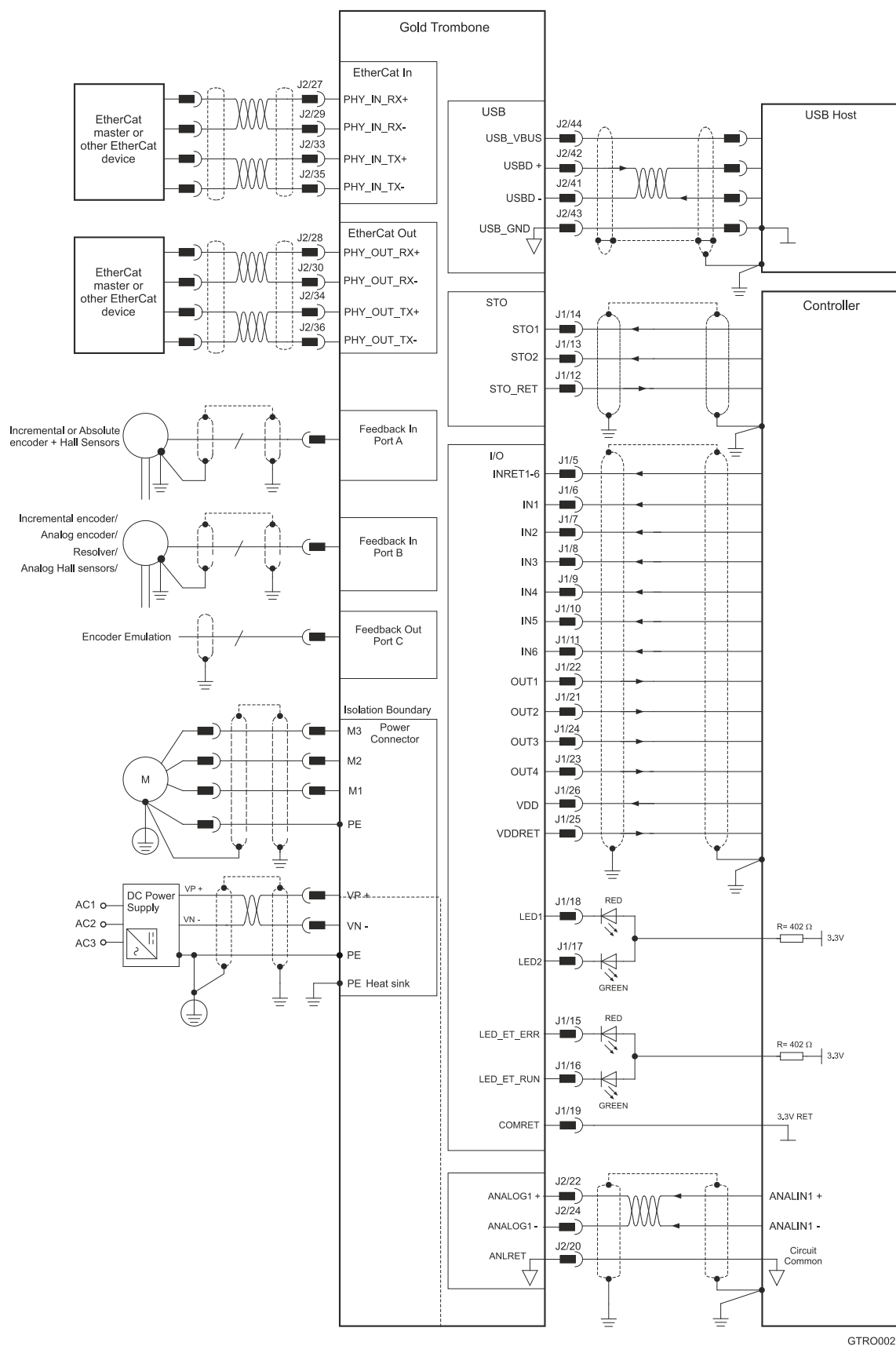


Figure 4: Gold Trombone Connection Diagram for **EtherCAT – 400 V without Backup Functions** (0 or 1 suffix)

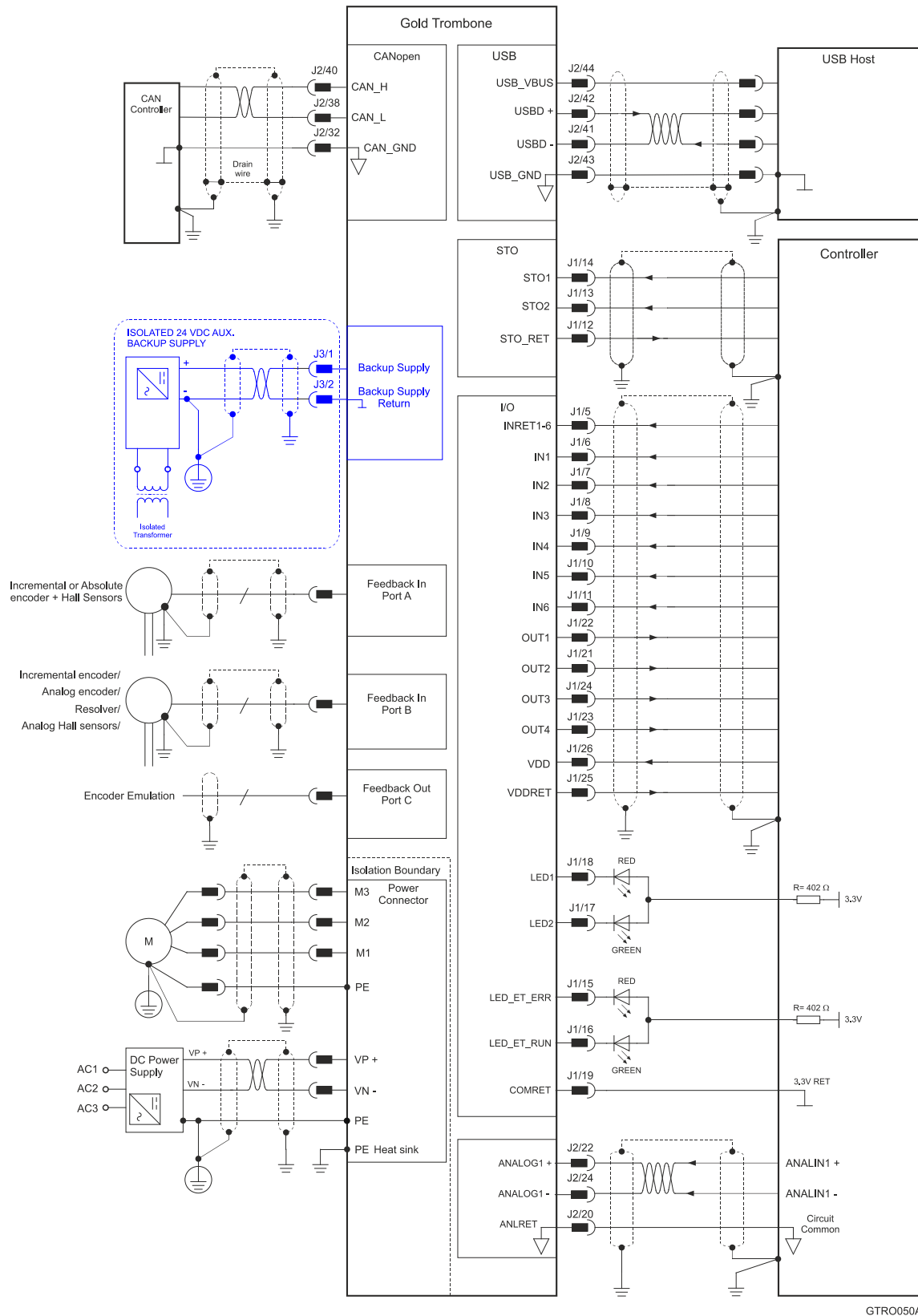


Figure 5: Gold Trombone Connection Diagram for CANopen – with Backup Functionality (S or T Model Drive)

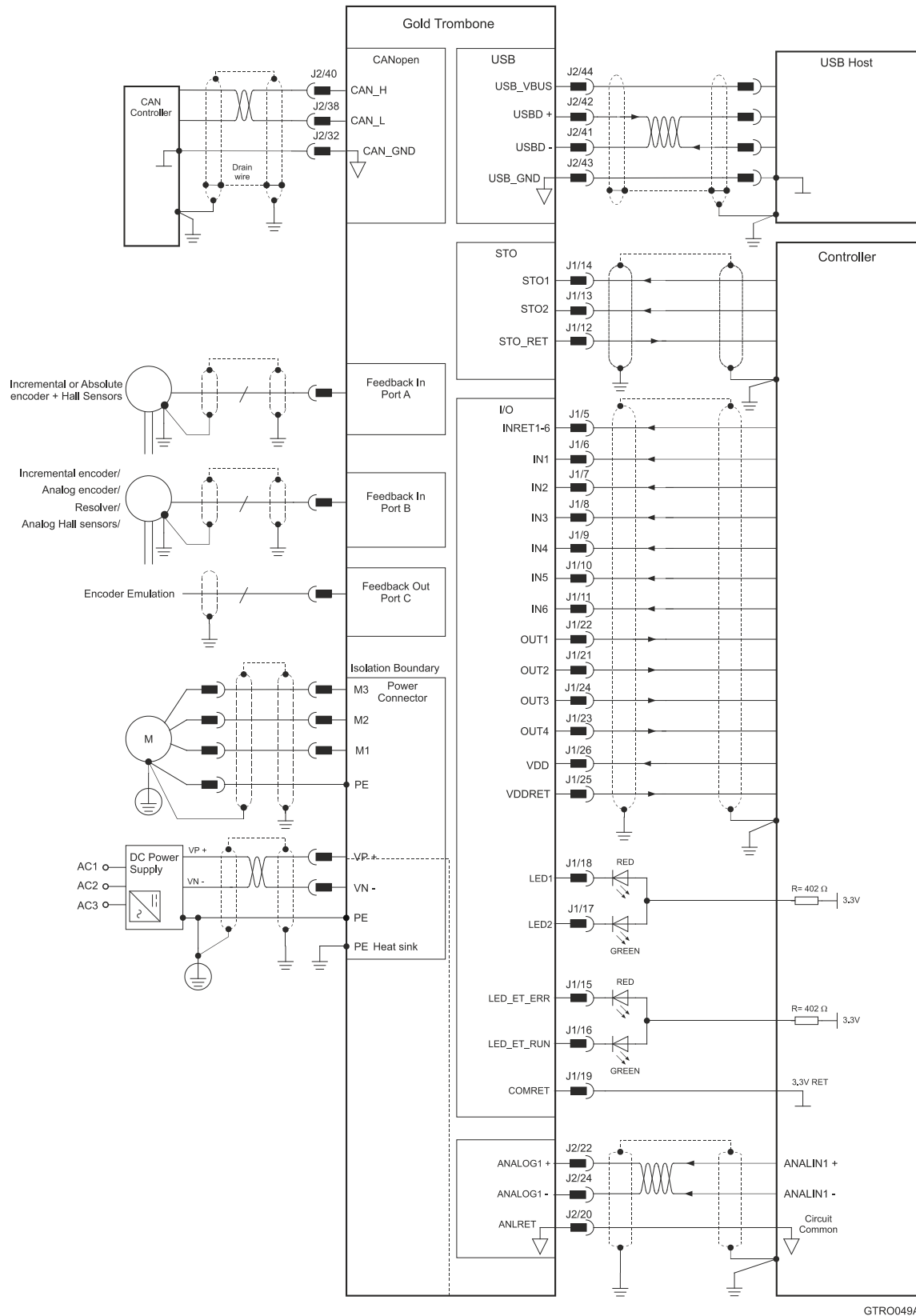


Figure 6: Gold Trombone Connection Diagram for CANopen – 400 V without Backup Functions (0 or 1 suffix)

4.7. Main Power, Motor Power and Auxiliary Power

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

Note: There are multiple voltage ratings of the Gold Trombone (80 V to 780 V), so you must use the correct power supply according to the maximum operating voltage of the Gold Trombone. See Section Chapter 3: Technical Information

4.7.1. Motor Power

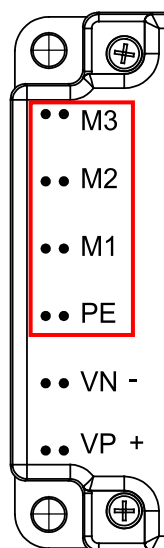
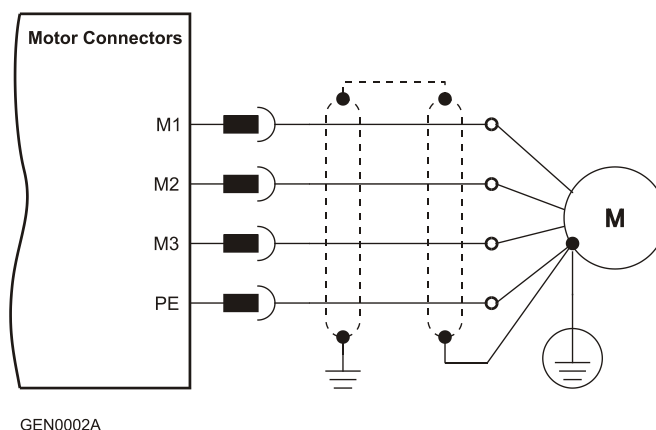
Pin	Function	Cable		Pin Positions
		Brushless Motor	Brushed DC Motor	
M3	Motor phase	Motor	Motor	
M2	Motor phase	Motor	Motor	
M1	Motor phase	Motor	N/C	
PE	Protective Earth	Power and Motor		

Table 8: Connector for Motor

Connect the M1, M2, M3 and PE pins on the Gold Trombone in the manner described in Section 4.5 (Integrating the Gold Trombone on a PCB). The phase connection is arbitrary as Elmo Application Studio (EAS) will establish the proper commutation automatically during setup. When tuning a number of drives, you can copy the setup file to the other drives and thus avoid tuning each drive separately. In this case the motor-phase order must be the same as on the first drive.



GEN0002A

Figure 7: Brushless Motor Power Connection Diagram

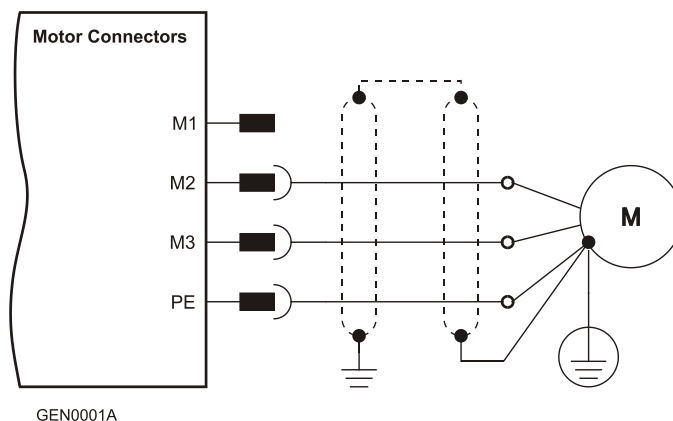


Figure 8: DC Brushed Motor Power Connection Diagram

Notes

- For best immunity, it is highly recommended to use a 4-wire shielded (not twisted) cable for the motor connection. The gauge is determined by the actual current consumption of the motor.
- Connect the cable shield to the closest ground connection at the motor end.
- Connect the cable shield to the closest PE terminal of the Gold Trombone.
- Ensure that the motor chassis is properly grounded.

4.7.2. Main Power

Pin	Function	Cable	Pin Positions
PE	Protective Earth	Power and Motor	
VN-	DC Negative Power input	Power	
VP+	DC Positive Power input	Power	

Table 9: Connector for Main Power

The DC power for the Gold Trombone is delivered from a separated rectifying unit (supplied by the user). Elmo recommends using the Tambourine rectifier specifically designed for use with Elmo drives which offers a range of versatile options.



The following sections contain topology recommendations for implementing three-phase and single-phase supply chains.

The power stage of the Gold Trombone is fully isolated from the other sections of the Gold 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 better performance of the Gold Trombone.

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

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

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

4.7.2.1. 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.

To connect 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, and tie the other end either to the PE pins of the module/PE terminal of the integration board, or attach it to one of the four mounting screws of the drive's heat-sink.

