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Part # **MA3400D rev 1**  
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# MA3400D

## PC3400D Family Hardware Reference Manual

### Single axis digital servo amplifier

The **PC34xxD** Series is a new generation of **DC input**, 18-74 VDC, digital servo amplifiers for controlling *Brushless DC* servomotors in position, digital velocity, or current (torque) mode and *Brush DC* servo motors in velocity mode. Units are available in current ratings of 2.5 and 5 amps RMS continuous. **The PC34xxD Series is an OEM product where the user is required to separately purchase; Ship-Kits (connectors), manuals, cables, etc. Please review the section on [Table 7.12 System Accessories](#) when ordering system components.**

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# PREFACE

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You've just purchased the finest Servo Controller(s) in its class. The PC34xxD Series servo amplifiers are designed to provide reliable long-term and economical operation in demanding field environments. Without exception the PC34xxD Series Digital Servo 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. **The PC34xxD 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.**

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The **PC34xxD** Series is a new generation of DC input, 18-74 VDC, digital servo amplifiers for controlling **Brushless DC** servomotors in position, digital velocity, or torque (current) mode and **Brush DC** servo motors in velocity mode. Units are available in current ratings of 2.5 and 5 amps RMS continuous. The product series includes three product families: the **PC34xxDd-001-E**, a **Digital** servo drive, the **PC34xxDi-001-E**, an **Intelligent** servo drive and the **PC34xxDi-001-EI**, an **Intelligent** servo drive with extended IO. See section [1.2 Model Designations and Specifications](#) for additional detail. The **PC34xxD** product series supports Hall only (Trapezoidal Commutation), Comcoder or Hall/Encoder for (Sinusoidal Commutation) or Tach feedback. Each model of the PC34xxD Series utilizes a space vector control algorithm. All modes of operation offer a PID loop-tuning feature to optimize the performance of the selected servomotor.

Each PC34xxD unit is an amplifier, controller and heatsink integrated into a single standalone package. The compact size and integrated design of the PC34xxD amplifier 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 **PC34xxD** amplifier 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 PC34xxD Series servo 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 PC34xxD 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 servo controller 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 Torque with the ability to accept Step/Dir, Step+/step- and Encoder quadrature in Following mode whereby you are commanding the servo system in a position following mode. Master/slave relationships can be developed from the secondary encoder inputs, providing motion output.
- Distributed Feedback; A mode of operation where a secondary encoder is used to close the Position loop in an application. When using Distributed Feedback you will lose the ability to provide Step/Dir, Step+/Step- or Encoder following as the secondary encoder is wired to these HSI inputs. Thus CAM and Master/Slave relationships are likewise not available.
- 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 **PC34xxDi-001-E** (Intelligent) Series and the **PC34xxDi-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 servo 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. For additional information, please refer to documentation available on our web site at the address shown below.

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

- <http://www.pacsci.com>.
- Complex SPLINE tables of up to 100 data points on the **PC340xDi** (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 **PC340xDi** (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 **PC340xDi-001-EI** has an additional 16 general-purpose digital inputs and 8 general purpose outputs.



## PC3400D Family Hardware Reference Manual

**Revision 1.0** - Initial documentation release.

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# 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.

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

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

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

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# 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 **PC340xD** Series Digital Servo Drives.

The product series includes units of 2.5 and 5 amp RMS continuous ratings. To simplify the use of this Installation User's Guide, we have organized the information into logical sections. In addition, we have created individual sub-sections on each of the **PC340xD** models for information specific to that model. When configuration information is specific to a model of the **PC340xD**, 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**

### **PC34xxDy-001-zz**

**PC34xxD = Servo Drive Family Designation**

**xx = Power Level**

- ◆ 02 = 2.5<sub>ARMS</sub> CONT. @ 40 °C, 5<sub>ARMS</sub> peak.
- ◆ 05 = 5<sub>ARMS</sub> CONT. @ 40 °C, 10<sub>ARMS</sub> peak.

**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**

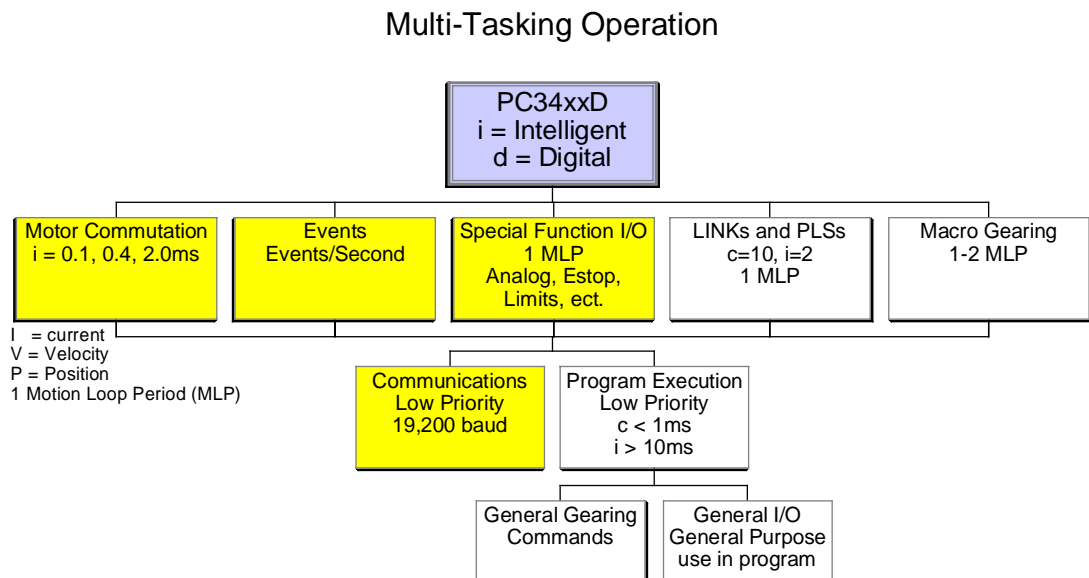
- ◆ E = Encoder Feedback
- ◆ EI = Encoder Feedback with extended I/O (Intelligent only)

**Table 1.2 PC34xxD drive specifications**

Servo Loop Update			
Model	Current	Velocity	Position
PC34xxD	102.4µs	408µs	2.0ms

Model	Processor	Clock	COMM	Serial	Ram	Flash
PC34xxD	Thompson F168	20 MHz	RS-232 RS-422 RS-485	19200	256K	256K

**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 [2]	Secondary Encoder Input	Outputs Digital	Encoder Outputs	Control Methods	Motor Types	Power Output Cont. Watt				
PC3402Dd-001-E	Hall Only, Encoder Only (diff), Comcoder (hall and diff encoder), Tachometer	2.5/5	18-74 VDC	26 Ohm 180 Watt (1 kW Peak)	30	Two inputs (cmd and tach), +/- 10 VDC, 10 Bit	<b>Total 5;</b> ENABLE, CW, CCW, plus 2 HSI [2]	Utilize the two HSI inputs [2] (2MHz Quadrature)	Drive-OK/Brake, Foldback, Isolated, 5-30 VDC, 50 mA Max	Buffered A, B, Z Differential	Current (torque), Velocity and Step/Dir, Step+/, Quadrature Encoder	Brushless DC, Brush DC	214				
PC3405Dd-001-E		5/10			50	427											
PC3402Di-001-E		2.5/5			30	Two inputs (cmd and tach), +/- 10 VDC, 16 Bit	<b>Total 7;</b> Includes: ENABLE, 3 General Purpose and 3 HSI [2]						Total 3; Includes: Drive-OK/Brake, 2 General Purpose (Isolated, 5-30 VDC, 50 mA Max)	Buffered A, B Differential	Current (torque), Velocity and Step/Dir, Step+/, Quadrature Encoder, external com port and Program	214	
PC3405di-001-E		5/10			50	427											
PC3402Di-001-EI		2.5/5			30	Two inputs (cmd and tach), +/- 10 VDC, 16 Bit	<b>Total 23;</b> Includes: ENABLE, 19 General Purpose and 3 HSI [2]									Total 11; Includes: Drive-OK/Brake, 10 General Purpose (Isolated, 5-30 VDC, 50 mA Max)	214
PC3405di-001-EI		5/10			50	427											

**Additional Features to all models:**

- [1] ToolPAC Configuration Software. Communication via RS-232/422/485
- [2] P2™, Over/Under-Voltage and Over-Current, includes drive 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](http://www.pacsci.com) for additional information.



## 2. Unpacking, Inspection, and Storage

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

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### 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 customer service number described in section [1.4 Customer Service](#) 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 the servo 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. During assembly of our product in a machine, startup (that is, normal operation) is prohibited until the end-product complies with Directive 89/392/EEC (Machine Directive) and directive 89/336/EEC (EMC Directive). The machine manufacturer must prove that the complete system conforms to all relevant European Directives. 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 on .

WARNING	
	<p>When wiring the servo 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. <b>The user is responsible for conforming to all applicable local, national and international codes.</b></p>

### 3.1 Shielding and Grounding of Electrical Panels

Motion control servo 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 servo 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 servo system into your application.

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

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 servo 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	
	<p><b>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.</b></p>





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 DC, 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.
- 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 Amplifier Placement and Installation

The user will install the amplifier(s) into a ventilated, metal industrial cabinet. Dimensions for the amplifier modules are given in [Figure 3-2 PC340xD Series Mounting Dimensions](#). [Figure 3-1](#) shows a typical panel layout for four PC34xxD Series modules.

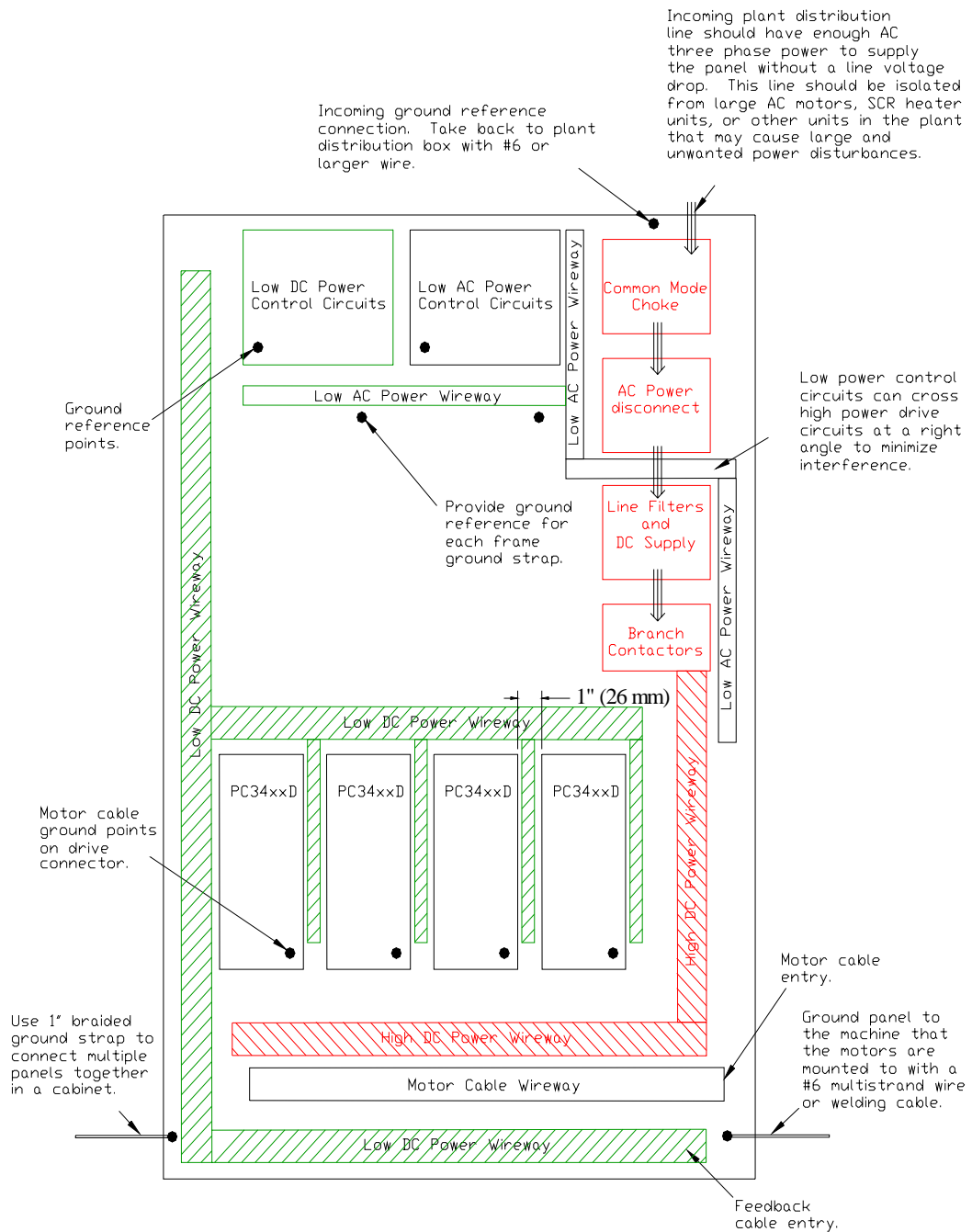
NOTE	
	<i>Allow a minimum distance of 1.0 inches (26 mm) above and below each drive and on each side of the drive to eliminate a servo system's two worst enemies: heat generation and electrical noise.</i>

NOTE	
	<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>

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

NOTE	
	<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>

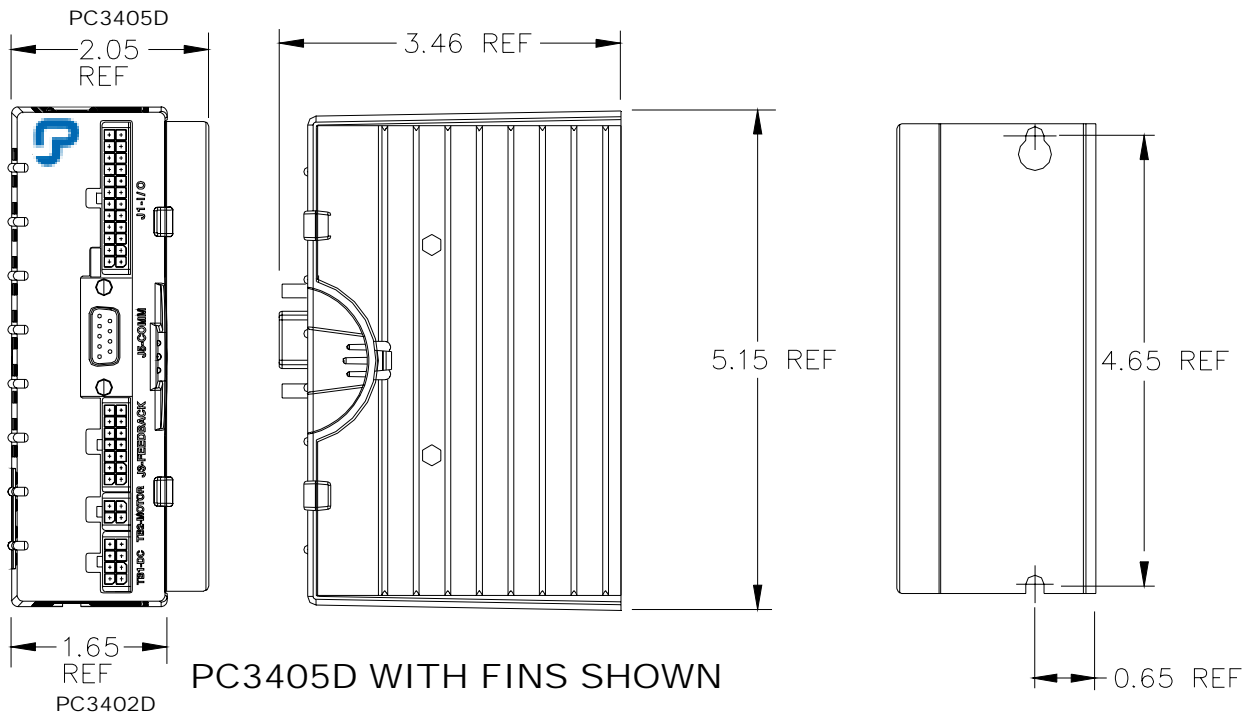
**Figure 3-1 Typical Panel Layout**



### 3.1.3 Mounting Dimensions

The PC34xxD 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 **PC340xD** 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.

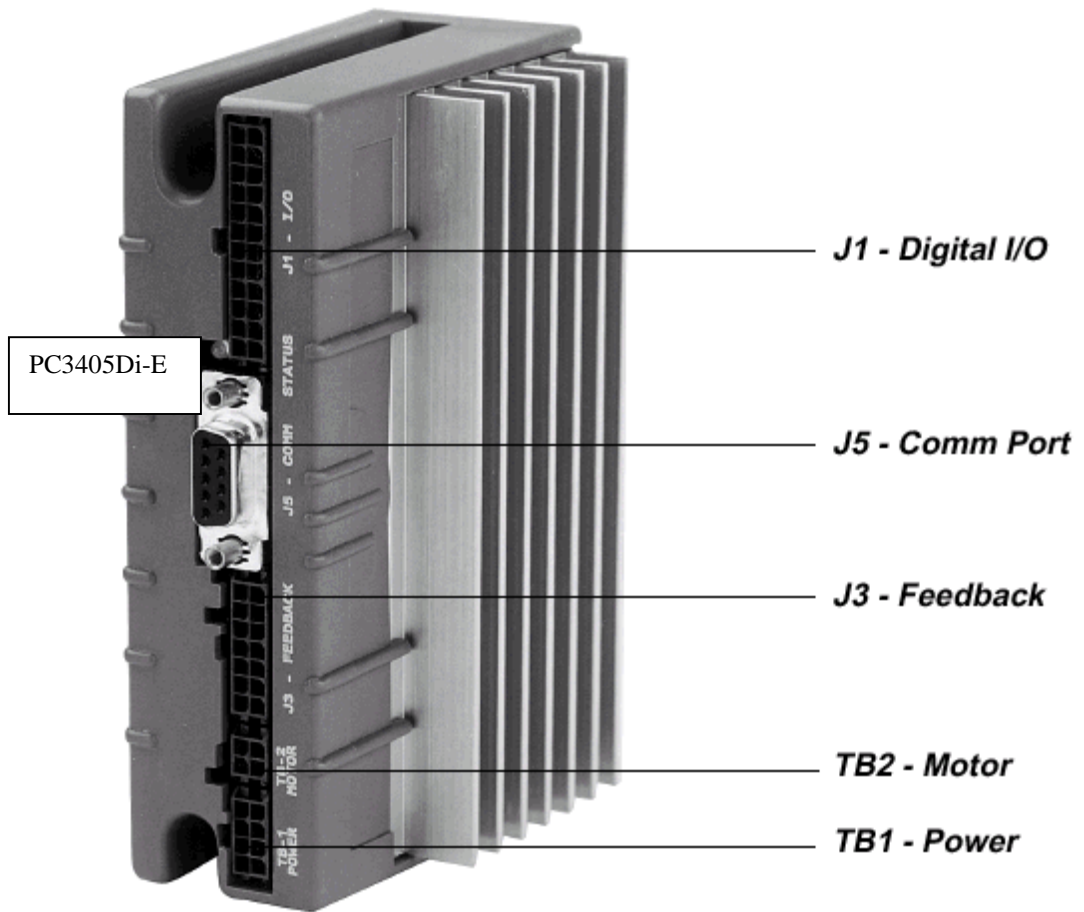
**Figure 3-2 PC340xD Series Mounting Dimensions**



**Dimensions: inches [mm]**

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

**Figure 3-3 PC34xxD 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 **PC34xx** Series Digital Servos have identical communications (Comm Port **J5**), thus making it possible to install a mixed combination of units for the most demanding applications.

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

*The user must configure the PC34xxD Series Digital Servo prior to mounting the unit.* To accomplish this task, the cover of the PC34xxD 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)

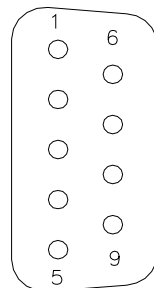
It should be noted that the communications port is only required to allow **ToolPAC** to communicate to the controller for purposes of configuration for a specific motor and programming of the intelligent series. This port does not need to be wired during normal usage of the unit, (for configuration 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. For additional information on network requirements, please visit our web site.

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

**Figure 3-4 Comm Port Pin Definition (J5)**

Comm Port  
All Models



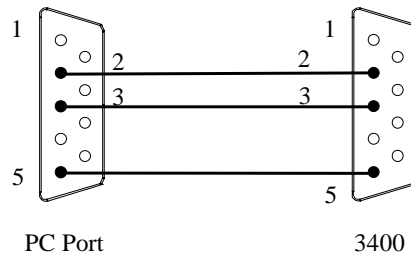
J5


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**




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

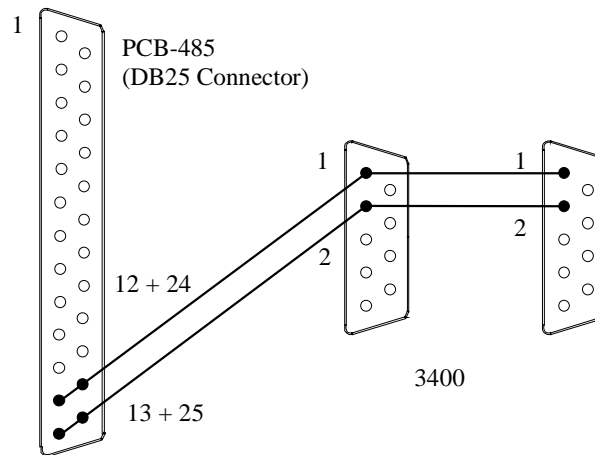


### RS-422/485 Two Wire Configuration


This communication method is used for applications requiring less than 5000 feet of communications cable. An **RS-485** communications card is required. **An RS-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>

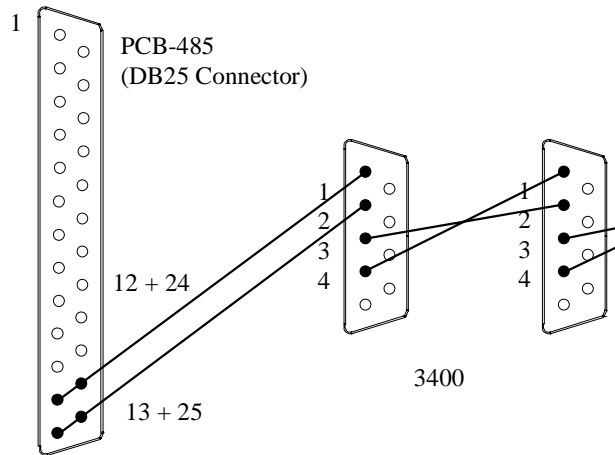
**Figure 3-6 Schematic of RS-422/485 Wiring (Two Wire)**



This is an alternate method of wiring the inter-axis cable and is used for applications requiring less than 5000 feet of communications cable. An **RS-485** communications card is required. *An RS-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)**

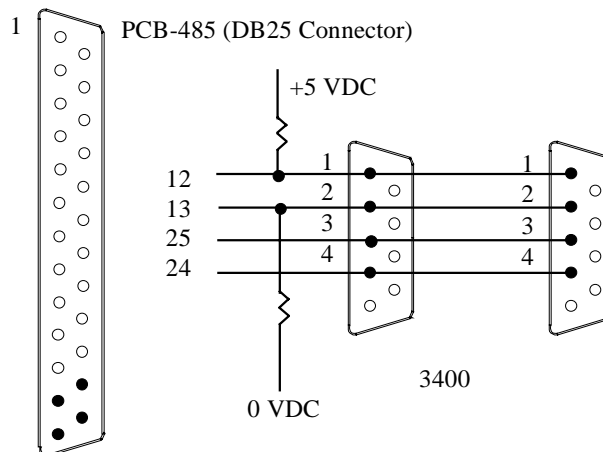


### RS-422/485 Four Wire Configuration

This method is used for applications requiring less than 5000 feet of communications cable. An **RS-485** communications card is required. *The RS-485 communications card must support "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>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).</p> <p>Use shielded cabling for all communication needs.</p> <p>Do not use ribbon cable to provide communications interconnect.</p>

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



**Preferred Method (full duplex)**

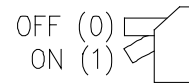
### 3.2.1.2 Serial Node Selection

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)

<b>CAUTION</b>	
	<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>

#### 3.3.1 High Power DC Connections


Consult [Table 7.12 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.

<b>NOTE</b>	
	<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.

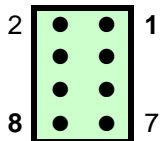
### 3.3.2 DC Power/Control/Regen (TB1)

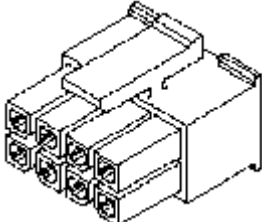
DC power, control power and regeneration wiring are made at the TB1 connector. Use care to ensure the correct pinout is used for the main power. Ensure that the amplifier's PE ground, pin #1, is taken directly to the panel's single point ground (SPG).

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

**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 amplifiers PWM circuit will cause interference to devices sharing this power supply.


