
ExtrIQ_{Line}

Panther Digital Servo Drive Installation Guide



October 2017 (Ver. 1.303)



www.elmomc.com

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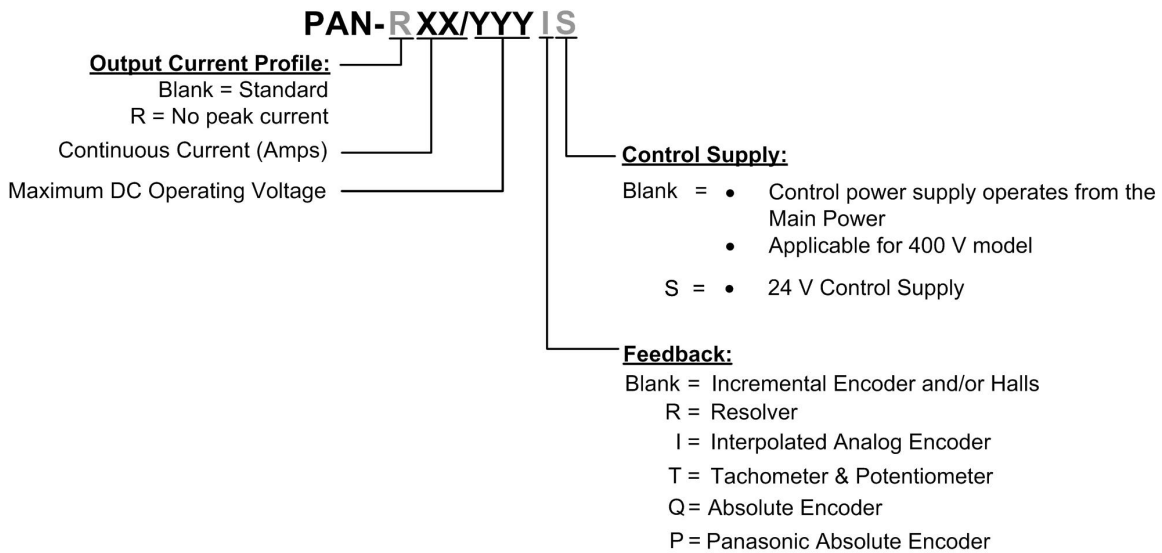
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Catalog Number



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Table of Contents

Chapter 1: Safety Information	8
1.1. Warnings.....	9
1.2. Cautions.....	9
1.3. Directives and Standards.....	10
1.4. CE Marking Conformance.....	11
1.5. Warranty Information	11
Chapter 2: Product Description	12
2.1. <i>ExtrIQ</i> Product Family.....	12
2.2. Drive Description.....	13
2.3. Product Features	14
2.3.1. Current Control.....	14
2.3.2. Velocity Control	14
2.3.3. Position Control	14
2.3.4. Advanced Position Control	15
2.3.5. Communication Options.....	15
2.3.6. Feedback Options	15
2.3.7. Fault Protection	16
2.4. System Architecture	16
2.5. How to Use this Guide.....	17
Chapter 3: Installation	18
3.1. Site Requirements	18
3.2. Unpacking the Drive Components.....	18
3.3. Pinouts.....	20
3.3.1. Connector Types.....	20
3.3.2. Connector J1	21
3.3.3. Connector J2.....	22
3.4. Mounting the Panther	23
3.5. Integrating the Panther on a PCB.....	24
3.5.1. Traces.....	24
3.5.2. Grounds and Returns.....	25
3.6. Connection Diagrams	26
3.7. Main Power and Motor Power	29
3.7.1. Connecting Motor Power	29
3.7.2. Connecting the DC Power.....	30
3.7.2.1. Direct-to-Mains Power Source (Non-Isolated Rectifier).....	30
3.7.2.2. Battery Power Supply	34
3.8. Connecting the Control and Backup Supply	34
3.9. Main Feedback	35
3.10. Auxiliary Feedback.....	46

3.10.1.	Main and Auxiliary Feedback Combinations	47
3.10.2.	Auxiliary Feedback: Emulated Encoder Output Option (YA[4]=4).....	49
3.10.3.	Auxiliary Feedback: Single-Ended Encoder Input Option (YA[4]=2)	51
3.10.4.	Auxiliary Feedback: Pulse-and-Direction Input Option (YA[4]=0)	53
3.11.	User I/Os.....	56
3.11.1.	Digital Input	56
3.11.2.	Digital Output	59
3.11.3.	Analog Input	61
3.12.	Communications.....	62
3.12.1.	RS-232 Communication	62
3.12.2.	CAN Communication	63
3.13.	Powering Up	65
3.13.1.	Initializing the System.....	65
3.14.	Heat Dissipation.....	65
3.14.1.	Panther Thermal Data	65
3.14.2.	Heat Dissipation Data	66
3.14.3.	How to Use the Charts.....	67
Chapter 4: Technical Specifications		68
4.1.	Features.....	68
4.1.1.	Motion Control Modes	68
4.1.2.	Advanced Positioning Control Modes	68
4.1.3.	Advanced Filters and Gain Scheduling.....	68
4.1.4.	Fully Programmable.....	68
4.1.5.	Feedback Options	69
4.1.6.	Input/Output	69
4.1.7.	Built-In Protection	70
4.1.8.	Status Indication	70
4.1.9.	Automatic Procedures	70
4.2.	Dimensions	71
4.3.	Power Ratings for 400 V models	72
4.4.	Power Ratings for 700 V models	73
4.5.	Power Ratings for 800 V models	74
4.6.	Auxiliary Supply	75
4.7.	Environmental Conditions	75
4.8.	Control Specifications.....	76
4.8.1.	Current Loop.....	76
4.8.2.	Velocity Loop	77
4.8.3.	Position Loop	77
4.9.	Feedbacks.....	78
4.9.1.	Feedback Supply Voltage.....	78
4.9.2.	Main Feedback Options.....	78
4.9.2.1.	Incremental Encoder Input.....	78
4.9.2.2.	Digital Halls	79
4.9.2.3.	Interpolated Analog (Sine/Cosine) Encoder	79



- 4.9.2.4. Absolute Serial Encoder..... 80
- 4.9.2.5. Resolver 80
- 4.9.2.6. Tachometer..... 81
- 4.9.2.7. Potentiometer 81
- 4.9.3. Auxiliary Feedback Port (output mode YA[4]= 4)..... 82
- 4.9.4. Auxiliary Feedback Port (input mode YA[4]= 2, 0)..... 83
- 4.10. I/Os 84
 - 4.10.1. Digital Input Interfaces 84
 - 4.10.2. Digital Output Interface..... 85
 - 4.10.3. Analog Input 85
- 4.11. Communications..... 86
- 4.12. Pulse-Width Modulation (PWM)..... 86
- 4.13. Compliance with Standards..... 87

Chapter 1: Safety Information

In order to operate the Panther servo drive safely, it is imperative that you implement the safety procedures included in this installation guide. This information is provided to protect you and to keep your work area safe when operating the Panther and accompanying equipment.

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

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

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

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

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

The following safety symbols are used in this manual:



Warning:

This information is needed to avoid a safety hazard, which might cause bodily injury.



Caution:

This information is necessary for preventing damage to the product or to other equipment.



1.1. Warnings

- To avoid electric arcing and hazards to personnel and electrical contacts, never connect/disconnect the servo drive while the power source is on.
- Disconnect the Panther from all voltage sources before it is opened for servicing.
- The Panther servo drive contains grounding conduits for electric current protection. Any disruption to these conduits may cause the instrument to become hot (live) and dangerous.
- After shutting off the power and removing the power source from your equipment, wait at least 1 minute before touching or disconnecting parts of the equipment that are normally loaded with electrical charges (such as capacitors or contacts). It is recommended to measure the electrical contact points with a meter before touching the equipment.



1.2. Cautions

- The Panther servo drive contains hot surfaces and electrically charged components during operation.
- The maximum DC power supply connected to the instrument must comply with the parameters outlined in this guide.
- When connecting to Panther to an approved isolated 24 VDC auxiliary power supply, connect it through a line that is separated from hazardous live voltages using reinforced or double insulation in accordance with approved safety standards.
- Before switching on the Panther, verify that all safety precautions have been observed and that the installation procedures in this manual have been followed.
- Do not clean any of the Panther drive's soldering with solvent cleaning fluids of pH greater than 7 (8 to 14). The solvent corrodes the plastic cover causing cracks and eventual damage to the drive's PCBs.

Elmo recommends using the cleaning fluid Vigon-EFM which is pH Neutral (7).

For further technical information on this recommended cleaning fluid, select the link:

http://www.zestron.com/fileadmin/zestron.com-usa/daten/electronics/Product_TI1s/TI1-VIGON_EFM-US.pdf

1.3. Directives and Standards

The Panther 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 Panther 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 Panther 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 Panther meets the provisions outlined in Council Directive 73/23/EEC. The party responsible for ensuring that the equipment meets the limits required by EMC regulations is the manufacturer of the end product.

1.5. Warranty Information

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

Chapter 2: Product Description

This installation guide describes the Panther 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. *ExtriQ* Product Family

Elmo Motion Control's *ExtriQ* product family is a set of durable motion control products for applications operating under extreme environmental conditions. The products are capable of

Feature	Operation Conditions	Range
Ambient Temperature Range	Non-operating conditions	-50 °C to +100 °C (-58 °F to 212 °F)
	Operating conditions	-40 °C to +70 °C (-40 °F to 160 °F)
Temperature Shock	Non-operating conditions	-40 °C to +70 °C (-40 °F to 160 °F) within 3 min
Altitude	Non-operating conditions	Unlimited
	Operating conditions	-400 m to 12,000 m (-1312 to 39370 feet)
Relative Humidity	Non-operating conditions	Up to 95% relative humidity non-condensing at 35 °C (95 °F)
	Operating conditions	Up to 95% relative humidity non-condensing at 25 °C (77 °F), up to 90% relative humidity non-condensing at 42 °C (108 °F)
Vibration	Operating conditions	20 Hz to 2000 Hz, 14.6 g
Mechanical Shock	Non-operating conditions	±40 g; Half sine, 11 msec
	Operating conditions	±20 g; Half sine, 11 msec

ExtriQ products have a high power density in the range of 50 W to 65 kW and current carrying capacity of up to 140 A (280 A peak). All *ExtriQ* servo drives have been tested using methods and procedures specified in a variety of extended environmental conditions (EEC) standards.

Based on Elmo Motion Control's innovative *ExtriQ* core technology, they support a wide range of motor feedback options, programming capabilities and communication protocols.

2.2. Drive Description

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

The digital drives are based on Elmo's advanced SimplIQ motion control technology. They operate from a DC power source in current, velocity, position and advanced position modes, in conjunction with a permanent-magnet synchronous brushless motor, DC brush motor, linear motor or voice coil. They are designed for use with any type of sinusoidal and trapezoidal commutation, with vector control. The Panther can operate as a stand-alone device or as part of a multi-axis system in a distributed configuration on a real-time network.

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

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

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

If backup functionality is required to store control parameters in the event of a mains power outage, then an S-model Panther 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, Panther models that do *not* have the Control Supply S option in the catalog number (only for 400 V models -see page 19) can be used, i.e., they do not have a 24 V control supply. In these models, a smart control-supply algorithm enables the Panther 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 Panther is a PCB-mounted device, which enables efficient and cost-effective implementation. It is a basic servo drive, which operates in current, velocity, and position modes including Follower and PT & PVT. It operates simultaneously via RS-232 and CAN DS 301, DS 305, DS 402 communications and features a third-generation programming environment, as well as advanced positioning capabilities: ECAM, Dual Loop and increased program size.

2.3. Product Features

2.3.1. 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

2.3.2. 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

2.3.3. Position Control

- Programmable PIP control filter
- Programmable notch and low-pass filters
- Position follower mode for monitoring the motion of the slave axis relative to a master axis, via an auxiliary encoder input
- Pulse-and-direction inputs
- Sample time: four times that of the current loop
- Fast event capturing inputs
- PT and PVT motion modes
- Fast output compare (OC)

2.3.4. Advanced Position Control

- Position-based and time-based ECAM mode that supports a non-linear follower mode, in which the motor tracks the master motion using an ECAM table stored in flash memory
- Dual (position/velocity) loop

2.3.5. Communication Options

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

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

2.3.6. Feedback Options

- Incremental Encoder – up to 20 Megacounts (5 Megapulses) per second
- Digital Halls – up to 2 kHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Megacounts per second for encoder
- Interpolated Analog (Sine/Cosine) Encoder – up to 250 kHz (analog signal)
 - Internal Interpolation - up to x4096
 - Automatic correction of amplitude mismatch, phase mismatch, signals offset
 - Auxiliary emulated, unbuffered, single-ended, encoder output
- Resolver
 - Programmable 10 to 15 bit resolution
 - Up to 512 revolutions per second (RPS)
 - Auxiliary emulated, unbuffered, single-ended, encoder output
- Tachometer, Potentiometer
- Absolute Encoder
 - Heidenhain 2.1
 - Heidenhain 2.2
 - Panasonic
- Elmo drives provide supply voltage for all the feedback options

2.3.7. Fault Protection

The Panther includes built-in protection against possible fault conditions, including:

- Software error handling
- Status reporting for a large number of possible fault conditions
- Protection against conditions such as excessive temperature, under/over voltage, loss of commutation signal, short circuits between the motor power outputs and between each output and power input/return
- Recovery from loss of commutation signals and from communication errors

2.4. System Architecture

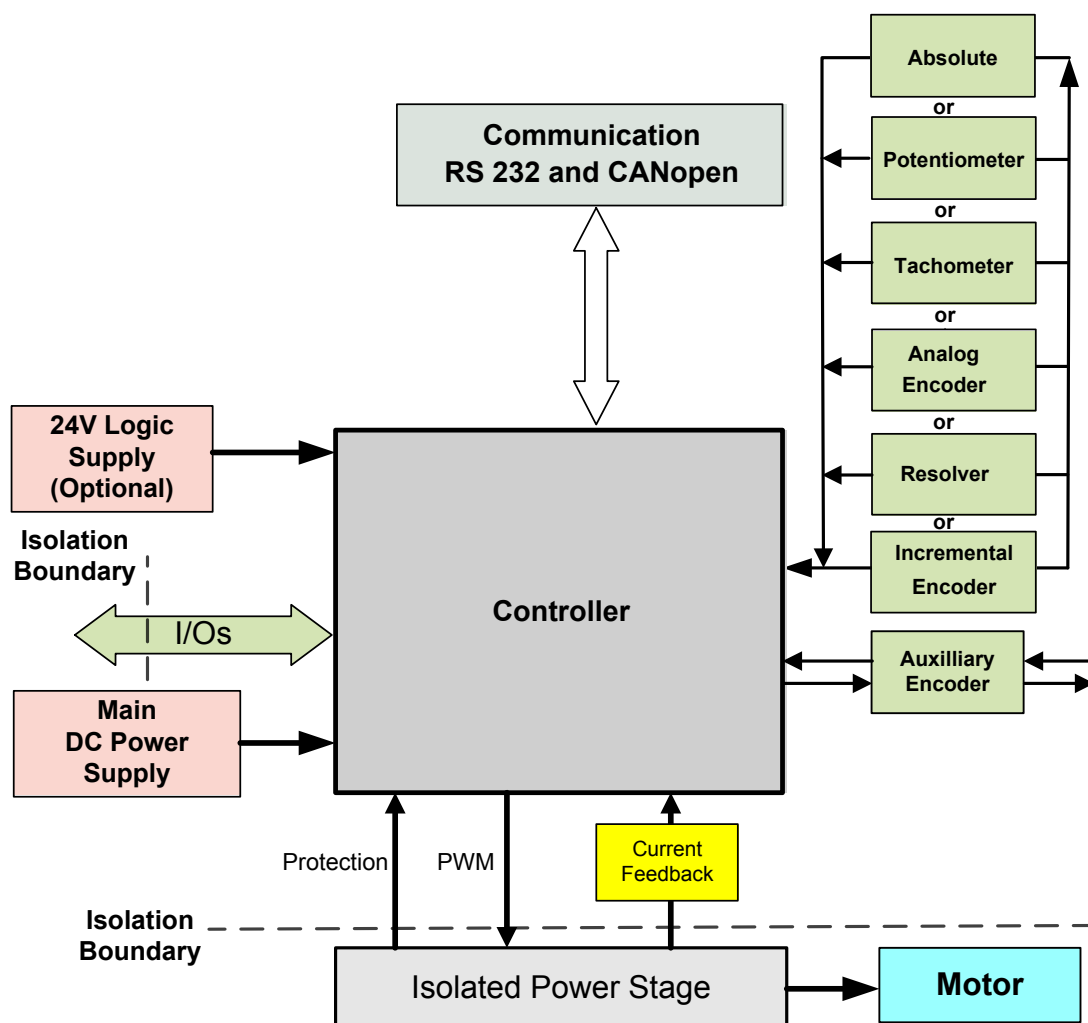


Figure 1: Panther System Block Diagram

2.5. How to Use this Guide

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

Upon completing the instructions in this guide, the Panther servo drive should be successfully mounted and installed. From this stage, you need to consult higher level Elmo documentation in order to set up and fine-tune the system for optimal operation:

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

Chapter 3: Installation

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

3.1. Site Requirements

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

Feature	Value
Ambient operating temperature	-40 °C to +70 °C (-40 °F to 160 °F)
Maximum operating altitude	12,000 m (39370 feet)
Maximum non-condensing humidity	95%
Operating area atmosphere	No flammable gases or vapors permitted in area



Caution:

The Panther dissipates its heat by convection. The maximum operating ambient temperature of 70 °C (160 °F) must not be exceeded.

3.2. Unpacking the Drive Components

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

- The Panther servo drive
- The Composer software and software manual

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

To unpack the Panther:

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.

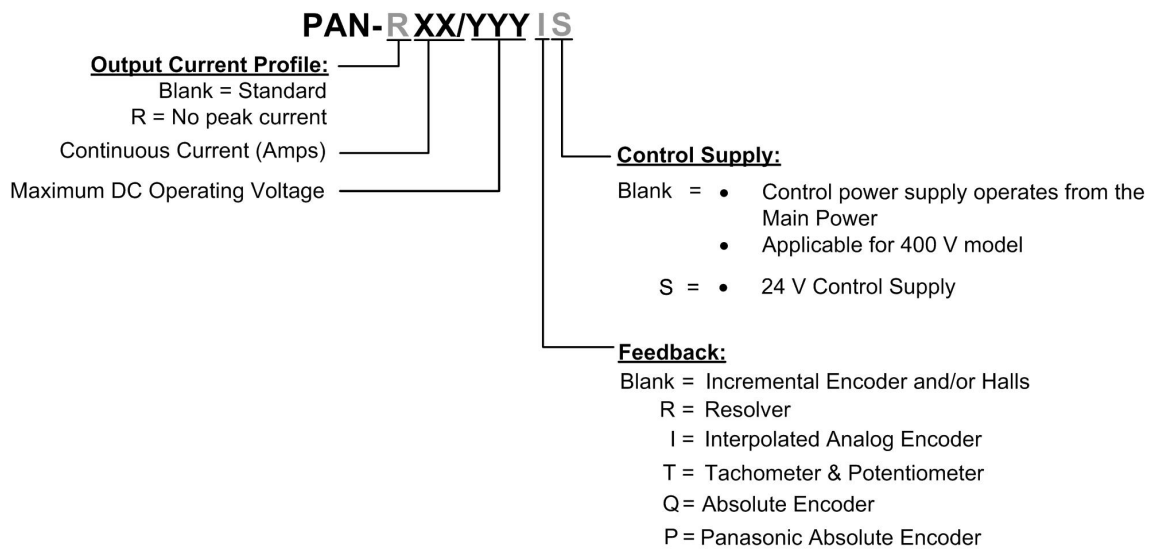
- To ensure that the Panther you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Panther. It looks like this:



PAN028B

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

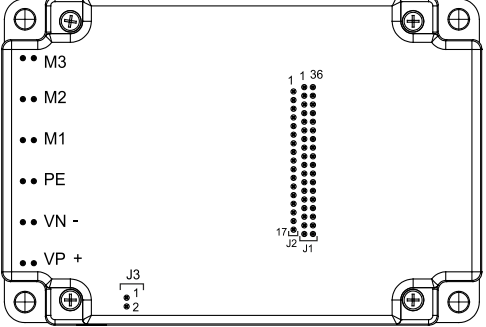
The part number at the top gives the type designation as follows:



3.3. Pinouts

The Panther has 9 connectors.

