



4301 Kishwaukee Street
Rockford, IL 61105-0106
Phone: (815) 226-3100
Fax: (815) 226-3080
www.pacsci.com

Part # **MA24xxD Rev 1.0**
List Price \$30 U.S.
February 2001

MA2400D

PD2400D Family Hardware Reference Manual

Single axis digital stepper drive

The **PD24xxD** Series is a new generation of **DC input, 18-74 VDC**, high performance Intelligent Digital Microstep Drives for controlling two or four phase step motors, (size 10mm to NEMA 34) in position or velocity modes. Units are available in current ratings of 3 and 6 amps. **The PD24xxD Series is an OEM product where the user is required to separately purchase; Ship-Kits (connectors), manuals, cables, etc. Please review the section on [Accessories 7.3.1](#) when ordering system components.**

PREFACE

You've just purchased the finest intelligent microstep motor Controller(s) in its class. The PD24xxD Series drives are designed to provide reliable long-term and economical operation in demanding field environments. Without exception the PD24xxD Series Intelligent Microstep Drives outperform every other competitor in the critical areas of size, performance, integration via its extensive I/O, ease of field service, and the versatility of its all-digital design. A graphical user interface program, ToolPAC, provides the user with the tools to configure the PD24xxD to a specific motor, application and for development of complex motion programs. (compatible with WIN95/WIN98/NT operating systems). **The PD24xxD Series is an OEM product where the user is required to separately purchase; Ship-Kits (connectors), manuals, cables, etc. Please review the section on [Accessories 7.3.1](#) when ordering system components.**

The **PD24xxD** Series is a new generation of **DC input, 18-74 VDC**, high performance Intelligent Digital Microstep Drives for controlling two or four phase step motors, (size 10mm to NEMA 34) in position or velocity modes. Units are available in current ratings of 3 and 6 amps. The product series includes three product families: the **PD24xxDd-001-E**, a **Digital** servo drive, the **PD24xxDi-001-E**, an **Intelligent** stepper drive and the **PD24xxDi-001-EI**, an **Intelligent** stepper drive with extended IO. See section [Table 1.1 Model Designations and Specifications](#) for additional detail. The product series is designed to support Encoder for stall detection and position feedback, **(at the time of this printing the encoder features have not been fully tested/activated in the units' firmware).**

Each PD24xxD unit is a bipolar, microstepping drive, controller and heatsink integrated into a single standalone package designed to drive two or four-phase step motors. The **PD24xxDi** offers recirculating current, which reduces torque ripple, auto-switch into two-phase, full-step mode at a user programmable velocity point to increase efficiency. This enables the units to achieve 33% more torque than when microstepping. The unit auto-switches back to microstep resolution during deceleration to provide accuracy and microstepping smoothness when it is needed most without loss of position accuracy. Units have full short circuit protection; phase to phase, phase to ground and under/over voltage protection of the DC input supply.

Each PD24xxD unit is an drive, controller and heatsink integrated into a single standalone package. The compact size and integrated design of the PD24xxD drive simplifies the installation process and reduces downtime should the need for replacement arise.

The unit is hardware configured for RS-232 (factory default), RS-422 or RS-485 serial communications with **ToolPAC**© software for configuration, debugging and trouble shooting of the unit. **ToolPAC** software allows complete configuration and diagnostics of all features in the unit.

Fundamentally, a **PD24xxD** drive is a computer that is dedicated to motion control. Like every other computer it has its own operating system, data storage capabilities, data manipulation capabilities. The unit also includes a serial interface for data communications. In addition, its built-in inputs/outputs allow for hard-wired connections for motor feedback and to sensor switches to ensure motion that is “in sync” with a user’s environment. All PD24xxD series stepper controllers provide the user with the same basic components, including:

- Serial communications port for use with **ToolPAC**® for purposes of trouble shooting and initial drive configuration.
- A graphical user interface program, **ToolPAC**, provides the user with the tools to quickly and easily configure the PD24xxD to a specific motor and application. **ToolPAC** provides Wizards for **Axis Setup, I/O Configuration, Tuning** and is compatible with WIN95/WIN98/NT operating systems.
- System software including commands and parameters that allow you to configure the unit to your application, to enter and manipulate data, and to tune the performance of the unit to your application.
- Methods of control include Position, Velocity, and the ability to accept Step/Dir, Step+/Step- and Encoder quadrature in Following mode whereby you are commanding the stepper system in a position following mode. Master/slave relationships can be developed from the secondary encoder inputs, providing motion output.
- The **I/O Configuration Wizard** provides the user with the tools to configure Hardware interfaces for High-Speed Encoder inputs, CW, CCW, Home inputs, Brake output that allow you to interface to your machinery/equipment.

The **PD24xxDi-001-E** (Intelligent) Series and the **PD24xxDi-001-EI** (Intelligent with extended I/O) Series Controllers accept high level commands directly, eliminating the need for a motion controller and can be operated standalone or networked. Each unit has the ability to store and execute motion programs. Additional features available are:

- Stored program mode refers to a method of control where you create and store “motion programs” on the stepper controller system and execute the programs when required. Motion programs provide the user with the ability to perform complex, repetitive functions without having to type each individual command line every time you wish to perform the same function. In this mode you may choose to initiate a program through your communications port or establish a monitor program to allow an input to “trigger” or begin execution of a particular sequence of commands.
- Networked configuration allows for up to 31 axis from a single PC serial port or similar host device. Multi-axis start and stop, along with on-the-fly speed change, are only a few of the networked features available on these units. The user must request additional documentation to gain a better understanding of the network requirements. To obtain the documents listed below, log onto the ftp site at the address shown below.

ToolPAC Software Reference Guide, for additional information on Advanced commands (Gearing, Macro's, Links, PLS)	MAToolPAC.zip
Intelligent Servo/Stepper Protocol (MA-ISP.pdf)	Below
Intelligent Servo/Stepper ASCII Protocol (MA-ISAP.pdf)	Below
Intelligent Motion Language (MA-IML.pdf)	Below
Dynamic Link Library (DLL)	ISPDLL.zip

- <http://www.pacsci.com>.
- Complex SPLINE tables of up to 100 data points on the **PD240xDi** (Intelligent) Series can be entered to define custom motion profiles as a function of time. Complex CAM tables of up to 100 data points on the **PD240xDi** (Intelligent) Series can be entered to define custom motion profiles as a function of the master encoder input.
- Master/slave (Electronic Gearing) relationships can be developed from the secondary encoder inputs, providing motion output as a RATIO, CAM, or SPLINE.
- The **PD240xDi-001-EI** has an additional 16 general-purpose digital inputs and 8 general purpose outputs.

PD2400D Family Hardware Reference Manual

Revision 1.0 - Initial documentation release.

The information contained in this document is provided for customer use only. Every effort has been made to ensure the accuracy of this information. However, Pacific Scientific assumes no responsibility for any errors or omissions. The information contained in this document is subject to change without prior notice. Users' critical evaluation is welcomed to assist in the preparation of future documentation.

This document is copyrighted by Pacific Scientific. It is supplied to the user with the understanding that it will not be reproduced, duplicated, or disclosed in whole or in part without the express written permission of Pacific Scientific.

Copyright © 2001 by Pacific Scientific. All rights reserved.


Printed in the United States of America.


SUMMARY OF SAFETY CONSIDERATIONS

This section contains duplications of each **NOTE**, **CAUTION**, and **WARNING** presented in the body of this document. These safety considerations are grouped according to the section that they appear in.

It is highly recommended that the safety considerations contained in this section be reviewed prior to equipment installation or operation.

NOTES, **CAUTIONS**, and **WARNINGS** contained in the text provide important information.

	NOTE
	A NOTE provides additional or special information to assist operation/maintenance personnel. Disregarding a NOTE may cause inconvenience but will not result in personal injury or equipment damage.

	CAUTION
	A CAUTION is provided in a procedure whenever electrical or mechanical damage may occur. Failure to heed a CAUTION will result in some form of damage to the equipment; however, personal injury is unlikely.


	WARNING
	A WARNING is provided in a procedure where personal injury may occur if the WARNING is not heeded. Electrical or mechanical damage may also occur.

TABLE OF CONTENTS

Preface.....	ii
Summary of Safety Considerations.....	vii
Table of Contents	viii
List of Illustrations.....	x
List of Tables	xii
1. Introduction	1-13
1.1 About This User’s Guide.....	1-13
1.2 Model Designations and Specifications	1-14
1.3 WARRANTY AND LIMITATION OF LIABILITY	1-17
1.4 Customer Service.....	1-19
2. Unpacking, Inspection, and Storage.....	2-21
2.1 Unpacking and Inspection	2-21
2.2 Handling	2-22
2.3 Storage	2-22
3. Installation and Wiring	3-1
3.1 Shielding and Grounding of Electrical Panels.....	3-2
3.2 Communications.....	3-8
3.3 DC Power (TB1).....	3-15
3.4 Motor Wiring (TB2).....	3-19
3.5 Logic (low) Power DC Connections	3-22
3.6 Encoder Feedback (J3)	3-22
3.7 I/O connector (J1) – all models	3-25
3.8 PD24xxDd-001-E	3-35

3.9	PD24xxDi-001-E (J1)	3-42
3.10	PD24xxDi-001-EI (J1).....	3-49
4.	ToolPAC Software Setup and Installation	4-2
4.1	Hardware Requirements	4-2
4.2	Software Installation.....	4-2
5.	System Startup	5-1
5.1	Preparation for Startup	5-1
5.2	Applying Power	5-5
5.3	Amplifier Configuration.....	5-5
6.	Maintenance/Troubleshooting	6-2
6.1	Status LED.....	6-2
6.2	Fault Recovery.....	6-2
6.3	Trouble Shooting.....	6-3
7.	Appendices.....	7-1
7.1	Electrical Procedures	7-1
7.2	Relevant Engineering Prints	7-9
7.3	Options and Accessories.....	7-21
7.4	Standards and Environmental Specifications	7-22

LIST OF ILLUSTRATIONS

Figure 1-1	Multi-Tasking Operation.....	1-15
Figure 3-1	Typical Panel Layout	3-5
Figure 3-2	PD2400D Series Mounting Dimensions	3-6
Figure 3-3	PD2400D Connector Placement.....	3-7
Figure 3-4	Comm Port Pin Definition (J5)	3-9
Figure 3-5	Schematic of RS-232 Wiring	3-10
Figure 3-6	Schematic of RS-422/485 Wiring (Two Wire)	3-11
Figure 3-7	Schematic of RS-422/485 Wiring (Alternate Two Wire Method).....	3-12
Figure 3-8	Schematic of RS-422/485 Wiring (Four Wire Method).....	3-13
Figure 3-9	PD24xxD Feedback Connector J3	3-23
Figure 3-10	Encoder Specification	3-23
Figure 3-11	Schematic of PD2400D Analog Inputs	3-27
Figure 3-12	Schematic of PD24xxD HSI Inputs.....	3-29
Figure 3-13	Wiring HSI Inputs as Differential Inputs	3-30
Figure 3-14	Wiring HSI Inputs as Single-ended.....	3-31
Figure 3-15	Relationship of HSI Signals	3-32
Figure 3-16	HSI Signal Timing.....	3-32
Figure 3-17	Drive-OK/Brake Output	3-34
Figure 3-18	PC24xxDd-001-E Connector Placement.....	3-36
Figure 3-19	PD24xxDd-001-E Connector J1.....	3-37
Figure 3-20	PD24xxDd-001-E Digital Input (Sourcing configuration A).....	3-38
Figure 3-21	PD24xxDd-001-E Digital Input (Sourcing configuration B).....	3-39

Figure 3-22	PC34xxDd-001-E Digital Input (Sinking configuration A)	3-40
Figure 3-23	PC34xxDd-001-E Digital Input (Sinking configuration B)	3-41
Figure 3-24	PD24xxDi-001-E Connector Placement.....	3-43
Figure 3-25	PD24xxDi-001-E Connector J1.....	3-44
Figure 3-26	PD24xxDi-001-E Digital Input (Sourcing configuration A).....	3-45
Figure 3-27	PD24xxDi-001-E Digital Input (Sourcing configuration B).....	3-46
Figure 3-28	PD24xxDi-001-E Digital Input (Sinking configuration A).....	3-47
Figure 3-29	PD24xxDi-001-E Digital Input (Sinking configuration B).....	3-48
Figure 3-30	PD24xxDi-001-EI Connector Placement	3-50
Figure 3-31	PD24xxDi-001-EI Connector J1	3-51
Figure 3-32	PD24xxDi-001-EI Connector (J6).....	3-52
Figure 3-33	PD24xxDi-001-EI Connector (J8).....	3-53
Figure 3-34	PD24xxDi-001-EI Digital Outputs.....	3-54
Figure 4-1	ToolPAC Main Screen	4-4
Figure 4-2	ToolPAC Axis Menu.....	4-5
Figure 4-3	ToolPAC Firmware Information	4-6
Figure 5-1	ToolPAC Wizards	5-6
Figure 5-2	ToolPAC Wizard – Stepper Axis Setup.....	5-7
Table 5-3	Step Motor Parameters	5-11
Figure 5-4	Upload New Firmware	5-12
Figure 7-1	Recommended Ground Strap	7-2
Figure 7-2	Recommended Ground Strap Mounting Technique.....	7-3
Figure 7-3	Suppression - DC Relay	7-6
Figure 7-4	Suppression - AC Relay	7-7
Figure 7-5	De-coupling - SS Relay	7-8
Figure 7-6	Function Block Diagram	7-10

LIST OF TABLES

Table 1.1 Model Designations and Specifications.....	1-14
Table 1.1 Model Designations and Specifications.....	1-15
Table 1.1 Model Designations and Specifications.....	1-16
Table 3.1 Axis ID and Communication Method - Switch Selection	3-14
Table 3.2 DC Power (TB1).....	3-16
Table 3.3 Control Power Specifications	3-16
Table 3.4 Regeneration Circuit Specifications	3-17
Table 3.5 External Regeneration Resistor Specifications.....	3-17
Table 3.6 Motor Connections (TB2).....	3-19
Table 7.1 Suggested Wire	7-5
Table 7.2 System Accessories.....	7-21

1. Introduction

This section provides a summary of model designation and specifications, basic warranty policies, and customer service information.

1.1 About This User's Guide

This User's Guide contains the information necessary to install, wire, start up, operate, and service a **PD24xxD** Series Microstep Drives.

The product series includes units of 2.5 and 5 amp RMS continuous ratings. To simplify the use of this Hardware Reference Manual, we have organized the information into logical sections. In addition, we have created individual sub-sections on each of the **PD24xxD** models for information specific to that model. When configuration information is specific to a model of the **PD24xxD**, it will be noted at the beginning of the section. The sections common to all modes of control and configuration are also covered.

1.2 Model Designations and Specifications

Table 1.1 Model Designations and Specifications

PD24xxDy-001-zz

PD24xxD = Step Drive Family Designation

xx = Power Level

◆ 03 = 3.0 _{ARMS} CONT. @ 40 °C

◆ 06 = 6.0 _{ARMS} CONT. @ 40 °C

D = DC input Designation

◆ 18-74 VDC

y = Drive configuration

◆ d = Digital Servo Drive

◆ i = Intelligent Servo Drive

- 001 = Customization Code

◆ 001 = Standard Unit

zz = Factory Assigned Hardware Customization

◆ E = Encoder Feedback

◆ EI = Encoder Feedback with extended I/O (Intelligent only)

Table 1.1 Model Designations and Specifications

Model	Velocity/Position
PD24xxD	408μs

Model	Processor	Clock	COMM	Serial	Ram	Flash
PD24xxD	Thompson F167	20 MHz	RS-232 RS-422 RS-485	19200	64K	128K

Figure 1-1 Multi-Tasking Operation

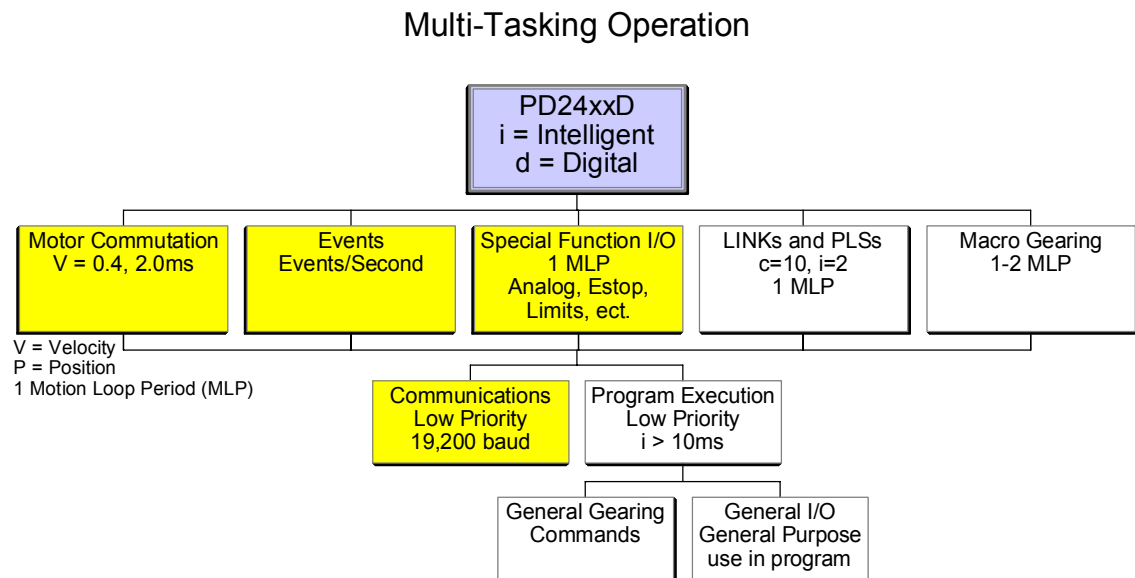


Table 1.1 Model Designations and Specifications

Features @ 40C Ambient													
Model [1]	Feedback Device	Current (RMS)	Bus Voltage	Regen External	Cabinet Watts (max) [3]	Inputs Analog [4]	Inputs Digital	Secondary Encoder Input	Outputs Digital	Control Methods [5]	Power Output Cont. Watt		
PD2403Dd-001-E	Differential Encoder Only (optional)	3	18-74 VDC	26 Ohm 180 Watt (1 kW Peak)	30	Two inputs (ADC1 and ADC2), +/-10 VDC, 10 Bit	Total 5; ENABLE, CW, CCW, plus 2 HSI [2]	Utilize the two HSI inputs, HSI1 and HSI2 [2] (2MHz Quadrature)	Max) Total 1: Drive-OK/Brake (Isolated, 5-30 VDC, 50 mA)	Velocity and Step/Dir, Step+/-, Quadrature Encoder	220		
PD2406Dd-001-E		6			60						Total 9; ENABLE, 5 general purpose, plus 3 HSI [2]	Total 4; includes: Drive-OK/Brake, 3 General Purpose	440
PD2403Di-001-E		3			30								220
PD2406Di-001-E		6			60		Total 25; ENABLE, 21 general purpose, plus 3 HSI [2]		Total 12; includes: Drive-OK/Brake, 11 General Purpose	440			
PD2403Di-001-EI		3			30					220			
PD2406Di-001-EI		6			60		440						

Additional Features to all models:

- [1] ToolPAC Configuration Software. Communication via RS-232/422/485 Over/Under-Voltage, Over-Current and motor Over-Temp protection
- [2] **High Speed Inputs, 1.0-5.0VDC.(NON-ISOLATED) (software programmable low-pass filter)**
General Purpose digital inputs are 5-30 VDC. (ISOLATED)
- [3] Does not include regen resistor dissipation.
- [4] Second analog input may be used for motor Over-Temp input

1.3 WARRANTY AND LIMITATION OF LIABILITY

Includes software provided by Pacific Scientific

Pacific Scientific warrants its motors and controllers (“Product(s)”) to the original purchaser (the “Customer”), and in the case of original equipment manufacturers or distributors, to their original consumer (the “Customer”) to be free from defects in material and workmanship and to be made in accordance with Customer’s specifications which have been accepted in writing by Pacific Scientific. In no event, however, shall Pacific Scientific be liable or have any responsibility under such warranty if the Products have been improperly stored, installed, used or maintained, or if customer has permitted any unauthorized modifications, adjustments, and/or repairs to such Products. Pacific Scientific’s obligation hereunder is limited solely to repairing or replacing (at its option), at its factory any Products, or parts thereof, which prove to Pacific Scientific’s satisfaction to be defective as a result of defective materials or workmanship, in accordance with Pacific Scientific’s stated warranty, provided, however, that written notice of claimed defects shall have been given to Pacific Scientific within two (2) years after the date of the product date code that is affixed to the product, and within thirty (30) days from the date any such defect is first discovered. The products or parts claimed to be defective must be returned to Pacific Scientific, transportation prepaid by Customer, with written specifications of the claimed defect. Evidence acceptable to Pacific Scientific must be furnished that the claimed defects were not caused by misuse, abuse, or neglect by anyone other than Pacific Scientific. Pacific Scientific also warrants that each of the Pacific Scientific Motion Control Software Programs (“Program(s)”) will, when delivered, conform to the specifications therefore set forth in Pacific Scientific’s specifications manual. Customer, however, acknowledges that these Programs are of such complexity and that the Programs are used in such diverse equipment and operating environments that defects unknown to Pacific Scientific may be discovered only after the Programs have been used by Customer. Customer agrees that as Pacific Scientific’s sole liability, and as Customer’s sole remedy, Pacific Scientific will correct documented failures of the Programs to conform to Pacific Scientific’s specifications manual. **PACIFIC SCIENTIFIC DOES NOT SEPARATELY WARRANT THE RESULTS OF ANY SUCH CORRECTION OR WARRANT THAT ANY OR ALL FAILURES OR ERRORS WILL BE CORRECTED OR WARRANT THAT THE FUNCTIONS CONTAINED IN PACIFIC SCIENTIFIC’S PROGRAMS WILL MEET CUSTOMER’S REQUIREMENTS OR WILL OPERATE IN THE COMBINATIONS SELECTED BY CUSTOMER.** This warranty for Programs is contingent upon proper use of the Programs and shall not apply to defects or failure due to: (I) accident, neglect, or misuse; (ii) failure of Customer’s equipment; (iii) the use of software or hardware not provided by Pacific Scientific; (iv) unusual stress caused by Customer’s equipment; or (v) any party other than Pacific Scientific who modifies, adjusts, repairs, adds to, deletes from or services the Programs. This warranty for Programs is valid for a period of ninety (90) days from the date Pacific Scientific first delivers the Programs to Customer.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES (EXCEPT AS TO TITLE), WHETHER EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR ANY PARTICULAR PURPOSE, AND ARE IN LIEU OF ALL OTHER OBLIGATIONS OR LIABILITIES ON THE PART OF PACIFIC SCIENTIFIC. PACIFIC SCIENTIFIC'S MAXIMUM LIABILITY WITH RESPECT TO THESE WARRANTIES, ARISING FROM ANY CAUSE WHATSOEVER, INCLUDING WITHOUT LIMITATION, BREACH OF CONTRACT, NEGLIGENCE, STRICT LIABILITY, TORT, WARRANTY, PATENT OR COPYRIGHT INFRINGEMENT, SHALL NOT EXCEED THE PRICE SPECIFIED OF THE PRODUCTS OR PROGRAMS GIVING RISE TO THE CLAIM, AND IN NO EVENT SHALL PACIFIC SCIENTIFIC BE LIABLE UNDER THESE WARRANTIES OR OTHERWISE, EVEN IF PACIFIC SCIENTIFIC HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, DAMAGE OR LOSS RESULTING FROM INABILITY TO USE THE PRODUCTS OR PROGRAMS, INCREASED OPERATING COSTS RESULTING FROM A LOSS OF THE PRODUCTS OR PROGRAMS, LOSS OF ANTICIPATED PROFITS, OR OTHER SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER SIMILAR OR DISSIMILAR, OF ANY NATURE ARISING OR RESULTING FROM THE PURCHASE, INSTALLATION, REMOVAL, REPAIR, OPERATION, USE OR BREAKDOWN OF THE PRODUCTS OR PROGRAMS, OR ANY OTHER CAUSE WHATSOEVER, INCLUDING NEGLIGENCE.

The foregoing shall also apply to Products, Programs, or parts for the same which have been repaired or replaced pursuant to such warranty, and within the period of time, in accordance with Pacific Scientific's date of warranty. No person, including any agent, distributor, or representative of Pacific Scientific, is authorized to make any representation or warranty on behalf of Pacific Scientific concerning any Products or Programs manufactured by Pacific Scientific, except to refer purchasers to this warranty.

1.4 Customer Service

1.4.1 Factory Service

Pacific Scientific is committed to quality customer service. We maintain a staff of experienced engineers dedicated to providing quick and accurate responses to our customers' application and installation questions at (815) 226-3100.

1.4.2 On-Site Field Service

On-site field service, installation, and startup assistance are offered on an hourly basis. Please contact our Applications Department at (815)-226-3100 for current rates and applicable information.

1.4.3 Training

We have found that properly trained support personnel are an important factor in successful and efficient equipment operation. Consequently, we provide formal training seminars aimed specifically at maintenance and operating personnel. These seminars can be conducted at our facility or at your site. Please visit our web site www.pacsci.com for additional information.

2. Unpacking, Inspection, and Storage

This section provides information concerning unpacking and inspection of equipment, proper handling procedures, and storage considerations.

2.1 Unpacking and Inspection

Although every precaution is taken to ensure the equipment is delivered in good condition, it is essential that a careful inspection be made upon arrival at your plant. While we make every effort at the factory to fully inspect, test, and package our products so that they reach you defect and damage free, we cannot be responsible for handling by the shipper.

Remove the contents of the carton in which the unit was shipped. Inspect the carton and all components for possible physical damage or discrepancies. If there is any discrepancy in the order or if any damage is discovered, it should be reported immediately to both the carrier and the factory, and a damage claim should be filed immediately with the carrier. This is your responsibility; shipping damage and unreported shortages are not covered by the product warranty.

2.2 Handling

Electronic components in the control equipment are static sensitive. Use proper procedures and common sense when handling the modules to prevent possible inadvertent damage.

In the unlikely event that a unit needs to be returned to the factory, call our toll-free customer service number described in [Section 1.4](#) to obtain a **Return Material Authorization**. Be sure to suitably pack the unit to endure the rigors of shipping.

2.3 Storage


It is often necessary to store the control equipment for some period of time before it is actually installed. Since electrical components are delicate and easily damaged, proper storage is very important to the future performance of the equipment. Store the equipment in a clean, dry, non-corrosive location protected from sudden temperature changes, high levels of moisture, shock, and vibration. **Ambient temperature should not exceed 85°C; room temperature is recommended. The minimum temperature must remain above 0°C and also above the dew point of the ambient air.**

When placing the equipment in storage, cover it to protect it against dust and/or dirt. However, the cover must not be airtight in order to allow air circulation and prevent moisture from being trapped inside.

3. Installation and Wiring

This section summarizes the recommended practices for installation of equipment. These practices are based on and consistent with IEEE Standard 518-1982, “IEEE Guide for Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources”, particularly Section 6, “Installation, Recommendations and Wiring Practices”. This standard must be followed. All equipment grounding should also be in conformance with applicable National and Local electrical codes. Failure to follow recommended procedures might result in incorrect system operation and void the product warranty.

Review [7.1 Electrical Procedures](#) for additional information.

WARNING	
	<p>When wiring the system, proper wiring procedures must be followed. The wiring is to be performed only by qualified electrical personnel familiar with the construction and operation of this equipment, the hazards involved, and the National Electrical Code (NEC) and local electrical codes. Equipment damage and/or injury could result if these procedures are not observed. The user is responsible for conforming to all applicable local, national and international codes.</p>

3.1 Shielding and Grounding of Electrical Panels

Motion control systems contain digital and microprocessor circuitry that can be affected by Electro-Magnetic Interference (EMI). They also contain switching amplifiers that can generate significant EMI at frequencies from 10 kHz to 300 MHz. The potential exists for this switching noise to interfere with the correct operation of both the system and any other electrical equipment in the vicinity.

While most manufacturers, including Pacific Scientific, design their products to minimize susceptibility to EMI, immunity is greatly affected by installation techniques. Some responsibility for avoiding EMI related problems must fall to the system integrator. This section describes panel layout, wiring, grounding, and shielding techniques effective in designing and integrating a stepper into your application.

