Danaher Motion

Single-Axis Brushless Servo Drive

PCE830/40 User Manual

Pacific Scientific

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SAFETY

The equipment described herein has been developed, produced, tested and documented in accordance with the corresponding standards. During use conforming with requirements, the equipment is not dangerous for people or equipment. Use conforming with requirements means that the safety recommendations and warnings detailed in this manual are complied with and applicable regulations for safety (machine directives, etc.) and noise suppression (EMC Directives) are observed while operating the drive. At the end of its lifetime, dispose of or recycle the drive according to the applicable regulations.

Installation and wiring of the drive must be completed only by qualified personnel having a basic knowledge of electronics, installation of electronic and mechanical components, and all applicable wiring regulations.

Commissioning of the machine utilizing the drives must be done only by qualified personnel having a broad knowledge of electronics and motion control technology.

As the user or person applying this unit, you are responsible for determining the suitability of this product for the application. In no event is the Pacific Scientific Company responsible or liable for indirect or consequential damage resulting from the misuse of this product.

Read this manual completely to effectively and safely operate the PCE830/40.

Comply with the applicable European standards and Directives. In Germany, these include:

- DIN VDE 0100 (instructions for setting up power installations with rated voltages below 1000V).
- DIN - EN 60 204 - Part 1, (VDE 0113, part 1) instructions relative to electric equipment in machines for industrial use.
- DIN EN 50178, (VDE 0160) equipping high-voltage current installations with electronic operating means.

Safety Requirements

The following requirements must be met to ensure compliance with the Low Voltage Directive:

- 380/400/480VAC mains must be balanced, three-phase, WYE-type with earthed neutral.
- Never connect or disconnect any drive connectors or terminals while the power is switched on.
- The climatic conditions shall be in accordance with EN 50178 climatic class: Type B, temperature and relative humidity: Class 3K3.
- This drive is to be installed inside a motor/control cabinet accessible only by qualified personnel.
- Electronic drives contain electrostatic-sensitive devices that can be damaged when handled improperly. Qualified personnel must follow ESD protection measures. For example, wear grounded heel and wrist straps when contacting drive.
- The discharge time for the bus capacitors may be as long as 5 minutes. After disconnecting the drive from the AC mains, wait at least 5 minutes before removing the drive’s cover and exposing live parts.
- Follow IEC 536-2 and IEC 1140 for installation protection against electric shock.
- Installation shall be performed in accordance with local electric codes, local accident prevention rules, EN 50178 and EN 61800-3.

- Due to high leakage current, this drive is to be permanently installed (hard wired). The PE connection shall be made by two separate conductors between the earth ground and the two PE terminals on the device.
- Consult the factory before using this product on a circuit protected by a residual-current-operated protective device (RCD).
- External, supply line fusing is required. PCE8x3: Bussman, KTK-20, PCE8x5: Bussmann KTK-30.
- Motor cable shield must be connected to protective earth.
- All covers shall be closed during operation.
- During periods of extreme regeneration or excessively high input voltage, the temperature of the regen resistor may exceed 70 °C.
- When using an external regen resistor, if regen cabling is accessible during normal machine operation, the regen resistor cable should be rated at 600VDC or higher and shielded with the shield connected to PE.

Contents

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1. MOUNTING AND INSTALLATION

This section provides information on mounting and installing the equipment as well as grounding and bonding requirements.

The equipment is not ready to operate without additional installations (cable, motor, etc.). All necessary tests and measurements must be made on a typical installation. The test installation (with all peripheral devices), as well as the test results and measurements are recorded in detail in documentation available on request from the manufacturer.

If the connection method on your machine is different from what is contained in this document, or in the event of use of components other than those that we have specified, adherence to interference limit values cannot be guaranteed.

To go through this procedure, you will need the following items.

- PCE830/40 Servo Drive
- Appropriate Brushless Motor with nothing attached to the shaft
- PC Running Windows 95/98, Windows 2000, or WindowsNT
- 800Tools Installation Disk
- Motor Power and Feedback Cables (TB1, J3)
- RS-232 Communications Cable (J1)
- DB-44 Connector Mate (J2)
- AC Power Line (TB1)

Wiring Connections

Connect the motor, feedback, and AC Power cables as shown in the following Connection Diagram but **do not apply the AC Power at this time**. It is highly recommended that Pacific Scientific motor and feedback cables be used during setup since improper cabling is the number one cause of start up problems.

The RS-232 cable made by Pacific Scientific (order number CS-232-5600) can be used to connect the 9-pin serial port socket on the PCE830/40 to the PC. If this cable is unavailable, a simple 3 wire cable can be made using the wiring diagram shown on page 1-3.

If you are using the drive’s +24VDC supply, connect I/O RTN (J2-38) to +24VDC output RTN (J2-39).
The last connection needed is to provide the hardware enable to the PCE830/40 via J2-37 and +24V on J2-40. Preferably connect a toggle switch between J2-37 and J2-40. If a toggle switch is not available a clip lead that can connect or not connect J2-40 to J2-37 will do.

1.1. Installing the PCE800 Servo Drive

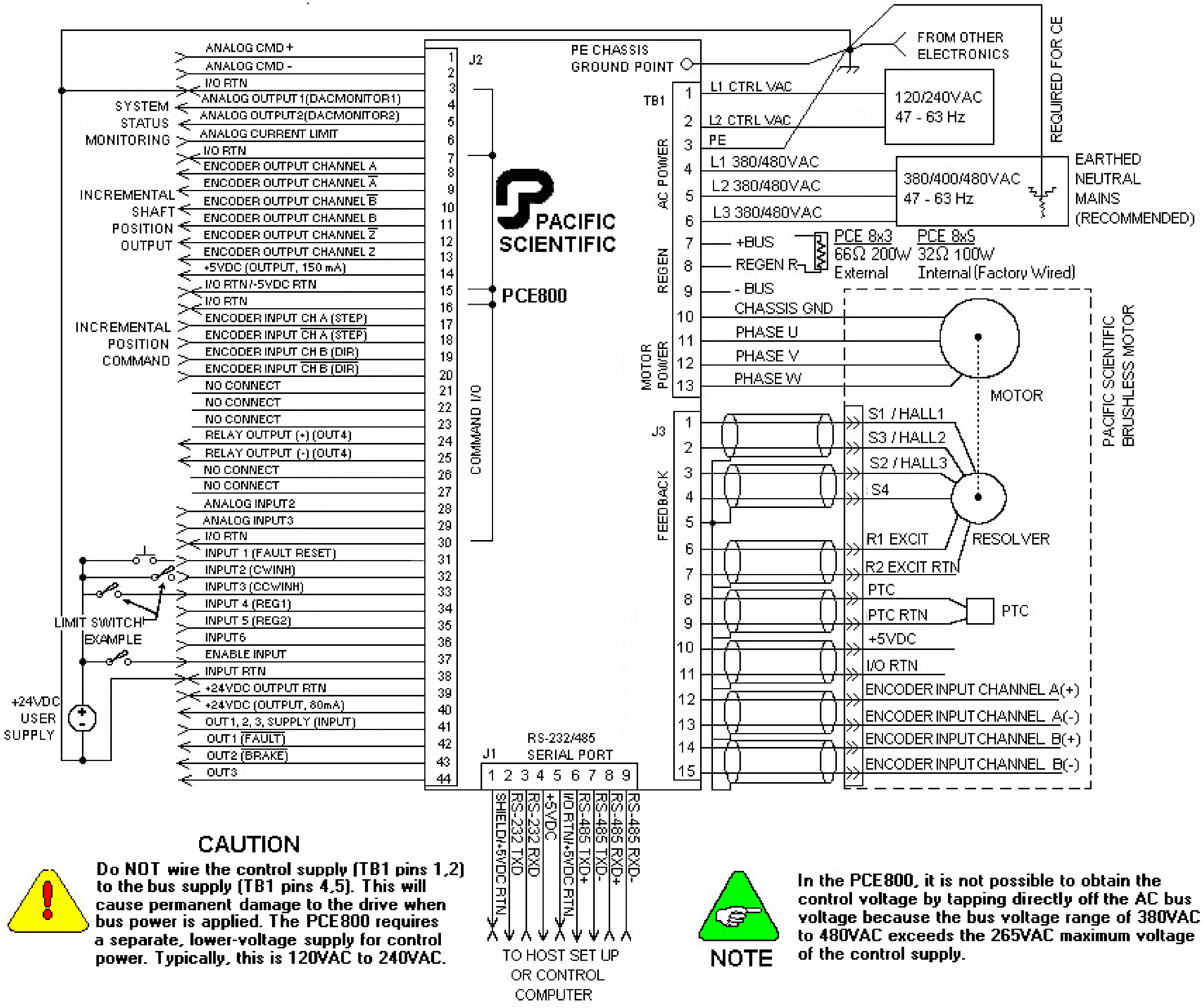
Much of the connection information presented in this section is contained in Section 2.2, Interfaces and Connections.