3.3.1. Connector Types

Pins	Type	Port	Function	Connector Location
2x18	2 mm pitch 0.51 mm ²	J1	I/O, COMM, Auxiliary Feedback	
17		J2	Main Feedback, Analog Input, LED	
1x2		J3.1	24 VDC Auxiliary power input positive (Only in Panther models with the S option)	
	J3.2	24 VDC Auxiliary power input return (Only in Panther models with the S option)		
2	2.54 mm pitch 0.64 mm ²	VP+	Positive DC power input	
2		VN-	Negative DC power input	
2		PE	Protective earth	
2		M1	Motor power output 1	
2		M2	Motor power output 2	
2		M3	Motor power output 3	

3.3.2. Connector J1

Connector J1: Communications, Auxiliary Feedback, I/O functions

Pin (J1)	Signal	Function
1	RS232_RX	RS-232 receive
2	RS232_TX	RS-232 transmit
3	RS232_COMRET	RS-232 communication return
4	AUX PORT CHA	Auxiliary port CHA (bidirectional)
5	AUX PORT CHB	Auxiliary port CHB (bidirectional)
6	COMRET	Common return
7	OUT1	Programmable digital output 1
8	OUT2	Programmable digital output 2
9	OUT3	Programmable digital output 3
10	OUT4	Programmable digital output 4
11	IN1	Programmable digital input 1
12	IN2	Programmable digital input 2
13	IN3	Programmable digital input 3
14	IN4	Programmable digital input 4
15	IN5	Programmable digital input 5
16	IN6	Programmable digital input 6
17	SAFETY1	Safety input 1
18	SAFETY2	Safety input 2
19	SAFETY2RET	Safety input 1 return (optionally connected to J1/20)
20	SAFETY1RET	Safety input 2 return (optionally connected to J1/19)
21	INRET6	Programmable digital input 6 return
22	INRET5	Programmable digital input 5 return
23	INRET4	Programmable digital input 4 return
24	INRET3	Programmable digital input 3 return
25	INRET2	Programmable digital input 2 return
26	INRET1	Programmable digital input 1 return
27	OUTRET4	Programmable digital output 4 return
28	OUTRET3	Programmable digital output 3 return
29	OUTRET2	Programmable digital output 2 return
30	OUTRET1	Programmable digital output 1 return

Pin (J1)	Signal	Function
31	+5 V	Encoder +5 V supply voltage Maximum output current: 200 mA
32	SUPRET	Supply return
33	AUX PORT INDEX	Auxiliary port index (bidirectional)
34	CAN_COMRET	CAN communication return
35	CAN_L	CAN_L bus line (dominant low)
36	CAN_H	CAN_H bus line (dominant high)

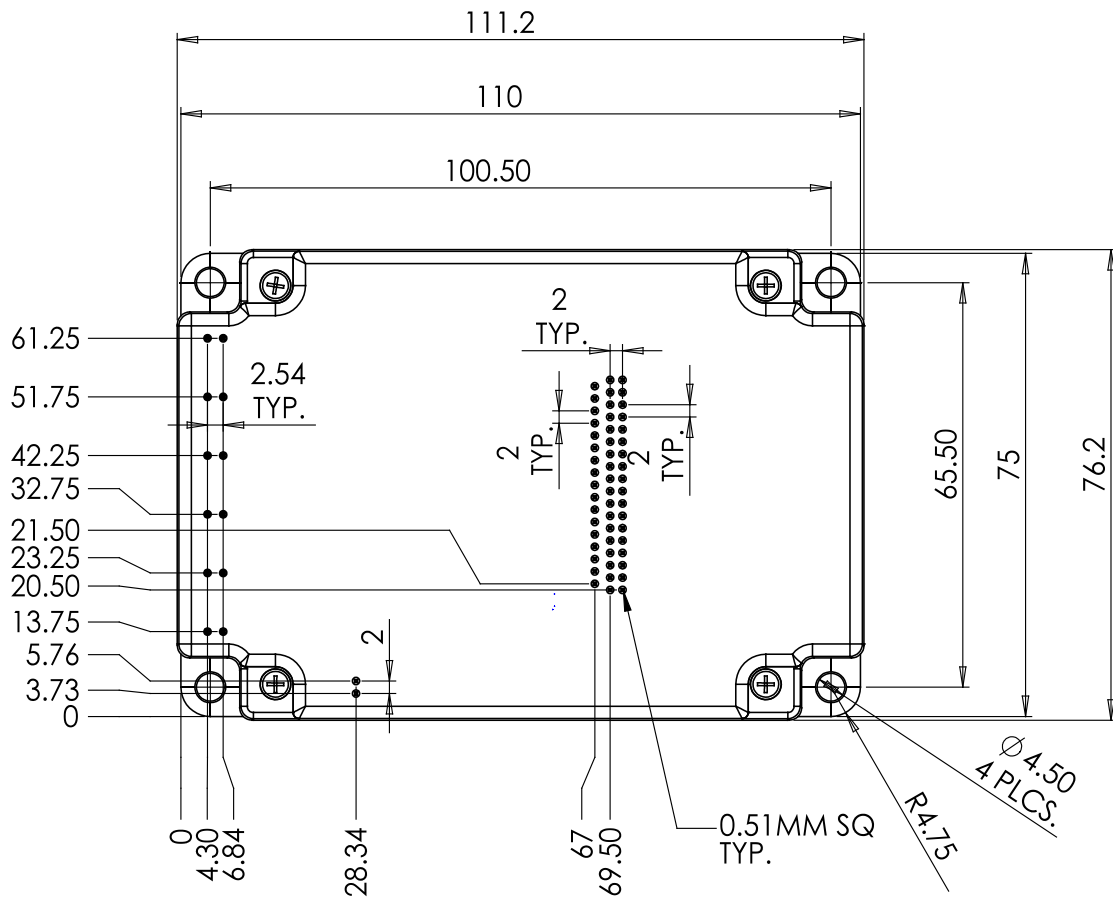
3.3.3. Connector J2

Connector J2: Main Feedback and Analog Input functions

Pin (J2)	Signal	Function
1	+5V	Encoder/Hall +5V supply voltage Maximum output current: 200 mA
2	COMRET	Supply and common return
3	ANALIN1+	Analog input 1+
4	ANALIN1-	Analog input 1-
5	CHA	Channel A+
6	CHA-	Channel A-
7	CHB	Channel B+
8	CHB-	Channel B-
9	INDEX+/DATA+	Index + or Data+
10	INDEX-/DATA-	Index – or Data-
11	CLOCK+	Clocking+
12	CLOCK-	Clocking-
13	HA	Hall sensor A input
14	HB	Hall sensor B input
15	HC	Hall sensor C input
16	LED_2_OUT	Bi-color indication output 2 (Cathode). Implement this pin-out usage by connecting it to a led (as necessary).
17	LED_1_OUT	Bi-color indication output 1 (Anode). Implement this pin-out usage by connecting it to a led (as necessary).

3.4. Mounting the Panther

The Panther (Figure 2) is designed for mounting on a printed circuit board (PCB). It is connected by 2 mm pitch 0.51 mm square pins and 2.54 mm pitch 0.64 mm square pins. When integrating the Panther into a PCB, be sure to leave about 1 cm (0.4") outward from the heat sink to enable free convection of the air around the Panther. We recommend that the Panther be soldered directly to the board. If the PCB is enclosed in a metal chassis, we recommend that the Panther be screw-mounted to it as well to help with heat dissipation. The Panther has screw-mount holes on each corner of the heat sink for this purpose.



TRO0001D

All dimensions are in mm.

Figure 2: Panther Dimensions

3.5. Integrating the Panther on a PCB

The Panther is designed to be mounted on a PCB, by soldering its pins directly to the PCB. The following procedures apply.

3.5.1. Traces

To implement 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 (Ic) of the Panther 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	700 & 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	700 & 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	700 & 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

Complying with the rules above will help satisfy UL safety standards, and the IPC-D-275 standard for non-coated conductors, operating at voltages lower than 800 VDC.

3.5.2. Grounds and Returns

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

Functional Block	Return Pin
RS-232 Communications	RS232_COMRET (J1/3)
CAN Communications	CAN_COMRET (J1/34)
Control section	COMRET (J1/6)
Aux. Feedback	SUPRET (J1/32)
Main Feedback/ Analog input	SUPRET (J2/2)

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

6. 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 Panther. **DO NOT USE A COMMON GROUND PLANE.** Shorting the common returns on the Integration Board may cause performance degradation (ground loops, etc.).
7. **Inputs:** The 6 digital inputs are optically isolated from the other parts of the Panther. Each input has its own return line, INRET#. To retain isolation, the Input Return pins and all other conductors on the input circuit, must be laid out separately.
8. **Outputs:** The 4 digital outputs are optically isolated from the other parts of the Panther. Each output has its own return line, OUTRET# that is also optically isolated. To retain isolation, all the output circuit conductors must be laid out separately.
9. **Return Traces:** The return traces should be as large as possible, but without shorting each other, and with minimal crossover.
10. **Main Power Supply and Motor Traces:** The power traces must be kept as far away as possible from the feedback, control and communication traces.
11. **PE Terminal:** The PE (Protective Earth) terminal is connected directly to the Panther’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.
12. 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.



Caution:

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

3.6. Connection Diagrams

The following three connection diagrams (Figure 3, Figure 4) show the three different ways of connecting the power supply:

- 400 V, 700 V, and 800 V S models (the catalog number has an S option) that feature backup functionality and require an auxiliary 24 V backup supply. The drive will not be operative without the external 24 VDC supply.
- 400 V model without backup functionality. The drive's internal DC/DC converter is fed from the VP+ and VN- of the internal drive's bus line.

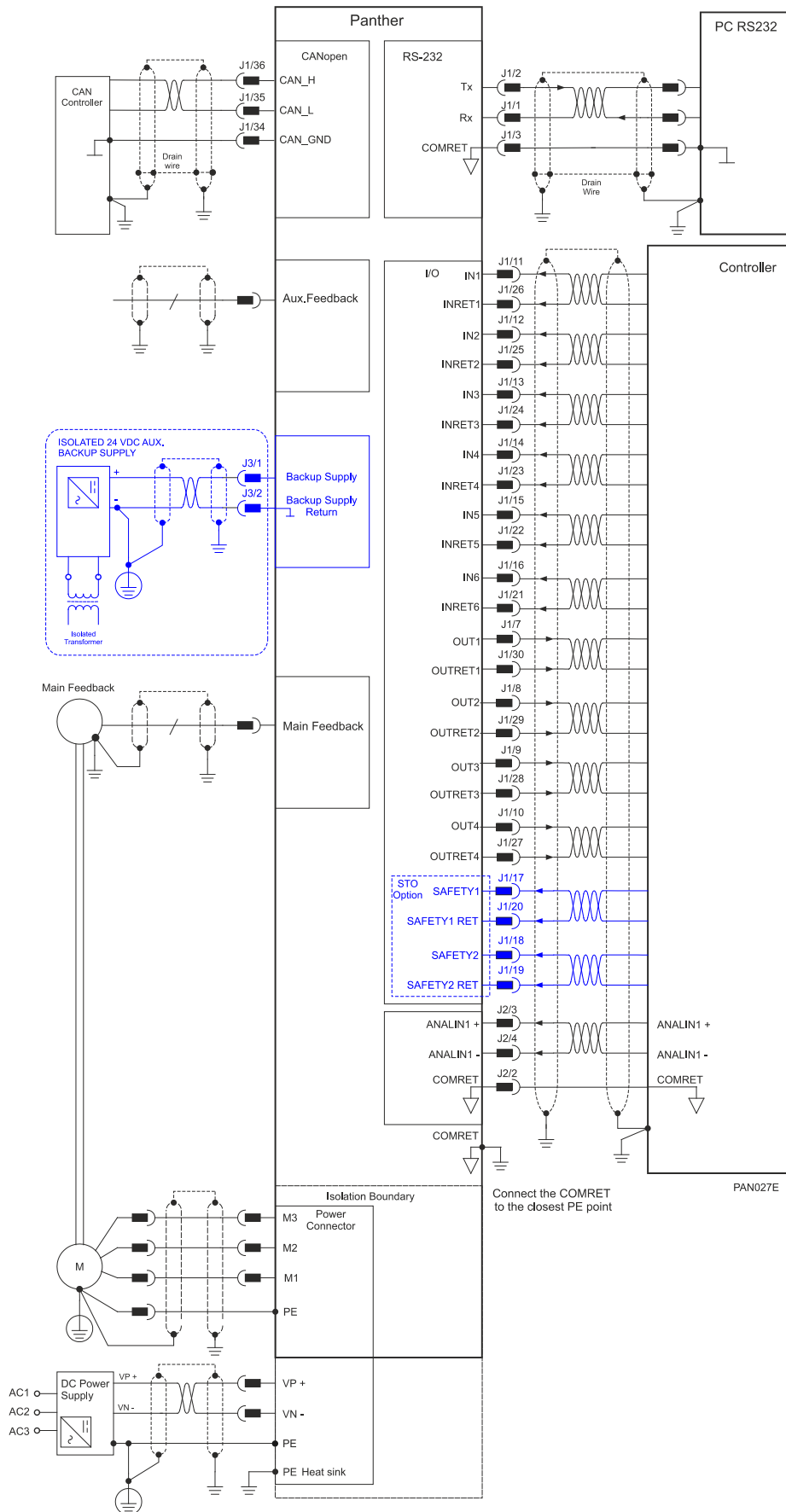


Figure 3: Panther Connection Diagram – with Backup Functionality (S Suffix Drive)

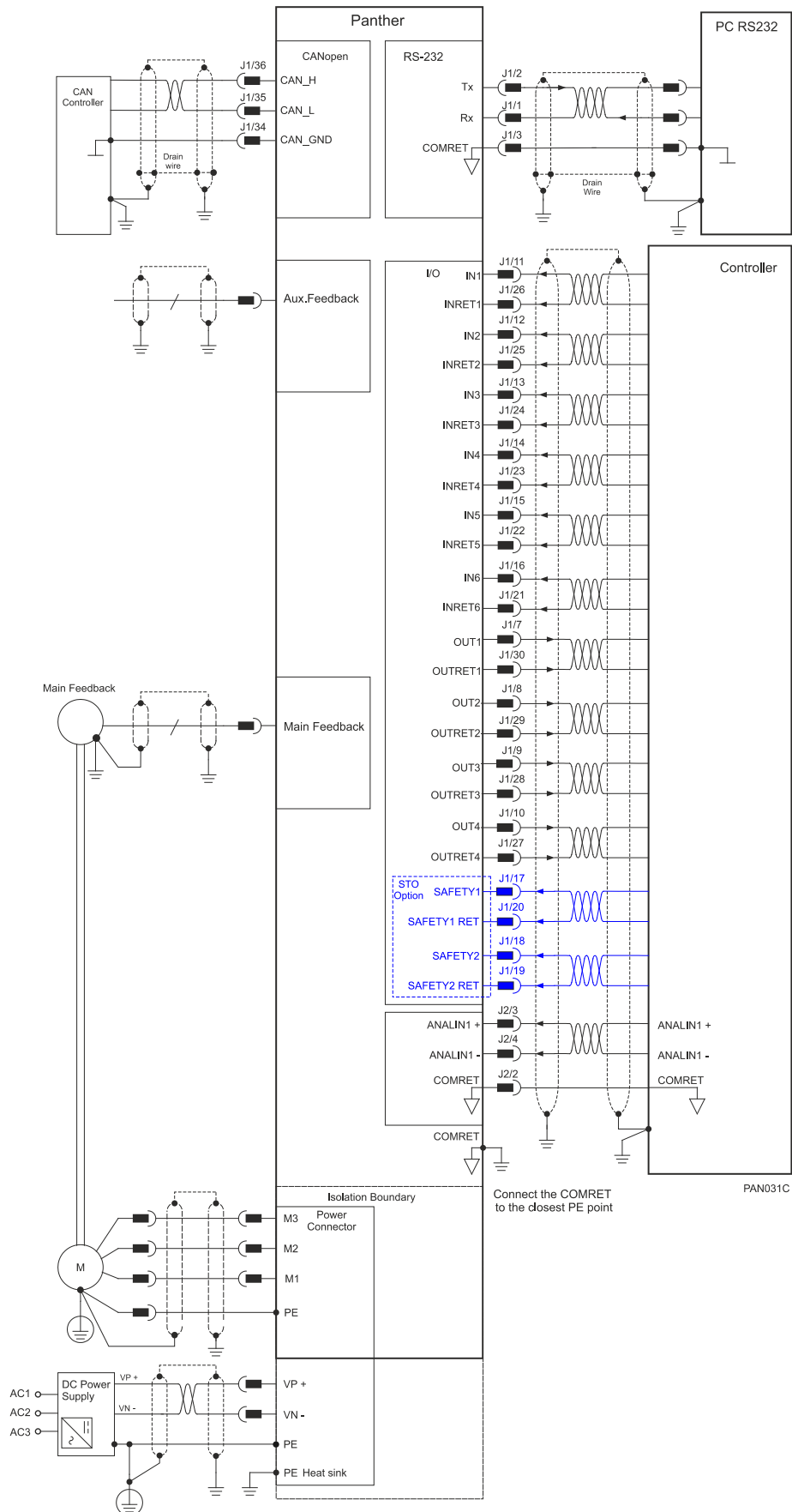
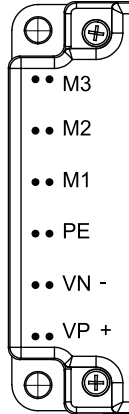


Figure 4: Panther Connection Diagram – 400 V without Backup Functionality

3.7. Main Power and Motor Power

The Panther receives power from main supply and delivers power to the motor. The table below describes the pinout connections to the main power and motor power cables.

Pin	Function	Cable		Pin Positions
		AC Motor	DC Motor	
M3	Motor phase	Motor	Motor	
M2	Motor phase	Motor	Motor	
M1	Motor phase	Motor	N/C	
PE	Protective Earth	Power and Motor		
VN-	DC Negative Power input	Power		
VP+	DC Positive Power input	Power		

3.7.1. Connecting Motor Power

Connect the M1, M2, M3 and PE pins (Figure 5) on the Panther in the manner described in section 3.5 Integrating the Panther on a PCB. The phase connection is arbitrary, as the Composer 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.

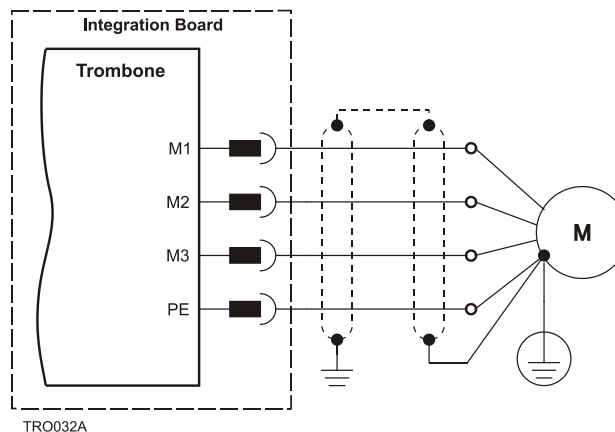


Figure 5: Motor Power Connection Diagram

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 Panther.
- Ensure that the motor chassis is properly grounded.

3.7.2. Connecting the DC Power

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

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

In addition, this isolation simplifies the requirements of the DC power supply that is used to power the DC bus of the Panther, 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 Panther can also operate from an isolated power supply or batteries.

When rectifying the AC voltage source, the AC voltage-level must be limited as follows:

Drive Model (V)	AC voltage-level limit (VAC)	DC Maximum (VDC)
400	270	390
700	477	680
800	528	747

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

3.7.2.1. 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 (Figure 6, Figure 7, Figure 8, and Figure 9).

Recommended connection of a 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 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.

3.7.2.1.a Three-Phase Direct-to-Mains Connection topology

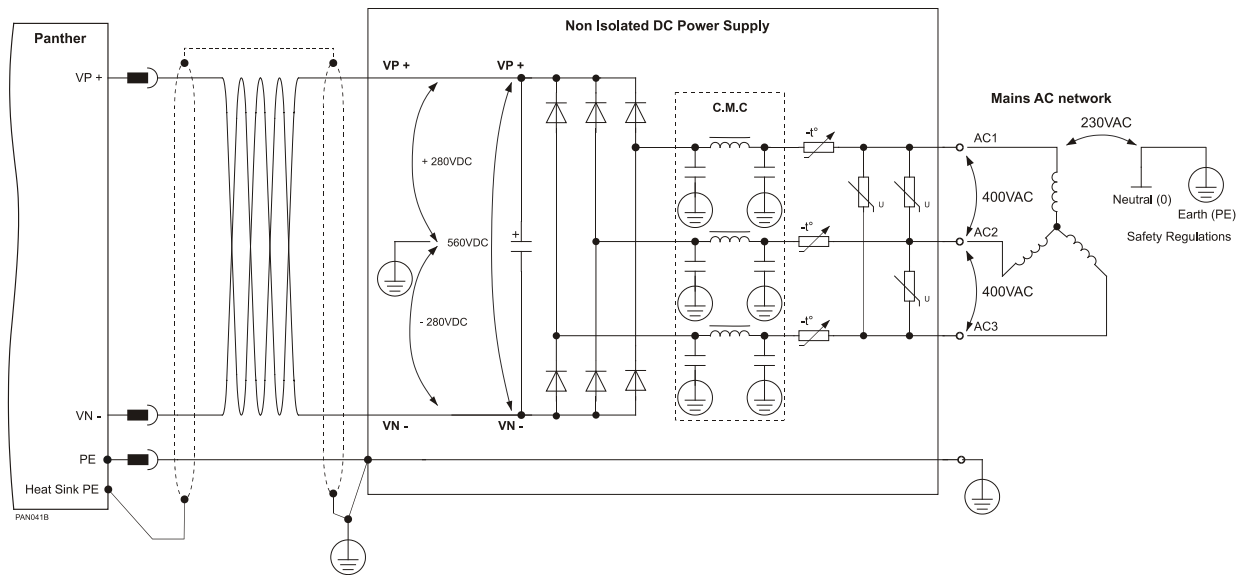


Figure 6: Non-Isolated Three-Phase Connection Topology



Caution:

Do not connect VN- to PE. In a direct-to-mains connection, the VN- must *not* be connected to the PE, as this will cause irreparable damage to the system.

Take care to note that in a direct-to-mains connection the Neutral point is *not* the most negative voltage level. It is the mid-point level of the rectified DC bus.

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

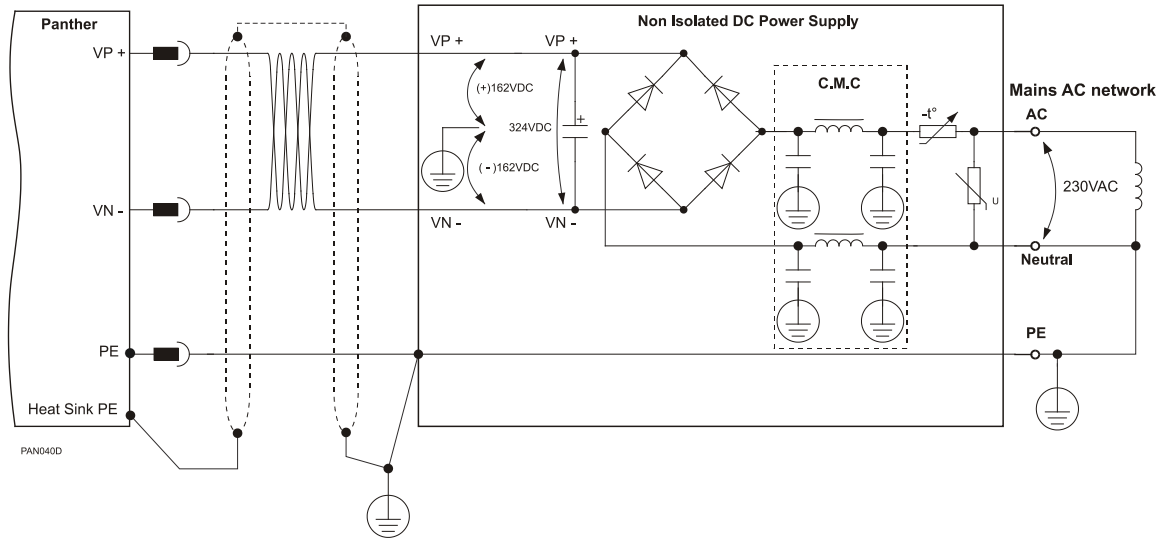


Figure 7: Non-Isolated Single-Phase Connection Topology

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



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.

3.7.2.1.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.