WARNING	
	<i>If there is a conflict between recommendations in this manual and safety codes, safety requirements must be followed. The user is responsible for conforming to all applicable local, national and international codes.</i>

As in all engineering designs, a trade-off between the perfect solution and what is practical is unavoidable. You may not be able to apply all the suggestions we make, but careful attention to EMI reduction will minimize startup costs and future operating problems in any installation.

3.1.1 Panel Layout - General Placement

How parts are placed on the sub-panel and on the enclosure door will play an important role in reducing the effects of EMI. When designing a control panel for the stepper system, the panel builder must recognize a system's two worst enemies: heat generation and electrical noise.

The importance of proper control panel layout cannot be overemphasized. First, it will set the stage for good noise-free wiring practices described later in this section. Second, it will minimize the effects of heat generation.

NOTE	
------	--



Mount unit to a vertical-mounting surface and provide a minimum of 1.0 inch of clearance on all sides to allow for adequate airflow.


Proper control panel layout can be achieved by following the simple rules listed below. Review additional information on electrical procedures in this section.


- Do not mix power and control signal wiring in the same conduit, duct, or wire tray without 1.0 inches (26 mm) of separation.
- Provide separate wire ways for main AC, low power AC, high power DC, and low power DC.
- Restrict all high voltage power wiring and power devices such as circuit breakers, contactors, fuses, etc., to an area separate from the low-level control wiring as stated above.
- The area above the amplifiers is to be used for the wiring of low level (noise sensitive) control signals, such as analog input and output signals and motor feedback signals.
- When mounting any unit, be sure to remove paint from the mounting surfaces to obtain metal-to-metal contact. Use a serrated washer (star washer) to improve the connection. If in doubt use a ground strap to ensure good connection between the unit and the enclosure.
- Use ground straps made of 1 inch (25 mm) silver tinned flat copper braid to connect cabinet doors to enclosures, the first sub-panel to the enclosure, and each sub-panel to the next.
- Where electrical codes call for the typical green safety ground wires, use them *in addition* to any ground strap suggested in this guide.
- Follow the electrical codes for grounding of the main three-phase power transformer.
- It is recommended that all heat-generating resistors be mounted outside the cabinet with a protective enclosure.
- Allow a minimum distance of 1.0 inches (26 mm) above and below each drive and a minimum of 1.0 inches (26 mm) on each side of the drive to eliminate the potential problems of heat generation and electrical noise.


- No heat generating devices, such as transformers, inductors, braking resistors, etc., should be mounted directly below the mounting assembly.
- The motor wiring must be properly strain relieved to ensure interconnects, wiring and terminal connections do not become damaged.

3.1.2 Drive Placement and Installation

The user will install the drive(s) into a ventilated, metal industrial cabinet. Dimensions for the drive modules are given in Figure 3-2 PD2400D Series Mounting Dimensions. shows a typical panel layout for four PD24xxD Series modules.

NOTE	
	<p><i>Allow a minimum distance of 1.0 inches (26 mm) above and below each drive and on each side of the drive to eliminate a system's two worst enemies: heat generation and electrical noise.</i></p>

NOTE	
	<p><i>Use ground straps made of 1 inch (25 mm) silver tinned flat copper braid to connect cabinet doors to enclosures, the first sub-panel to the enclosure, and each sub-panel to the next.</i></p>

NOTE	
	<p><i>Where electrical codes call for the typical green safety ground wires, use them in addition to any ground strap suggested in this guide.</i></p>


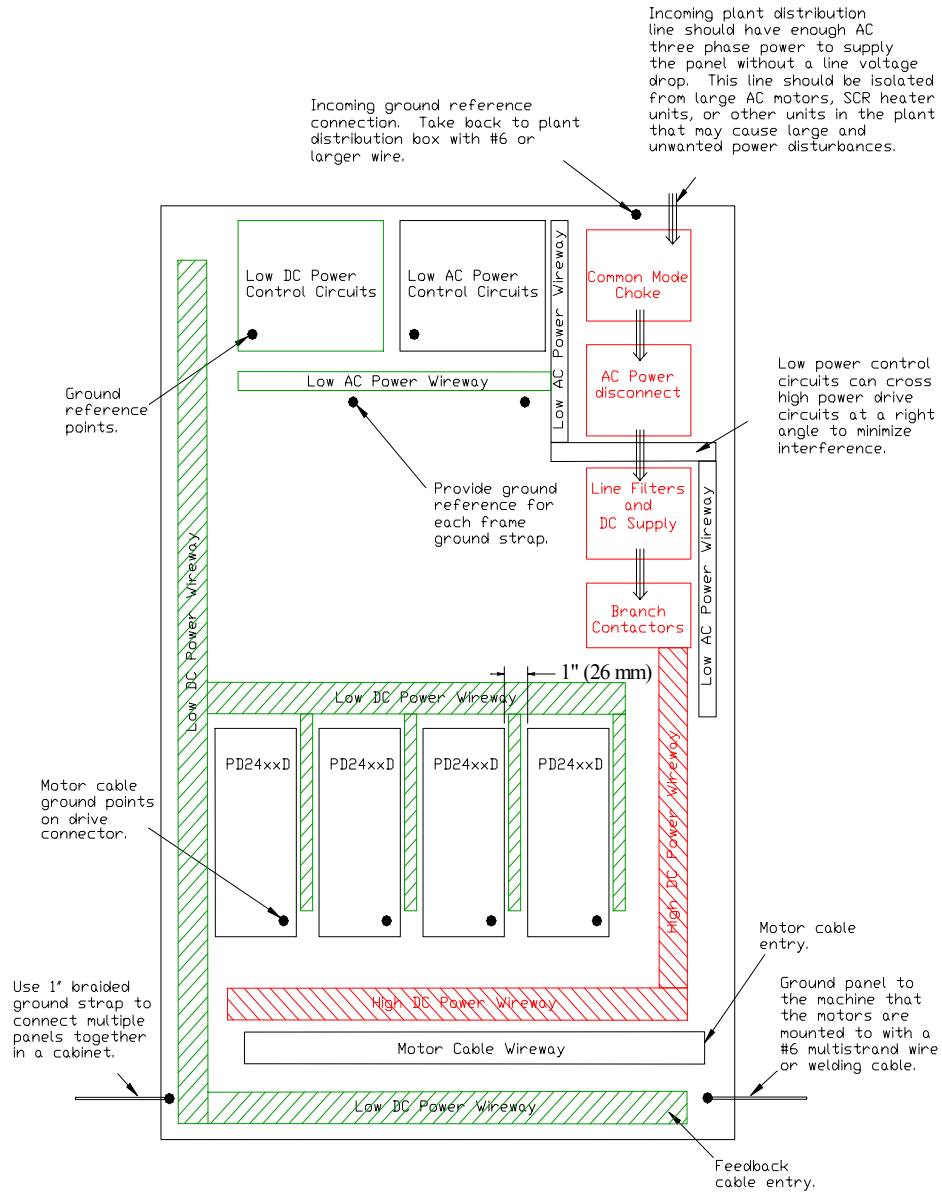
NOTE	
	<p><i>To obtain rated output current from all amplifiers, the ambient air temperature below the amplifiers must be between 0°C and +40°C. No heat generating devices, such as transformers, power supplies, or power resistors, should be mounted directly beneath the modules.</i></p>

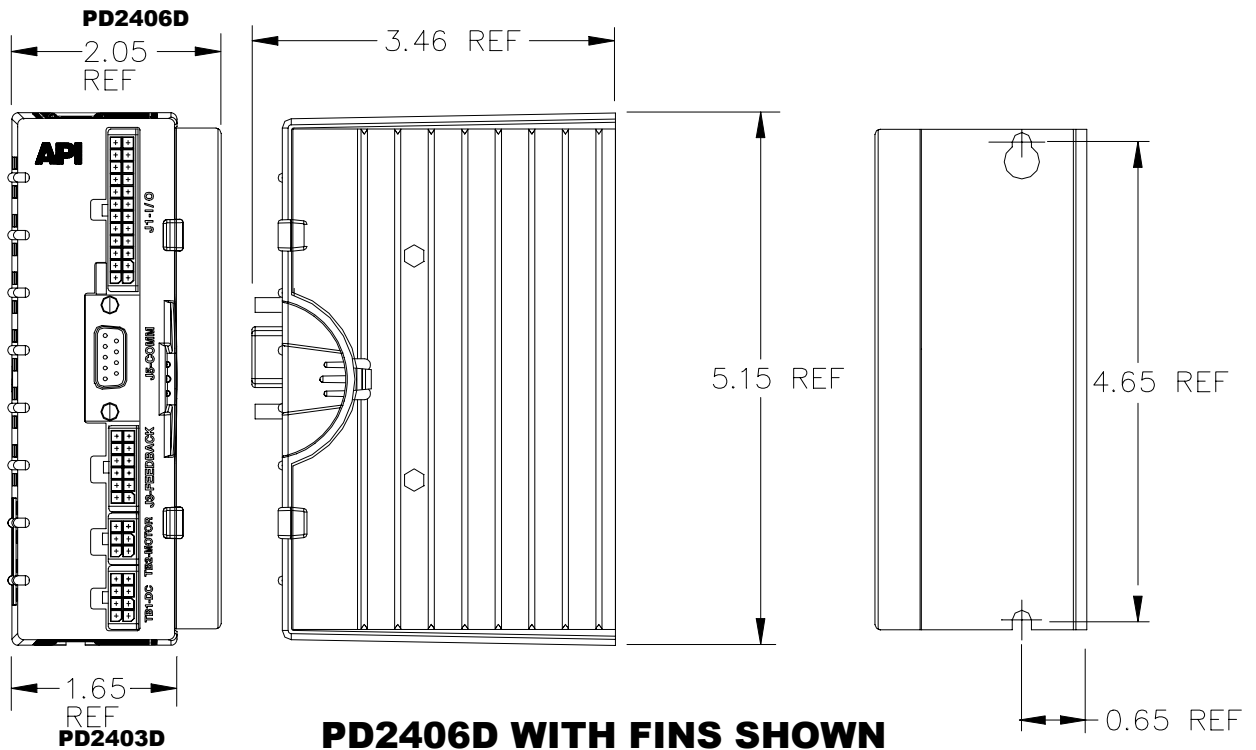
Figure 3-1 Typical Panel Layout



3.1.3 Mounting Dimensions

The PD24xxD is designed for easy installation into an electrical cabinet or sub-panel. The integral heatsink and mounting surface heat-plate design increases the heat dissipation path and the product reliability. The user must attach the **PD24xxD** to a suitable *vertical-mounting surface* to optimize heat dissipation and provide a *minimum of 1.0 inch of clearance* on all sides to allow for adequate airflow.

Figure 3-2 PD2400D Series Mounting Dimensions




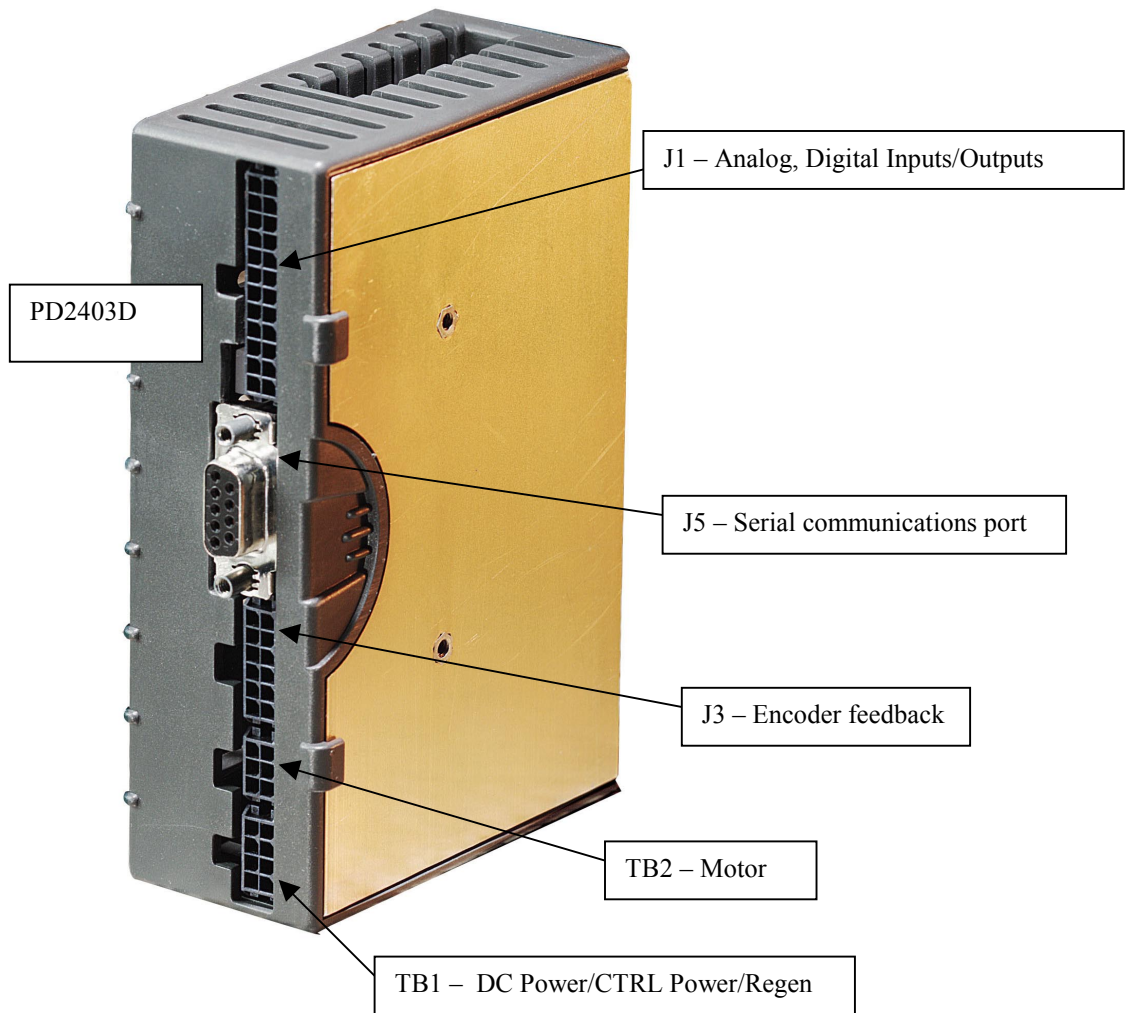
NOTE	
	<p>Mount unit to a vertical-mounting surface and provide a minimum of 1.0 inch of clearance on all sides to allow for adequate airflow.</p>

Figure 3-3 PD2400D Connector Placement




3.2 Communications

3.2.1 Serial Communication Hardware Configuration

The only hardware configuration that must be configured by the user prior to mounting is the method of communication and the serial node ID. *The factory settings are RS-232, Node#1.*

All models of the **PD2400D** Series Digital Drives have identical communications (Comm Port **J5**), thus making it possible to install a mixed combination of units for the most demanding applications.

NOTE	
	<i>Set the unit's axis id and method of communications prior to proceeding with mounting. Once configured, we suggest that the front of each unit be marked with its unique Axis ID to facilitate installation and startup.</i>

The user must configure the PD24xxD prior to mounting the unit. To accomplish this task, the cover of the PD24xxD must be removed (no tools are required).

1. Grasp the heatsink in one hand and the enclosure in the other. Gently squeeze the center semi-circle feature of the enclosure to disengage the locking mechanism and slide it off the front of the drive.
2. Locate the 10-position dip-switch and set the unit's AXIS ID and COMMUNICATIONS METHOD per **Table 3.1**.
3. After the switches are configured we suggest that the user indicate the axis number on the front of each unit for later identification.
4. To reinstall the cover, gently slide the cover into position until the locking mechanism is engaged.

3.2.1.1 Serial Comm Port (J5)

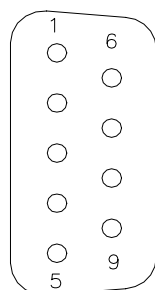
It should be noted that the communications port is only required to allow **ToolPAC** to communicate to the controller for purposes of configuration for a specific motor and programming of the intelligent series. This port does not need to be wired during normal usage of the unit, (for configuration and diagnostics only).

Networked configuration of the intelligent series allows for up to 31 axis from a single PC serial port or similar host device (RS-485 full duplex). Multi-axis start and stop, along with on-the-fly speed change, are only a few of the networked features available on these units. The user must request additional documentation to gain a better understanding of the network requirements. The documents listed below may be accessed via our internet site.

ToolPAC Software Reference Guide, for additional information on Advanced commands (Gearing, Macros, Links, PLS)	MAToolPAC.zip
Intelligent Servo/Stepper Protocol (MA-ISP.pdf)	Below
Intelligent Servo/Stepper ASCII Protocol (MA-ISAP.pdf)	Below
Intelligent Motion Language (MA-IML.pdf)	Below
Dynamic Link Library (DLL)	ISPDLL.zip

Figure 3-4 Comm Port Pin Definition (J5)

Comm Port
All Models



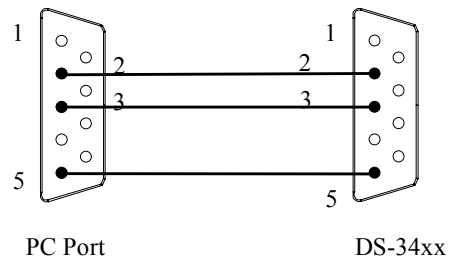
J5


J5 - Comm Port (DB9-F)			
Pin #	RS-232	RS-422 RS-485	RS-485 two wire
1	NC	Tx+	Rx+/Tx+
2	Tx	Tx-	Rx-/Tx-
3	Rx	Rx-	Rx-/Tx-
4	NC	Rx+	Rx+/Tx+
5	COM	COM	COM
6	-	-	-
7	-	-	-
8	-	-	-
9	-	-	-

RS-232 Three Wire Configuration

This is the factory default configuration. This communication method is used for applications requiring less than 25 feet of communications cable.

Figure 3-5 Schematic of RS-232 Wiring



NOTE	
	<p><i>Use shielded cabling for all communication needs.</i></p> <p><i>Do not use ribbon cable to provide communications interconnect.</i></p>

RS-422/485 Two Wire Configuration

This communication method is used for applications requiring less than 5000 feet of communications cable. The **PCB-485** communications card is required. *The PCB-485 communications card that supports “Automatic Data Send Control” which only enables the transmitter when a character is ready to be transferred is required.* This method is cost-effective and provides increased noise immunity.


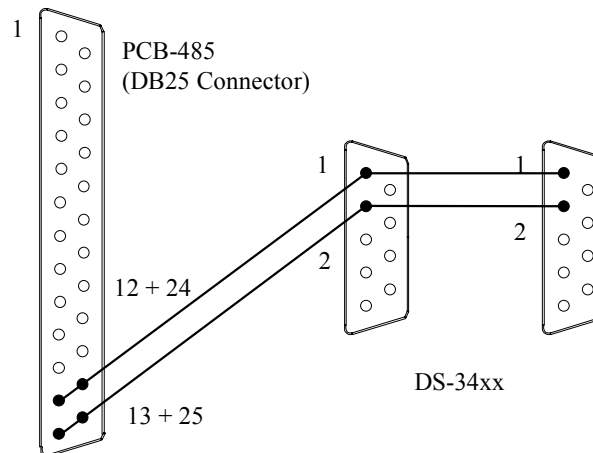
NOTE	
	<p>Utilizing RS-422/485 communications cards by other manufacturers than those recommended by Pacific Scientific may result in erratic behavior and reduced noise immunity.</p> <p>Use shielded cabling for all communication needs.</p> <p>Do not use ribbon cable to provide communications interconnect.</p>

Figure 3-6 Schematic of RS-422/485 Wiring (Two Wire)



This is an alternate method of wiring the inter-axis cable and is used for applications requiring less than 5000 feet of communications cable. The **PCB-485** communications card is required. *The PCB-485 communications card that supports "Automatic Data Send Control" which only enables the transmitter when a character is ready to be transferred is required.* This method provides additional noise immunity.


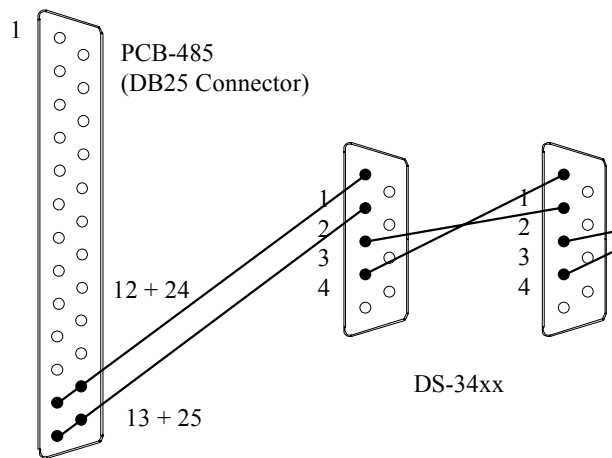
NOTE	
	<p>Utilizing RS-422/485 communications cards by other manufacturers than those recommended by Pacific Scientific may result in erratic behavior and reduced noise immunity.</p> <p>Use shielded cabling for all communication needs.</p> <p>Do not use ribbon cable to provide communications interconnect.</p>

Figure 3-7 Schematic of RS-422/485 Wiring (Alternate Two Wire Method)



RS-422/485 Four Wire Configuration

This method is used for applications requiring less than 5000 feet of communications cable. The **PCB-485** communications card is required. The PCB-485 communications card that supports “Automatic Data Send Control” which only enables the transmitter when a character is ready to be transferred is required. This method provides the highest noise immunity.


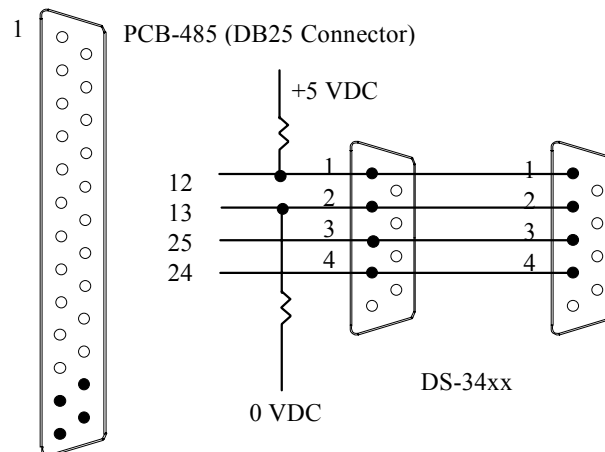
NOTE	
	<p><i>Utilizing RS-422/485 communications cards by other manufacturers than those recommended by Pacific Scientific may result in erratic behavior and reduced noise immunity. (Use 10k resistors if not in PC Card, install at PC end of communications cable).</i></p> <p><i>Use shielded cabling for all communication needs.</i></p> <p><i>Do not use ribbon cable to provide communications interconnect.</i></p>

Figure 3-8 Schematic of RS-422/485 Wiring (Four Wire Method)



Preferred Method (full duplex)

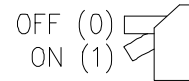
3.2.1.2 Serial Node Selection

The user must configure the axis selection switches to define the communications method and axis address of the unit. A unique axis address (from 1 through 31) must be selected for each unit when multiple axes will be on the same communications link. The default factory setting is node 1.

Table 3.1 Axis ID and Communication Method - Switch Selection

Node ID *			
Axis ID	Switch 12345	Axis ID	Switch 12345
0	00000	16	00001
1	10000	17	10001
2	01000	18	01001
3	11000	19	11001
4	00100	20	00101
5	10100	21	10101
6	01100	22	01101
7	11100	23	11101
8	00010	24	00011
9	10010	25	10011
10	01010	26	01011
11	11010	27	11011
12	00110	28	00111
13	10110	29	10111
14	01110	30	01111
15	11110	31	11111


*Node 1 is factory default.
Node 0 is reserved.




Communication Methods	
Switch 678910	Communication
0010 0	RS-232 Three Wire
1100 1	RS-422/485 Two Wire *
0000 1	RS-422/485 Four Wire *
xxx1 x	* Switch 9 is ON for termination resistor on last unit

3.3 DC Power (TB1)

3.3.1 High Power DC Connections

CAUTION	
	<p><i>Only qualified service and installation personnel should install this device.</i></p> <p><i>All connections or configurations should be made with the power sources disconnected from the system.</i></p> <p><i>Damage to the unit will result if the supply voltage is incorrectly applied.</i></p>

Consult [Table 7.2 System Accessories](#) for engineering data on the selection of cables and related information on the specific model being installed. System interconnect diagrams are provided in [Section 7.2 Relevant Engineering Prints](#). Be certain to use the diagram that refers to your system. Review [Section 3.1, Shielding and Grounding of Electrical Panels](#), for information on placement of components.

NOTE	
	<p><i>High power wiring and low power DC signal wiring within the panel or enclosure should not share wire raceways and should be separated by a minimum of 6 inches (152 mm) for parallel runs. If wire paths should cross and touch, they should do so only at right angles to each other.</i></p>

- Provide separate wire ways for main AC, low power AC, high power DC, and low power DC. Restrict all high voltage power wiring and power devices; such as circuit breakers, contactors, fuses, etc., to an area separate from the low-level control wiring.
- Constant voltage power supplies can be installed if the DC power tends to drop below the specified minimum voltages required to keep the controllers from resetting. Where loss of control power is critical or an orderly shutdown in the event of a power loss is required, consider wiring the Control Power from a separate feed. Consult the following section for wiring and specifications.

3.3.2 DC Power/Control/Regen (TB1)

DC power, control power and regeneration wiring are made at the TB1 connector. Use care to ensure the correct pinout is used for the main power. Ensure that the drive's PE ground, pin #1, is taken directly to the panel's SPG.


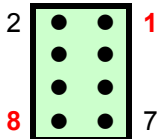
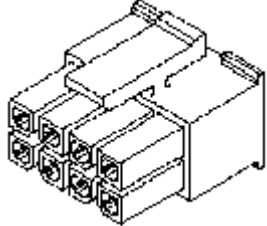
WARNING	
	<p>Use care to ensure the correct pinout is used for the main power connections. Improper wiring will result in damage to the amplifier.</p>

Table 3.2 DC Power (TB1)

TB1 - DC Power/Regen			
Pin #	Connection	Pin #	Connection
2	Ground	1	Ground
4	Regen +	3	Regen -
6	Control +	5	Control -
8	DC Power	7	DC common





3.3.3 Control Power (TB1) (Optional)

Wiring a separate Control Power should be considered where loss of control power is critical or an orderly shutdown in the event of a power loss is required. **Warning!** This power supply should NOT be utilized for any other machine function, the drives PWM circuit will cause interference to devices sharing this power supply.


WARNING	
	<p>The Control power supply must be common to chassis ground; otherwise, equipment damage and/or injury could result. This control power supply must not be utilized for any other function(s) in the application</p>

Table 3.3 Control Power Specifications

Model	Control Power Requirements
PD24xxD (all models)	18 - 48 VDC, 1 A maximum. This power supply must be common to chassis ground.

3.3.4 External Regen

The PD24xxD can dissipate regeneration energy internally. When applications require hard deceleration that exceeds the unit’s ability, an external regen resistor must be added to the system at the two terminals labeled **Regen +** and **Regen -** on TB1. A fuse should be placed in series with the regen resistor to protect the resistor. Specifications of the regeneration circuits are summarized in **Table 3.4** and **Table 3.5**.


WARNING	
	<p>External regen resistors are connected to the drive dc bus voltage that can reach 100 VDC. Connections to external regen resistors must be electrically insulated and mechanically shielded for safety. High voltage warning stickers are also recommended.</p> <p>It is recommended that all heat-generating resistors be mounted outside the cabinet with a protective enclosure.</p>

Table 3.4 Regeneration Circuit Specifications

Regen active at	85 VDC
Bus fault /Over-Voltage/ active above	95 VDC
Bus fault /Under-Voltage/ active below	12 VDC

Table 3.5 External Regeneration Resistor Specifications

Model	External Continuous	External Peak	External Regen Resistor Kit
PD2400D	26 Ohm, 180 W	1 kW	PRK-0180-26

Resistor Kits include: resistor, fuse, fuse holder, and 1 meter of wire.