1.1.1. Mounting the Drive

The PCE830/40 drives are designed for operation in a cabinet. Follow these installation instructions:

- Mount the drives vertically inside a cabinet on a flat, solid, electrically conductive, mounting surface connected to PE (protective earth ground) and capable of supporting the weight of the unit.
- Remove the paint on the mounting surface over an area extending at least 12 mm (0.5”) from the mounting bolts to achieve good electrical connection over a large area between the drive and grounded mounting surface.
- Install conductive clamps near the drive on the mounting panel (ground plane) for electrically connecting the outer shield of certain cables (defined below) to the panel. The conductive clamps can also be attached to PE on the front of the drive. Remove about 10mm (0.5”) of the outer jacket of these cables where the clamp will be exposed to the braided shield before inserting under the clamp and tightening. The length of the cable between the drive connection and the clamp should be as short as possible (not exceeding 0.6 meters (two feet)). If a ground plane is available at the other end of these cables, use a conductive clamp at that end to connect the shield to that ground plane as well.
- Provide a minimum unobstructed space of 100 mm (4”) above and below the drive. With convection cooling, provide 40mm (1.6”) free space on either side of each unit. With forced air cooling, provide 25mm (1") free space on the side of the drive with the heat sink.
- Insure the environment within the cabinet meets the requirements defined in the Specifications section.

Connection Diagram



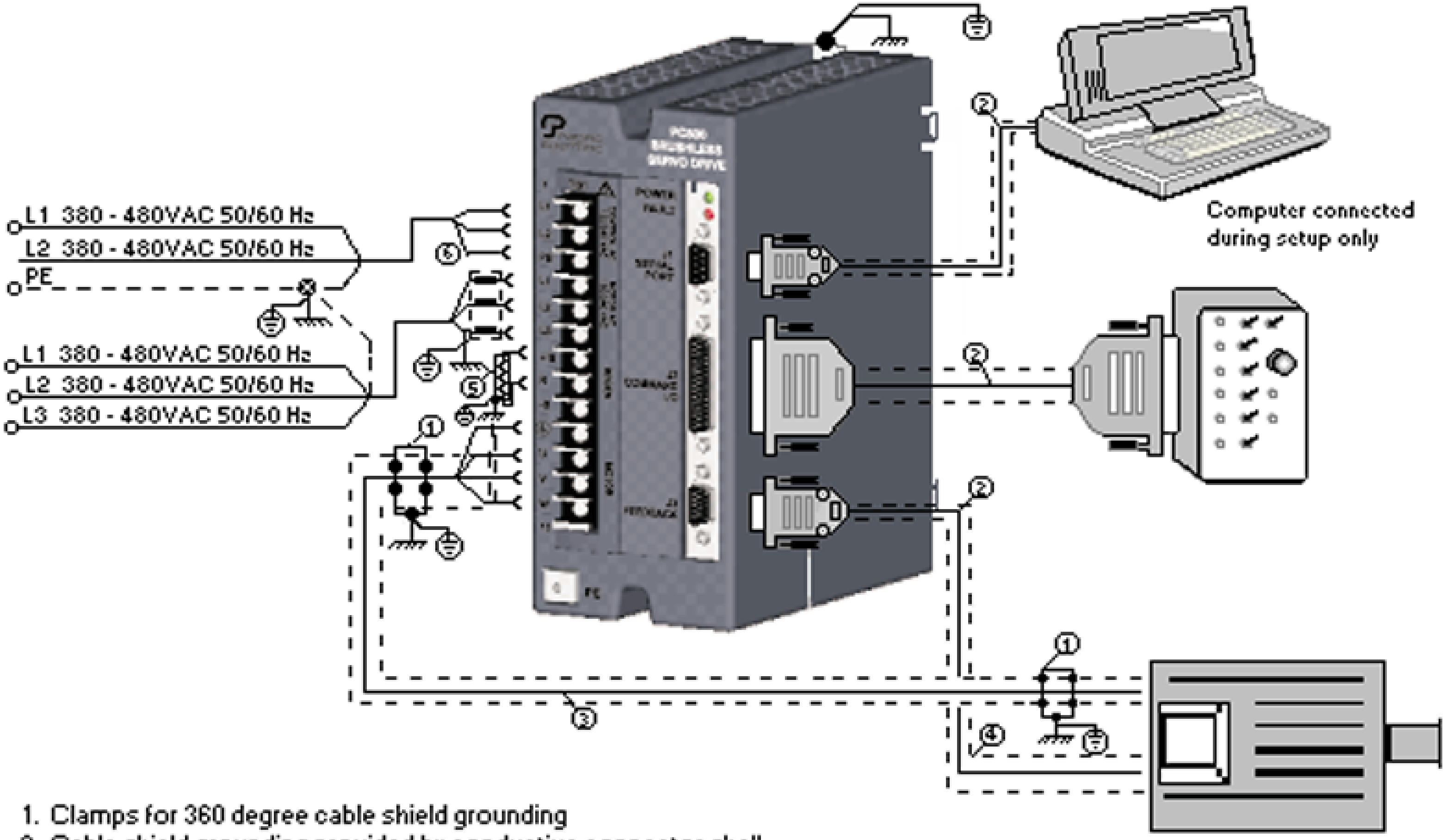
CAUTION

Do NOT wire the control supply (TB1 pins 1,2) to the bus supply (TB1 pins 4,5). This will cause permanent damage to the drive when bus power is applied. The PCE800 requires a separate, lower-voltage supply for control power. Typically, this is 120VAC to 240VAC.

NOTE

In the PCE800, it is not possible to obtain the control voltage by tapping directly off the AC bus voltage because the bus voltage range of 380VAC to 480VAC exceeds the 265VAC maximum voltage of the control supply.

Block Diagram



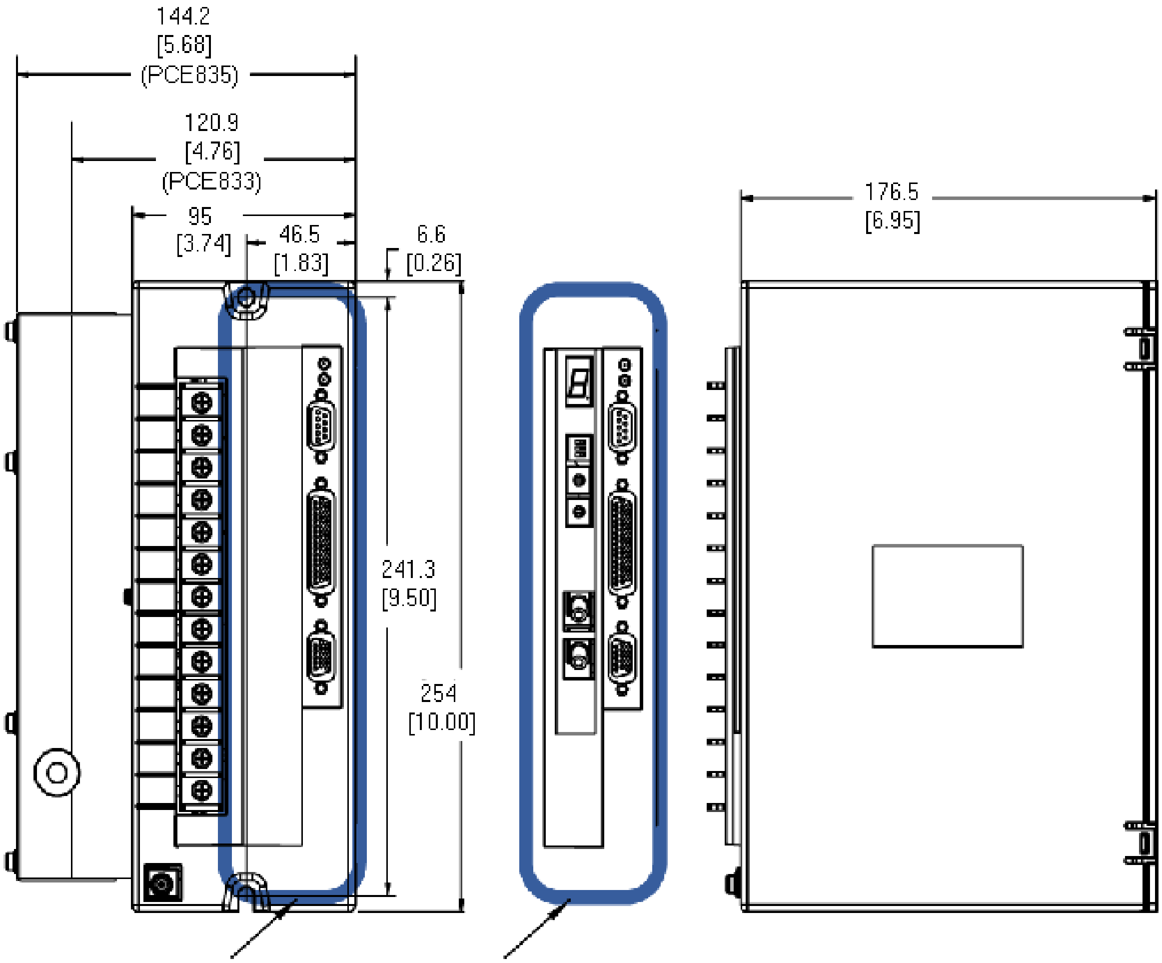
1. Clamps for 360 degree cable shield grounding
2. Cable shield grounding provided by conductive connector shell
3. Motor cable, Pacific Scientific, PPC-03-01-01-164 (50m) for conducted emissions PPC-03-01-01-17 (5.18m) for radiated emissions
4. Feedback cable, Pacific Scientific PFC-03-01-01-164 (50m) for conducted emissions Pfc-03-01-01-17 (5.18m) for radiated emissions
5. External Regen Resistor, Pacific Scientific REG-833
6. Line filter used for testing, MTE 50CE4

Mounting Guidelines

The figure below gives key dimensions for use in physically mounting the product.