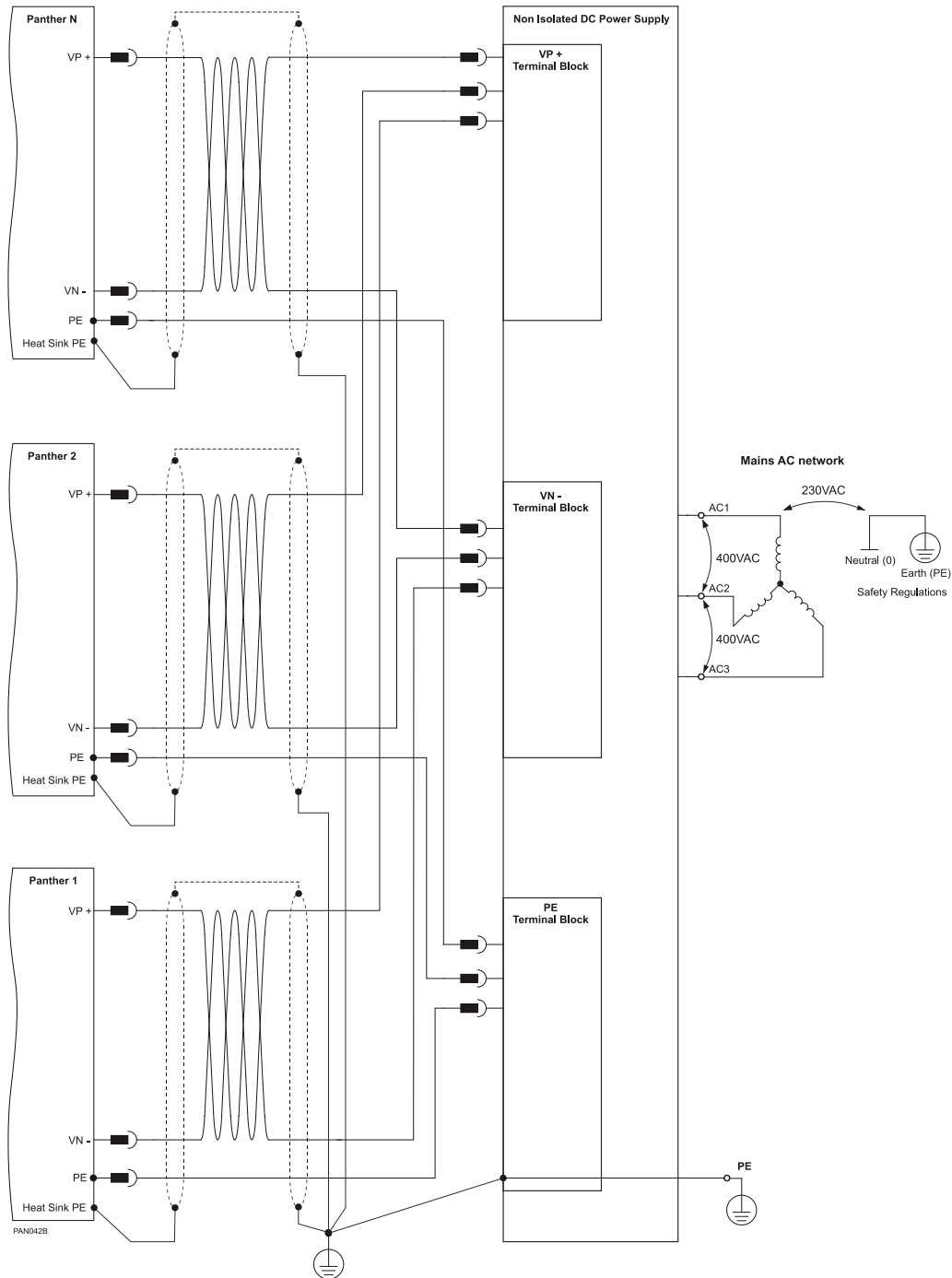


Figure 8: Non-Isolated Three-Phase Multiple Connection Topology

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

3.7.2.2. Battery Power Supply

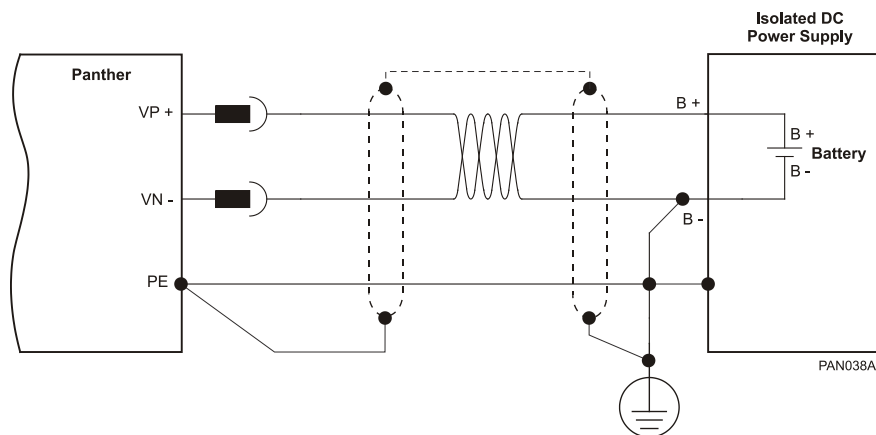


Figure 9: Battery Connection Topology



Caution:

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

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

3.8. Connecting the Control and Backup Supply

In Panther models that do not have an S option in the catalog number, a smart control-supply algorithm enables the Panther to operate with the main power supply only, *with no need for an auxiliary supply voltage to supply the drive's logic section.*

Note: In Panther models without the S option, there is no backup ability at all.

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

Note: The S-model Panther 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 (Figure 10).

Notes for 24 VDC backup supply connections:

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

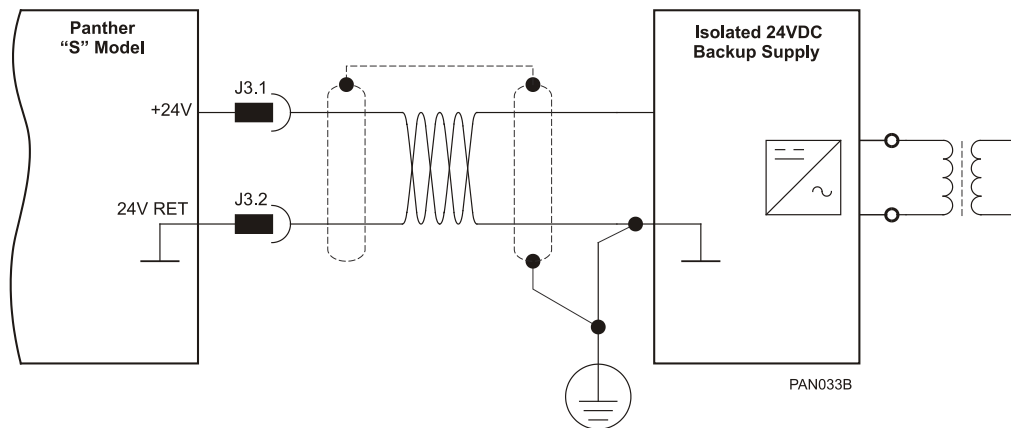


Figure 10: Auxiliary 24 VDC Backup Supply Connection Diagram

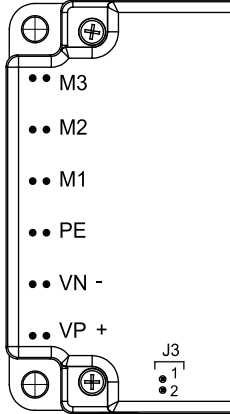
Pin (J3)	Function	Pin Positions
1	+24V Auxiliary Supply Input Positive	
2	24VRET Auxiliary Supply Input Return	

Table 1: Auxiliary 24 VDC Backup Supply Pins and Polarity

3.9. Main Feedback

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

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

- Incremental encoder only
- Incremental encoder with digital Hall sensors
- Digital Hall sensors only
- Interpolated Analog (Sine/Cosine) encoder (optional)
- Resolver (optional)
- Tachometer (optional)
- Potentiometer (optional)
- Absolute Encoder (optional)

Table 2 and Table 3 describe the various options available for the main feedback pin assignments for Encoders, Resolver, and the Tachometer & Potentiometer.

Incremental Encoder		Interpolated Analog Encoder		Absolute Encoder		
PAN-XX/YYY_		PAN-XX/YYYYI		PAN-XX/YYYYQ		
Pin (J2)	Signal	Function	Signal	Function	Signal	Function
1	+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
3	ANALIN+ is used for Analog Input					
4	ANALIN- is used for Analog Input					
5	CHA	Channel A+	A+	Sine A+	A+	Sine A+
6	CHA-	Channel A-	A-	Sine A-	A-	Sine A-
7	CHB	Channel B+	B+	Cosine B+	B+	Cosine B+
8	CHB-	Channel B -	B-	Cosine B -	B-	Cosine B -
9	INDEX	Index+	R+	Reference+	DATA+	Data+
10	INDEX-	Index -	R-	Reference -	DATA-	Data-
11	NC		NC		Clock+	Clock+
12	NC		NC		Clock-	Clock-
13	HA	Hall sensor A input	HA	Hall sensor A input	HA	Hall sensor A input
14	HB	Hall sensor B input	HB	Hall sensor B input	HB	Hall sensor B input
15	HC	Hall sensor C input	HC	Hall sensor C input	HC	Hall sensor C input
16	LED_2_OUT (AOKLED cathode) is used for implementing LED indication					
17	LED_1_OUT (AOKLED anode) is used for implementing LED indication					

Table 2: Main Feedback Pin Assignments in Encoders

Resolver			Tachometer & Potentiometer	
PAN-XX/YYYYR			PAN-XX/YYYYT	
Pin	Signal	Function	Signal	Function
1	+5V		+5V	Encoder/ Hall +5V supply
2	SUPRET		SUPRET	Supply return
3	ANALIN+ is used for Analog Input			
4	ANALIN- is used for Analog Input			
5	S1	Sine A+	Tac 1+	Tacho Input 1 Pos. (20V max)
6	S3	Sine A -	Tac 1-	Tacho Input 1 Neg. (20 V max)
7	S2	Cosine B+	Tac 2+	Tacho Input 2 Pos. (50V max)
8	S4	Cosine B -	Tac 2-	Tacho Input 2 Neg. (50 V max)
9	R1	Vref f=1/TS, 50mA Max.	POT	Potentiometer Input (5V Max)
10	R2	Vref- f= 1/TS, 50 mA Max.	NC	-
11	NC		NC	
11	NC		NC	
13	HA		HA	Hall sensor A input
14	HB		HB	Hall sensor B input
13	HC		HC	Hall sensor C input
16	LED_2_OUT (AOKLED cathode) is used for LED indication			
17	LED_1_OUT (AOKLED anode) is used for LED indication			

Table 3: Main Feedback Pin Assignments in the Resolver, Tachometer & Potentiometer

The connection diagrams shown in Figure 11 through Figure 20 describe the main feedback connections for the pin assignments listed in Table 2 and Table 3.

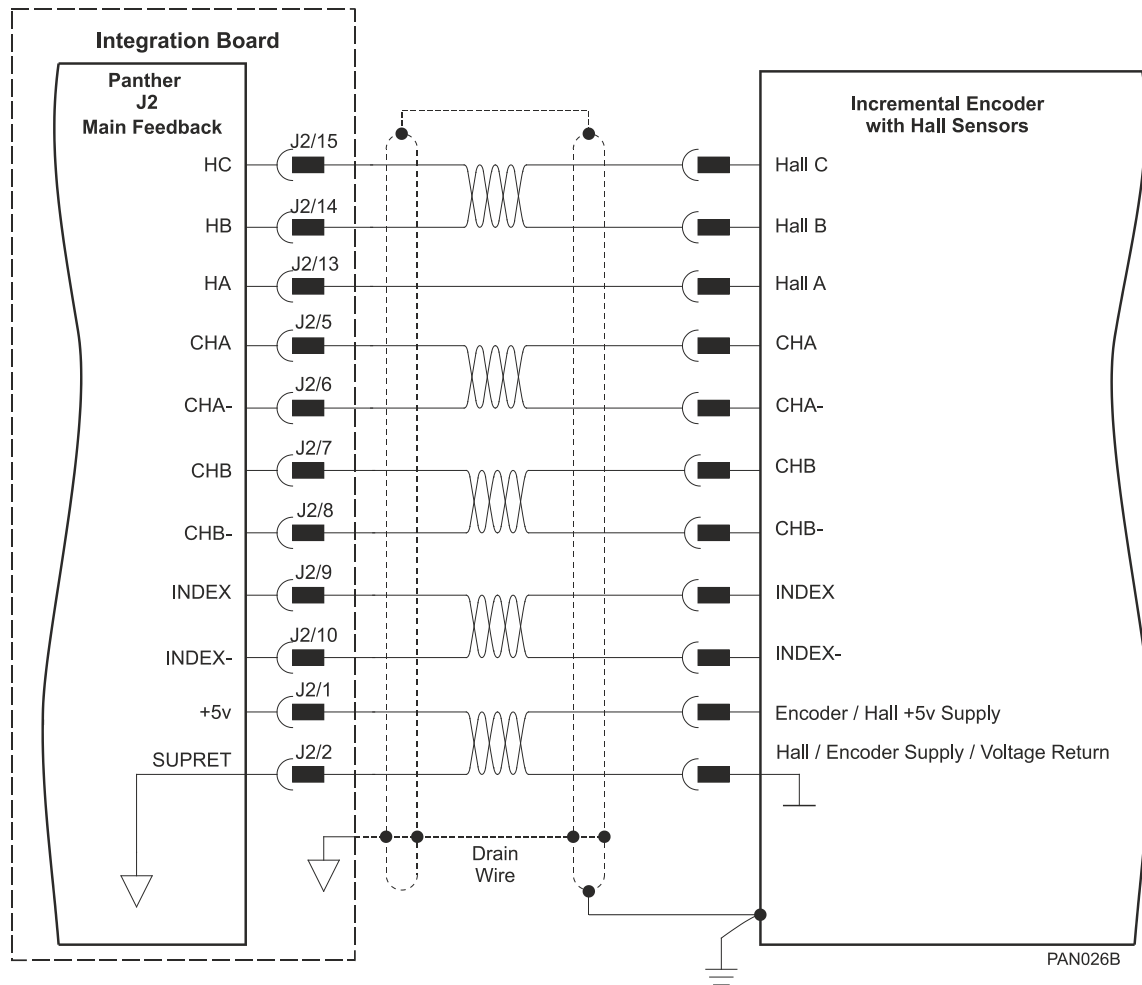


Figure 11: Main Feedback- Incremental Encoder with Digital Hall Sensors Connection Diagram

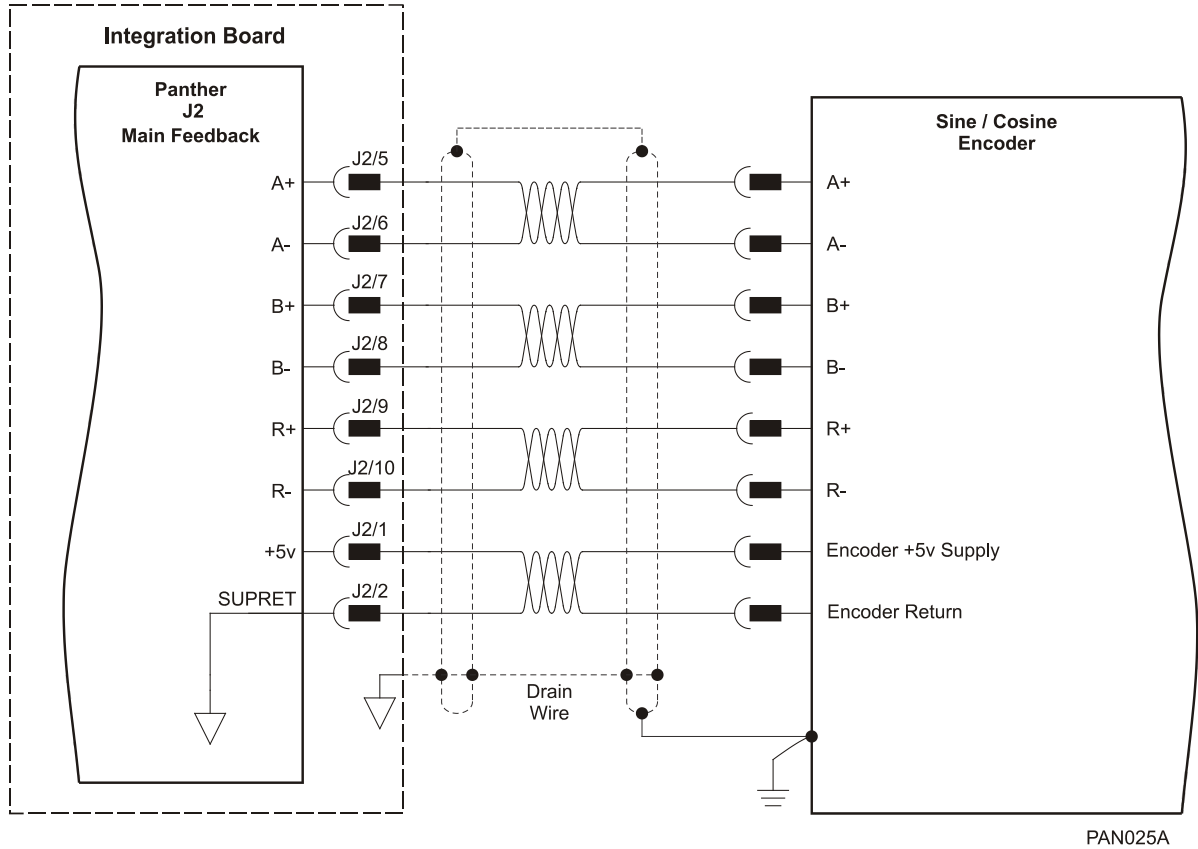


Figure 12: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder Connection Diagram

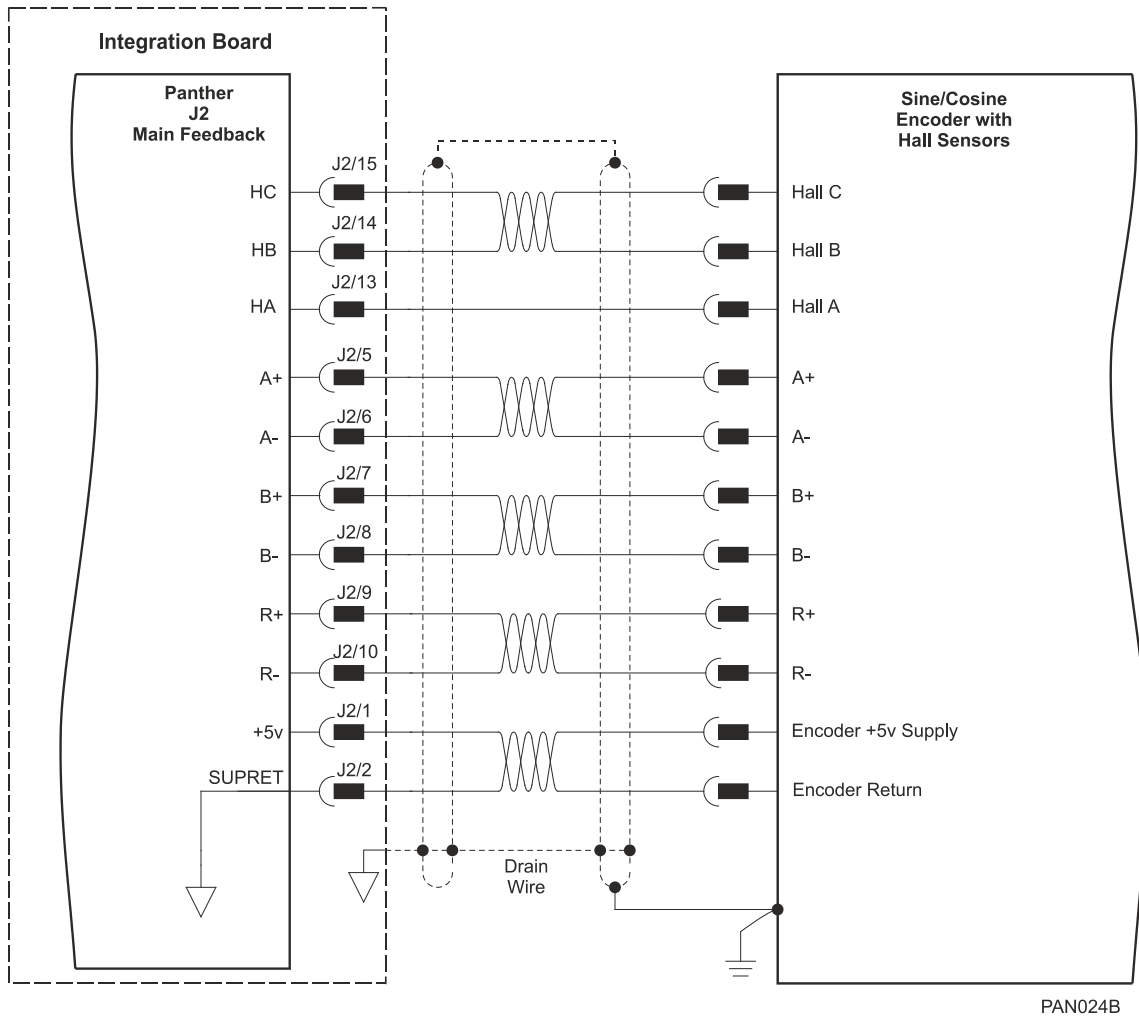


Figure 13: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder with Digital Hall Sensors Connection Diagram