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

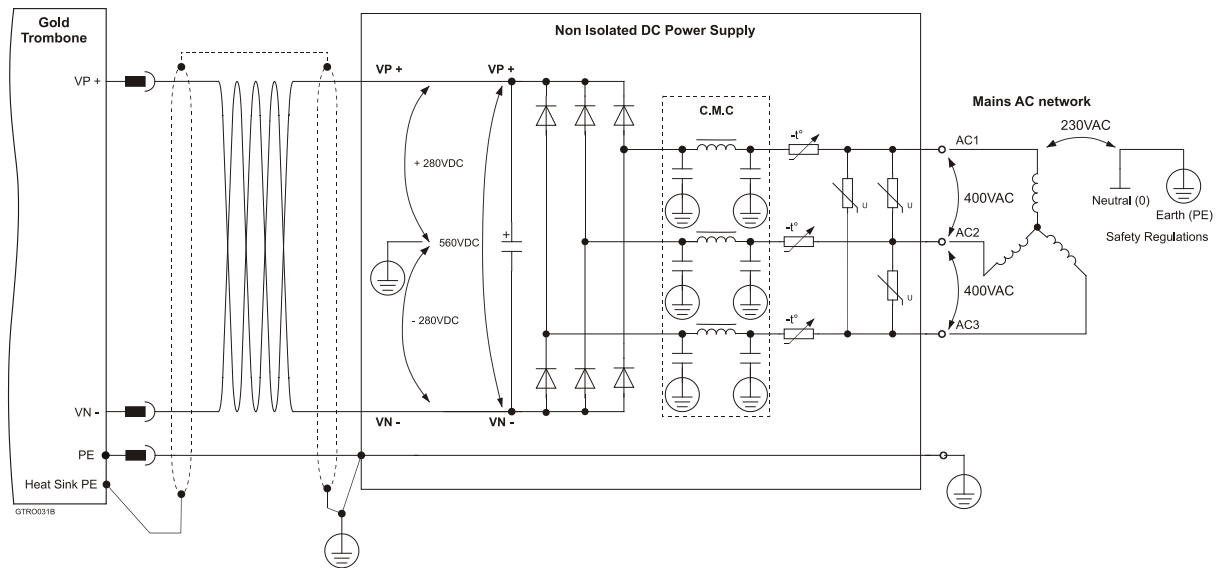


Figure 9: Non-Isolated Three-Phase Connection Topology



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 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.

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

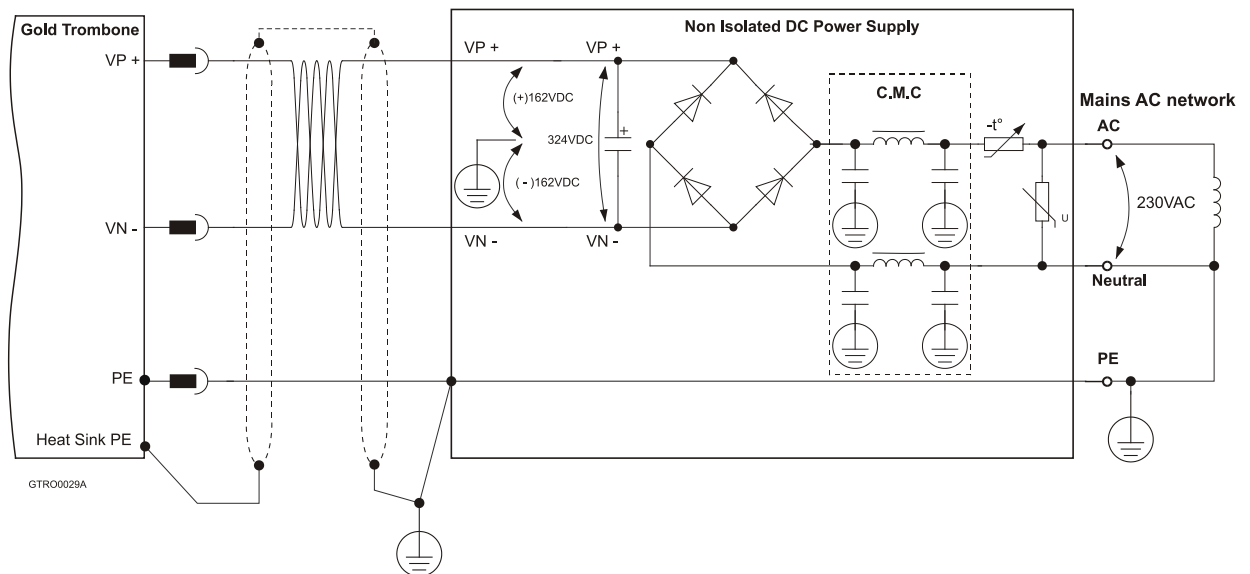


Figure 10: Non-Isolated Single-Phase Connection Topology

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.

4.7.2.1.c Multiple Connections Topology

In a multi-axis application it is likely that a single power supply can feed several drives in parallel. This topology is efficient and cost saving, by reducing the number of power supplies and the amount of wiring. Most importantly it utilizes an energy sharing environment among all the drives that share the same DC bus network.

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

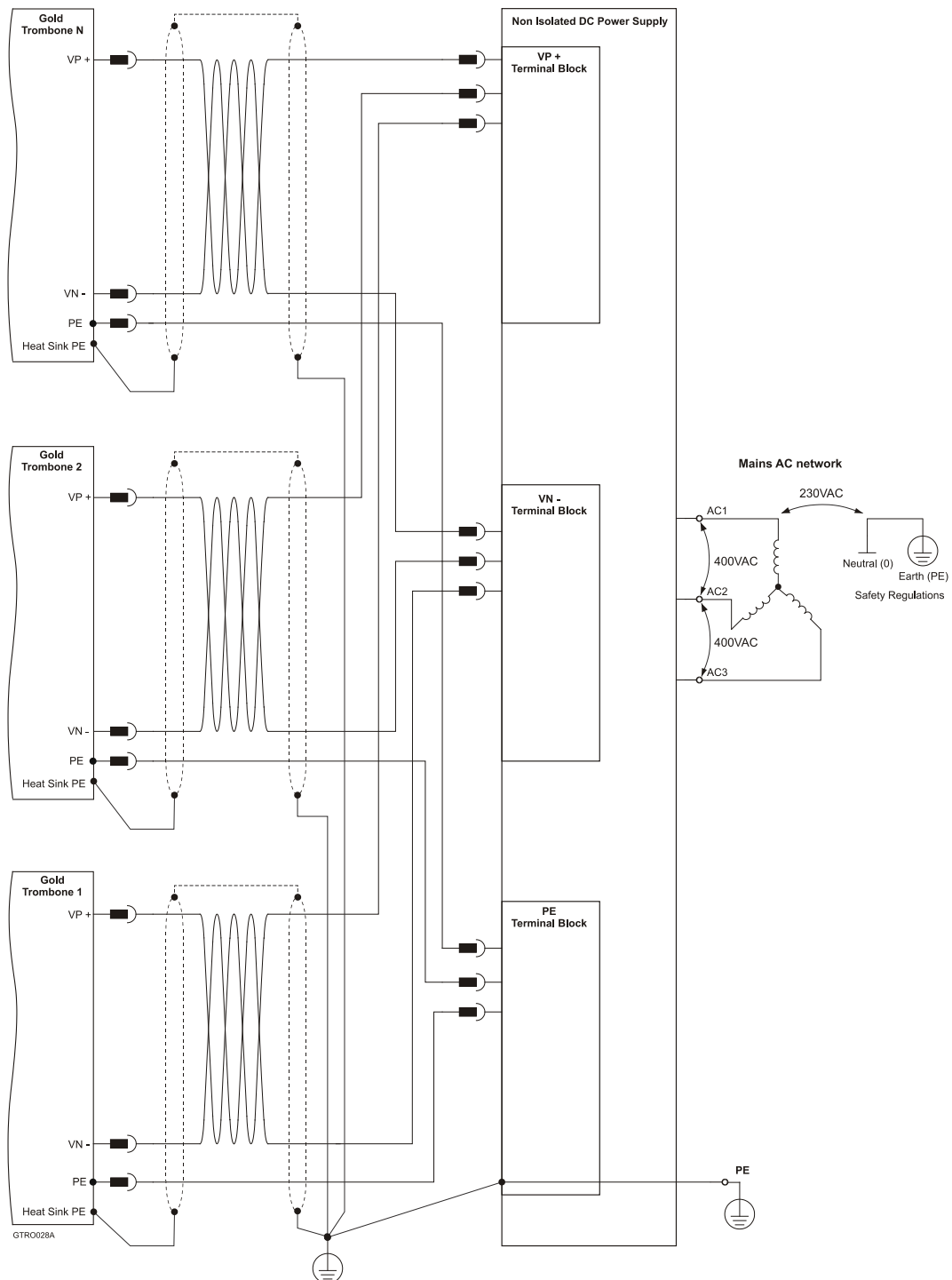


Figure 11: Non-Isolated Three-Phase Multiple Connection Topology

4.7.2.2. Battery Power Supply

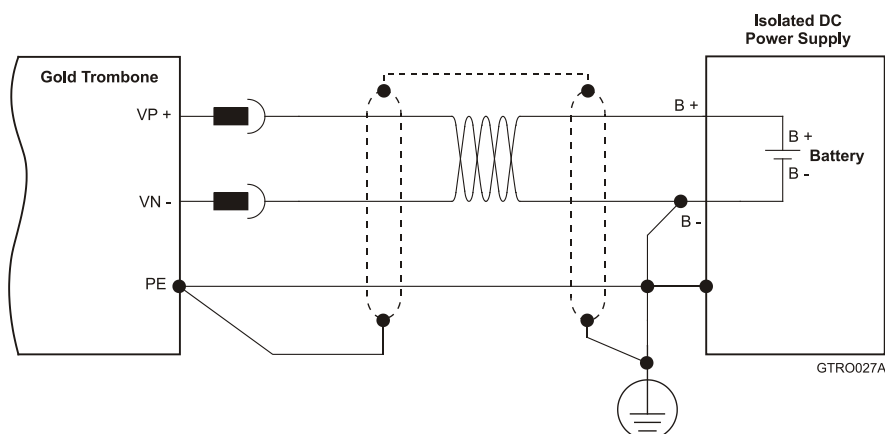


Figure 12: Battery Connection Topology



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.

4.7.3. +24 V Auxiliary Supply (J3)

Pin (J3)	Function	Pin Positions
1	+24 V Auxiliary Supply Input Positive	
2	24 V RET Auxiliary Supply Input Return	

Table 10: Auxiliary 24 VDC Backup Supply Pins and Polarity

In drives that have an 0 or 1 suffix (only for 400V models), a smart control-supply algorithm enables the Gold Trombone to operate with the main power supply only, *with no need for an auxiliary supply voltage to supply the drive's logic section*. However, it should be noted that in such model there is no backup ability at all.

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

Note that the S or T-model Gold 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.

To connect the 24 VDC backup supply:

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 with 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 that the polarity of the connection is correct.

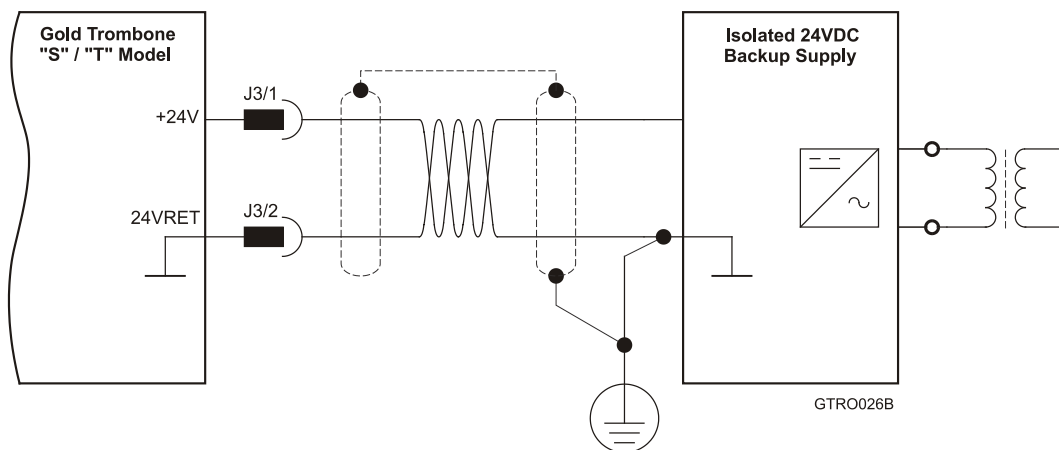


Figure 13: Auxiliary 24 VDC Backup Supply Connection Diagram

4.8. STO (Safe Torque Off) Inputs (J1)

Activation of Safe Torque Off causes the drive to stop providing power that can cause rotation (or motion in the case of a linear motor) to the motor.

This function may be used to prevent unexpected motor rotation (of brushless DC motors) without disconnecting the drive from the power supply.

The motor is active only as long as 24 VDC (or 5 V for the TTL option) is provided to both STO1 and STO2. Whenever any input voltage is no longer present, power is not provided to the motor and the motor shaft continues to rotate to an uncontrolled stop.

In circumstances where external influences (for example, falling of suspended loads) are present, additional measures such as mechanical brakes are necessary to prevent any hazard.

This function corresponds to an uncontrolled stop in accordance with Stop Category 0 of IEC 60204-1.

Note: This function does not protect against electrical shock, and additional measures to turn the power off are necessary.

The following table defines the behavior of the motor as a function of the state of the STO inputs:

Signal – STO1	Signal – STO2	Function
Not Active	Not Active	Motor is disabled
Not Active	Active	Motor is disabled
Active	Not Active	Motor is disabled
Active	Active	Motor can be enabled

Table 11: Motor Behavior According to Safety Inputs

Note: In the Gold Trombone, STO1 also latches a software disable condition.

Pin (J1)	Signal	Function
14	STO1	Safety 1 input (default 24 V)
13	STO2	Safety 2 input (default 24 V)
12	STO_RET	Safety signal return

Table 12: Safety Inputs Pin Assignments

See Figure 14 for the PLC option connection and Figure 15 for the TTL option connection.

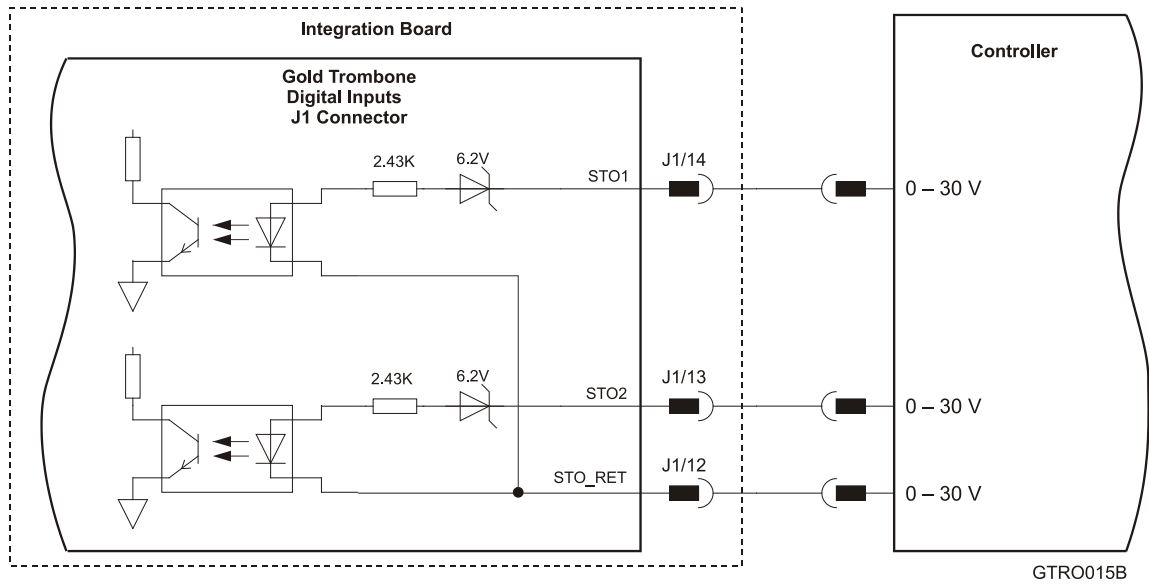


Figure 14: STO Input Connection – PLC Option for S or 0 suffixes

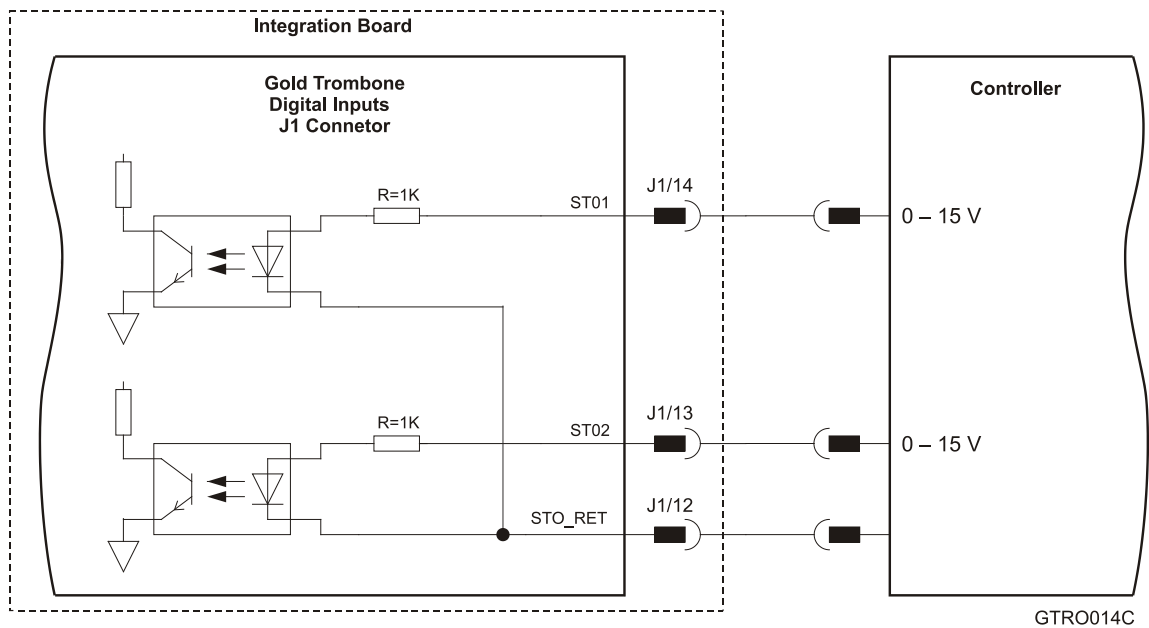
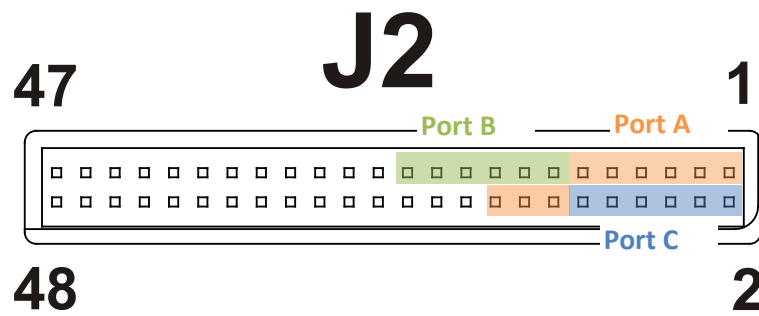


Figure 15: Safety Input Connection – TTL Option for T or 1 Suffixes

4.9. Feedback



GTR0048A

Figure 16: Feedback Ports on J2

The Gold Trombone has two configurable motion sensor input ports, namely, Port A and Port B, and the emulated buffered output Port C. Motion sensors from the motor being controlled and from other sources can be connected to any of the available inputs on Port A or Port B. Software configuration designates each input a role, e.g., the incremental encoder on Port B is the controlled motor position feedback, the Hall sensors on Port A are commutation feedback, and the incremental encoder on Port A is follower input.