When mounting multiple drives in a row, some customers have found the stiffness of the drive and their mounting panel to be too low. To increase the mounted mechanical integrity, connect to the threaded insert on the top front edge.

Mounting Dimensions



Faceplate detail of PCE83x

Faceplate detail of PCE84x

1.1.2. Connecting to AC Power

The PCE830/40 is designed to operate on balanced, three-phase mains from 380VAC to 480VAC. To insure compatibility with CE safety standard EN50178, the mains phase voltage to neutral (PE) must remain within certain limits. Compatibility of the PCE800-series with the major types of three-phase mains is outlined below:

- **380/400/480 WYE with Earthed Neutral Mains (TB1-4, 5, 6)**
  This is the preferred mains for the PCE830/40 and insures that CE safety standard EN50178 is met. An earthed neutral forces the phase voltages to remain balanced with respect to neutral (PE), even if loads are unbalanced. The phase to PE voltage of balanced mains measures about 57.7% of the line-line voltage, so 380/400/480V_{RMS} mains measures 220/231/277V_{RMS} nominal, meeting the EN50178 requirement for the PCE800-series of 300V_{RMS} max.
- **380/400/480 Delta or WYE Unearthed Mains (TB1-4, 5, 6)**
  Phase to neutral (PE) voltages of unearthed WYE or delta mains often measure balanced and below the 300V_{RMS} requirement of EN50178. However, the lack of neutral point earthing means the balance is not as well maintained as with an earthed neutral. Pacific Scientific is unable to ensure the unearthed 380/400/480VAC mains are compatible with CE safety standard EN50178. You are advised to consult your CE safety engineer about unearthed mains. For reference, the PCE830/40 human safety barrier internal spacings are 5.5mm.
- **380/400/480 Delta or WYE Earthed, Unbalanced Mains (TB1-4, 5, 6)**
  Some three-phase mains are earthed in an unbalanced manner. One example is a delta or WYE with one phase voltage earthed. 480VAC mains of this type measure phase to PE: 480VAC, 480VAC, and 0VAC. Another example is a delta mains with the mid-point of one delta leg earthed: 480VAC mains of this type measure phase to PE: 240VAC, 240VAC, and 416VAC. Since the phase-to-PE voltage of these mains exceeds the EN50178 design limit for PCE830/40 creepages and clearances, the PCE800-series is not rated for operation on these mains.

Control Power

The control power (TB1-1, 2) is typically single-phase 115VAC to 240VAC referenced to neutral (PE).

The control power is input to a switching power supply. The input (TB1-1 to TB1-2) will accept voltages ranging from 85VAC to 265VAC or 120VDC to 375VDC.

To meet safety standard EN50178, the voltage from control voltage inputs (TB1-1,2) to PE (TB1-3) must be less than 300V RMS.

- **Obtaining control power from the high voltage, three-phase AC bus power mains**
  - **Method 1: Stepdown Transformer (380/400/480VAC)**
    480VAC to 240VAC stepdown transformer, 25W to 50W connected line-line from (380/400/480VAC) mains generates (190/200/240VAC) suitable for the AC control power. Use of a line filter on the AC control power input is recommended. For systems that must meet conducted line noise regulatory requirements, a line filter on the AC control power is required.

    Method 2: No Transformer (380/400VAC ONLY)
    Phase to neutral voltage of 380VAC and 400VAC mains is 220VAC and 231VAC. The phase to neutral voltage of these mains is within the range of the AC control supply and can be coupled through a line filter to the AC control power inputs. Use of a line filter on the AC control power input is REQUIRED when there is no transformer to block mains spikes from the control supply.

A phase to neutral connection from 480VAC mains to AC control power without a transformer is NOT possible. The phase to neutral voltage for 480VAC mains is 277VAC, which is outside the range of the AC control supply.

Fusing

Use high surge fuses in series with TB1 pins 4, 5, and 6.

Model	Fuse
PCE8x3	Bussman, KTK-20
PCE8x5	Bussman, KTK-30

AC control supply TB1 pins 1 and 2 is internally fused by a 1A, 250V fuse with 50A interrupt capability.

1.1.3. Connection to PE Ground

TB1-3 and chassis ground point **must be connected to Protective Earth ground (they are marked with the PE symbol)**. The connection at the Protective Earth ground end **must be hard wired** (not utilize pluggable connections)

A ground fault detector (RCD) cannot be depended on for safety.

1.1.4. Grounding Shields for Safety and Low Emissions and Susceptibility

Dangerous voltages resulting from cable capacitance exist on some cable shields, if the shields are not connected to PE ground.

If the motor power cable braid shield is exposed, it MUST be clamped to PE to avoid a dangerous shock hazard.

Proper grounding of shields is also required to reduce radiated and conducted emissions as well as to protect against susceptibility to external and self-generated noise. Follow these shielding requirements carefully:

- The drive end of the motor cable shield must be connected to the PE or ⏚ location on the TB1 connector. The shield must also be clamped to the ground plane (described above). If cable with a separate inner foil shield and outer braided shield is used (Pacific Scientific CE cables for example), connect the foil shield to the PE or ⏚ location on the TB1 connector and clamp the outer braided shield to the ground plane. If the leads for a motor holding brake are run with the motor leads, the holding brake leads must be separately shielded and the shield connected to the PE or ⏚ location on the TB1 connector.
- The resolver cable should have inner shields around each twisted pair as well as an overall outer braided shield. The inner shields are connected to J3 pin 5 while the outer shield are clamped to the ground plane.
- The control leads to the J2 connector should have an outer braided shield with the shield terminated through a conductive shell or clamped to the ground plane.
- When using an external regen resistor, if regen cabling is accessible during normal machine operation, regen resistor cable should be rated at 600VDC and shielded with shield connected to PE.

1.1.5. Grounding the Motor Case

Insure that the motor’s case is connected to PE ground by connecting the fourth wire TB1-10 ⏚ in the motor cable to the motor case.

If the motor is not properly grounded, dangerous voltages can be present on the motor case due to capacitive coupling between the motor windings and case.

1.1.6. Long Motor Power Cables and Baluns

Pacific Scientific cables are recommended for use with PCE830/40 drives. The drives have been tested and characterized using these cables. There are two risks in using non-Pacific Scientific cables:

- Drive performance or reliability may be adversely affected. The motor cable capacitance, characteristics impedance, and shield termination affect the switching loss of the transistors in the inverter.
- The motor power cable insulation can degrade over time and may fail. A long cable driven by a switching inverter has internal voltage pulses due to reflections up and down the cable that can easily be twice the bus voltage. If the cable is not designed for this type of operation, even though it has the correct voltage rating, it will not be reliable.

If a non-Pacific Scientific cable is used, observe the following guidelines:

- Motor power cables should be "VFD" type. These cables are rated by the cable manufacturer for Variable Frequency Drive operation.
- Motor power cables should be #14 AWG, 600V to 1,000V.
- Motor power cable shield and PE wire should be joined and connected to the PE terminal of the drive.

PCE830/40 drives operated with Pacific Scientific PCE830/40 cables do not require a motor cable balun for cables up to the maximum specified length (50m), but a motor cable balun is RECOMMENDED when motor cable length exceeds 10m (32 ft.). The reasons for this recommendation are:

Less Noise Coupling to Nearby Equipment
Motor cable baluns reduce the noise the drive can introduce into the machine grounding resulting in an electrically quieter drive. When motor cable baluns are correctly applied (i.e., they are sized for voltage and cable length such that they do not saturate), substantial quieting is achieved.

Less Conducted Link Noise
Motor cable baluns lower conducted line noise by reducing the rise time of current flowing in the motor cable shield. An external motor cable balun may be required to meet CE when the motor cable is long.

Cooler Running Drive
Motor cable baluns used with long cables provide some reduction in transistor heating and result in a cooler running drive. They lower the transistor switching loss by raising the cable common mode impedance during the switching interval.

Pacific Scientific manufactures external motor cable baluns in different sizes and ratings. New wide gap, high-energy baluns optimized for 480VAC drives like the PCE800 family are in development. Contact the factory for assistance.

1.2. Safe Operation of the Drive

It is the machine builder's responsibility to insure that the complete machine complies with the Machine Directive (EN60204). The following requirements relate directly to the servo controller:

Prevent Damage to the Drive

Follow these guidelines to prevent damage to the servo drive during operation:

- Never plug or unplug connectors with power applied.
- Never connect or disconnect any wires to terminals with power applied
- Never plug or unplug an option card with control power applied
- If the drive indicates a fault condition, find the cause of the fault and fix it prior to resetting the fault or power-cycling the drive.

Emergency Stop

If personal injury can result from motor motion, the user must provide an external, hardwired emergency stop circuit outside the drive. This circuit must simultaneously remove power from the drive's motor power terminal TB1-11, TB1-12, and TB1-13 and disable the drive (by disconnecting J2 pin 37 from I/O RTN).

The motor coasts under this condition with no braking torque.