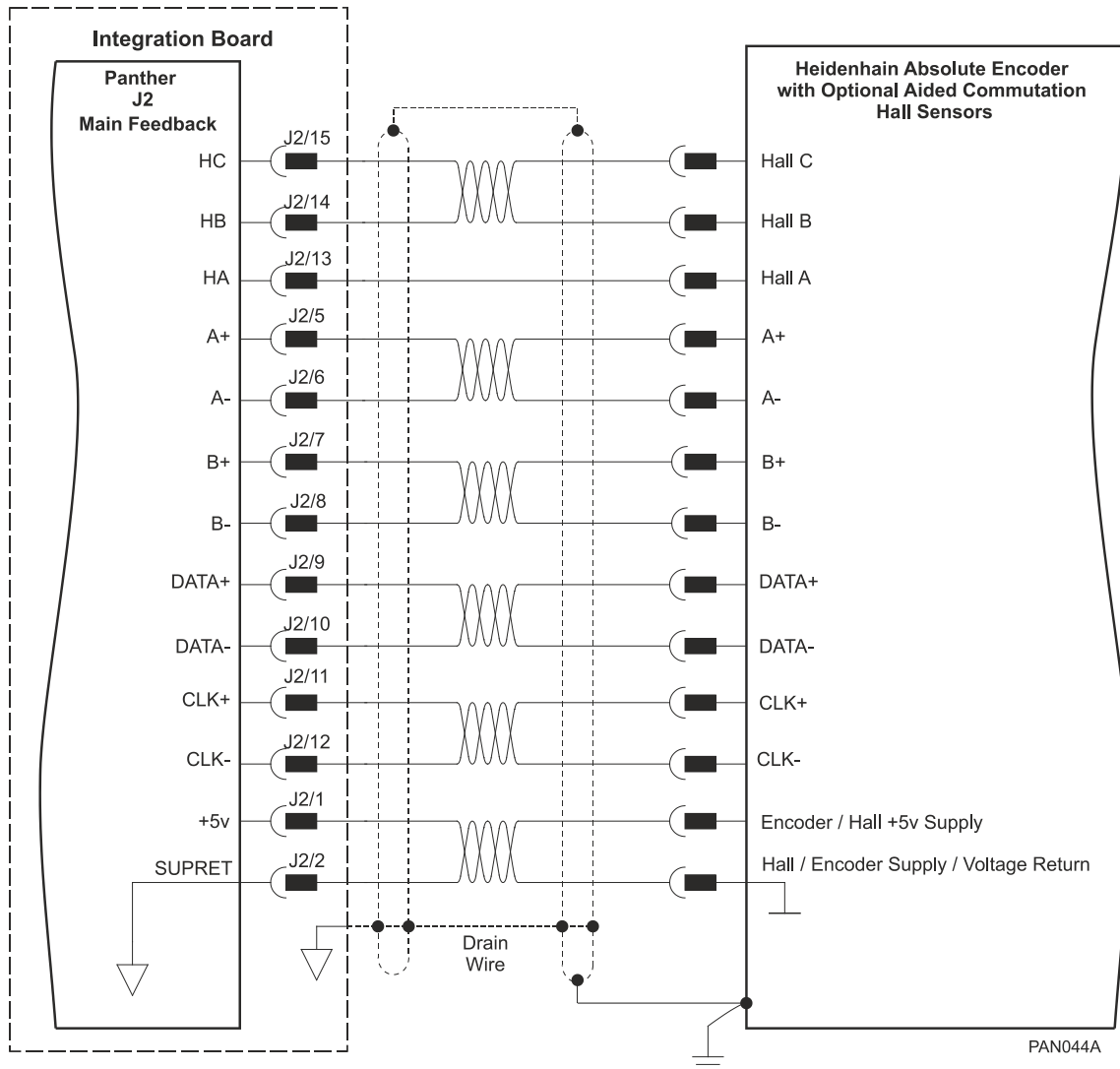


Figure 14: Main Feedback – Heidenhain Absolute Encoder with Digital Hall Sensors Connection Diagram

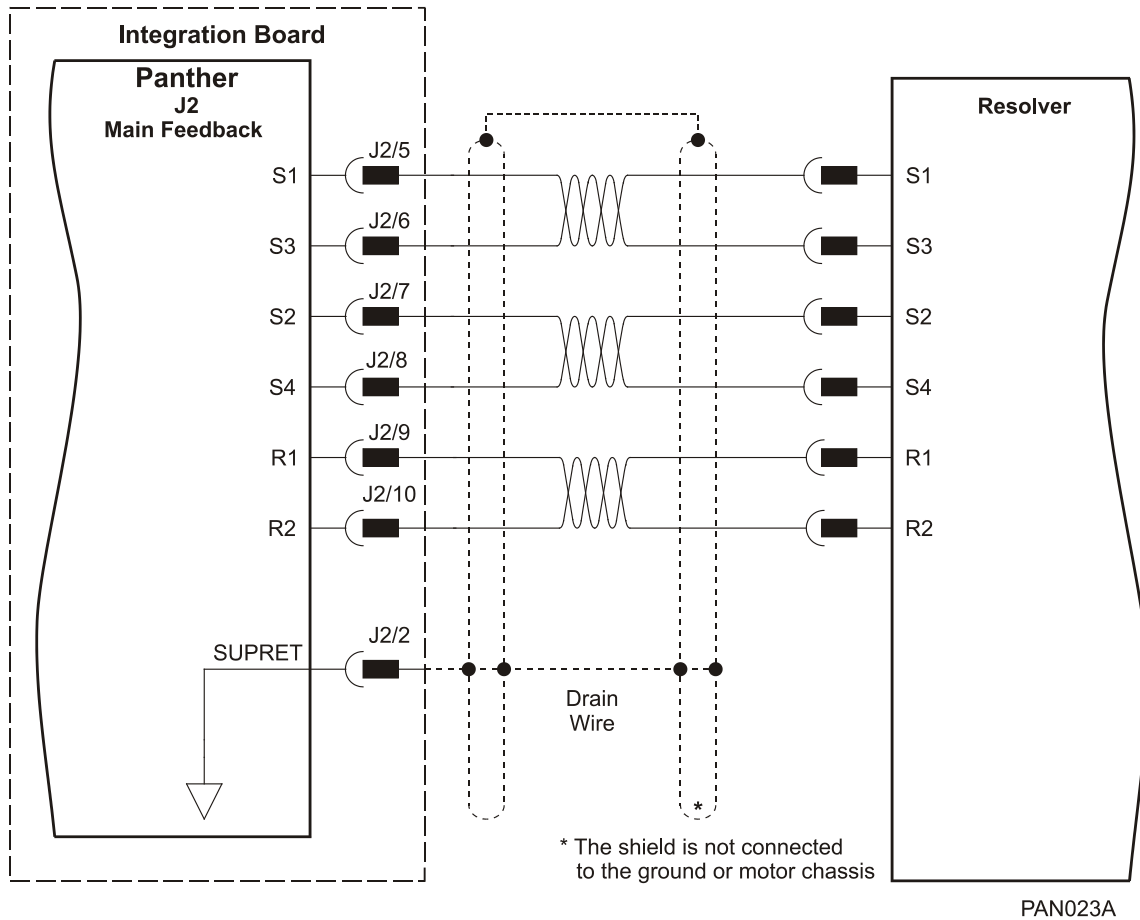
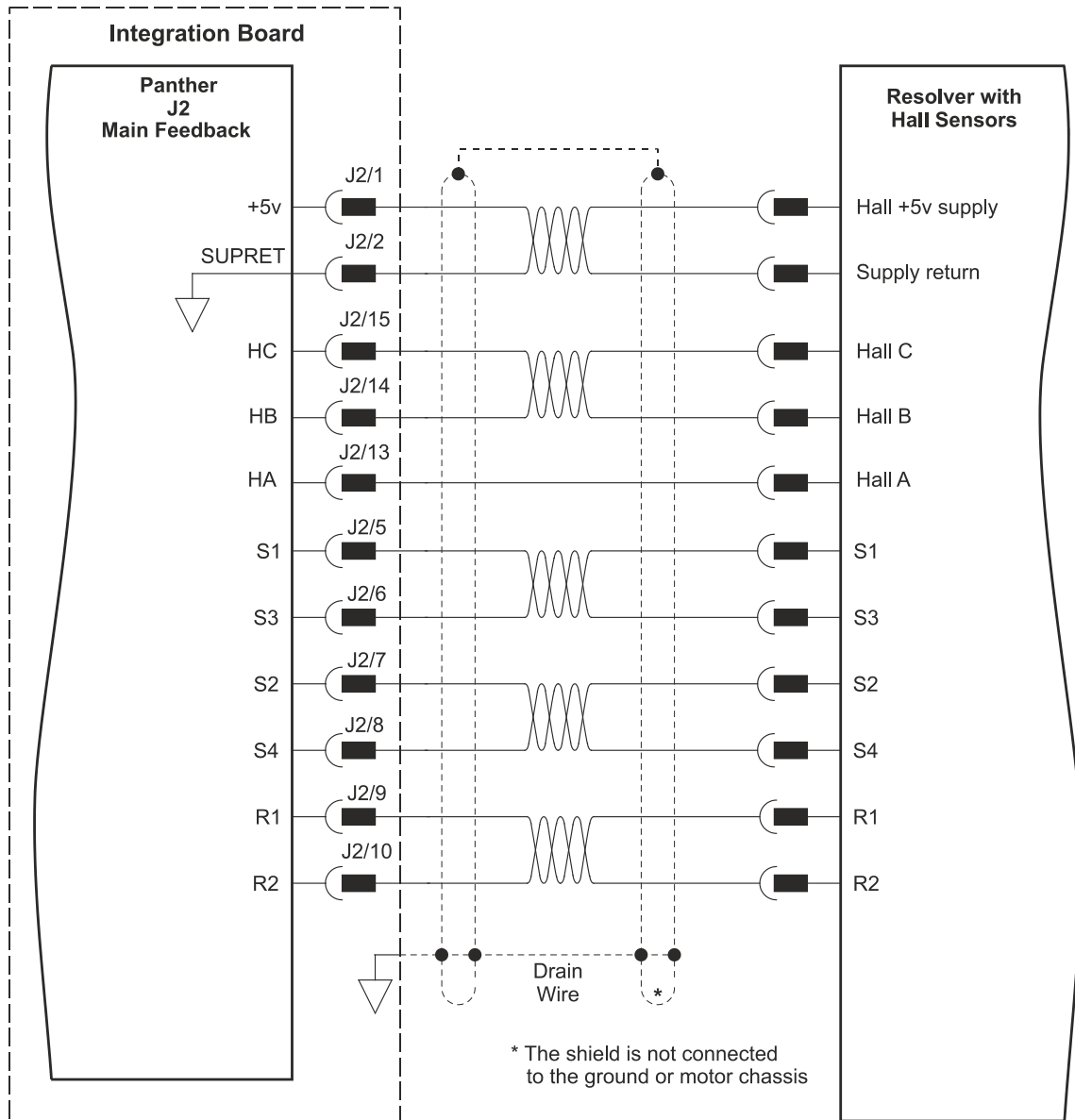


Figure 15: Main Feedback – Resolver Connection Diagram



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Figure 16: Main Feedback – Resolver and Digital Hall Sensors Connection Diagram

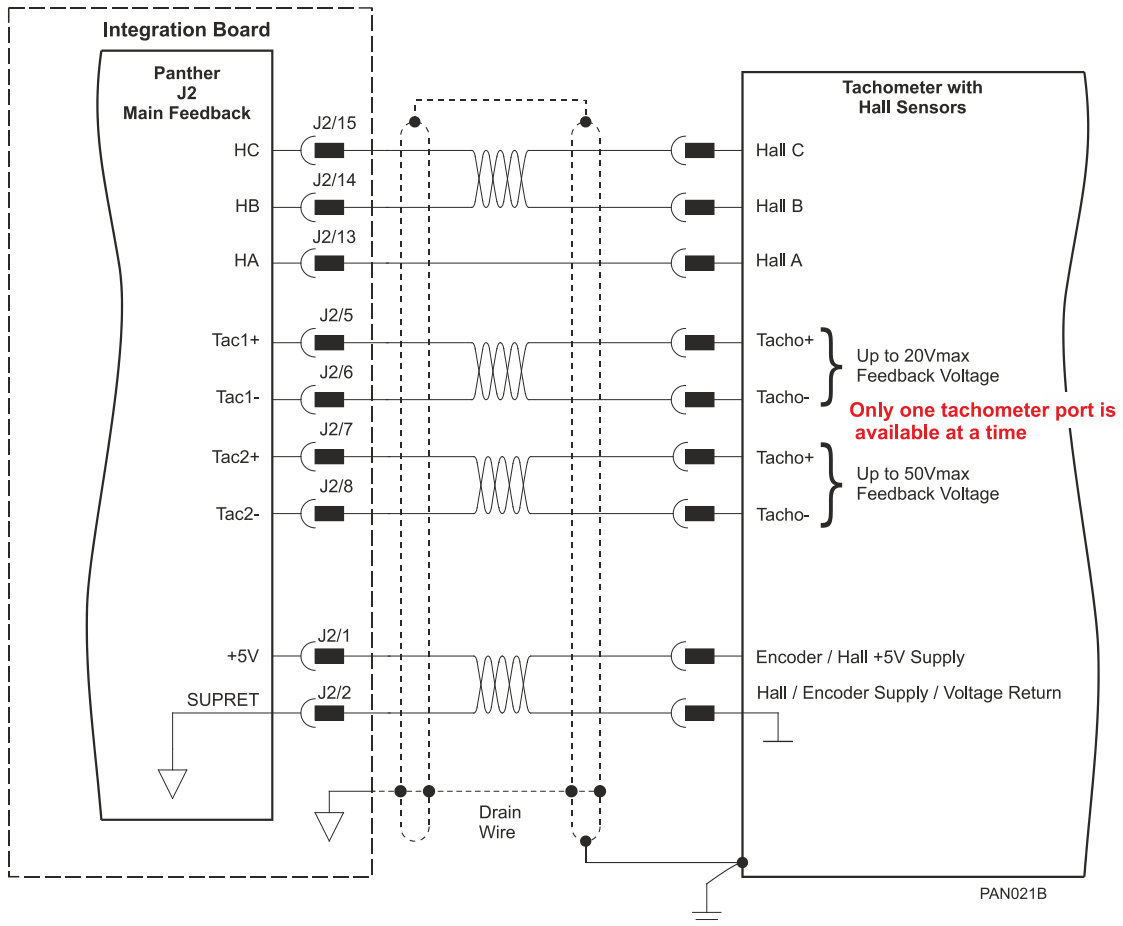


Figure 17: Main Feedback – Tachometer Feedback with Digital Hall Sensors (Connection Diagram for Brushless Motors)

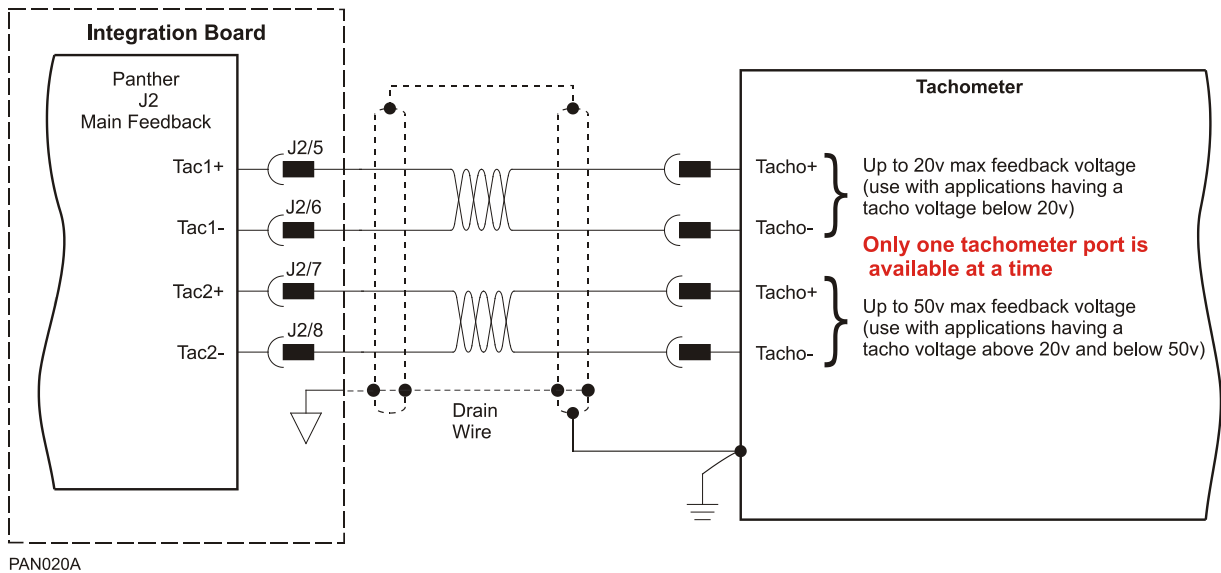


Figure 18: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors

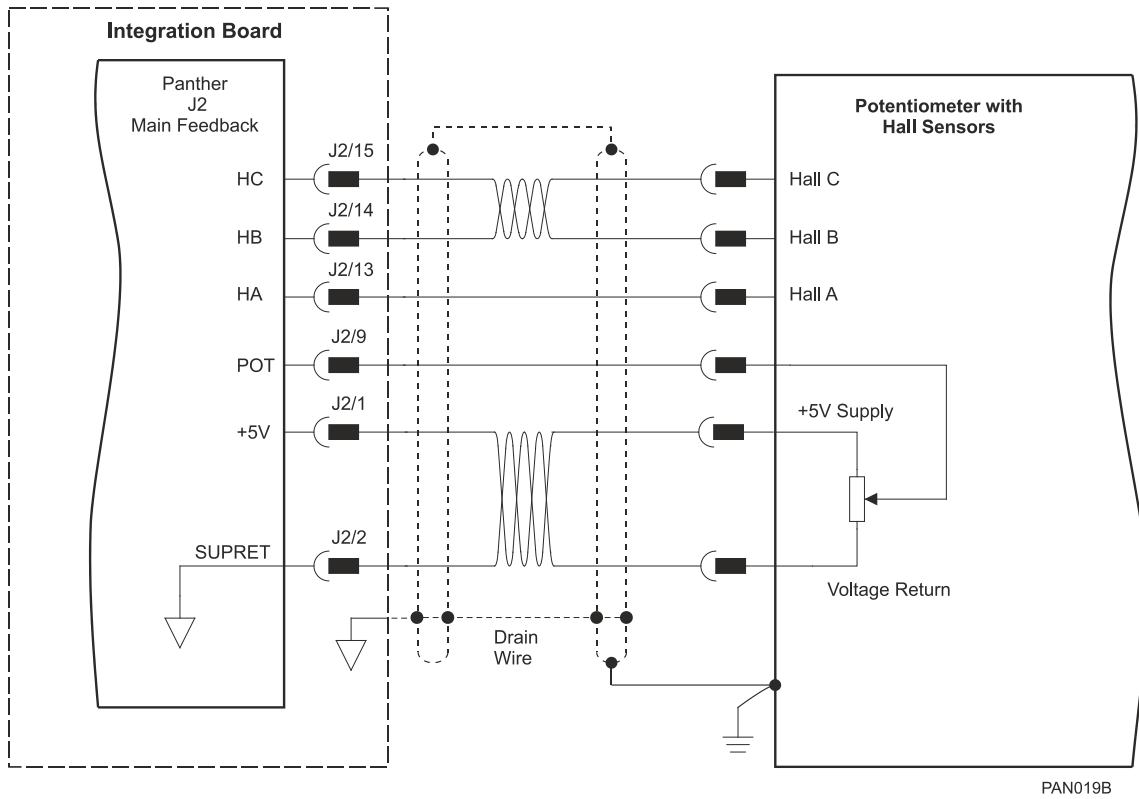


Figure 19: Main Feedback – Potentiometer Feedback with Digital Hall Sensors (Connection Diagram for Brushless Motors)

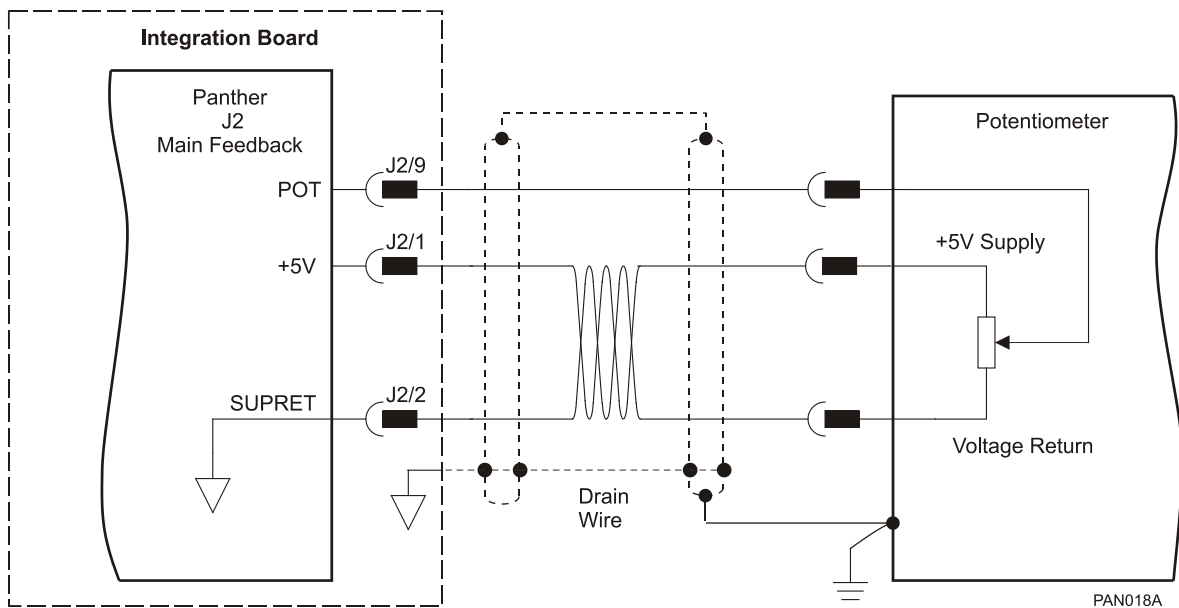


Figure 20: Main Feedback – Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils

3.10. Auxiliary Feedback

For auxiliary feedback, select one of the following options:

- a. **Single-ended emulated encoder outputs**, used to provide emulated encoder signals to another controller or drive. The Emulated Encoder Output option is only available when using a resolver, interpolated analog encoder, tachometer or potentiometer as the main feedback device.

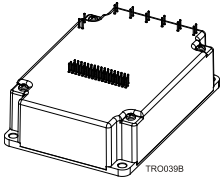
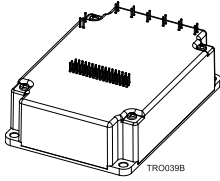
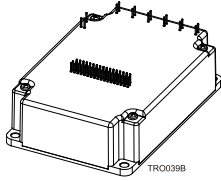
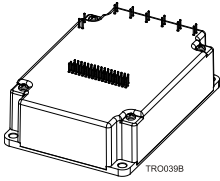
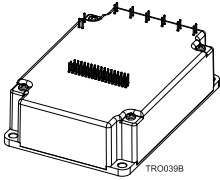
This option can be used in the following scenarios:

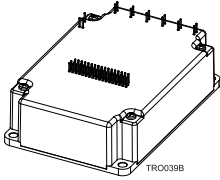
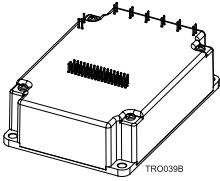
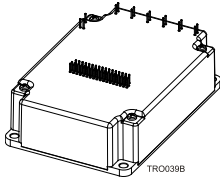
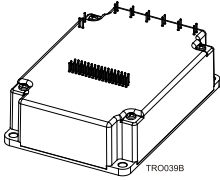
- The Panther is used as a current amplifier to provide position data to the position controller.
 - The Panther is used in velocity mode to provide position data to the position controller.
 - The Panther is used as a master in follower or ECAM mode.
- b. **Single-ended auxiliary encoder input**, for the input of position data of the master encoder in follower or ECAM mode.
 - c. **Pulse-and-direction input**, for single-ended input of pulse-and-direction position commands.