For more information about sensors and their use refer to the Gold Line Software Manual.

4.9.1. Port A (J2, J1)

Port A supports the following sensor inputs:

- Digital Hall sensors
- Incremental encoder or absolute serial encoder, depending on the specific model

Differential PWM signal input can be connected to Port A in the models that support input from an incremental encoder. The PWM signal can be connected to the applicable pair of matching + and - encoder channels and is configurable by software.

Differential pulse and direction signal inputs can be connected to Port A in the models that support input from an incremental encoder. The signals can be connected to the applicable pair of matching + and - encoder channels and are configurable by software.



Port A - Incremental Encoder			Port A - Absolute Serial Encoder	
Pin	Signal	Function	Signal	Function
J1/2	+5V	Encoder +5V supply	+5V	Encoder +5V supply
J1/1	SUPRET	Supply return	SUPRET	Supply return
J2/1	PortA_ENC_A+	Channel A+	ABS_CLK+	Abs encoder clock +
J2/3	PortA_ENC_A-	Channel A-	ABS_CLK-	Abs encoder clock -
J2/5	PortA_ENC_B+	Channel B+	ABS_DATA+	Abs encoder data +
J2/7	PortA_ENC_B-	Channel B-	ABS_DATA-	Abs encoder data -
J2/9	PortA_ENC_Index+	Index+	Reserved	Reserved
J2/11	PortA_ENC_Index-	Index-	Reserved	Reserved
J2/18	HA	Hall sensor A	HA	Hall sensor A
J2/16	HB	Hall sensor B	HB	Hall sensor B
J2/14	HC	Hall sensor C	HC	Hall sensor C

Table 13: Port A Pin Assignments

4.9.1.1. Incremental Encoder Connection Diagram

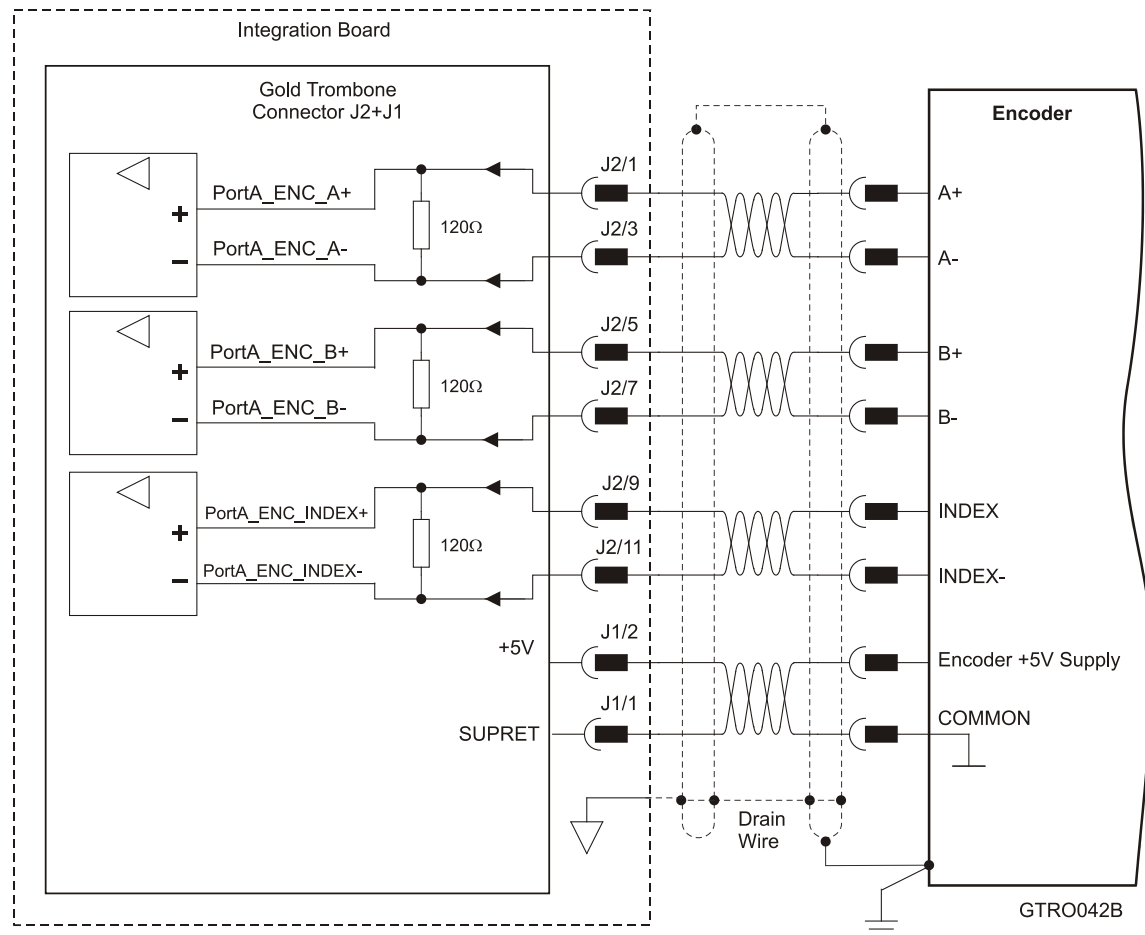


Figure 17: Port A Incremental Encoder Input – Recommended Connection Diagram

4.9.1.2. Absolute Serial Encoder Connection Diagram

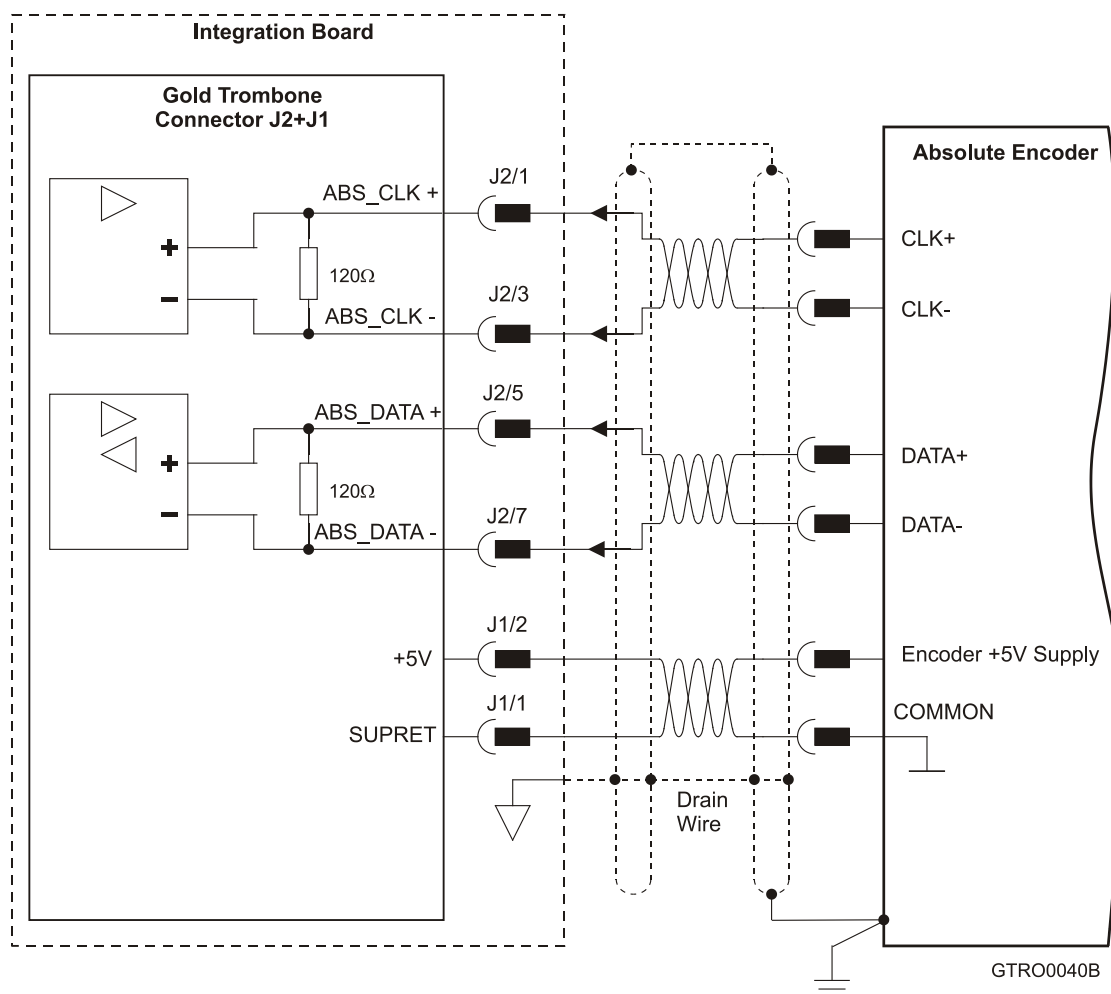


Figure 18: Absolute Serial Encoder – Recommended Connection Diagram for Sensors Supporting Data/Clock (e.g., Biss/SSI/EnDAT etc.)

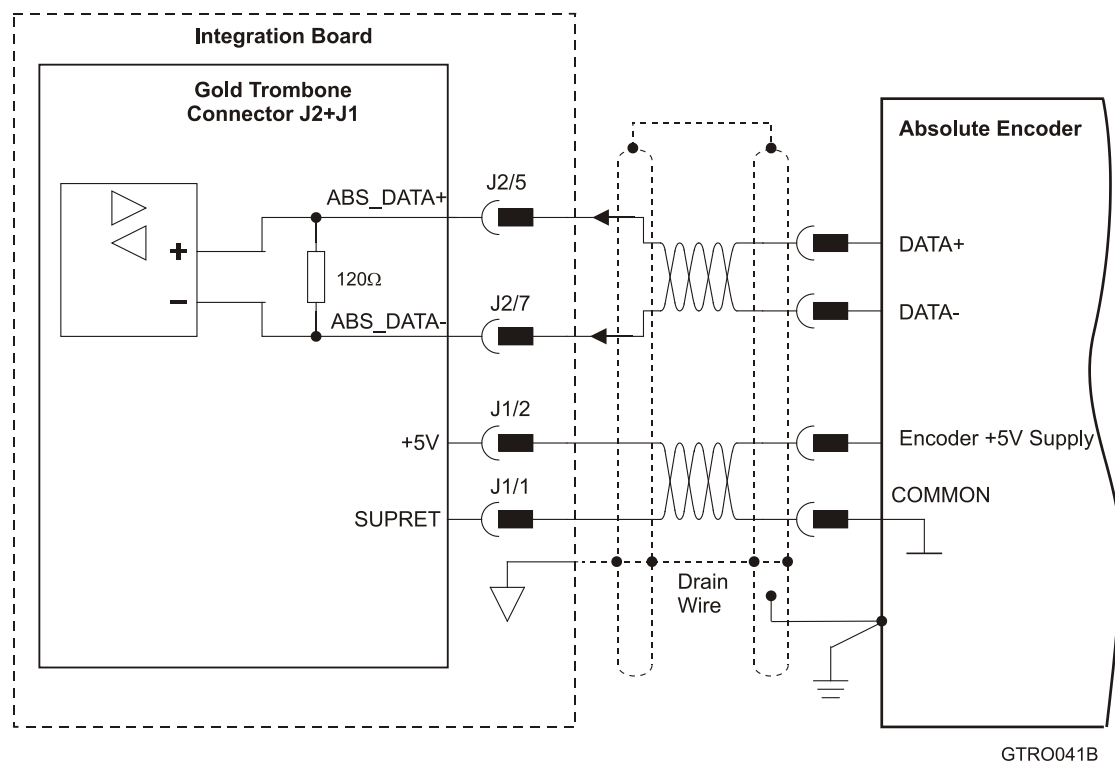


Figure 19: Absolute Serial Encoder – Recommended Connection Diagram for Sensors Supporting Data Line Only (NRZ types, e.g., Panasonic / Mitutoyo / etc.)

4.9.1.3. Hall Sensor Connection Diagram

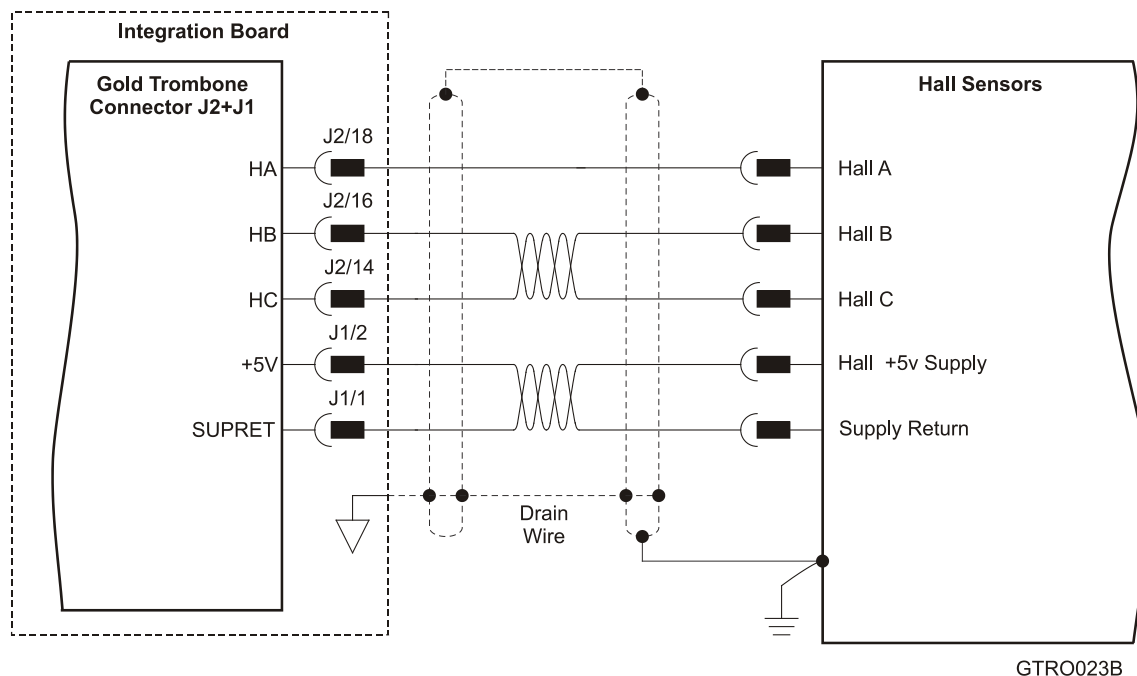


Figure 20: Hall Sensors Connection Diagram

4.9.2. Port B (J2, J1)

Port B supports the following sensors:

- Incremental encoder, interpolated analog encoder or as analog Hall sensors

Or:

- Resolver (separate hardware option)

Differential PWM signal input can be connected to port B in the models that support input from an incremental encoder. The PWM signal can be connected to the applicable pair of matching + and – encoder channels and is configurable by software.