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

**Table 3.3 Control Power Specifications**

Model	Control Power Requirements
PC34xxD (all models)	<b>18 - 48 VDC, 1 A maximum. This power supply must be common to chassis ground.</b>

### 3.3.4 External Regen (TB1)

The PC34xxD can dissipate regeneration energy internally. Less than 10% of common installations require external regeneration resistors. 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**.

<b>WARNING</b>	
	<p><b>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.</b></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
PC340xD	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 PC34xxD'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.

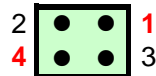
- Do not mix power and control signal wiring in the same conduit, duct, or wire tray without 6 inches (152 mm) of separation.
- Utilize shielded four (4) conductor wiring with drain for motor power cabling. Follow electrical codes to ensure the proper wire gauge for the motor and amplifier being installed 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.**
- If your motor is provided with an internal thermal Over Temperature (OT) switch, it should be wired to the appropriate connections on the amplifier, see section [Motor OT Sensor input \(ADC2\)](#). Make this mode ACTIVE via ToolPAC parameter **COT** *Check motor OT input. (Not available when a tachometer is being utilized as a feedback device.)*

### 3.4.1 Brushless DC Motors (TB2)

All of the PC34xxD series of controllers can run **Brushless DC** motors (BLDC), some times referred to as **Brushless AC** motors. The following is a guide to setting up BLDC motors with the PC34xxD controllers. ([Table 5.11 Brushless DC Motor Parameters](#))

**Table 3.6 BLDC Motor Connections (TB2)**

TB2 - BLDC Motor			
Pin #	Connection	Pin #	Connection
2	Phase V	1	Phase W
4	Phase U	3	Ground



**Table 3.7 BLDC Motor Configurations**

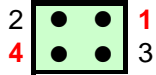
Feedback Type (BLDC Motor)	Control modes	Command source *	
Hall/Encoder feedback  Note: * Program = Intelligent series only	Current mode	Analog, Digital or Program	
	Velocity mode	Analog, Digital or Program	
	Position mode	Program	Step/Dir
		Step Up/ Step Down	Secondary Encoder Following
		Distributed-Feedback (encoder)	Analog or Digital Current Analog or Digital Velocity Program/Position
Hall Only	Current mode	Analog or Digital	
	Velocity mode	Analog or Digital	
Encoder only  (motor must be manually rotated through the Z-channel to initiate motor commutation)	Current mode	Analog, Digital or Program	
	Velocity mode	Analog, Digital or Program	
	Position mode	Program	Step/Dir
		Step Up/ Step Down	Secondary Encoder Following
		Distributed-Feedback (encoder)	Analog or Digital Current Analog or Digital Velocity Program/Position

### 3.4.2 Brush Motors (TB2)

The PC34xxD series of controllers can run Brush DC motors. The following is a guide to setting up Brush motors with the PC34xxD controllers. ([Table 5.10 Brush DC Motor Parameters](#))

**Table 3.8 Brush DC Motor Connections (TB2)**

TB2 - Brush DC Motor			
Pin #	Connection	Pin #	Connection
2	DC -	1	n/c
4	DC +	3	Ground




The following motor types and control modes are supported:

**Table 3.9 Brush DC Motor Configurations**

Feedback Type (Brush Motor)	Control modes	Command source *
Encoder Only  <i>Note: *</i> <i>Program = Intelligent series only</i>	Velocity mode	Digital Velocity Command
		Analog Velocity Command
	Position mode	Program
		Step/Dir
		Step Up/ Step Down
Secondary Encoder Following		
Tachometer Feedback	Velocity mode	Digital Velocity Command
		Analog Velocity Command
No Feedback	Current mode	Digital Current Command
		Analog Current Command
	Open Loop Speed mode	Digital Velocity Command
		Analog Velocity Command
Distributed-Feedback (encoder) motor feedback is not utilized	Distributed-Feedback (encoder)	Analog or Digital Current
		Analog or Digital Velocity
		Program/Position

### 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	
	<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>

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 [Figure 7-3 Suggested Wire](#).**

### 3.6 Motor Feedback (J3)

The PC34xxD Motor Feedback connector J3 is a 14 pin dual-row connector. The J3 connections also include a non-isolated +5 VDC supply, **250mA maximum**, for the HED, Encoder power, and motor over-temperature sensor (OT).

The **PC34xxD** Series is a digital amplifier that will only accept an **encoder with Hall** or an **encoder with Commutation Tracks encoded on the Z-Channel** or **Tachometer** as a feedback device.

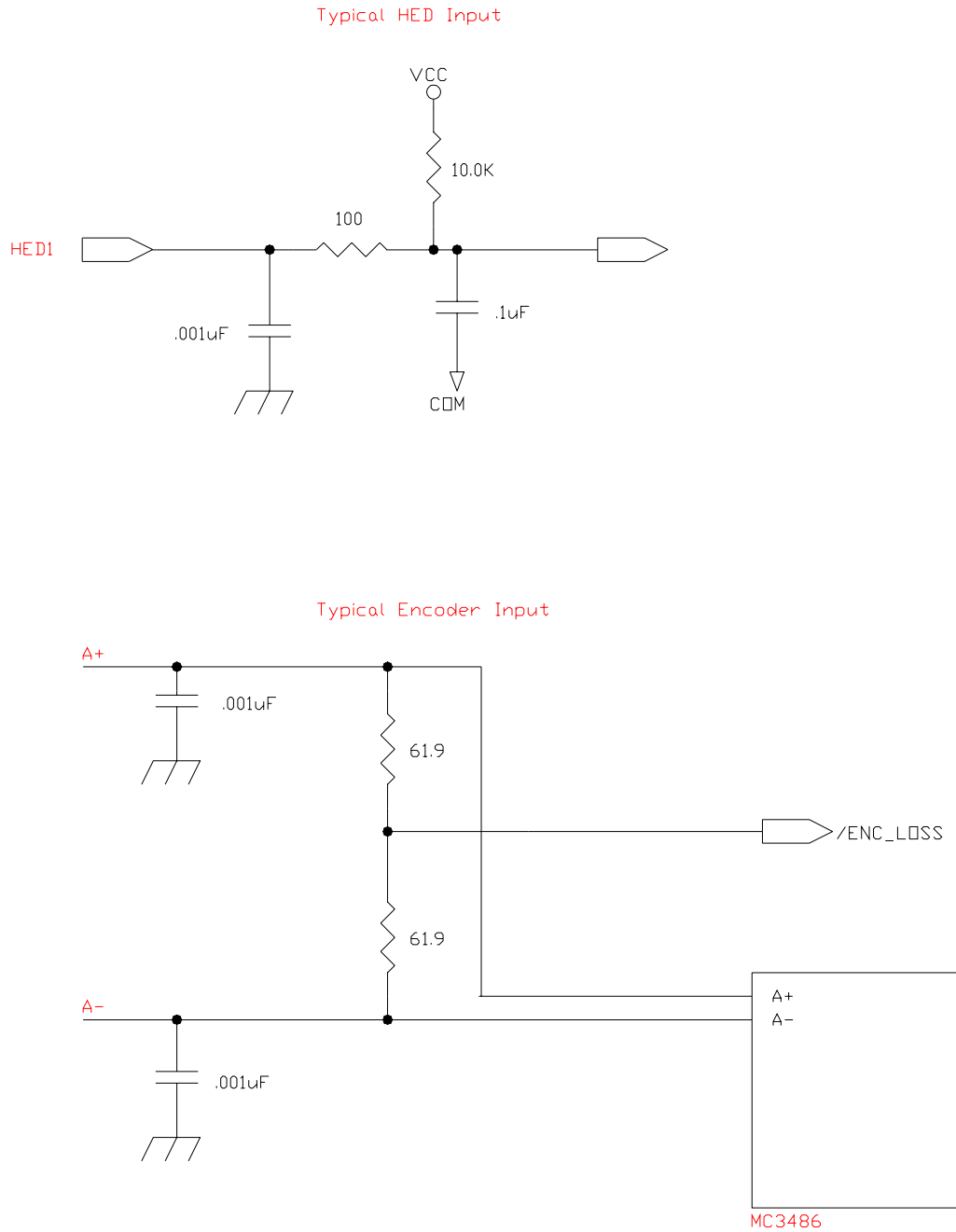
NOTE	
	<p><i>The PC34xxD Series accepts differential A/A', B/B' and Z/Z' encoder signals. It will NOT accept single-ended encoder signals.</i></p>

**Figure 3-9 PC34xxD Feedback Connector J3**

J3 - Encoder Feedback			
Pin #	Signal	Pin #	Signal
2	A -	1	A +
4	B -	3	B +
6	Z -	5	Z +
8	HED 1	7	Gnd
10	HED 3	9	HED 2
12	+5 VDC	11	+5 Return(com)
14	ADC2 - /OT -	13	ADC2 + / OT +

A cable assembly, **PFC-000502-010**, may be purchased to facilitate wiring the J3 connector. This shielded cable assembly is pre-wired to the mating connector, ten feet in length (also available in 025 and 050 foot lengths).

**Figure 3-10 Hall and Encoder Feedback Schematic J3**




The **PC34xxD** Series is a digital amplifier that will accept;

### 3.6.1 Hall Only (BLDC, 6-Step - Trap)

If you are utilizing a Brushless DC motor with Hall Effect Devices, only the HALL1, HALL2 and HALL3 inputs need be wired. Power for the Hall Effect Devices is supplied from the +5VDC and COM on the J3 connector.

If utilizing a motor with HALL ONLY feedback, the encoder channels need not be wired. Operation is limited to Current or Velocity commands.

Position mode operation can be accomplished via a secondary encoder. Read section [Selecting Operation Mode](#) for additional information.


NOTE	
	<p><i>To ensure proper configuration when using "HALL Only" mode, be sure to set the EPPR to 3X Motor Poles.</i></p>

### 3.6.2 Encoder Only (Brush DC)

If utilizing an encoder for feedback, the A+, A-, B+, B-, Z+ and Z- connections must be wired. Power for the Encoder is supplied from the +5VDC and COM on the J3 connector.

If utilizing a motor with this type of feedback, only the Encoder channels need to be wired. The unit can be operated in Velocity or Position mode (Brush DC Motor) with Step/Dir, Step+/Step- or Quadrature Encoder Following modes

Position mode operation can also be accomplished via a secondary encoder. Read section [Selecting Operation Mode](#) for additional information.


NOTE	
	<p><b><i>The PC34xxD Series accepts differential A/A', B/B' and Z/Z' encoder signals. It will NOT accept single-ended encoder signals.</i></b></p>

### 3.6.3 Encoder with Halls or (Comcoder)

If utilizing an encoder/halls or a comcoder for feedback, the A+, A-, B+, B-, Z+ and Z- connections, and the HALL1, HALL2 and HALL3 inputs must be wired. Power for the Hall Effect Devices and the Encoder is supplied from the +5VDC and COM on the J3 connector.

The unit can be operated in Analog, Current, Velocity or Position mode with Step/Dir, Step+/Step- or Quadrature Encoder Following modes. Refer to section for [Commutating Encoder Specification](#) compatible with encoder based controllers.

Position mode operation can also be accomplished via a secondary encoder. Read section [Selecting Operation Mode](#) for additional information.

NOTE	
	<p><b>The PC34xxD Series accepts differential A/A', B/B' and Z/Z' encoder signals. It will NOT accept single-ended encoder signals.</b></p>

### 3.6.4 Encoder with Commutation Tracks encoded on the Z-Channel.

If utilizing a Brushless DC motor and an incremental Encoder with Commutation Tracks encoded on the Z-Channel, the HALL signals need not be wired. The unit can be operated in Analog, Current, Velocity or Position mode with Step/Dir, Step+/Step- or Quadrature Encoder Following modes.

Position mode operation can also be accomplished via a secondary encoder. Read section [Selecting Operation Mode](#) for additional information.

### 3.6.5 Tachometer (ADC2)


The ADC2 input can be used as a second analog input. Brush-DC motors with tachometer feedback can be operated in Velocity command mode. The encoder and hall channels need not be wired when utilizing this type of feedback device.


When utilizing a Brush DC Motor with differential tachometer feedback the user must confirm configuration the PC34xxD hardware to receive an analog feedback signal. The cover must be removed from the PC34xxD to access the internal components. *The jumper JP3 must be removed from the PCB*, thus converting to an analog input for the tachometer.



If a tachometer is to be utilized in an application, then parameter Check Motor OT input (COT) must be set to **Inactive** in ToolPAC for the PC34xxD to monitor this input.


Position mode operation can also be accomplished via a secondary encoder. Read section [Selecting Operation Mode](#) for additional information.

NOTE	
	<p>The ADC2+ and ADC2- inputs (pins J3-14 and J3-13) are factory configured as a motor OT analog input. <b>If utilizing a Tachometer feedback device, you must ensure that JP3 jumper is removed.</b> You will not have the ability to use a motor thermal OT.</p>

CAUTION	
	<p>The tachometer's analog input is <math>\pm 10</math> VDC input. <b>Maximum feedback velocity is determined when the tachometer output voltage equals <math>\pm 10</math> VDC.</b> Please use care in selecting the proper tachometer voltage for your application.</p> <p>Failure to heed this <b>CAUTION</b> will result in damage to the PC34xxD.</p>

### 3.6.6 Auxiliary Analog Input (ADC2)


If you have chosen to use the **ADC2/OT** input as a motor thermal Over Temperature (OT) switch, then you do not have access to this additional analog input. If your application should require use of the **ADC2** analog inputs on the amplifier J3 connector and disable this feature in the software configuration. Make this mode **INACTIVE** via parameter **COT** Check motor OT input. For additional information see sections [Tachometer \(ADC2\)](#) and [Motor OT Sensor input \(ADC2\)](#).

NOTE	
	<p><b>To utilize the ADC2+ and ADC2- inputs as a motor Over Temperature (OT) input, you must remove the jumper JP3 internal to the unit and disable this feature in the software configuration. Make this mode INACTIVE via parameter COT Check motor OT input.</b></p>

### 3.6.7 Motor OT Sensor input (ADC2)

If your motor is provided with an internal thermal Over Temperature (OT) switch, it should be wired to the **ADC2/OT** 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	
	<b>To utilize the ADC2+ and ADC2- inputs as a motor Over Temperature (OT) input, you must enable this feature in the software configuration. Make this mode ACTIVE via parameter COT Check motor OT input.</b>

### 3.6.8 Motor Feedback 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 PC34xxD series controllers. **It is the responsibility of the user to ensure compatibility.**

### Commutating Encoder Specification

Encoder/Hall	Value	Units
<b>Encoder</b>		
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	
Alignment (Z-Channel)	N/A	
<b>HALL</b>		
Input Voltage	5	volts
Input Current (max)	80	mamp
Output Device	LM339	
Sink (max)	16	mamp
HALL pull up (R=1K)		
Alignment (HALL1)	See Note 1	

[1] Low-to-High transition of HALL1 aligns with positive going zero-crossing of motor Phase-A to Phase-C BEMF waveform.

## 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; [PC34xxDd-001-E](#), [PC34xxDi-001-E](#), or [PC34xxDi-001-EI](#).**

A cable assembly, **PCA-MM24-006**, may be purchased to facilitate wiring the J1 connector, see [Table 7.12 System Accessories](#). This shielded cable assembly is pre-wired to the mating connector, six feet in length.

### 3.7.1 Enable Input (J1)

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 PC34xxD.
  - 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) PC34xxD directly wired to the brake coil.
  - 2) PLC/ Multi-axis motion control card controls the brake function.

### 3.7.2 Analog Input (J1)

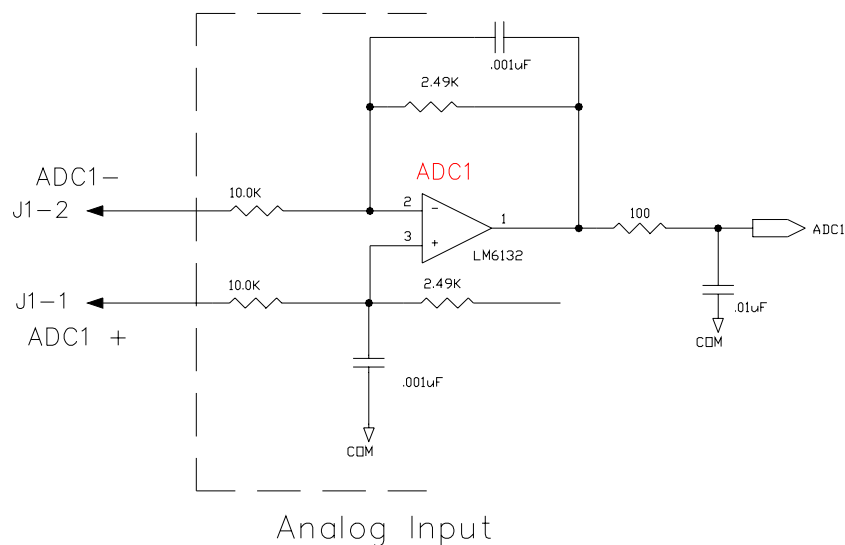
If you are using the HSI inputs for command input, you may skip this section.

The PC34xxD contains connections for a single analog input for use as a command reference. This differential analog input is intended to provide  $\pm 10$  VDC 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 “current” commands.

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

NOTE	
	<p><b>PC34xxDd (Digital Servo) is 10-bit analog resolution.</b></p> <p><b>PC34xxDi (Intelligent Servo) is 16-bit analog resolution.</b></p>

**Figure 3-11 Schematic of PC34xxD 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 Distributed Feedback, 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 PC34xxDi models.**

When utilizing **Distributed Feedback** mode of operation HSI1 and HSI2 are wired as a master encoder (Quad) to a secondary encoder. Read section [Selecting Operation Mode](#) for additional information.

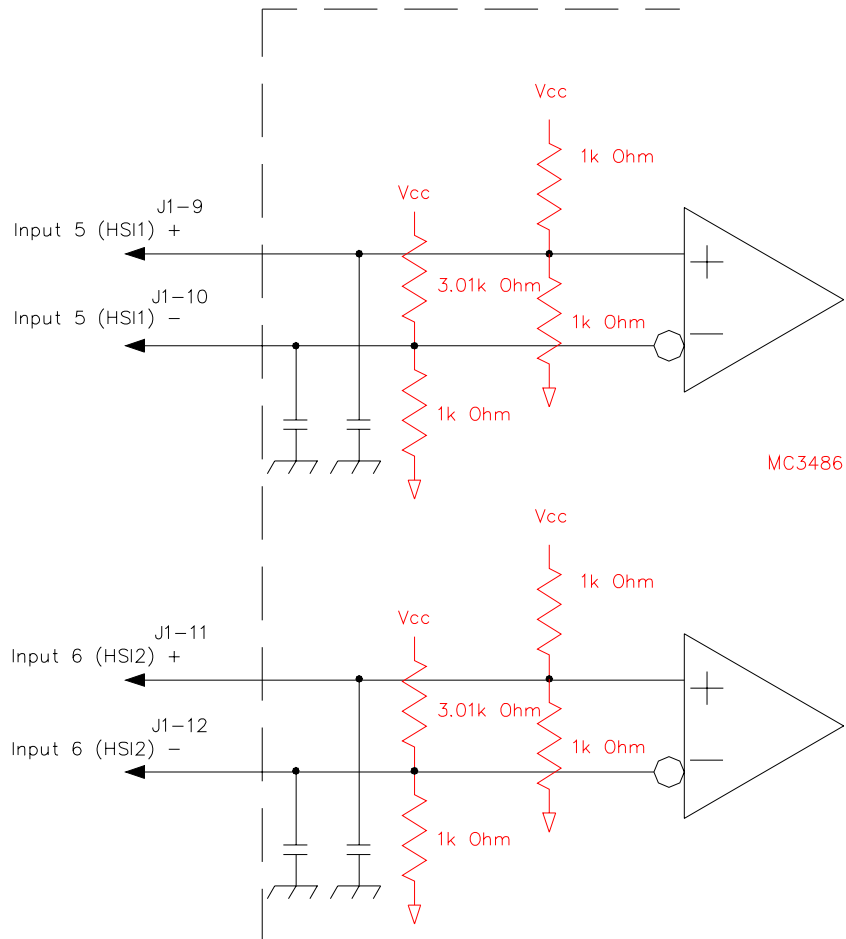
The HSI inputs are intended for use with a differential output driver such as a 23LS31 line driver [Figure 3-13 Wiring HSI Inputs as Differential Inputs](#). However since this is not always possible, single-ended Open collector or TTL outputs may be wired to these inputs. Please review the [Figure 3-14 Wiring HSI Inputs as Single-ended](#) inputs to the PC34xxD.

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 all of the HSI input signals. **HSIF may be set for 30kHz, 250kHz or 2MHz.**

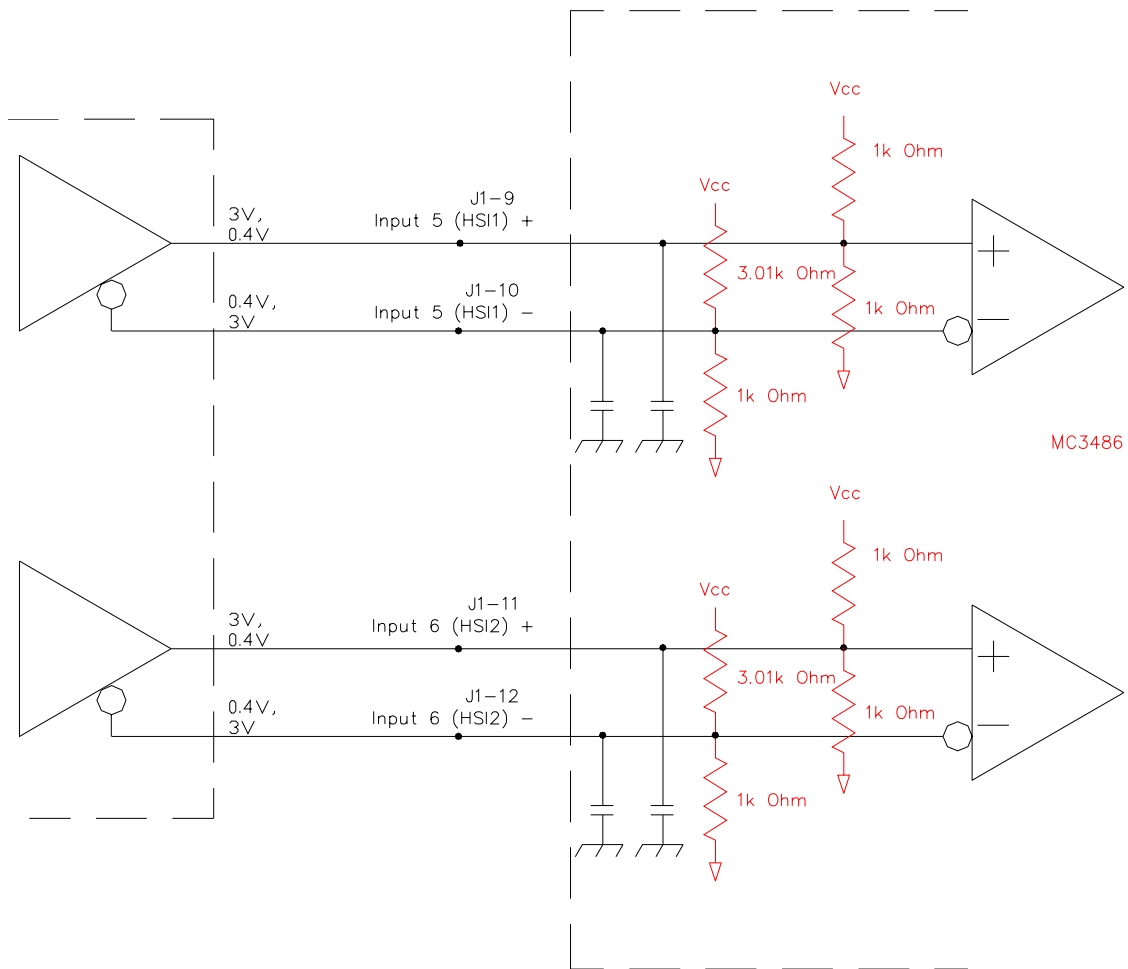
CAUTION	
	<p><i>The High Speed Inputs (HSI) require a signal level of 0-5VDC relative to J1-3 (Shield).</i></p> <p><i>The voltage difference between HSI+ and HSI- must be greater than ±0.25 volts.</i></p> <p><i>Exceeding this voltage specification will result in damage to the equipment.</i></p> <p style="text-align: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

**Figure 3-12 Schematic of PC34xxD HSI Inputs**



**Figure 3-13 Wiring HSI Inputs as Differential Inputs**

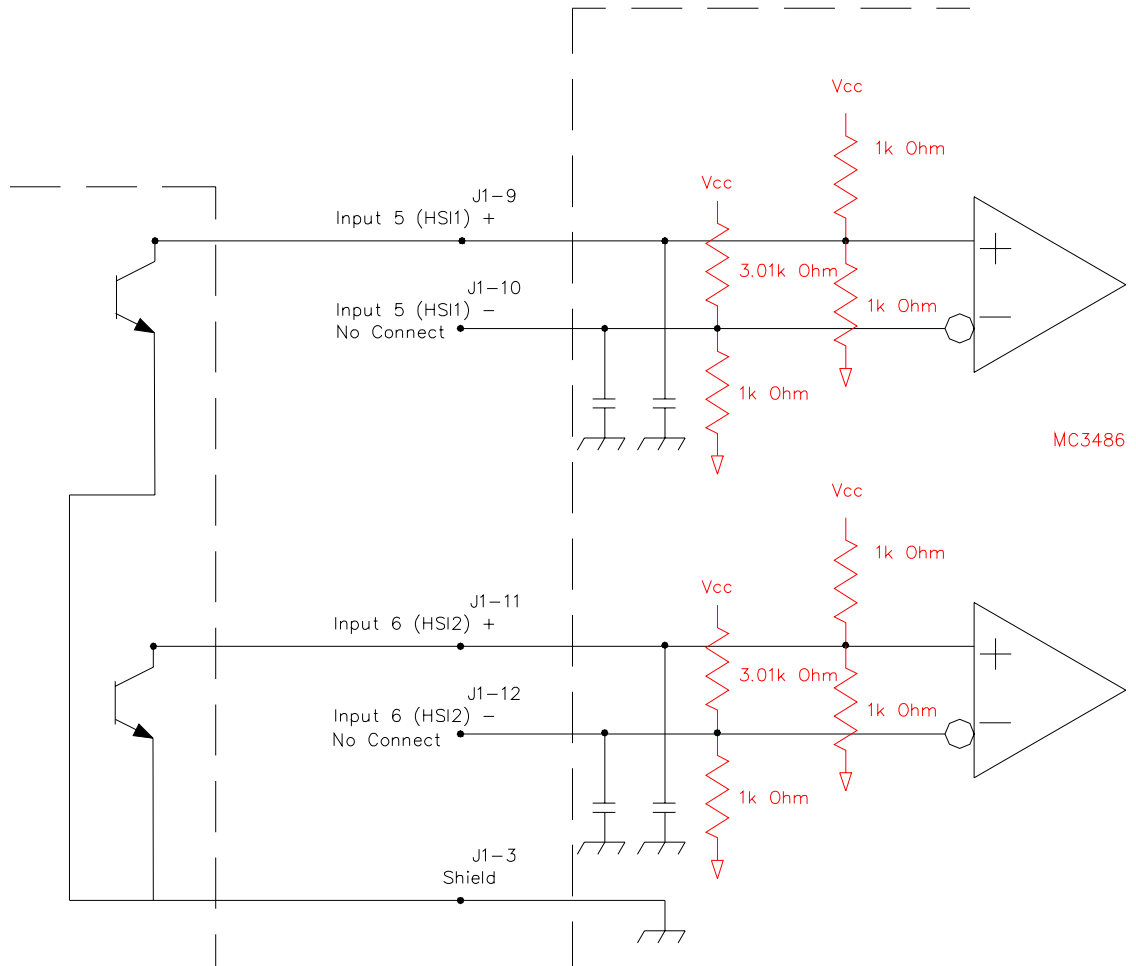
Note the measured voltages below.