When using one of the auxiliary feedback options, the relevant functionality is selected by the software for that option. Refer to the *SimplIQ Command Reference Manual* for detailed setup information.

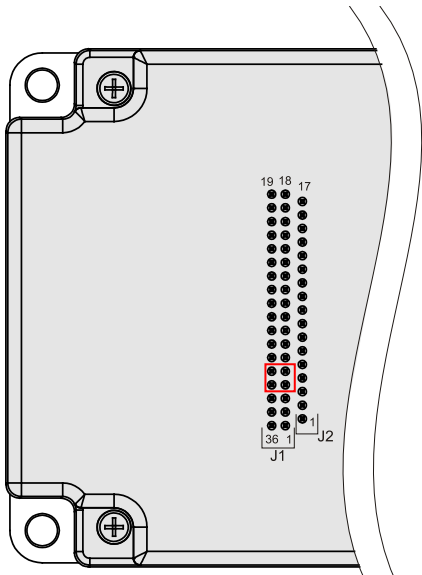
3.10.1. Main and Auxiliary Feedback Combinations

The Main Feedback is always used in motion control devices, whereas Auxiliary Feedback is often, but not always used. The Auxiliary Feedback connector on the Panther has three bi-directional pins (CHA, CHB and INDEX). When used in combination with Main Feedback, the Auxiliary Feedback can be set, by software, as follows:

Main Feedback		Auxiliary Feedback	
Software Setting	YA[4] = 4 (Aux. Feedback: output)	YA[4] = 2 (Aux. Feedback: input)	YA[4] = 0 (Aux. Feedback: input)
Incremental Encoder Input	<p>Main Feedback: Incremental Encoder</p>  <p>Aux. Feedback: There is no Aux. Feedback output option, when an Incremental Encoder is the main feedback device.</p>	<p>Main Feedback Input: Incremental Encoder or Analog Encoder or Resolver or Absolute encoder or Tachometer or Potentiometer</p> 	<p>Main Feedback Input: Incremental Encoder or Analog Encoder or Resolver or Absolute encoder or Tachometer or Potentiometer</p> 
Interpolated Analog (Sine/Cosine) Encoder Input	<p>1. Main Feedback: Analog Encoder</p>  <p>Aux. Feedback: Analog Encoder position data, emulated in single-ended, un-buffered incremental Encoder format</p>	<p>Aux. Feedback: Single-ended Incremental Encoder Input</p>	<p>Aux. Feedback: Single-ended Pulse and Direction Commands</p>
Resolver Input	<p>2. Main Feedback: Resolver</p>  <p>Aux. Feedback: Resolver position data emulated in single-ended un-buffered Incremental Encoder format</p>		

Main Feedback		Auxiliary Feedback	
Software Setting	YA[4] = 4 (Aux. Feedback: output)	YA[4] = 2 (Aux. Feedback: input)	YA[4] = 0 (Aux. Feedback: input)
Absolute Encoder Input	<p>3. Main Feedback: Absolute Encoder</p>  <p>Aux. Feedback: Absolute position data emulated in single-ended un-buffered Incremental Encoder format</p>	<p>Main Feedback Input: Incremental Encoder or Analog Encoder or Resolver or Absolute Encoder or Tachometer or Potentiometer</p> 	<p>Main Feedback Input: Incremental Encoder or Analog Encoder or Resolver or Absolute Encoder or Tachometer or Potentiometer</p> 
Potentiometer or Tachometer Input	<p>4. Main Feedback: Potentiometer or Tachometer</p>  <p>Aux. Feedback: Tachometer or Potentiometer position data, emulated in single-ended un-buffered Incremental Encoder format</p>	<p>Aux. Feedback: Single-ended Incremental Encoder Input</p>	<p>Aux. Feedback: Single-ended Pulse and Direction Commands</p>
Typical Applications	<ol style="list-style-type: none"> Analog Encoder applications where position data is required in the Encoder's quadrature format. Resolver applications where position data is required in the Encoder's quadrature format. Tachometer or potentiometer applications where position data is required in the Encoder's quadrature format. Absolute Encoder applications where position data is required by means of a digital word 	<p>Any application where two feedbacks are used by the drive.</p> <p>The Auxiliary Feedback port serves as an input for the auxiliary incremental encoder.</p> <p>For applications such as Follower, ECAM, or Dual Loop.</p>	<p>Any application where two feedbacks are used by the drive.</p> <p>The Auxiliary Feedback port serves as an input for Pulse & Direction Commands.</p>

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

Pin (J1)	Signal	Function	Pin Positions
32	COMRET	Common return	
33	INDEXO	Auxiliary index output	
5	CHBO	Auxiliary Channel B output	
4	CHAO	Auxiliary Channel A output	

Note: The Emulated Encoder Output Option (Figure 21, Figure 22 (recommended)) is only available when using a resolver, absolute encoder, analog encoder, tachometer or potentiometer as the main feedback device. The Panther's Auxiliary Feedback is single-ended. When mounted on an integration board, circuitry can be added to make it differential (Figure 23 (highly recommended)).

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Table 4: Emulated Single-Ended Encoder Output Pin Assignments

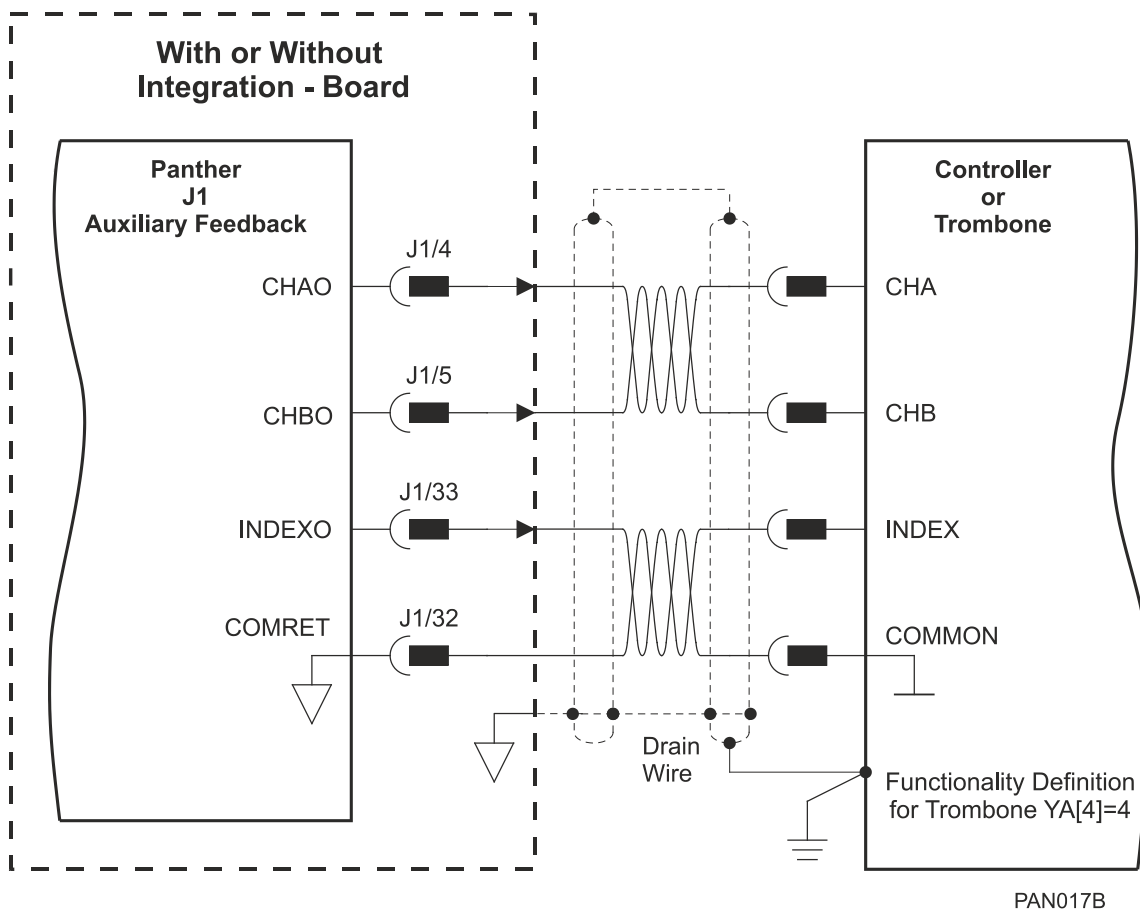


Figure 21: Emulated Encoder Direct Output – Acceptable Connection Diagram

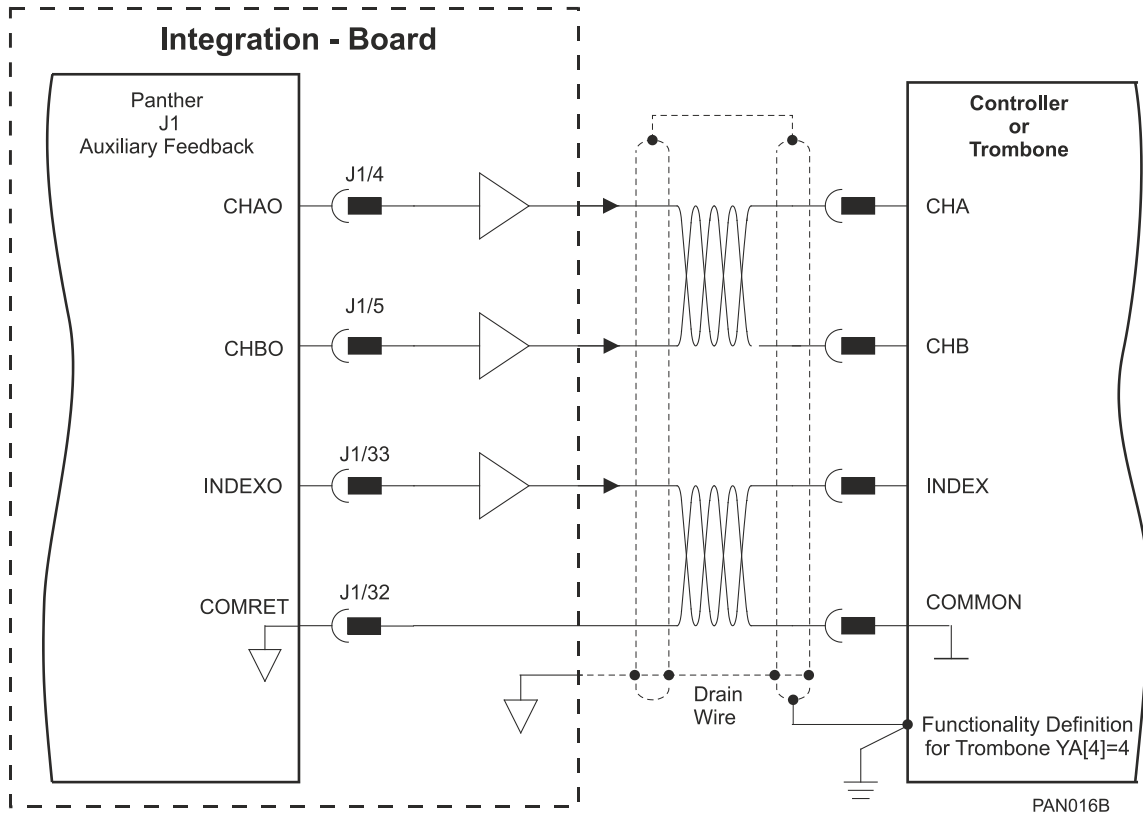


Figure 22: Emulated Encoder Buffered Output – Recommended Connection Diagram

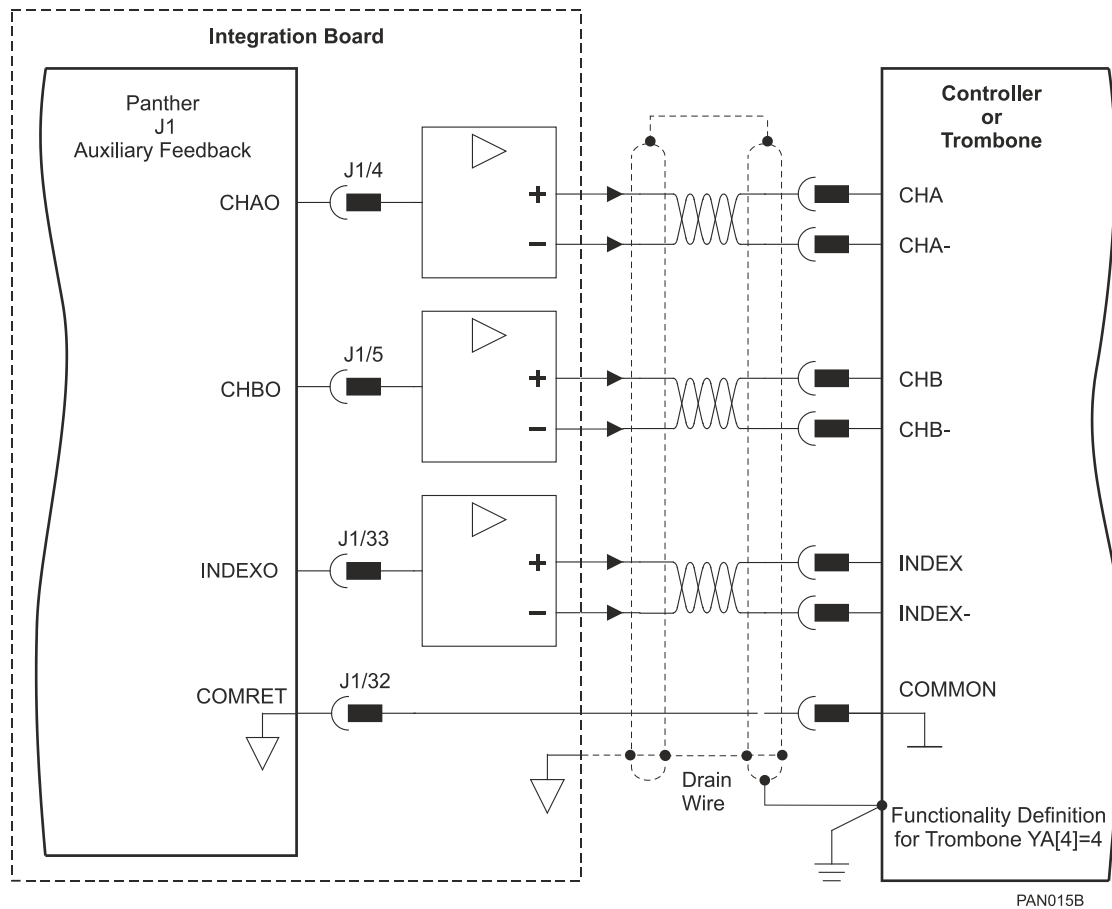
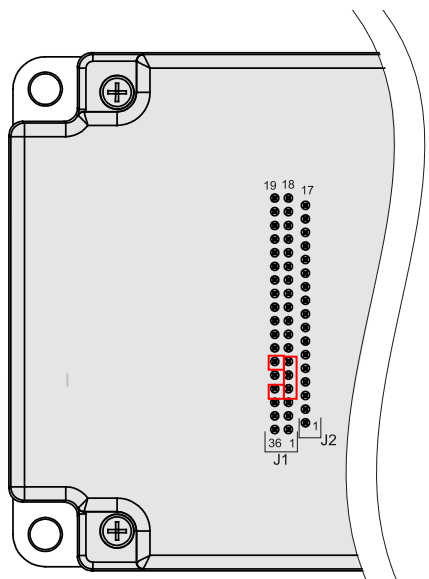


Figure 23: Emulated Encoder Differential Output – Highly Recommended Connection Diagram

3.10.3. Auxiliary Feedback: Single-Ended Encoder Input Option (YA[4]=2)

Pin (J1)	Signal	Function	Pin Positions
31	+5 V	Encoder supply voltage	
6	SUPRET	Supply return	
33	INDEX	Auxiliary index input	
5	CHB	Auxiliary channel B input	
4	CHA	Auxiliary channel A input	

Note: The Panther's Auxiliary Feedback is single-ended (Figure 24, Figure 25 (recommended)). When mounted on an integration board, circuitry can be added to make it differential (Figure 26 (highly recommended)).