Differential pulse and direction signal inputs can be connected to port B in the models that support input from an incremental encoder. The signals can be connected to the applicable pair of matching + and – encoder channels and are configurable by software.

Port B - Incremental or Interpolated Analog Encoder			Port B - Resolver	
	G-TRO XXX /YYYYE XS		G-TRO XXX /YYYYR XS	
Pin	Signal	Function	Signal	Function
J1/2	+5V	Encoder +5V supply	NC	
J1/1	SUPRET	Supply return	SUPRET	Supply return
J2/13	PortB_ENC_A+/SIN+	Channel A+ / Sine+	SIN+	Sine+
J2/15	PortB_ENC_A-/SIN-	Channel A- / Sine-	SIN-	Sine-
J2/17	PortB_ENC_B+/COS+	Channel B+ / Cosine+	COS+	Cosine+
J2/19	PortB_ENC_B-/COS-	Channel B - / Cosine -	COS-	Cosine-
J2/21	PortB_ENC_INDEX+/Analog_Index+	Index +/ Analog_Index+	RESOLVER_OUT+	Vref f=1/TS, 50 mA max.
J2/23	PortB_ENC_INDEX-/Analog_Index-	Index -/ Analog_Index-	RESOLVER_OUT-	Vref complement f= 1/TS, 50 mA max.

Table 14: Port B Pin Assignments

4.9.2.1. Incremental Encoder Connection Diagram

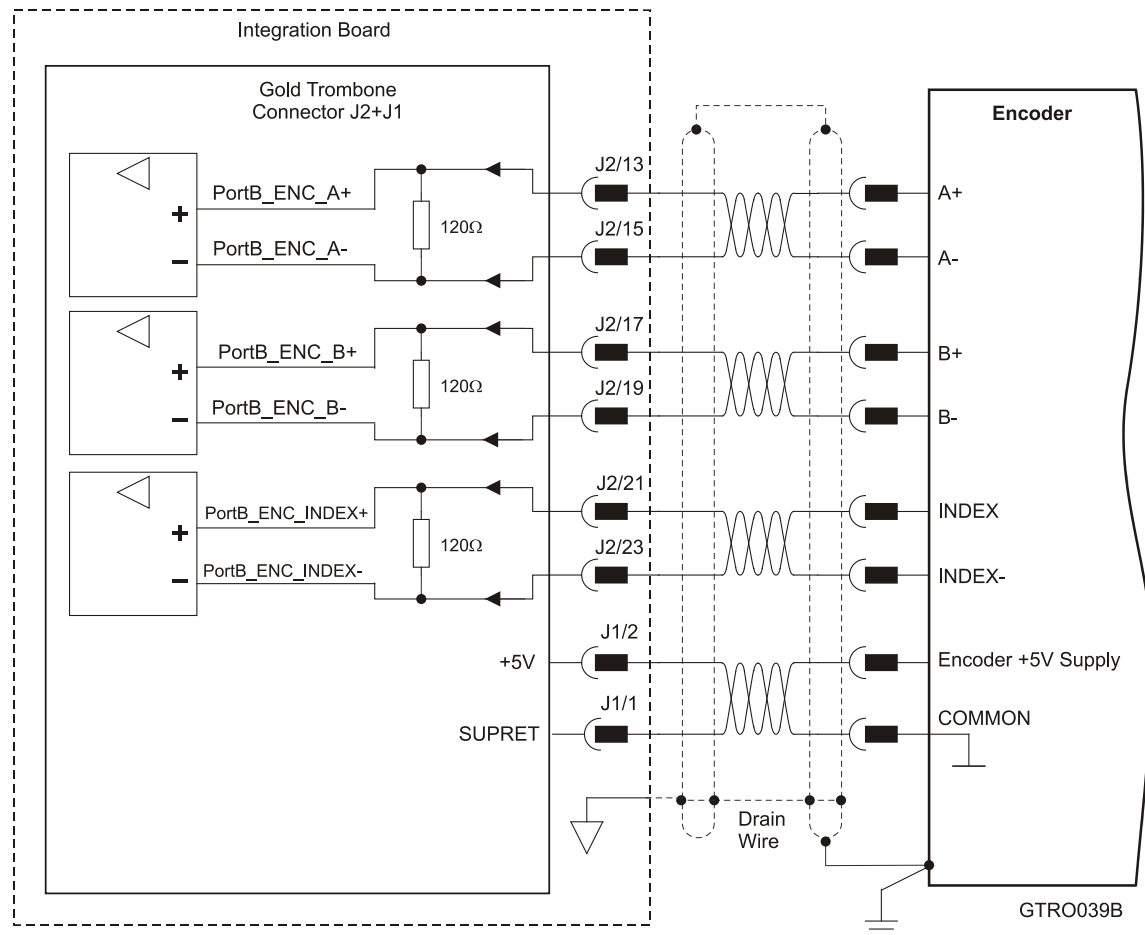


Figure 21: Port B Incremental Encoder Input – Recommended Connection Diagram



4.9.2.2. Interpolated Analog Encoder Connection Diagram

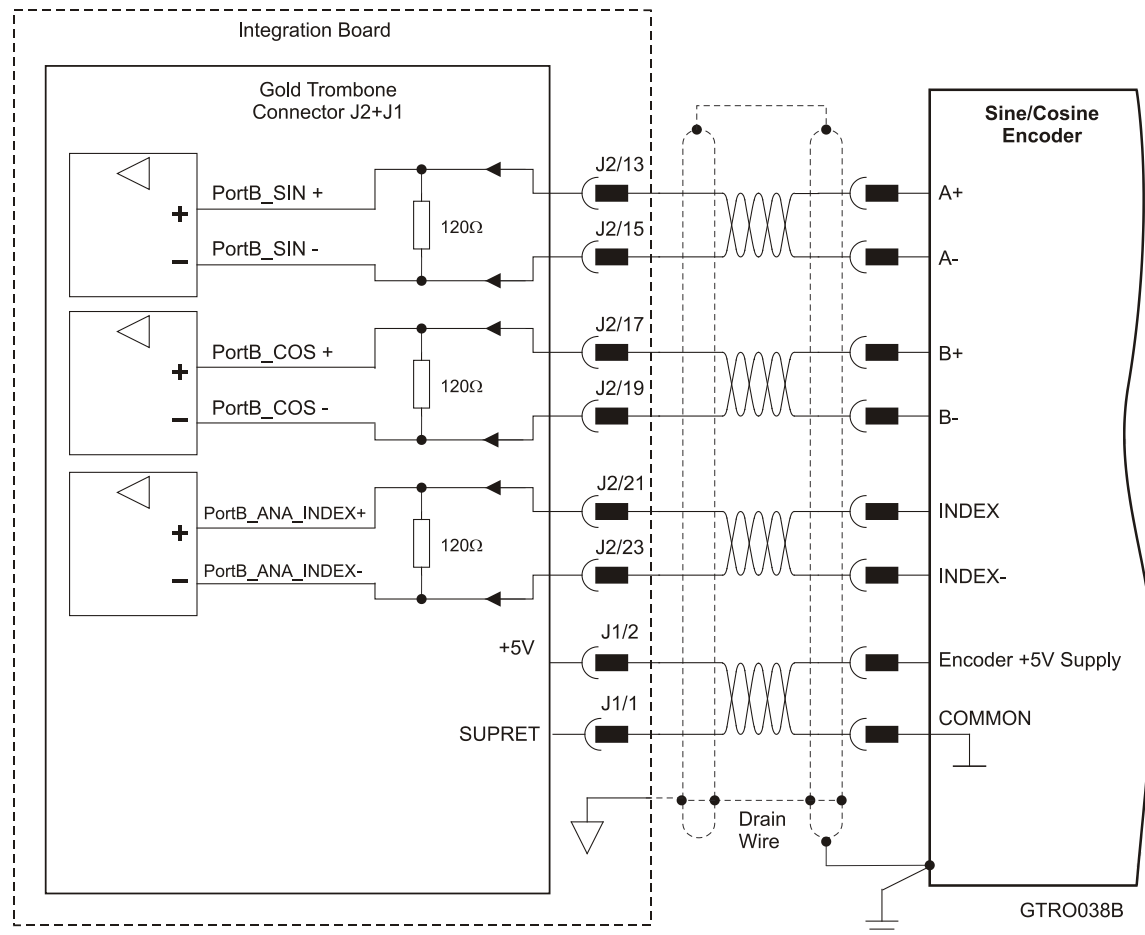


Figure 22: Port B - Interpolated Analog Encoder Connection Diagram

4.9.2.3. Resolver Connection diagram

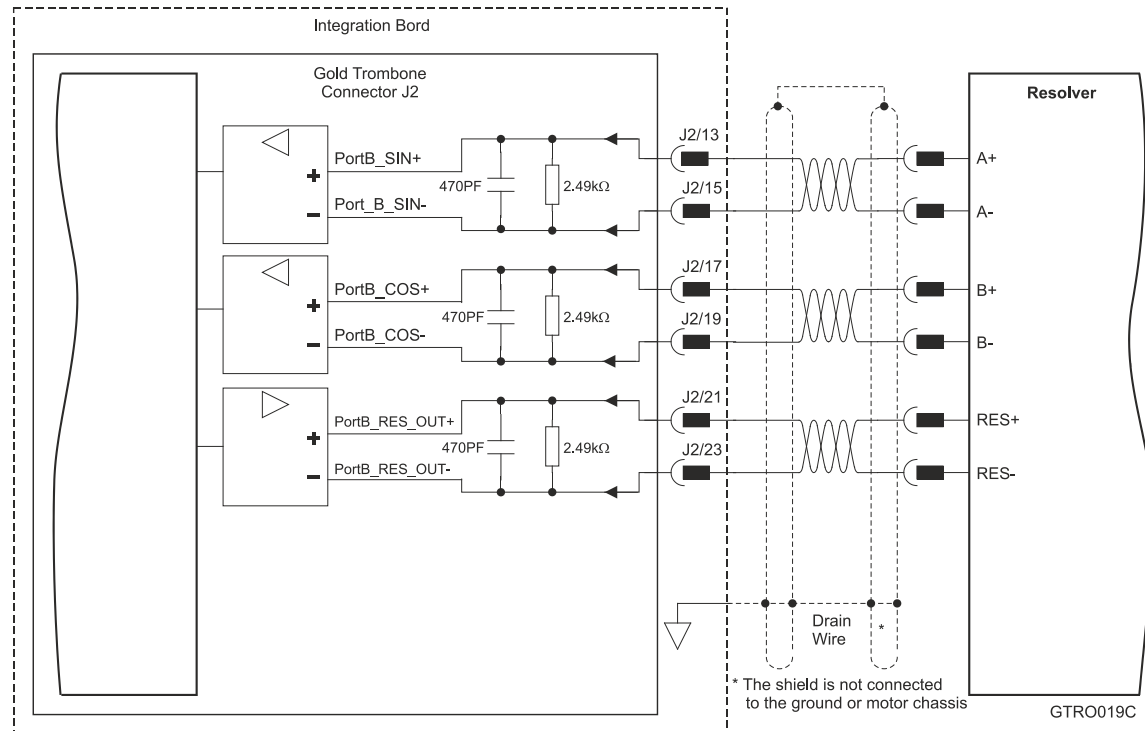


Figure 23: Port B – Resolver Connection Diagram

4.9.3. Port C – Emulated Encoder Output (J2)

Port C provides emulated encoder output derived from port A or port B feedback inputs, or from internal variables. The output options are:

- Port A/B daisy chain (1:1) for incremental encoder
- Encoder emulation: Emulate any input sensor, digital or analog, or use to emulate an internal variable such as virtual profiler.
- PWM output: any pair of outputs that is used as an encoder channel (e.g. channel A+ and channel A-) can be configured by software to become PWM output.
- Pulse & Direction output: The output pins that are assigned as channel A and channel B when used as encoder out, can be configured by software to become pulse and direction outputs respectively.

This port is used when:

- The Gold Trombone is used as a current amplifier to provide position data to the position controller.
- The Gold Trombone is used in velocity mode, to provide position data to the position controller.
- The Gold Trombone is used as a master in follower or ECAM mode.

Pin (J2)	Signal	Function
4	PortC_ENCO_A+	Buffered Channel A+ output/Pulse+/PWM+
2	PortC_ENCO_A-	Buffered Channel A- output / Pulse- / PWM-
8	PortC_ENCO_B+	Buffered Channel B+ output / Dir+
6	PortC_ENCO_B-	Buffered Channel B- output / Dir-
12	PortC_ENCO_INDEX+	Buffered Channel INDEX+ output
10	PortC_ENCO_INDEX-	Buffered Channel INDEX- output

Table 15: Port C Pin Assignment

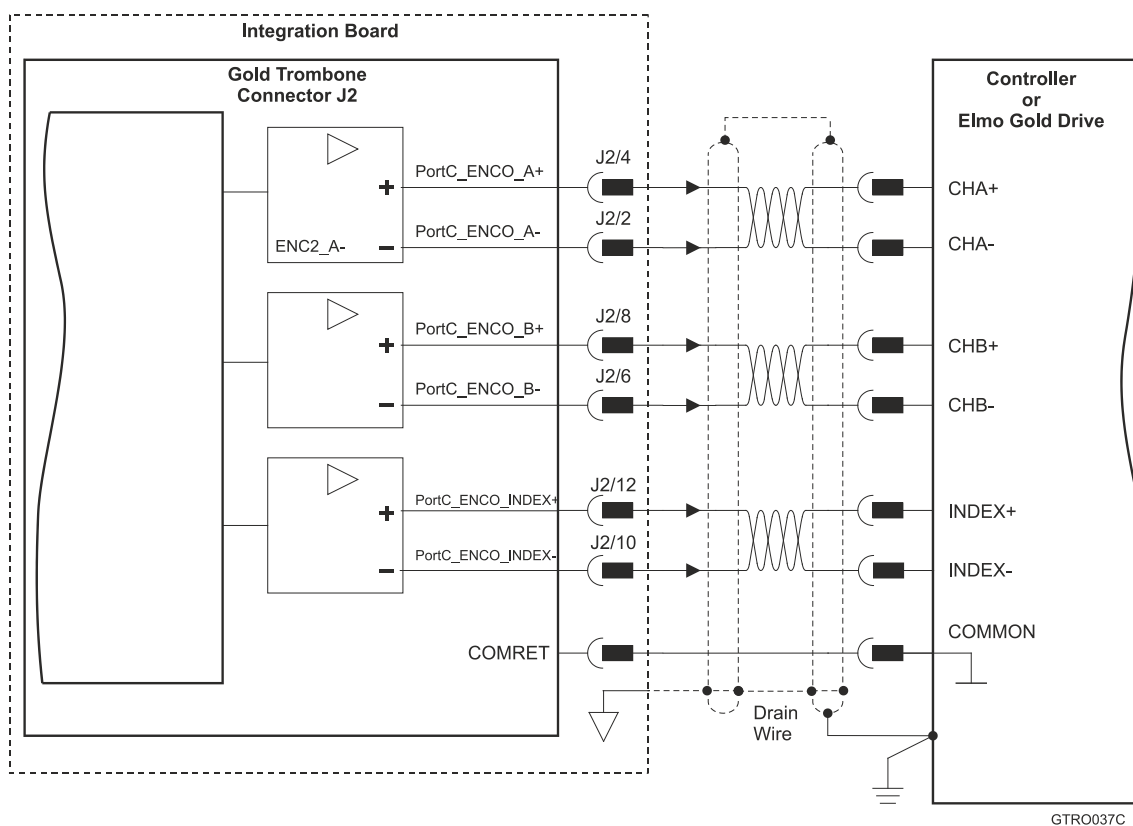


Figure 24: Emulated Encoder Differential Output – Recommended Connection Diagram

4.10. User I/Os

The Gold Trombone has six programmable digital inputs (J1), four digital outputs (J1) and one analog input (J2).

4.10.1. Digital Inputs (J1)

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

Pin (J1)	Signal	Function
6	IN1	High speed programmable input 1 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
7	IN2	High speed programmable input 2 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
8	IN3	High speed programmable input 3 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
9	IN4	High speed programmable input 4 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
10	IN5	High speed programmable input 5 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
11	IN6	High speed programmable input 6 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
5	INRET1-6	Programmable inputs 1 - 6 return

Table 16: Digital Input Pin Assignments

See Figure 25 for the PLC option connection and Figure 26 for the TTL option connection.