If breaking torque is required to quickly stop the motor, a dynamic brake can be added that loads the motor's windings resistively. The motor should not be loaded until the servo drive is disabled.

The holding brake (optional on Pacific Scientific motors) is NOT intended to stop a spinning motor. It is designed to prevent a stopped motor from rotating due to an applied torque

Avoiding Unexpected Motion

Always remove power from TB1 before working on the machine or working anywhere machine motion can cause injury.

Avoiding Electrical Shock

Never power the servo drive with the cover removed or with anything attached to circuitry inside the cover.

If the drive must be removed from the cabinet, wait at least five minutes after turning off power before removing any cables from the drive or removing the drive from the mounting panel.

Never connect or disconnect any wiring to the drive while power is applied. Always power down and wait five minutes before connecting or disconnecting any wires to the terminals.

Avoiding Burns

The temperature of the drive's heat sink and housing as well as external regen resistor can be as high as 70°C (158°F). There is a danger of severe burns if these regions are touched.

2. PCE830

2.1. 800Tools

This section provides a step-by-step introduction to setting up the PCE830. This procedure uses the minimum possible equipment to run an unloaded motor and set motor speed from a PC's serial port. It is strongly recommended that all first time users go through this procedure to become familiar with the PCE830 and the PC interface software before installing the servo system in a machine.

2.1.1. Installing 800Tools

Procedure To install 800Tools:

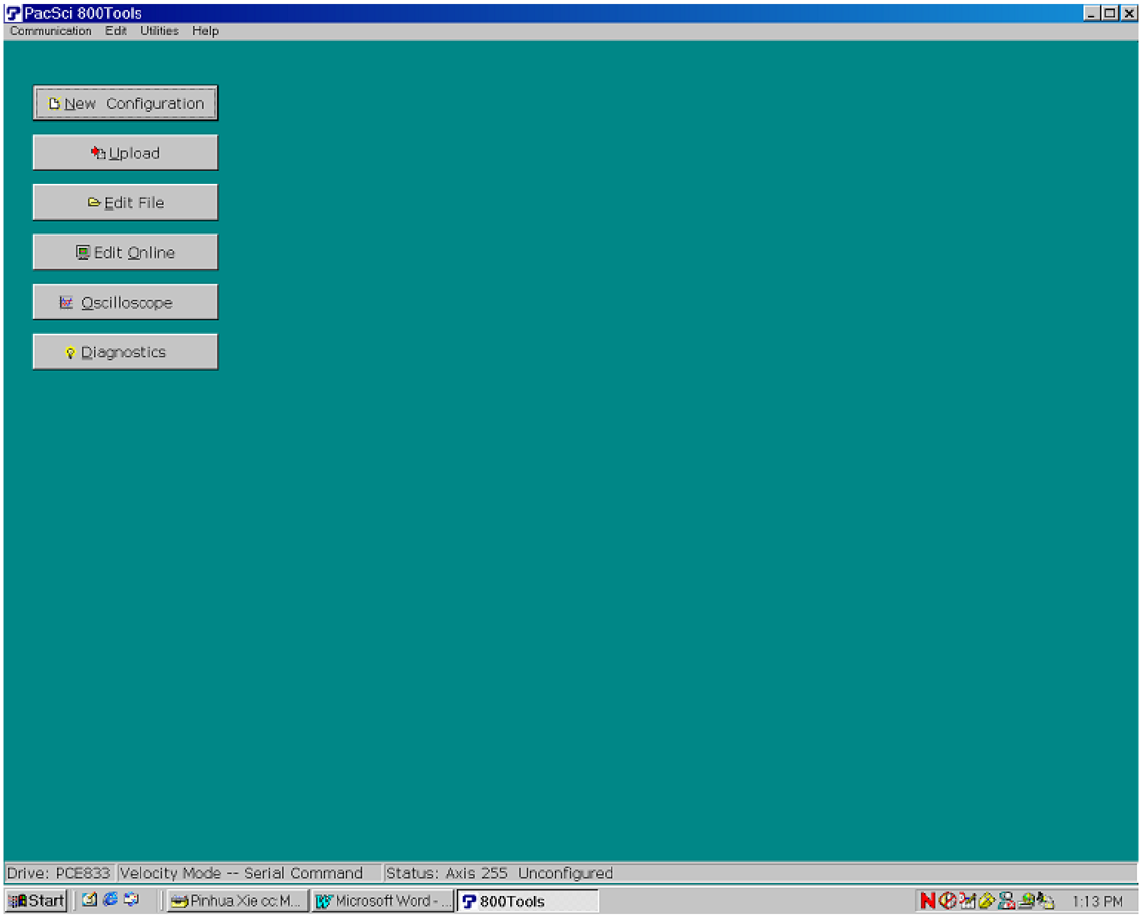
1. Insert the 800Tools Installation disk in your CD-ROM drive (D:). From the Windows95 or NT **Start** menu, select **Run**. At the Command Line, type **D:\setup.exe** and click **OK**.
2. The install wizard will guide you through the installation.

When finished, the 800Tools disk should be removed from the PC and stored in a safe place.

2.1.2. Starting 800Tools

Procedure To begin using 800Tools, select **Start|Program Files|Pacific Scientific|800Tools** or double click on the icon and the following window appears:

800Tools Main Menu



Drive: PCE833 | Velocity Mode -- Serial Command | Status: Axis 255 Unconfigured

2.1.3. Getting Around in 800Tools

800Tools is a standard Windows application and the normal cursor movement keys operate the same way as in all windows applications.

- <**F1**> gives context sensitive on-line help

2.1.4. Configuring Your System

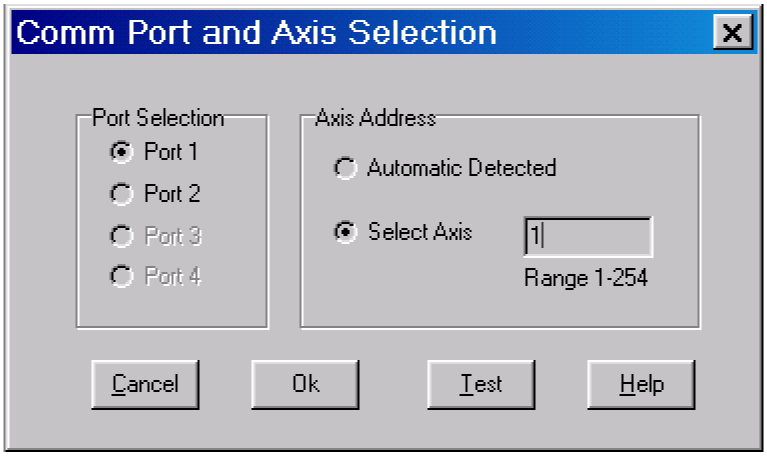
Applying AC Power

Carefully check all wiring connections and ensure that J2-37 is not connected to J2-40. Apply AC power to your controller.

Serial Port

To specify the PC serial port that is connected to the PCE830:

1. Select **Communication|Port/Axis** and the following dialogue box appears:



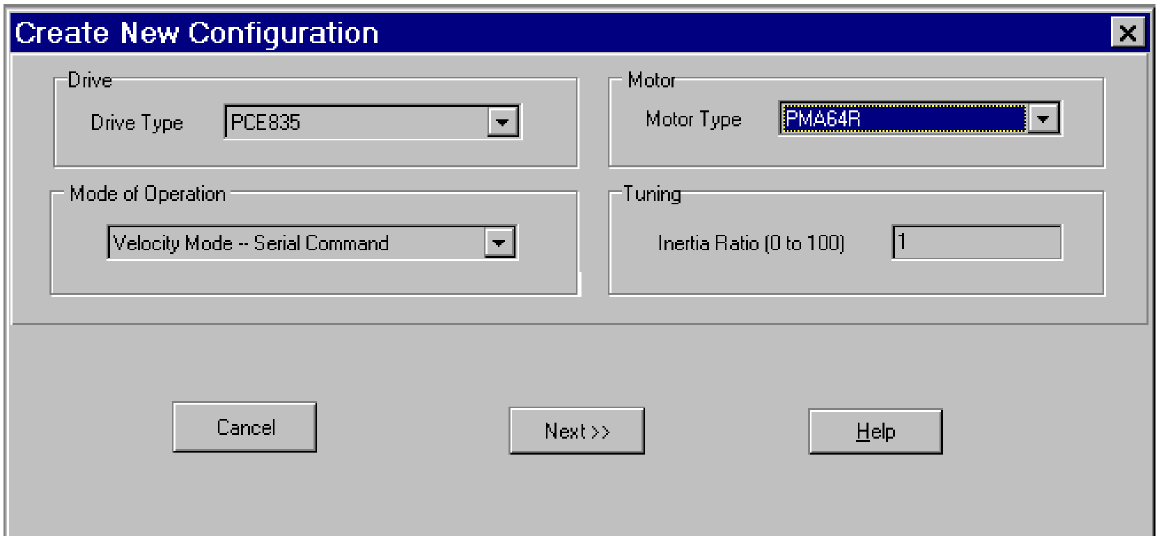
● Port 1
○ Port 2
○ Port 3
○ Port 4

○ Automatic Detected
● Select Axis 1
Range 1-254

2. Specify the serial port that a drive is connected with and the axis address of the drive. If you do not know the axis address, choose **Automatic Detected**.
3. To verify your settings, click **Test**.