TRO008B

Table 5: Single-Ended Auxiliary Encoder Pin Assignment

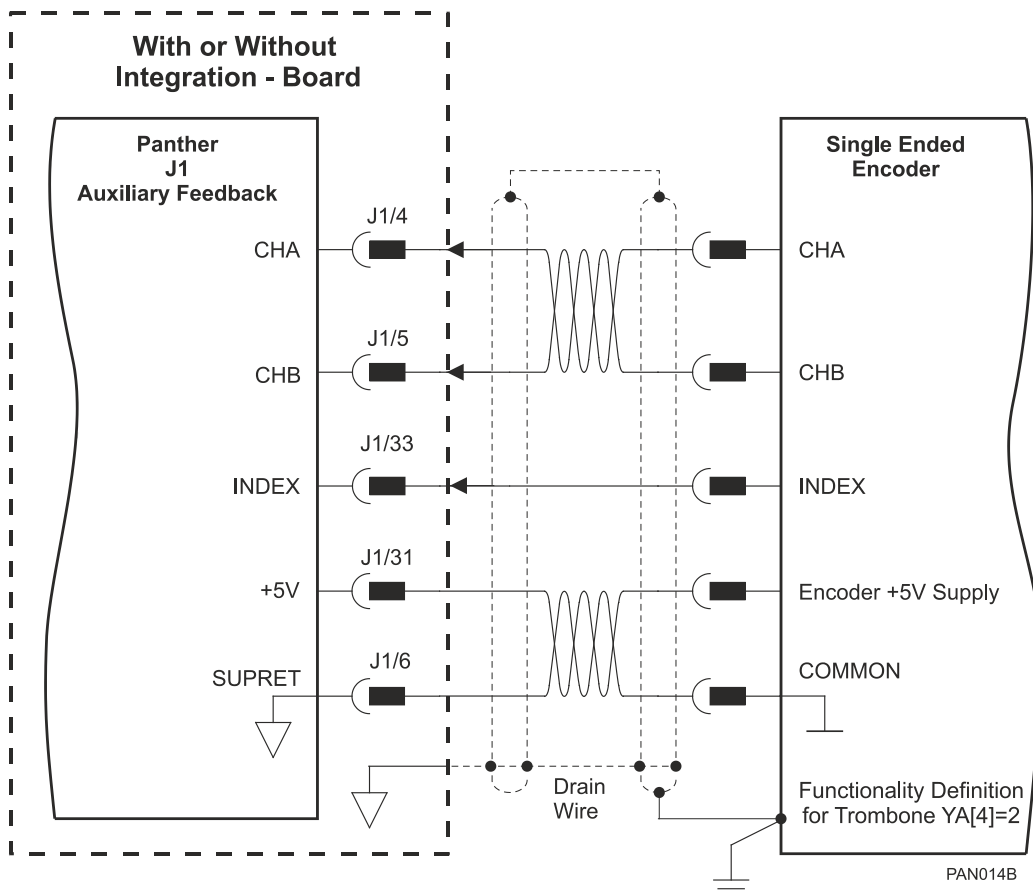


Figure 24: Single-Ended Auxiliary Encoder Input - Acceptable Connection Diagram

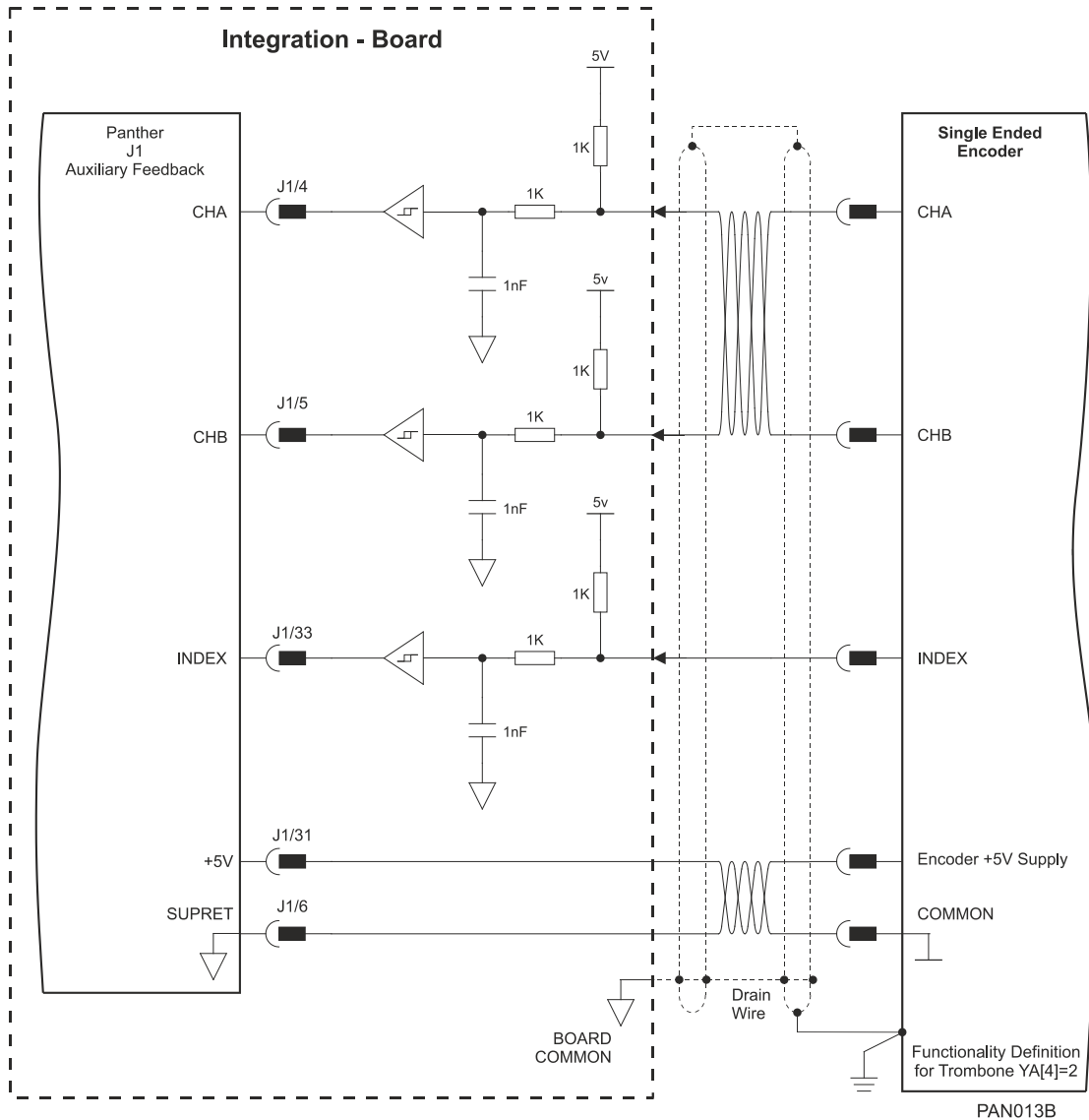


Figure 25: Single-Ended Auxiliary Encoder Input - Recommended Connection Diagram

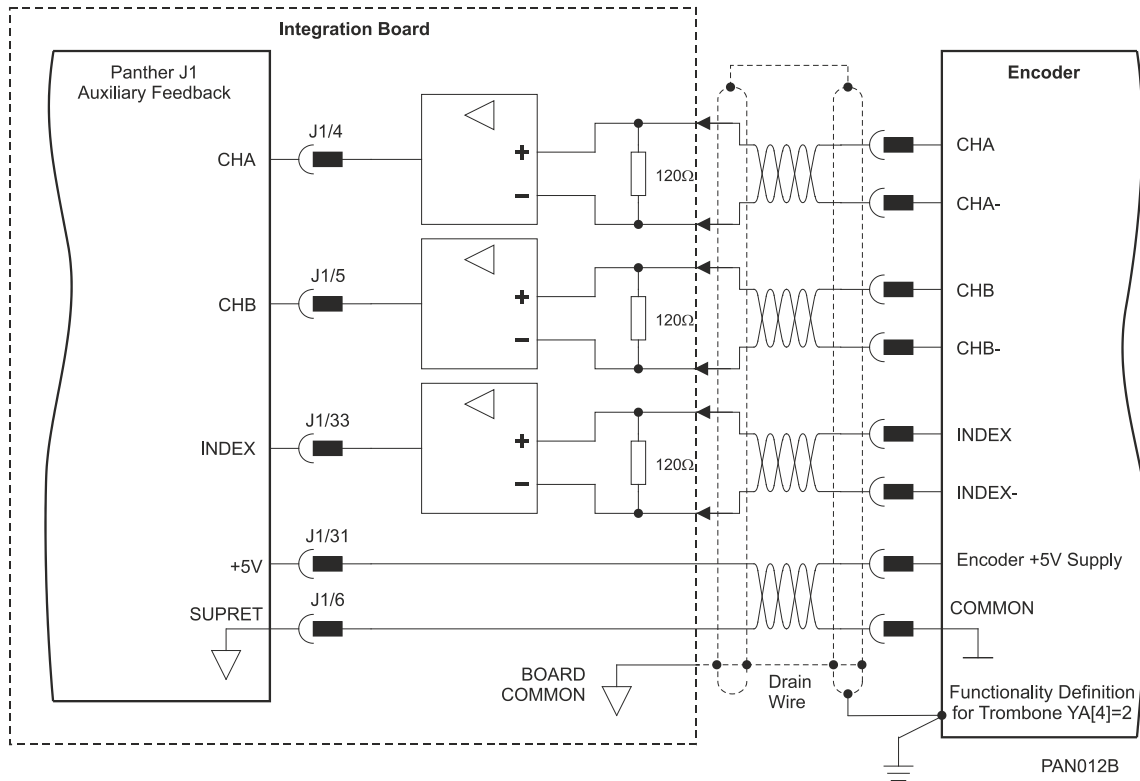


Figure 26: Differential Auxiliary Encoder Input – Highly Recommended Connection Diagram

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

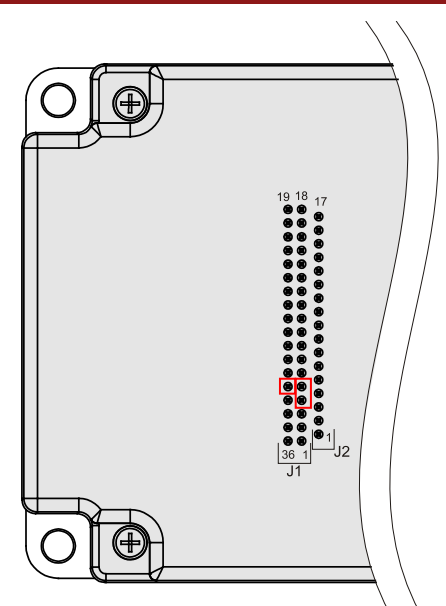
Pin (J1)	Signal	Function	Pin Positions
32	COMRET	Common return	
5	DIR/CHB	Direction input (push/pull 5 V or open collector)	
4	PULS/CHA	Pulse input (push/pull 5 V or open collector)	
<p>Note: The Panther’s Auxiliary Feedback is single-ended (Figure 27, Figure 28 (recommended)). When mounted on an integration board, circuitry can be added to make it differential Figure 29 (highly recommended)).</p>			

Table 6: Pulse-and-Direction Pin Assignments

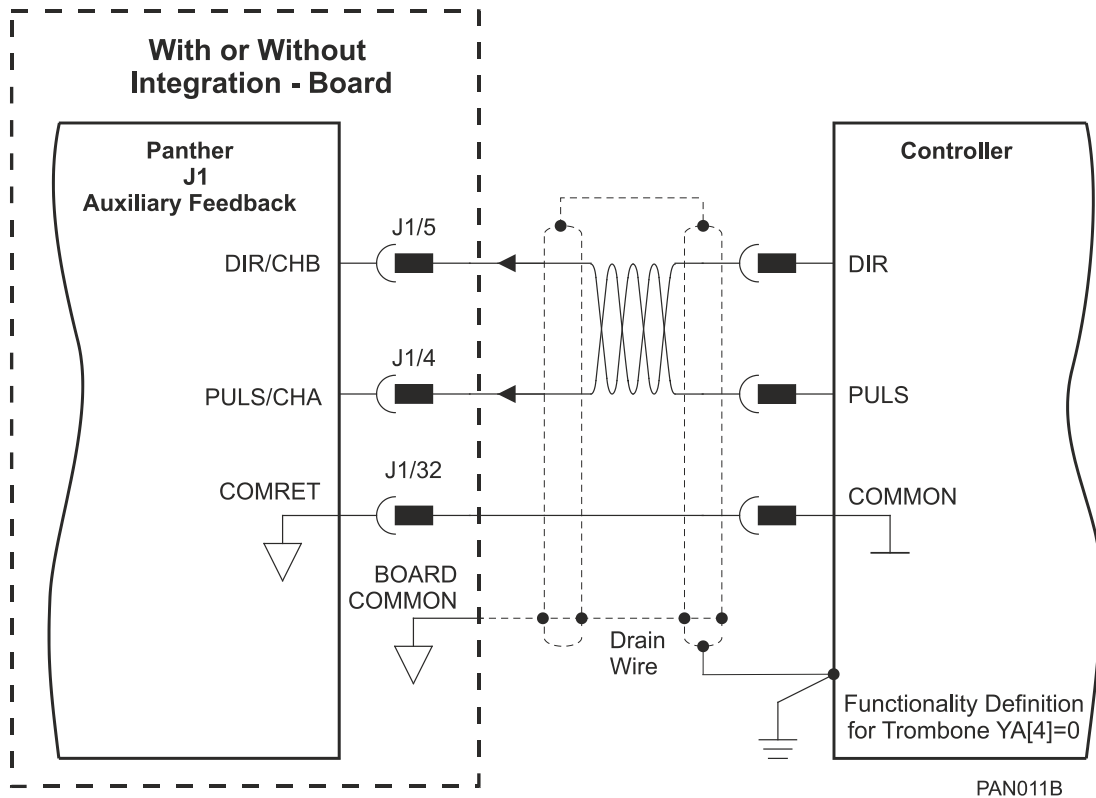


Figure 27: Pulse-and-Direction Auxiliary Encoder Input – Direct Connection Diagram, Acceptable

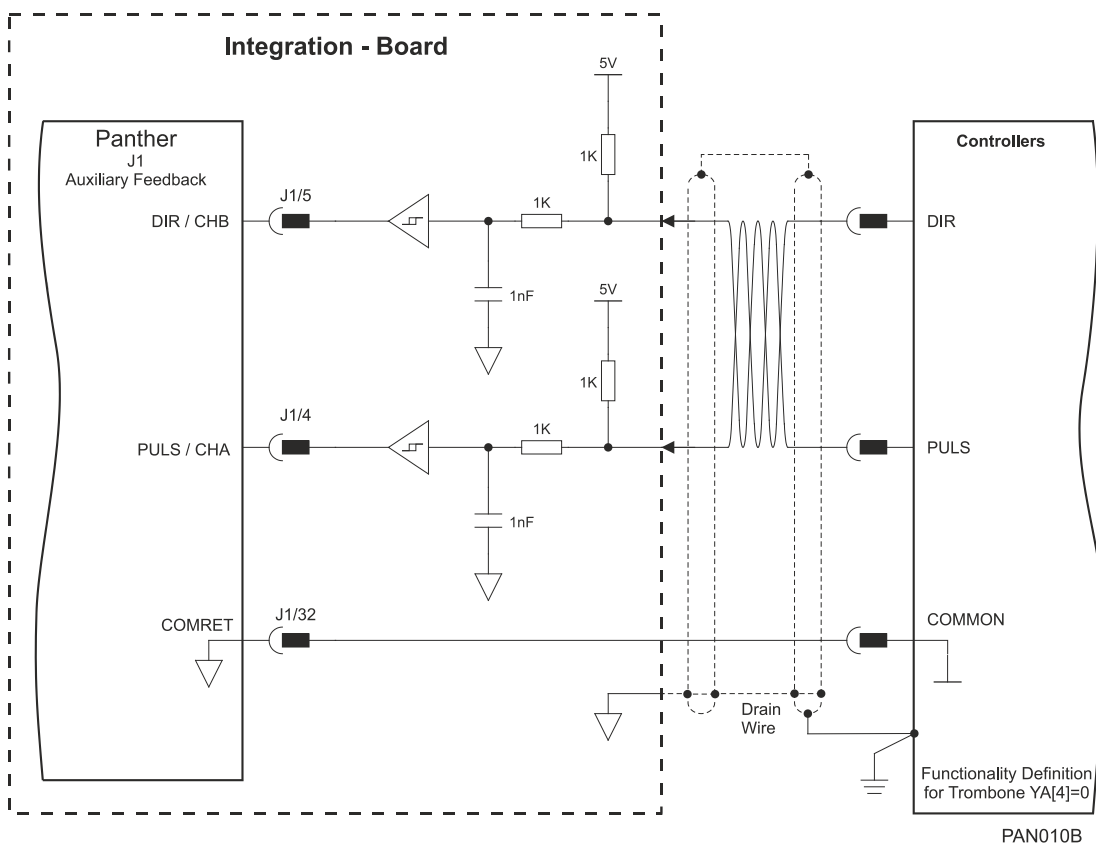


Figure 28: Pulse-and-Direction Auxiliary Encoder Input – Buffered Connection Diagram, Recommended

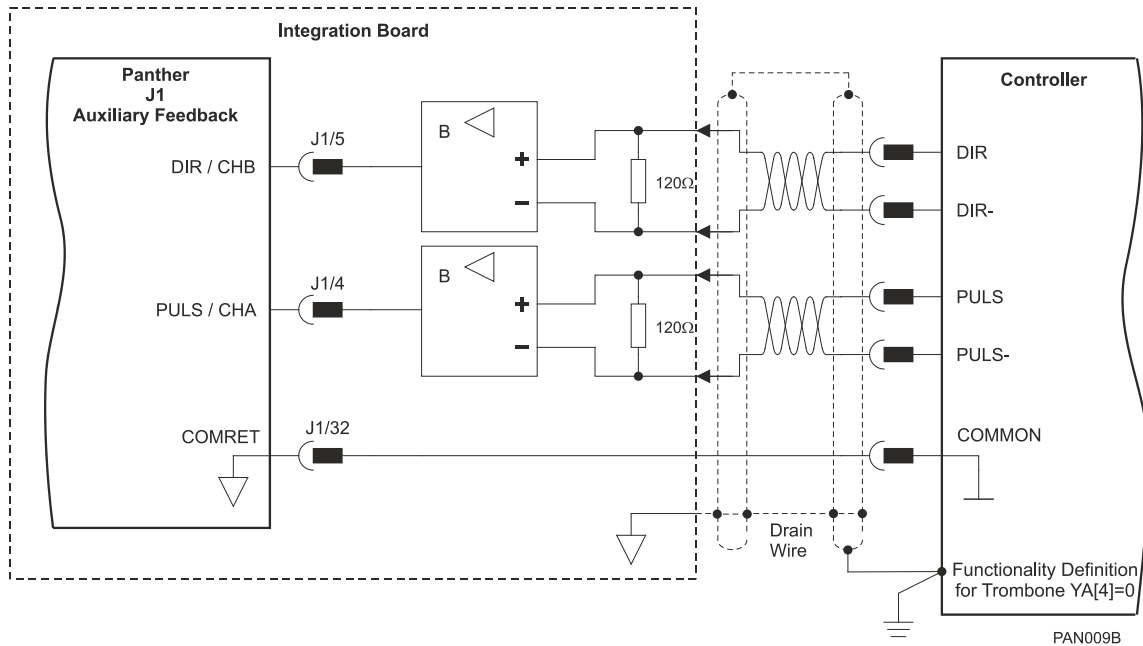


Figure 29: Pulse-and-Direction Auxiliary Encoder Input – Differential Connection Diagram, Highly Recommended

3.11. User I/Os

The Panther has 6 Digital Inputs, 4 Digital Outputs, and 1 Analog Input

I/O	J1	J2
Digital Input	6	-
Digital Output	4	-
Analog Input	-	1

Table 7: Various I/O Distributions

3.11.1. Digital Input

Each of the pins below can function as an independent input (Figure 30, Figure 31).

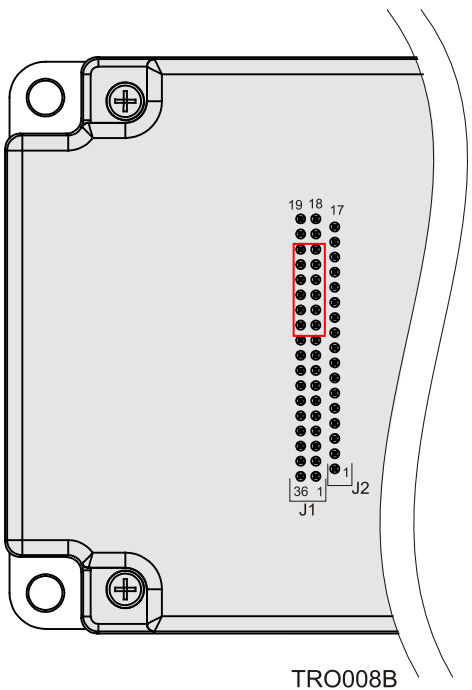
Pin (J1)	Signal	Function	Pin Positions
11	IN1	Programmable input 1 (general purpose, RLS, FLS, INH)	
12	IN2	Programmable input 2 (general purpose, RLS, FLS, INH)	
13	IN3	Programmable input 3 (general purpose, RLS, FLS, INH)	
14	IN4	Programmable input 4 (general purpose, RLS, FLS, INH)	
15	IN5	Hi-Speed Programmable input 5 (event capture, Main Home, general purpose, RLS, FLS, INH)	
16	IN6	Hi-Speed Programmable input 6 (event capture, Auxiliary Home, general purpose, RLS, FLS, INH)	
21	INRET6	Programmable input 6 return	
22	INRET5	Programmable input 5 return	
23	INRET4	Programmable input 4 return	
24	INRET3	Programmable input 3 return	
25	INRET2	Programmable input 2 return	
26	INRET1	Programmable input 1 return	

Table 8: Digital Input Pin Assignments

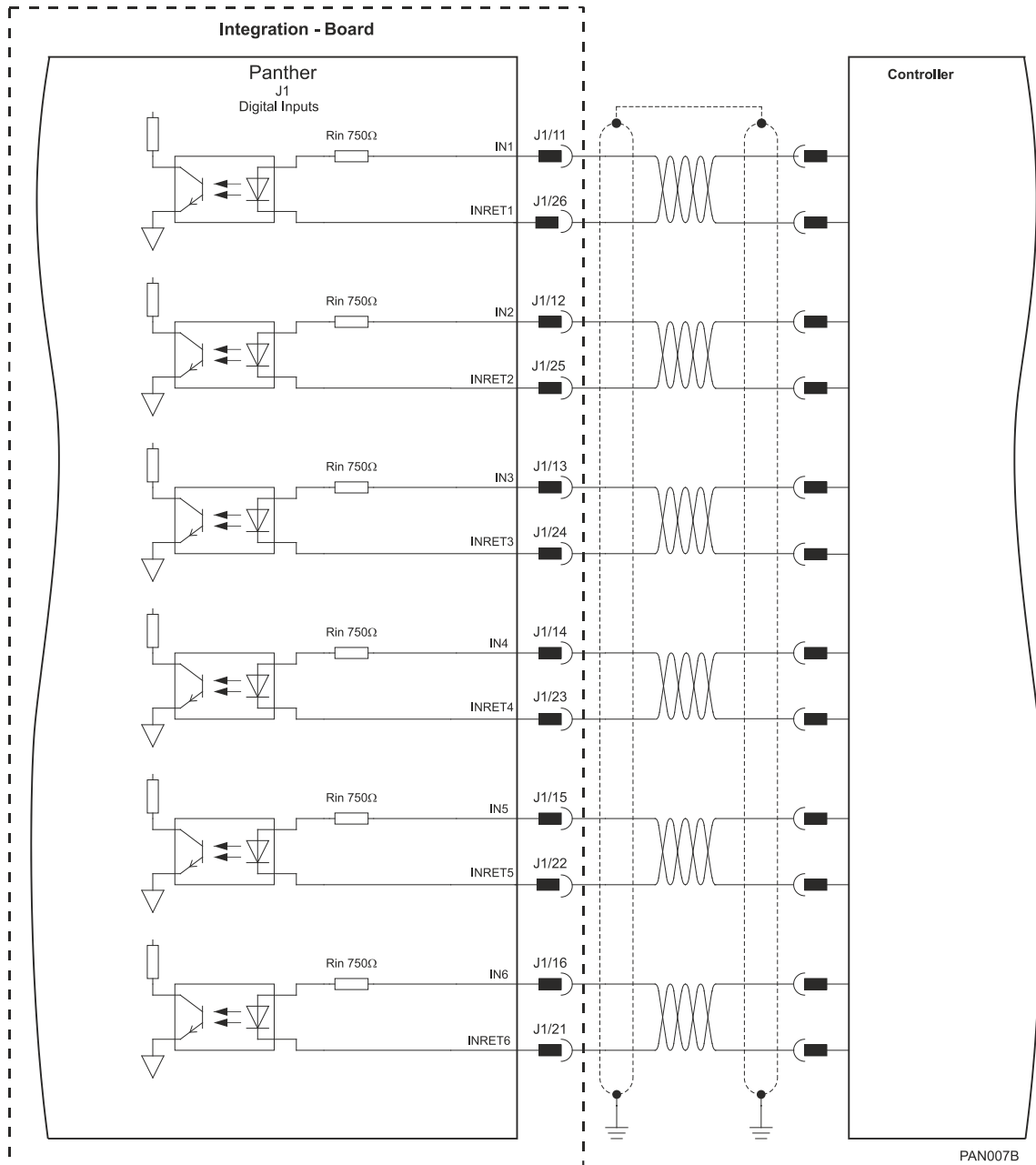


Figure 30: Digital Input Connection Diagram – 5V Level

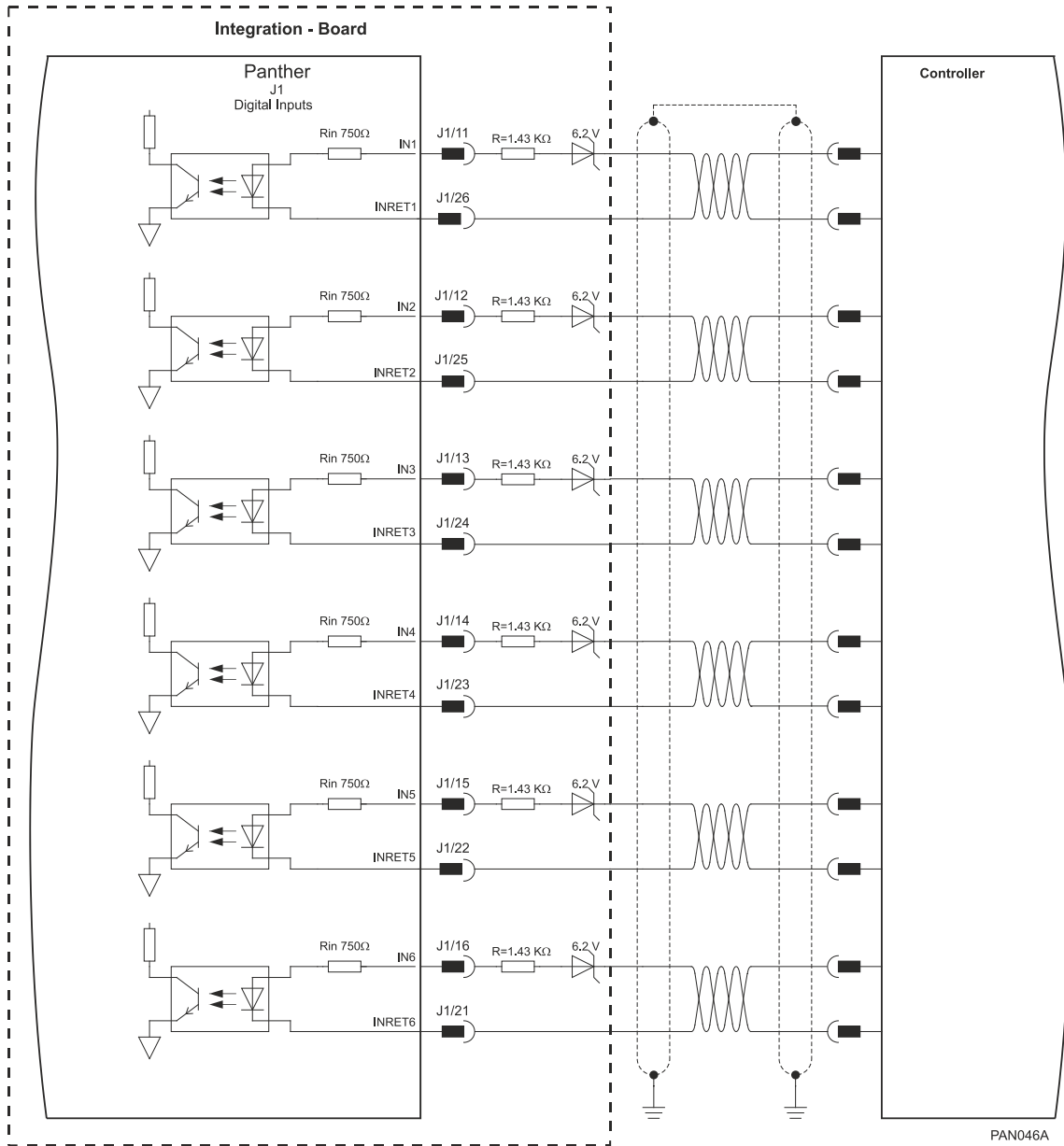


Figure 31: Digital Input Connection Diagram -PLC

3.11.2. Digital Output

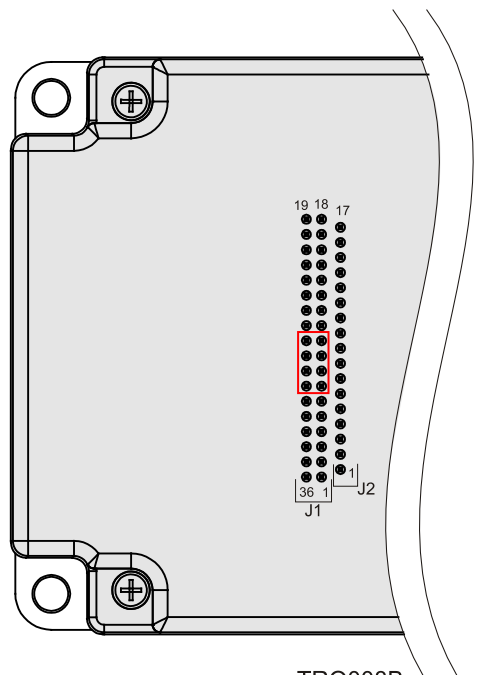
Pin (J1)	Signal	Function	Pin Positions
7	OUT1	High-Speed Programmable digital output 1	 <p>TRO008B</p>
8	OUT2	Programmable digital output 2	
9	OUT3	Programmable digital output 3	
10	OUT4	Programmable digital output 4	
30	OUTRET1	Programmable digital output 1 return	
29	OUTRET2	Programmable digital output 2 return	
28	OUTRET3	Programmable digital output 3 return	
27	OUTRET4	Programmable digital output 4 return	