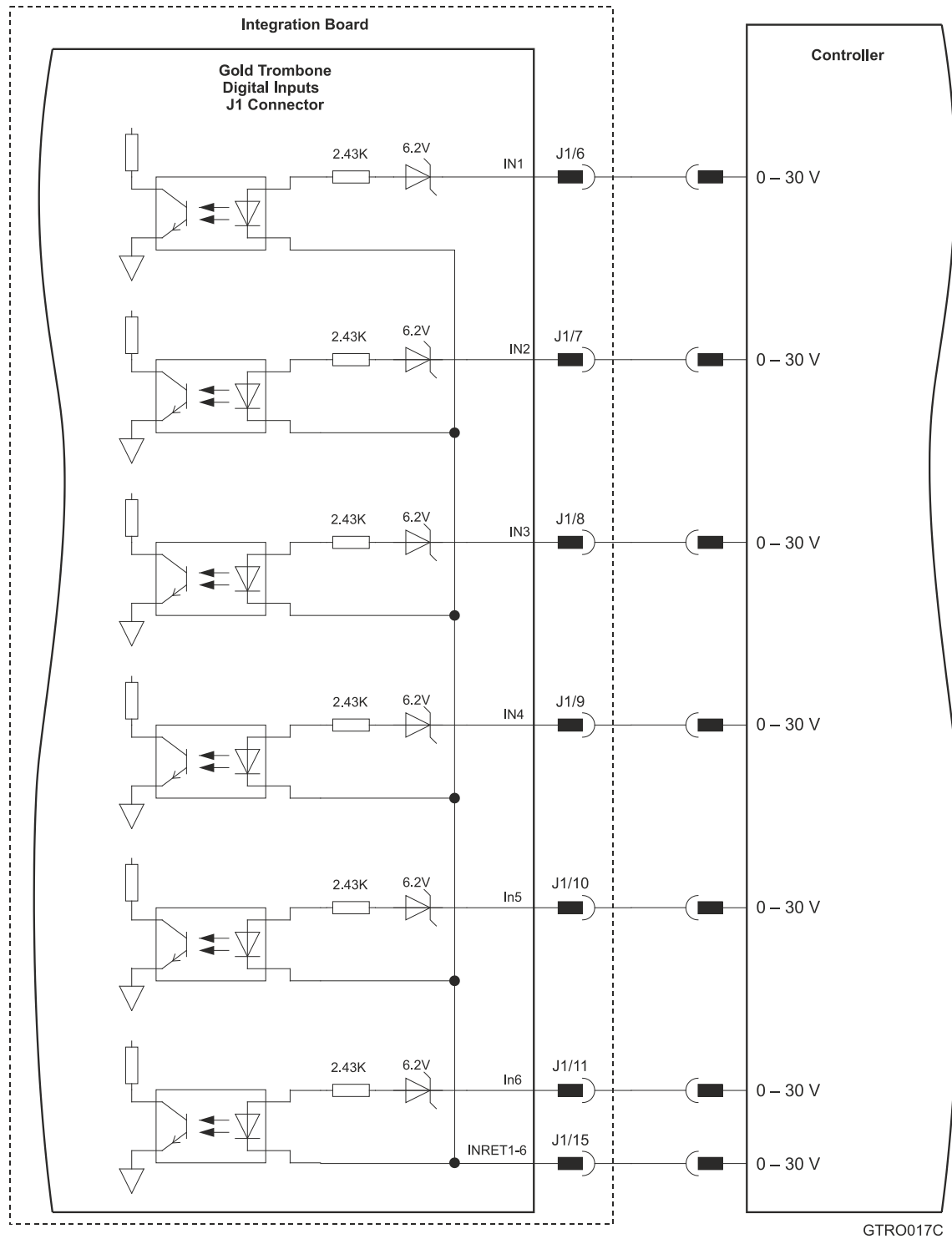


Figure 25: Digital Input PLC Mode Connection Diagram for S or O suffixes

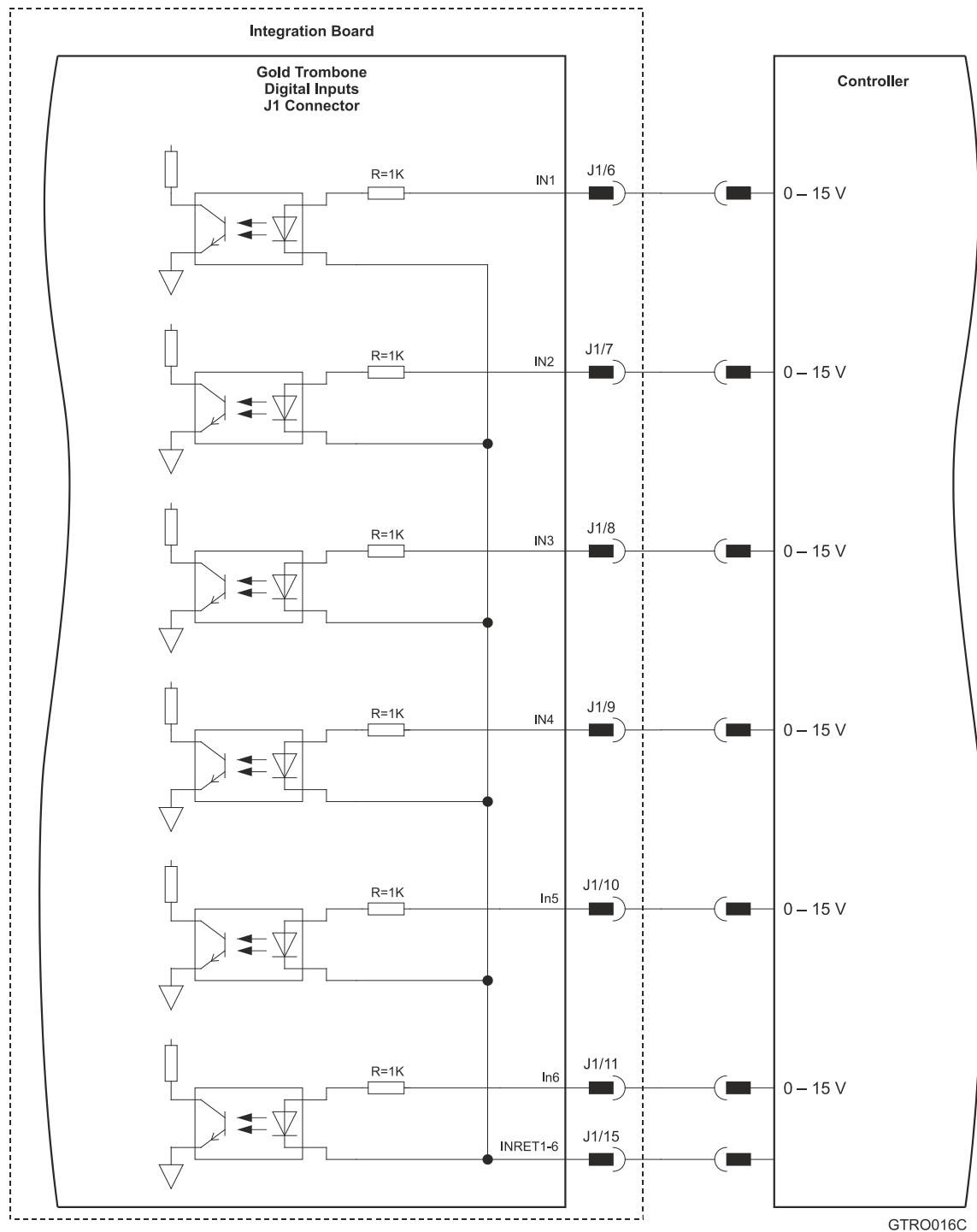


Figure 26: Digital Input TTL Mode Connection Diagram for T or 1 Suffixes



4.10.2. Digital Outputs (J1)

The outputs conform to the PLC standard. TTL configuration is available upon request.

Pin (J1)	Signal	Function
22	OUT1	High speed programmable digital output 1: • 500 mA for PLC models • 7 mA for TTL models
21	OUT2	Programmable digital output 2: • 250 mA for PLC models • 7 mA for TTL models
24	OUT3	Programmable digital output 3: • 250 mA for PLC models • 7 mA for TTL models
23	OUT4	Programmable digital output 4: • 250 mA for PLC models • 7 mA for TTL models
26	VDD	Supply for outputs 1 to 4
25	VDDRET	Supply return for outputs 1 to 4

Table 17: Digital Output Pin Assignment

See Figure 27 for the PLC option connection and Figure 28 for the TTL option connection.

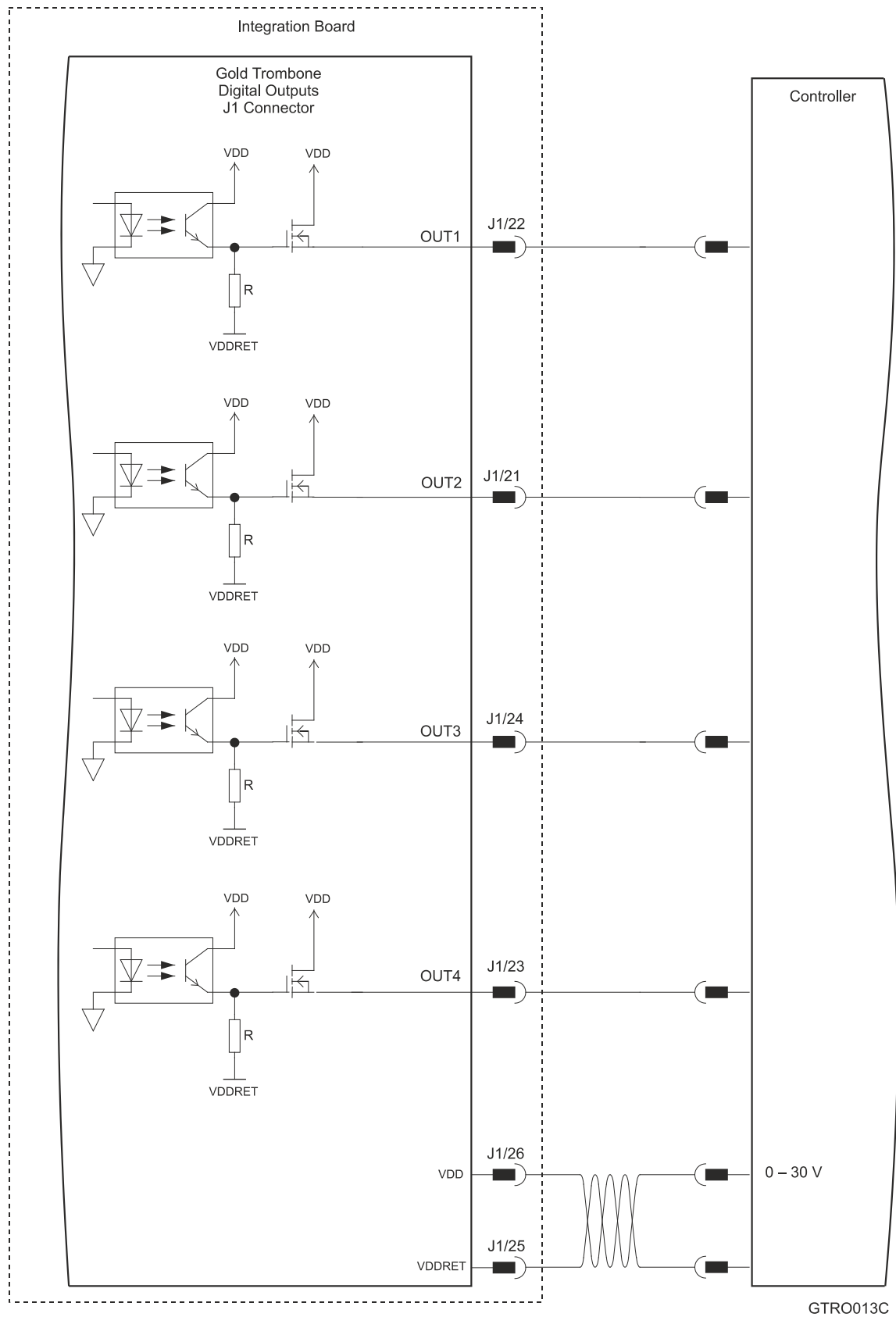


Figure 27: Digital Output Connection Diagram – PLC option for S or O Suffixes

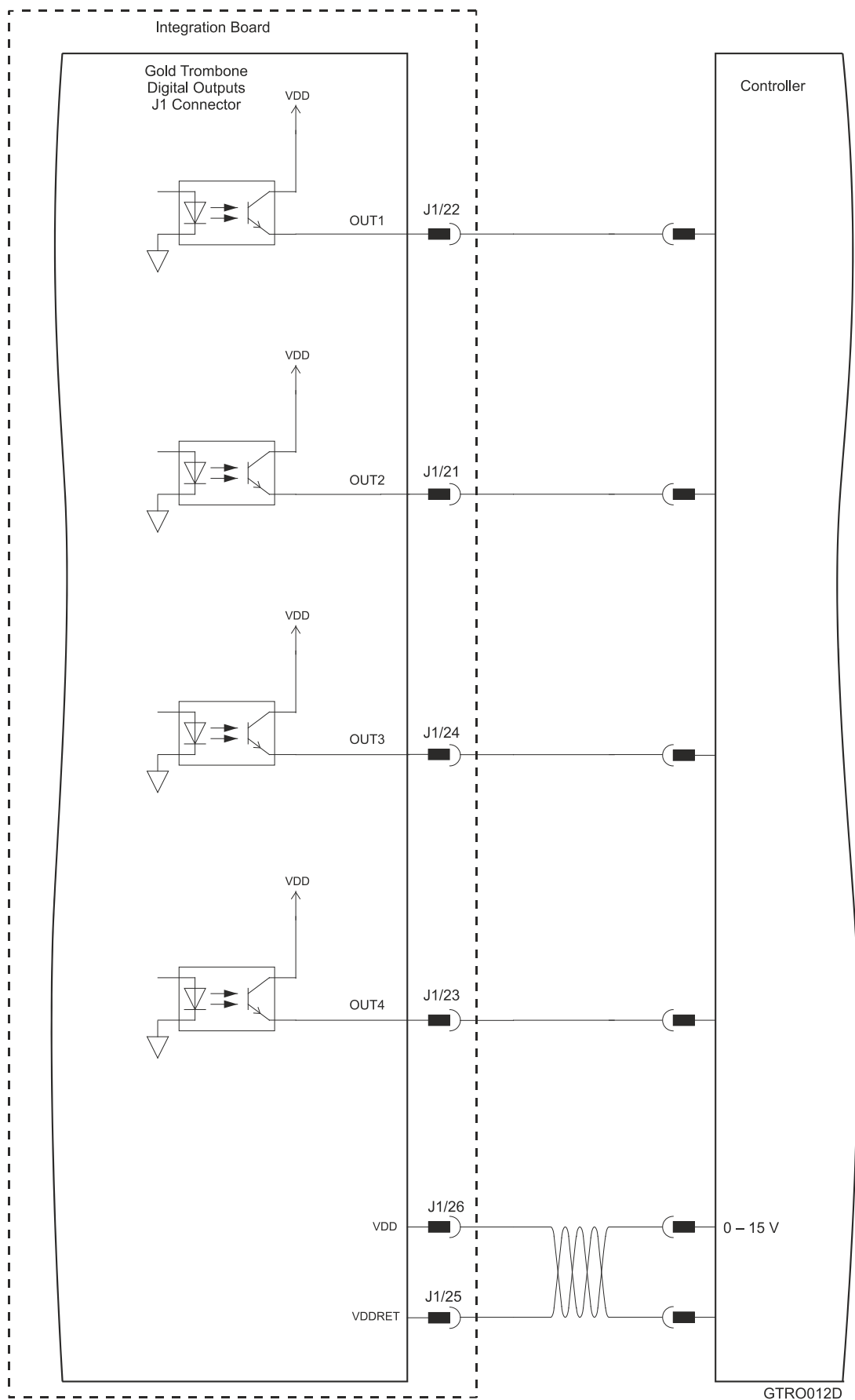


Figure 28: Digital Output Connection Diagram – TTL option for T or 1 Suffixes



4.10.3. Input (J2)

An analog user input can be configured by software to be used as either tachometer velocity sensor input or potentiometer position feedback.

Pin (J2)	Signal	Function
22	ANALOG1+	Analog input 1+
24	ANALOG1-	Analog input 1-
20	ANLRET	Analog ground

Table 18: Analog Input Pin Assignment

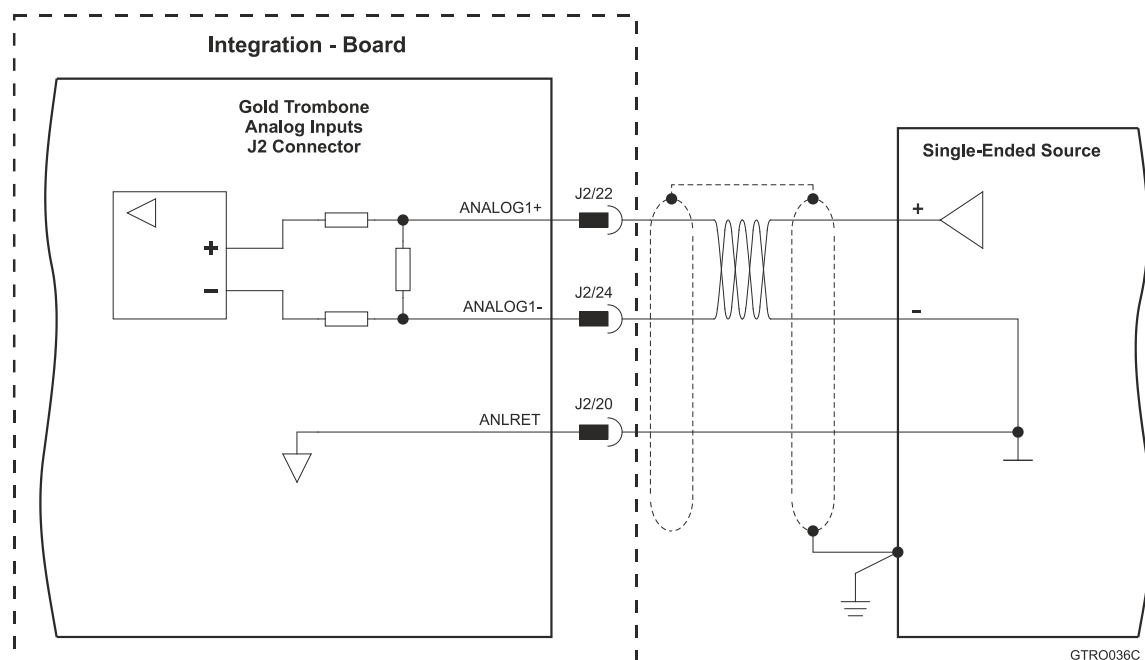


Figure 29: Analog Input with Single-Ended Source

4.11. Communications

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

Standard	EtherCAT
G-TRO XXX /YYYS XX	G-TRO XXX /YYYE XX
CANopen	EtherCAT
USB 2.0	USB 2.0

Table 19: Gold Trombone Communication Options

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

NOTE: When the EtherCAT is connected, and FoE in operation, the USB cable connection must be disconnected.