**Figure 3-14 Wiring HSI Inputs as Single-ended**

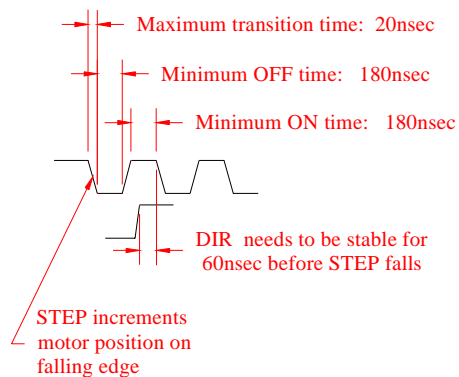
Open collector or TTL inputs must have the ability to sink 5ma and may be wired as shown below.



**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 Distributed Feedback (J1)

If you are NOT using the Distributed Feedback mode of operation, you may skip this section.

All models of the PC3400 have Inputs 5 and 6 as High Speed Inputs (HSI1 and HSI2) that can be utilized for the purpose of Distributed Feedback. When utilizing **Distributed Feedback** mode of operation HSI1 and HSI2 are wired as a secondary encoder (Quad).

NOTE	
	<p>When utilizing Distributed Feedback you will <b>NOT</b> have the ability of performing Electronic Gearing, CAM, Step/Dir, Step+/Step- or Quadrature encoder following.</p> <p>The maximum motor velocity is limited to the capability of the encoder output or a 2Mhz-count rate whichever is less.</p> <p>Encoder z-channel is not supported, thus the software command Move to the Feedback Null (+/-) is <b>NOT</b> available.</p>

- When utilizing **Distributed Feedback** with a **Brushless DC (BLDC)** motor, the motors feedback is utilized for commutation purposes only! The secondary feedback device, an encoder, is wired to HSI1 and HSI2 inputs.
- When utilizing **Distributed Feedback** with a **Brush DC** motor, the motors feedback is NOT utilized nor required! The secondary feedback device, an encoder, is wired to HSI1 and HSI2 inputs.
- Velocity and Position loop tuning is performed utilizing the encoder signals wired to the **HSI1** and **HSI2** inputs. Thus it is important in an application utilizing Distributed Feedback to have a “rigid mechanical transmission” with minimal backlash and compliance. ***A system with backlash or compliance may be nearly impossible to tune!***

Please read sections [Digital HSI inputs \(J1\)](#) and [Selecting Operation Mode](#) for additional information.

### 3.7.5 Drive-OK/Brake Output (J1)

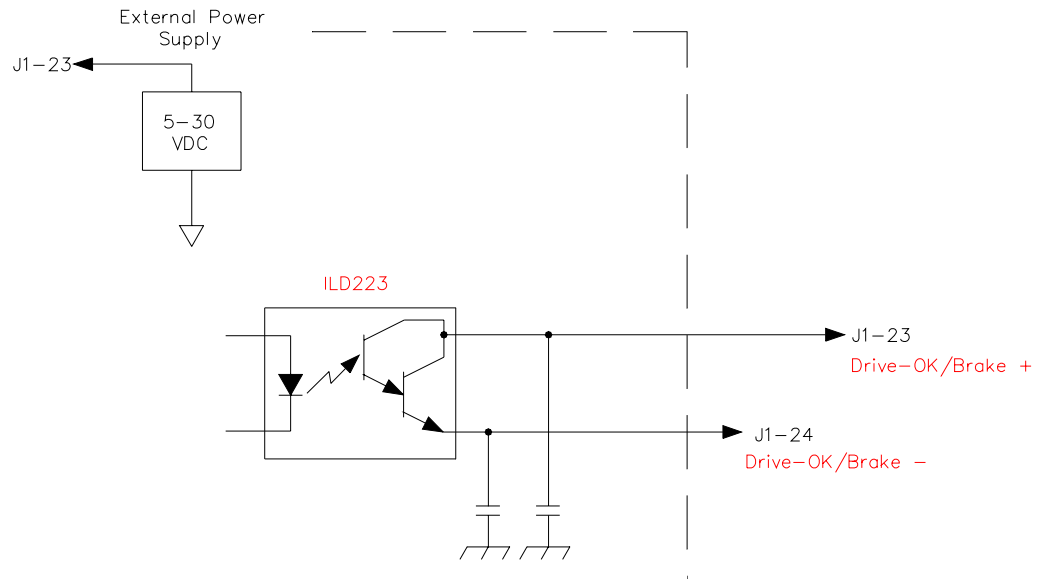
A special output #1 is factory default as Drive-OK for use as a interlock in the users application. This output is active whenever power is applied to the unit and there are no faults present. ToolPAC's **I/O Configuration Wizard** may be utilized to configure this output as a Brake Output, [Figure 5-4 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. ToolPAC's **I/O Configuration Wizard** is utilized to configure this output as a Brake Output, [Figure 5-4 ToolPAC Wizards](#).

**Figure 3-17 Drive-OK/Brake Output**



<b>CAUTION</b>	
	<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 <a href="#">Figure 7-4 Suppression - DC Relay</a> for proper coil suppression and <a href="#">Figure 7-6 De-coupling - SS Relay</a>.</i></p>

### 3.7.6 Encoder Outputs (J1)

All models have buffered encoder outputs that may be used as a position or velocity signal. The encoder outputs are available for use in all modes of operation except when utilizing tachometer feedback.

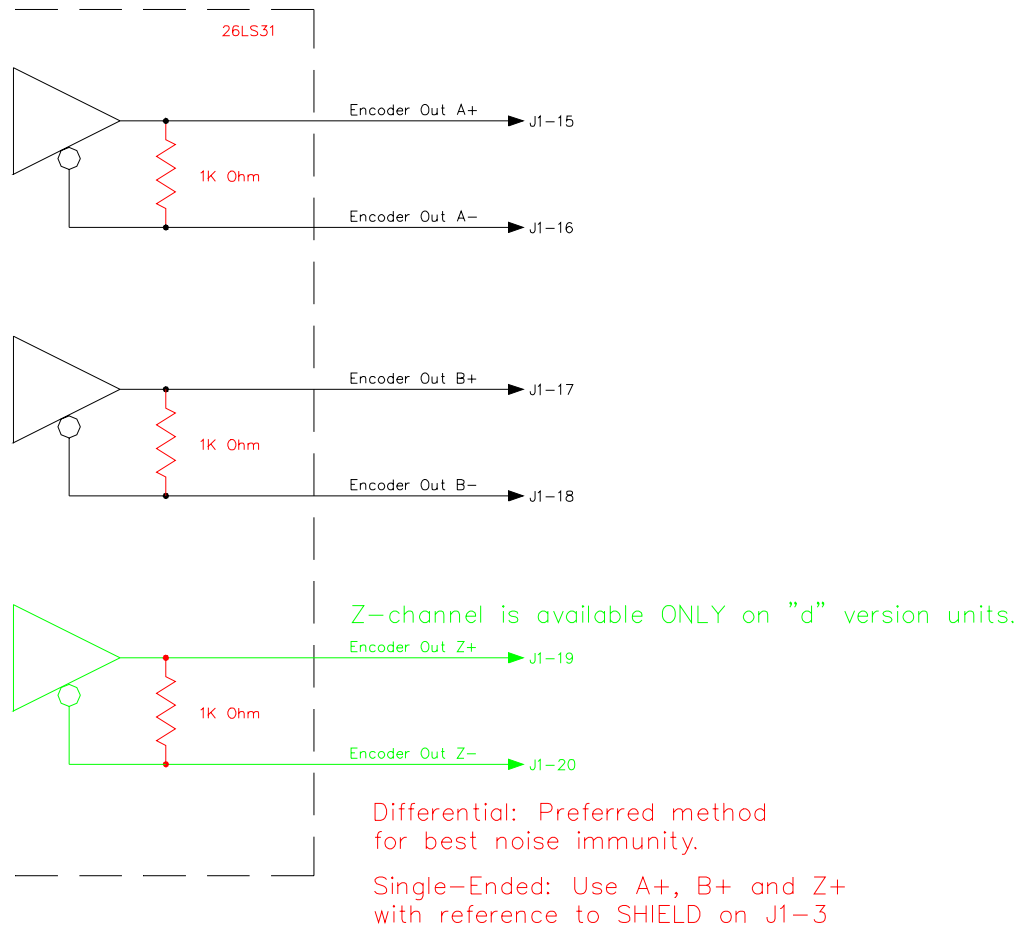
*The A/B outputs are clocked at a frequency with respect to the Halls (hall only mode) or Encoder (encoder only, hall/encoder, comcoder or encoder/encoded z-channel). This output is not user scalable, it is the user responsibility to purchase the proper motor/feedback to meet the system requirements.*

- The **PC340xDd-001-E** version drives have A, B and Z channel outputs.
- The **PC340xDi-001-E** and **PC34xxDi-001-EI** version drives only have A and B channel outputs.

The buffered encoder output(s) can be wired to a users differential or single-ended encoder input(s), refer to [Figure 3-18 Encoder outputs](#) for wiring information on your specific model and interface.

*The encoder outputs may be wired to the HSI inputs of other controller(s) so that Master/Slave relationships can be developed to synchronize multiple axis of motion as a function of position or velocity.*

**Figure 3-18 Encoder outputs**



### 3.8 PC34xxDd-001-E

Each **PC34xxDd-001-E** Series unit is an amplifier and heatsink integrated into a single standalone package.

The PC34xxDd Series is a digital amplifier that will accept the following feedback devices; **Hall-only**, an **Encoder with Hall**, **Comcoder** an **encoder with Commutation Tracks encoded on the Z-Channel** or **Tachometer**.

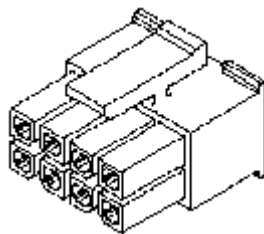
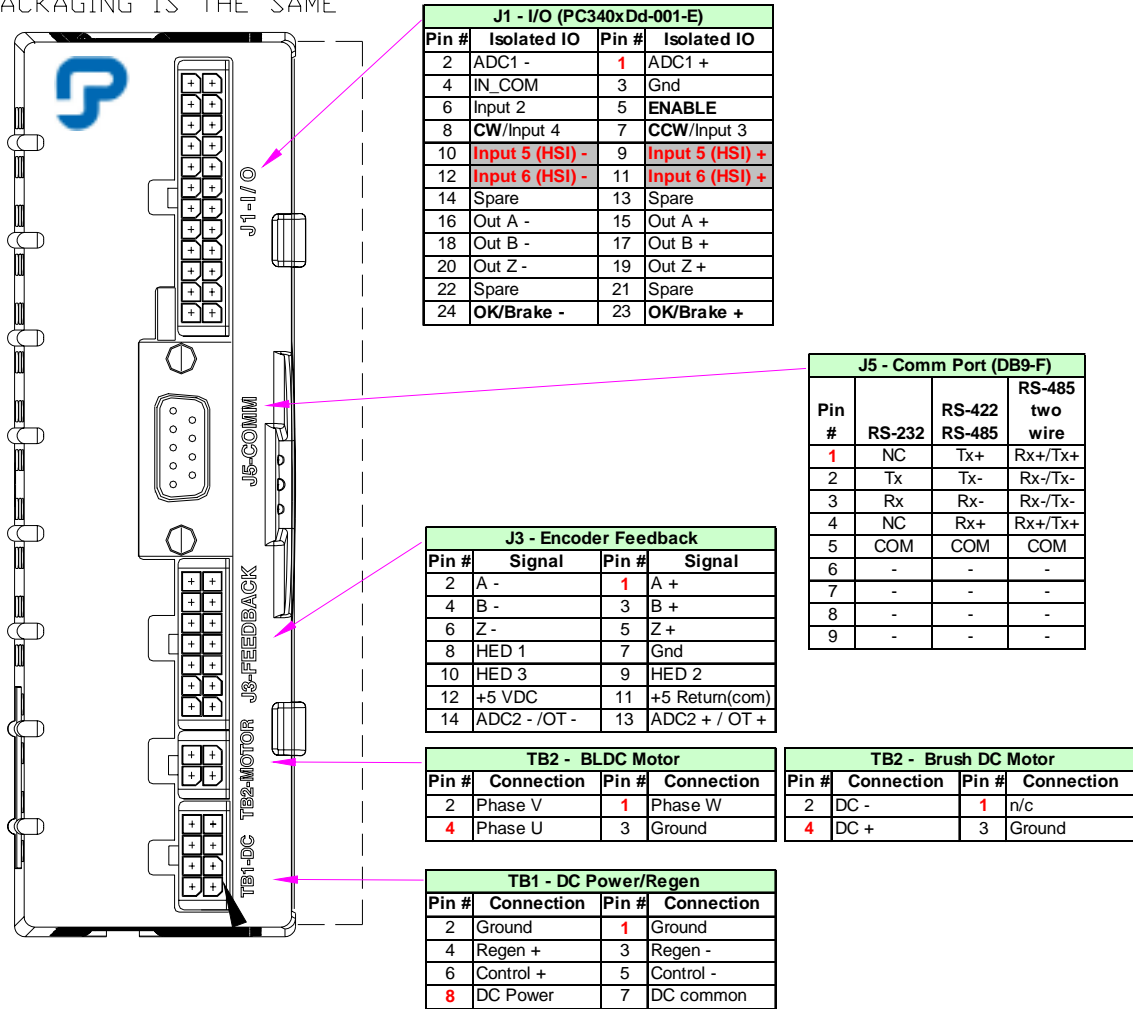
The **PC34xxDd** Series servo controllers provide the user with the basic components:

- A graphical user interface program, **ToolPAC**, provides the user with the tools to easily configure the PC34xxD to the specific application. **ToolPAC** is a Windows/NT-based program that provides Wizards for axis setup, tuning and I/O Configurations.
- A method of control is Analog input for Current (torque) 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.
- Distributed Feedback is not available on this series.
- 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 3-19 PC34xxDd-001-E Connector Placement**

PC3405Dd-001-E USES HEATSINK WITH FINS  
PACKAGING IS THE SAME



TB1 connector is shown above.

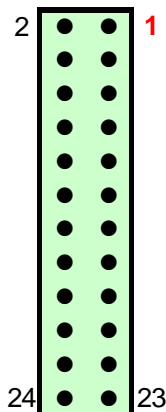
### 3.8.1.1 PC34xxDd-001-E Digital inputs (J1)


The PC34xxDd-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 3-20 PC34xxDd-001-E Connector J1**

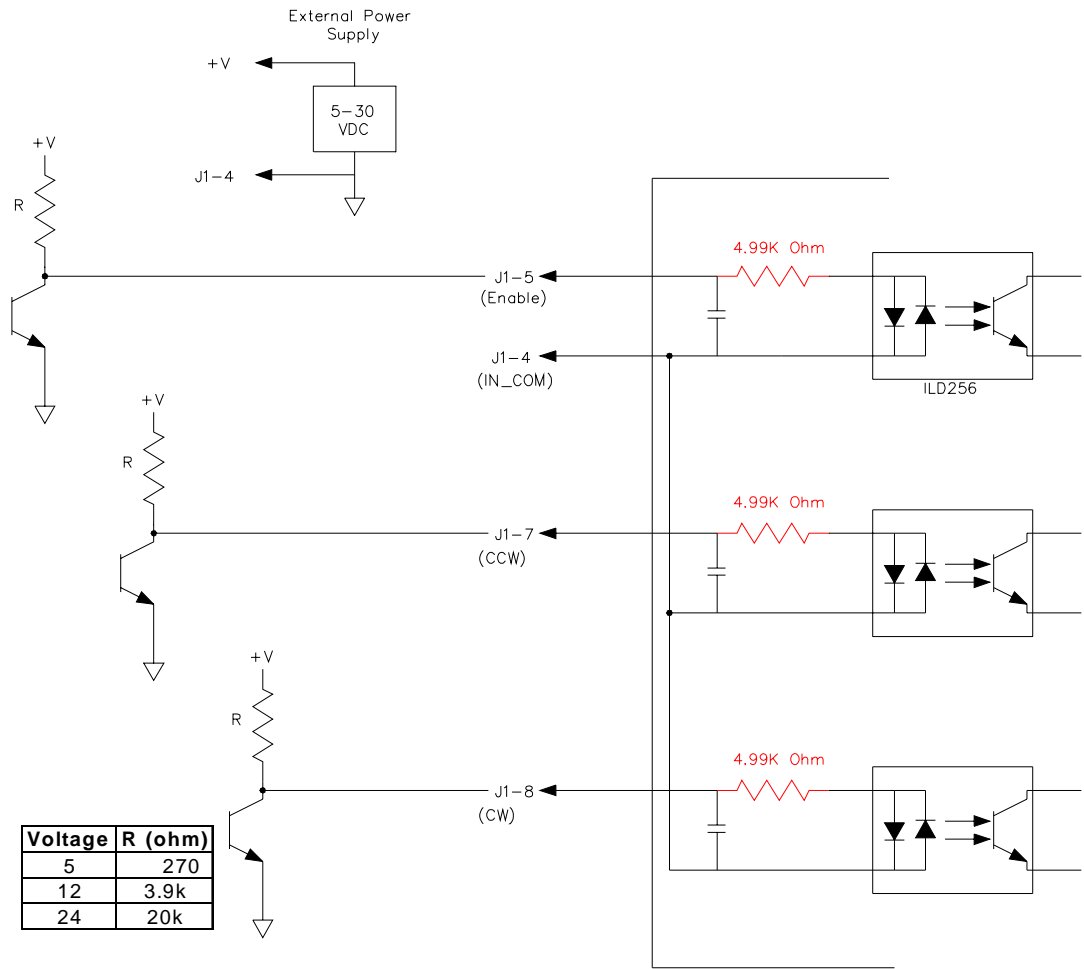
J1 - I/O (PC340xDd-001-E)			
Pin #	Isolated IO	Pin #	Isolated IO
2	ADC1 -	1	ADC1 +
4	IN_COM	3	Gnd
6	Input 2	5	ENABLE
8	CW/Input 4	7	CCW/Input 3
10	Input 5 (HSI) -	9	Input 5 (HSI) +
12	Input 6 (HSI) -	11	Input 6 (HSI) +
14	Spare	13	Spare
16	Out A -	15	Out A +
18	Out B -	17	Out B +
20	Out Z -	19	Out Z +
22	Spare	21	Spare
24	OK/Brake -	23	OK/Brake +



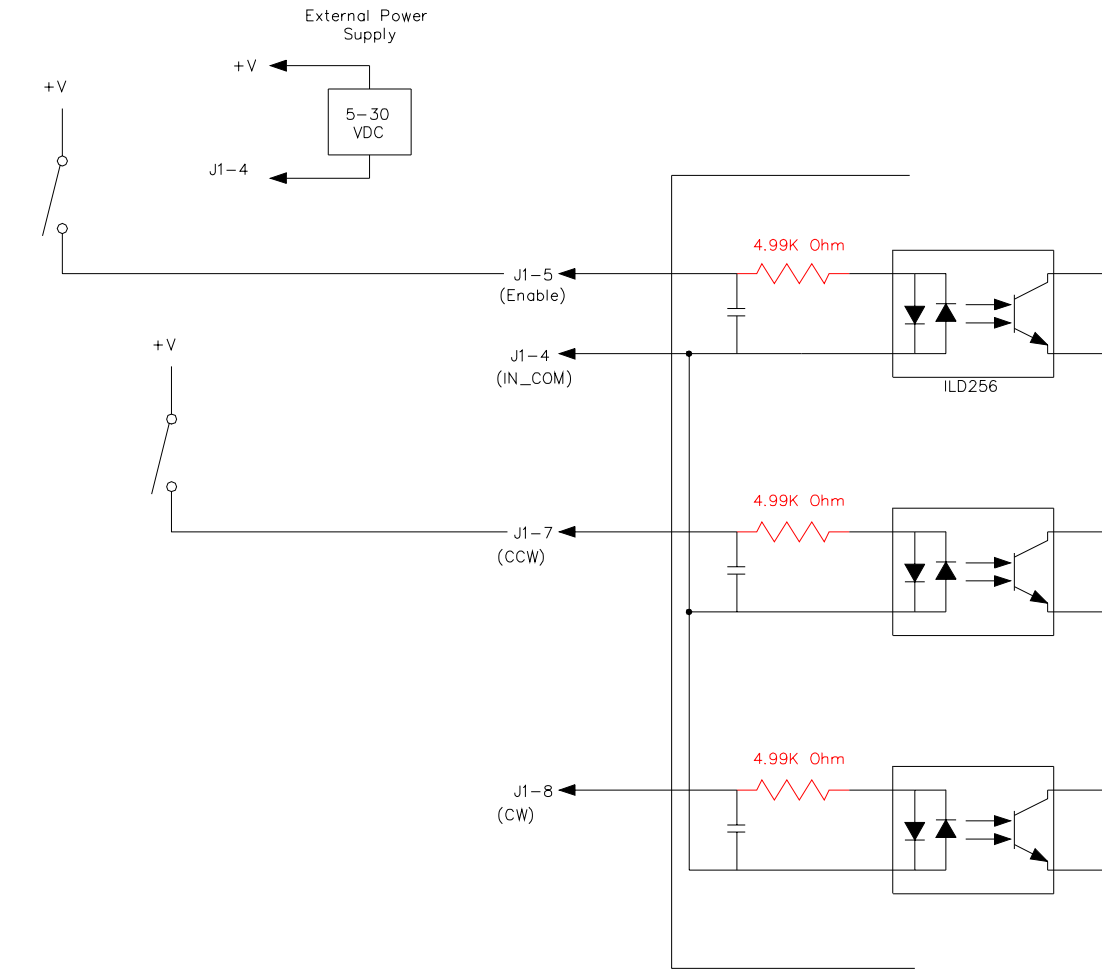
CAUTION	
	<i>The High Speed Inputs (HSI) require a signal level of 0-5VDC relative to J1-3 (Shield). The voltage difference between HSI+ and HSI- must be greater than ±0.25 volts. Exceeding this voltage specification will result in damage to the equipment. <b>NON-ISOLATED</b></i>

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.