Table 9: Digital Output Pin Assignment

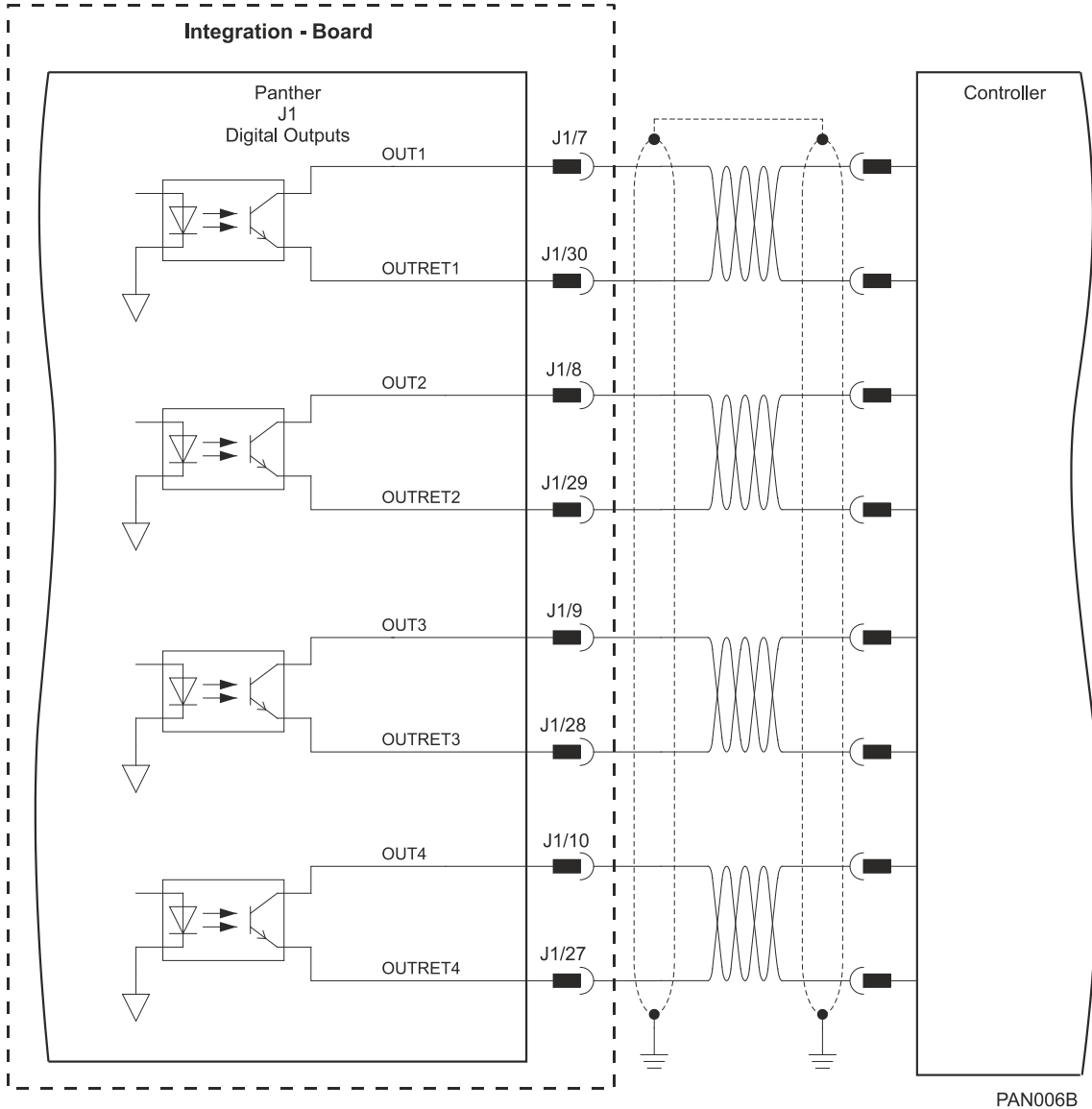


Figure 32: Digital Output Connection Diagram

3.11.3. Analog Input

Pin (J2)	Signal	Function
3	ANLIN1+	Analog input 1+
4	ANLIN1-	Analog input 1-
2	ANLRET	Analog ground

Table 10: Analog Input Pin Assignments

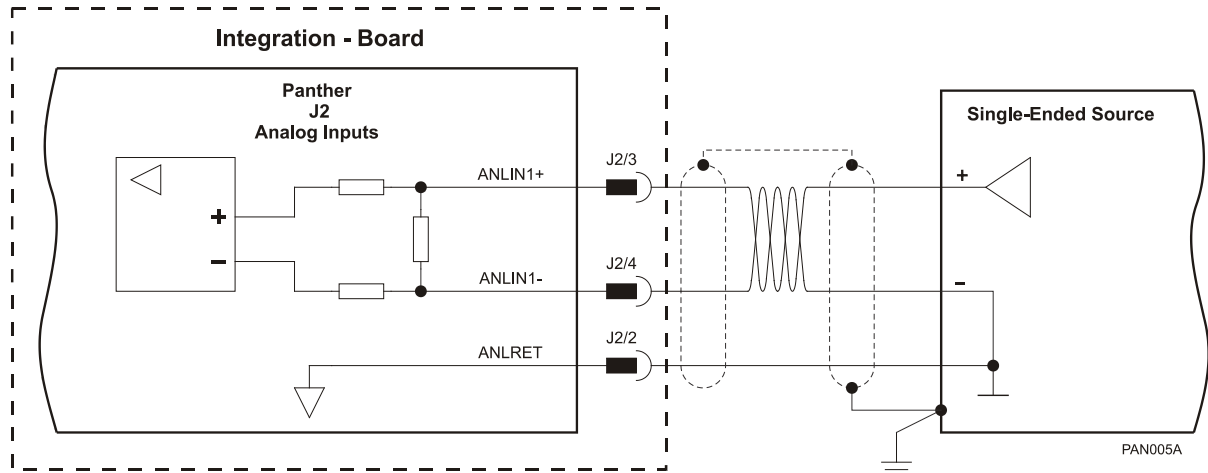


Figure 33: Analog Input with Single-Ended Source

3.12. Communications

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

- a. RS-232, full duplex
- b. CAN

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

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

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

3.12.1. RS-232 Communication

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.

Ensure that the shield of the cable is connected to the shield of the connector used for RS-232 communications. The drain wire can be used to facilitate the connection.

Pin (J1)	Signal	Function
1	RS232_Rx	RS-232 receive
2	RS232_Tx	RS-232 transmit
3	RS232_COMRET	Communication return

Table 11: RS-232 Pin Assignments

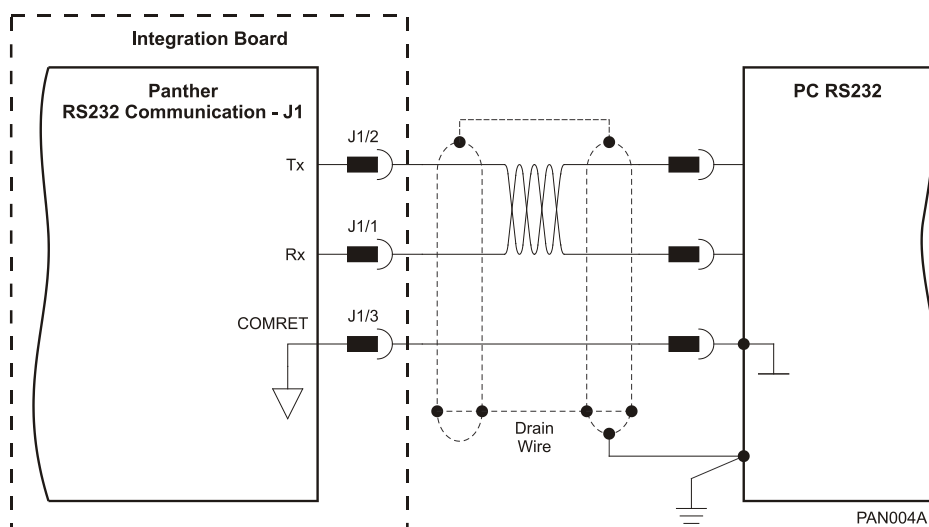


Figure 34: RS-232 Connection Diagram

3.12.2. CAN Communication

Connecting the CAN 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.

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.

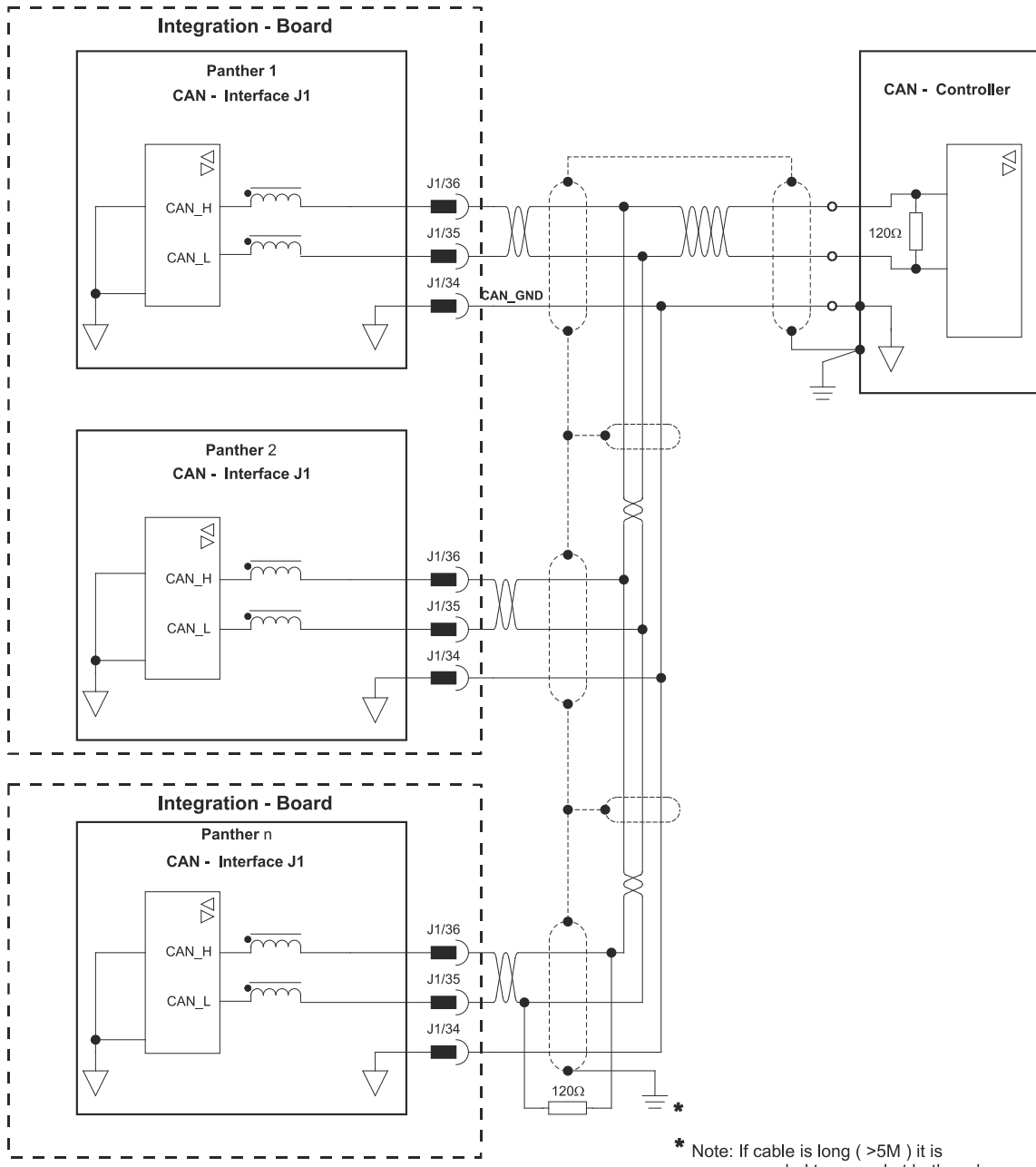
Make sure to have a 120-Ω resistor termination at each of the two ends of the network cable

The Panther's CAN port is non-isolated.

Pin (J1)	Signal	Function
34	CAN_RET	CAN ground
35	CAN_L	CAN_L bus line (dominant low)
36	CAN_H	CAN_H bus line (dominant high)

Table 12: CAN – Pin Assignments

Note: The CAN_RET terminal must always be used and connected, to provide electrical immunity.



PAN003B

Figure 35: CAN Network Diagram



Caution:

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

3.13. Powering Up

After the Panther 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.

3.13.1. Initializing the System

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

3.14. Heat Dissipation

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

3.14.1. Panther Thermal Data

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

3.14.2. Heat Dissipation Data

Heat Dissipation is shown graphically below:

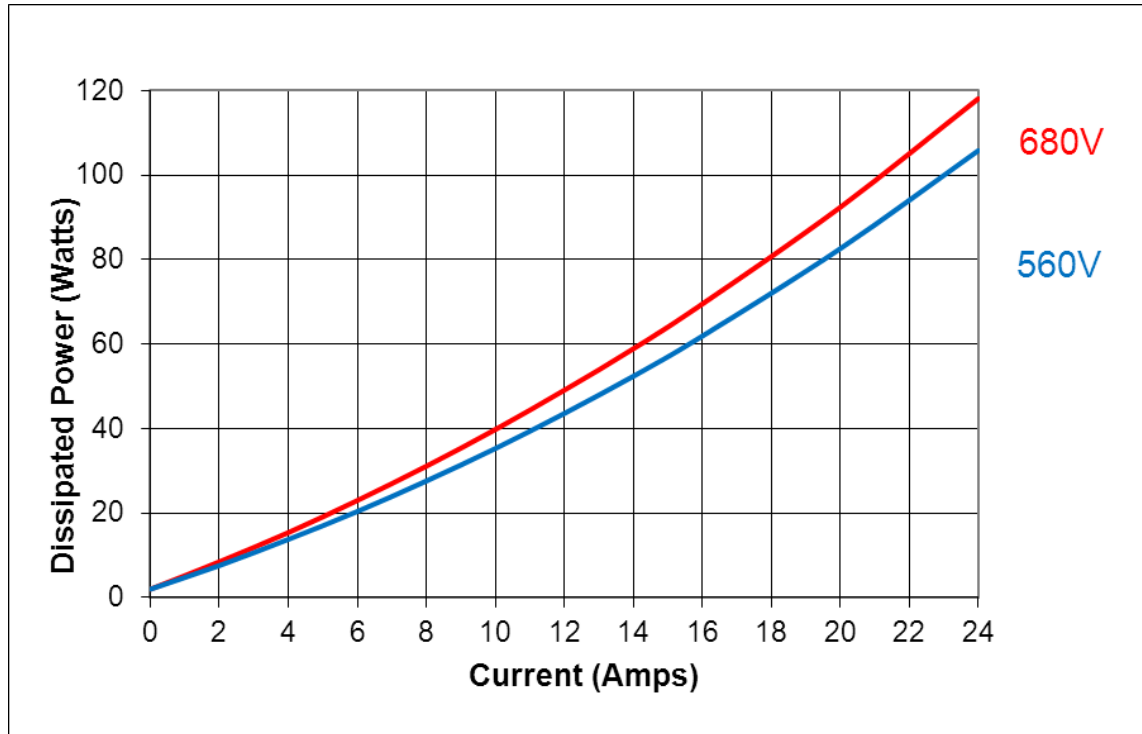


Figure 36: Dissipation versus Current Graph for 560 and 680 VDC

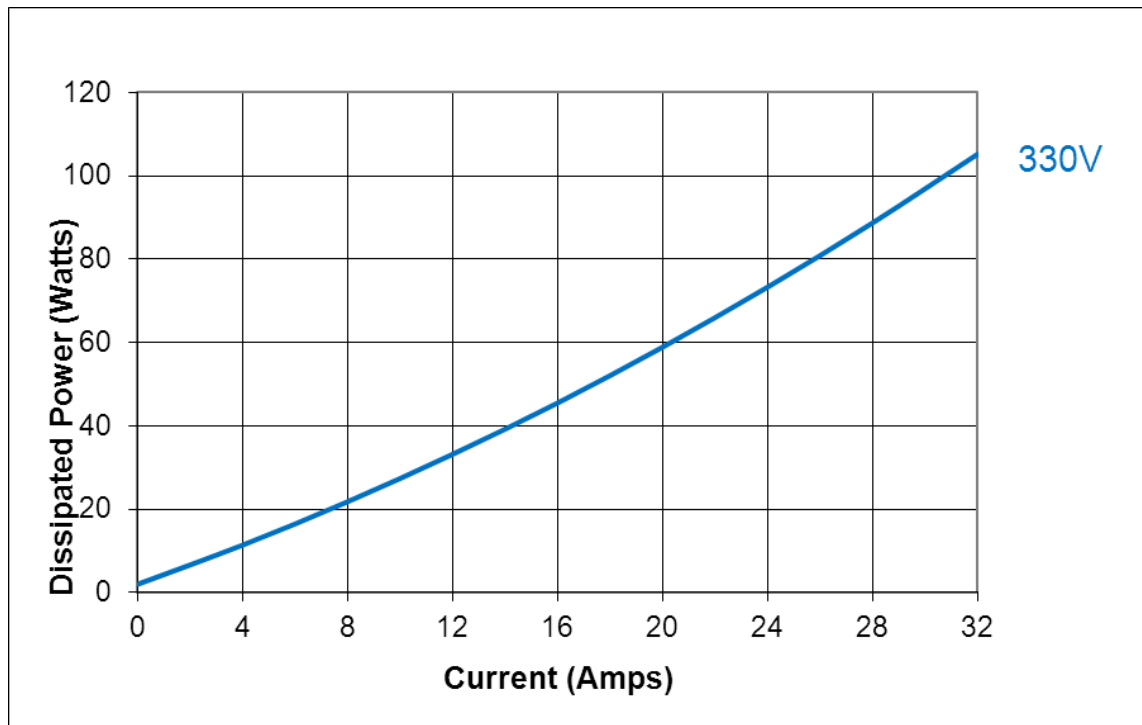


Figure 37: Dissipation versus Current Graph for 330 VDC

3.14.3. 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 Panther 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 4: Technical Specifications

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

4.1. Features

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

4.1.1. Motion Control Modes

- Current/Torque - up to 14 kHz sampling rate
- Velocity - up to 7 kHz sampling rate
- Position - up to 3.5 kHz sampling rate

4.1.2. Advanced Positioning Control Modes

- PTP, PT, PVT, ECAM, Follower, Dual Loop, Current Follower
- Fast event capturing inputs
- Fast output compare (OC)
- Motion Commands: analog, pulse-width modulation (PWM), digital (software) and pulse and direction

4.1.3. Advanced Filters and Gain Scheduling

- “On-the-fly” gain scheduling of current and velocity
- Velocity and position with “1-2-4” PIP controllers
- Automatic commutation alignment
- Automatic motor phase sequencing

4.1.4. Fully Programmable

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

4.1.5. Feedback Options

- Incremental Encoder – up to 20 Megacounts (5 Megapulses) per second
- Digital Halls – up to 2 kHz
- Absolute Encoder
- Incremental Encoder with Digital Halls for commutation – up to 20 Megacounts per second for encoder
- Interpolated Analog (Sine/Cosine) Encoder – up to 250 kHz (analog signal)
 - Internal interpolation – up to x4096
 - Automatic correction of amplitude mismatch, phase mismatch, signal offset
 - Emulated outputs of the analog encoder: single-ended and unbuffered
- Analog Hall sensor
- Resolver
 - Programmable 10 to 15 bit resolution
 - Up to 512 revolutions per seconds (RPS)
 - Emulated outputs of the resolver: single-ended and unbuffered
- Auxiliary encoder inputs (ECAM, follower, etc.) single-ended, unbuffered
- Tachometer & Potentiometer
- The Panther can provide power (5 V, 2 x 200 mA max) for Encoders, Resolver or Halls.