High Power DC Bus

The PD24xxD's protection circuitry monitors the DC bus to determine if excessive regeneration is occurring. Exceeding the regeneration resistor's power rating will cause the Regen circuit to be disabled which will result in a bus fault, shutting down the amplifier to safeguard the system, and displaying a fault. When external Regen is used, the circuit must be fused with a **Bussman KLM-4** or equivalent for UL certification. When this bus fault condition exists the motor will become "free-wheeling" and protective measures should be employed to prevent personal injury or damage to the system. **This fault condition can be cleared by toggling the Enable input OFF-to-ON or through cycling power to the unit.** When a bus fault occurs, the user should examine the application to determine if an external regeneration resistor is required, the motion can be slowed, or that the proper equipment has been selected for the application.

During the deceleration phase of motion the motor will regenerate energy into the amplifier. This regeneration will cause the voltage of the DC bus to rise. The regeneration resistor will turn on when the bus voltage exceeds 85 VDC. The peak power dissipation is calculated by the following formula:

$$PeakPower = \frac{V^2}{R} = \frac{(85)^2}{26} = 300W$$

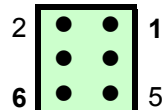
Peak power dissipation occurs the moment the circuit is enabled. As soon as Regen is enabled, the regeneration power begins to be dissipated in the resistor and unless the system is generating peak Regen power greater than the Regen circuit peak-power capability, the bus voltage decreases.

3.4 Motor Wiring (TB2)

The motor is the prime mover in any installation. Special care should be taken to ensure that the motor is not damaged due to improper wiring and installation. Follow the general procedures listed below to ensure proper installation.

- Do not mix power and control signal wiring in the same conduit, duct, or wire tray without 6 inches (152 mm) of separation.
- Utilize shielded four (4) conductor wiring with drain for motor power cabling. Follow electrical codes to ensure the proper wire gauge for the motor and amplifier being installed into your application.
- Provide separate a wire way for the high power DC cables to the motor.
- **The motor wiring must be properly strain relieved to ensure that interconnect wiring and connections do not become damaged.**
- **Do not use excessive force, (hammer) to install power transmission components to the motors shaft as this may result in damage to the bearings or feedback device.**

Table 3.6 Motor Connections (TB2)

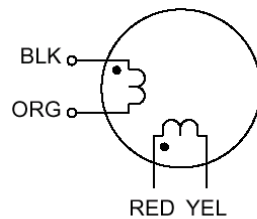


TB2 - Motor			
Pin #	Description	Pin #	Description
2	A-	1	A+
4	Shield	3	Shield
6	B-	5	B+

The PD24xxDi Series is capable of running a wide range of step motors with their bipolar chopping technique. The limits of these ranges fall into several categories; winding type and number of leads.

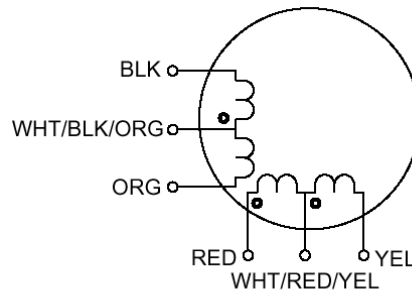
Winding Type The motor winding type should be a two phase motor that is capable of bipolar operation, characterized by the need for current to flow in both directions in each coil of the motor. Most motors that fall into the "HYBRID" motor classification will work. Step angles of 0.9, 1.8, 3.6 and 15 degrees are the most common.

Number of Leads Hybrid style motors have 4, 6, or 8 leads depending on how they are wound and connected. **ALL THREE OF THESE TYPES OF WINDINGS CAN BE OPERATED.**



4-Lead Configuration

Note the Current (IC) is set at **1*motor rating**.

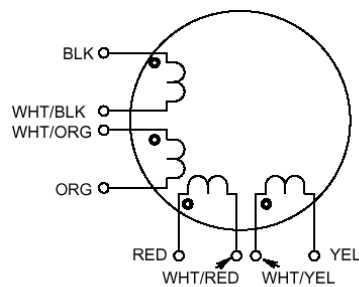


6-Lead Configuration

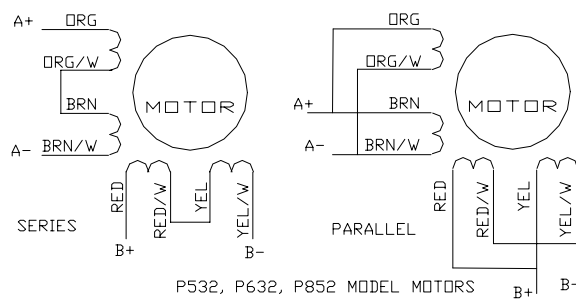
Note the Current (IC) is set at **0.7*motor rating** for a series connected motor. The center-tap wires must be individually terminated no-connection.

Pacific Scientific provides 8 lead motors as shown in the drawing below. These motors can be wired as a Series or Parallel connected motor. This allows the user the most flexibility in applying a given motor within their application. Below are a number of items that may assist you in determining the proper wiring configuration for your application.

- Series and Parallel configurations provide the same static torque. Typically, the torque/speed curves are similar below 10 RPS (600 RPM).
- Series configurations will result in a lower motor temperature than a Parallel connected motor.
- Increased drive voltage will provide improved speed performance.




8-Lead Configuration



Note the Current is set at **0.7*motor rating**.

3.5 Logic (low) Power DC Connections

Special care must be taken to ensure that the proper wiring is employed for the model being installed into your application. Please review Section [7.1](#) on [Electrical Procedures](#) before proceeding.

NOTE	
	<p><i>High power wiring and low power DC signal wiring within the panel or enclosure should not share wire raceways and should be separated by a minimum of 6 inches (152 mm) for parallel runs. If wire paths should cross and touch, they should do so only at right angles to each other.</i></p>

All control signals interfacing to the system must be wired with twisted cable, with at least one twist per inch, to minimize inductive noise coupling. **Encoder wiring must be wired with three (3) individual twisted shielded pairs, using cable equivalent to those listed in [Table 7.1 Suggested Wire](#).**

3.6 Encoder Feedback (J3)

If not utilizing an encoder for position verification, You may skip this section.

The PD24xxD Motor Feedback connector J3 is a 12 pin dual-row connector that contains connections for encoder feedback, A+, A-, B+, B-, Z+ and Z- signals and a secondary analog (ADC2) or Motor Over-Temperature input. The connections also include a non-isolated +5 VDC supply, **250mA maximum**, for Encoder power, and motor over-temperature sensor (OT).


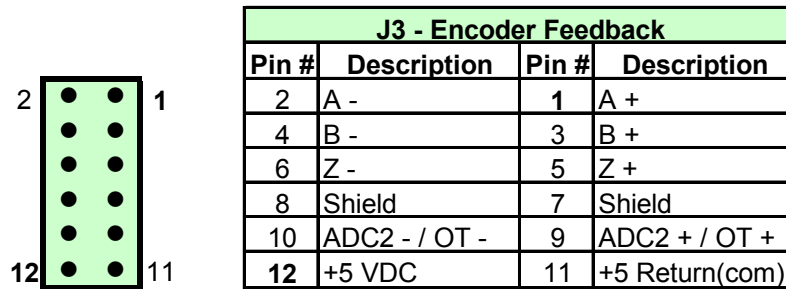
NOTE	
	<p><i>The PD24xxD Series accepts differential A/A', B/B' and Z/Z' encoder signals. It will NOT accept single-ended encoder signals.</i></p>

Figure 3-9 PD24xxD Feedback Connector J3



A cable assembly, **PCA-MM12-010**, may be purchased to facilitate wiring the J3 connector. This shielded cable assembly is pre-wired to the mating connector, three feet in length.

NOTE	
	The ADC2+ and ADC2- inputs (pins J3-9 and J3-10) are factory configured as an analog input ADC2 .

3.6.1 Encoder Specification

If the customer is utilizing a motor not supplied by Pacific Scientific then specific care must be taken to ensure that the motor feedback is compatible and able to interface to the PD24xxD series controllers. **It is the responsibility of the user to ensure compatibility.**


Figure 3-10 Encoder Specification

Encoder/Hall	Value	Units
Encoder		
Input Voltage	5	volts
Input Current (max)	135	mamp
Operating Frequency	200	kHz max
Output Device load (Z=2K)	26LS31	
Sink/Source. (Minimum)	2	mamp
Suggested Interface	26LS32	

3.6.2 ADC2/Motor OT Sensor input

If your motor is provided with an internal thermal Over Temperature (OT) switch, it should be wired to the **ADC2** analog inputs on the amplifier. This input is wired to a N.C thermal switch internal to the motor ($Z < 1k$ means motor is OK).

If a motor over temperature sensor is being utilized, you must install a jumper across JP3 (internal to the drive) and enable this feature in the software configuration. Make this mode **ACTIVE** via parameter **COT** *Check motor OT input*.

NOTE	
	<i>To utilize the ADC2+ and ADC2- inputs as a motor Over Temperature (OT) input, you must install a jumper across JP3 internal to the drive (not factory installed).</i>

3.7 I/O connector (J1) – all models


The PC34xxD's I/O connector J1 is a 24 pin dual-row connector that contains connections for an Analog command, Digital Inputs, Digital Outputs, High-Speed-Inputs (HSI) and Encoder Output signals. The various methods of wiring I/O common to all models are described in this section.

Please be sure to review this entire section prior to making connections. In addition, please read the sections specific to the models being installed; [PD24xxDd-001-E](#), [PD24xxDi-001-E \(J1\)](#) or [PD24xxDi-001-EI \(J1\)](#).

A cable assembly, **PCA-MM24-006**, may be purchased to facilitate wiring the J1 connector, see [Table 7.2 System Accessories](#). This shielded cable assembly is pre-wired to the mating connector, six feet in length.

3.7.1 Enable Input (J1)

The **Enable** input on the J1-5 is specifically mentioned, as this type of input is not normally associated with step motor amplifiers. This input is **Rising-Edge-Triggered** and is utilized to both Enable the H-Bridge of the amplifier, and is also used to clear any (drive related) re-settable faults that may be present.

CAUTION	
	<p><i>The Enable/Reset input (J1 pin 5) is Rising Edge-Triggered.</i></p> <p><i>If this input is active when power is applied to the unit, you must make the input transition Active-Inactive-Active before the unit will enable the unit.</i></p>

A clear understanding of the ENABLE input (J1-5) and the (J1-23 and J1-24)-1 as Drive-OK or Brake control is necessary for developing the proper hardware interconnects. **Some of the questions that the user MUST answer PRIOR to developing a system interconnect wiring for installations are;**

- **Where does the systems motion controller reside?**
 - 1) In the PD24xxD.
 - 2) Via network connection.
 - 3) Multi-axis motion control card.
- **What will be providing the servo Enable signal?**
 - 1) Opto input (ENABLE), factory default (preferred)
 - 2) Opto input (ENABLE) and'd with Software Enable (SWE)
 - 3) Opto input (ENABLE) or'd Software Enable (SWE)
 - 4) Software Enable (SWE)
- **If not utilizing a Brake, how will be Drive-OK output be utilized?**
- **If utilizing a Brake, what will control the brake release?**
 - 1) PD24xxD directly wired to the brake coil.
 - 2) PLC/ Multi-axis motion control card controls the brake function.

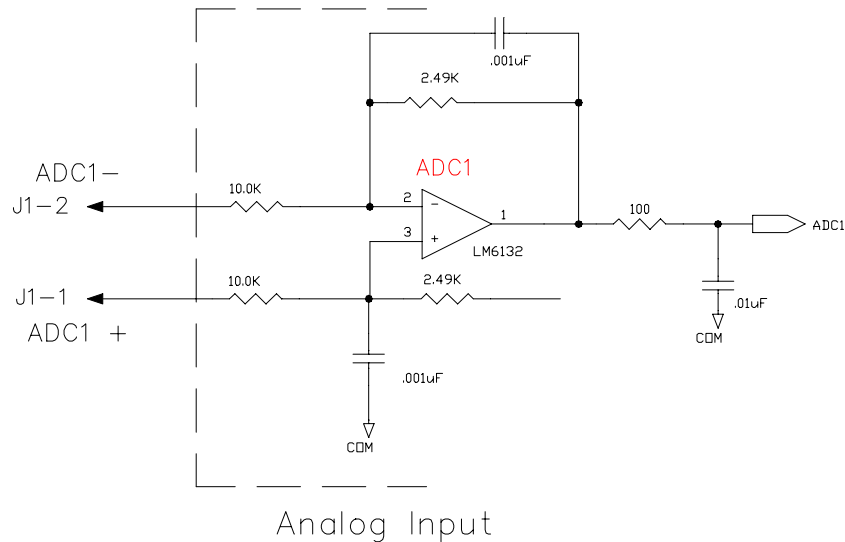
3.7.2 Analog Input (J1)

If you are using the motion program or HSI inputs for command input, you may skip this section.

The PD2400D contains connections for a single analog input for use as a command reference. This differential analog input is intended to provide ± 10 VDC as a 10-bit control signal to the amplifier. The differential input should be driven via the users differential output and should be connected with individually shielded twisted pairs to provide the best possible noise immunity. Depending on the software configuration, the analog signal (software name ADC1) can be utilized to provide a “velocity” or “software” command.

Single-ended analog command signals may be utilized by connecting the signal command to ADC1+ and the ADC1- to signal reference.

Figure 3-11 Schematic of PD2400D Analog Inputs



3.7.3 Digital HSI inputs (J1)

If you are using the **Analog** input for command input, you may skip this section.

Inputs 5 and 6 are 2Mhz High Speed Inputs (HSI1 and HSI2) that can be utilized for the purpose of following a master encoder (Quad), Step/Direction or Step+/Step-signal. **An additional High Speed Input (Input 7) is available as registration input on the PD2400Di models.**

The HSI inputs are intended for use with a differential output driver such as a 23LS31 line driver [Figure 3-13 Wiring HSI Inputs as Differential Inputs](#). However since this is not always possible, single-ended Open collector or TTL outputs may be wired to these inputs. Please review the [Figure 3-14 Wiring HSI Inputs as Single-ended](#) inputs to the PD2400D.

Relationships of the HSI inputs are shown in [Figure 3-15 Relationship of HSI Signals](#). Please review for applications requiring Step/Dir, Step+/Step- or quadrature inputs for commanded motion.

Signal timing for the HSI inputs is shown in [Figure 3-16 HSI Signal Timing](#). In applications where the user is not able to provide the required transition timing, open collector or TTL type, it should be noted that an ToolPAC command parameter, High Speed Input Filter (**HSIF**) is provided for applying a low-pass filter to the HSI input signals. **HSIF may be set for 30kHz, 250kHz or 2MHz.**


CAUTION	
	<p><i>The High Speed Inputs (HSI) require a signal level of 0-5VDC relative to J1-3 (Shield).</i></p> <p><i>The voltage difference between HSI+ and HSI- must be greater than ± 0.25 volts.</i></p> <p><i>Exceeding this voltage specification will result in damage to the equipment</i></p> <p style="text-align: center;">NON-ISOLATED</p>

Figure 3-12 Schematic of PD24xxD HSI Inputs

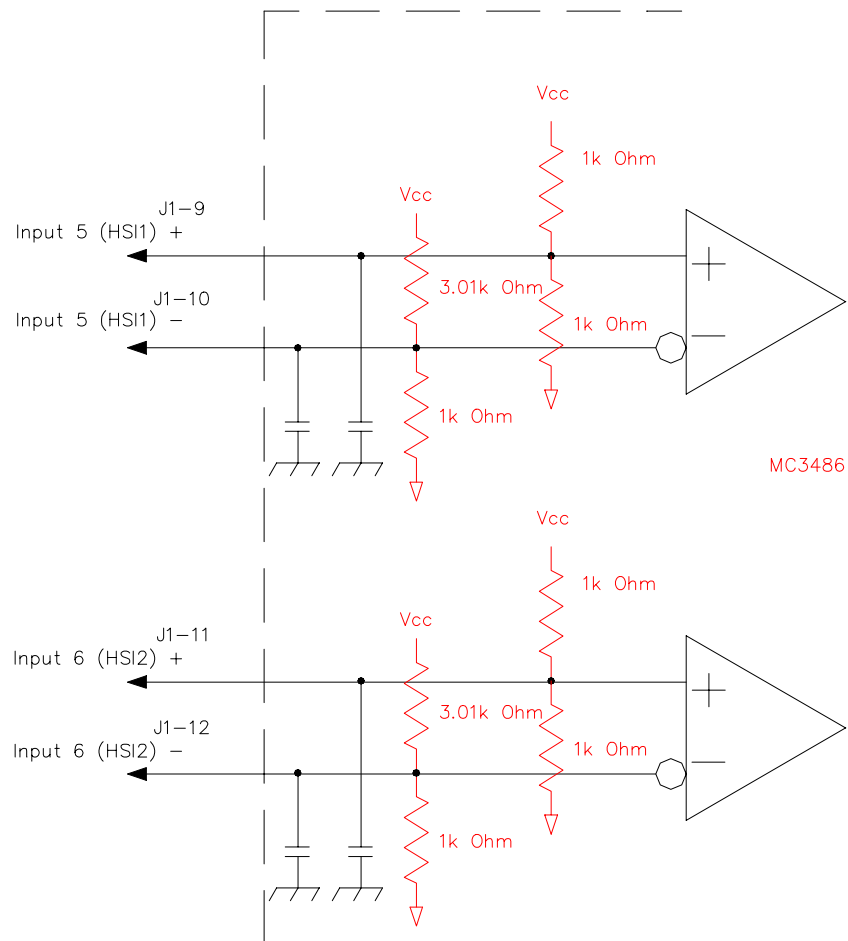


Figure 3-13 Wiring HSI Inputs as Differential Inputs

Note the measured voltages below.

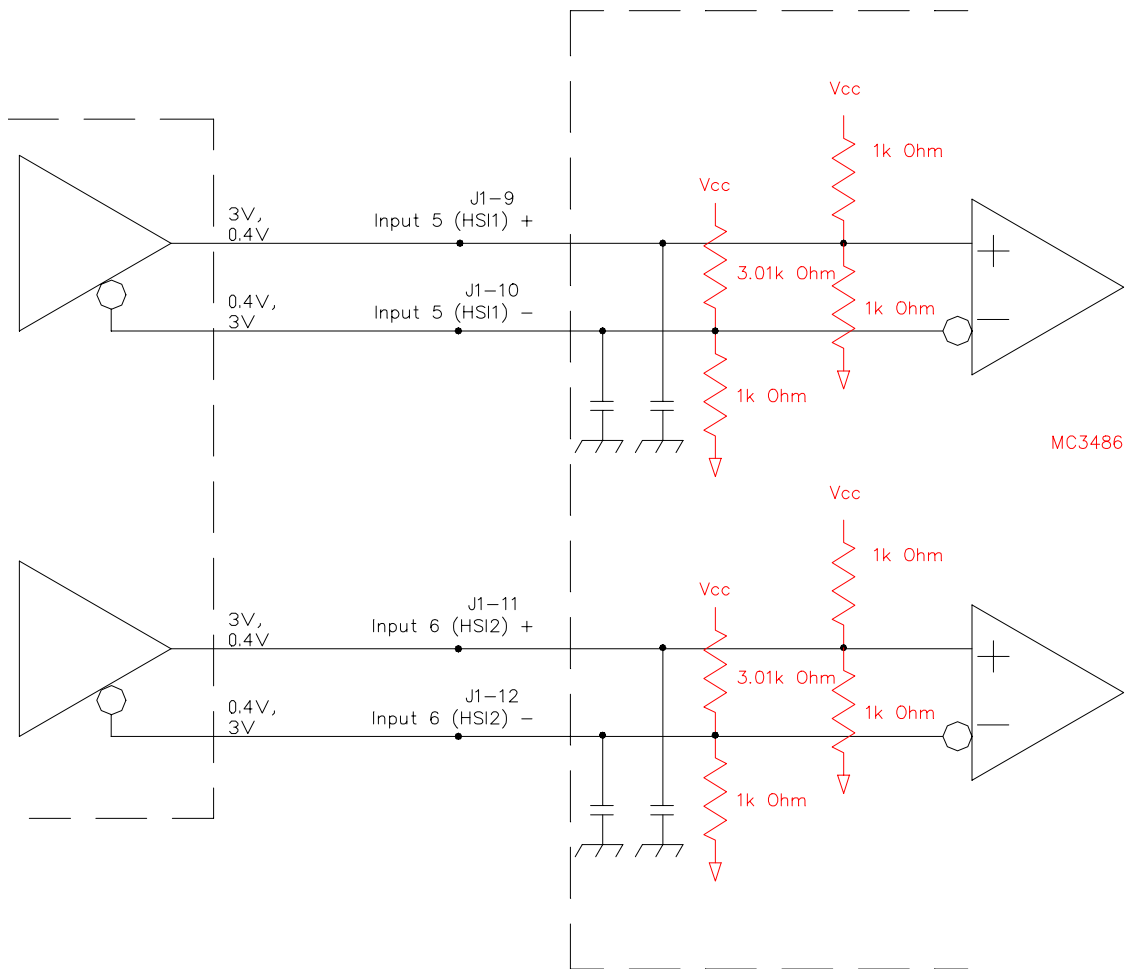


Figure 3-14 Wiring HSI Inputs as Single-ended

Open collector or TTL inputs must have the ability to sink 5ma and may be wired as shown below.

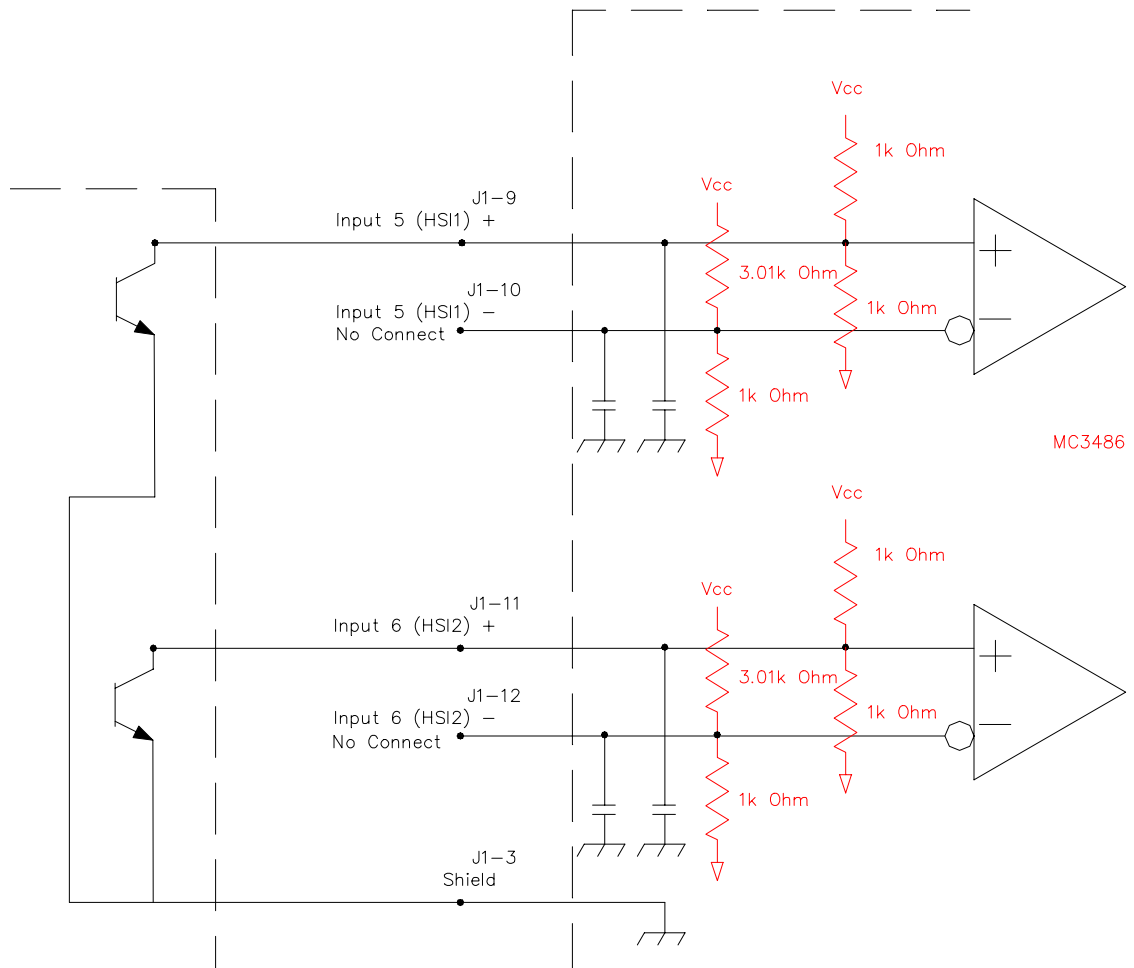
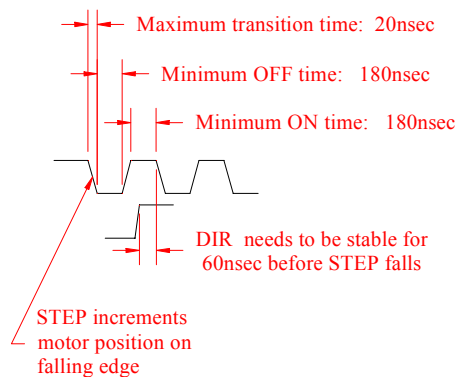


Figure 3-15 Relationship of HSI Signals

Signals for High Speed Inputs		
Mode	HSI5	HSI6
Step/Dir	Direction 0 = CCW, 1 = CW	Step when falling
Step+/Step-	Step CCW when HSI6 = 0	Step CW when HSI5 = 0
Quadrature	Phase A Quadrature	Phase B Quadrature
	CCW on A (HSI5) rising with B (HSI6) low	

Figure 3-16 HSI Signal Timing



3.7.4 Digital Outputs (J1)

The digital outputs can be wired as “current sourcing” or “current sinking”, with a maximum “sink” of 50 mA. An additional external power source of 5-30 VDC is required. The output is not short-circuit proof.

A special output #1 is factory default as Drive-OK for use as a interlock in the users application. This output is active whenever power is applied to the unit and there are no faults present. ToolPAC's **I/O Configuration Wizard** may be utilized to configure this output as a Brake Output, [Figure 5-1 ToolPAC Wizards](#) for applications utilizing a motor/brake assembly.

When output #1 is configured as a BRAKE output, the BRAKE output is active when main power is applied, the unit is enabled and no fault conditions exist. This output becomes active 200ms after the leading edge of the Enable signal. This output is inactive immediately if a fault conditions exists or the drive becomes disabled.

3.7.5 Drive-OK/Brake Output (J1)

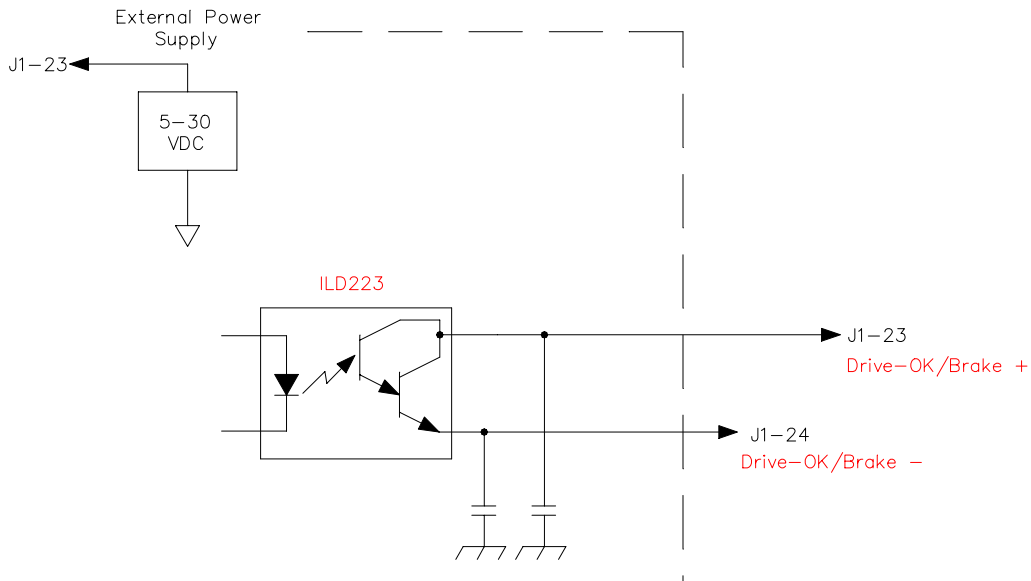
A special output #1 is factory default as Drive-OK for use as a interlock in the users application. This output is active whenever power is applied to the unit and there are no faults present. ToolPAC's **I/O Configuration Wizard** may be utilized to configure this output as a Brake Output, [Figure 5-1 ToolPAC Wizards](#) for applications utilizing a motor/brake assembly.