2.1.5. Configuring Your Drive

Procedure Click the **New Configuration** button in the main screen and the following dialog box appears:



Create New Configuration

Drive Type: PCE835

Motor Type: PMA64R

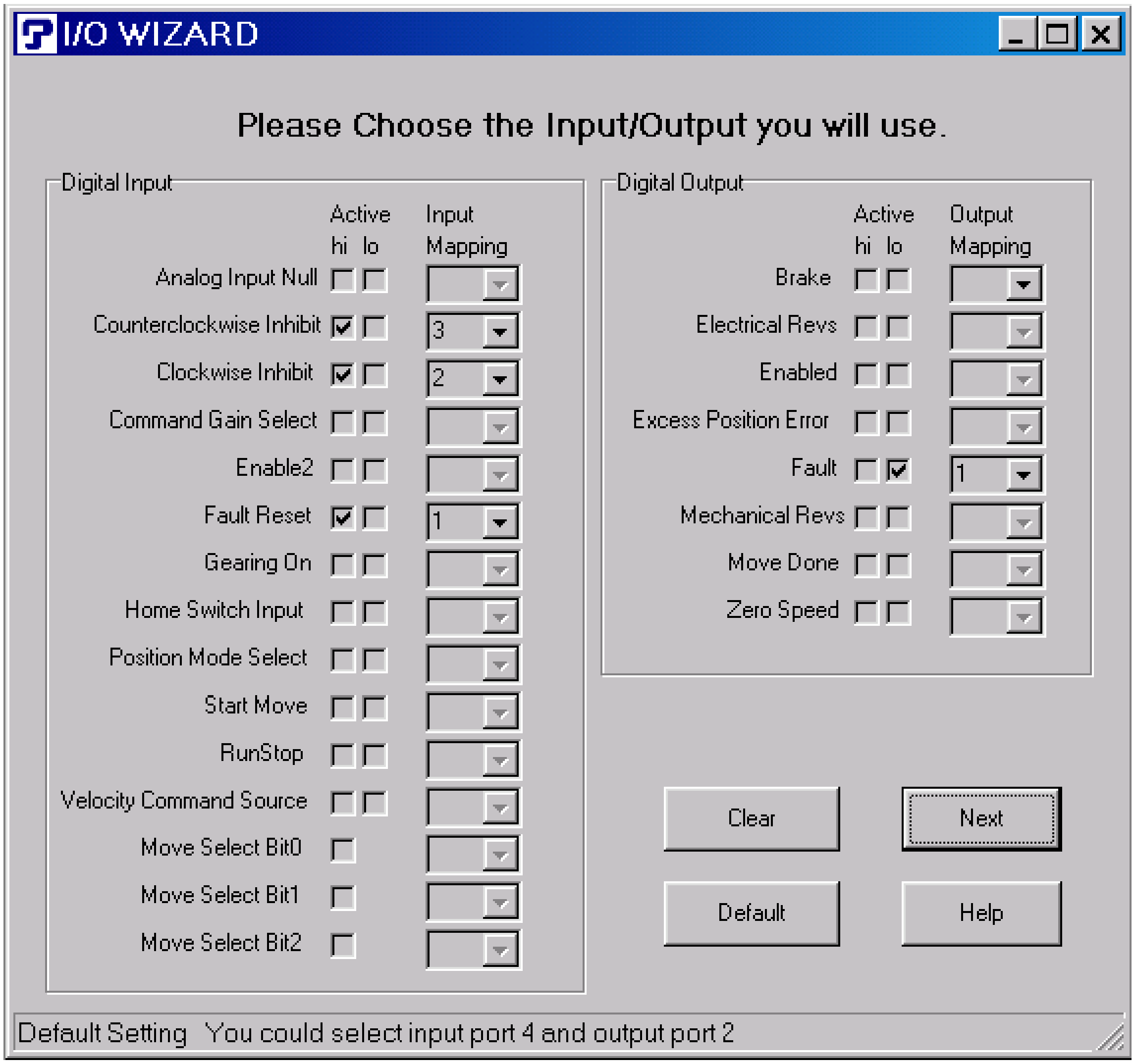
Mode of Operation: Velocity Mode -- Serial Command

Inertia Ratio (0 to 100): 1

- Select motor type from the drop down list box.

To add a motor to the database please see Section 2.1.9, "Editing The Motor Database."

- Select drive type from the drop down list box.
- Select mode of operation. For example, **Velocity Mode - Serial Command** from the drop down list box.
- Enter an inertia ratio. (Inertia Ratio = Load Inertia/Motor Inertia).
- Click **Next**. A **Digital I/O Wizard** window appears.



Please Choose the Input/Output you will use.

Digital Input

	Active hi	Active lo	Input Mapping
Analog Input Null	☐	☐	
Counterclockwise Inhibit	☑	☐	3
Clockwise Inhibit	☑	☐	2
Command Gain Select	☐	☐	
Enable2	☐	☐	
Fault Reset	☑	☐	1
Gearing On	☐	☐	
Home Switch Input	☐	☐	
Position Mode Select	☐	☐	
Start Move	☐	☐	
RunStop	☐	☐	
Velocity Command Source	☐	☐	
Move Select Bit0	☐		
Move Select Bit1	☐		
Move Select Bit2	☐		

Digital Output

	Active hi	Active lo	Output Mapping
Brake	☐	☐	
Electrical Revs	☐	☐	
Enabled	☐	☐	
Excess Position Error	☐	☐	
Fault	☐	☑	1
Mechanical Revs	☐	☐	
Move Done	☐	☐	
Zero Speed	☐	☐	

Default Setting You could select input port 4 and output port 2

Digital I/O Setting

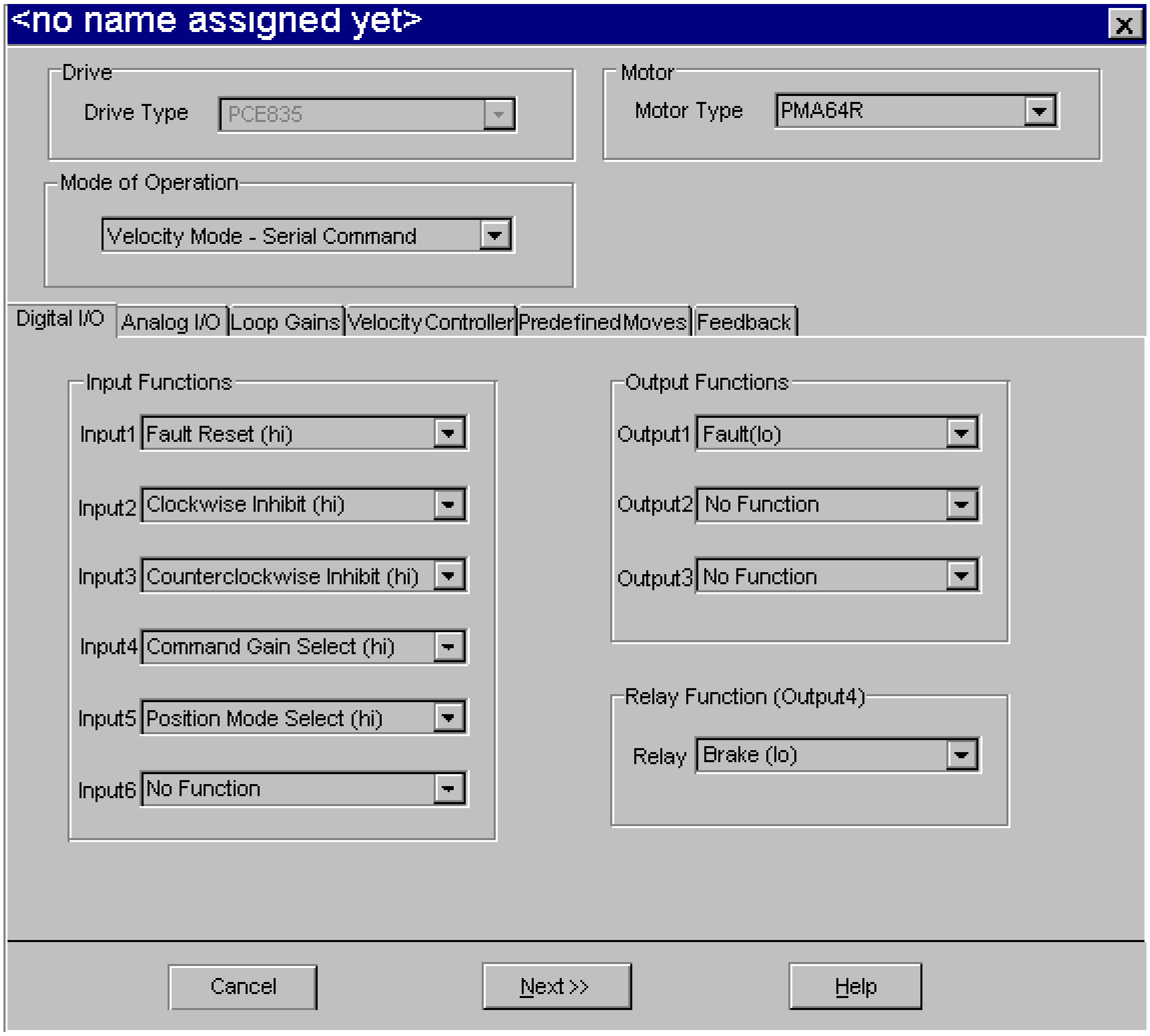
This wizard reminders you to set up the digital input and output. When the page pops up, it shows default setting.