4.1.6. Input/Output

- One **Analog Input** – up to 14-bit resolution
- Six separate programmable **Digital Inputs**, optically isolated (two of which are fast event capture inputs)
 - Inhibit/enable motion
 - Software and analog reference stop
 - Motion limit switches
 - Begin on input
 - Abort motion
 - Homing
 - General purpose
- Four separate programmable **Digital Outputs**, optically isolated (open collector), one with fast output compare (OC):
 - Brake control
 - Servo-Drive fault indication
 - General purpose
 - Servo enable indication
- Pulse and direction inputs (single-ended)
- PWM current command output for torque and velocity

4.1.7. Built-In Protection

- Software error handling
- Abort (hard stops and soft stops)
- Status reporting
- Protection against:
 - Shorts between motor power outputs
 - Shorts between motor power outputs and power input/return
 - Failure of internal power supplies
 - Over-heating
 - Continuous temperature measurement. Temperature can be read on-the-fly, and a warning can be initiated x degrees before temperature disable is activated.
 - Over-/under-voltage
 - Loss of feedback
 - Following error
 - Current limits

4.1.8. Status Indication

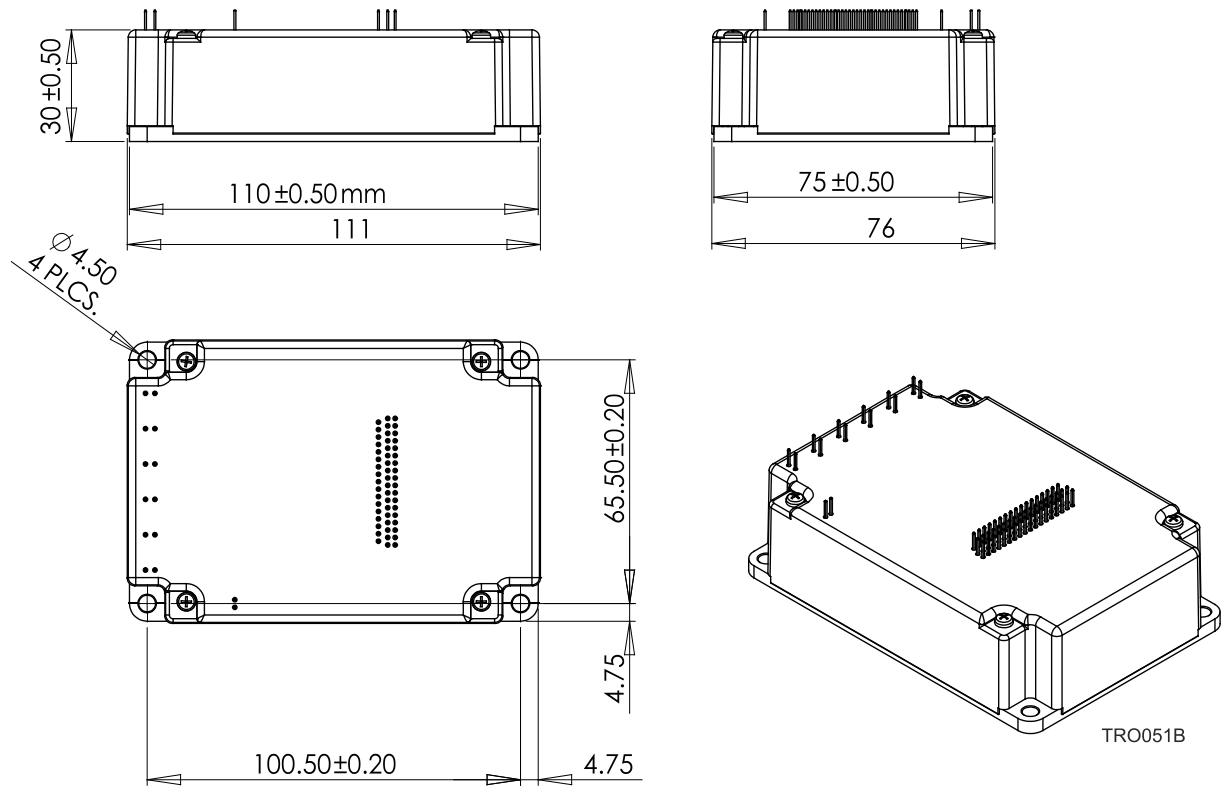
- By software/composer interface during continuous communication
- Output for a bi-color LED - to be implemented via user external LED.

4.1.9. Automatic Procedures

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



4.2. Dimensions





4.3. Power Ratings for 400 V models

Feature	Units	12/400	16/400	R17/400	R22/400
Minimum supply voltage	VDC	S option in P/N*: 50 No S option in P/N: 100			
Nominal supply voltage	VDC	325			
Maximum supply voltage	VDC	400			
Maximum continuous power output	kW	4	5	5.5	7
Efficiency at rated power (at nominal conditions)	%	> 98			
Auxiliary supply voltage option	VDC	18 V to 30 V Only for Control Supply S option Model			
Auxiliary power supply	VA	7			
Continuous current limit (I _c) Amplitude sinusoidal/DC trapezoidal commutation	A	12	16	17	22
Sinusoidal continuous RMS current limit (I _c)	A	8.5	11.3	12	15.5
Peak current limit	A	2 x I _c		No peak	
Weight	g (oz)	250 g (8.8 oz)			
Dimensions	mm (in)	111 x 76 x 30 (4.33" x 2.95" x 1.18")			
Digital in/Digital out/ Analog in		6/4/1			
Mounting method		PCB Mounted			



4.4. Power Ratings for 700 V models

Note: This model will not be used in new designs of the drive.

Feature	Units	8/700	12/700	R11/700	R16/700
Minimum supply voltage	VDC	S option in P/N*: 95+			
Nominal supply voltage	VDC	560 for 400 VAC 680 for 480 VAC			
Maximum supply voltage	VDC	700			
Maximum continuous power output	kW	4.5	7	6.3	9
Efficiency at rated power (at nominal conditions)	%	> 98			
Auxiliary supply voltage option	VDC	18 V to 30 V Only for Control Supply S option Model			
Auxiliary power supply	VA	7			
Continuous current limit (Ic) Amplitude sinusoidal/DC trapezoidal commutation	A	8	12	11	16
Sinusoidal continuous RMS current limit (Ic)	A	5.7	8.5	7.8	11.3
Peak current limit	A	2 x Ic		No peak	
Weight	g (oz)	250 g (8.8 oz)			
Dimensions	mm (in)	111 x 76 x 30 (4.33" x 2.95" x 1.18")			
Digital in/Digital out/ Analog in		6/4/1			
Mounting method		PCB Mounted			

4.5. Power Ratings for 800 V models

Feature	Units	8/800	12/800	R11/800	R16/800
Minimum supply voltage	VDC	S option in P/N*: 95+			
Nominal supply voltage	VDC	560 for 400 VAC 680 for 480 VAC			
Maximum supply voltage	VDC	780			
Maximum continuous power output	kW	5	7.5	7	10
Efficiency at rated power (at nominal conditions)	%	> 98			
Auxiliary supply voltage option	VDC	18 V to 30 V Only for Control Supply S option Model			
Auxiliary power supply	VA	7			
Continuous current limit (Ic) Amplitude sinusoidal/DC trapezoidal commutation	A	8	12	11	16
Sinusoidal continuous RMS current limit (Ic)	A	5.7	8.5	7.8	11.3
Peak current limit	A	2 x Ic		No peak	
Weight	g (oz)	250 g (8.8 oz)			
Dimensions	mm (in)	111 x 76 x 30 (4.33" x 2.95" x 1.18")			
Digital in/Digital out/ Analog in		6/4/1			
Mounting method		PCB Mounted			

The following notes apply to all the above Power Rating models 400, 700, and 800 V.

*See page 19 for details on the part number. The S option appears in models where there is a 24 V control supply. If there is no S option, the control power supply operates from the main power.

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

4.6. Auxiliary Supply

This table applies only to the models with an S option. See page 19 for further details on the part number.

Feature	Details
Auxiliary power supply	Isolated DC source only
Auxiliary supply input voltage	18 to 30 VDC
Auxiliary supply input power	7 VA

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

4.7. Environmental Conditions

The ExtriQ products are designed, manufactured and tested to meet extreme environmental conditions. The **ExtriQ durability** is qualified, verified and tested according to the most severe environmental, EMC and safety standards exceeding the traditional and senior military Standards.

The ExtriQ series of drives support the following extended environmental conditions.

Feature	Operation Conditions	Range
Ambient Temperature Range	Non-operating conditions	-50 °C to +100 °C (-58 °F to 212 °F)
	Operating conditions	-40 °C to +70 °C (-40 °F to 160 °F)
Temperature Shock	Non-operating conditions	-40 °C to +70 °C (-40 °F to 160 °F) within 3 min
Altitude	Non-operating conditions	Unlimited
	Operating conditions	-400 m to 12,000 m (-1312 to 39370 feet)
Relative Humidity	Non-operating conditions	Up to 95% relative humidity non-condensing at 35 °C (95 °F)
	Operating conditions	Up to 95% relative humidity non-condensing at 25 °C (77 °F), up to 90% relative humidity non-condensing at 42 °C (108 °F)
Vibration	Operating conditions	20 Hz to 2000 Hz, 14.6 g
Mechanical Shock	Non-operating conditions	±40 g; Half sine, 11 msec
	Operating conditions	±20 g; Half sine, 11 msec

4.8. Control Specifications

4.8.1. Current Loop

Feature	Details
Controller type	Vector, digital
Compensation for bus voltage variations	On-the-fly automatic gain scheduling
Motor types	<ul style="list-style-type: none"> • AC brushless (sinusoidal) • DC brushless (trapezoidal) • DC brush • Linear motors • “Voice” coils
Current control	<ul style="list-style-type: none"> • Fully digital • Sinusoidal with vector control • Programmable PI control filter based on a pair of PI controls of AC current signals and constant power at high speed
Current loop bandwidth	< 2.5 kHz
Current loop sampling time	Programmable 100 to 200 μsec
Current loop sampling rate	Default 10 kHz

4.8.2. Velocity Loop

Feature	Details
Controller type	PI
Velocity control	<ul style="list-style-type: none"> Fully digital Programmable PI and FFW control filters On-the-fly gain scheduling Automatic, manual and advanced manual tuning
Velocity and position feedback options	<ul style="list-style-type: none"> Incremental Encoder Digital Halls Interpolated Analog (Sine/Cosine) Encoder (optional) Resolver (optional) Tachometer and Potentiometer (optional) <p>Note: With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).</p>
Velocity loop bandwidth	< 350 Hz
Velocity loop sampling time	140 - 200 μ sec (twice the current loop sample time)
Velocity loop sampling rate	Up to 8 kHz; default 5.5 kHz
Velocity command options	<ul style="list-style-type: none"> Analog Internally calculated by either jogging or step <p>Note: All software-calculated profiles support on-the-fly changes.</p>

4.8.3. Position Loop

Feature	Details
Controller type	"1-2-4" PIP
Position command options	<ul style="list-style-type: none"> Software Pulse and Direction Analog Potentiometer
Position loop bandwidth	< 80 Hz
Position loop sampling time	280 - 400 μ sec (four times the current loop sample time)
Position loop sampling rate	Up to 4 kHz; default 2.75 kHz

4.9. Feedbacks

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

4.9.1. Feedback Supply Voltage

The Panther has two feedback ports (Main and Auxiliary). It supplies voltage to the Main feedback device, and to the Auxiliary feedback device if needed.

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

4.9.2. Main Feedback Options

4.9.2.1. Incremental Encoder Input

Feature	Details
Encoder format	<ul style="list-style-type: none"> • A, B and Index • Differential • Quadrature
Interface	RS-422
Input resistance	Differential: 120 Ω
Maximum incremental encoder frequency	Maximum absolute: 5 MHz pulses
Minimum quadrature input period (P_{IN})	112 nsec
Minimum quadrature input high/low period (P_{HL})	56 nsec
Minimum quadrature phase period (P_{PH})	28 nsec
Maximum encoder input voltage range	Common mode: \pm 7 V Differential mode: \pm 7 V

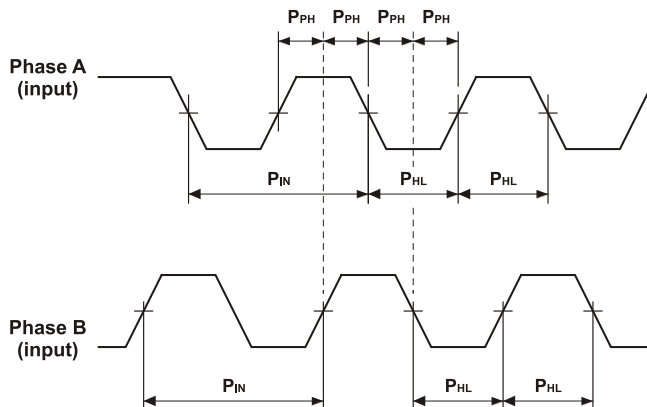


Figure 38: Main Feedback - Encoder Phase Diagram

4.9.2.2. Digital Halls

Feature	Details
Halls inputs	<p>H_A, H_B, H_C.</p> <p>Single-ended inputs</p> <p>Built in hysteresis of 1 V for noise immunity</p>
Input voltage	<p>Nominal operating range: $0\text{ V} < V_{\text{In_Hall}} < 5\text{ V}$</p> <p>Maximum absolute: $-1\text{ V} < V_{\text{In_Hall}} < 15\text{ V}$</p> <p>High level input voltage: $V_{\text{InHigh}} > 2.5\text{ V}$</p> <p>Low level input voltage: $V_{\text{InLow}} < 1\text{ V}$</p>
Input current	Sink current (when input pulled to the common): 5 mA
Maximum frequency	$f_{\text{MAX}} : 2\text{ kHz}$

4.9.2.3. Interpolated Analog (Sine/Cosine) Encoder

Feature	Details
Analog encoder format	Sine and Cosine signals
Analog input signal level	<ul style="list-style-type: none"> Offset voltage: 2.2 V to 2.8 V Differential, 1 V peak to peak
Input resistance	Differential 120 Ω
Maximum analog signal frequency	$f_{\text{MAX}} : 250\text{ kHz}$
Interpolation multipliers	Programmable: x4 to x4096
Maximum “counts” frequency	80 Megacounts/sec “internally”
Automatic error correction	<p>Signal amplitudes mismatch</p> <p>Signal phase shift</p> <p>Signal offsets</p>
Encoder outputs	See Auxiliary Encoder Outputs specifications (4.9.3)

**4.9.2.4. Absolute Serial Encoder**

Feature	Details
Encoder format	<ul style="list-style-type: none"> • NRZ (Panasonic) • EnDAT 2.21 (with analogue Sin/Cos) • Stegmann in DC-TRO/SOL-TRO
Interface	<ul style="list-style-type: none"> • RS-485 • Clock – Differential output line • Data – Differential bidirectional line
Input Resistance	Differential 120 Ω
Transmission Rate	Up to 2.5 MHz

4.9.2.5. Resolver

Feature	Details
Resolver format	<ul style="list-style-type: none"> • 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 Panther
Reference current	up to ± 50 mA
Encoder outputs	See Auxiliary Encoder Output specifications (4.9.3)

4.9.2.6. Tachometer*

Feature	Details
Tachometer format	Differential
Maximum operating differential voltage for TAC1+, TAC1-	±20 V
Maximum absolute differential input voltage for TAC1+, TAC1-	±25 V
Maximum operating differential voltage for TAC2+, TAC2-	±50 V
Maximum absolute differential input voltage for TAC2+, TAC2-	±60 V
Input resistance for TAC1+, TAC1-	46 kΩ
Input resistance for TAC2+, TAC2-	100 kΩ
Resolution	14 bit

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

4.9.2.7. Potentiometer

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

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

Feature	Details
Emulated output	<ul style="list-style-type: none"> • A, B, Index • Single ended
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	<ul style="list-style-type: none"> • Emulated encoder outputs of following: • Analog encoder • Resolver • Absolute encoder • Tachometer • Potentiometer
Maximum frequency	$f_{MAX} : 5 \text{ MHz pulses/output}$
Edge separation between A & B	Programmable number of clocks to allow adequate noise filtering at remote receiver of emulated encoder signals
Index (marker)	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

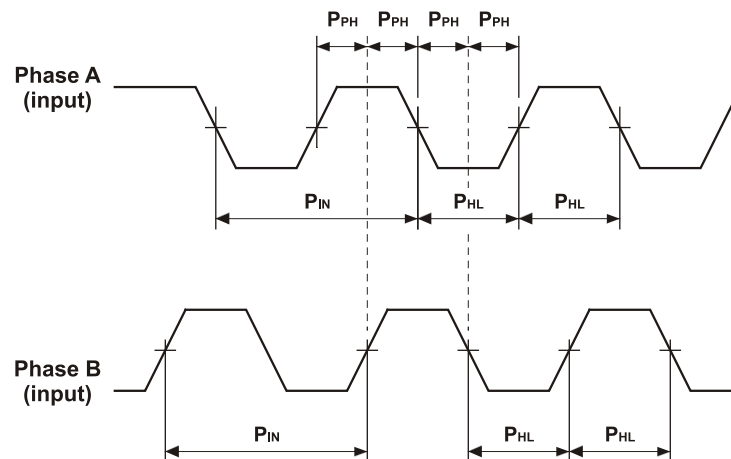


Figure 39: Auxiliary Feedback - Encoder Phase Diagram

4.9.4. Auxiliary Feedback Port (input mode YA[4]= 2, 0)

Feature	Details
Encoder input, pulse and direction input	<ul style="list-style-type: none"> • A, B, Index • Single ended
Input voltage	V_{in} Low: $0\text{ V} < V_{IL} < 0.8\text{ V}$ V_{in} High: $2\text{ V} < V_{IH} < 5\text{ V}$ Maximum absolute voltage: $0 < V_{in} < 5.5\text{ V}$ Input current: $\pm 1\ \mu\text{A}$
Available as options	<ul style="list-style-type: none"> • Single-ended Encoder inputs • Pulse and Direction inputs
Edge separation between A & B	Programmable number of clocks to allow adequate noise filtering at remote receiver of emulated encoder signals
Index (marker):	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

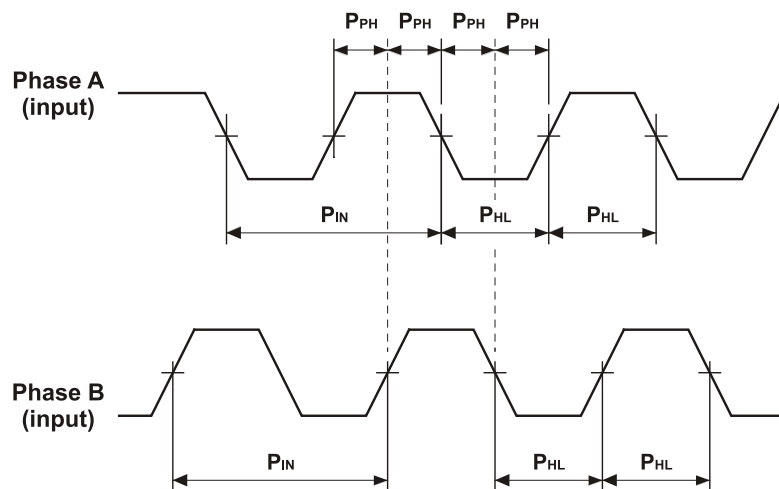


Figure 40: Auxiliary Feedback - Encoder Phase Diagram

4.10. I/Os

The Panther has:

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

4.10.1. Digital Input Interfaces

The digital inputs are 5 V level compatible by default, but can be configured to PLC level, on the integration board.

Feature	Details
Type of input	<ul style="list-style-type: none"> • Optically isolated • Each input has its own return
Input current for all inputs	$I_{in} = 4.7 \text{ mA @ } V_{in} = 5 \text{ V}$
High-level input voltage	$3.0 \text{ V} < V_{in} < 10 \text{ V}$, 5 V typical
Low-level input voltage	$0 \text{ V} < V_{in} < 1 \text{ V}$
Minimum pulse width	$> 4 \times TS$, where TS is sampling time
Execution time (all inputs): the time from application of voltage on input until execution is complete	<p>If input is set to one of the built-in functions — Home, Inhibit, Hard Stop, Soft Stop, Hard and Soft Stop, Forward Limit, Reverse Limit or Begin — execution is immediate upon detection: $0 < T < 4 \times TS$</p> <p>If input is set to General input, execution depends on program. Typical execution time: $\cong 0.5 \text{ msec}$.</p>
High-speed inputs – 5 & 6 minimum pulse width, in high-speed mode	<p>Capture Time (T) $< 5 \mu\text{sec}$</p> <p>Notes:</p> <ul style="list-style-type: none"> • 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 the same value as the digital filter (EF) of the main encoder. • The highest speed is achieved when turning on optocouplers.

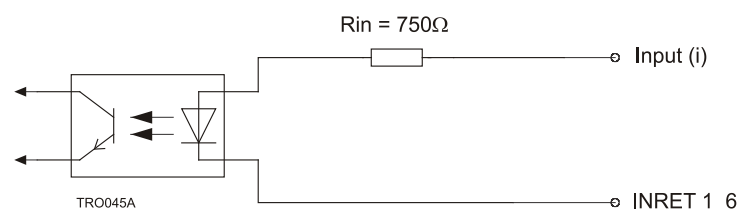



Figure 41: Digital Input Schematic

4.10.2. Digital Output Interface

Feature	Details
Type of output	<ul style="list-style-type: none"> • Optically isolated • Open collector and open emitter • Each output has its own return
Maximum supply output (VCC)	30 V
Max. output current $I_{out} (max) (V_{out} = Low)$	$I_{out} (max) \leq 8 \text{ mA}$
VOL at maximum output voltage (low level)	$V_{out} (on) \leq 0.4 \text{ V}$
R_L	<p>The external resistor R_L must be selected to limit the output current to no more than 8 mA.</p> $R_L = \frac{VCC - VOL}{I_{out} (max)}$
Executable time	<p>If output is set to one of the built-in functions — Home flag, Brake or AOK — execution is immediate upon detection: $0 < T < 4 \times TS$</p> <p>If output is set to General output and is executed from a program, the typical time is approximately 0.5 msec.</p>
 <p>Figure 42: Digital Output Schematic</p>	

4.10.3. Analog Input

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



4.11. Communications

Specification	Details
RS-232	<p>Signals:</p> <ul style="list-style-type: none"> • RxD, TxD, GND • Full duplex, serial communication for setup and control • Baud Rate of 9,600 to 57,600 bit/sec
CAN	<p>CAN bus Signals:</p> <ul style="list-style-type: none"> • CAN_H, CAN_L, CAN_GND • Maximum Baud Rate of 1 Mbit/sec <p>Version:</p> <ul style="list-style-type: none"> • DS 301 v4.01 <p>Layer Setting Service and Protocol Support:</p> <ul style="list-style-type: none"> • DS 305 <p>Device Profile (drive and motion control):</p> <ul style="list-style-type: none"> • DS 402

4.12. Pulse-Width Modulation (PWM)

Feature	Details
PWM resolution	12-bit
PWM switching frequency on the load	2/Ts (factory default 22 kHz on the motor)

4.13. 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 style="list-style-type: none"> • 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)