The Drive-OK/BRAKE output can be wired as “current sourcing” or “current sinking”, with a maximum “sink” of 50 mA. An additional external power source of 5-30 VDC is required. The output is not short-circuit proof.

When software configured as a Drive-OK output, the output will be active as long as there are no faults present. **(This does not imply that the controller is Enabled!)**

The BRAKE output is active when main power is applied, the unit is enabled and no fault conditions exist. This output becomes active 200ms after the leading edge of the Enable signal. This output is inactive immediately if a fault conditions exists or the drive becomes disabled.

Figure 3-17 Drive-OK/Brake Output



CAUTION	
	<p><i>This output is not short circuit proof. If utilizing this output to control a brake, the user must ensure that a Solid State Relay is used to energize the brake coil. Review Figure 7-3 Suppression - DC Relay for proper coil suppression and Figure 7-5 De-coupling - SS Relay.</i></p>

3.8 PD24xxDd-001-E

Each **PD24xxDd-001-E** Series Microstep Drive is a drive, intelligent controller and heatsink integrated into a single standalone package.

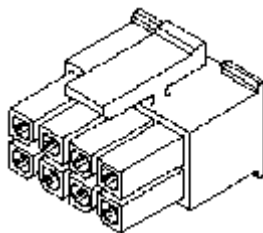
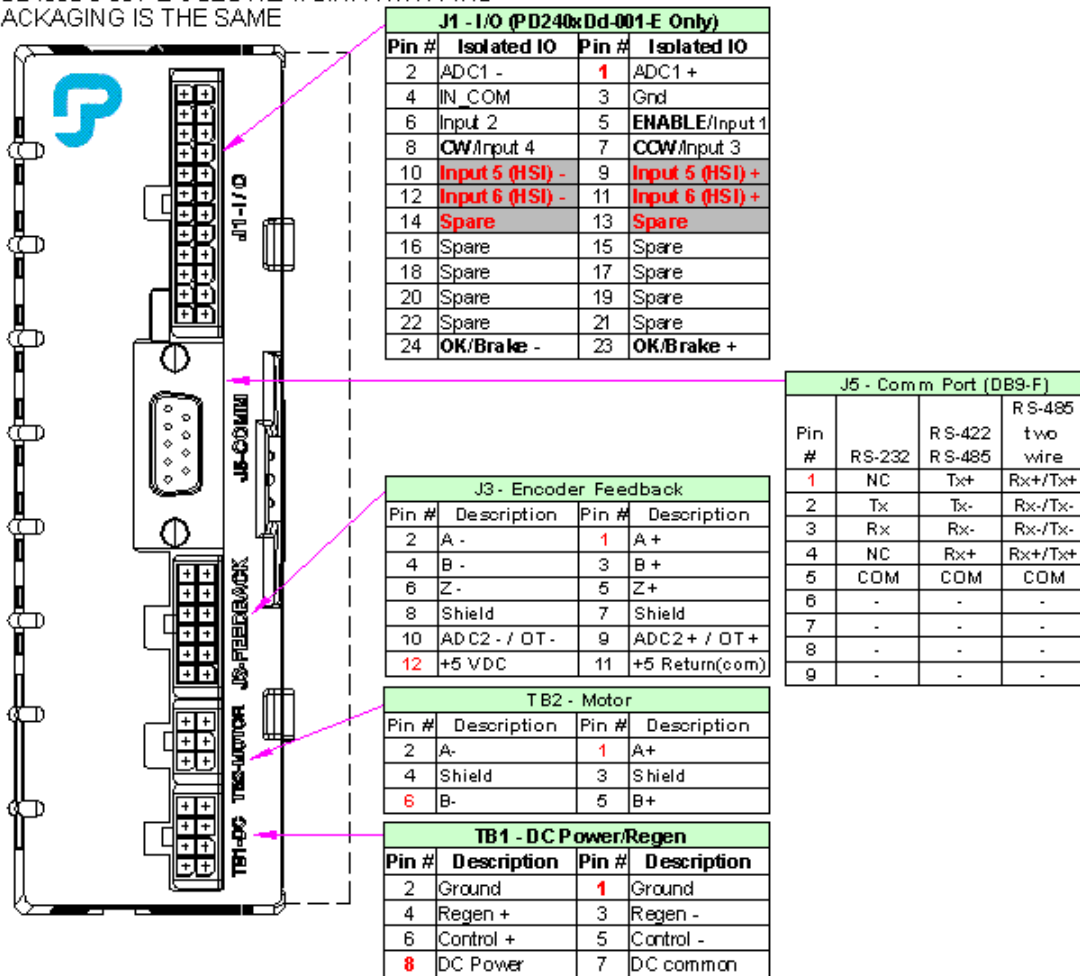
The PD24xxDd Series is a digital drive that will accept an encoder as a feedback device.

All **PD24xxDd** Series controllers provide the user with the same basic components:

- A graphical user interface program, **ToolPAC**, provides the user with the tools to easily configure and program the PD24xxD to the specific application. **ToolPAC** is a Windows/NT-based program that provides Wizards for axis setup and I/O Configurations.
- A method of control is Analog input for Velocity mode, Step/Dir, Step+/Step- or Following of a master quadrature encoder signal. Determine your required configuration, then review the appropriate section.
- Master/slave relationships can be developed from the master encoder HSI inputs when used in Follow mode.
- Hardware interfaces for Enable, Motor OT, [Digital HSI inputs \(J1\)](#), CW, CCW inputs, [Drive-OK/Brake Output \(J1\)](#) that allow you to interface to your machinery/equipment.

Figure 3-18 PC24xxDd-001-E Connector Placement

PD2406Dd-001-E USES HEATSINK WITH FINS
PACKAGING IS THE SAME



TB1 connector is shown above.

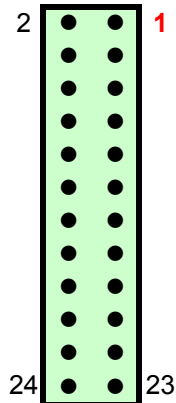
3.8.1.1 PD24xxDd-001-E Digital inputs (J1)


The PD24xxDd-001-E digital I/O connector J1 contains all of the connections for the unit; **10-bit Analog** input, 3 inputs (Enable and CCW/CW limits), plus 2 HSI inputs, buffered encoder outputs and 1 output for [Drive-OK/Brake Output \(J1\)](#) control to allow the user to interface to the most demanding application. The various methods of wiring I/O are described in this section.

The optically isolated inputs, (Enable, CW Limit and CCW limit) are current activated, 10 mA minimum. The user must supply a 5-30 VDC voltage to utilize the optically isolated I/O. Since the digital inputs are current activated, the user may utilize PNP or NPN outputs to the drive.

Figure 3-19 PD24xxDd-001-E Connector J1

J1 - I/O (PD240xDd-001-E Only)			
Pin #	Isolated IO	Pin #	Isolated IO
2	ADC1 -	1	ADC1 +
4	IN_COM	3	Gnd
6	Input 2	5	ENABLE/Input 1
8	CW/Input 4	7	CCW/Input 3
10	Input 5 (HSI) -	9	Input 5 (HSI) +
12	Input 6 (HSI) -	11	Input 6 (HSI) +
14	Spare	13	Spare
16	Spare	15	Spare
18	Spare	17	Spare
20	Spare	19	Spare
22	Spare	21	Spare
24	OK/Brake -	23	OK/Brake +



CAUTION	
	<i>The High Speed Inputs (HSI) require a signal level of 0-5VDC relative to J1-3 (Shield). The voltage difference between HSI+ and HSI- must be greater than ±0.25 volts. Exceeding this voltage specification will result in damage to the equipment. NON-ISOLATED</i>

A cable assembly, **PCA-MC24-006**, may be purchased to facilitate wiring the J1 connector. This shielded cable assembly is pre-wired to the mating connector, six feet in length.

Figure 3-20 PD24xDd-001-E Digital Input (Sourcing configuration A)

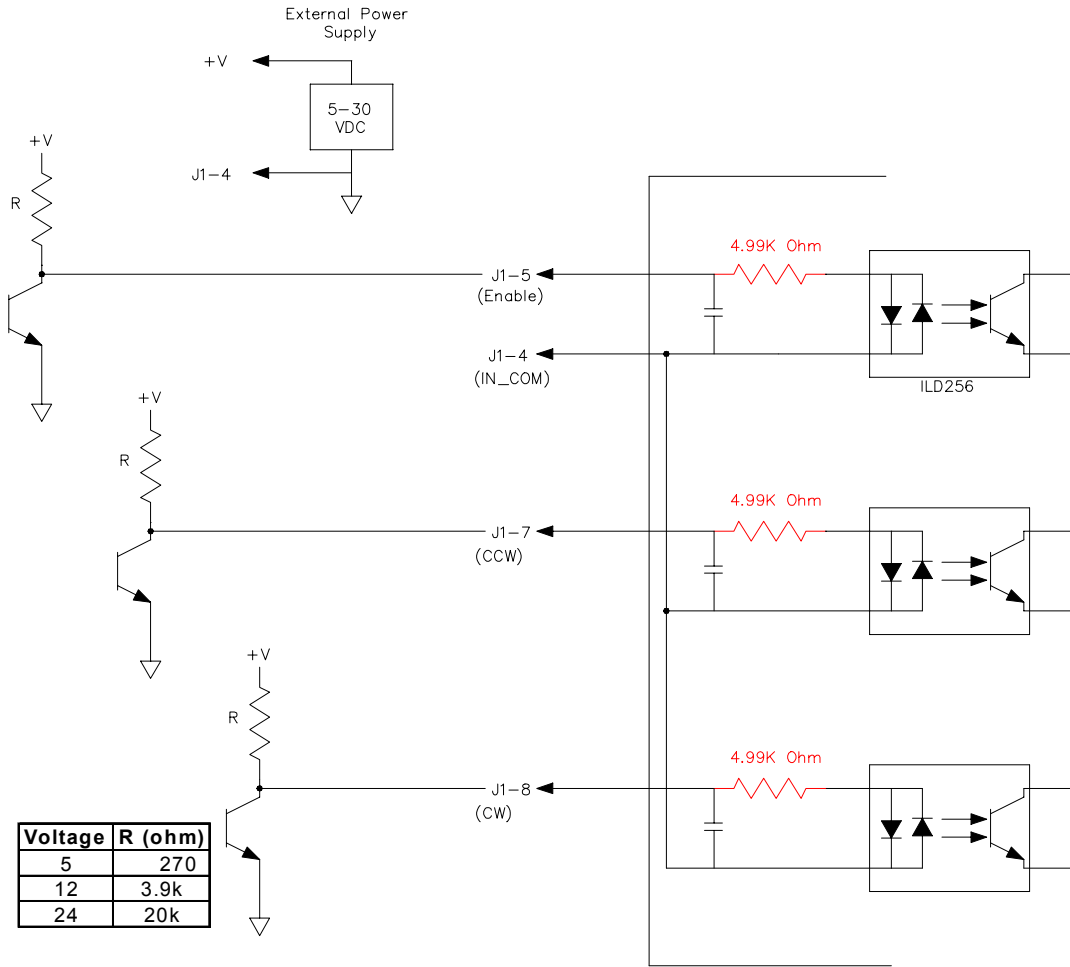


Figure 3-21 PD24xDd-001-E Digital Input (Sourcing configuration B)

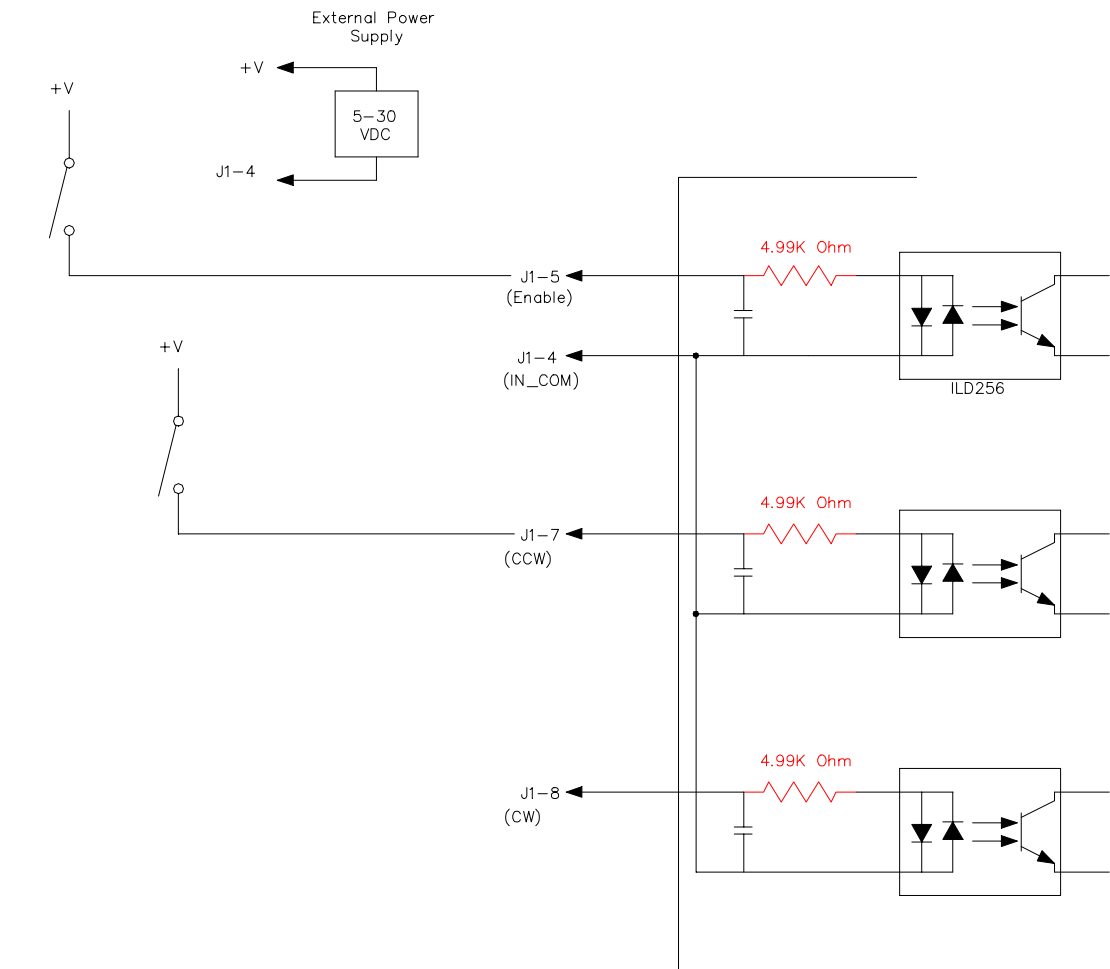


Figure 3-22 PC34xxDd-001-E Digital Input (Sinking configuration A)

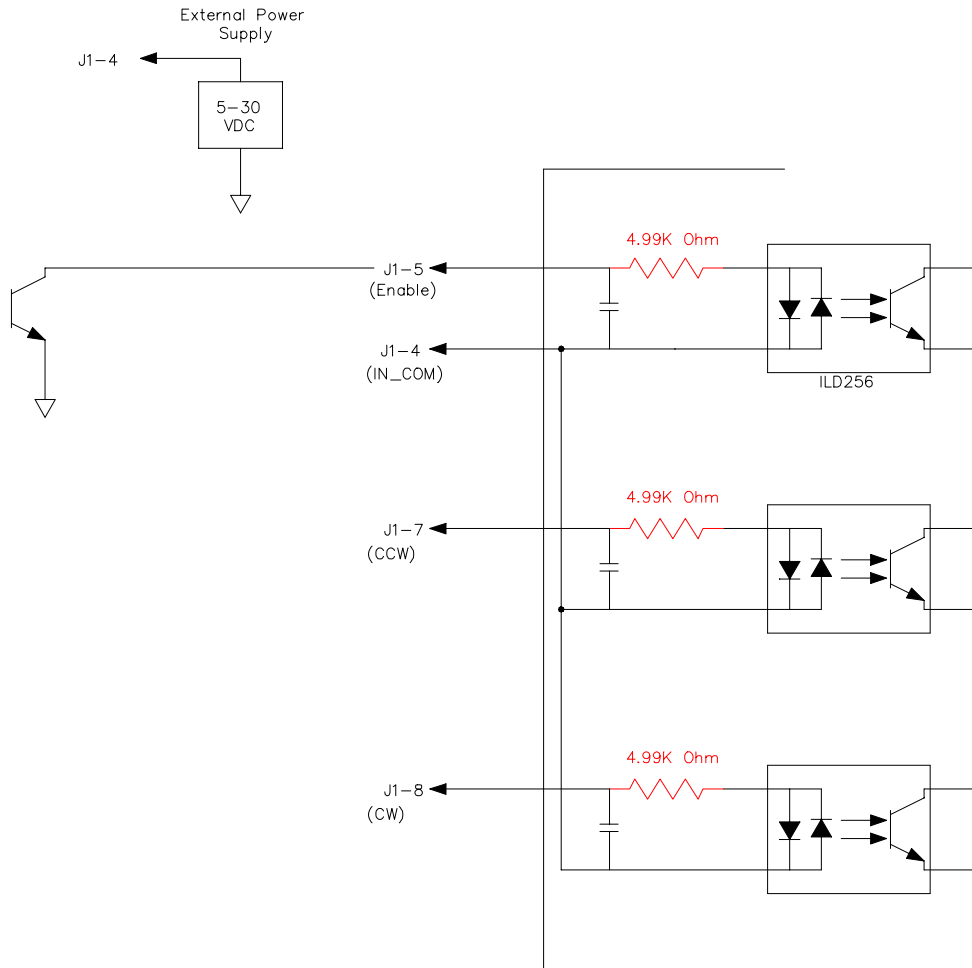
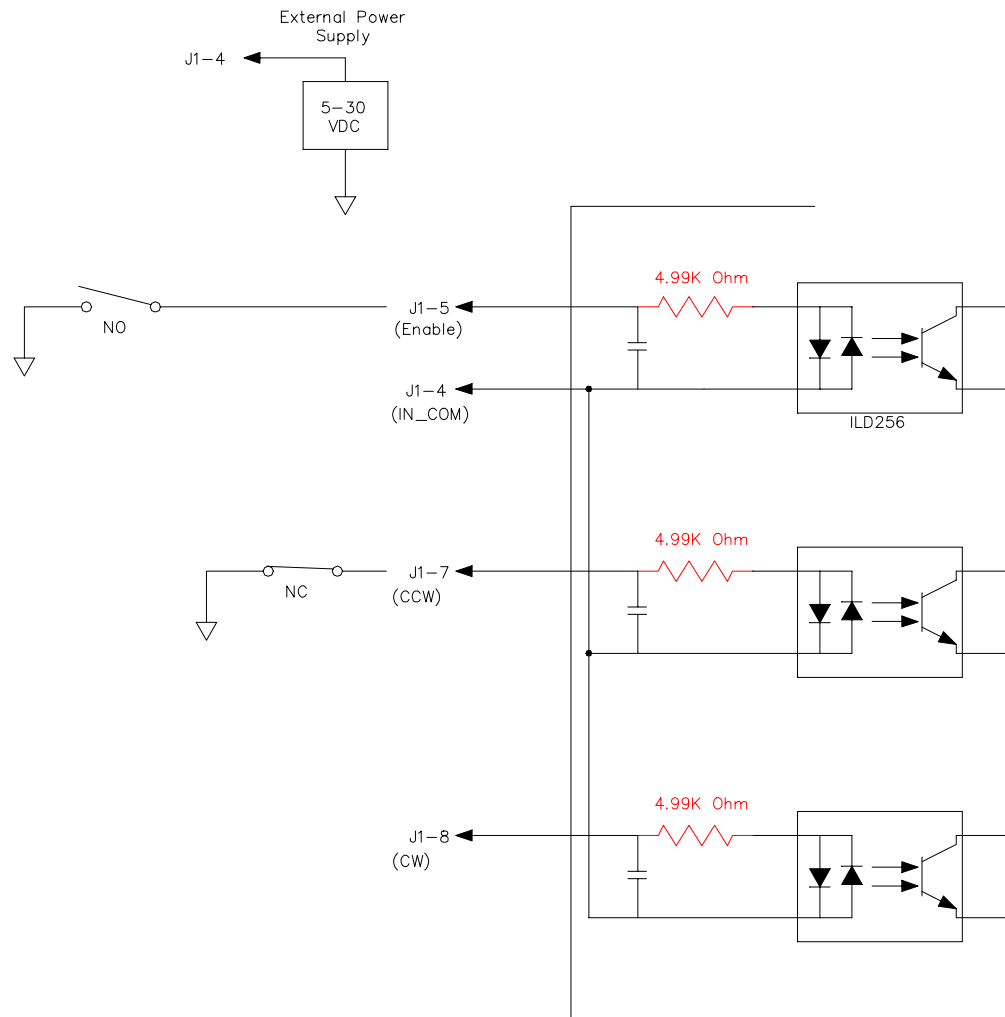


Figure 3-23 PC34xxDd-001-E Digital Input (Sinking configuration B)



3.9 PD24xxDi-001-E (J1)

Each **PD24xxDi-001-E** Series Microstep Drive is a drive, intelligent controller and heatsink integrated into a single standalone package.

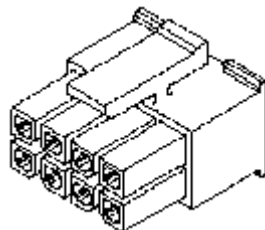
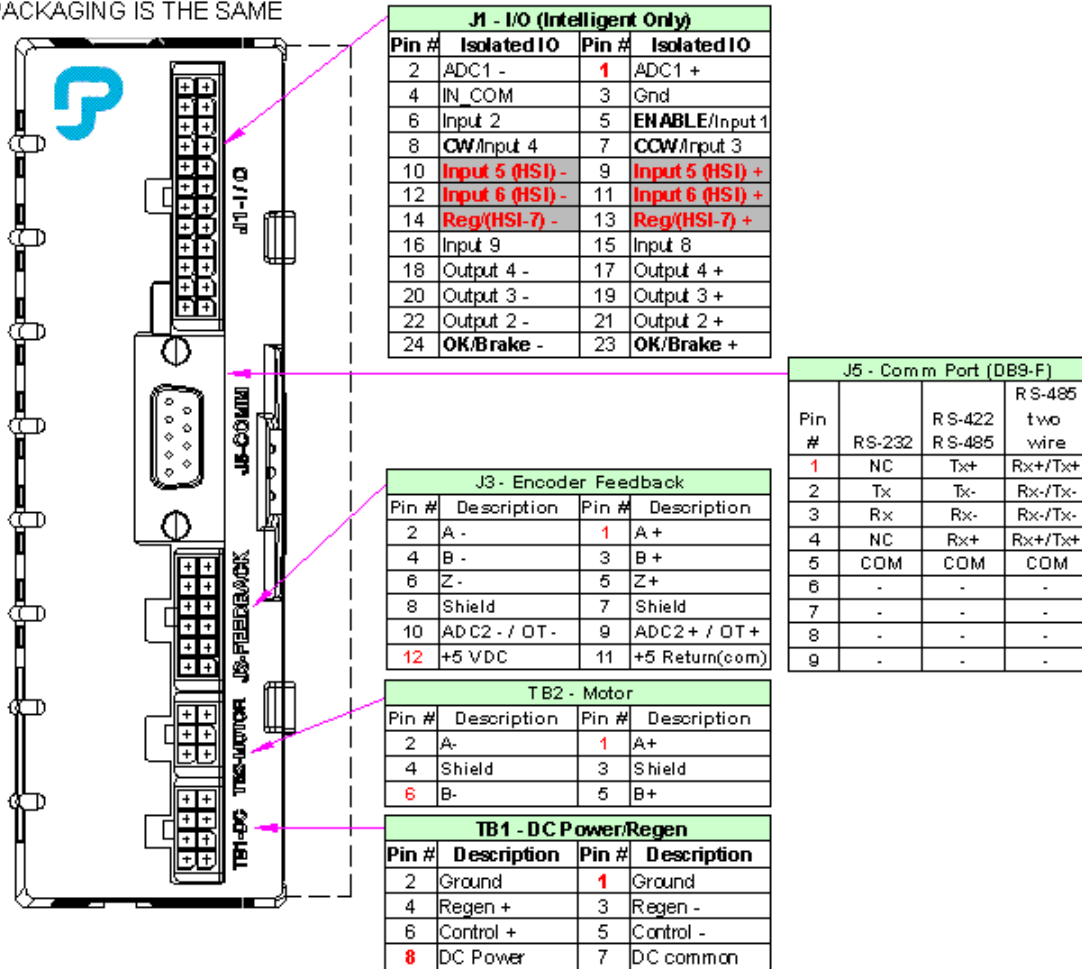
The PD24xxDi Series is a digital drive that will accept an encoder as a feedback device.

All **PD24xxDi** Series controllers provide the user with the same basic components:

- A graphical user interface program, **ToolPAC**, provides the user with the tools to easily configure and program the PD24xxD to the specific application. **ToolPAC** is a Windows/NT-based program that provides Wizards for axis setup and I/O Configurations.
- A method of control is Stand-alone program mode, Analog input for Program input or Velocity mode, Step/Dir, Step+/Step- or Following of a master quadrature encoder signal. Determine your required configuration, then review the appropriate section.
- Master/slave relationships can be developed from the master encoder HSI inputs when used in Follow mode. Advanced ToolPAC programming features are available for performing complex Electronic Gearing and CAM motion.
- Hardware interfaces for Enable, Motor OT, [Digital HSI inputs \(J1\)](#), CW, CCW inputs, [Drive-OK/Brake Output \(J1\)](#) that allow you to interface to your machinery/equipment.

Figure 3-24 PD24xxDi-001-E Connector Placement

PD2406Di-001-E USES HEATSINK WITH FINS
PACKAGING IS THE SAME



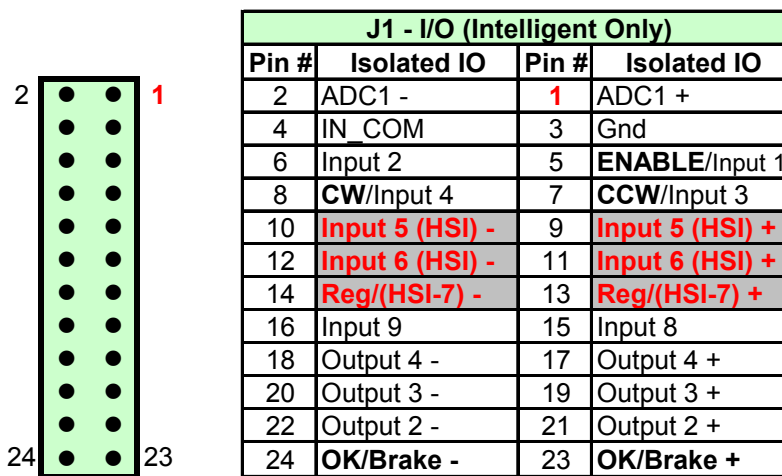
TB1 connector is shown above.

3.9.1.1 PD24xxDi-001-E Digital inputs (J1)

The **PD24xxDi-001-E** Series is an intelligent amplifier with I/O capability. The digital I/O connector J1 contains all of the connections for the unit; a 10-bit Analog input, 6 isolated inputs (Enable and 5 general purpose), plus 3 HSI inputs, 3 general purpose outputs and 1 output for Drive-OK or Brake control to allow the user to interface to the most demanding application.

The optically isolated inputs are current activated, 10 mA minimum. The user must supply a 5-30 VDC voltage to utilize the optically isolated I/O. Since the digital inputs are current activated, the user may utilize PNP or NPN outputs to the drive.