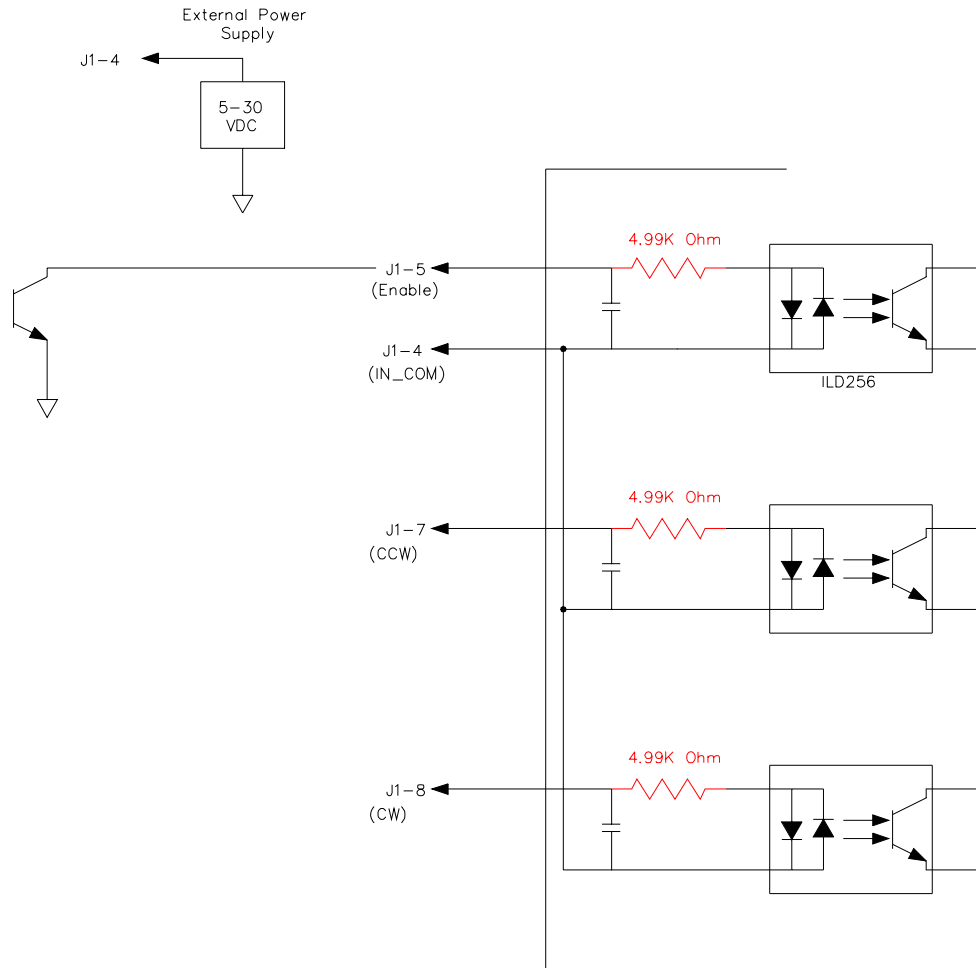
**Figure 3-21 PC34xxDd-001-E Digital Input (Sourcing configuration A)**



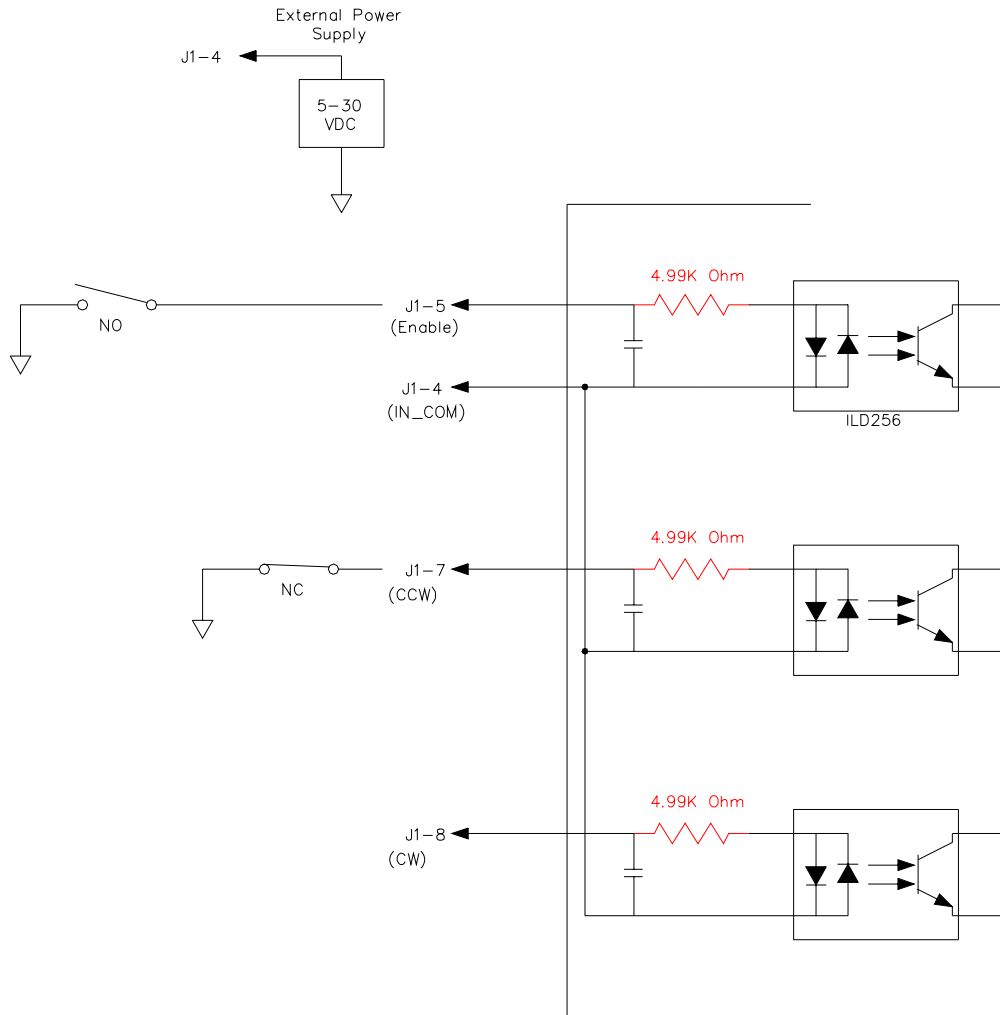
**Figure 3-22 PC34xxDd-001-E Digital Input (Sourcing configuration B)**



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



**Figure 3-24 PC34xxDd-001-E Digital Input (Sinking configuration B)**



### 3.9 PC34xxDi-001-E

Each **PC34xxDi-001-E** Series unit is an amplifier, intelligent controller and heatsink integrated into a single standalone package.

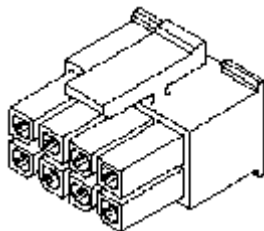
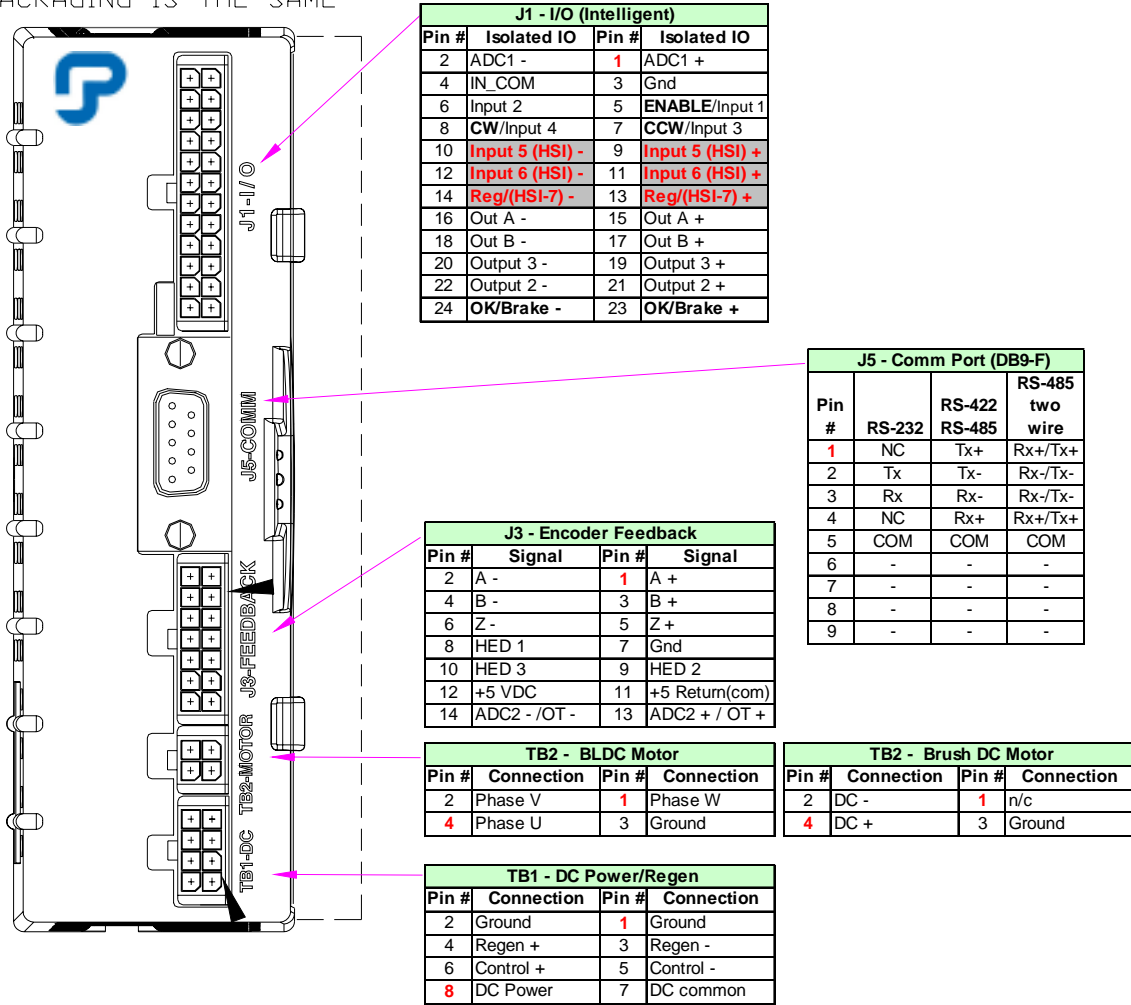
The PC34xxDi Series is a digital amplifier that will accept the following feedback devices; **Hall-only**, an **Encoder with Hall**, **Comcoder** or an **encoder with Commutation Tracks encoded on the Z-Channel** or **Tachometer**.

The **PC34xxDi** Series servo controllers provide the user with the basic components:

- A graphical user interface program, **ToolPAC**, provides the user with the tools to easily configure and program the PC34xxD to the specific application. **ToolPAC** is a Windows/NT-based program that provides Wizards for axis setup, tuning and I/O Configurations.
- A method of control is Stand-alone program mode, Analog input for Current (torque) 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.
- Distributed Feedback; A mode of operation where a secondary encoder is used to close the Position loop in an application. When using Distributed Feedback you will lose the ability to provide Step/Dir, Step+/Step- or Encoder following as the secondary encoder is wired to these HSI inputs. Thus, CAM and Master/Slave relationships are likewise not available.
- Hardware interfaces for Enable, Motor OT, High-Speed Encoder inputs, CW, CCW inputs, Drive-OK or Brake output that allow you to interface to your machinery/equipment.

**Figure 3-25 PC34xxDi-001-E Connector Placement**

PC3405Di-001-E USES HEATSINK WITH FINS  
PACKAGING IS THE SAME



TB1 connector is shown above.




### 3.9.1.1 PC34xxDi-001-E Digital inputs (J1)

The **PC34xxDi-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 **16-bit Analog** input, 4 isolated inputs (Enable and 3 general purpose), plus 3 HSI inputs, buffered encoder outputs (A and B channels), 2 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 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.

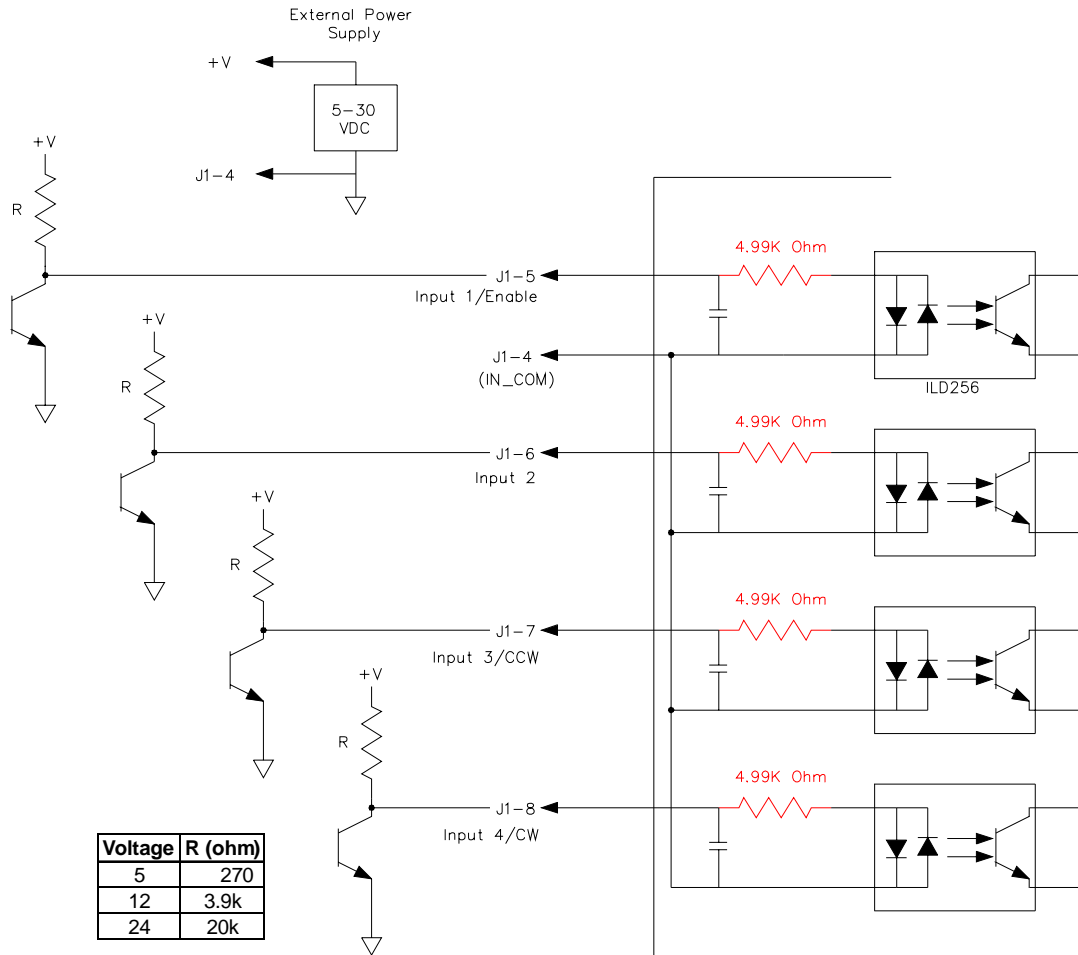
**Figure 3-26 PC34xxDi-001-E Connector J1**

J1 - I/O (Intelligent)			
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	Out A -	15	Out A +
18	Out B -	17	Out B +
20	Output 3 -	19	Output 3 +
22	Output 2 -	21	Output 2 +
24	OK/Brake -	23	OK/Brake +

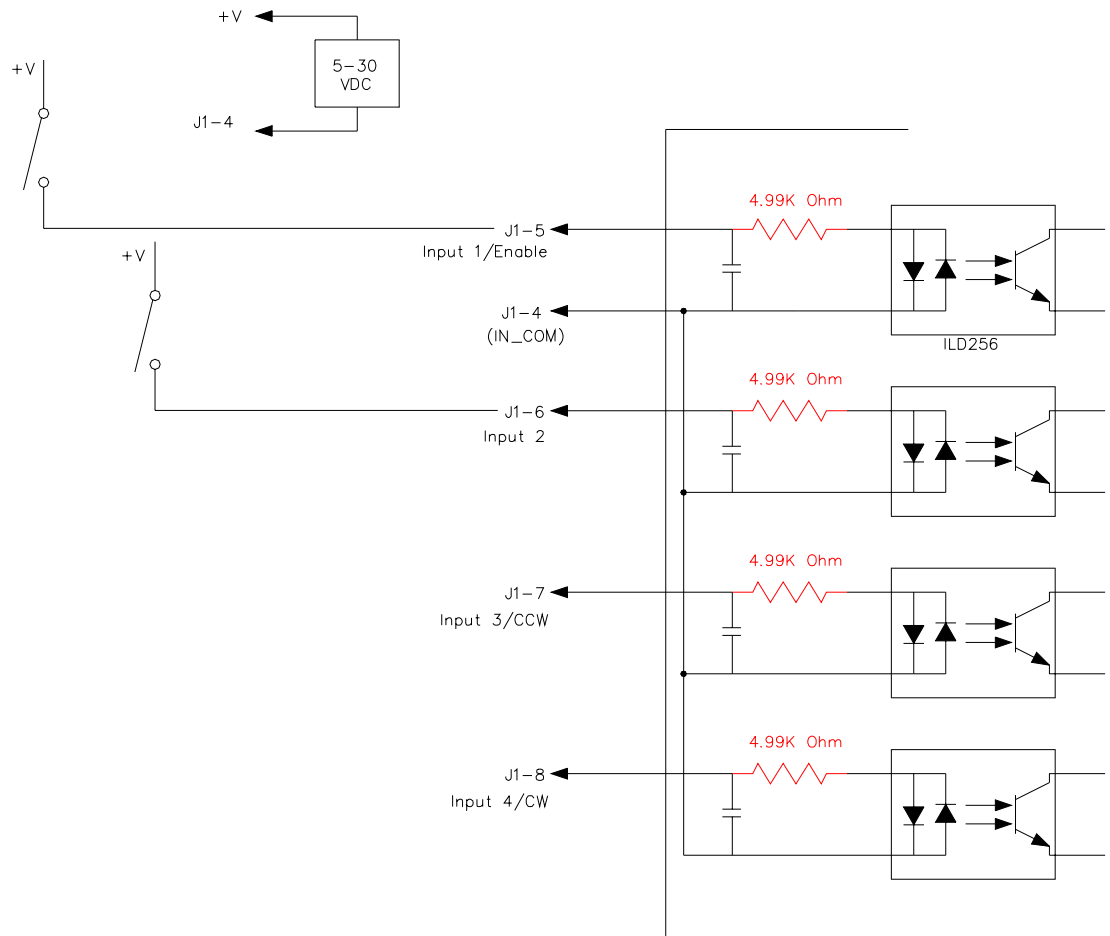
CAUTION	
	<p>The High Speed Inputs (HSI) require a signal level of 0-5VDC relative to J1-3 (Shield). The voltage difference between HSI+ and HSI- must be greater than <math>\pm 0.25</math> volts. Exceeding this voltage specification will result in damage to the equipment. <b>NON-ISOLATED</b></p>

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.

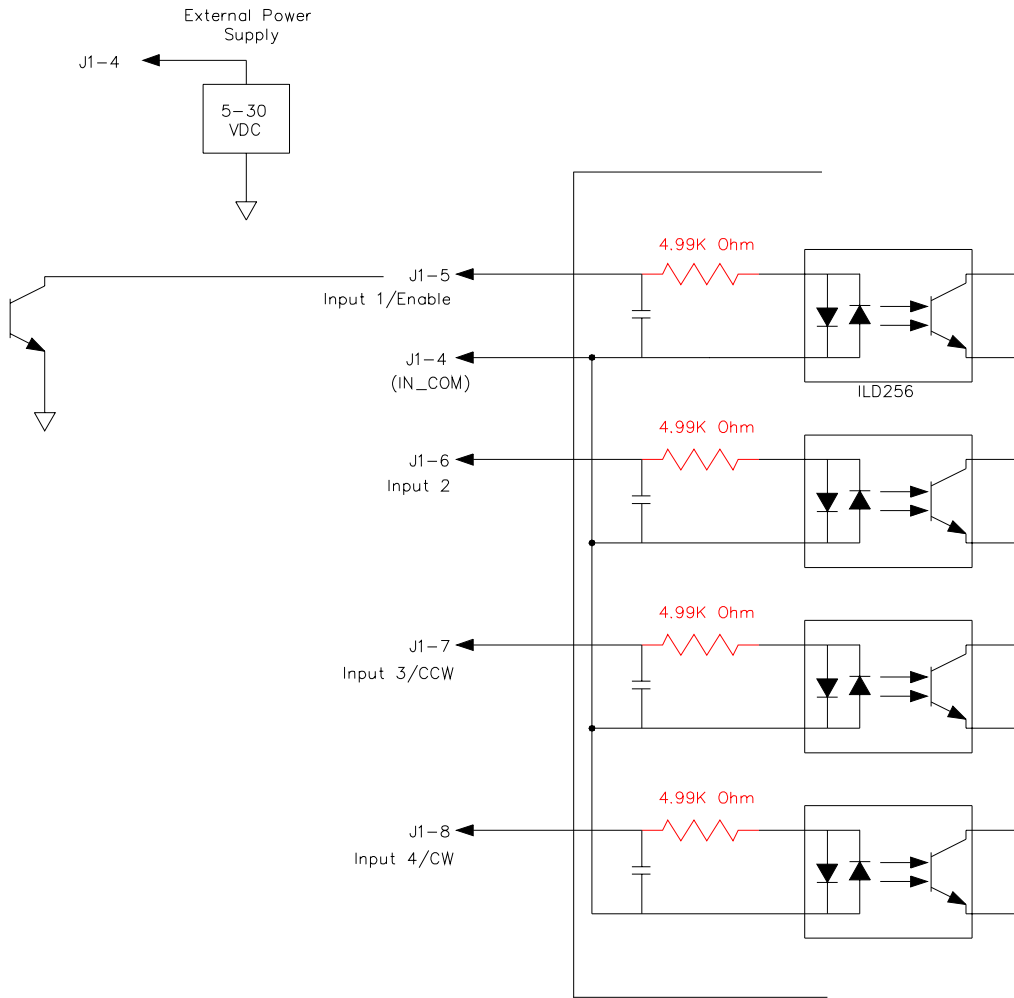
**Figure 3-27 PC34xxDi-001-E Digital Input (Sourcing configuration A)**



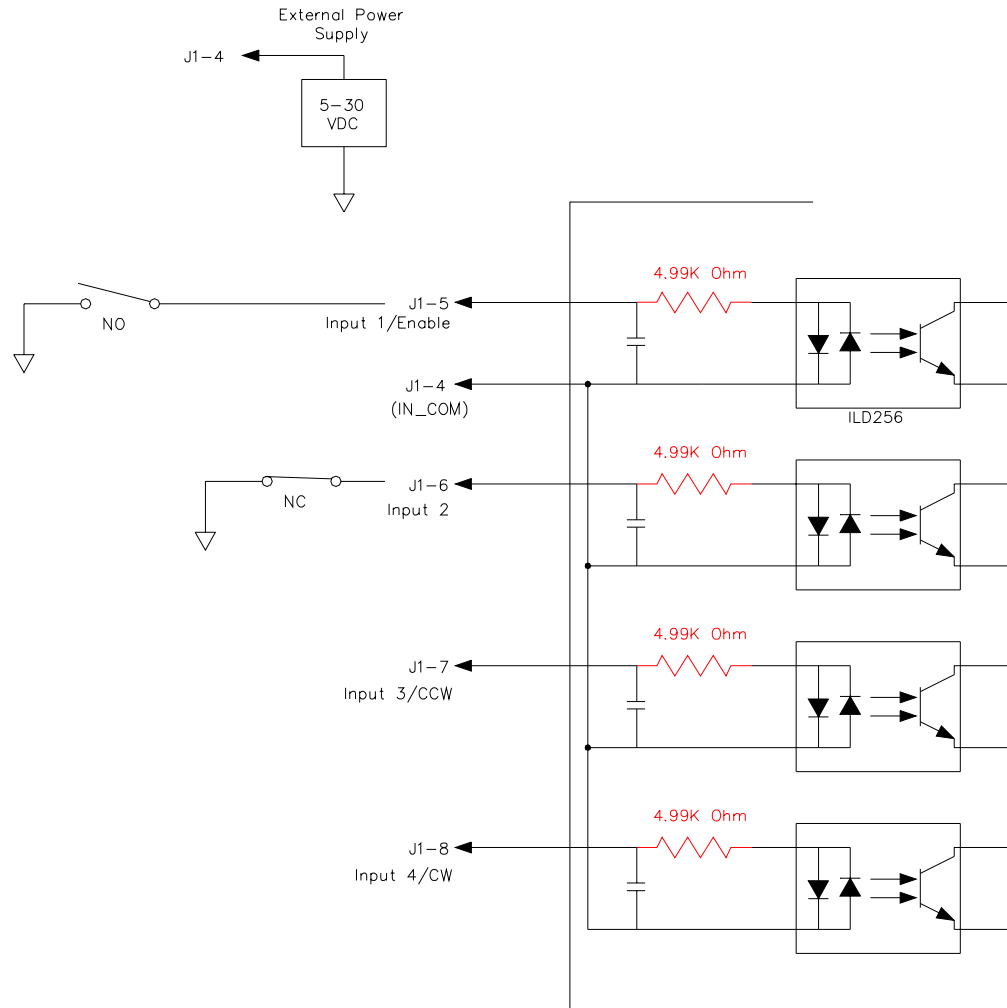
**Figure 3-28 PC34xxDi-001-E Digital Input (Sourcing configuration B)**