You can make your choice depended on your hardware connection.

Clicking **Default** brings back the default settings. Click **Clear** to clear all selections.

After selecting I/O, click **Next** to go to the **Parameter Edit Screen**.

Parameter Edit In a parameter edit screen, which is shown below, you are allowed to configure additional features of the PCE830/40. During this initial set up, the default values on each of these tabs are used.



Drive
Drive Type: PCE835

Motor
Motor Type: PMA64R

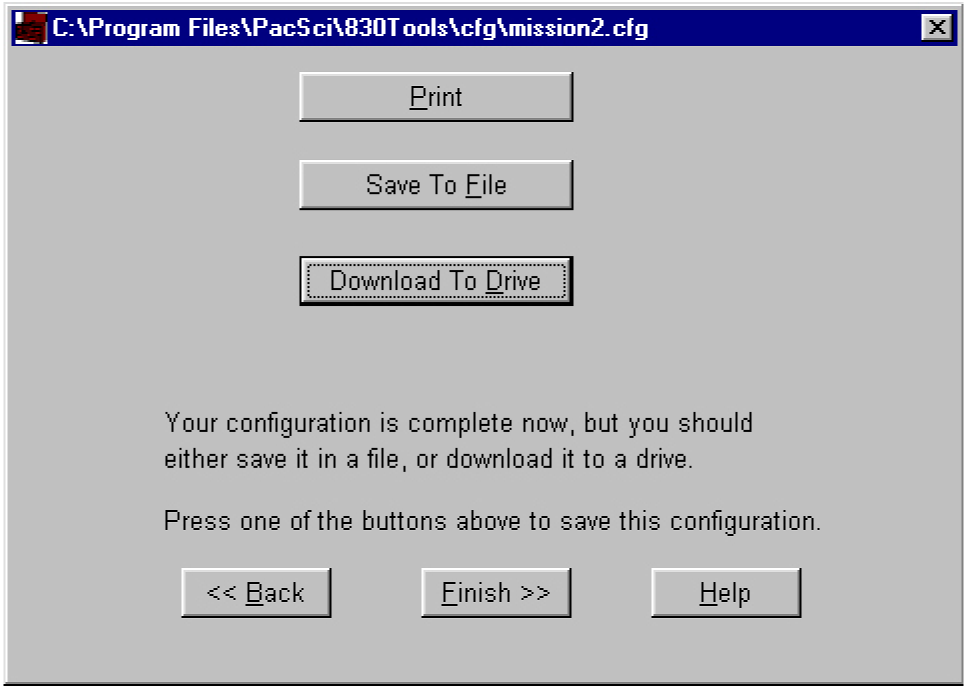
Mode of Operation: Velocity Mode - Serial Command

Input Functions
Input1: Fault Reset (hi)
Input2: Clockwise Inhibit (hi)
Input3: Counterclockwise Inhibit (hi)
Input4: Command Gain Select (hi)
Input5: Position Mode Select (hi)
Input6: No Function

Output Functions
Output1: Fault(lo)
Output2: No Function
Output3: No Function

Relay Function (Output4)
Relay: Brake (lo)

- Click **Next** to go to the next page.



Your configuration is complete now, but you should either save it in a file, or download it to a drive.

Press one of the buttons above to save this configuration.

Print Parameters

- Click **Print** to print all parameters in the **Edit Parameter** screen.

Save Parameters to Disk

- Click **Save To File** to save all parameters in the **Edit Parameter** screen to a configuration file on PC disk.

Download To Drive

- Click **Download To Drive** to download the all parameters that were edited in **Edit Parameter** screen to the drive.

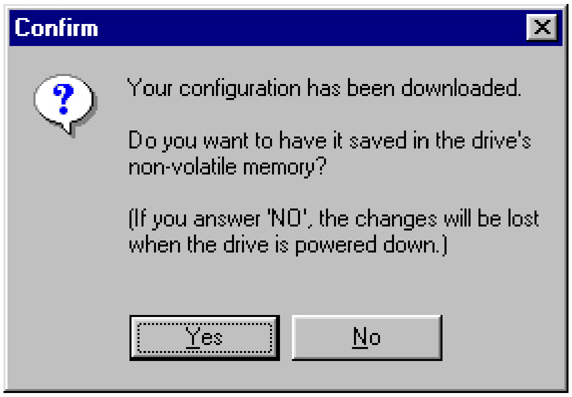
Pacific Scientific recommends that you save the configuration to a file as a backup.

Changing values on the **Parameter Edit Window** only affects the PC RAM copy. You must download them to the drive to take affect.

800Tools sets the drive variable Enable to 0 at the beginning of the download. To enable the drive you can use the Variables screen to set Enable = 1. If the downloaded parameters were NVSaved, turning control AC power OFF and then ON again will also return Enable to its default value of 1.

NVSave to Drive

To save the configuration to the drive’s non-volatile memory:



Confirm

Your configuration has been downloaded.

Do you want to have it saved in the drive's non-volatile memory?

(If you answer 'NO', the changes will be lost when the drive is powered down.)

- Click **Yes** to save to the drive's non-volatile memory.
- Click **Finish**.

Verify Setup

To verify that the set up procedure worked, turn the control AC power OFF and then ON again. The Power LED should be BLINKING. If both LEDs are still blinking, repeat the set up procedure.

The PCE830 is configured as a serial port commanded controller. The current loop is properly compensated for the selected motor and the servo parameters have been setup to give medium response (approximately 75 Hz velocity loop bandwidth) with the unloaded motor. Additional default settings have also been made.

Enable the Drive

The controller can be enabled at this time by closing the switch between the Enable input (J2-37) and +24VDC (J2-40). Once enabled, the Power LED should be ON. The commanded motor speed will be the power up default, set to 0 during configuration. Because the parameters were saved in non-volatile memory, the controller can now be power cycled and, after power-up, be ready to run with the parameters established during this session.

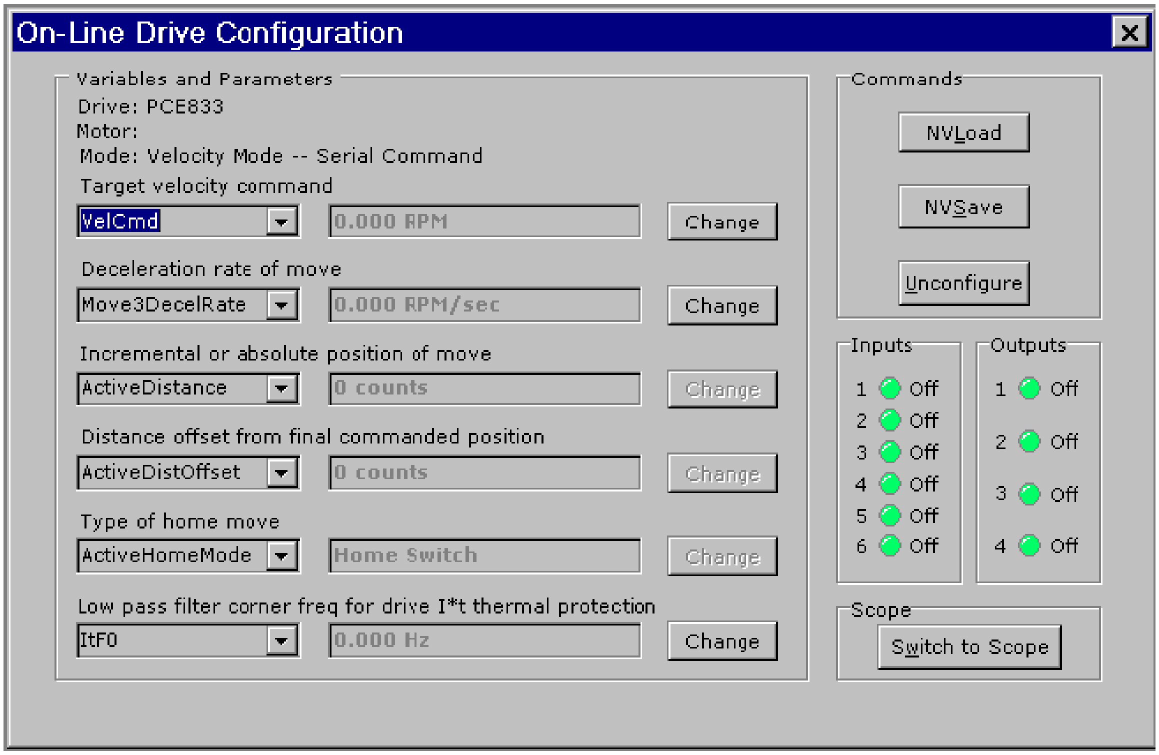
Before proceeding, the motor should be attached or temporarily clamped to the table or bench. The inertial forces created during speed steps may make the motor hop around.

2.1.6. Changing Variables On-Line

Changing Motor Velocity

Click **Edit Drive Configuration On-Line** to activate the variables window.