Figure 3-25 PD24xxDi-001-E Connector J1



CAUTION	
	<p>The High Speed Inputs (HSI) require a signal level of 0-5VDC relative to J1-3 (Shield). The voltage difference between HSI+ and HSI- must be greater than ±0.25 volts. Exceeding this voltage specification will result in damage to the equipment. NON-ISOLATED</p>

A cable assembly, **PCA-MM24-006**, may be purchased to facilitate wiring the J1 connector. This shielded cable assembly is pre-wired to the mating connector, six feet in length

Figure 3-26 PD24xxDi-001-E Digital Input (Sourcing configuration A)

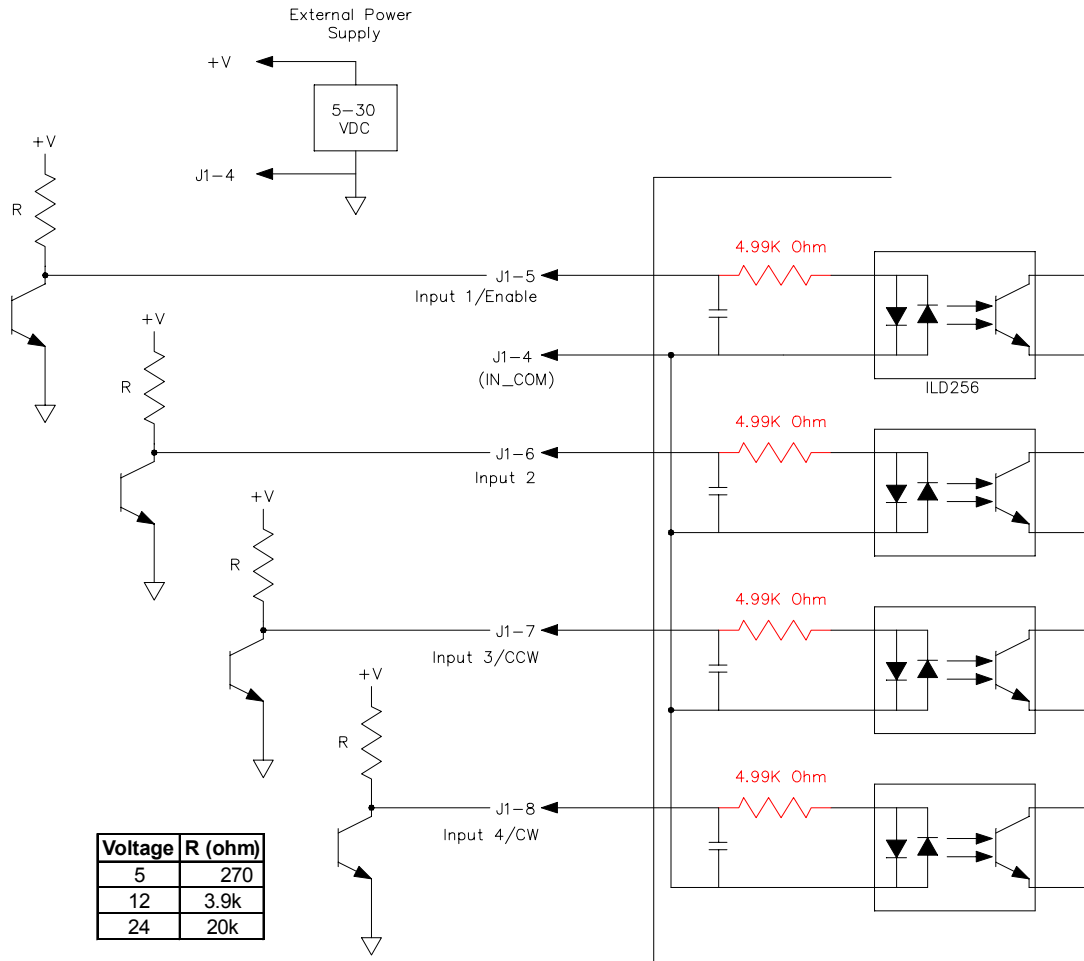


Figure 3-27 PD24xxDi-001-E Digital Input (Sourcing configuration B)

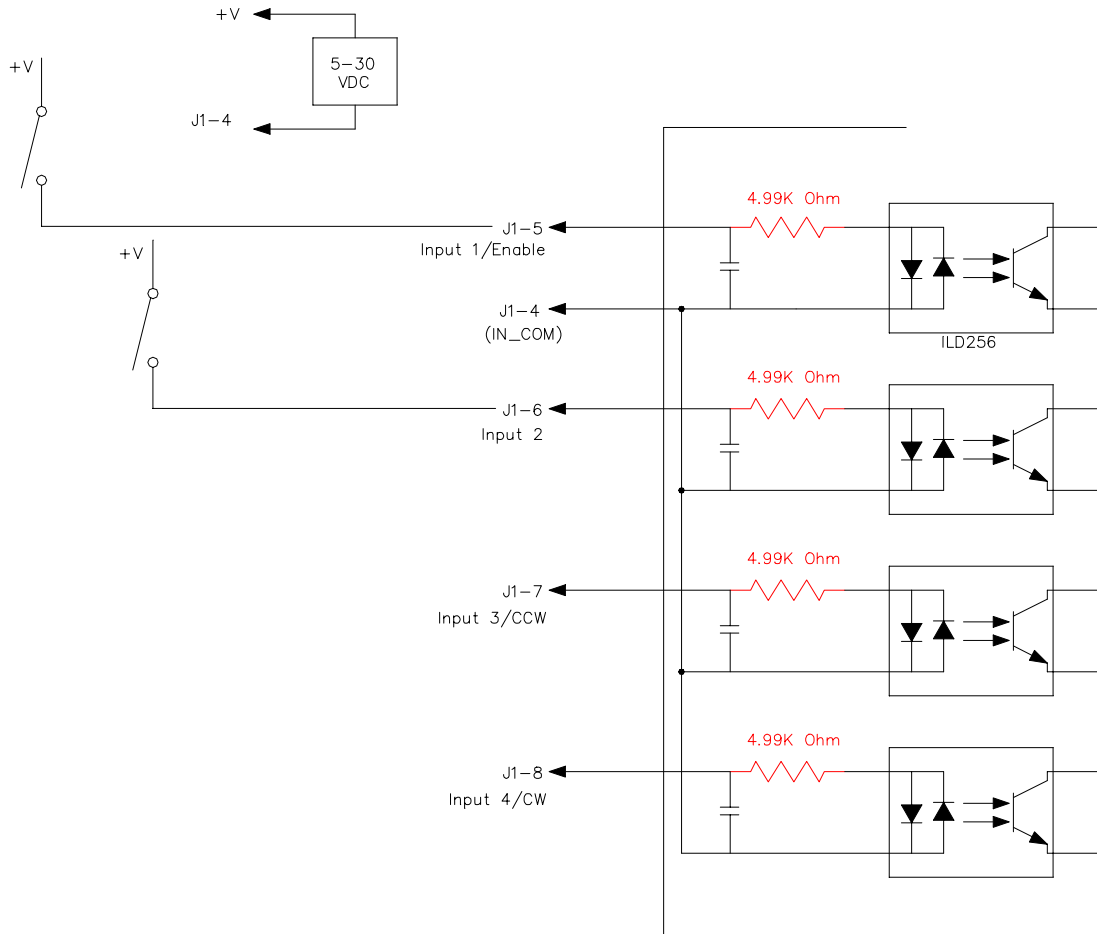


Figure 3-28 PD24xxDi-001-E Digital Input (Sinking configuration A)

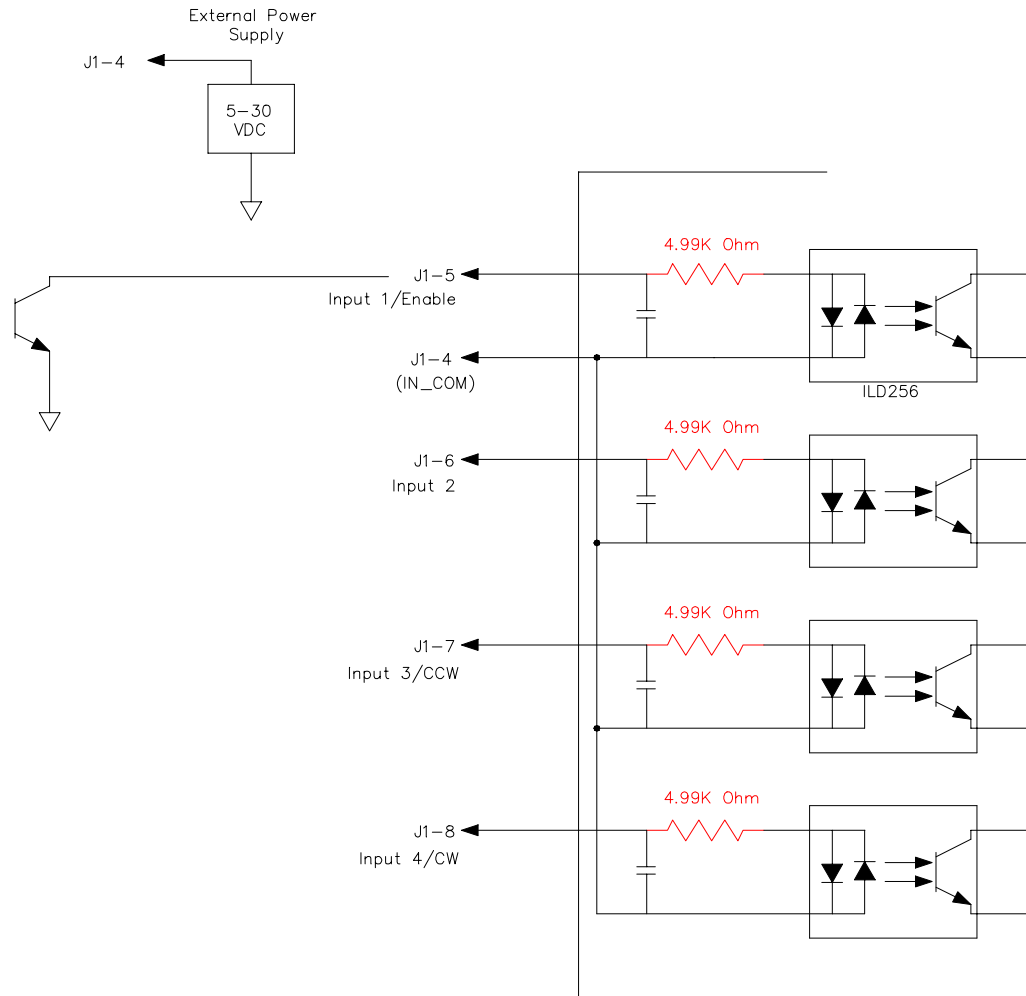
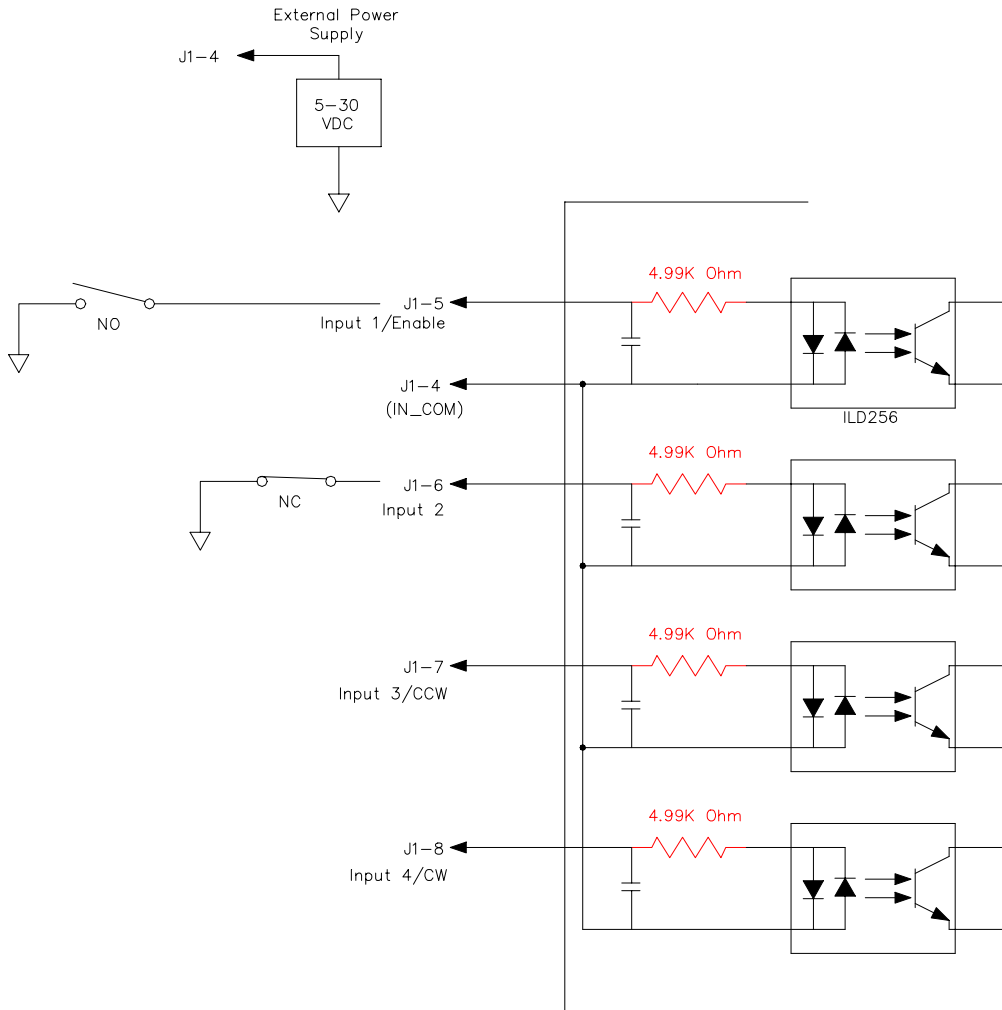


Figure 3-29 PD24xxDi-001-E Digital Input (Sinking configuration B)



3.10 PD24xxDi-001-EI (J1)

Each **PD24xxDi-001-EI** Series Microstep Drive is a drive, intelligent controller and heatsink integrated into a single standalone package.

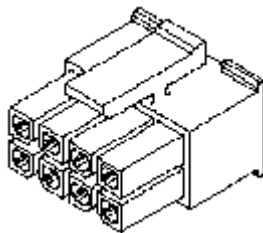
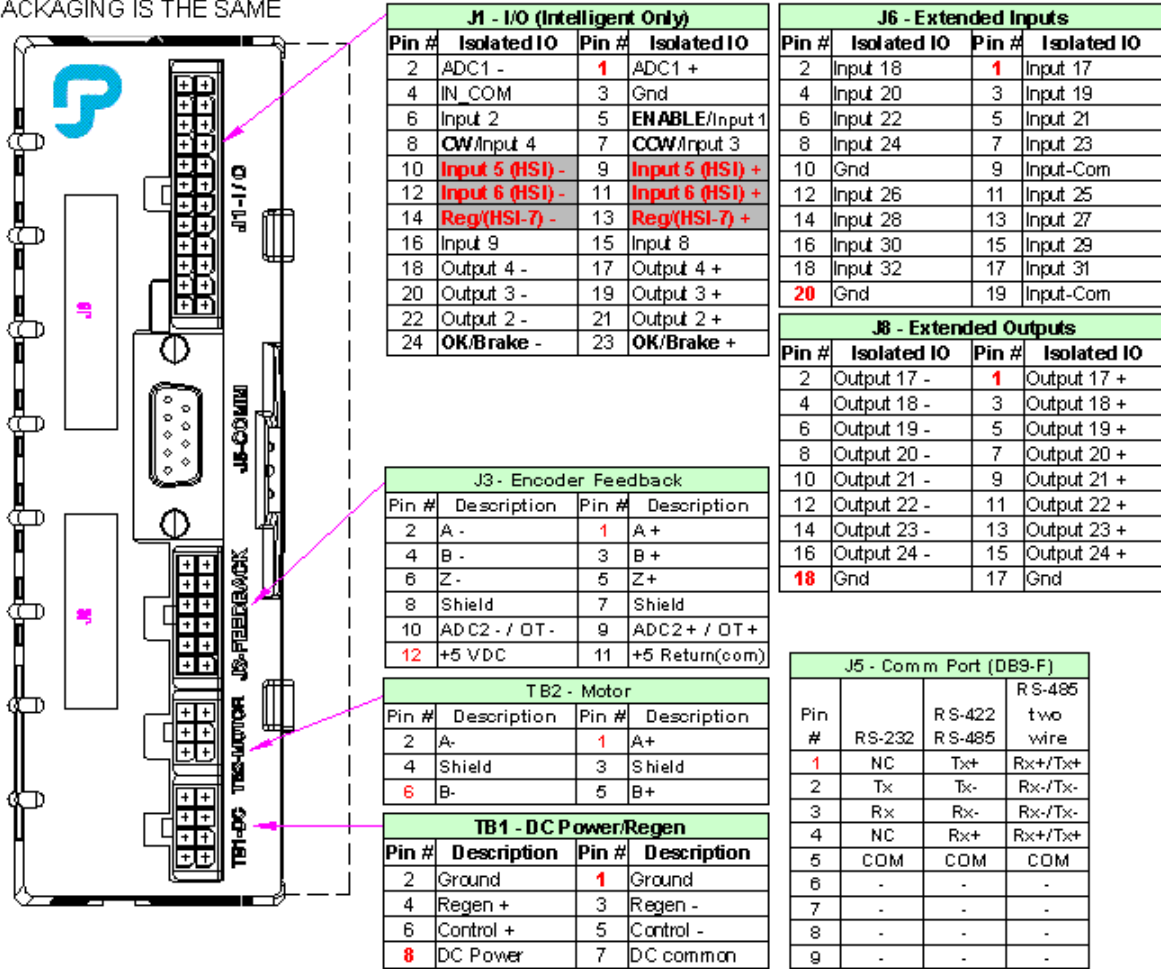
The PD24xxDi Series is a digital drive that will accept an encoder as a feedback device.

All **PD24xxDi** Series controllers provide the user with the same basic components:

- A graphical user interface program, **ToolPAC**, provides the user with the tools to easily configure and program the PD24xxD to the specific application. **ToolPAC** is a Windows/NT-based program that provides Wizards for axis setup and I/O Configurations.
- A method of control is Stand-alone program mode, Analog input for Program input or Velocity mode, Step/Dir, Step+/Step- or Following of a master quadrature encoder signal. Determine your required configuration, then review the appropriate section.
- Master/slave relationships can be developed from the master encoder HSI inputs when used in Follow mode. Advanced ToolPAC programming features are available for performing complex Electronic Gearing and CAM motion.
- Hardware interfaces for Enable, Motor OT, [Digital HSI inputs \(J1\)](#), CW, CCW inputs, [Drive-OK/Brake Output \(J1\)](#) that allow you to interface to your machinery/equipment.

Figure 3-30 PD24xxDi-001-EI Connector Placement

PD2406Di-001-EI USES HEATSINK WITH FINS PACKAGING IS THE SAME



TB1 connector is shown above.

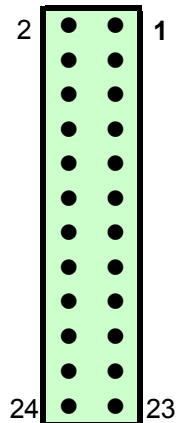
3.10.1.1 Digital inputs (J1)


The **PD24xxDi-001-EI** Series is an intelligent drive with extended I/O capability. The digital I/O connector J1 contains all of the connections for the unit; a 10-bit Analog input, 6 isolated inputs (Enable and 8 general purpose), plus 3 HSI inputs, 3 general purpose outputs and 1 output for Drive-OK or Brake control to allow the user to interface to the most demanding application.

The optically isolated inputs are current activated, 10 mA minimum. The user must supply a 5-30 VDC voltage to utilize the optically isolated I/O. Since the digital inputs are current activated, the user may utilize PNP or NPN outputs to the drive.

Figure 3-31 PD24xxDi-001-EI Connector J1

J1 - I/O (Intelligent Only)			
Pin #	Isolated IO	Pin #	Isolated IO
2	ADC1 -	1	ADC1 +
4	IN COM	3	Gnd
6	Input 2	5	ENABLE /Input 1
8	CW /Input 4	7	CCW /Input 3
10	Input 5 (HSI) -	9	Input 5 (HSI) +
12	Input 6 (HSI) -	11	Input 6 (HSI) +
14	Reg/(HSI-7) -	13	Reg/(HSI-7) +
16	Input 9	15	Input 8
18	Output 4 -	17	Output 4 +
20	Output 3 -	19	Output 3 +
22	Output 2 -	21	Output 2 +
24	OK/Brake -	23	OK/Brake +



CAUTION	
	<p>The High Speed Inputs (HSI) require a signal level of 0-5VDC relative to J1-3 (Shield). The voltage difference between HSI+ and HSI- must be greater than ± 0.25 volts. Exceeding this voltage specification will result in damage to the equipment. NON-ISOLATED</p>

A cable assembly, **PCA-MM24-006**, may be purchased to facilitate wiring the J1 connector. This shielded cable assembly is pre-wired to the mating connector, six feet in length.

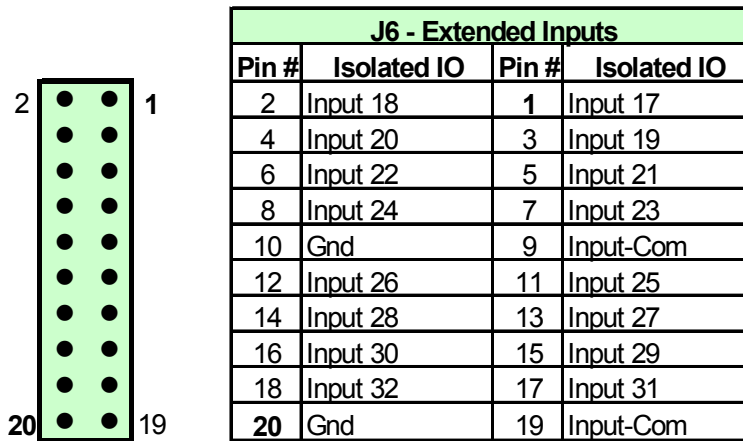
3.10.1.2 Digital Inputs (J6)

The **PC34xxDi-001-EI** Series has 16 additional general-purpose inputs located on the J6 connector, the inputs are software numbered 17 through 32. The various methods of wiring I/O are described in this section.

The optically isolated inputs are current activated, 10 mA minimum. The user must supply a 5-30 VDC voltage to utilize the optically isolated I/O. Since the digital inputs are current activated, the user may utilize PNP or NPN outputs to the drive.

Refer to [Figure 3-20 PD24xxDd-001-E Digital Input \(Sourcing configuration A\)](#), [Figure 3-21 PD24xxDd-001-E Digital Input \(Sourcing configuration B\)](#), [Figure 3-22 PC34xxDd-001-E Digital Input \(Sinking configuration A\)](#) or [Figure 3-23 PC34xxDd-001-E Digital Input \(Sinking configuration B\)](#) for additional information on wiring of digital inputs.

Figure 3-32 PD24xxDi-001-EI Connector (J6)



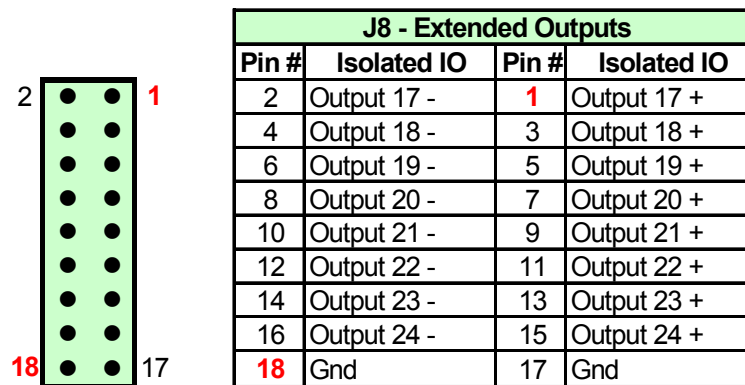
A cable assembly, **PCA-MM20-006**, may be purchased to facilitate wiring the J6 connector. This shielded cable assembly is pre-wired to the mating connector, six feet in length.

3.10.1.3 Digital Outputs (J8)

The **PD24xxDi-001-EI** Series has eight additional general-purpose outputs located on the J8 connector, the outputs are software numbered 17 through 24. The various methods of wiring I/O are described in this section.

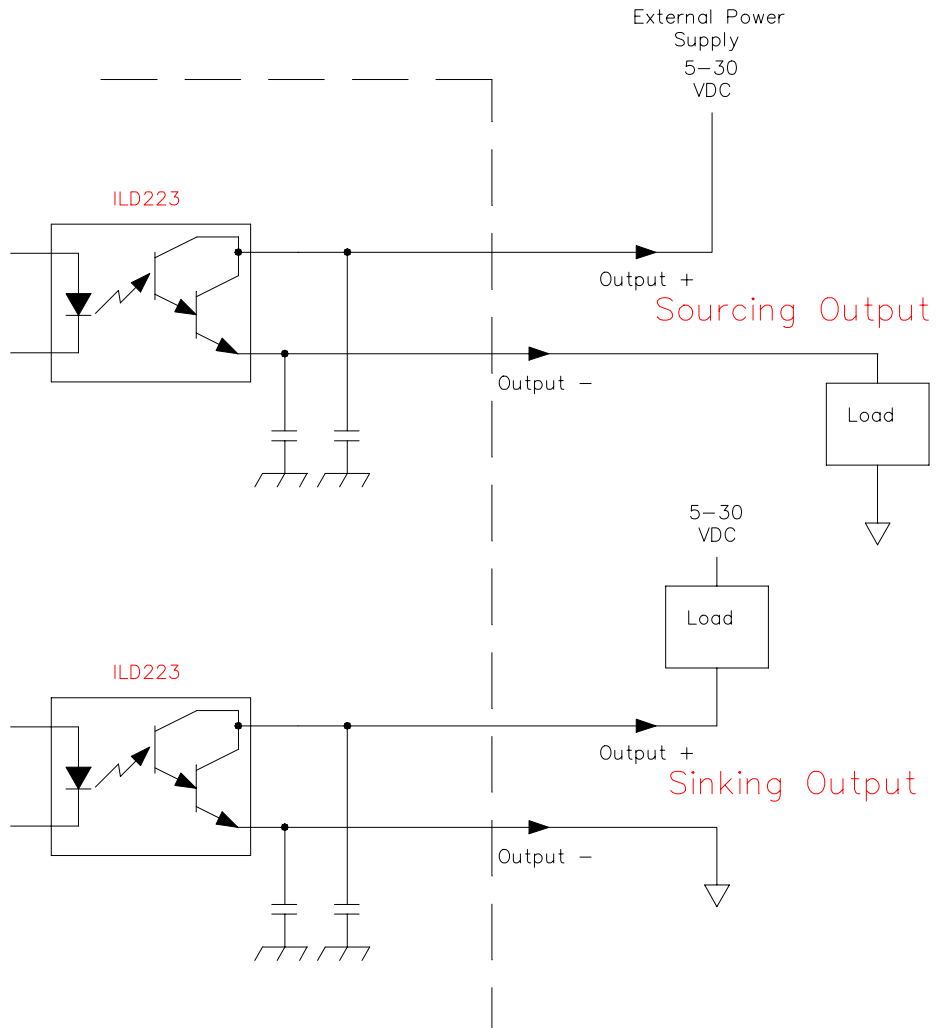
The optically isolated outputs are 5-30 VDC, 50 ma maximum.

Figure 3-33 PD24xxDi-001-EI Connector (J8)



A cable assembly, **PCA-MM18-006**, may be purchased to facilitate wiring the J8 connector. This shielded cable assembly is pre-wired to the mating connector, six feet in length.

Figure 3-34 PD24xxDi-001-EI Digital Outputs



4. ToolPAC Software Setup and Installation

This section will guide the user through the ToolPAC[®] software installation. ToolPAC[®] is a Win95/Win98/NT based program that provides Wizards for axis setup, tuning and programming of the 2400 and 3400 Series Intelligent Drives. The graphical user interface of the ToolPAC provides the user with the tools to easily configure the 2400 to his specific application.

ToolPAC

ToolPAC is a registered trademark of Pacific Scientific.

4.1 Hardware Requirements

To take full advantage of the tools available within **ToolPAC**, the system integrator must have a PC with Win95/Win98/NT, a hard disk with a minimum of 10M free space, a communications port, a mouse, and a CD-ROM drive.