**Figure 3-29 PC34xxDi-001-E Digital Input (Sinking configuration A)**



**Figure 3-30 PC34xxDi-001-E Digital Input (Sinking configuration B)**



### 3.10 PC34xxDi-001-EI /Extended I/O

The **PC34xxDi-001-EI** may be purchased with (extended I/O) an additional 16 general purpose inputs on the J6 connector and 8 general purpose outputs on the J8 connector. *Units must be purchased with this option, they cannot be field upgraded.*

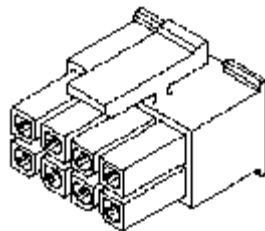
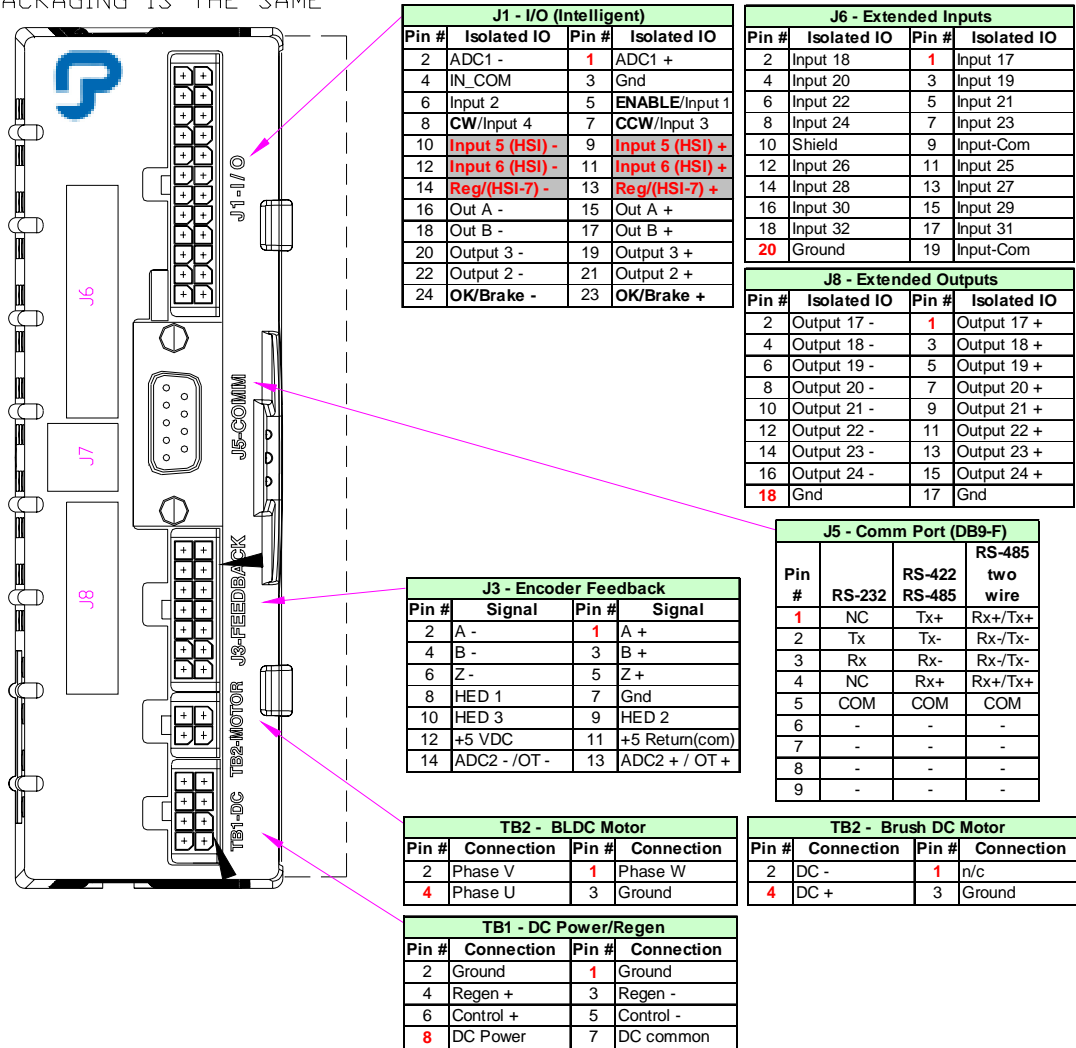
The PC34xxDi-001-EI Series is a digital amplifier that will accept the following feedback devices; **Hall-only**, an **Encoder with Hall**, **Comcoder** or an **encoder with Commutation Tracks encoded on the Z-Channel** or **Tachometer**.

All **PC34xxDi-EDN** Series servo 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 PC34xxD to the specific application. **ToolPAC** is a Windows/NT-based program that provides Wizards for axis setup, tuning and I/O Configurations.
- 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.
- Distributed Feedback; A mode of operation where a secondary encoder is used to close the Position loop in an application. When using Distributed Feedback you will lose the ability to provide Step/Dir, Step+/Step- or Encoder following as the secondary encoder is wired to these HSI inputs. Thus CAM and Master/Slave relationships are likewise not available.
- Hardware interfaces for Fault (Enable), Registration, Motor OT, High-Speed Encoder inputs, CW, CCW, Home inputs, Brake output that allow you to interface to your machinery/equipment.

**Figure 3-31 PC34xxDi-001-EI Connector Placement**

PC3405Di-001-EI USES HEATSINK WITH FINS PACKAGING IS THE SAME



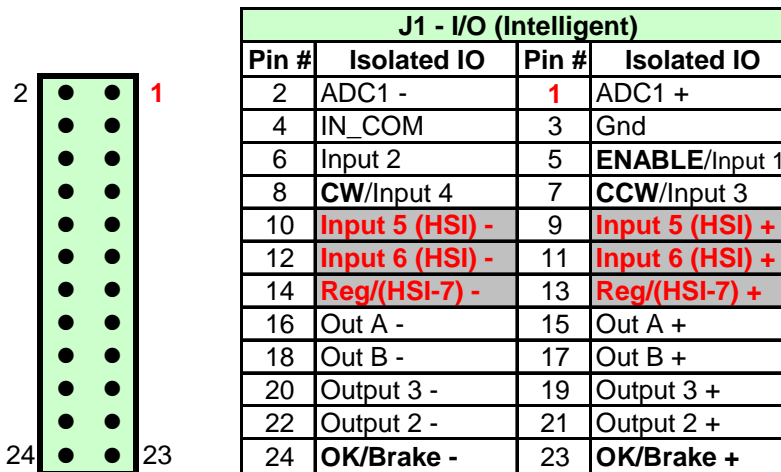
TB1 connector is shown above.

### 3.10.1.1 Digital inputs (J1)

The **PC34xxDi-001-EI** Series is an intelligent amplifier with I/O capability. The digital I/O connector J1 contains all of the connections for the unit; a **16-bit Analog** input, 20 isolated inputs (Enable and 6 general purpose), plus 3 HSI inputs, buffered encoder outputs (A and B channels), 2 outputs and 1 output for Drive-OK or Brake 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 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 3-32 PC34xxDi-001-EI Connector J1**



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. <b>NON-ISOLATED</b></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.



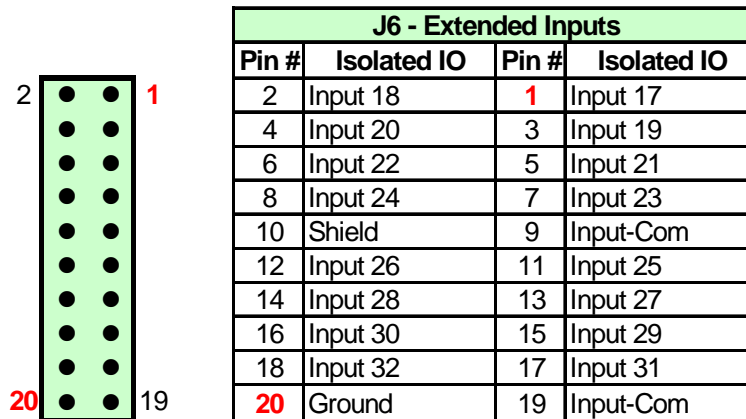
### 3.10.1.2 Digital Inputs (J6)

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 3-27 PC34xxDi-001-E Digital Input \(Sourcing configuration A\)](#), [Figure 3-28 PC34xxDi-001-E Digital Input \(Sourcing configuration B\)](#), [Figure 3-29 PC34xxDi-001-E Digital Input \(Sinking configuration A\)](#) or [Figure 3-30 PC34xxDi-001-E Digital Input \(Sinking configuration B\)](#) for additional information on wiring of digital inputs.

**Figure 3-33 PC34xxDi-001-EI Connector (J6)**



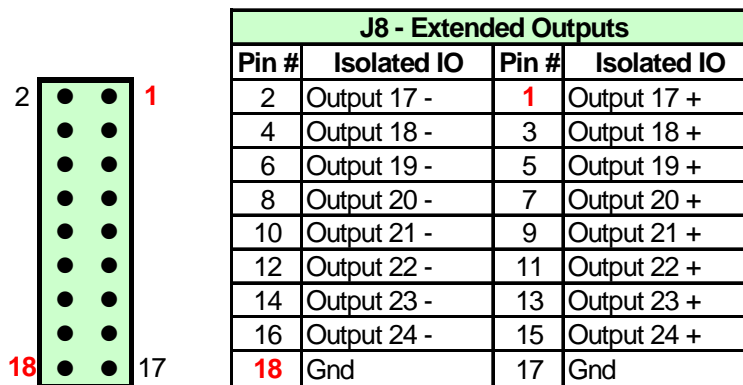
A cable assembly, **PCA-MM20-006**, may be purchased to facilitate wiring the J6 connector. This shielded cable assembly is pre-wired to the mating connector, six feet in length.

### 3.10.1.3 Digital Outputs (J8)

The **PC34xxDi-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.

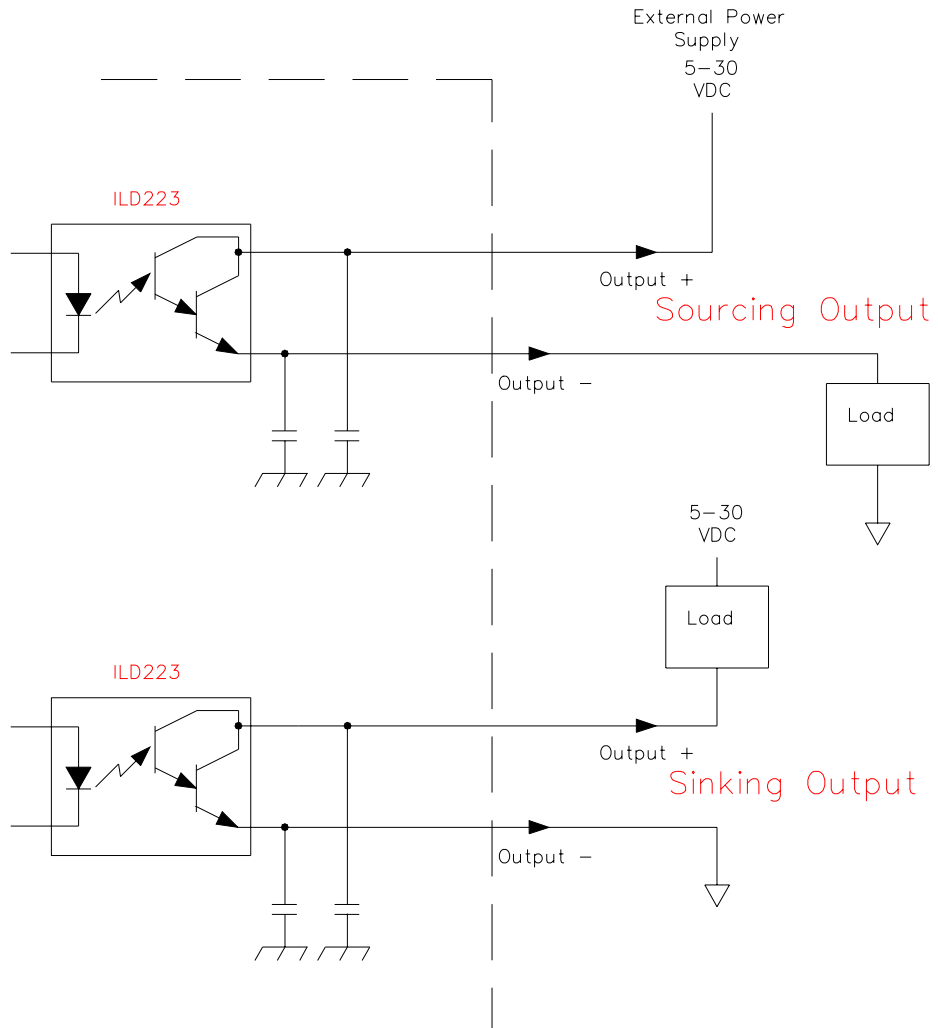
The optically isolated outputs are 5-30 VDC, 50 ma maximum.

**Figure 3-34 PC34xxDi-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 3-35 PC34xxDi-001-EI Digital Outputs**



## 4. ToolPAC Software Setup and Installation

---

This section will guide the user through the ToolPAC<sup>®</sup> software installation. ToolPAC<sup>®</sup> 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 3400 to his specific application.

# ToolPAC

ToolPAC is a registered trademark of Pacific Scientific.

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### 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

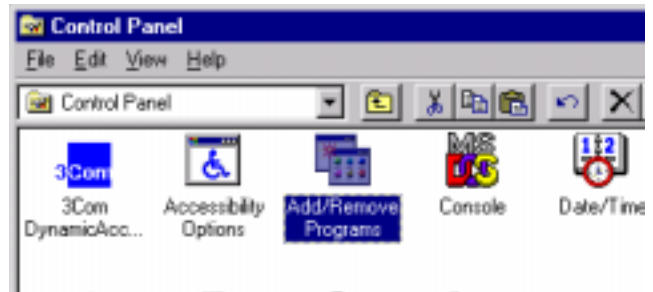
#### 4.2.1 Preliminary Steps

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 our 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.

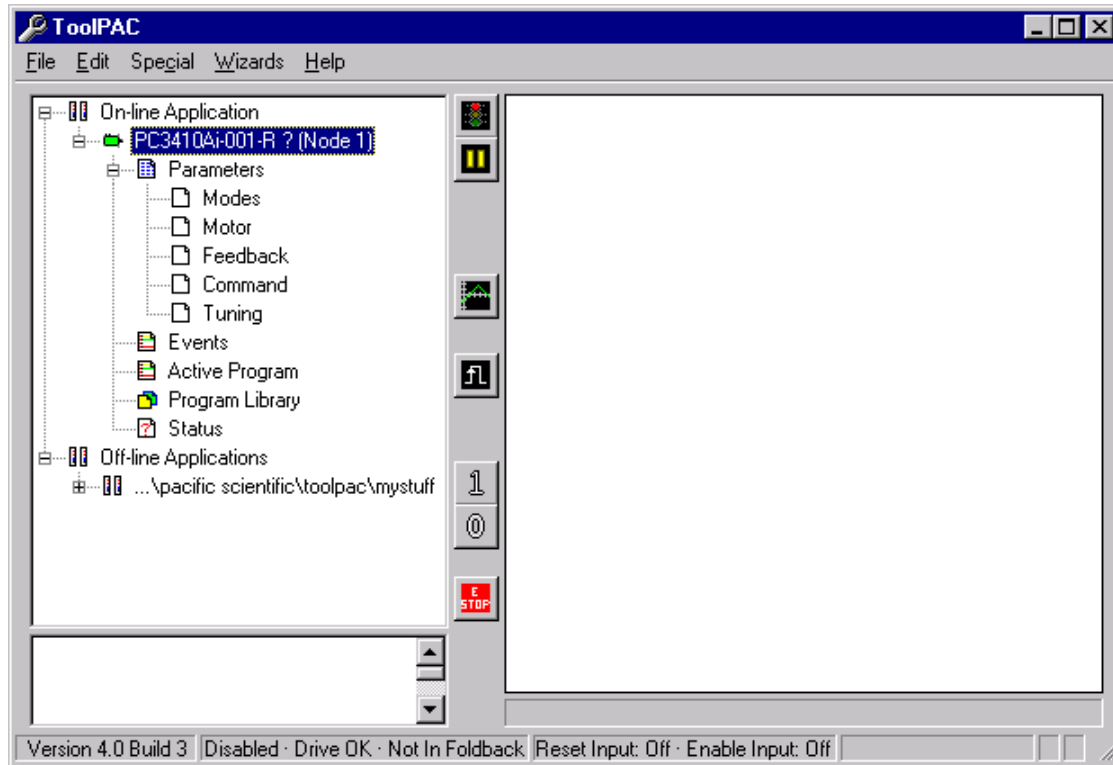
Note that extensive help menus are available with ToolPAC to assist the user in determining the function of each command, parameter, or feature. Help screens for commands and parameters are accessed by first highlighting the item and then performing a right-mouse click.

#### 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 to select the proper location of your communications port. *Shared IRQs 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**

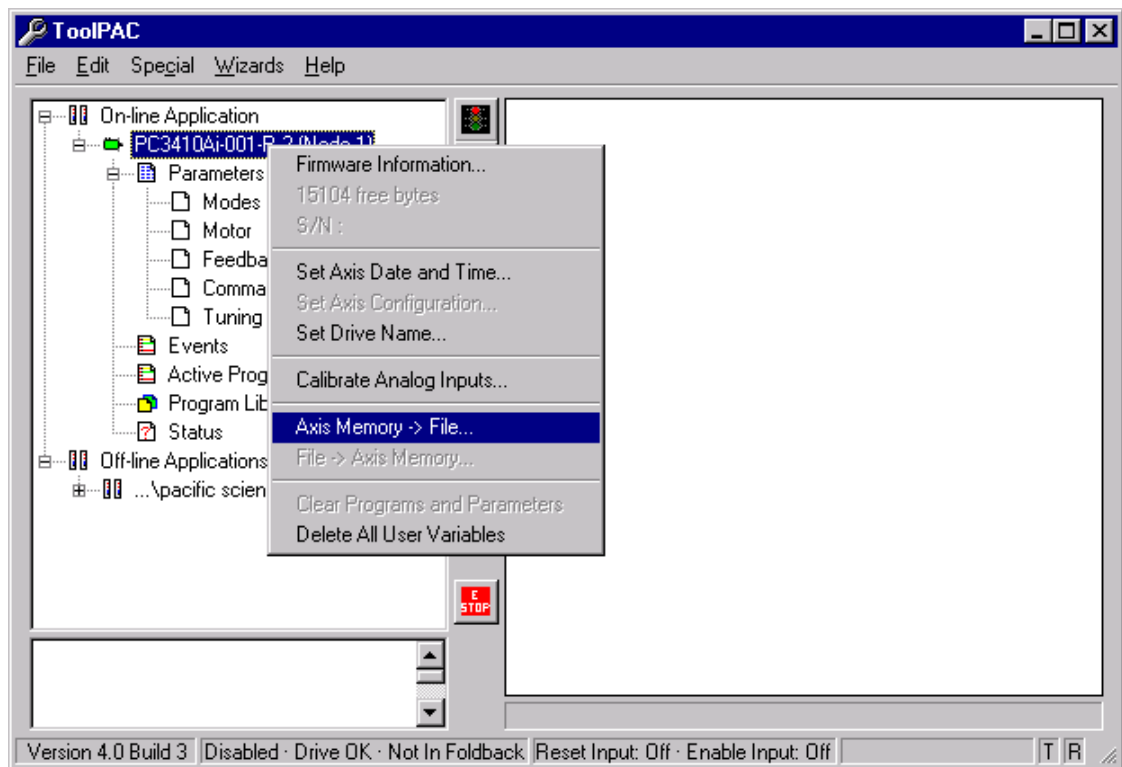


A green icon of a motor under the connected application lets you know which axes model is currently connected to the PC. The Axis Menu can be accessed via a right-mouse click.

*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.*

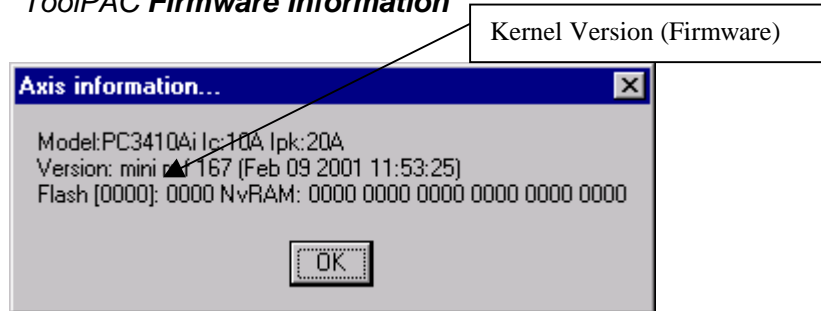
*When requesting applications assistance, this file may be sent via e-mail to assist in prompt response to your application needs. Call customer service at (815) 226-3100 to obtain our current e-mail address. Be sure to supply additional application information that may be useful in determining your 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 amplifier.

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 servo 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 servo system, a step-by-step Startup procedure has been included. This procedure should always be followed to ensure proper operation of the servo 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 3400 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 **PC34xxD** series amplifiers can operate **Brush** and **Brushless DC** servomotors.

All models of the **PC34xxD** series are easily configured as a servo amplifier in a Torque mode for direct input to the current loop, in Velocity (speed) mode, Position or Follow mode. All modes of operation offer a PID-loop tuning feature to properly control Brush or Brushless DC servomotors.

### 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 7-7 Function Block Diagram](#).

#### Current (torque) Mode


In Current (torque) mode, the amplifier will accept a torque command via analog input #1 (**ADC1**) or a Digital current command via the serial port or program, (parameter **DCC**).

#### Velocity Mode

In Velocity mode, the amplifier will accept an analog velocity 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 **PC34xxD** 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 amplifier will accept a Step/Dir, Step+/Step- or Quadrature Encoder signal for Following. In Position-Following mode, the amplifiers High Speed Inputs (HSI) are utilized to accept encoder quadrature A and B channels respectively. The amplifier 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.

<b>CAUTION</b>	
	<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;"><b>NON-ISOLATED</b></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 amplifiers 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 MA-ToolPAC located on our ftp site, <http://www.pacsci.com>.

The amplifier utilizes the parameters similar to position mode to control the number of encoder quadrature signals. Since the HSI1 and HSI2 inputs are utilized for applications requiring Electronic Gearing, **you cannot operate in Step/Dir, Step+/Step- or Distributed Feedback - Position mode.**

## Distributed Feedback - Position Mode

When utilizing **Distributed Feedback - Position mode** of operation HSI1 and HSI2 are wired as a master encoder (Quad) to a secondary encoder to close the systems position loop. The motor's feedback is utilized for purposes of motor commutation and velocity control. Since the HSI1 and HSI2 inputs are utilized for applications requiring Distributed Feedback, **you cannot operate in Electronic Gearing, CAM, Step/Dir, Step+/Step- or Quadrature Encoder mode.**

The amplifier utilizes the parameters similar to position mode to control the number of encoder quadrature signals, **SPPR** equivalent to one revolution of the Master Encoder. The IO Configuration Wizard is utilized to set the amplifier into the Distributed Feedback mode. Motion is commanded via Program Control.

## Program Control

Under Program Control the Intelligent servo amplifier will execute Motion, Torque 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 our ftp site, [www.pacsci.com](http://www.pacsci.com).

## Digital/Serial mode

The user may elect to command Current, 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++ DLLs 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.

#### 5.1.3.2 Motor Over Temperature (OT) Input


Motor over-temperature inputs are provided on the feedback connector, J3 on the PC34xxD 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 PC34xxD to monitor this input.

NOTE	
	<p><i>The ADC2+ and ADC2- inputs (pins J3-14 and J3-13) is factory configured as a motor OT input. If utilizing a Tachometer feedback device, you will not have the ability to use a motor thermal OT.</i></p>

#### 5.1.3.3 Tachometer Input

When utilizing a Brush DC Motor with tachometer feedback the user must configure the PC34xxD hardware to receive an analog feedback signal. The cover must be removed from the PC34xxD to access the internal components. *The jumper JP3 must be removed from the PCB*, thus disabling the motor thermal OT and converting it to an analog input for the tachometer.

If a tachometer is to be utilized in an application, then parameter Check Motor OT input (COT) must be set to **Inactive** for the PC34xxD 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. If utilizing a Tachometer feedback device, you must remove the JP3 jumper, (will not have the ability to use a motor thermal OT.)</i></p>

#### 5.1.3.4 Drive-OK/Brake Output

This output can be wired into the customers' hardware e-stop chain and/or utilized to control the relay that energizes the coil of the motor's safety power-off brake. The [Drive-OK/Brake Output \(J1\)](#) must be defined to operate as a Brake output via the **I/O Configuration Wizard** prior to being utilized, [Figure 5-4 ToolPAC Wizards](#). If the drive faults the BRAKE output will be disabled.