Select **VelCmd** from the Variable dropdown list box. The current value of VelCmd is displayed.



On-Line Drive Configuration

Variables and Parameters

Drive: PCE833

Motor:

Mode: Velocity Mode -- Serial Command

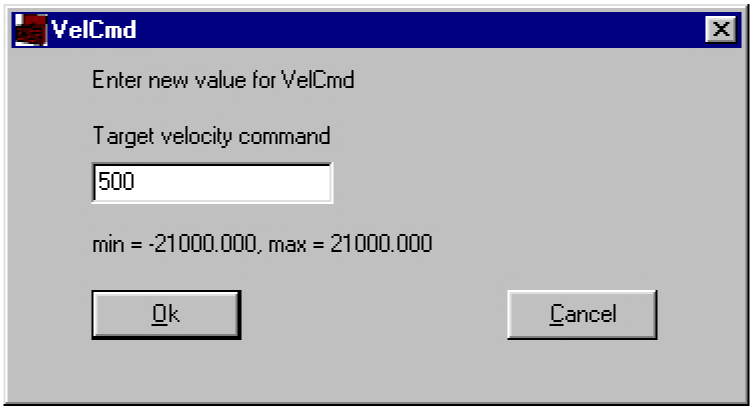
Target velocity command	VelCmd	0.000 RPM
Deceleration rate of move	Move3DecelRate	0.000 RPM/sec
Incremental or absolute position of move	ActiveDistance	0 counts
Distance offset from final commanded position	ActiveDistOffset	0 counts
Type of home move	ActiveHomeMode	Home Switch
Low pass filter corner freq for drive I*t thermal protection	ItF0	0.000 Hz

Getting Help

Context sensitive help is also available in the **Parameter Edit** window. Press <**F1**> to get help information about a highlighted variable. Information about all variables is available in this way.

Changing A Variable

To change the value of a VelCmd, click **Change** and the following window appears:



Enter new value for VelCmd

Target velocity command

500

min = -21000.000, max = 21000.000

- Type in a new value.
- Click **OK** to send the new value to the drive and return to the **On-Line Drive Configuration** window.

2.1.7. Uploading Parameters from the PCE830

Click **Upload** in the main screen to upload the current parameter values in the drive's RAM to the **Parameter Edit** screen. You can browse and modify them in this screen. Afterward, you can click **Next** to go to the next pages to **Save A File**, **Download To Drive** or **Print** out. See Section 2.1.5, Configuring Your Drive.

2.1.8. Edit a Configuration File

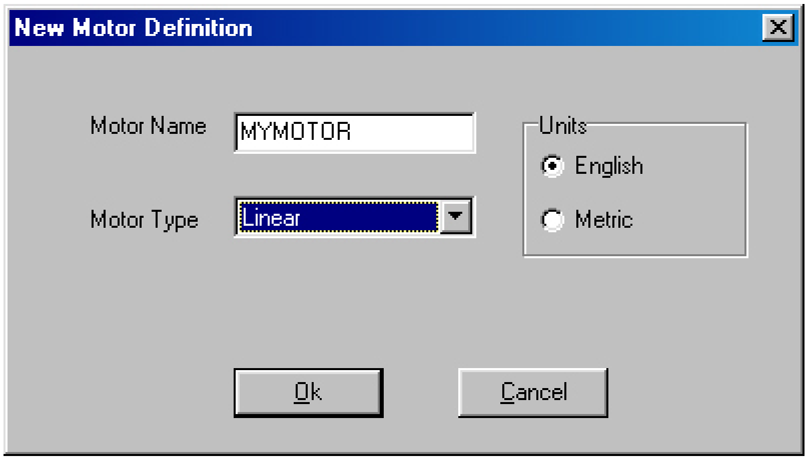
Click **Edit File** in the main screen. Select the file you would like to open from the list of files displayed. The parameters in the file are loaded in the **Edit Parameter** screen. You can browse and modify them in this screen. Afterward, you can click **Next** to go to the next pages to **Save A File**, **Download To Drive** or **Print** out. See Section 2.1.5, Configuring Your Drive.

2.1.9. *Editing The Motor Database*

Add A Motor

To edit the motor database:

1. Select **Utilities | Edit Motor Database**.
2. Click **New Motor** to add a motor to the database. The following window appears:

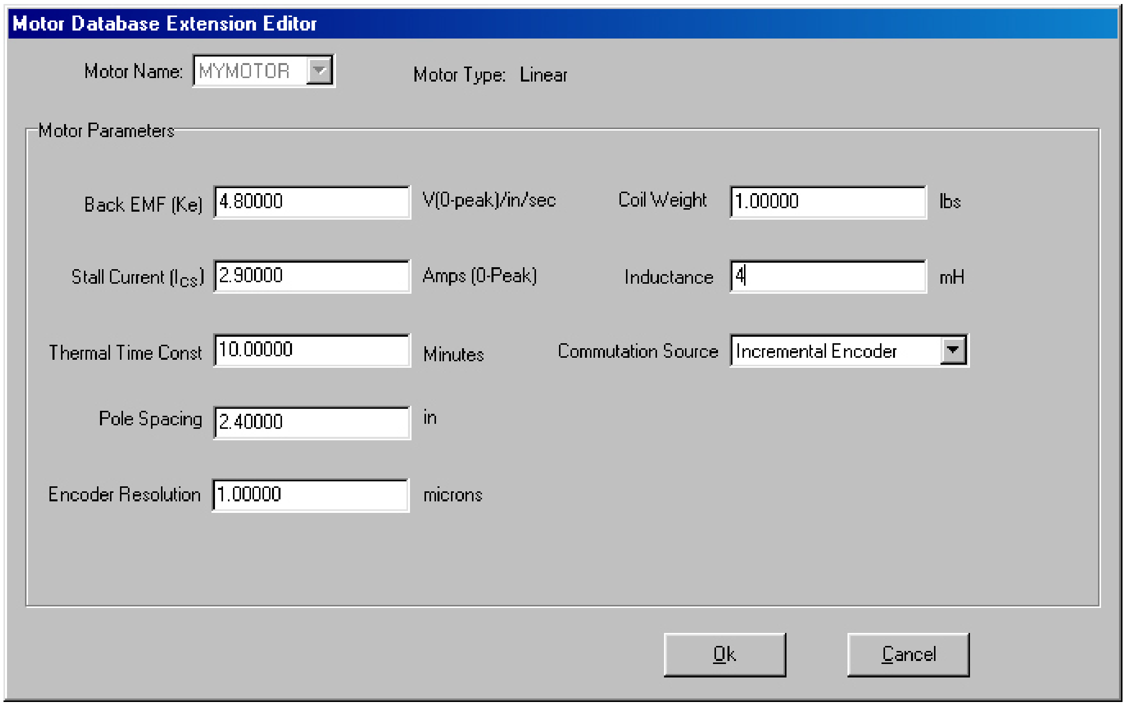


Motor Name: MYMOTOR

Motor Type: Linear

Units: ● English ○ Metric

3. Enter in a name for the motor. For example, MYMOTOR.
4. Select either **Rotary** or **Linear** as the **Motor Type**.
5. Select either **English** or **Metric** as the units.
6. Click **OK**.
7. Enter the motor parameters in the **Motor Database Editor** screen.



Motor Name: MYMOTOR

Motor Type: Linear

Back EMF (Ke): 4.80000 V(0-peak)/in/sec

Coil Weight: 1.00000 lbs

Stall Current (I_{CS}): 2.90000 Amps (0-Peak)

Inductance: 4 mH

Thermal Time Const: 10.00000 Minutes

Commutation Source: Incremental Encoder

Pole Spacing: 2.40000 in

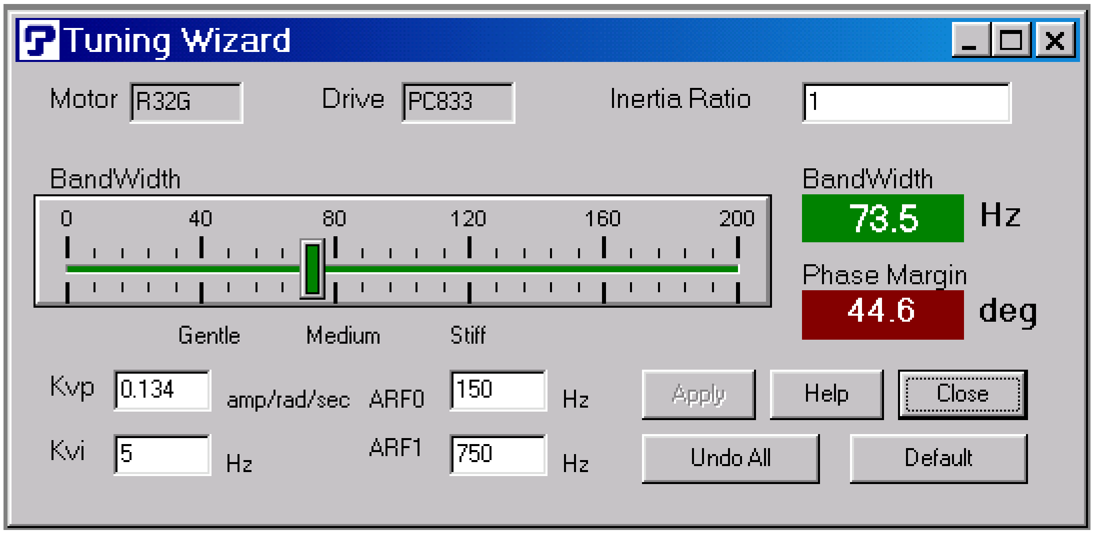
Encoder Resolution: 1.00000 microns

8. Click **OK**. This motor appears in the motor list of **Creating New Configuration**. See Section 2.1.5, Configuring Your Drive.