4.2 Software Installation

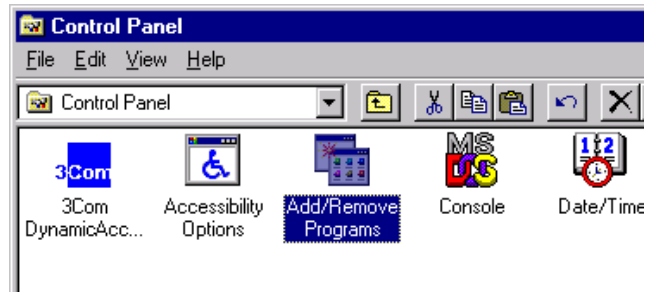
4.2.1 Preliminary Steps

The **ToolPAC** user interface program is provided on a CD-ROM. The purchased copy is considered a site license. The end user may make backup copies for multiple installations of this software. When available, software and firmware upgrades may be made available to end users with purchased copies. To obtain upgrades, you may log onto web site at <http://www.pacsci.com>.

It is recommended that the OEM or system integrator purchase a copy of the **ToolPAC** software for each installation and their end user for additional tuning and maintenance of the equipment.

4.2.2 Installation Procedure

The **ToolPAC** user interface program is supplied on a read/write CD ROM disk. Install this disk in the CD ROM drive of your PC, select the Add/Remove Programs icon, and follow the instructions for adding a program.



An Install Shield is provided to guide you through the installation process. Follow the instructions presented in the Install Shield.

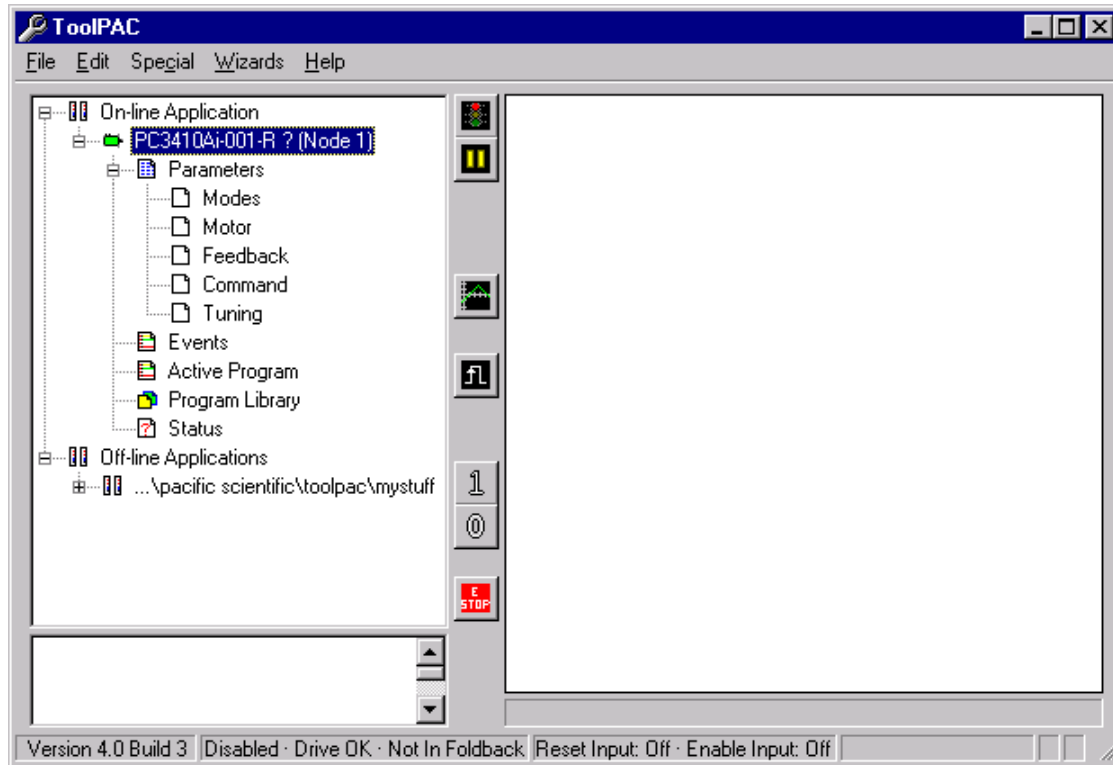
Note that extensive help menus are available with ToolPAC to assist the user in determining the function of each command, parameter, or feature. Help screens for commands and parameters are accessed by first highlighting the item and then performing a right-mouse click.

4.2.3 ToolPAC Configuration

To take full advantage of the ToolPAC software features, the user must first configure the software for his computer. Launch the ToolPAC software from your program menu. Below is an example of the file functions available [Figure 4-1 ToolPAC Main Screen](#).

The user should take this time to configure the software for the printer. The user should also confirm the communications port being utilized by the software to communicate to the amplifiers. Whenever ToolPAC is loaded, a check is completed of the PC's ports is performed to select the proper location of your communications port. *Shared IRQ's for the selected communications port and LAN, MODEM, IR ports or MOUSE will result in erratic operation of the software.*

Figure 4-1 ToolPAC Main Screen

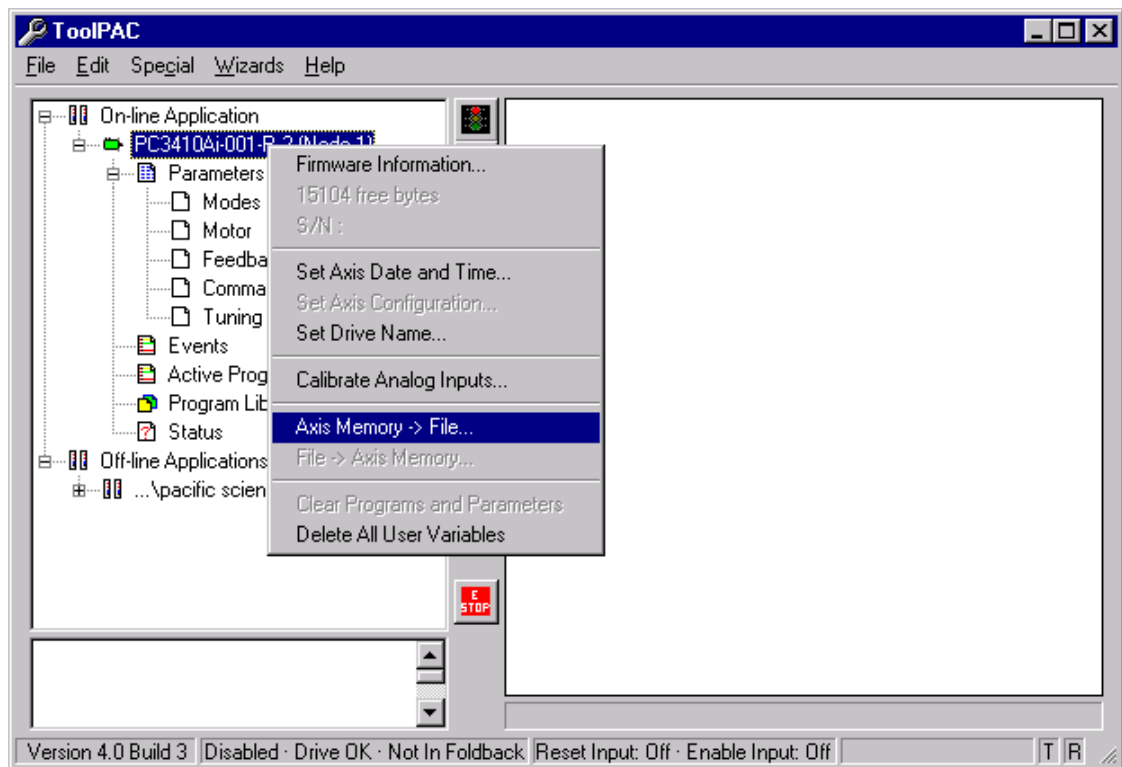


A green icon of a motor under the connected application lets you know which axes model is currently connected to the PC. The Axis Menu can be accessed via a right-mouse click.

The feature Axis Memory-> File will make a snapshot or backup copy of the existing unit. This snapshot is saved as a file type SNA and includes all the information necessary to completely duplicate the function of an amplifier.

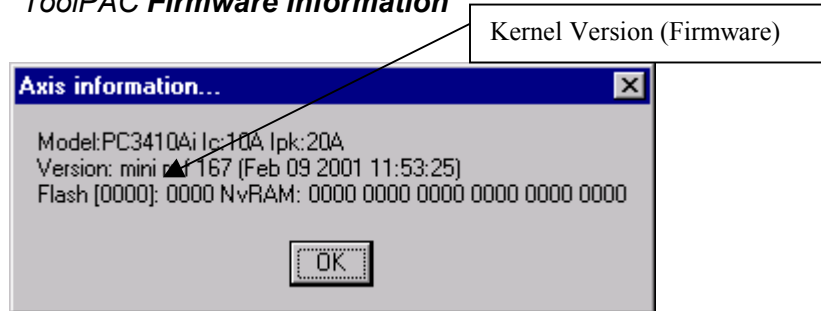
When requesting applications assistance, this file may be sent via e-mail to assist in prompt response to your application needs. Call our toll-free customer service number described in Section 1.4 to obtain our current e-mail address. Be sure to supply additional application information that may be useful in determining your application configuration and desired function.

Figure 4-2 ToolPAC Axis Menu




The firmware information presented here must be available when calling for applications assistance. This information will provide you with the Model and Kernel Version of the firmware currently installed in flash.

Figure 4-3 ToolPAC Firmware Information



You are now ready to proceed with the configuration of the drive.

WARNING	
	<i>Before proceeding, make sure that the ENABLE input is INACTIVE to prevent accidental motion during the amplifier configuration process.</i>

5. System Startup

After the system has been installed and wired, it is ready for startup. This section will detail the startup procedure of the step motor system and verify proper wiring and operation. Parameter settings and tuning adjustments to the amplifier will be accomplished for your particular application.

To assist you in starting up the system, a step-by-step Startup procedure has been included. This procedure should always be followed to ensure proper operation of the system. This procedure assumes that the correct interconnect diagrams have been followed and International, National and Local electrical wiring codes have been carefully adhered to.

The PD24xxD is a digital motion controller that will process commands within the hardware and software limits dictated by the user (wiring, configuration, parameters, events, etc.). The output of the system is the motion(s) created in response to the command(s) input. Be sure to review all software commands and hardware prior to installing the system.

5.1 Preparation for Startup

5.1.1 Selecting Operation Mode

Before the Startup procedure can proceed, the system integrator must determine the motor parameters and type of motor being used.

The **PD24xxD** series drives can operate **two** or **four phase** step motors in open loop or encoder closed loop operation.

All models of the **PD24xxD** series are easily configured as a step motor drive in a Velocity (speed) mode, Position or Follow mode.

5.1.2 Modes of Operation


This section is to briefly describe possible modes of operation that the user may adopt for their application. For additional information on parameters and function, please refer to [Figure 7-6 Function Block Diagram](#).

Velocity Mode

In Velocity mode, the drive will accept an analog velocity (10-bit) command via analog input #1 (**ADC1**). The maximum acceleration and deceleration rates are limited via parameters **ACC** and **DEC** respectively. In this mode of operation the position loop is closed within an external motion controller and the **PD24xxD** controls the inner velocity and current loops. Additionally the user may command a Digital velocity via the serial port or program, (parameter **DCV**).

Position-Following mode

In Position-Following Mode the drive will accept a Step/Dir, Step+/Step- or Quadrature Encoder signal for Following. In Position-Following mode, the drive's High Speed Inputs (HSI) are utilized to accept encoder quadrature A and B channels respectively. The drive utilizes the parameters similar to position mode to control the number of encoder quadrature signals, **SPPR** equivalent to one revolution of the motor shaft. These ratio numbers should NOT be changed on-the-fly as the change is instantaneous and will result in abrupt changes in velocity.

CAUTION	
	<p><i>The High Speed Inputs (HSI) require a signal level of 0-5VDC relative to J1-3 (Shield).</i></p> <p><i>The voltage difference between HSI+ and HSI- must be greater than ± 0.25 volts.</i></p> <p><i>Exceeding this voltage specification will result in damage to the equipment</i></p> <p style="text-align: center;">NON-ISOLATED</p>

Electronic Gearing

Electronic Gearing is a special form of Position-Following Mode that utilizes a master Quadrature Encoder signal for Following. Electronic Gearing is ONLY available on the intelligent series controllers. The drive's High Speed Inputs (HSI) are utilized to accept a Master encoder quadrature A and B channels respectively. A program is required to control the Slave motor with-respect to the Master encoder. The Electronic gearing software commands are too extensive to be discussed in this manual, please refer to the MAToolPAC located at www.pacsci.com.

The drive utilizes the parameters similar to position mode to control the number of encoder quadrature signals.

Program Control

Under Program Control the Intelligent drive will execute Motion or Velocity commands and accept a Quadrature Encoder signal for Electronic Gearing. Possible methods of commanding motion are so varied that it not practical to document them all here. For additional information on motion commands, Gearing, Macros, Links and PLS functions, download **ToolPAC Software Reference Guide** from <http://www.pacsci.com>.

Digital/Serial mode

The user may elect to command Velocity or Position commands via the serial communications port. Please review the following documents, available on the ToolPAC CD ROM, if you are intending on utilizing this method of control.

- **ToolPAC Software Reference Guide**, for additional information on Advanced commands (Gearing, Macros, Links, PLS) (MAToolPAC.zip)
- **Dynamic Link Library (DLL)** (ISPDLL.zip)
 - **MSVB and C++ DLL's are provided**
 - **Intelligent Servo/Stepper Protocol (MA-ISP.pdf)**
 - **Intelligent Servo/Stepper ASCII Protocol (MA-ISAP.pdf)**
 - **Intelligent Motion Language (MA-IML.pdf)**


5.1.3 Summary of Functions

5.1.3.1 Enable Input (Reset)

The Enable input to the drive is leading-edge triggered only. Any reset-able faults will be cleared on the rising-edge of the Enable input. See ToolPAC Help menus for proper configuration of the unit for your application. See section [Enable Input \(J1\)](#) for additional information.

5.1.3.2 Motor Over Temperature (OT) Input

Motor over-temperature inputs are provided on the feedback connector, J3 on the PD24xxD drives. This input is wired to a N.C thermal switch internal to the motor (Z < 1k means motor is OK). If a motor **OT** sensor is to be utilized in an application, then ToolPAC parameter Check Motor OT must be set to **Active** for the PD24xxD to monitor this input.

NOTE	
	<p><i>The ADC2+ and ADC2- inputs (pins J3-14 and J3-13) are factory configured as an analog input.</i></p>

5.1.3.3 Drive-OK/Brake Output

The factory default setting is as Drive-OK output to allow wiring into the applications safety interlocks. The Drive-OK/Drive-OK must be defined to operate as a Brake output via the I/O Configuration Wizard prior to being utilized. The Brake output is only wired in applications where a brake is being utilized to maintain the motor's position when the motor is not energized. If the drive faults the BRAKE output will be disabled. The user has NO software control over this output. See section [3.7.5 Drive-OK/Brake Output \(J1\)](#) for additional information.

5.1.3.4 High Speed Inputs

The HSI1 and HSI2 inputs are utilized for applications requiring Follow Mode or the Advanced Electronic Gearing Capabilities of the **PD240xDi-001-E** and **PD240xDi-001-EI**. Please review the section on [Digital HSI inputs \(J1\)](#).

5.2 Applying Power

5.3 Amplifier Configuration

5.3.1 General Description

ToolPAC supplies the tools necessary to configure the drive to your application. The screen images and descriptions provided in this section are intended to highlight some of the major features available within the software.

[ToolPAC Wizards](#) for Setup, Tuning and **I/O Configuration** are provided to step the user through the basic configuration of the system.

A **dual trace scope** is provided to allow the user to capture data on the commanded and actual motor motion.

ToolPAC provides **HELP** on commands, parameters, features and functions available within the 2400 Series product line.

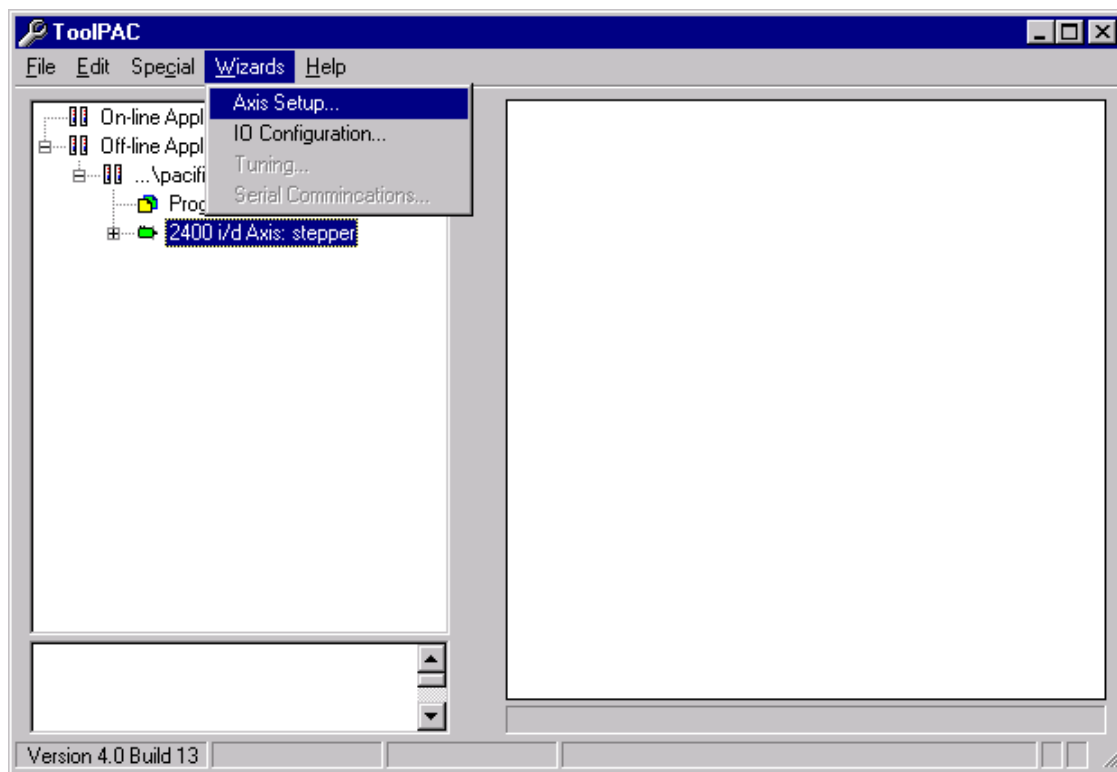
Review this section to familiarize yourself with the features available prior to programming the unit. This will save time in the startup of a new application.

5.3.2 Wizard: Axis Setup

The amplifier configuration is done primarily via the Axis Setup Wizard. The Setup Wizard will configure all of the system parameters necessary to allow you to generate motion within your selected application. **The Setup Wizard should be the first screen accessed when configuring a new drive.** This wizard will utilize the information provided to create stable current loop tuning parameter IKP.

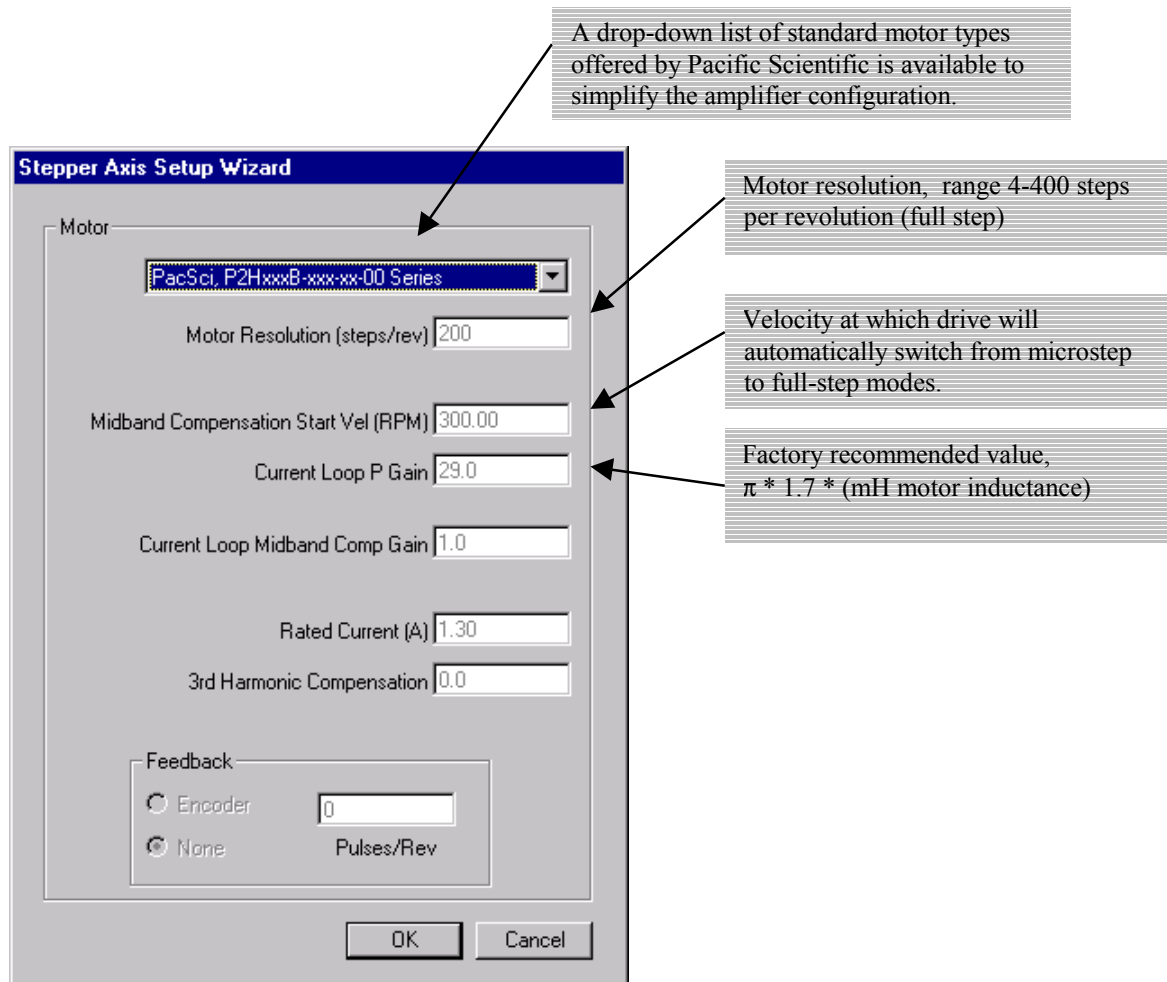
The customer is required to have the minimal information about the motor type: full step resolution, IC, Inductance (mH) feedback type, etc. Examples of these screens are shown below.

Figure 5-1 ToolPAC Wizards



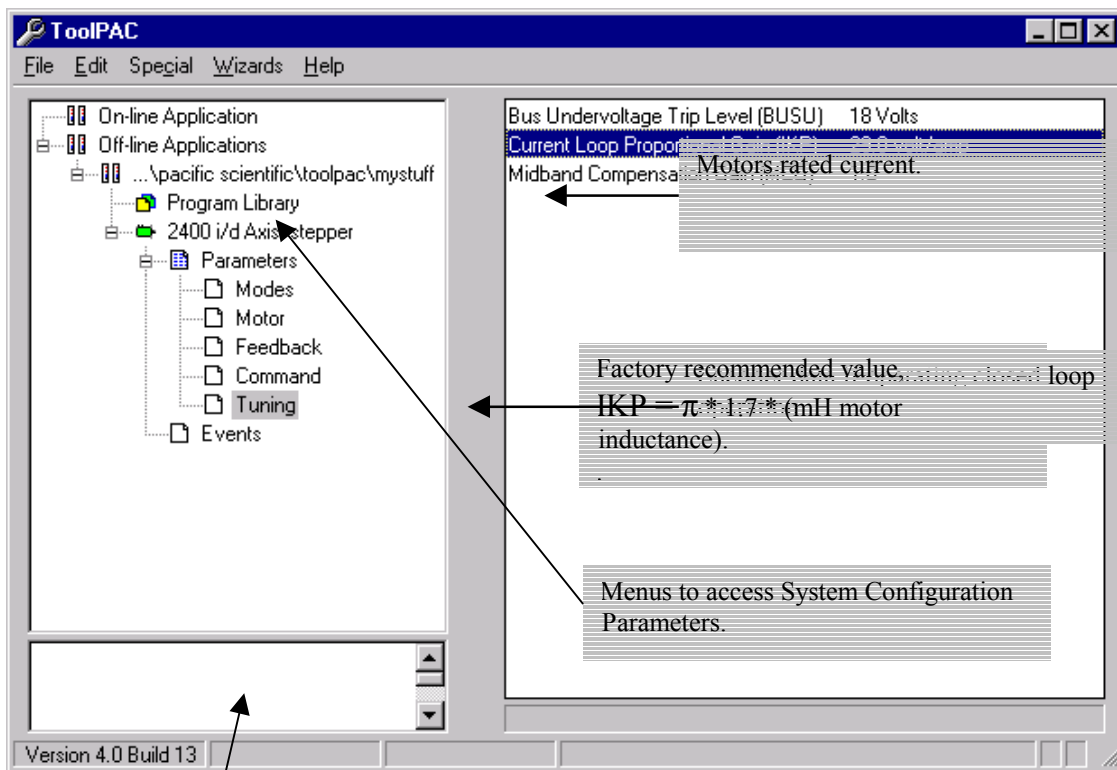
All versions of the PD24xxD Series can be configured for two or four phase step motors. The user is required to provide minimal information about the motor type, the application mode, and the command source.

Figure 5-2 ToolPAC Wizard – Stepper Axis Setup



5.3.3 Digital Current loop tuning procedure

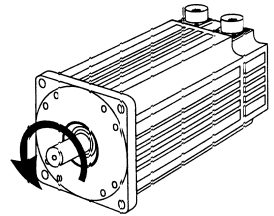
The PD24xxD Series is a 100% digital stepper drive, (the exception are two analog sensors for voltage and current) thus it is necessary for the user to "Tune the Current loop", parameter **IKP**, prior to operating the system. **This procedure MUST be followed when operating a motor that is not listed in the [ToolPAC Wizard – Stepper Axis Setup](#), to prevent damage to the motor and to provide optimal performance.**



<Double-Click> for a menu of options.
Select Arbitrary Expression and enter IFBK.

The tuning procedure is as follows:

- 1) Put drive in Velocity mode, digital command. (Menu: Parameters/Modes)
- 2) If using a Closed loop operation, temporarily set the Drive Mode to Open-Loop. (Menu: Parameters/Modes)
- 3) Set **IKP** to low value ($\leq \pi * 1.7 * \text{mH motor inductance}$).
- 4) Put variable **IFBK** up in ToolPAC Monitor Window
- 5) Enable drive. Incrementally increase **IKP** until **IFBK** is about 95% of **IC**. At this point, the current loop gains are set properly. *Be sure to record values for future reference.* If a high frequency noise is coming from the motor or IFBK is greater than IC, please reduce the value of IKP.
- 6) Disable drive.
- 7) Enable drive and verify the direction of rotation to be **CCW** as viewed from the motor shaft end. Disable and correct motor wiring if the direction of motor rotation is not **CCW**. You have now verified that the motor wiring is correct. *Note that feedback is not being utilized at this time, (DM = Open Loop). If you desire to have the motor rotate in the CW direction for positive motion, change the A+/A- motor leads. Be sure to record wiring for future reference.*
- 8) Disable drive. The drives current loop parameter IKP is now set properly.
- 9) Change the Drive Mode back to the proper setting for the test motor. See item #2 above.
- 10) If you will be operating in a closed loop application with an encoder for feedback, proceed with verification of feedback wiring

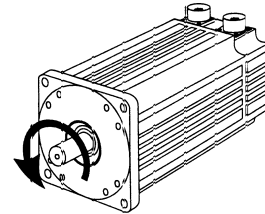


5.3.4 Feedback device and wiring verification

If using the stepper system in Open Loop mode then you may skip this section.

Please follow the steps under [Digital Current loop tuning procedure](#) to verify motor wiring and current loop parameters are correct before proceeding.