- 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!)
- When software configured as a BRAKE output, the output is only active when main power is applied, the unit is enabled and no fault conditions exist. 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 enabled. The relay 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.
- The user has NO software control over this output.

#### 5.1.3.5 High Speed Inputs

The HSI1 and HSI2 inputs are utilized for applications requiring Follow Mode or the Advanced Electronic Gearing Capabilities of the PC340xDi-E. 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 amplifier 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 3400 Series product line.

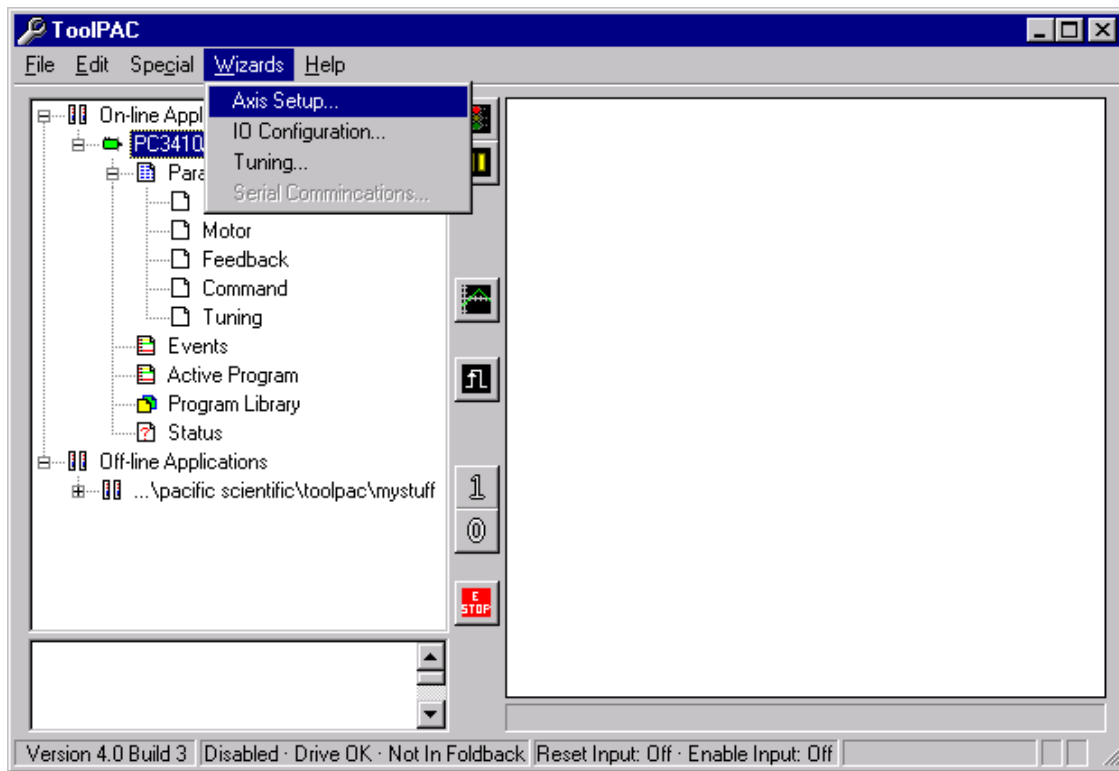
Review this section to familiarize yourself with the features available prior to programming the unit. This will save time in the startup of a new application.

### 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 amplifier.** This wizard will utilize the information provided to create stable tuning parameters Kf, Kp, Ki and PPG.

The customer is required to have the minimal information about the motor type: Kt, Jmotor, Icont, feedback type, etc. Examples of these screens are shown below.

**Figure 5-4** ToolPAC Wizards

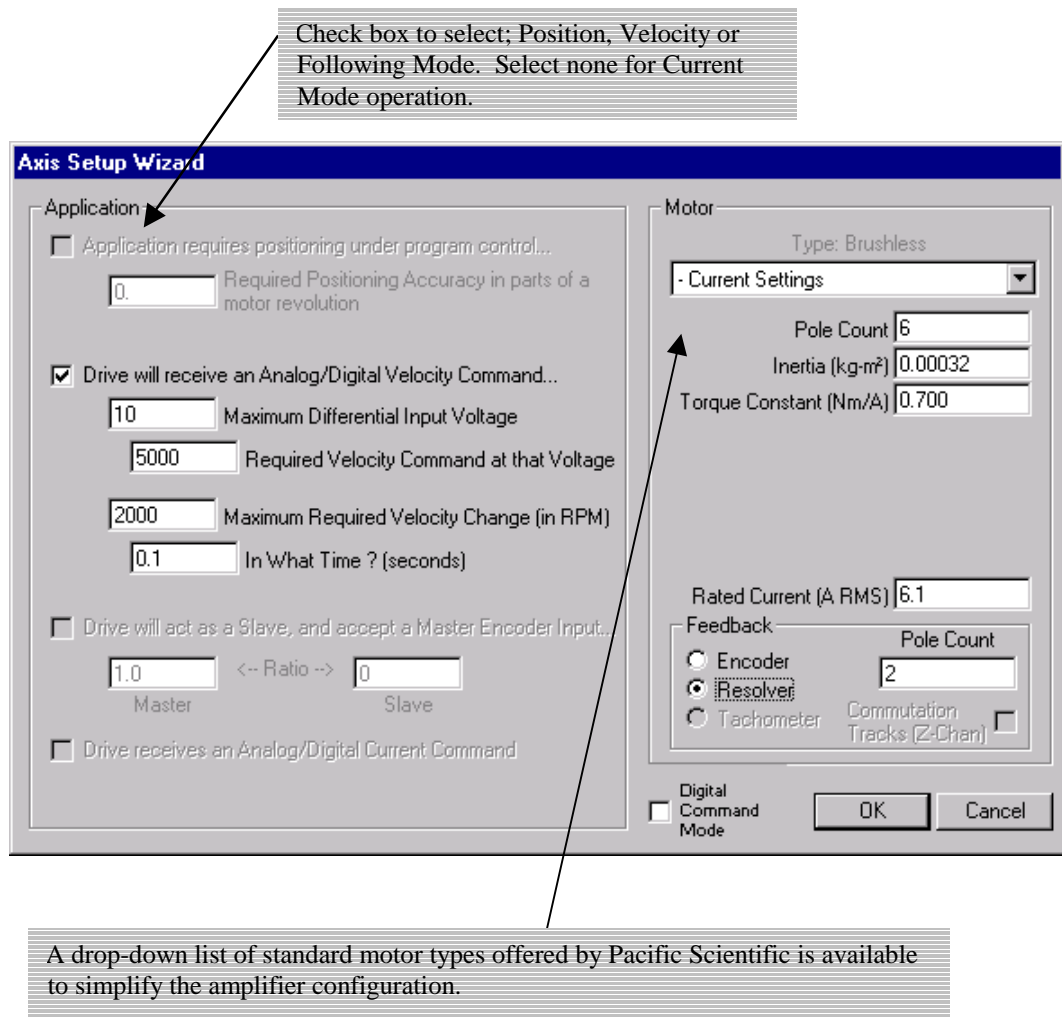




All versions of the 3400 Series can be configured for a **Brush** or **Brushless DC** motor.

The user is required to provide minimal information about the motor type, the application mode, and the command source.

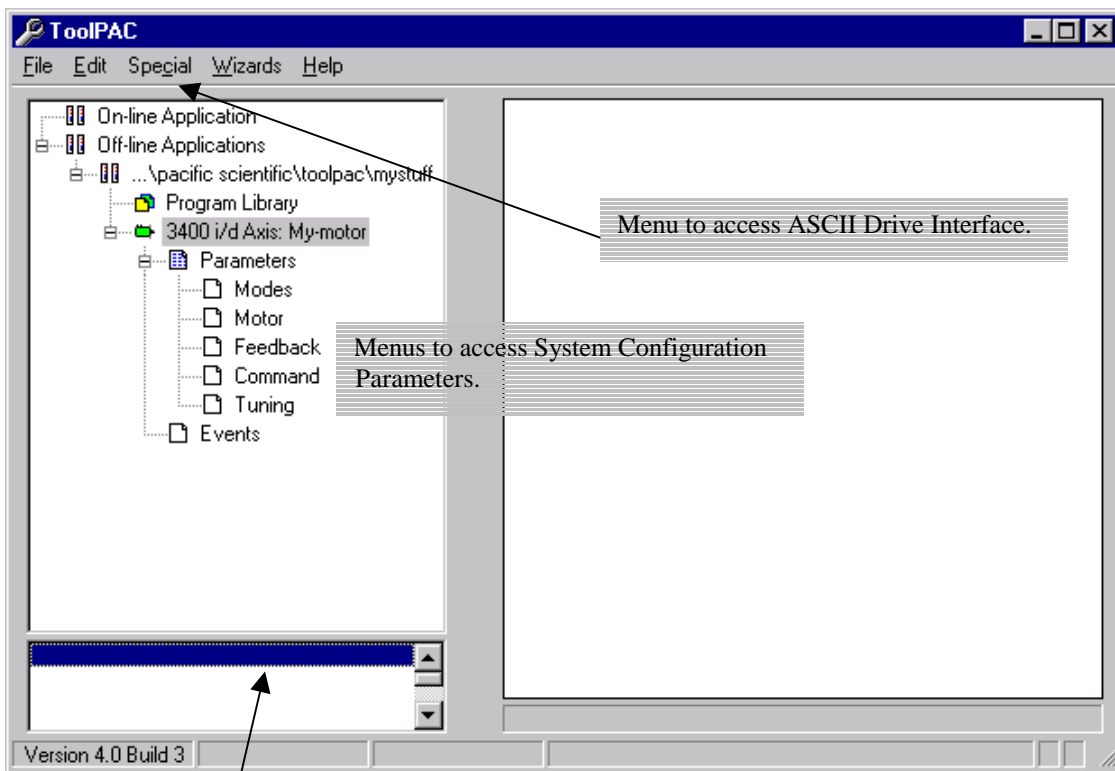
**Figure 5-5 ToolPAC Wizard - Brushless Motor**



### 5.3.3 Digital Current loop tuning procedure

The 3400 Series is a 100% digital servo drive, (the exception are two analog sensors for voltage and current) thus it is necessary for the user to "Tune the Current loop" prior to operating the system. **This procedure MUST be followed when operating a motor that is not listed in the [Axis Setup Wizard](#), to prevent damage to the motor and to provide optimal performance.**

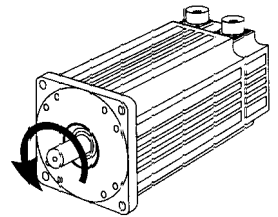
Current loops must be tuned in a similar way to tuning a Brush or Brushless motor. The systems tuning parameters **IKPD** and **IKPQ** must be set (to the same value, i.e.  $IKPD = IKPQ$ ). The tuning of the current loops will have to be done with a locked motor shaft and in current mode, since when the motor is running unloaded the feedback currents are much lower than the command.



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

The tuning procedure is as follows:

- 1) Put drive in current mode, digital command. (Menu: Parameters/Modes)
- 2) If using a Brush DC motor, ensure that the Drive Mode is set to **Brush DC**.  
If using a Brushless DC motor, ensure that the Drive Mode is changed to **Variable-Frequency** for this configuration procedure. (Menu: Parameters/Modes)
- 3) When using Brush motor; lock motor shaft. Set current command **DCC** to a value of between 50% and 100% of **IRMS**. (Menu: Parameters/Command)
- 4) When using Brushless motor; Set the Variable Frequency Current command **VFI** to a value of between 50% and 100% of **IRMS** and Variable Frequency Frequency command **VFF** to 0.0 (Menu: Parameters/Command)
- 5) Set **IKPD**, **IKPQ** to low value (~1000) (Menu: Parameters/Tuning)
- 6) Put variable **IFBK** up in ToolPAC Monitor Window
- 7) Enable drive. Incrementally increase **IKPD** and **IKPQ** until **IFBK** is between 50% and 66% of **DCC** or **VFI**. At this point, the current loop gains are set properly..
- 8) Disable drive.
- 9) Unlock motor shaft.
- 10) Complete the current loop tuning by setting the current loop integral gains **IKID** and **IKIP**.  $IKID=IKPd*0.1$  and  $IKIQ=IKPD*0.1$ . *Be sure to record values for future reference*
- 11) Enable drive and verify the direction of rotation to be **CCW** as viewed from the motor shaft end. You will need to set **VFI=1.0** to command a velocity when utilizing a BLDC motor. 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, thus the motors rotation may be rough. Be sure to record wiring for future reference.*
- 12) Disable drive.
- 13) Change the Drive Mode back to the proper setting for the test motor. See item #2 above.
- 14) Proceed with verification of feedback wiring

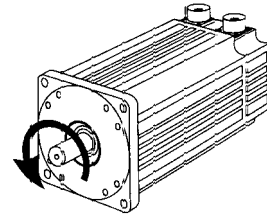


### 5.3.4 Feedback device and wiring verification

If using a Brush DC motor with IR compensation (open-loop, no feedback) then you may skip this section.

Please follow steps #1, #2, #10 and #12 under [Digital Current loop tuning procedure](#) to verify motor wiring is correct before proceeding.

- 1) Put the Motor Velocity and Feedback position in the ToolPAC Monitor Window.
- 2) Manually rotate the Motor CCW and verify that the motor velocity is positive.



- Hall Only (Brushless 6-Step (trap): Put the parameter **HED** in the Monitor Window (Arbitrary Expression). Slowly turn the motor counter-clockwise, CCW while observing the Hall Effect Device (HED) variable. Ensure that (HED) changes in the following order: Verify that the value **HED** for CCW rotation is in the following pattern. *If not, then the halls are wired backwards, swap HALL2 and HALL3 wires or you may change the direction for counting the Hall states via parameter **HINV=1**.*

- Tachometer Feedback: Put the parameter **ADC2** in the Monitor Window (Arbitrary Expression). Verify that the value is positive for CCW rotation. *If not, then the tachometer is wired backwards.*

HED Status					
	H3	H2	H1	CCW	CW
1	0	0	1		▲
5	1	0	1		
4	1	0	0		
6	1	1	0		
2	0	1	0		
3	0	1	1	▼	
1	0	0	1		

- Encoder Only (Brush DC) (Brushless Ignore halls) or Encoder/Hall (Brushless): *If not positive velocity, then the Encoder is wired backwards, swap the B+/B- wires or or you may change the direction for counting the feedback signals states via parameter **FINV=1**.*
- Encoder/Hall: Follow the steps above for Hall Only and Encoder Only.
- *HED counts in REVERSE order for motors with ENCODER/Z-channel encoded commutation.*

- 3) Set current command **DCC** to a value of between 50% and 100% of **IRMS**. (Menu: Parameters/Command)
- 4) Enable the drive.
- 5) Verify that in current mode the motor rotates **CCW** with a positive current command.
  - If Brush DC motor and direction is not **CCW**, repeat steps above to isolate improper wiring. Verify that motor velocity is positive for **CCW** motor rotation if using encoder or tachometer feedback. **You are now finished with your configuration.**
  - If Brushless DC motor you may need to adjust the value of the Commutation Offset **COFF** to account for manufacturer's location of the feedback devices relative to the motor poles. In this next series of steps we will determine the angular offset between the motor phasing and the feedback to determine the Commutation Offset (**COFF**). Proceed with the following steps
- 6) Enable the drive.
- 7) Set current command **DCC** to a value of between 50% and 100% of **IRMS**. (Menu: Parameters/Command)
- 8) Adjust the Commutation Offset (**COFF**) from -180 to 180 degrees to obtain **CCW** motion. (To set **COFF** >180 enter a negative value. IE. 190 > **COFF** = -170 and 200 > **COFF** = -160) (Menu: Parameters/Motor)
- 9) Note the Motor Velocity in the Monitor Window. The Motor Velocity is positive for **CCW** motion. The motor should spin **CCW** with a positive current command.
- 10) Incrementally adjust **COFF** to achieve the highest "positive" motor velocity.
- 11) Set current command **DCC** to a negative of its current value. (Menu: Parameters/Command)
- 12) With a negative Current Command (**DCC**), the motor spins **CW**. Note the Motor Velocity in the Monitor Window. *The Motor Velocity is negative for **CW** motion.*
- 13) Repeat steps 7, through 12 (with the exception of 10) and continue to adjust **COFF** until the Motor Velocity is within 10% of the same speed in the **CCW** and **CW** directions.
- 14) The Commutation Offset (**COFF**) is now properly set.

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; Current, Velocity, Position, Step/Dir, etc. **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 servo system. You may also wish to review [Figure 7-7 Function Block Diagram](#) for additional details on system parameters.

**Table 5.10 Brush DC Motor Parameters**

Brush DC Motor		
Relevant Motor Parameters		
	<b>MRES</b>	motor line-to-line resistance
	<b>KT</b>	motor torque constant
	<b>INER</b>	motor inertia
	<b>IRMS</b>	motor continuous current limit
	<b>IMAX</b>	motor peak current limit
Feedback Parameters		
	<b>EPPR</b>	encoder pulses (edges) per motor revolution
	<b>FBF</b>	feedback filter frequency (usually 100 to 500Hz)
Tachometer Feedback Parameters		
	<b>FBS</b>	motor feedback scaling (volts per kRPM)
	<b>FBF</b>	feedback filter frequency (usually 100 to 500Hz)
	<b>COT</b>	check motor OT input (must be inactive) (remove jumper J3 on the PCB)

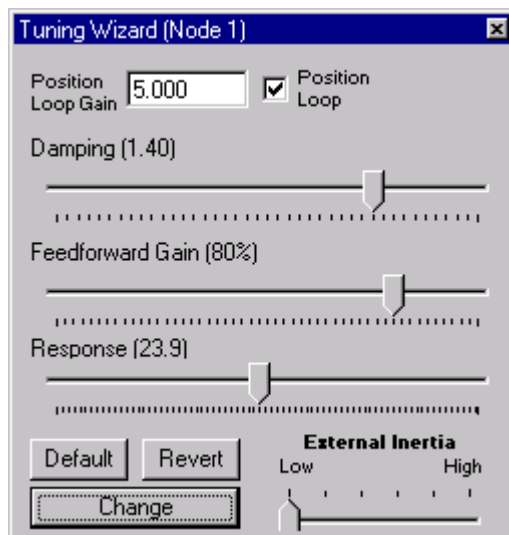
**Table 5.11 Brushless DC Motor Parameters**

BLDC Motor		
Relevant Motor Parameters		
	<b>COFF</b>	commutation offset
	<b>KT</b>	motor torque constant
	<b>MPOL</b>	Motor poles
	<b>INER</b>	motor inertia
	<b>IRMS</b>	motor continuous current limit
	<b>IMAX</b>	motor peak current limit
	<b>IMAX</b>	motor peak current limit
Feedback Parameters (encoder)		
	<b>FEED</b>	encoder, commutating encoder
	<b>EPPR</b>	encoder pulses (edges) per motor revolution
	<b>FBF</b>	feedback filter frequency (usually 100 to 500Hz)

### 5.3.6 Wizard: Tuning

The Tuning Wizard is typically utilized in conjunction with the ToolPAC Scope to monitor the commanded motion versus the motion output. The slider bars are provided to assist with making adjustments. The slider bars are arranged in the order of importance, the most important is displayed at the top of this Tuning Wizard screen. During the adjustment process the software will automatically adjust the Kp, Ki, and Kf parameters. If the system becomes unstable during this process, select DEFAULT or REVERT, then select CHANGE.

**Figure 5-6** ToolPAC Wizard - Tuning





### 5.3.7 Update New Firmware

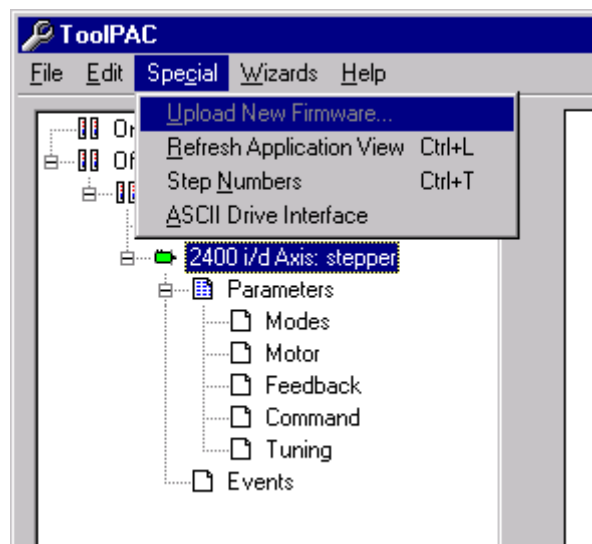
A special feature of the 3400 series drive is the ability of the user to upgrade the FLASH Memory with new firmware. This feature is useful for performing field upgrades to units as software enhancements or custom commands are made available.

ToolPAC will prevent you from accidentally loading the improper firmware to your unit.

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 amplifier) 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. <b>POWER MUST NOT BE INTERRUPTED DURING FIRMWARE UPLOAD!</b></i></p>

**Figure 5-7 Upload New Firmware**



---

## 6. Maintenance/Troubleshooting

---

This section summarizes the status and error codes that may result in a fault on the PC34xxD Series Servos. It also makes recommendations for troubleshooting and fault recovery procedures.

**LOOK at the Fault history available in the ToolPAC STATUS screen!**

---

### 6.1 Status LED

A status Red/Green LED is located on the front of the PC34xxD Series amplifier to provide the user with information on the current status of the amplifier. 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
<b>Green</b>	Drive OK
<b>Red</b>	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!
- Configure the drive for your selected motor type and feedback type.
- 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 Feedback parameters are set properly.
- Verify that Current loop and velocity loop parameters are set properly.
- Verify that hard-limit input is not active.
- Verify brake is released.
- Verify motor is connected. Check parameter **IFBK** in the monitor window.
- Verify load is not jammed
- Verify motor Check wiring for loose connections, possible shorts and verify module and I/O is correctly wired.
- Verify motor for shorts.

### 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.
- Bus-Fault; Verify that you are supplying the correct DC voltage to the drive. Check parameter **VDC** in the monitor window.
- Verify motor Check wiring for loose connections, possible shorts and verify module and I/O is correctly wired.
- Verify motor for shorts.
- Verify that the Motor and Feedback 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


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

### 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.


	<b>NOTE</b>
	<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>

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.

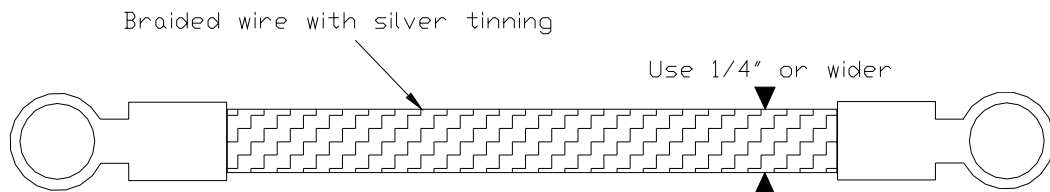
<b>CAUTION</b>	
	<p><i>Use Star grounding arrangement. Chain grounding or daisy-chain arrangements should not be used.</i></p>

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 mm<sup>2</sup>) 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.

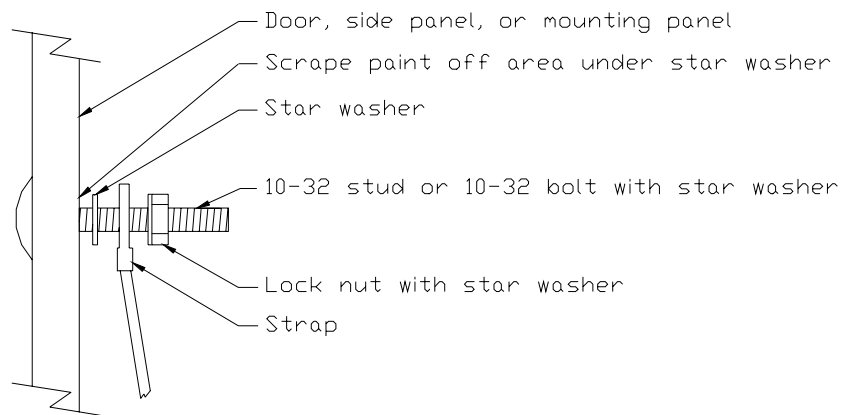
<b>NOTE</b>	
	<p><i>Where electrical codes call for the typical green safety ground wires, use them <b>in addition</b> to any ground strap suggested in this guide.</i></p>

**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>

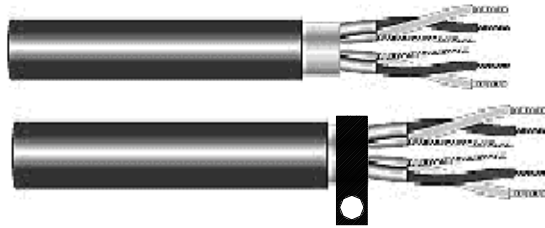
NOTE	
	<p><i>Provide separate wire ways for main AC, low power AC, high power DC, and low power DC.</i></p>

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 **34xx** Series Amplifiers 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 [Figure 7-3 Suggested Wire](#) below.