4.11.1. CANopen Communication (J2)

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

To connect the CANopen communication cable:

1. Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.
2. Ensure that the shield of the cable is connected to the shield of the connector used for communications. The drain wire can be used to facilitate the connection.
3. Make sure to have a 120-Ohm resistor termination at each of the two ends of the network cable.
4. The Gold Trombone's CAN port is non-isolated.

Pin (J2)	Signal	Function
31, 32	CAN_COMRET	CAN Communication Return
38	CAN_L	CAN_L bus line (dominant low)
40	CAN_H	CAN_H bus line (dominant high)

Table 20: CANopen Pin Assignments

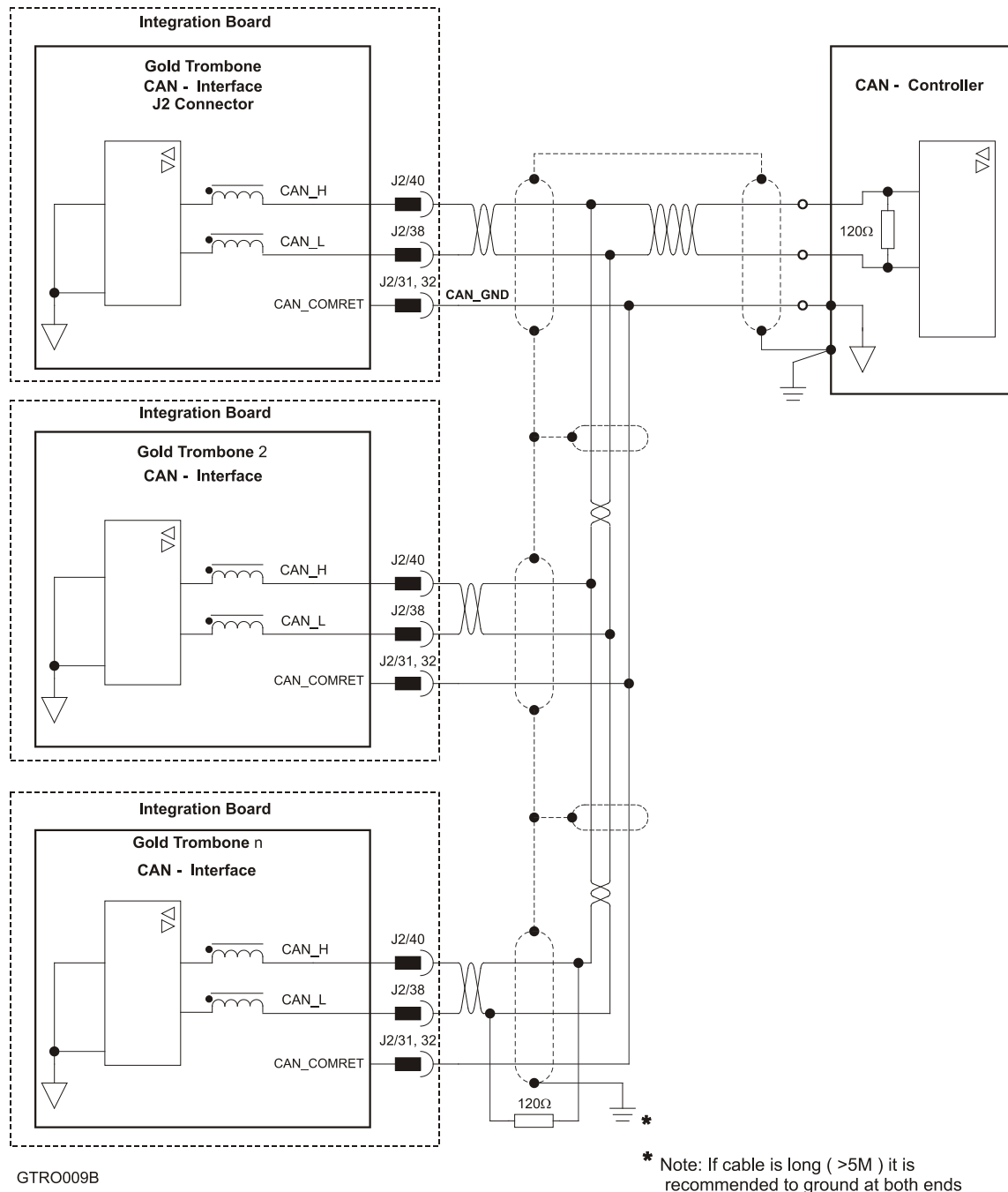


Figure 30: CANopen Network Diagram



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

4.11.2. USB 2.0 Communication (J2)

The USB network consists of a Host controller and multiple devices. The Gold Trombone is a USB device.

To connect the USB communication cable:

1. Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.
2. Ensure that the shield of the cable is connected to the shield of the connector used for communications. The drain wire can be used to facilitate the connection.

Pin (J2)	Signal	Function
44	USB VBUS	USB VBUS 5 V
43	USB COMRET	USB Communication return
41	USBD-	USB _N line
42	USBD+	USB _P line

Table 21: USB 2.0 Pin Assignments

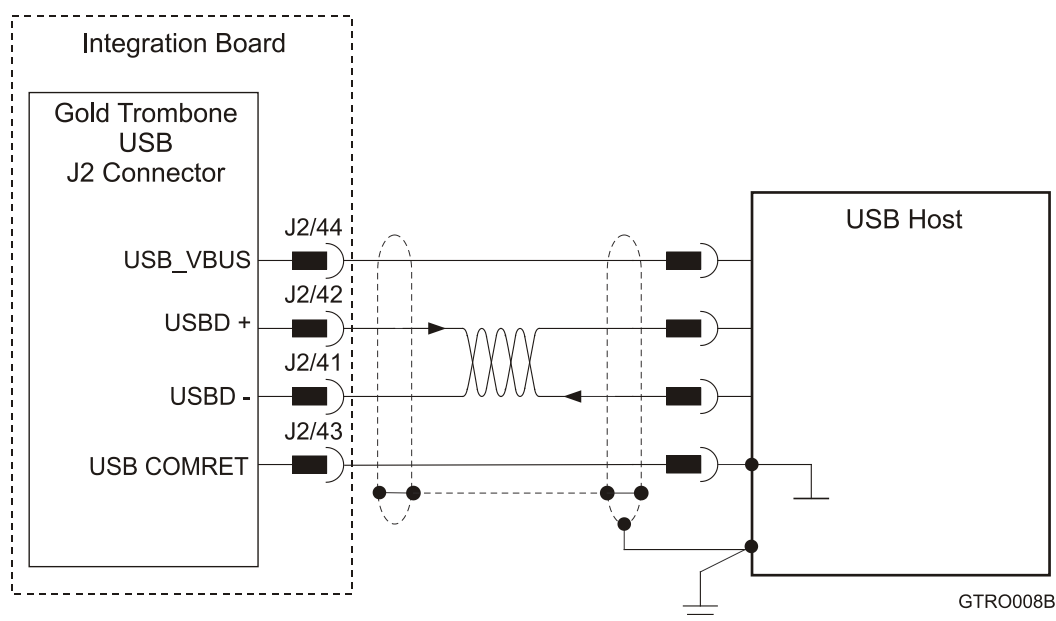


Figure 31: USB Network Diagram

4.11.3. EtherCAT Communication (J2)

To use EtherCAT and Ethernet communication with the Gold Trombone, it is required to use an isolation transformer. The most common solution is to use RJ-45 connectors that include transformer isolation.

This section describes how to connect the Gold Trombone's EtherCAT interface using the above mentioned connectors.

Notes for EtherCAT communication:

1. The EtherCAT IN port can be configured as an Ethernet port for TCP/IP – see the EtherCAT Manual.
2. It is recommended to use CAT5e (or higher) cable. Category 5e cable is a high signal integrity cable with four twisted pairs.

Pin (J2)	Signal	Function
26	3.3 V	3.3 V for EtherCAT LEDs
31, 32	PHY_IN_COMRET	EtherCAT Communication Return
27	PHY_IN_RX+	EtherCAT IN RX+ Line
29	PHY_IN_RX-	EtherCAT IN RX- Line
33	PHY_IN_TX+	EtherCAT IN TX+ Line
35	PHY_IN_TX-	EtherCAT IN TX- Line
39	PHY_IN_SPEED	Indicates EtherCAT Speed
37	PHY_IN_LINK_ACT	Indicates EtherCAT LINK
31, 32	PHY_OUT_COMRET	EtherCAT Communication return
28	PHY_OUT_RX+	EtherCAT OUT RX+ Line
30	PHY_OUT_RX-	EtherCAT OUT RX- Line
34	PHY_OUT_TX+	EtherCAT OUT TX+ Line
36	PHY_OUT_TX-	EtherCAT OUT TX- Line
40	PHY_OUT_SPEED	Indicates EtherCAT Speed
38	PHY_OUT_LINK_ACT	Indicates EtherCAT LINK

Table 22: EtherCAT - Pin Assignments

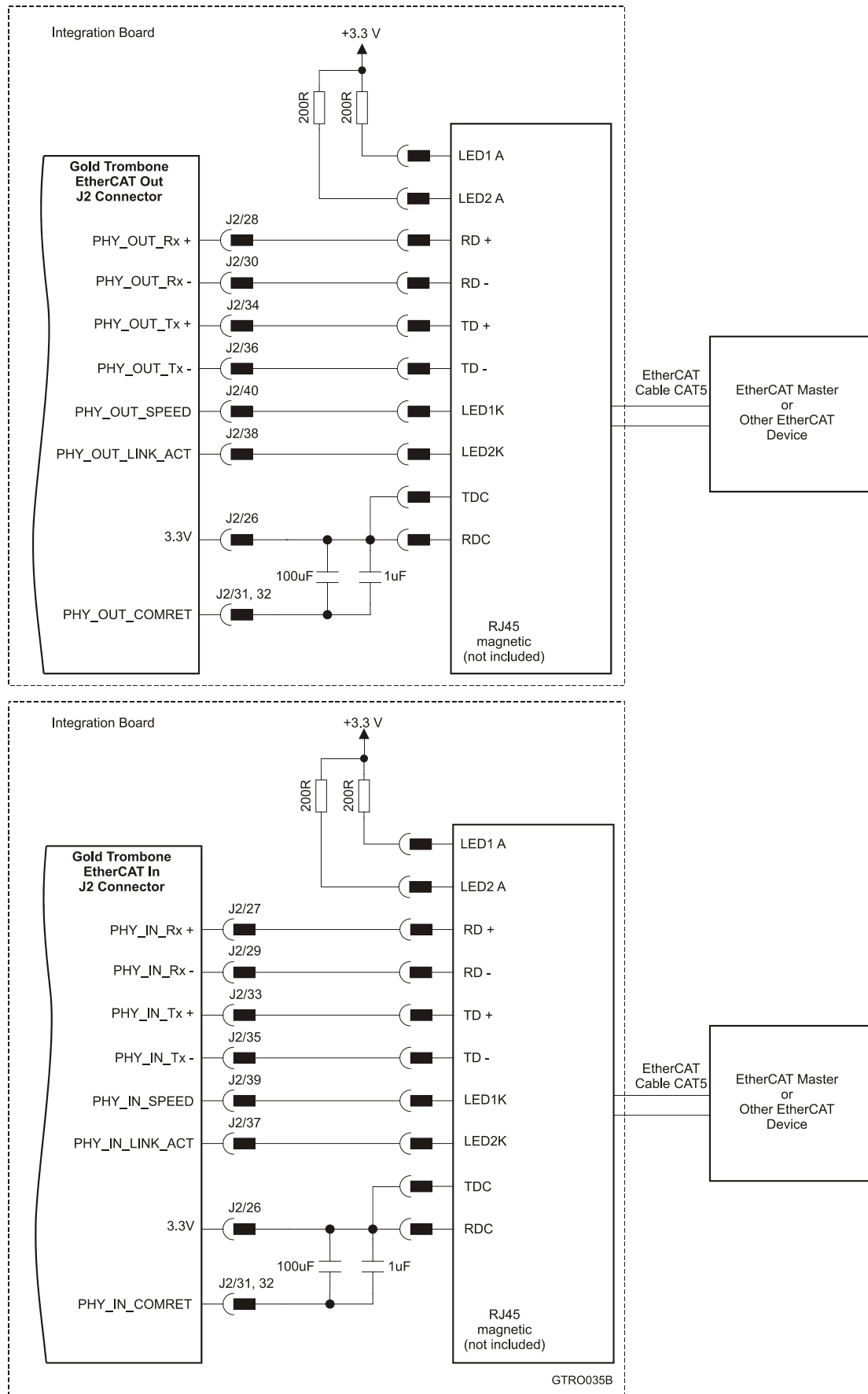


Figure 32: EtherCAT Connection Schematic Diagram

Note: The diagram above ignores line interface for simplicity.

When connecting several EtherCAT devices in a network, the EtherCAT master must always be the first device in the network. The output of each device is connected to the input of the next device. The output of the last device may remain disconnected. If redundancy is required, the output of the last device should be connected to the input of the EtherCAT master.

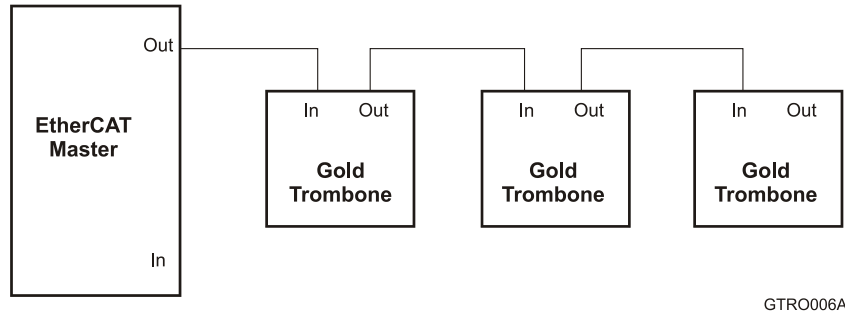


Figure 33: EtherCAT Network with no Redundancy

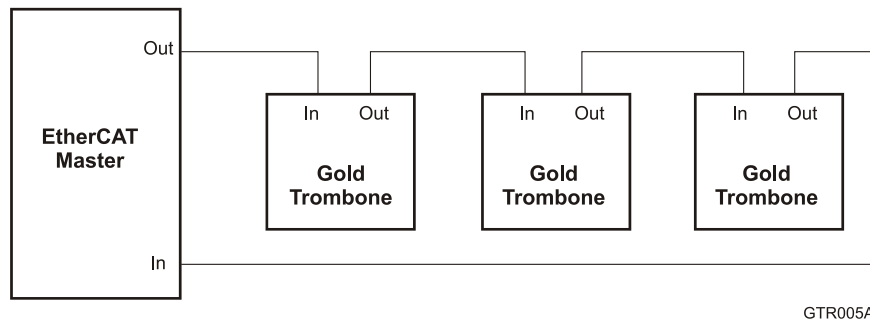


Figure 34: EtherCAT Network with Redundancy

4.11.4. Ethernet Communication (J2)

To use EtherCAT and Ethernet communication with the Gold Trombone, it is required to use an isolation transformer. The most common solution is to use RJ-45 connectors that include transformer isolation.

This section describes how to connect the Gold Trombone Ethernet interface using the above mentioned connectors.

For other available options, please see Section 04.11.5.

To initiate Ethernet communication:

1. The EtherCAT IN port can be configured as an Ethernet port for TCP/IP – see the EtherCAT Manual.
2. It is recommended to use CAT5e (or higher) cable. Category 5e cable is a high signal integrity cable with four twisted pairs.