- 1) Disable the drive.
- 2) Set the Drive Mode to Closed-Loop. (Menu: Parameters/Modes)
- 3) Set the value of EPPR to be the quadrature value of encoder counts per revolution. (Menu: Parameters/Feedback)
- 4) Put the **Motor Velocity** and **Feedback Position** in the ToolPAC Monitor Window.
- 5) Manually rotate the Motor CCW and verify that the motor velocity is positive. Note in step #7 under Digital Current Loop Tuning, if you have decided to make the positive direction CW.
 - If the encoder is counting positive for a positive motion direction *If not positive velocity, then the Encoder is wired backwards, swap the B+/B-wires.*



At this point you have completed the procedures for determining the proper motor wiring, feedback wiring and drive configurations. You may now complete configuration of the unit for your chosen application; Velocity, Position, Step/Dir, etc. **We suggest that you document the motor and feedback wiring and print out a record of the parameter settings for future reference.**

5.3.5 Relevant Motor Parameters

Below is a listing of relevant motor parameters necessary for a proper configuration of a stepper system.

Table 5-3 Step Motor Parameters

Step Motor	
	Relevant Motor Parameters
	DM: Drive mode; Open Loop or Closed Loop with encoder feedback
	FEED: motor feedback device: Encoder
	FSTV: full step velocity (RPM)
	IC: motor continuous current
	IKP: drive current loop tuning parameter
	MCG: midband compensation gain
	MCSV: midband compensation start velocity
	MRSN: motor resolution
	PET: motor position error tolerance
	PDD: power down delay (time)
	PUD: power up delay (time)
	SPP: standing power percentage
	THC: third harmonic compensation
	Feedback Parameters
	EPPR: encoder pulses (edges) per motor revolution
	FBF: feedback filter frequency (usually 500 – 2048Hz)

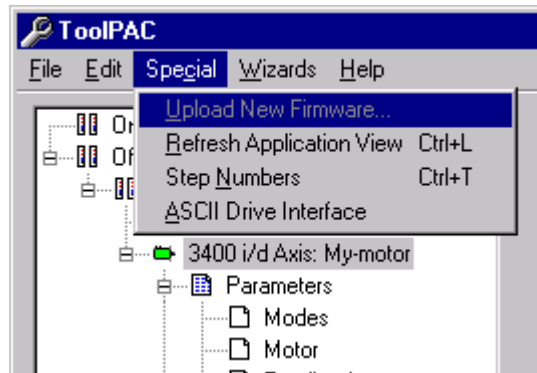
5.3.6 Update New Firmware

A special feature of the PD24xxD series drive is the ability of the user to upgrade the FLASH Memory with new firmware. This feature is useful for performing field upgrades to units as software enhancements or custom commands are made available.

Functions are available when the mouse is placed on the green motor icon. When in the connected application view, the user may refresh the connected application view (reread the data from the connected application from the drive) or Upload New Firmware.

WARNING	
	<p><i>When uploading new firmware, the user is prompted to observe safety precautions to prevent accidental damage to the application. The amplifier will be disabled while the firmware is being copied into flash memory. POWER MUST NOT BE INTERRUPTED DURING FIRMWARE UPLOAD!</i></p>

Figure 5-4 Upload New Firmware



6. Maintenance/Troubleshooting

This section summarizes the status and error codes that may be displayed on the PD24xxD Series Digital Microstep drives. It also makes recommendations for troubleshooting and fault recovery procedures.

6.1 Status LED

A status Red/Green LED is located on the front of the PD24xxD Series drive to provide the user with information on the current status of the drive. If a fault condition exists that prevents the unit from performing its function, the status Red LED will indicate that an error is present.

LED	Status
Green	Drive OK
Red	Drive in fault condition
OFF	No DC power to unit

6.2 Fault Recovery

Software faults are cleared on the leading-edge of the ENABLE input. Hardware faults are cleared ONLY after the condition has been cleared and the ENABLE input is activated.

6.3 Trouble Shooting

Motor does not move

- Check to see if drive is powered-up or if the module's Status LED is RED. LOOK at the Fault history available in the ToolPAC STATUS screen!
- Verify that the motor current is set properly, (refer to Installation Manual) and that an acceleration and velocity command other than zero was executed prior to the move command.
- Verify that the Motor and Current loop and velocity loop parameters are set properly.
- Verify that hard-limit input is not active.
- Verify motor is connected. Check parameter **IFBK** in the monitor window.
- Verify load is not jammed (brake released)
- Verify motor wiring for loose connections, possible shorts and verify module and I/O is correctly wired.

Module Status LED – solid Red

- Power up the module without the motor connected. If the Status LED changes to **GREEN**, it is a good possibility that the motor is bad or the DC power supply is under sized.
- Verify that you are supplying the correct DC voltage to the drive.
- Verify motor Check wiring for loose connections, possible shorts and verify module and I/O is correctly wired.
- Verify that the Motor and Current loop and velocity loop parameters are set properly.

Communicate Errors

- Check communication cable for proper wiring or a loose connection.
- Confirm that switch setting for communication match the communication type. (RS-232, RS-485, etc. Refer to Installation Manual)
- Verify that the correct PC communication port is selected in Axis Configuration.

7. Appendices

The information contained in the following appendices is provided for reference purposes for the proper selection of system components.

7.1 Electrical Procedures


NOTE	
	<p><i>Read this section before proceeding with any system wiring!</i></p>

7.1.1 Wiring Precautions


Grounding

To minimize the effects of electrical noise, a systematic rack, panel, and system grounding procedure should be followed. Review Section 3.1, [Shielding and Grounding of Electrical Panels](#), for pertinent information.

The panel or rack in which the equipment is installed should provide a Single-Point Ground, hereafter referred to as SPG, stud, or bar. The SPG should be welded or bolted inside the enclosure and be electrically continuous with the mounting assembly. The panel's SPG should, in turn, be tied by a 1-inch (25mm) braided strap to a good Physical Earth (PE) ground, to which other panels, cabinets, and the controlled machinery are similarly grounded.

NOTE	
	<p><i>Use ground straps made of 1 inch (25 mm) silver tinned flat copper braid to connect cabinet doors to enclosures, the first sub-panel to the enclosure, and each sub-panel to the next.</i></p>

The PE ground could consist of a copper rod driven into the earth (a grounding electrode), a building column which is embedded in the earth, or another mass which has been determined to be at a true earth ground potential. A copper rod driven into the earth is the recommended method.

CAUTION	
	<p><i>Use Star grounding arrangement. Chain grounding or daisy-chain arrangements should not be used.</i></p>

The system ground and equipment grounds for other units on the panel, if any, should be *individually* wired to the SPG, utilizing 10 AWG (5.5 mm²) stranded copper wire.

In any system connection to a physically separated piece of equipment or another part of the control system, careful attention should be given to the avoidance of ground loops. Ground loops can cause erratic system operation.


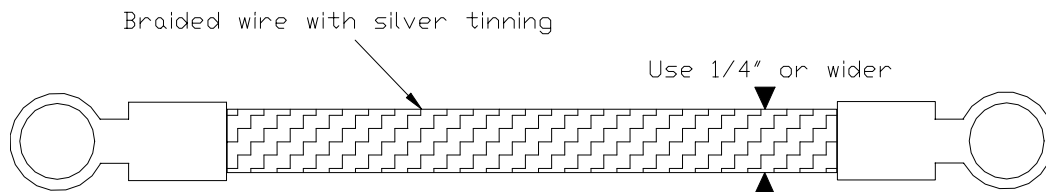
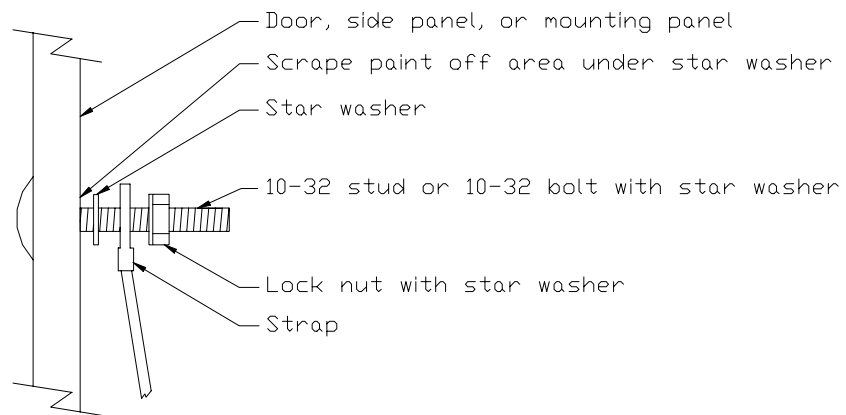
NOTE	
	<p><i>Where electrical codes call for the typical green safety ground wires, use them in addition to any ground strap suggested in this guide.</i></p>

Figure 7-1 Recommended Ground Strap




When mounting any unit, be sure to remove paint from the unit and the mounting surface to obtain metal-to-metal contact. Use a serrated washer (star washer) to improve the connection. If in doubt use a ground strap to ensure good connection between the unit and the panel.


Figure 7-2 Recommended Ground Strap Mounting Technique



Wiring and shielding

Wired connections to the system are of two categories: high power wiring and low power control signal wiring.

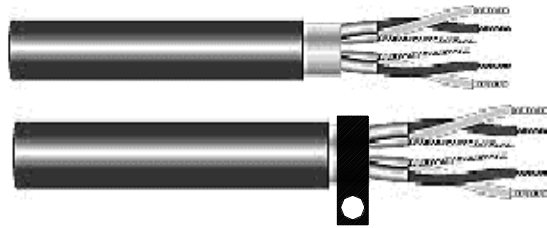
NOTE	
	<p><i>High power wiring and low power DC signal wiring within the panel or enclosure should not share wire raceways and should be separated by a minimum of 12 inches (305 mm) for parallel runs. If wire paths should cross and touch, they should do so only at right angles to each other.</i></p>

NOTE	
	<p><i>Provide separate wire ways for main AC, low power AC, high power DC, and low power DC.</i></p>

Low power DC signal level wiring (logic and analog signals) leaving the panel/enclosure on which the system is mounted should run in separate metallic conduits or channels from AC power, motor power conductors, or other power equipment circuits.

The analog and High Speed Inputs of the **PD24xxD** Series Drives are differential inputs. These differential inputs should be driven via the users differential outputs and should be connected with individually shielded twisted pairs to provide the best possible noise immunity.

All control signals interfacing to the system must be wired with twisted cable, with at least one twist per inch, to minimize inductive noise coupling. Encoder wiring must be wired with individual twisted shielded pairs, using cable equivalent to those listed in [Table 7.1](#) below.



"P" Clamp cable shield
to pannel ground
(remove paint for direct
mechanical contact)

Table 7.1 Suggested Wire

Wire Selection Table		
Purpose	Description	Manufacturer
Signal	22 AWG, 2 Pair, Shield & Drain	Alpha 5482C
Signal	22 AWG, 3 Pair, Shield & Drain	Alpha 5484C
Signal	24 AWG, 2 Pair, Shield & Drain, Low Capacitance	Belden 8102
Signal	24 AWG, 4 Pair, Shield & Drain, Low Capacitance	Belden 8104
Signal	24 AWG, 8 Pair, Shield & Drain, Low Capacitance	Belden 8108
Signal	28 AWG, 2 Pair, Shield & Drain, Low Capacitance	Alpha 3492C/Belden 8132
Signal	28 AWG, 4 Pair, Shield & Drain, Low Capacitance	Alpha 3494C
Signal	28 AWG, 8 Pair, Shield & Drain, Low Capacitance	Alpha 3498C
Ground Strap		

Unused conductor pairs should be grounded to the SPG at *one end only* to avoid a ground loop. Ensure that any interface cable shield is individually wired to the appropriate cable shield termination point. Shields should be insulated from ground and all other electrostatic shields along the length of the run. *The ungrounded end should have the shield cut back and taped to prevent contact with other conductors or conduits.* If a twisted shielded pair must be broken (at terminal boards or connector pairs), the unshielded length is not to exceed 2 inches (50 mm) and carry the shield through the connection on a separate pin or terminal.

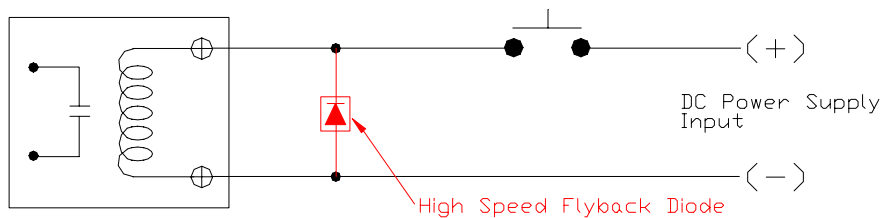
Secondary power (logic commons), if provided by individual equipment, should be directly wired from their source to the SPG utilizing 12 AWG (3.5 mm²) wire.

Noise Source Suppression

It is necessary to suppress all relay and contactor coils, both AC and DC. Noise suppressors can be purchased locally and are an effective, inexpensive method of eliminating potential noise problems in the system.

Any connection to an inductive load (such as a DC coil) should be terminated with a high-speed flyback diode to absorb the high-energy spikes caused when the coil is switched off and its magnetic field collapses. Such diodes should be connected close to the inductive load to provide suppression at its source, across the coil with the reverse polarity to the voltage that powers the coil. The amount of energy absorbed is considerable and the diode must be rated accordingly.

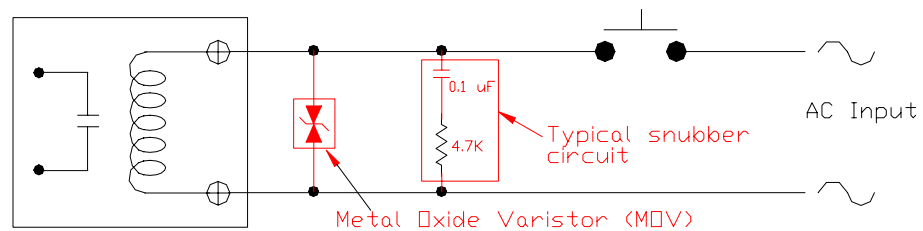
Figure 7-3 Suppression - DC Relay



Any connection to an inductive load (such as an AC coil) should be terminated with an RC snubber circuit or metal oxide varistor (MOV) to absorb the high energy spikes caused when the coil is switched off and its magnetic field collapses. An RC snubber (4.7k ohm resistor in series with a 0.1 μF capacitor) placed across an AC coil will effectively suppress noise generation. Such suppression devices should be connected close to the inductive load to provide suppression at its source. The amount of energy absorbed is considerable and the suppressor must be rated accordingly.

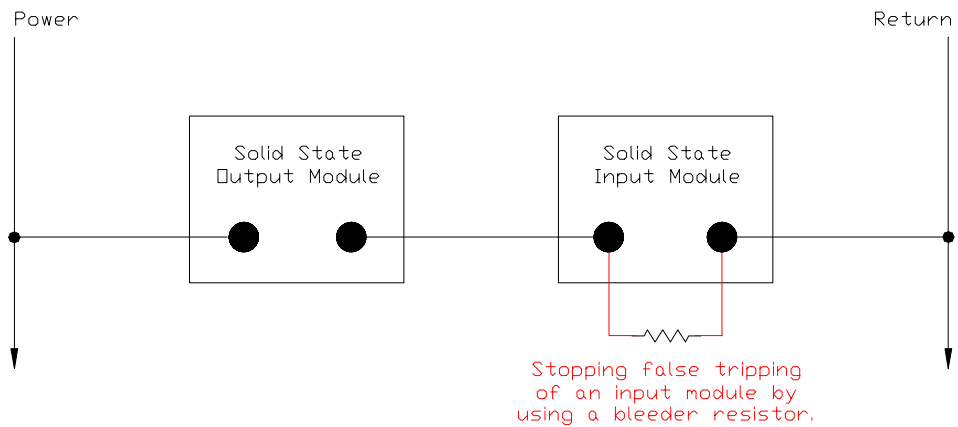
Metal Oxide Varistors (MOV) are less effective than an RC Snubber for noise suppression and tend to degrade over time.

Figure 7-4 Suppression - AC Relay



Solid state inputs that are driven from solid state outputs should have a bleeder resistor across the input to provide a path for the output's leakage current when the output is off. This will help prevent false tripping on the input when the output is off. This is extremely important when utilizing the high-speed inputs or when utilizing Solid State Devices on the outputs of the 2400. The resistor's rating depends on the output device's leakage current and the input device's OFF voltage.

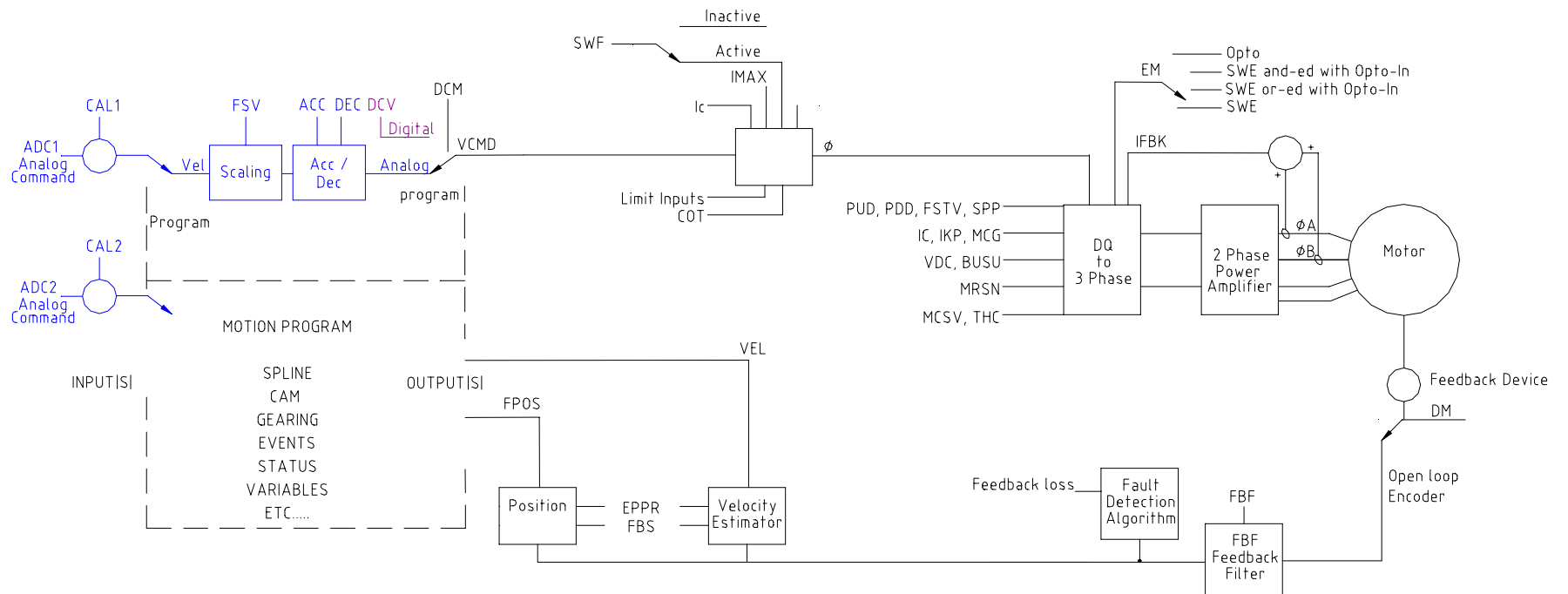
Figure 7-5 De-coupling - SS Relay

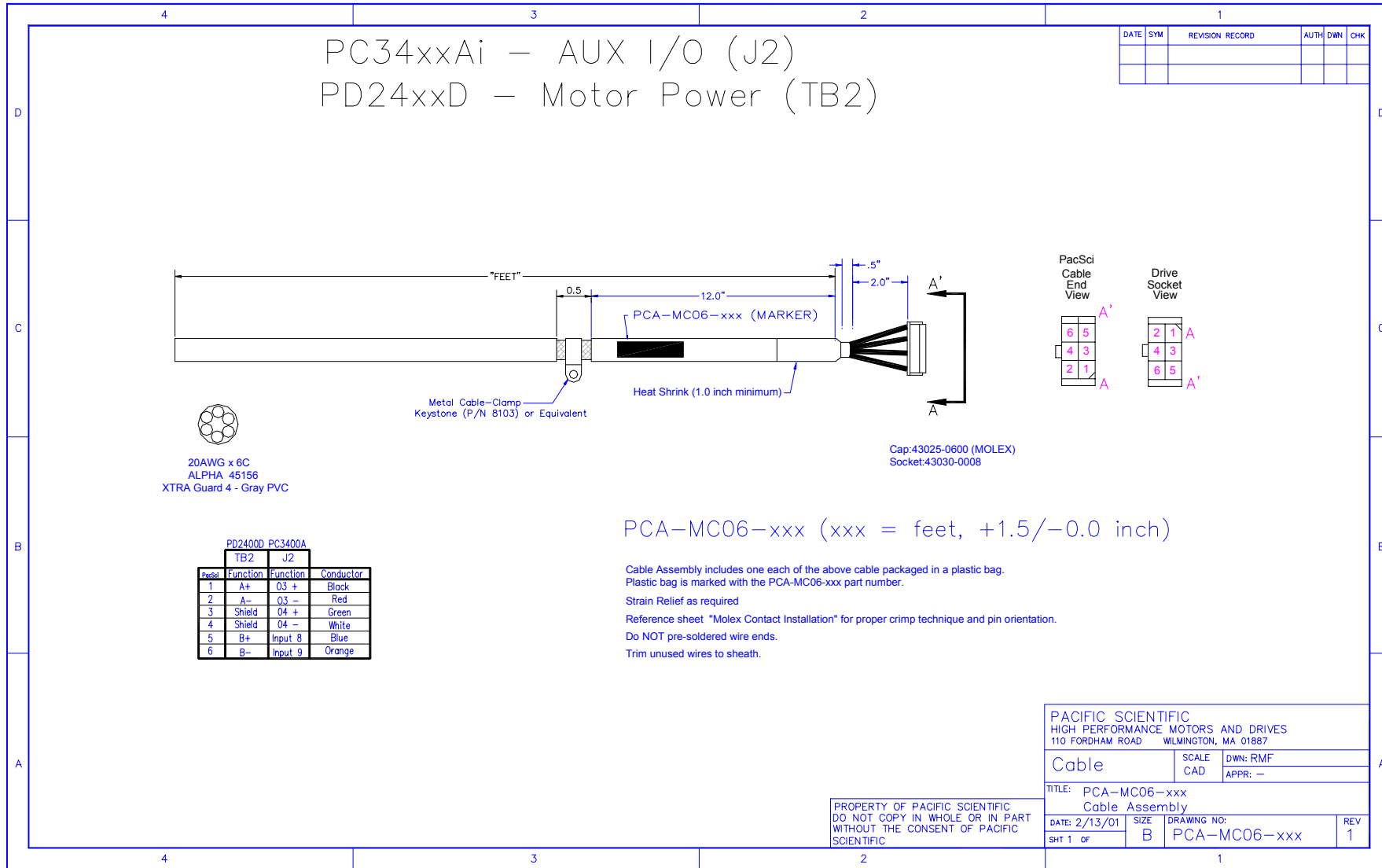


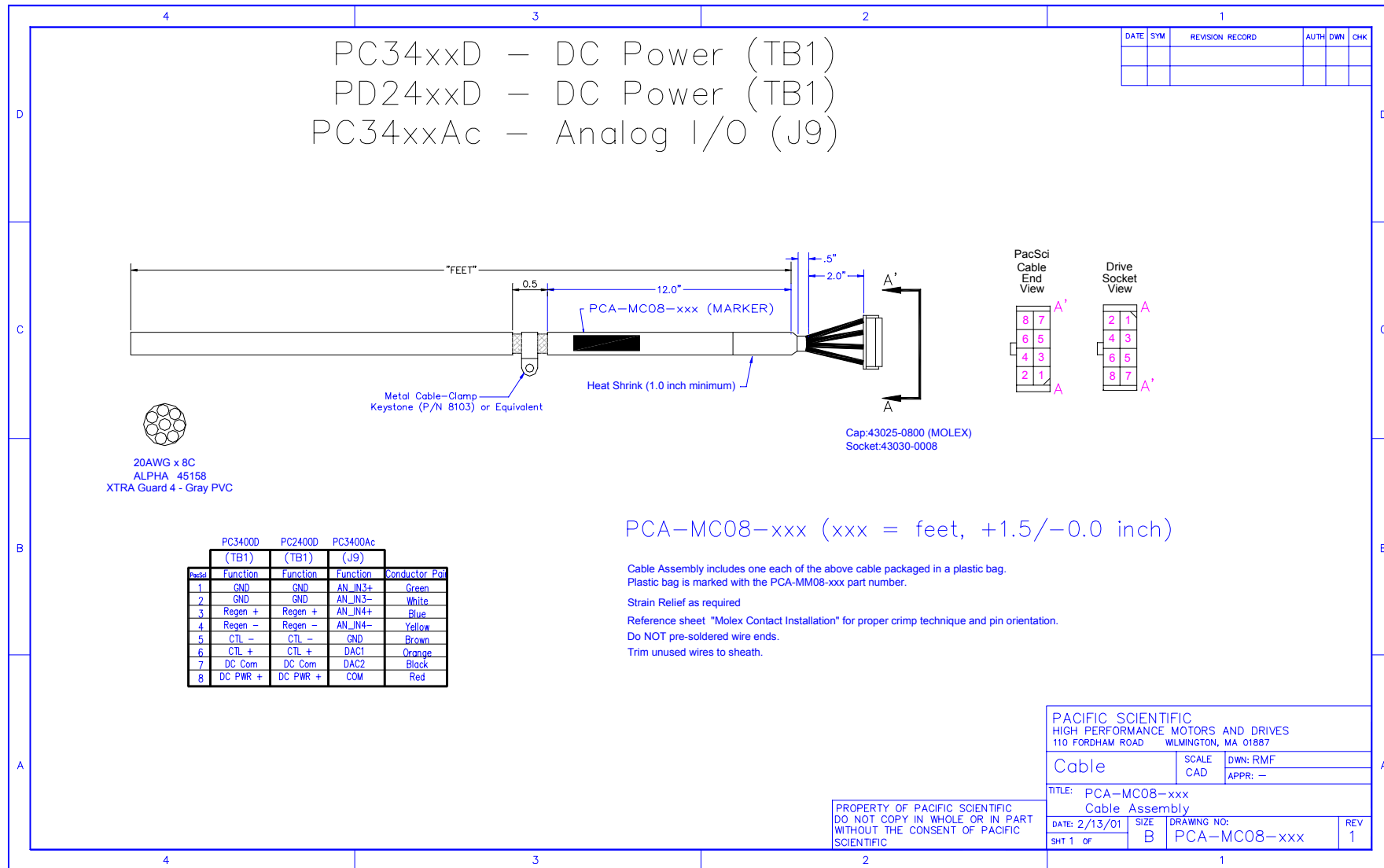
7.2 Relevant Engineering Prints

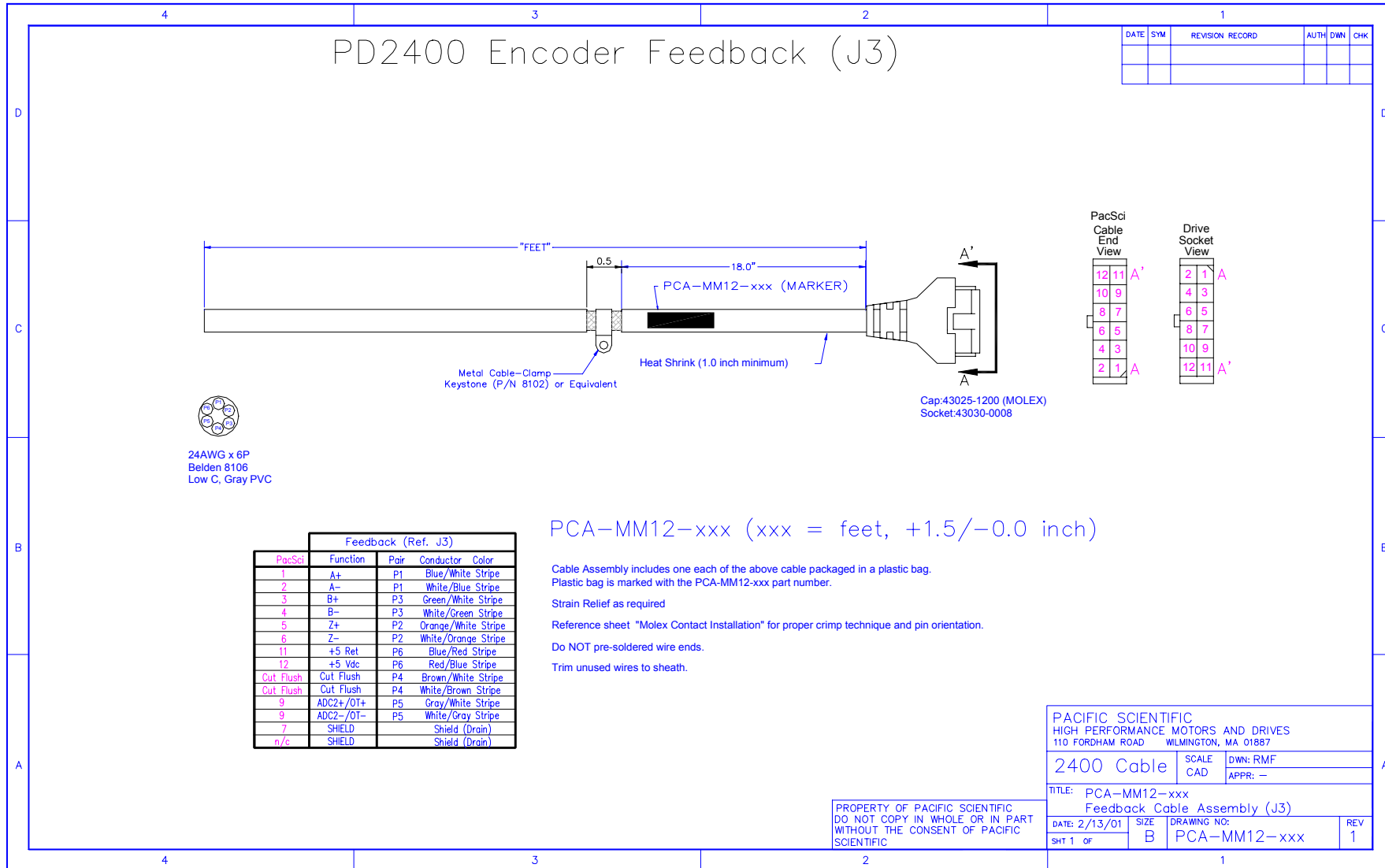
In this section we present a number of system interconnect drawings to be utilized as guidelines for a generic installation.