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

**Figure 7-3 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.

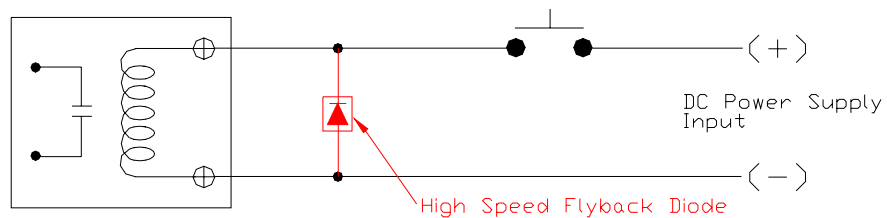
Secondary power (logic commons), if provided by individual equipment, should be directly wired from their source to the SPG utilizing 12 AWG (3.5 mm<sup>2</sup>) wire.

## 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.

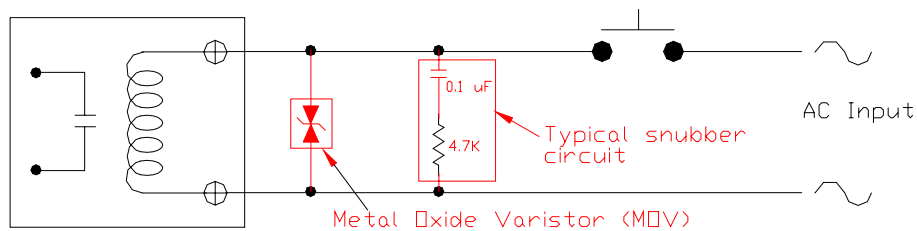
**Figure 7-4 Suppression - DC Relay**



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  $\mu\text{F}$  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.

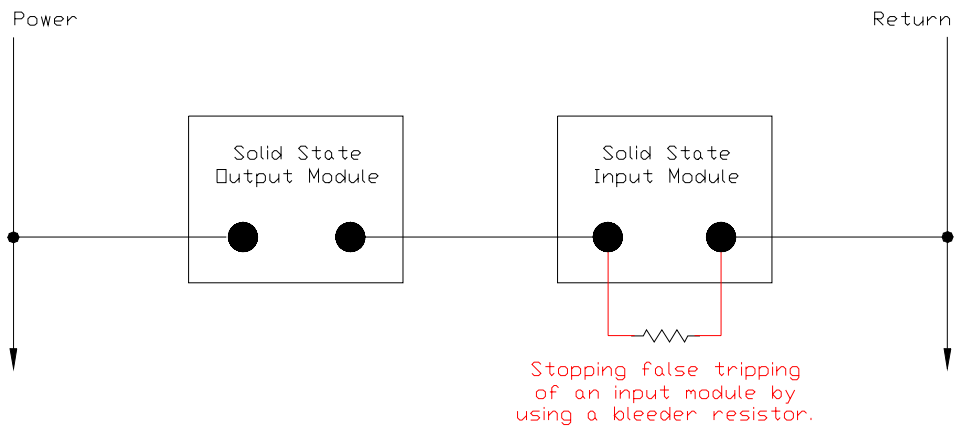
Metal Oxide Varistors (MOV) are less effective than an RC Snubber for noise suppression and tend to degrade over time.

**Figure 7-5 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 3400. The resistor's rating depends on the output device's leakage current and the input device's OFF voltage.

**Figure 7-6 De-coupling - SS Relay**



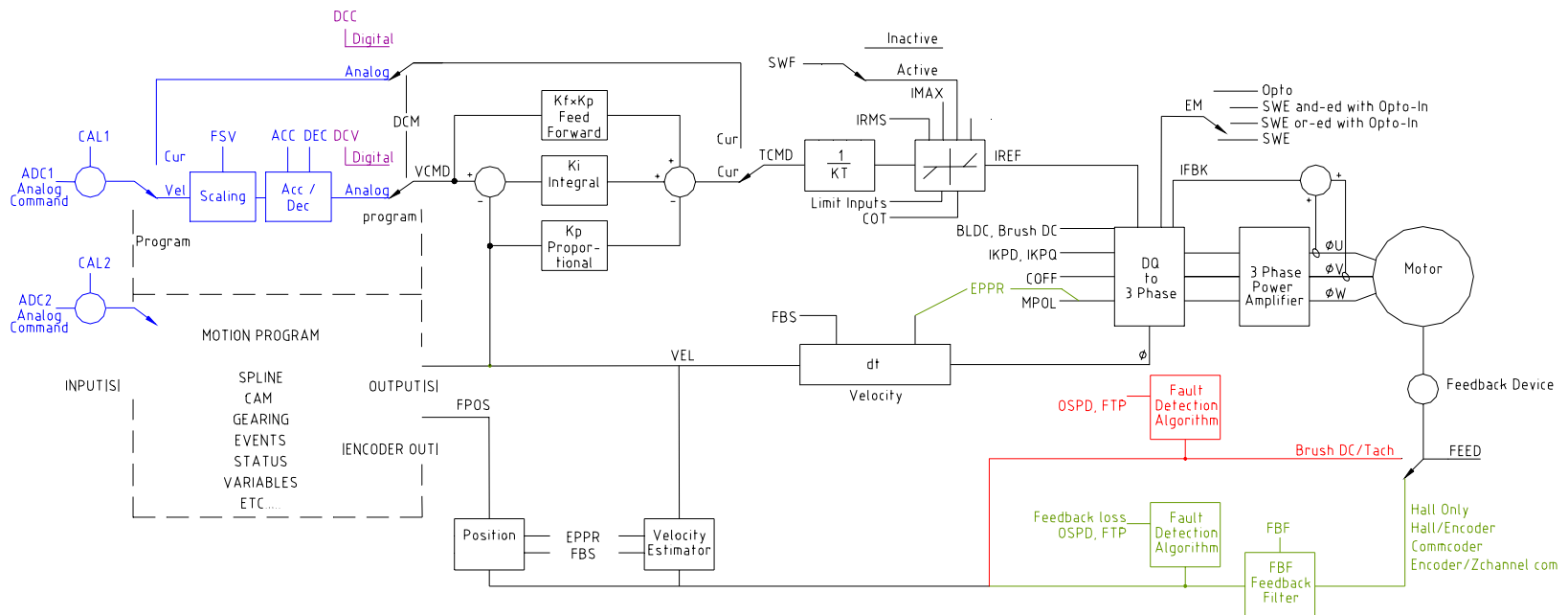
## 7.2 Relevant Engineering Prints

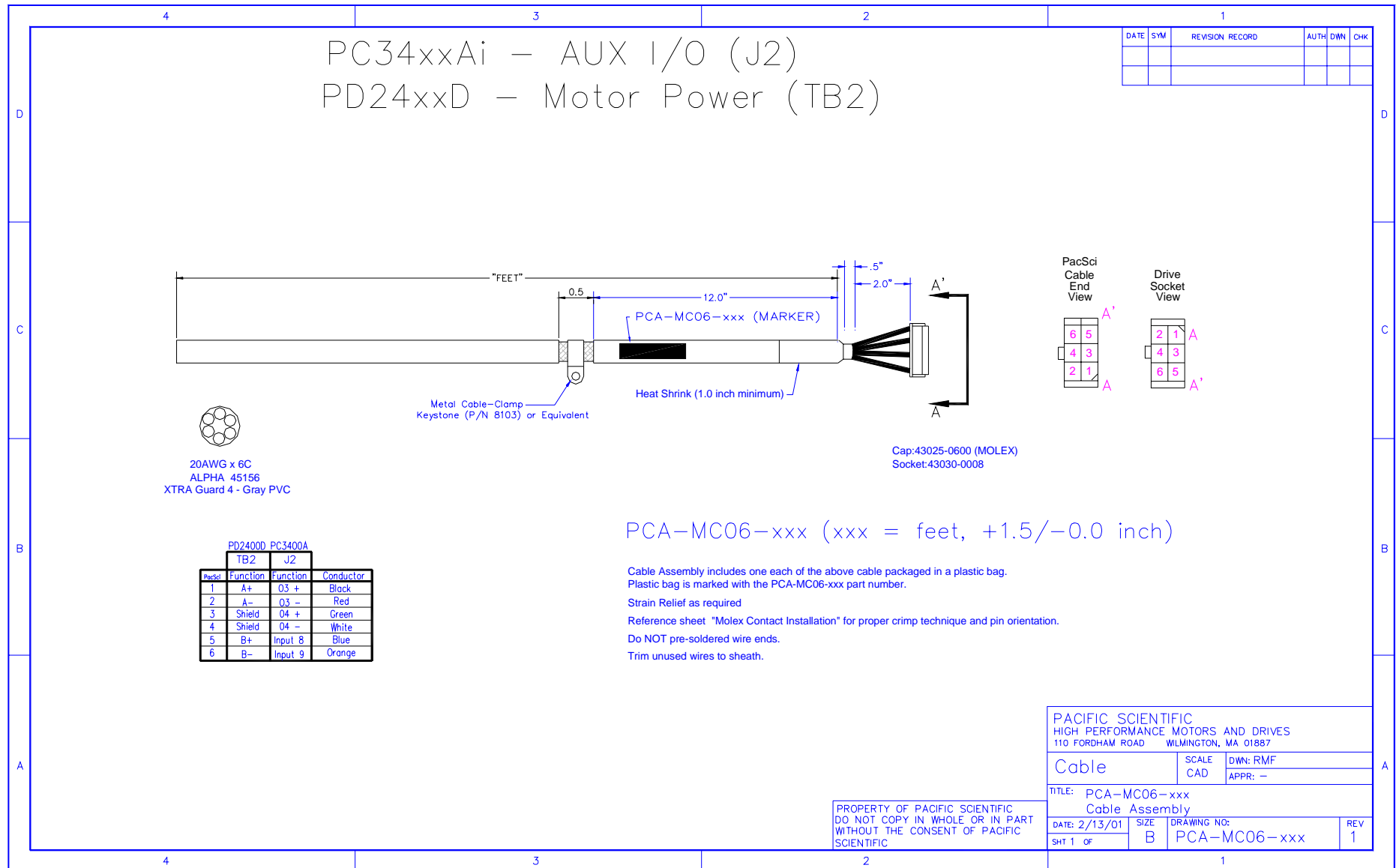
In this section we present a number of system interconnect drawings to be utilized as guidelines for a generic installation.

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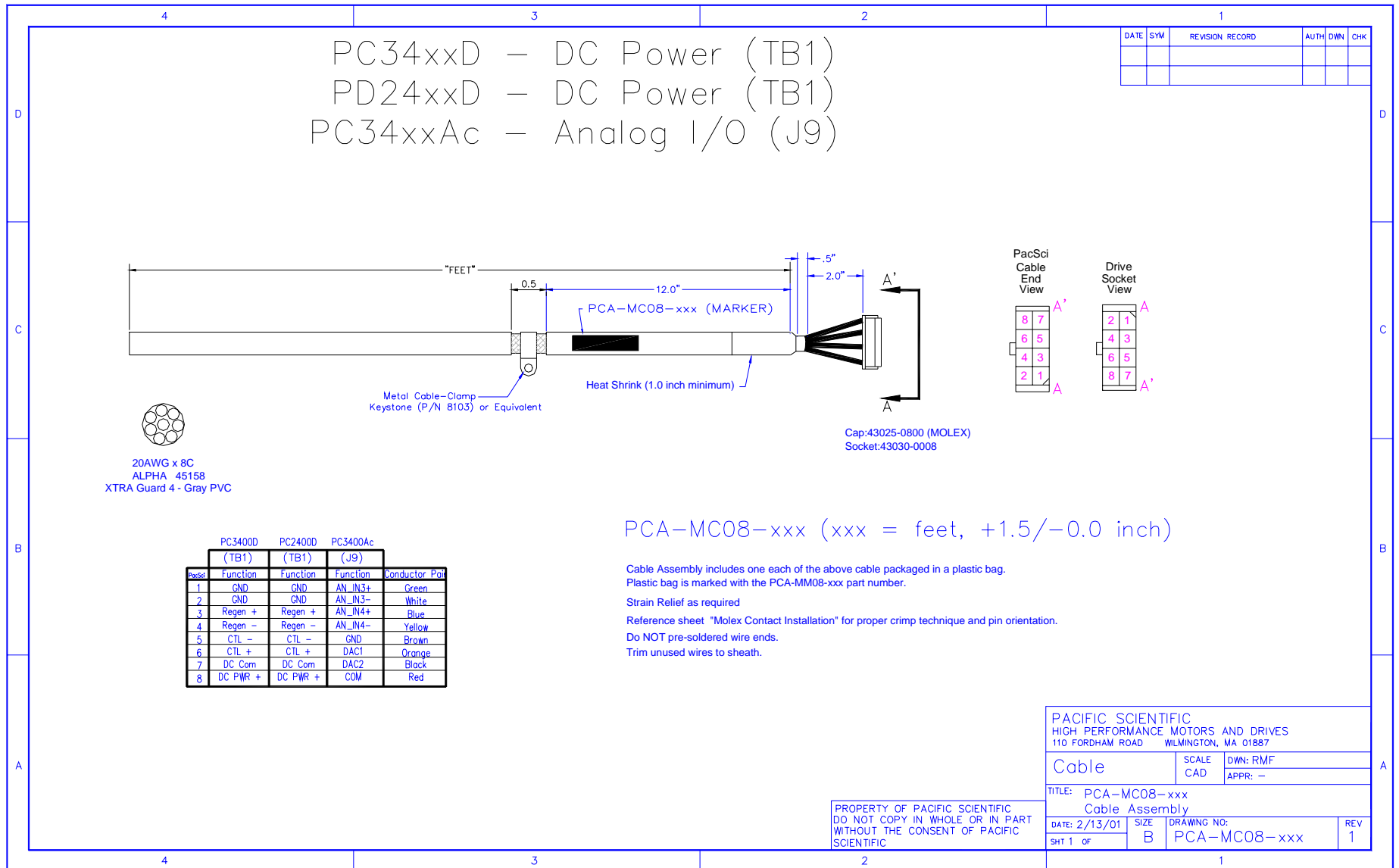