Pin (J2)	Signal	Function
26	3.3 V	3.3 V for Ethernet LEDs
27	PHY_IN_RX+	Ethernet RX + Line
29	PHY_IN_RX-	Ethernet RX – Line
31, 32	Ethernet COMRET	Ethernet Communication return
33	PHY_IN_TX+	Ethernet TX + Line
35	PHY_IN_TX-	Ethernet TX – Line
39	PHY_IN_SPEED	Indicates Ethernet Speed
37	PHY_IN_LINK_ACT	Indicates Ethernet LINK

Table 23: Ethernet - Pin Assignments

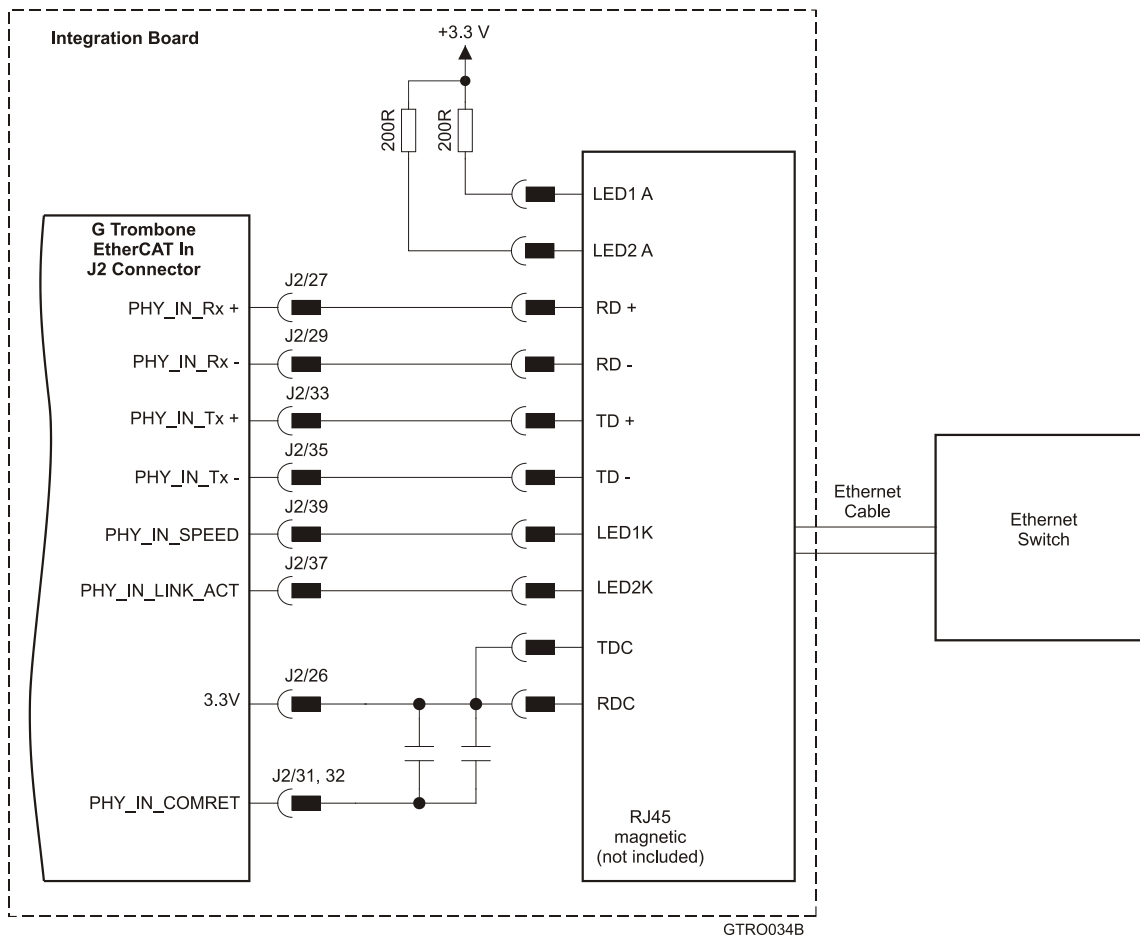


Figure 35: Ethernet Network Schematic Diagram

Note: The diagram above ignores line interface for simplicity.



4.11.5. EtherCAT/Ethernet Line Interface

Ethernet transceivers require either isolation transformers or capacitor coupling for proper functioning. The Gold Trombone unit does not include such isolation, therefore you must take this into consideration when designing the integration board.

In Sections 4.11.3 and 4.11.4, a schematic connection with a standard RJ-45 connector that includes transformer isolation is described.

Other recommended connection options are:

- Gold Trombone to an RJ-45 connector without an integrated magnetic isolation (e.g. M12 connectors) – an isolation transformer is required.
- Connecting two EtherCAT ports on the same board can be done using capacitive coupling or transformer coupling.

For more detailed explanations, including layout recommendations and component selection guidelines contact Elmo's technical support.



4.12. Powering Up

After the Gold Trombone is connected to its peripheral devices, it is ready to be powered up.



Caution: Before applying power, ensure that

1. The DC supply is within the specified range.
2. The proper plus-minus connections are in order.
3. The VN- is not connected to the PE nor to the Neutral, when working with a non-isolated power supply.

4.12.1. Initializing the System

After the Gold Trombone has been connected and mounted, the system must be set up and initialized. This is accomplished using the Elmo Application Studio, Elmo's Windows-based software application. Install the application and then perform setup and initialization according to the directions in the Elmo Application Studio User's Manual.

4.13. Heat Dissipation

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

4.13.1. Gold Trombone Thermal Data

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

4.13.2. Heat Dissipation Data

Heat Dissipation is shown graphically below:

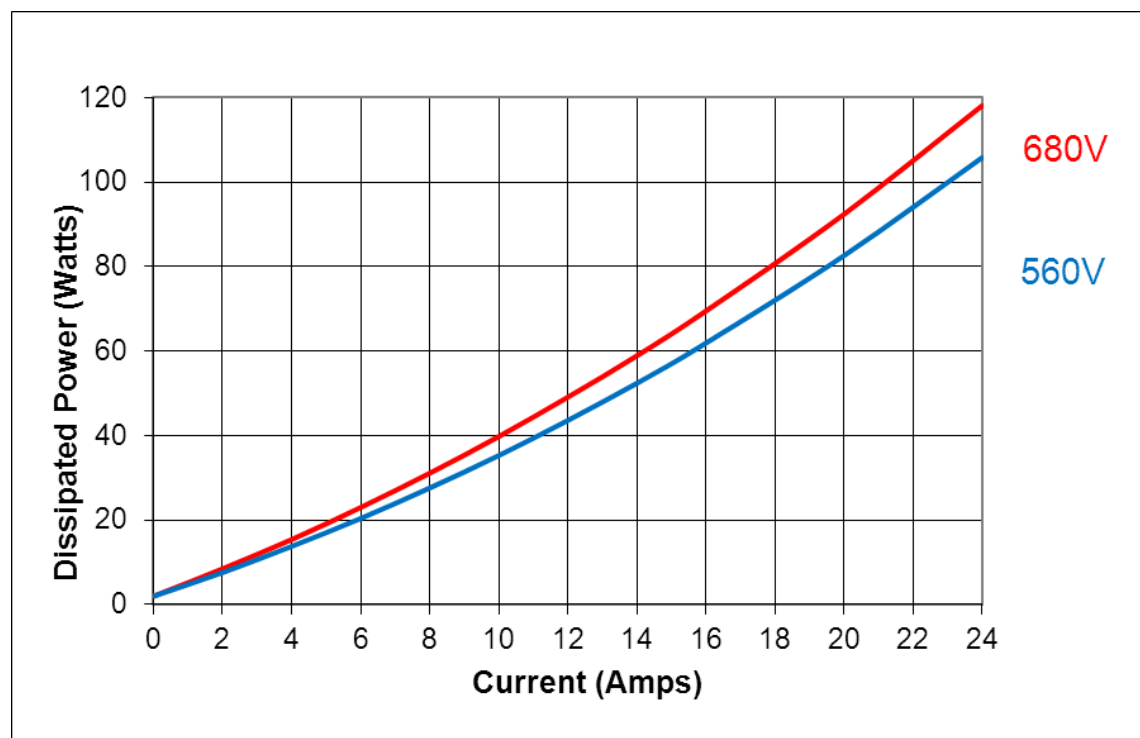


Figure 36: Dissipation versus Current Graph for 560 and 680 VDC

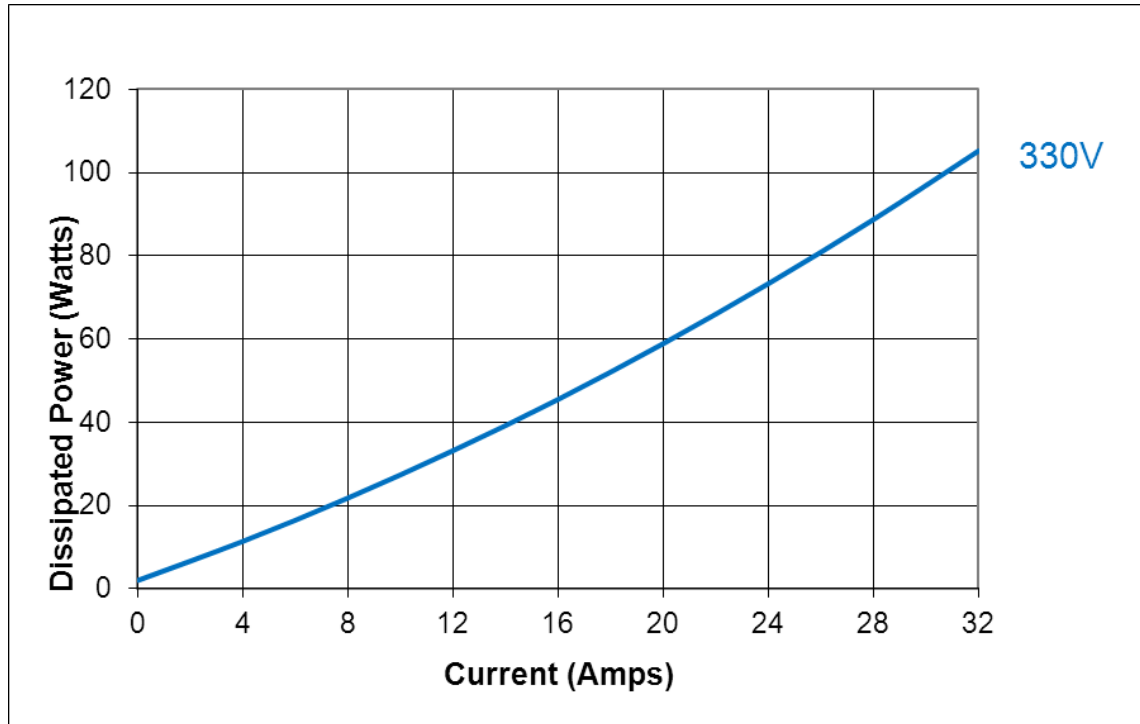


Figure 37: Dissipation versus Current Graph for 330 VDC

4.13.3. How to Use the Charts

The power dissipation in the chart includes the losses of the rectifying bridge.

Regarding Figure 36 and Figure 37, the following should be noted:

DC Bus Voltage (VDC)	Rectified Voltage (VAC)
560	3X400
680	3X480
330	3X230

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

To determine if your application needs a heat sink:

1. Allow maximum heat sink temperature to be 80 °C or less (shunt down is 6 °C to 8 °C higher).
2. Determine the ambient operating temperature of the Gold Trombone as ≤ 40 °C.
3. Calculate the allowable temperature increase according to the following example: For an ambient temperature of 40 °C, $\Delta T = 80$ to $40^{\circ}\text{C} = 40^{\circ}\text{C}$
4. Use the chart to find the actual dissipation power of the drive. Follow the voltage curve to the desired output current and then find the dissipated power.

Chapter 5: Technical Specifications

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

5.1. Features

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

5.1.1. Motion Control Modes

- Current/Torque - up to 20 kHz sampling rate (50 μ s)
- Velocity - up to 10 kHz sampling rate (100 μ s)
- Position - up to 10 kHz sampling rate (100 μ s)

5.1.2. Advanced Positioning Control Modes

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

5.1.3. Advanced Filters and Gain Scheduling

- “On-the-Fly” gain scheduling of current and velocity
- Velocity and position with “1-2-2” PIP controllers
- Automatic commutation alignment
- Automatic motor phase sequencing
- Current gain scheduling to compensate for the motor’s non-linear characteristics
- Advanced filtering: Low pass, Notch, General Biquad
- Current loop gain scheduling to compensate for bus voltage variations
- Velocity gain scheduling for reliable velocity loop performance
- Gains & filter scheduling vs. position for mechanical coupling optimization, speed and position tracking errors
- High order filters gain scheduling vs. speed and position



5.1.4. Fully Programmable

- Third generation programming structure
- Event capturing interrupts
- Event triggered programming

5.1.5. Feedback Options

- Incremental Encoder – up to 75 Megacounts per second (18 MHz PPS(Pulses Per Second))
- Digital Halls:
 - Up to 4 kHz commutation frequency
 - 5 V logic
 - Input voltage up to 15 VDC
- Incremental encoder with digital Halls for commutation – up to 75 Megacounts per second for encoder
- Interpolated Analog (Sine/Cosine) Encoder:
 - Supports 1 V PTP Sin/Cos
 - Sin/Cos frequency: up to 500 kHz
 - Internal interpolation: up to ×8192
 - Automatic correction of amplitude mismatch, phase mismatch, signal offset
 - Emulated encoder output of the analog encoder
- Analog Hall Sensor:
 - One feedback electrical cycle = one electrical cycle of the motor
 - Supports 1 V PTP Sin/Cos
 - Sin/Cos Frequency: up to 500 kHz
 - Internal Interpolation: up to ×8192
 - Automatic correction of amplitude mismatch, phase mismatch, signal offset
- Resolver
 - 14 bit resolution
 - Up to 512 revolutions per second (RPS)
 - Emulated encoder outputs of the resolver
- Auxiliary encoder inputs (ECAM, follower, etc.) single-ended, unbuffered
- Tachometer & Potentiometer
- Absolute serial encoders:
 - NRZ (Panasonic, Tamagawa, Mitutoyo, etc.)
 - EnDAT 2.2
 - BiSS/SSI

The Gold Trombone can provide power (5 V, 2x200 mA max) for encoders, resolver or Halls.



5.1.6. Input/Output

- One **analog input** – up to 14-bit resolution
- Six separate programmable **digital inputs**, optically isolated, PLC compatible, can be configured to TTL Level.
- Optional functions:
 - Fast event capture
 - Inhibit/Enable motion
 - Stop motion under control (hard stop)
 - Motion reverse and forward limit switches
 - Begin on input
 - Abort motion
 - Homing
 - General purpose
 - Four separate programmable **digital outputs**
 - TTL level: optically isolated sink and source
 - PLC: optically isolated source
- Optional functions:
 - Fast output compare (for one output only)
 - Brake control
 - Amplifier fault indication
 - General purpose
 - Servo enable indication
- Pulse and Direction inputs (single-ended)
- PWM current command output for torque and velocity

5.1.7. STO (Safe Torque Off) Inputs

- Two **STO inputs**, optically isolated, PLC compliant, can be configured to TTL Level.