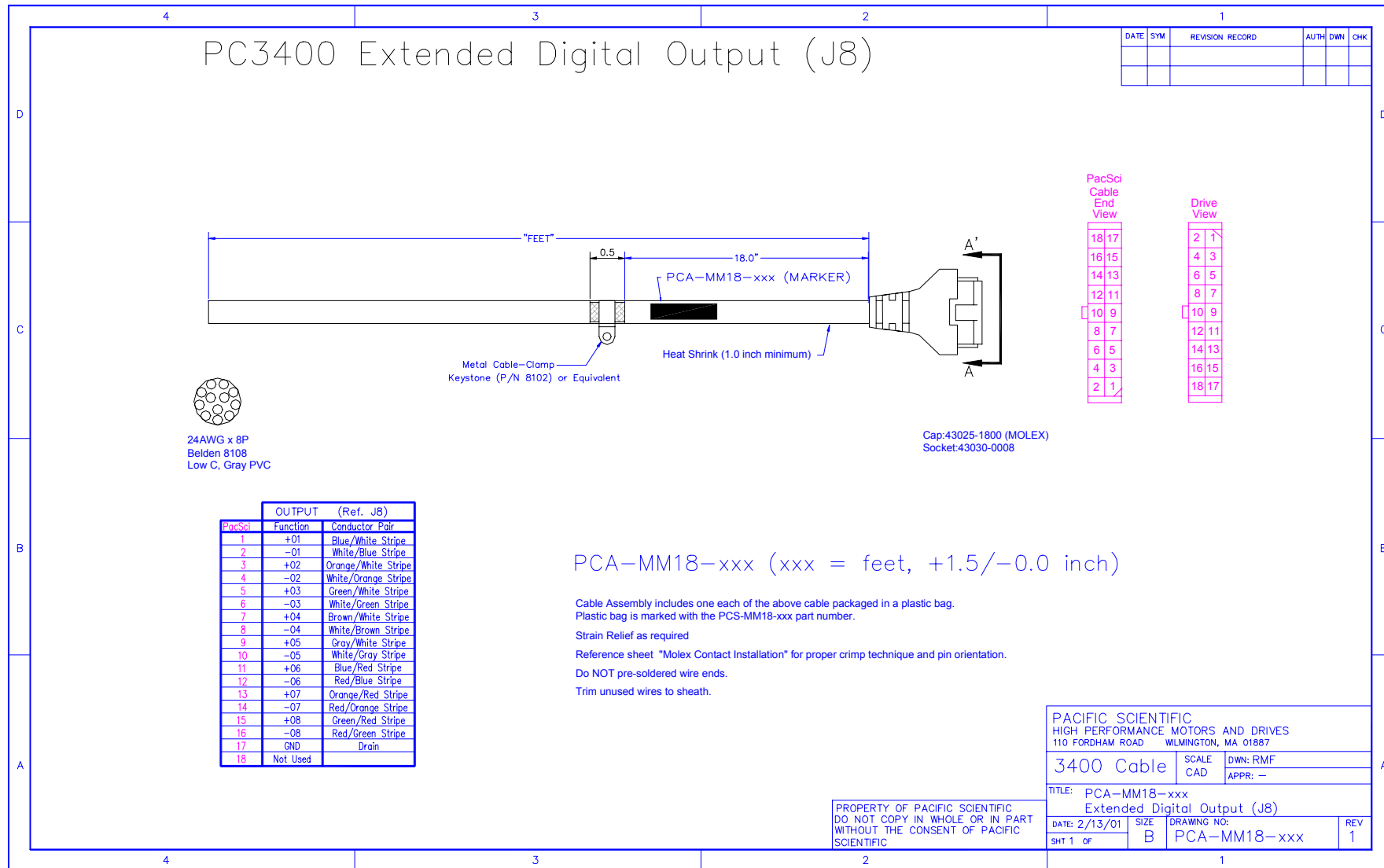
Figure 7-6 Function Block Diagram

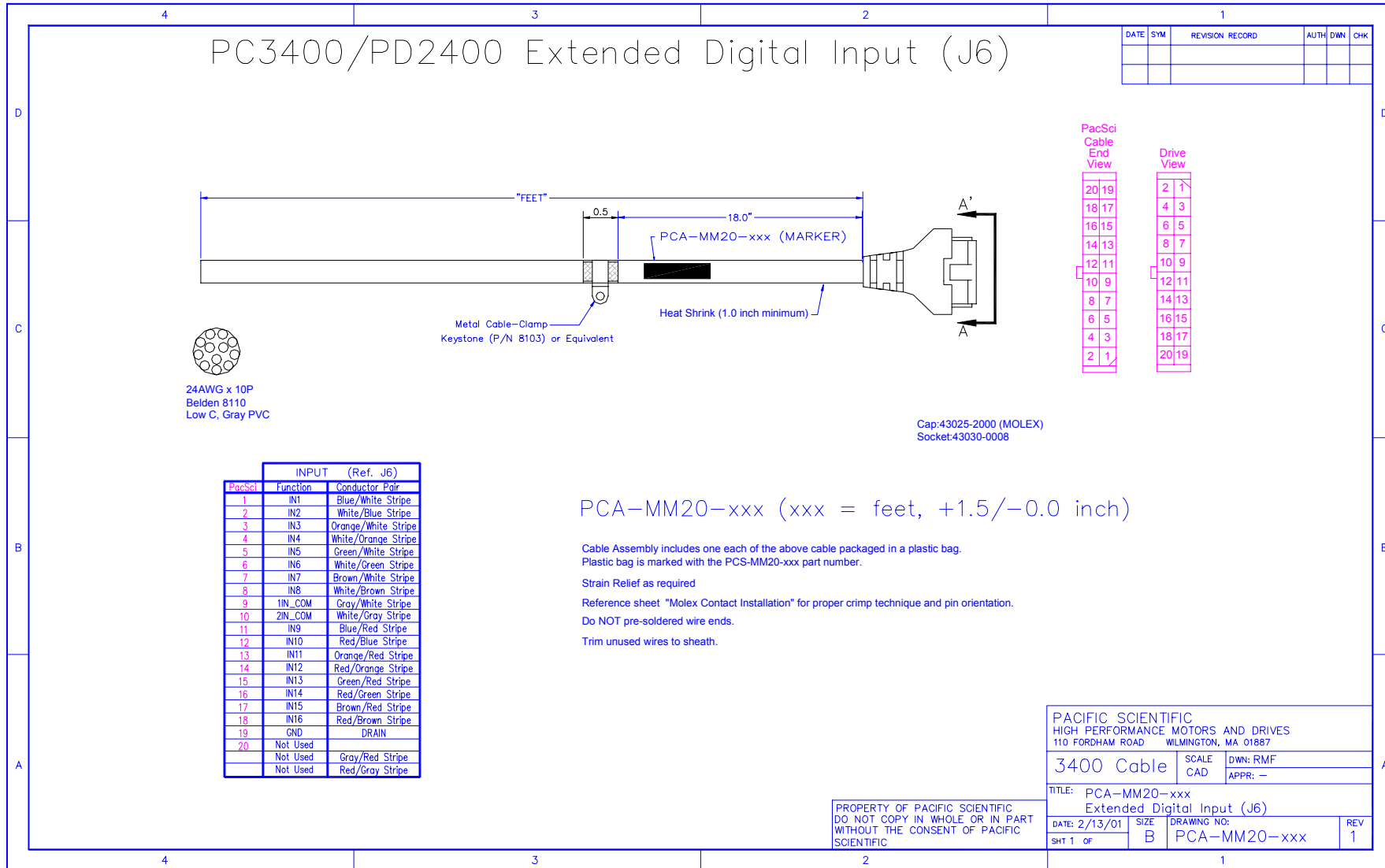


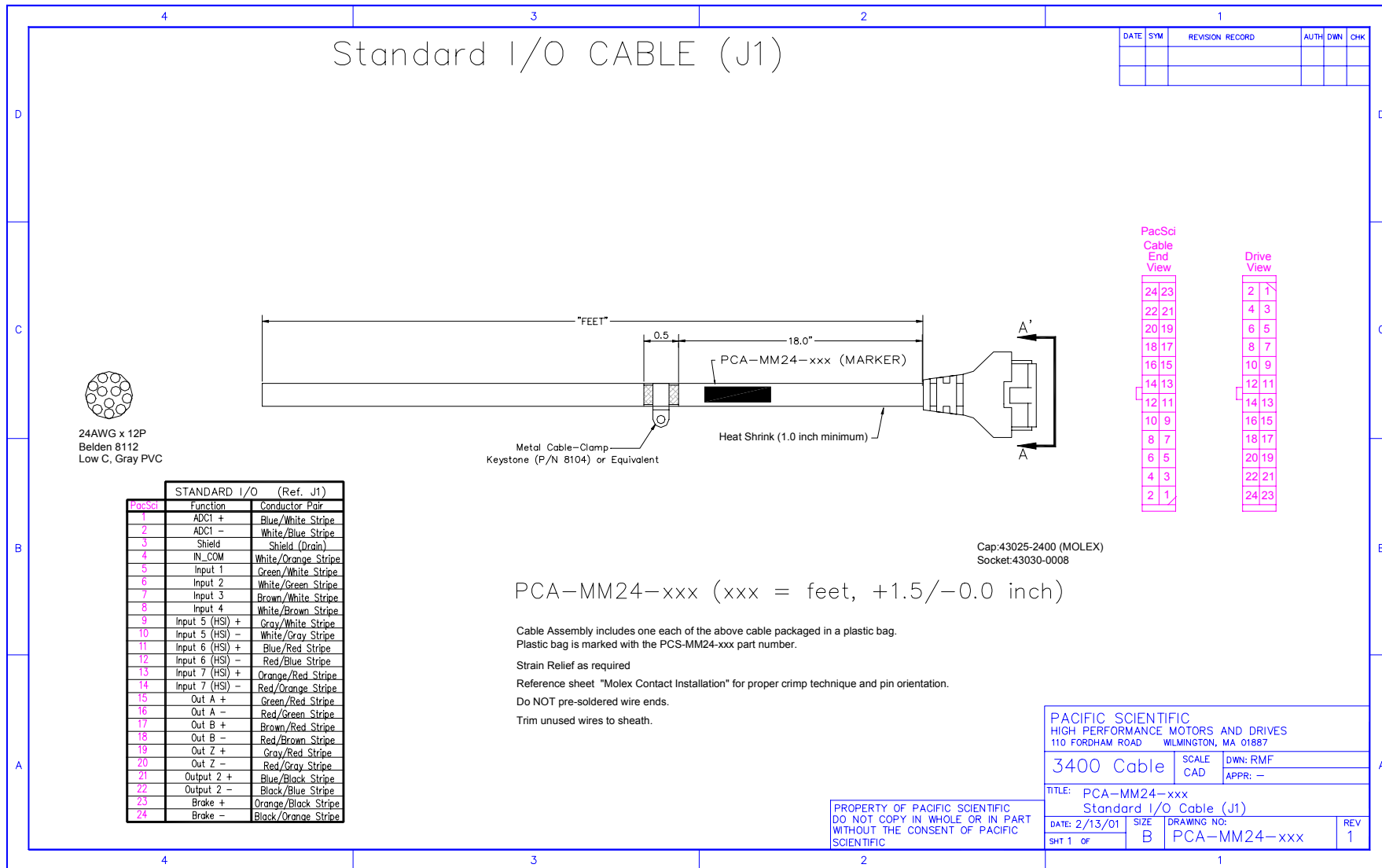


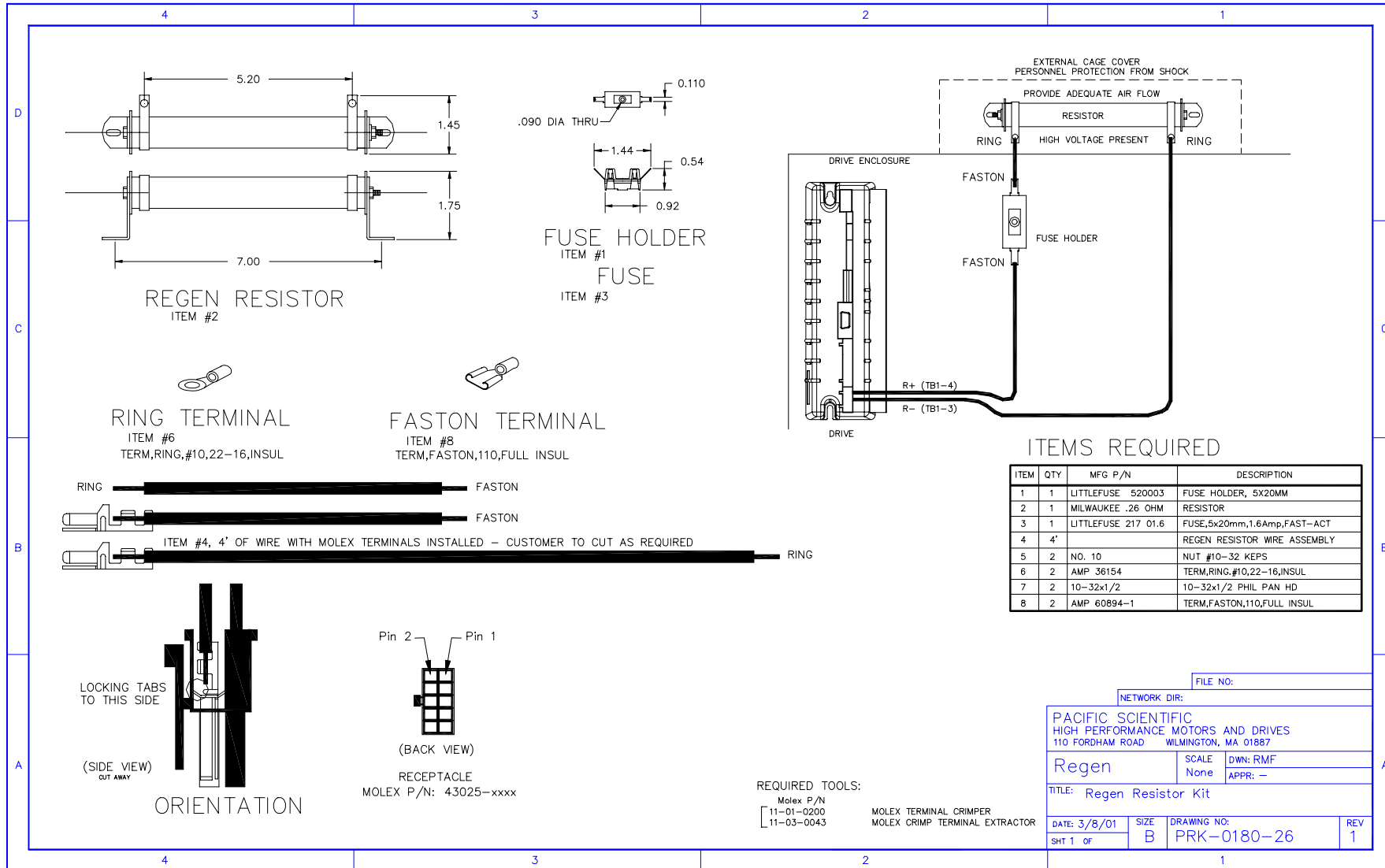


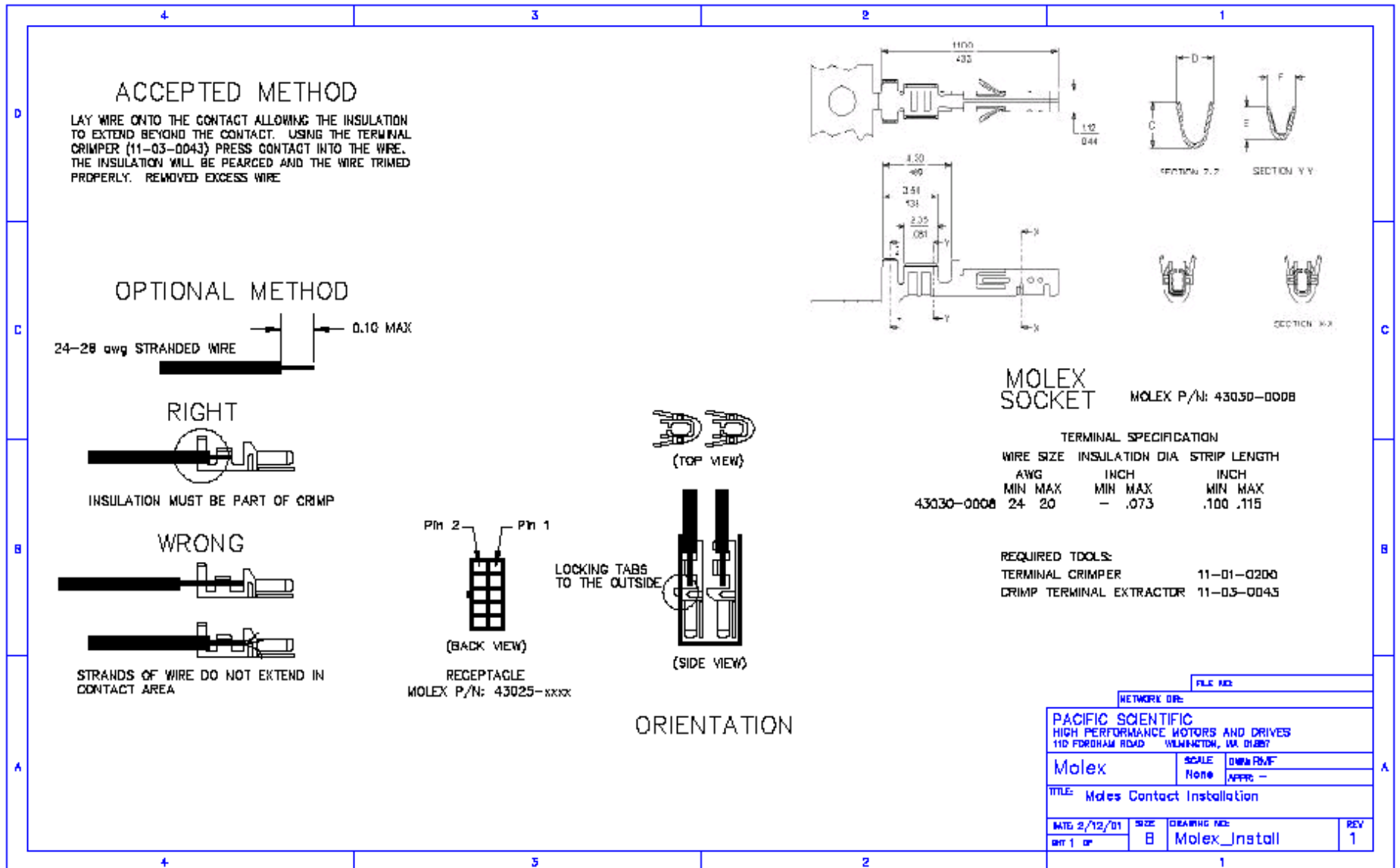


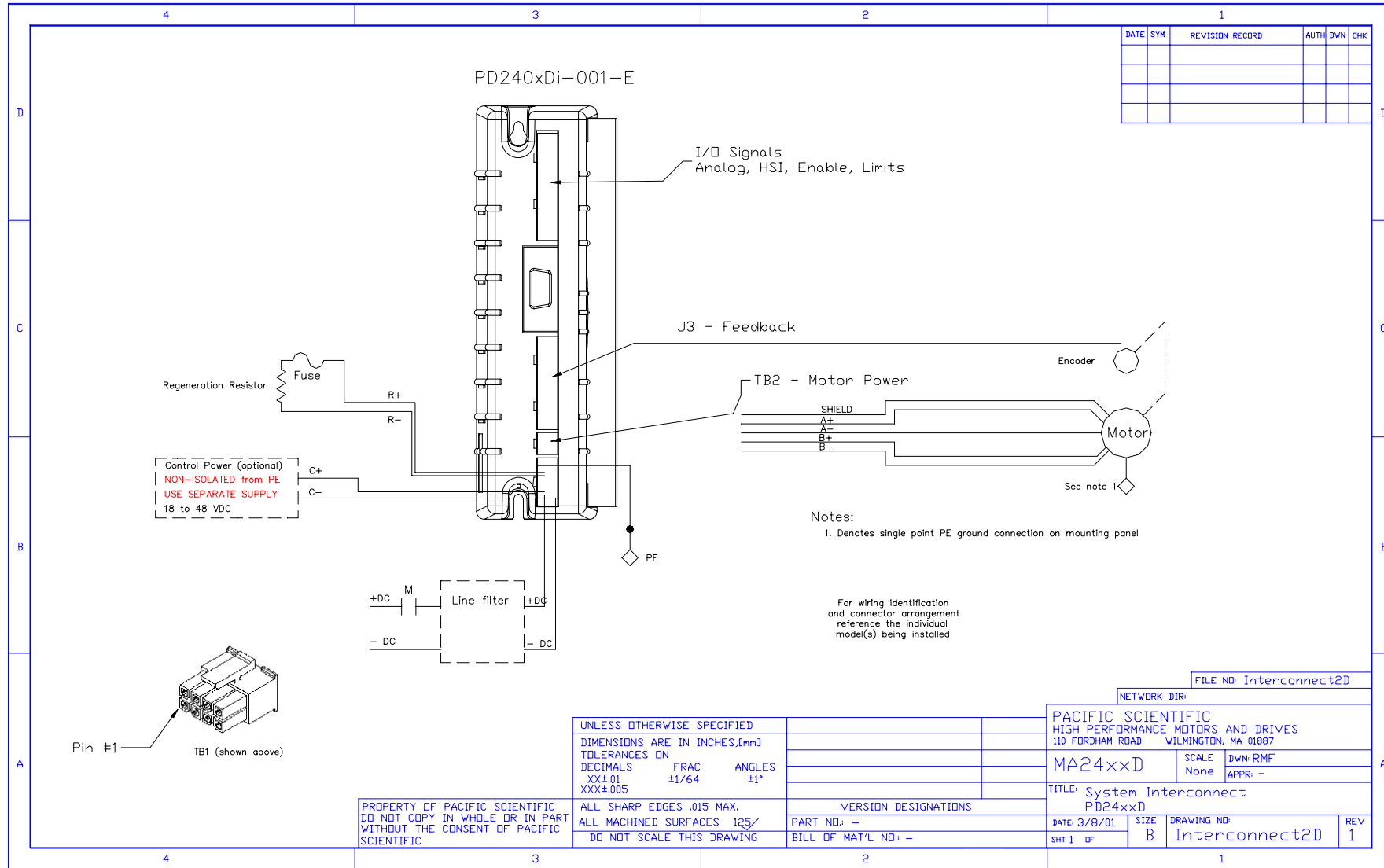












7.3 Options and Accessories

7.3.1 Accessories

Table 7.2 System Accessories

ToolPAC	ToolPAC SOFTWARE, CD ROM (includes manuals)
MA24xxD	PD24xxD Family Hardware Reference Manual
MAToolPAC	ToolPAC Software Reference Manual
PCA-MC6-006	CABLE ASSEMBLY, EXTENDED I/O, 6 POS, 6 FT (J2)
PCA-MM12-006	CABLE ASSEMBLY, FEEDBACK, 12 POS, 10 FT (J3)
PCA-MM18-006	CABLE ASSEMBLY, EXTENDED OUTPUTS, 18 POS, 6 FT (J8)
PCA-MM20-006	CABLE ASSEMBLY, EXTENDED INPUTS, 20 POS, 6 FT (J6)
PCA-MM24-006	CABLE ASSEMBLY, I/O, 24 POS, 6 FT (J1)
PRK-0180-26	REGEN RESISTOR KIT
RS-232-5600	CABLE ASSEMBLY, DB9, RS-232, 6 FT
PTK-3MD-001	HAND CRIMP TOOL, MOLEX 3mm/EXTRACTOR
	HAND CRIMP TOOL, MOLEX 3MM (Molex 11-01-0200)
SK-240xD	SHIP KIT FOR PD240xD(d/i)-001-E STEPPER (includes the following)
102-3MD-0008	Pins, Gold, Loose, 20-24 AWG (Molex 43030-0008)
102-3MD-04	Receptacle, 4 pos, 3mm, Dual Row (Molex 43025-0400)
102-3MD-08	Receptacle, 8 pos, 3mm, Dual Row (Molex 43025-0800)
102-3MD-12	Receptacle, 12 pos, 3mm, Dual Row (Molex 43025-1400)
102-3MD-24	Receptacle, 24 pos, 3mm, Dual Row (Molex 43025-2400)
SK-24xxD-1	SHIP KIT FOR PD240Di-001-EI STEPPER (includes the following)
102-3MD-0008	Pins, Gold, Loose, 20-24 AWG (Molex 43030-0008)
102-3MD-04	Receptacle, 4 pos, 3mm, Dual Row (Molex 43025-0400)
102-3MD-08	Receptacle, 8 pos, 3mm, Dual Row (Molex 43025-0800)
102-3MD-12	Receptacle, 12 pos, 3mm, Dual Row (Molex 43025-1400)
102-3MD-18	Receptacle, 18 pos, 3mm, Dual Row (Molex 43025-1800)
102-3MD-20	Receptacle, 20 pos, 3mm, Dual Row (Molex 43025-2000)
102-3MD-24	Receptacle, 24 pos, 3mm, Dual Row (Molex 43025-2400)

7.4 Standards and Environmental Specifications

7.4.1 Environmental Specifications

Operating Ambient Temperature Range	0 to 40 °C
Storage Ambient Temperature Range	-25 °C to 70 °C
Humidity	5% to 95% non-condensing
Altitude (<i>Derate output 2% per 1000 feet above 3300 feet.</i>)	3300 feet
Vibration	According to IEC 68, Parts 2-6
Frequency	10 to 55 Hz
Amplitude	0,075 mm
Cycles per axis (xyz)	10
Frequency sweep	1 octave/minute

7.4.2 Agency Listings / Certifications

North America - UL and UL-C (Canada)

Unavailable at time of printing

European Community - CE Mark

Unavailable at time of printing