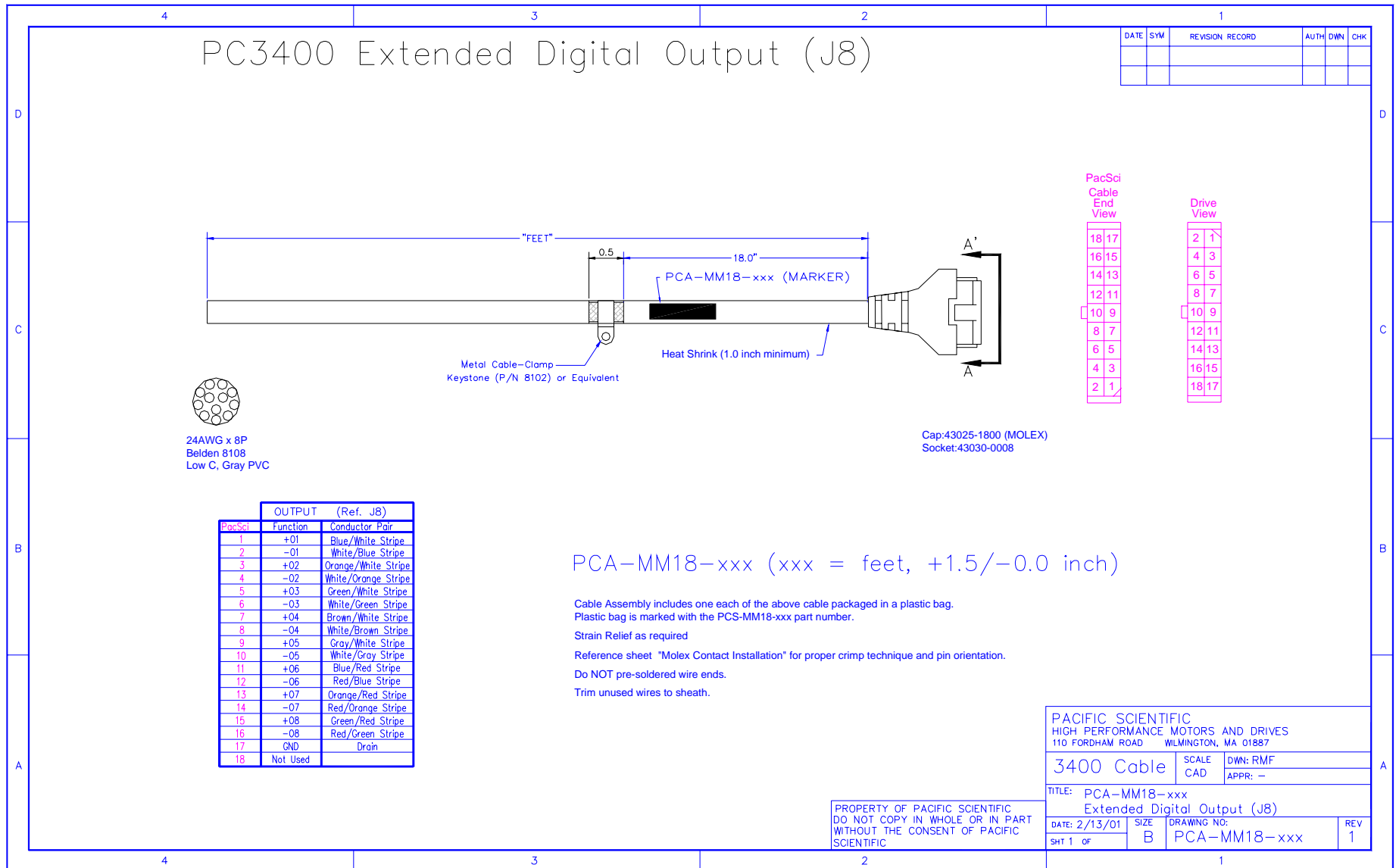
**Figure 7-7 Function Block Diagram**

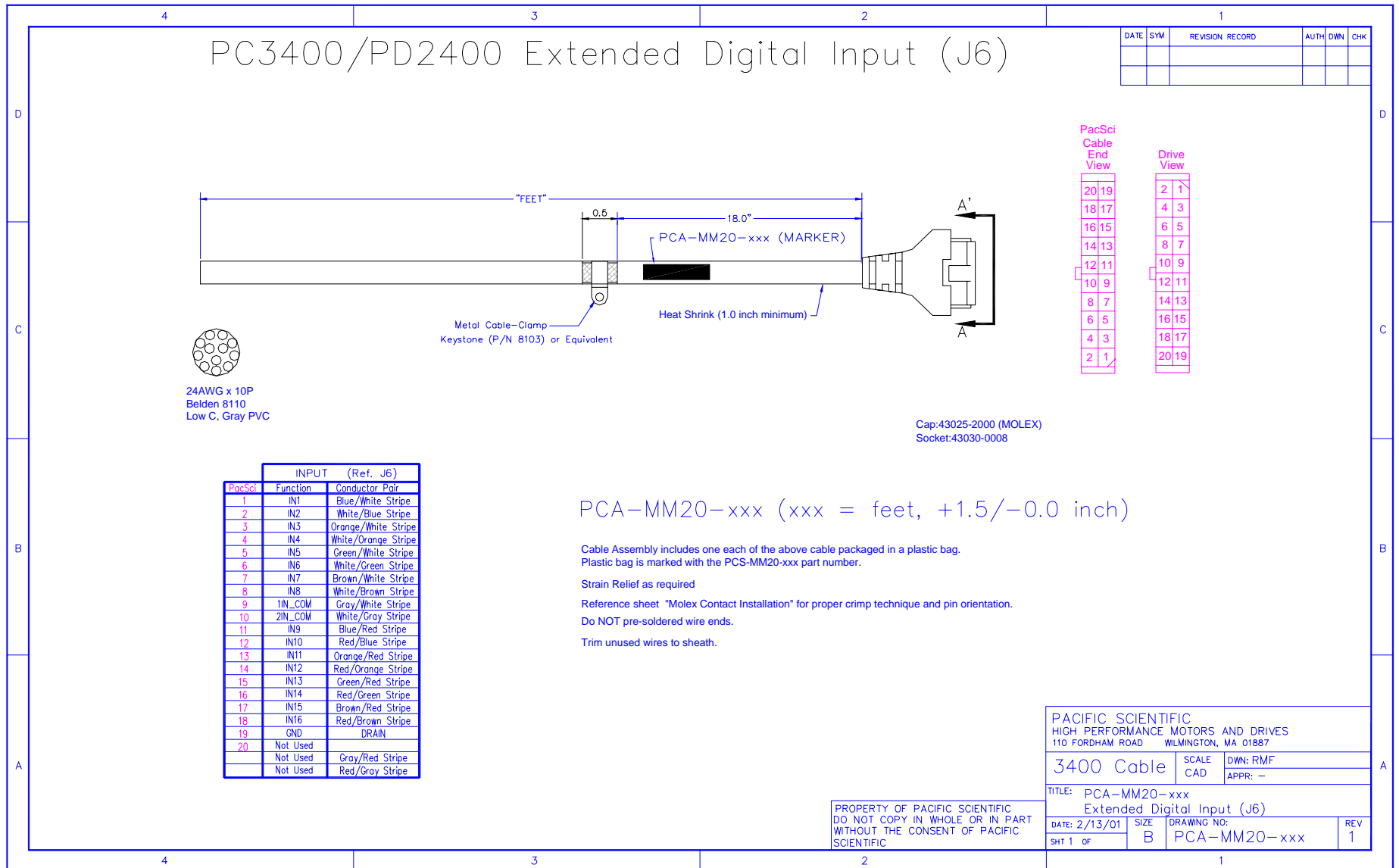


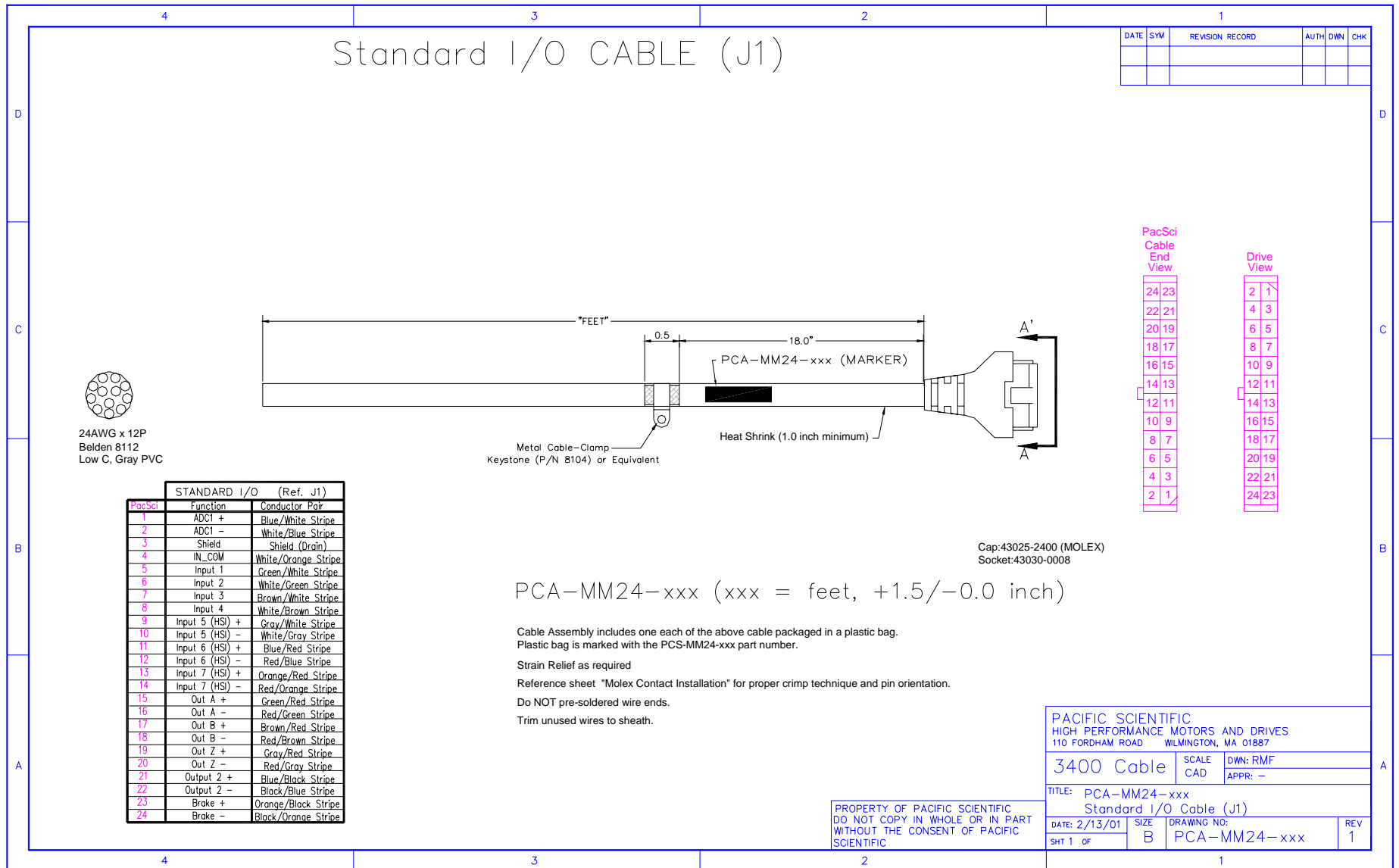


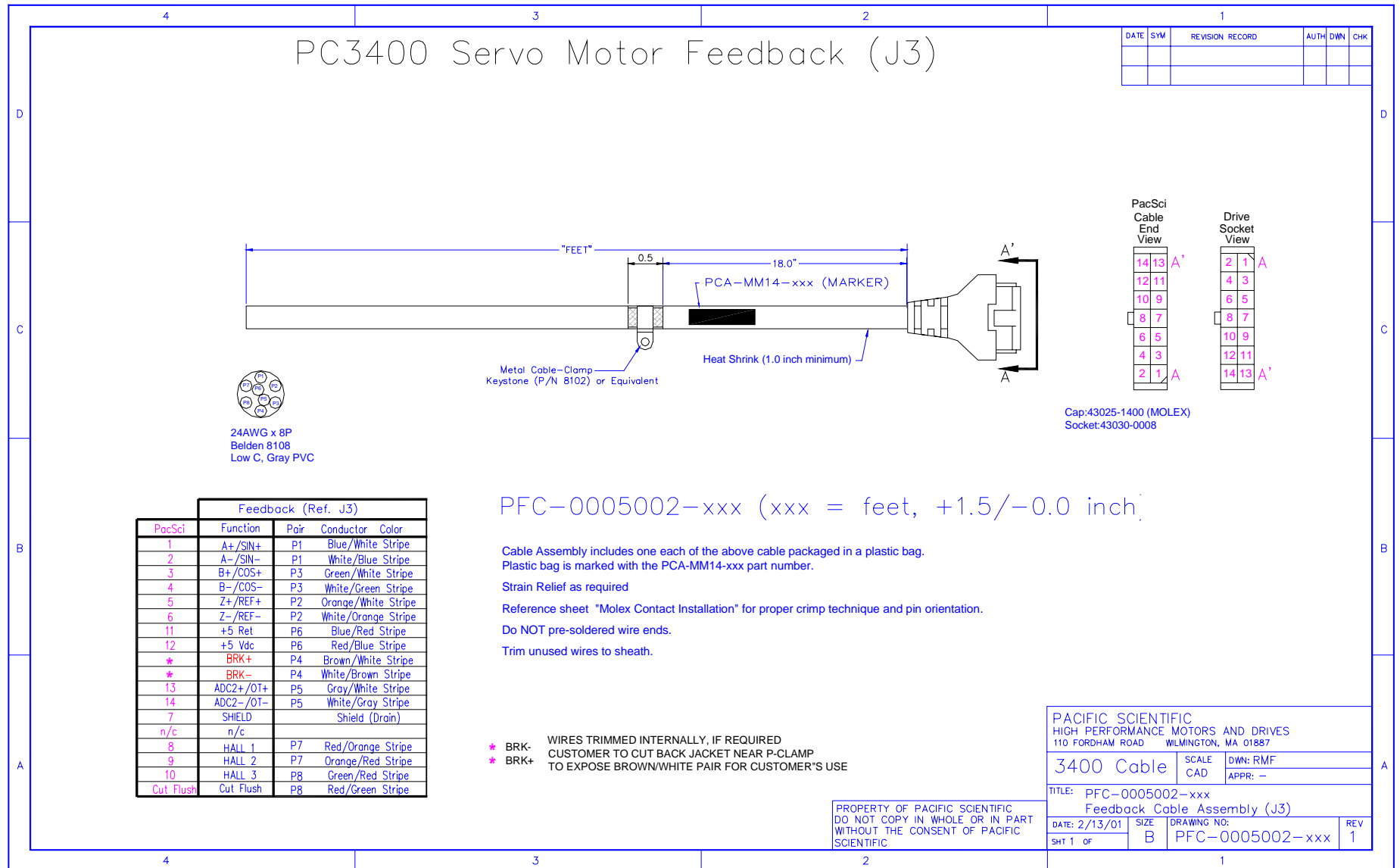




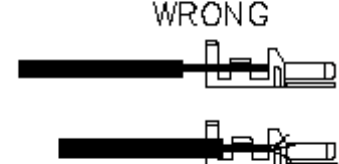
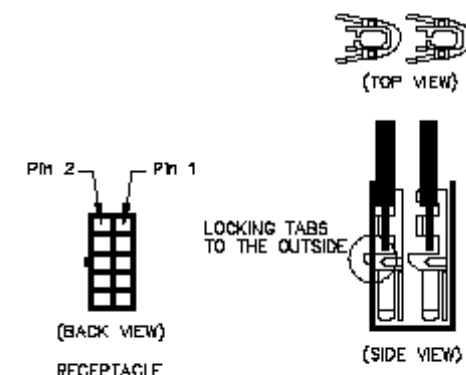
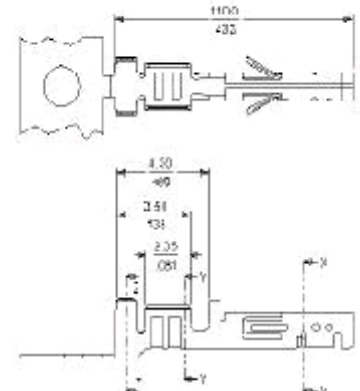


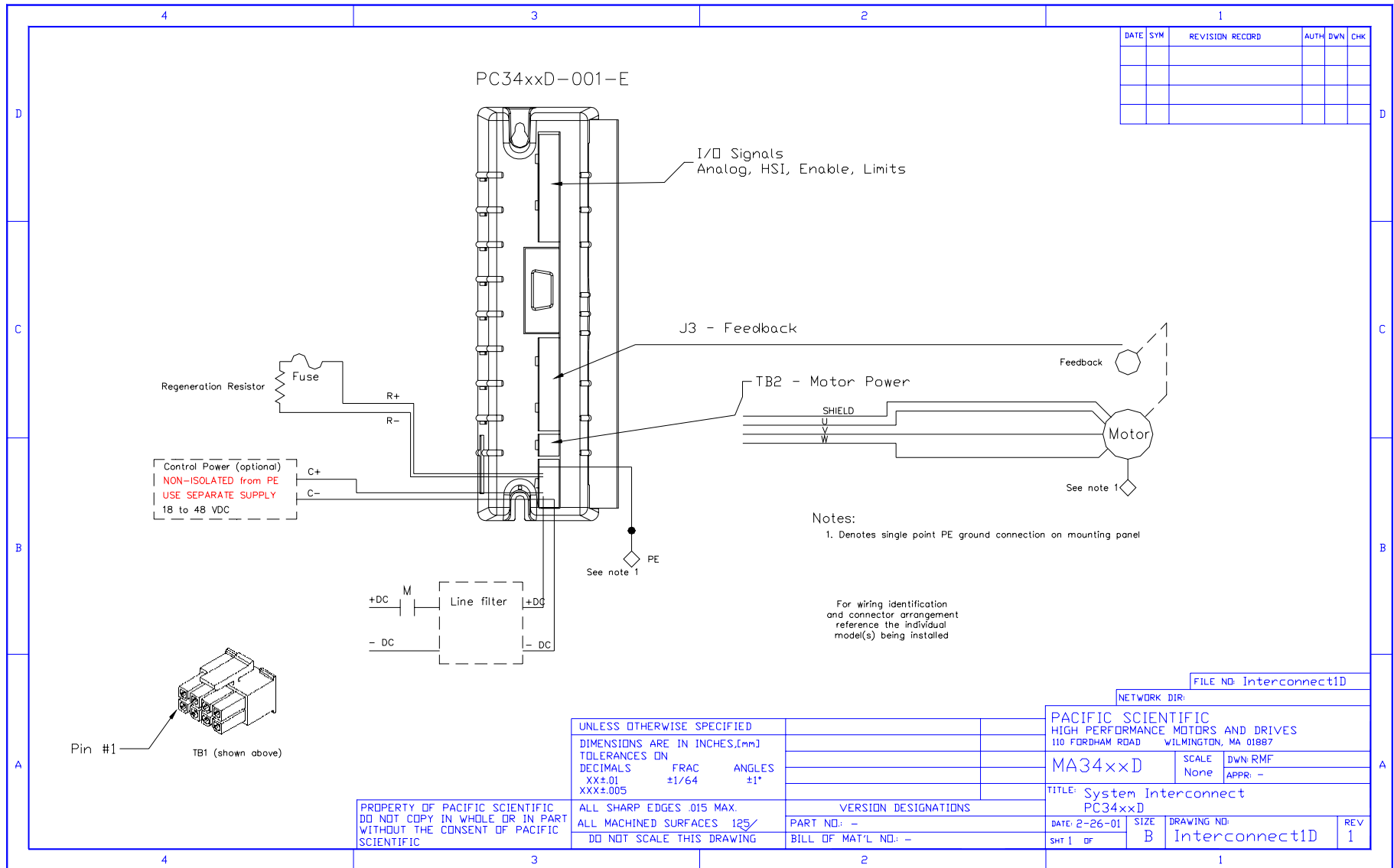








<p style="text-align: center;"><b>ACCEPTED METHOD</b></p> <p>LAY WIRE ONTO THE CONTACT ALLOWING THE INSULATION TO EXTEND BEYOND THE CONTACT. USING THE TERMINAL CRIMPER (11-03-0043) PRESS CONTACT INTO THE WIRE. THE INSULATION WILL BE PEARCED AND THE WIRE TRIMMED PROPERLY. REMOVED EXCESS WIRE.</p>	<p style="text-align: center;"><b>OPTIONAL METHOD</b></p> <p>24-28 awg STRANDED WIRE</p>  <p style="text-align: center;"><b>RIGHT</b></p>  <p>INSULATION MUST BE PART OF CRIMP</p> <p style="text-align: center;"><b>WRONG</b></p>  <p>STRANDS OF WIRE DO NOT EXTEND IN CONTACT AREA</p>	<p style="text-align: center;"><b>ORIENTATION</b></p>  <p style="text-align: center;">(TOP VIEW)</p> <p style="text-align: center;">(BACK VIEW)</p> <p style="text-align: center;">(SIDE VIEW)</p> <p style="text-align: center;">LOCKING TABS TO THE OUTSIDE</p> <p style="text-align: center;">RECEPTACLE MOLEX P/N: 43025-XXXX</p>	 <p style="text-align: center;"><b>MOLEX SOCKET</b></p> <p style="text-align: right;">MOLEX P/N: 43030-0008</p> <p style="text-align: center;"><b>TERMINAL SPECIFICATION</b></p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">WIRE SIZE</th> <th colspan="2">INSULATION DIA</th> <th colspan="2">STRIP LENGTH</th> </tr> <tr> <th>AWG</th> <th></th> <th>INCH</th> <th></th> <th>INCH</th> <th></th> </tr> </thead> <tbody> <tr> <td rowspan="2">43030-0008</td> <td>MIN</td> <td>MAX</td> <td>MIN</td> <td>MAX</td> <td>MIN</td> <td>MAX</td> </tr> <tr> <td>24</td> <td>20</td> <td>-</td> <td>.073</td> <td>.100</td> <td>.115</td> </tr> </tbody> </table> <p style="text-align: center;"><b>REQUIRED TOOLS:</b></p> <table border="0" style="width:100%;"> <tr> <td>TERMINAL CRIMPER</td> <td style="text-align: right;">11-01-0200</td> </tr> <tr> <td>CRIMP TERMINAL EXTRACTOR</td> <td style="text-align: right;">11-03-0043</td> </tr> </table>		WIRE SIZE		INSULATION DIA		STRIP LENGTH		AWG		INCH		INCH		43030-0008	MIN	MAX	MIN	MAX	MIN	MAX	24	20	-	.073	.100	.115	TERMINAL CRIMPER	11-01-0200	CRIMP TERMINAL EXTRACTOR	11-03-0043
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<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td colspan="2" style="text-align: right;">FILE NO:</td> </tr> <tr> <td colspan="2" style="text-align: right;">NETWORK DR:</td> </tr> <tr> <td colspan="2" style="text-align: right;">PACIFIC SCIENTIFIC HIGH PERFORMANCE MOTORS AND DRIVES 110 FORDHAM ROAD WILMINGTON, VA 01887</td> </tr> <tr> <td style="text-align: right;">Molex</td> <td>SCALE: None</td> <td>DWG P/N: APPR: -</td> </tr> <tr> <td colspan="3" style="text-align: center;">TITLE: Molex Contact Installation</td> </tr> <tr> <td style="text-align: right;">DATE: 2/12/01</td> <td style="text-align: right;">SIZE: B</td> <td style="text-align: right;">DRAWING NO: Molex_Install</td> </tr> <tr> <td style="text-align: right;">SHT 1 OF</td> <td></td> <td style="text-align: right;">REV: 1</td> </tr> </table>			FILE NO:		NETWORK DR:		PACIFIC SCIENTIFIC HIGH PERFORMANCE MOTORS AND DRIVES 110 FORDHAM ROAD WILMINGTON, VA 01887		Molex	SCALE: None	DWG P/N: APPR: -	TITLE: Molex Contact Installation			DATE: 2/12/01	SIZE: B	DRAWING NO: Molex_Install	SHT 1 OF		REV: 1													
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### PC3402Dd-001-E Series PC3405Dd-001-E Series

AREA FOR OPT ION CARD'S Extended IO  
(See - Options + Cables/vol)

PC3405D USES HEATSHRINK WITH FHS PACKAGING IS THE SAME

Comm Part All Models

Pin #	RB-232	RB-422	RB-422	RB-426
1	NC	Tx+	Rx-	Rx+/Tx-
2	Tx	Tx-	Rx-	Rx+/Tx-
3	Rx	Rx-	Rx-	Rx+/Tx-
4	NC	Rx+	Rx+	Rx+/Tx-
5	COM	COM	COM	COM
6	-	-	-	-
7	-	-	-	-
8	-	-	-	-
9	-	-	-	-

**CA-DB9-232-6**

#### Drive Socket

2	1
4	3
6	5
8	7
10	9
12	11
14	13
16	15
18	17
20	19
22	21
24	23

#### Wiring Table

##### J1 - VO (PC340x Dd-001-E)

Pin #	Isolated IO	Pin #	Isolated IO
2	ADC1 -	1	ADC1+
4	IN_COM	3	Grid
6	Input2	5	ENABLE
8	CAWInput 4	7	CAWInput 3
10	Inputs (HS I)-	9	Inputs (HS I)+
12	Inputs (HS I)-	11	Inputs (HS I)+
14	Spare	13	Spare
16	Out A -	15	Out A +
18	Out B -	17	Out B +
20	Out Z -	19	Out Z +
22	Spare	21	Spare
24	OK/Brake -	23	OK/Brake +

##### J3 - Encoder Feedback

Pin #	Signal	Pin #	Signal
2	A -	1	A +
4	B -	3	B +
6	Z -	5	Z +
8	HED 1	7	Grid
10	HED 3	9	HED 2
12	+5 VDC	11	+5 Return (com)
14	ADC2 -/OT -	13	ADC2+/OT +

##### TB2 - BLDC Motor

Pin #	Connection	Pin #	Connection
2	Phase V	1	Phase W
4	Phase U	3	Grid

##### TB3 - Brush DC Motor

Pin #	Connection	Pin #	Connection
2	DC -	1	VCC
4	DC +	3	Grid

##### TB1 - DC Power/Regen

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

#### Cable p/n \*

PCA-XXnn-xxx  
XX = Connector Style  
nn = number of pins  
xxx = 12.1, +1.5"-0.0 inch

Molex Connector

Color Coded Flying Leads

"FEET" 12.0"

PCA-MM24-xxx (MARKER)

PFC-0005002-XXX (MARKER)

PCA-MC4-xxx (MARKER)

PCA-MDB-xxx (MARKER)

Motor and Feedback - Cable Set Available for Many Standard Motor Series

Pin REFERENCE

PIN 1

\* SK-PC340xxD includes all connectors and pins for customers to build their own cables (NOT included with Drive)

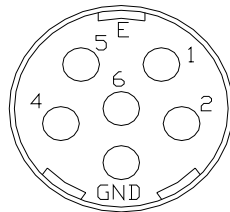
PACIFIC SCIENTIFIC		NETWORKS	
1000 FERRIS BLVD, SUITE 100, WILMINGTON, MA 01897			
PC340xD	DATE	DATE	APP
TITLE: PC340xDd-001-E Cables	04/01	04/01	-
REV: 2/10	REV: 04/01	REV: 04/01	REV: 1
REV: 03/10	REV: 04/01	REV: 04/01	REV: 1



## 7.2.1 Motor connectors

**Figure 7-8 Interconnectron (6-Pin)**

Interconnectron "E" Option  
Power Connector  
PMA Series, S series



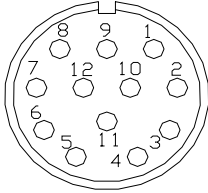
Motor Pin	Motor	PC3400	Drive Pin
1	U	V	TB2-2
2	W	W	TB2-1
gnd	Earth case	GND	TB2-4
4	Brake -		
5	V	U	TB2-3
E	Brake +		

**SUGGESTED MATING CONNECTOR**

CONNECTOR
LPLA 06D FRRN 213 00 A5 PACIFIC SCIENTIFIC 769-004916-00.

**Figure 7-9 Interconnectron (12-Pin and 17-Pin)**

**Interconnectron "E" Option  
Hall Feedback 12-Pin  
PMA Series, S series with Hall only**

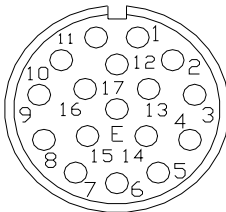


Motor Pin	Motor	PC3400	Drive Pin
1	+ 5 VDC	+5 VDC	J3-12
2	0V supply	+5 Return(com)	J3-11
3	Hall 3	Hall 3	J3-10
4	Hall 1	Hall 1	J3-8
5	Hall 2	Hall 2	J3-9
6	not used		
7	OT +	ADC2 + / OT +	J3-13
8	OT -	ADC2 - /OT -	J3-14
9	not used		
10	not used		
11	not used		
12	not used		

**SUGGESTED MATING CONNECTOR**

CONNECTOR
SPNA 12T FRON 169 00 D9 PACIFIC SCIENTIFIC 769-004915-00

**Interconnectron "E" Option  
Feedback Connector 17-Pin  
PMA Series, Commutating Encoder**



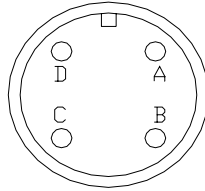
**SUGGESTED MATING CONNECTOR**

CONNECTOR
SPNA 17H FRON 169 00 E3 PACIFIC SCIENTIFIC 769-004917-00

Motor Pin	PMA Series	PC3400	Drive Pin
1	5V +	+5 VDC	J3-12
2	PTC	ADC2 + / OT +	J3-13
3	0V supply	+5 Return(com)	J3-11
4	Hall Sensor W +		
5	Hall Sensor W -		
6	Hall Sensor U +		
7	Hall Sensor U -		
8	Hall Sensor V +		
9	Hall Sensor V -		
10	A +	A+	J3-1
11	A -	A-	J3-2
12	B +	B+	J3-3
13	B -	B-	J3-4
14	Z +	Z+	J3-5
15	Z -	Z-	J3-6
16	not used		
17	PTC rtn	ADC2 - /OT -	J3-14

**Figure 7-10 MS Connector (4-Pin)**

**Connector "C" Option  
Power Connector  
S30/R30/40/R60 Series**



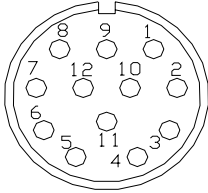
Motor Pin	Motor	PC3400	Drive Pin
A	R	V	TB2-2
B	S	U	TB2-3
C	T	W	TB2-1
D	Ground	GND	TB2-4

**SUGGESTED MATING CONNECTOR  
AND CLAMP**

SERIES	MATING CONNECTOR	CLAMP
R20, R30 R40, R60	MS3106A20-4S PACIFIC SCIENTIFIC PIN C200007	MS3057-12A-1 PACIFIC SCIENTIFIC PIN CE00003
R60	MS3106A24-22S PACIFIC SCIENTIFIC PIN C200010	MS3057-16A-1 PACIFIC SCIENTIFIC PIN CE00004

**Figure 7-11 MS Connector (12-Pin and 17-Pin)**

**Connector "C" Option**  
**Hall Feedback 12-Pin**  
PMA Series, S series with Hall only

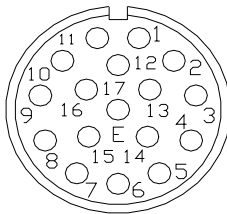


Motor Pin	Motor	PC3400	Drive Pin
1	+ 5 VDC	+5 VDC	J3-12
2	0V supply	+5 Return(com)	J3-11
3	Hall 3	Hall 3	J3-10
4	Hall 1	Hall 1	J3-8
5	Hall 2	Hall 2	J3-9
6	not used		
7	OT +	ADC2 + / OT +	J3-13
8	OT -	ADC2 - /OT -	J3-14
9	not used		
10	not used		
11	not used		
12	not used		

**SUGGESTED MATING CONNECTOR**

CONNECTOR
SPNA 12T FRON 169 00 D9
PACIFIC SCIENTIFIC
769-004915-00

**Interconnectron "E" Option**  
**Feedback Connector 17-Pin**  
PMA Series, Commutating Encoder



Motor Pin	PMA Series	PC3400	Drive Pin
1	5V +	+5 VDC	J3-12
2	PTC	ADC2 + / OT +	J3-13
3	0V supply	+5 Return(com)	J3-11
4	Hall Sensor W +		
5	Hall Sensor W -		
6	Hall Sensor U +		
7	Hall Sensor U -		
8	Hall Sensor V +		
9	Hall Sensor V -		
10	A +	A+	J3-1
11	A -	A-	J3-2
12	B +	B+	J3-3
13	B -	B-	J3-4
14	Z +	Z+	J3-5
15	Z -	Z-	J3-6
16	not used		
17	PTC rtn	ADC2 - /OT -	J3-14

**SUGGESTED MATING CONNECTOR**

CONNECTOR
SPNA 17H FRON 169 00 E3
PACIFIC SCIENTIFIC
769-004917-00

## 7.3 Options and Accessories

### 7.3.1 Accessories

**Table 7.12 System Accessories**

<b>ToolPAC</b>	ToolPAC SOFTWARE, CD ROM (includes manuals)
<b>MA34xxD</b>	PC34xxD Family Hardware Reference Manual
<b>MAToolPAC</b>	ToolPAC Software Reference Manual
<b>PCA-MC6-006</b>	CABLE ASSEMBLY, EXTENDED I/O, 6 POS, 6 FT (J2)
<b>PCA-MM18-006</b>	CABLE ASSEMBLY, EXTENDED OUTPUTS, 18 POS, 6 FT (J8)
<b>PCA-MM20-006</b>	CABLE ASSEMBLY, EXTENDED INPUTS, 20 POS, 6 FT (J6)
<b>PCA-MM24-006</b>	CABLE ASSEMBLY, I/O, 24 POS, 6 FT (J1)
<b>PFC-000502-010</b>	CABLE ASSEMBLY, FEEDBACK, 14 POS, 10 FT (J3)
<b>PRK-0180-26</b>	REGEN RESISTOR KIT
<b>RS-232-5600</b>	CABLE ASSEMBLY, DB9, RS-232, 6 FT
<b>PTK-3MD-001</b>	HAND CRIMP TOOL, MOLEX 3mm/EXTRACTOR
	HAND CRIMP TOOL, MOLEX 3MM (Molex 11-01-0200)
<b>SK-340xD</b>	SHIP KIT FOR PC340xDd/PC340xDi SERVOS (includes the following)
<b>102-3MD-0008</b>	Pins, Gold, Loose, 20-24 AWG (Molex 43030-0008)
<b>102-3MD-04</b>	Receptacle, 4 pos, 3mm, Dual Row (Molex 43025-0400)
<b>102-3MD-08</b>	Receptacle, 8 pos, 3mm, Dual Row (Molex 43025-0800)
<b>102-3MD-14</b>	Receptacle, 14 pos, 3mm, Dual Row (Molex 43025-1400)
<b>102-3MD-24</b>	Receptacle, 24 pos, 3mm, Dual Row (Molex 43025-2400)
<b>SK-34xxD-1</b>	SHIP KIT FOR PC340Di-001-EI SERVO (includes the following)
<b>102-3MD-0008</b>	Pins, Gold, Loose, 20-24 AWG (Molex 43030-0008)
<b>102-3MD-04</b>	Receptacle, 4 pos, 3mm, Dual Row (Molex 43025-0400)
<b>102-3MD-08</b>	Receptacle, 8 pos, 3mm, Dual Row (Molex 43025-0800)
<b>102-3MD-14</b>	Receptacle, 14 pos, 3mm, Dual Row (Molex 43025-1400)
<b>102-3MD-18</b>	Receptacle, 18 pos, 3mm, Dual Row (Molex 43025-1800)
<b>102-3MD-20</b>	Receptacle, 20 pos, 3mm, Dual Row (Molex 43025-2000)
<b>102-3MD-24</b>	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