5.1.8. 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

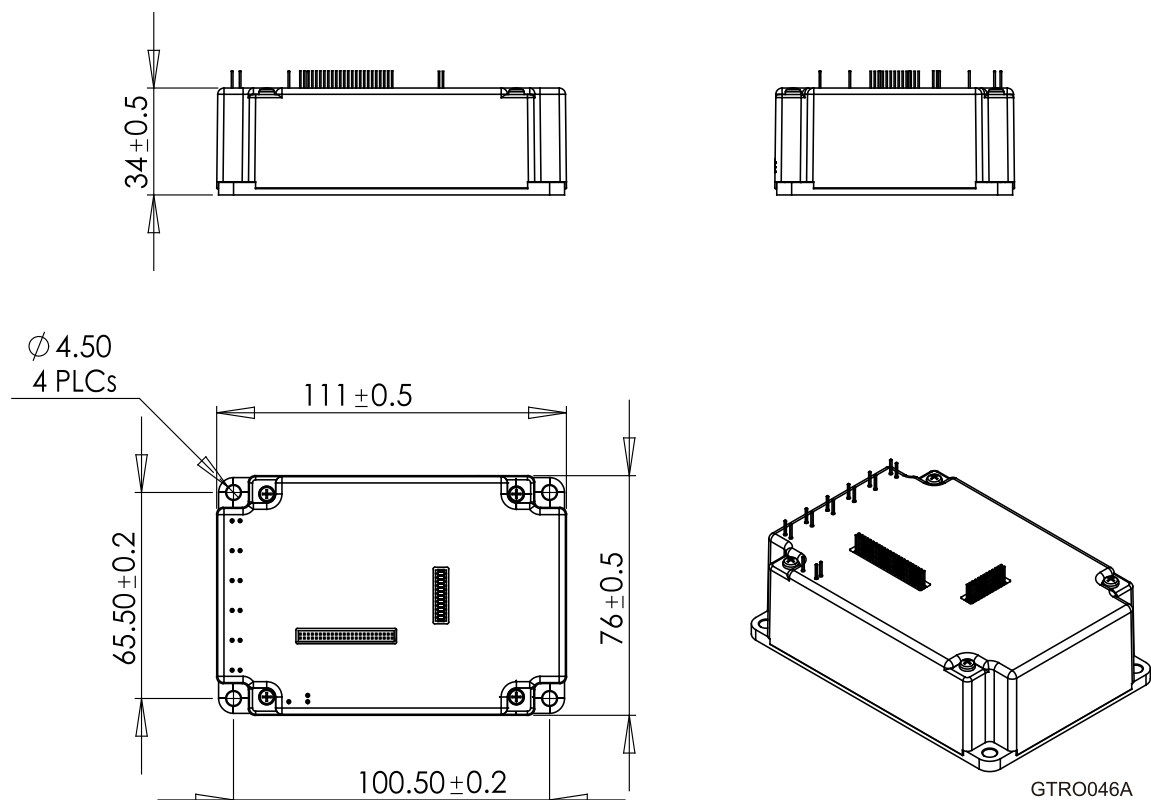
5.1.9. Status Indication

- 2 outputs for a bi-color LEDs

5.1.10. Automatic Procedures

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

5.2. Gold Trombone Dimensions



5.3. Environmental Conditions

Feature	Details
Ambient operating temperature	0 °C to 40 °C (32 °F to 104 °F)
Storage temperature	-20 °C to 85 °C (-4 °F to 185 °F)
Maximum Altitude	10,000 m
Maximum non-condensing humidity	90%
Protection level	IP64



5.4. Control Specifications

5.4.1. Current Loop

Feature	Details
Controller type	Vector, digital
Compensation for bus voltage variations	“On-the-fly” automatic gain scheduling
Motor types	• AC brushless (sinusoidal) • DC brushless (trapezoidal) • DC brush • Linear motors • “Voice” coils
Current control	• Fully digital • Sinusoidal with vector control • Programmable PI control filter based on a pair of PI controls of AC current signals and constant power at high speed
Current loop bandwidth	> 4 kHz closed loop
Current sampling time	Programmable 40 to 120 µsec
Current sampling rate	Up to 20 kHz; default 20 kHz



5.4.2. Velocity Loop

Feature	Details
Controller type	PI + Four advanced filters + Two advanced gain scheduling filters
Velocity control	• Fully digital • Programmable PI and feed forward control filters • On-the-fly gain scheduling according to either speed or position command or feedback. • Automatic, quick, advanced or expert tuning
Velocity and position feedback options	• Incremental Encoder • Digital Halls • Interpolated Analog (sin/cos) Encoder (optional) • Resolver (optional) • Absolute serial encoder Note: With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).
Velocity loop bandwidth	< 500 Hz
Velocity sampling time	80 to 240 µsec (2x current loop sample time)
Velocity sampling rate	Up to 10 kHz; default 10 kHz
Velocity command options	Internally calculated by either jogging or step Note: All software-calculated profiles support on-the-fly changes.

5.4.3. Position Loop

Feature	Details
Controller type	"1-2-2" PIP + three advanced filters + one advanced gain scheduling filter
Position command options	• Software • Pulse and Direction
Position loop bandwidth	< 200 Hz
Position sampling time	80 to 240 µsec (2x current loop sample time)
Position sampling rate	Up to 10 kHz; default 10 kHz



5.5. Feedback

5.5.1. Feedback Supply Voltage

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

Feature	Details
Encoder supply voltage	5 V $\pm$ 5% @ 2 x 200 mA (maximum)

5.5.2. Feedback Options

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



5.5.2.1. Incremental Encoder Input

Feature	Details
Encoder format	• A, B and Index • Differential • Quadrature
Interface	RS-422
Input resistance	Differential: 120 Ω
Maximum incremental encoder frequency	Maximum absolute: 75 Megacounts per second (18 MHz on A/B)
Minimum quadrature input period (PIN)	53 nsec
Minimum quadrature input high/low period (PHL)	26 nsec
Minimum quadrature phase period (PPH)	13 nsec
Maximum encoder input voltage range	Common mode: ± 7 V Differential mode: ± 7 V

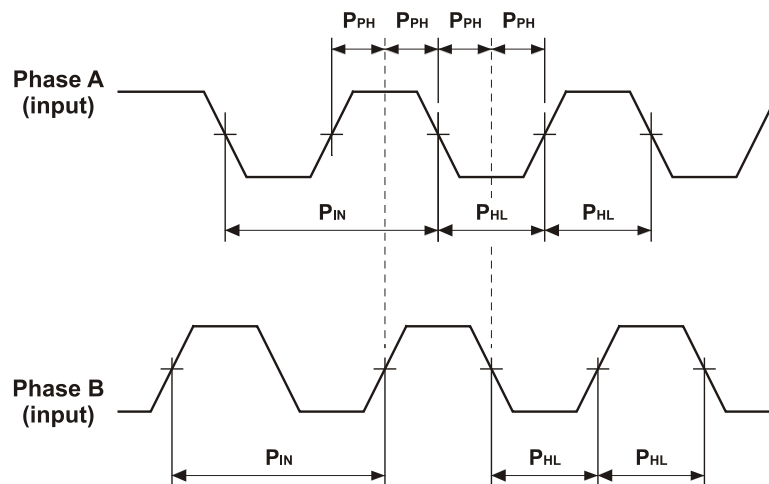


Figure 38: Main Feedback - Encoder Phase Diagram



5.5.2.2. Digital Halls

Feature	Details
Hall inputs	• H_A, H_B, H_C • Single ended inputs • Built in hysteresis of 1 V for noise immunity
Input voltage	Nominal operating range: $0\text{ V} < V_{In_Hall} < 5\text{ V}$ Maximum absolute: $-1\text{ V} < V_{In_Hall} < 15\text{ V}$ High level input voltage: $V_{InHigh} > 2.5\text{ V}$ Low level input voltage: $V_{InLow} < 1\text{ V}$
Input current	Sink current (when input pulled to the common): 5 mA
Maximum frequency	$f_{MAX} : 4\text{ kHz}$

5.5.2.3. Interpolated Analog (Sine/Cosine) Encoder

Feature	Details
Analog encoder format	Sine and Cosine signals
Analog input signal level	• Offset voltage: 2.2 V to 2.8 V • Differential, 1 V peak to peak
Input resistance	Differential: 120 Ω
Maximum analog signal frequency	$f_{MAX} : 500\text{ kHz}$
Interpolation multipliers	Programmable: x4 to x8192
Maximum “counts” frequency	$2 \times 10^9\text{ counts/sec}$
Automatic error correction	• Signal amplitudes mismatch • Signal phase shift • Signal offsets
Encoder outputs	See Port C Encoder Outputs Specifications, Section 5.5.3.



5.5.2.4. Resolver

Feature	Details
Resolver format	• Sine/Cosine • Differential
Input resistance	Differential 2.49 k Ω
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 Gold Trombone
Reference current	up to ± 50 mA
Encoder outputs	See Port C Encoder Output Specifications, Section 5.5.3.

5.5.2.5. Absolute Serial Encoder

Feature	Details
Encoder format	• NRZ (Panasonic, Tamagawa, Mitutoyo, etc.) • EnDAT 2.2 • BiSS/SSI
Interface	• RS-485 • Clock – Differential output line • Data – Differential bidirectional line
Input Resistance	Differential 120 Ω
Transmission Rate	Up to 2.5 MHz



5.5.3. Port C Feedback Output

Feature	Details
Emulated output	• A, B, Index • Differential
Interface	RS-422
Output current capability	Maximum output current: $I_{OH} (\text{max}) = 2 \text{ mA}$ High level output voltage: $V_{OH} > 3.0 \text{ V}$ Minimum output current: $I_{OL} = 2 \text{ mA}$ Low level output voltage: $V_{OL} < 0.4 \text{ V}$
Available as options	• Emulated encoder output of any sensor on Port A or Port B • Daisy chain Port A or Port B • Emulated encoder output of internal variables • Emulated encoder outputs of the tachometer • Emulated encoder outputs of the potentiometer
Maximum frequency	f_{MAX} : 8 MHz pulses/output
Edge separation between A & B	Programmable number of clocks to allow adequate noise filtering at remote receiver of emulated encoder signals (default 2 MHz)
Index (marker)	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

5.6. I/Os

The Gold Trombone has:

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

5.6.1. Digital Input Interfaces – TTL Mode

Feature	Details
Suffix applicable	T or 1
Type of input	Optically isolated
Input current for all inputs	$I_{in} = 3.8 \text{ mA @ } V_{in} = 5 \text{ V}$
High-level input voltage	$2.4 \text{ V} < V_{in} < 15 \text{ V}$, 5 V typical
Low-level input voltage	$0 \text{ V} < V_{in} < 0.8 \text{ V}$
Minimum pulse width	>250 μsec for inputs 1-6, >3 msec for STO
Execution time (all inputs): the time from application of voltage on input until execution is complete	$0 < T < 250 \mu\text{sec}$
High-speed inputs – 1 to 6 minimum pulse width, in high- speed mode	$T > 5 \mu\text{sec}$ if the input functionality is set to latch/capture (index/strobe). Notes: • Home mode is high-speed mode and can be used for fast capture and precise homing. • Highest speed is achieved when turning on optocouplers.
Capture with differential input Port A, Port B Index	$T > 0.1 \mu\text{sec}$ if the differential input functionality is set to touch probe/capture (index/strobe).

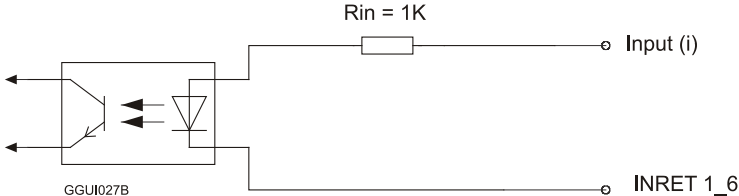
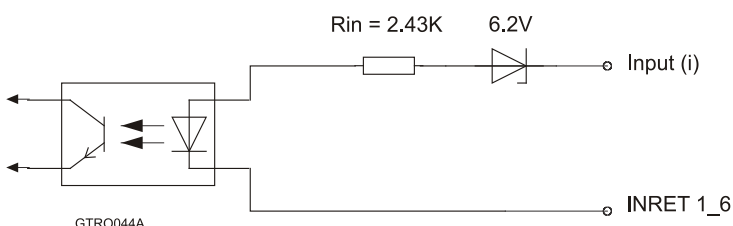


Figure 39: Digital Input Schematic

5.6.2. Digital Input Interfaces – PLC Mode

Feature	Details
Suffix applicable	S or 0
Type of input	Optically isolated
Input current for all inputs	$I_{in} = 2 \text{ mA} @ V_{in} = 12 \text{ V}$
High-level input voltage	$12 \text{ V} < V_{in} < 30 \text{ V}$
Low-level input voltage	$0 \text{ V} < V_{in} < 7 \text{ V}$
Minimum pulse width	$> 250 \mu\text{sec}$
Execution time (all inputs): the time from application of voltage on input until execution is complete	$0 < T < 250 \mu\text{sec}$
High-speed inputs – 1 to 6 minimum pulse width, in high- speed mode	$T > 5 \mu\text{sec}$ if the input functionality is set to latch/capture (index/strobe). Notes: - Home mode is high-speed mode and can be used for fast capture and precise homing. - Highest speed is achieved when turning on optocouplers.
Capture with differential input Port A, Port B Index	$T > 0.1 \mu\text{sec}$ if the differential input functionality is set to touch probe/capture (index/strobe).
 Figure 40: Digital Input Schematic	

5.6.3. Digital Output Interface – PLC Mode

Feature	Details
Suffix applicable	S or 0
Type of output	Optically isolated source
Maximum supply output (VDD)	30 V
Maximum output current $I_{out} (max) (V_{out} = Low)$	$I_{out} (max) \leq 500 \text{ mA}$ for output 1 $I_{out} (max) \leq 250 \text{ mA}$ for outputs 2 to 4
VOL at maximum output voltage (low level)	$V_{out} (on) \leq 0.3 \text{ V}$
R_L	The external resistor R_L must be selected to limit the output current to no more than 500 mA (output 1) or 250 mA (outputs 2 to 4). $R_L = \frac{VDD - VOL}{I_{out} (max)}$
Executable time	$0 < T < 250 \mu\text{sec}$

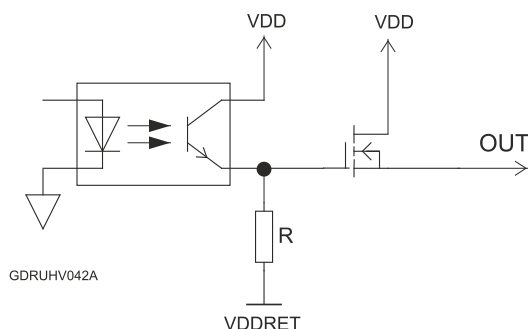


Figure 41: Digital Output Schematic

5.6.4. Digital Output Interface – TTL Mode

Feature	Details
Suffix applicable	T or 1
Type of output	• Optically isolated • Source/Sink
Maximum supply output (VDD)	15 V
Max. output current $I_{out} (max) (V_{out} = Low)$	7 mA
VOL at maximum output voltage (low level)	$V_{out} (on) \leq 0.4 V$
Executable time	$0 < T < 250 \mu sec$

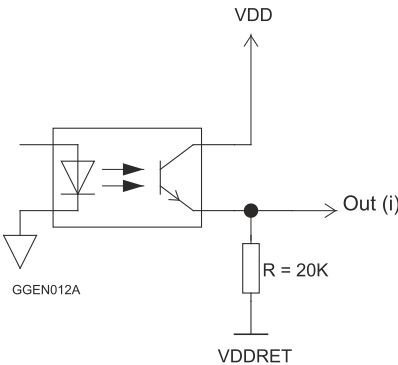


Figure 42: Digital Output Schematic

5.6.5. Analog Input

Feature	Details
Maximum operating differential voltage	$\pm 10 V$
Maximum absolute differential input voltage	$\pm 16 V$
Differential input resistance	3.74 k Ω
Analog input command resolution	14-bit

5.7. Safe Torque Off (STO)

The Gold Trombone has two STO (Safe Torque Off) inputs.

5.7.1. STO Input Interfaces – TTL Mode

Feature	Details
Suffix applicable	T or 1
Type of input	Optically isolated
Input current for all inputs	$I_{in} = 3.8 \text{ mA @ } V_{in} = 5 \text{ V}$
High-level input voltage	$2.4 \text{ V} < V_{in} < 15 \text{ V}$, 5 V typical
Low-level input voltage	$0 \text{ V} < V_{in} < 0.8 \text{ V}$
Minimum pulse width	$>3 \text{ ms}$

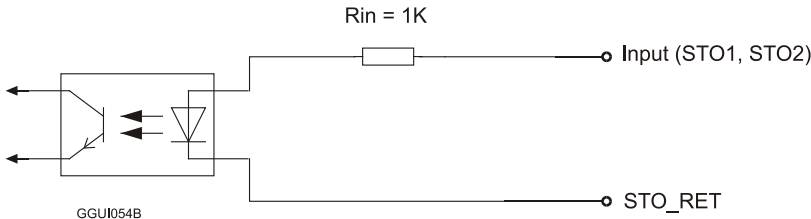


Figure 43: STO Input Schematic

5.7.2. STO Input Interfaces – PLC Mode

Feature	Details
Suffix applicable	S or 0
Type of input	Optically isolated
Input current for all inputs	$I_{in} = 2 \text{ mA @ } V_{in} = 12 \text{ V}$
High-level input voltage	$12 \text{ V} < V_{in} < 30 \text{ V}$
Low-level input voltage	$0 \text{ V} < V_{in} < 7 \text{ V}$
Minimum pulse width	$>3 \text{ ms}$

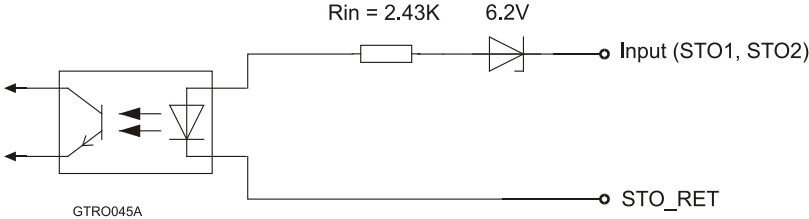


Figure 44: STO Input Schematic



5.8. Communications

Specification	Details
CANopen	CAN bus Signals: • CAN_H, CAN_L, CAN_COMRET • 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
EtherCAT	• 100base-T • Baud Rate: 100 Mbit/sec • CAT5 Cable • CoE, FoE, EoE
Ethernet	• 100base-T • Baud Rate: 100 Mbit/sec • CAT5 Cable • UDP, Telnet
USB	• USB 2.0 Device mode

5.9. Pulse-Width Modulation (PWM)

Feature	Details
PWM resolution	12-bit
PWM switching frequency on the load	1/Ts (factory default 20 kHz on the motor)

5.10. 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)