2.1.10. Tuning Wizard

The Tuning Wizard helps you to tuning your system. It applies only to the velocity loop.

Select **Utilities | Tuning Wizard** in the main menu. After inputting the **Inertia Ratio**, the following window appears.



Motor R32G

Drive PC833

Inertia Ratio 1

BandWidth 73.5 Hz

Phase Margin 44.6 deg

Kvp 0.134 amp/rad/sec

ARF0 150 Hz

Kvi 5 Hz

ARF1 750 Hz

Tuning Wizard You can:

- Adjust the **slider** bar to change Bandwidth
- **Inertia Ratio**, **KVP**, **KVI**, **ARF0** and **ARF1** can be altered.
- Click **Apply** to send the changes to the drive.
- Click **Undo All** to recover all variables in this page.
- Click **Default** to set all variables in this page to default value.

For more information on Inertia, Bandwidth and Phase Margin, see Section 2.5, Tuning and Section 2.7, Servo Loop Parameters.

2.1.11. Exiting 800Tools

Click **Communication | Exit** in the main menu to terminate 800Tools.

2.2. Interfaces and Connections

This section describes all the connections to the PCE830 and provides the information required to interface to it.

In the list below, an overbar on a signal name means that the signal is active low logic. For example, $\overline{\text{Fault}}$ indicates the drive is faulted when it is pulled low.

Earth Ground Chassis Ground, M4 x 12 screw with flat and lock washer.

2.2.1. Power Board Connector

TB1 **13 Position Terminal Strip**

Pin	Label	Description
TB1-1	L1C	120/240VAC Control Power
TB1-2	L2C	120/240VAC Control Power
TB1-3	PE	Chassis Ground
TB1-4	L1	380/400/480VAC (Input)
TB1-5	L2	380/400/480VAC (Input)
TB1-6	L3	380/400/480VAC (Input)
TB1-7	+B	+ Bus
TB1-8	R	Regen Transistor
TB1-9	-B	- Bus
TB1-10	PE	Chassis Ground
TB1-11	U	Motor Phase U
TB1-12	V	Motor Phase V
TB1-13	W	Motor Phase W

AC Power

**L1C, L2C (TB1-1, 2)
120VAC / 240VAC
Control Power**

These terminals connect the 120/240 VAC power provided by the user to the drive's control voltage power supply.

Control power L1C, L2C (TB1-1,2) are NOT connected internally to bus power L1, L2 (TB1-4,5).

The control voltage for the PCE830 controllers is input to a switching power supply. This input accepts voltages ranging from 85VAC to 265VAC.

Chassis Ground

PE (TB1-3)

Convenience connector point for the user to connect the drive's control power and bus power to protective earth ground. This pin is directly connected to the chassis and thus to the Chassis Ground Stud. Local electrical code may require using the Earth Ground Chassis stud for this function.

L1, L2, L3 (TB1-4, 5, 6)
380VAC/400VAC/480VAC

These terminals connect the balanced, three-phase 380/400/480 VAC power provided by the user to the drive's power output stage bus to drive the motor.

380/400/480 VAC three-phase mains **MUST** be WYE type with **earthed neutral** for PCE830 to be compatible with CE safety standard EN50178. Earthed neutral WYE-type mains are strongly recommended for all installations.

Single-phase or lower voltage operation is possible for short periods of time to support installation or testing.

Regeneration Interface

+B, R, -B (TB1-7, 8, 9)
+Bus, Regen Resistor, - Bus

These terminals provide the connection points for a resistor to absorb regenerated energy from the motor. A regeneration resistor goes from +B to R. In the PCE833, if a regeneration resistor is not needed, (see Appendix E), +B and R are open. In the PCE835, an internal regen resistor is factory-wired to +B and R. **-Bus (-B) on TB1-9 is usually left open.**

High Voltage! During normal operation +B, R, and -B operate at the bus power voltages. The PCE830 regen operates at about 800VDC. These are dangerous voltages.

Regen Resistors

The table below lists the recommended values for regen resistors. To order 66Ω, 200W regen resistor from Pacific Scientific, use part number PRK-200-66.

Model	Resistance	Regen Resistor Location	External Regen Resistor
PCE833	66Ω	External	66Ω, ±10%, 200W, 1500V min. isolation
PCE835	33Ω	Internal (factory-wired TB1-7 to TB1-8) 100W	External 400W option (see below)

Regen Resistance MUST be in the range as shown below.

Model	Resistance
PC833	60 Ω to 72 Ω
PC835	30 Ω to 36 Ω

For safety it is recommended that the external resistor be mounted on a grounded panel or use a grounding wire connected to a mounting screw. The terminals of the resistor must not be grounded.

In a few installations, heavy duty regen may be needed. In such cases, it is necessary to increase the regen resistor wattage without changing its ohms. The recommended way to increase regen wattage is shown below:

PCE833 – Wire to +B and R four 66Ω, 200W resistors in series, parallel (66Ω, 800W).

PCE835 – Cut off wires to +B and R from internal regen resistor. Wire to +B and R two 66Ω, 200W resistors in parallel (33Ω, 400W).

Wait 10 minutes after Bus Power is removed for the bus cap voltage to decay to a safe level before touching regen resistor or wiring. The voltage on the bus caps can be monitored with a voltmeter from +BUS (TB1-7) to -BUS (TB1-9).

Motor Power

PE (TB1-10) Motor Case Ground

This termination provides a convenient point for the motor ground connection and motor power wire shield. Local electrical code may require using the Earth Ground Chassis stud for this function.

U, V, W (TB1-11, 12, 13) Motor Phase

These three terminations provide the 3-phase power output to the brushless motor. Observe motor polarity on these connections. For example, connect U on the drive to U on the motor.

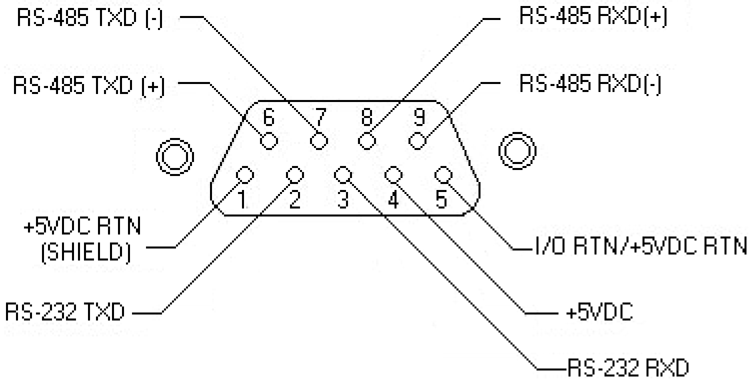
2.2.2. Serial Port

J1

The serial port (J1), utilizes the 9 contact female D subminiature style connector shown below. A brief description of each signal is included in the J1 I/O table on following page. For additional information, please refer to the Serial Communications Transceiver Schematic at the end of this section.

The figureS below illustrates the pin-out for the 9-pin connector. It shows the front view looking at the PCE830.

J1 Diagram



I/O Table

Pin Number	Input/Output	Explanation
J1-1	+5VDC RTN/ Shield	Common/shield - serial port interface
J1-2	RS-232 TXD	RS-232 transmitter output (from PCE830)
J1-3	RS-232 RXD	RS-232 receiver input (to PCE830)
J1-4	+5VDC	+5VDC output (250 mA maximum between J1-4 and J1-5)
J1-5	I/O RTN/+5VDC RTN	Common serial port interface
J1-6	RS-485 TXD (+)	RS-485 transmitter output (from PCE830)
J1-7	RS-485 TXD (-)	
J1-8	RS-485 RXD (+)	RS-485 receiver input (to PCE830)
J1-9	RS-485 RXD (-)	

An adapter can be powered from the serial port +5VDC output on J1-4 as long as the load current on J1-4, J2-14, and J3-10 total less than 250 mA.

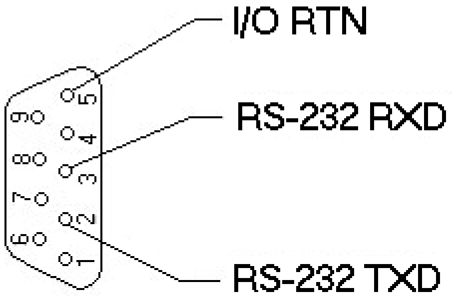
The information provided in this section should be used to connect the PCE830 to your computer for use with 800Tools. Two communication links are available, RS-232 and RS-485. RS-485 allows a single computer to communicate with up to 32 PCE830s in multi-axis configurations. 800Tools defaults to communicate with axis 255 upon start up.

2.2.2.1. RS-232 CONNECTIONS

RS-232 Connections RS-232 connections on J1 are shown below. Cable wiring required for connecting to either 9 or 25 pin serial ports of most computers are also shown.

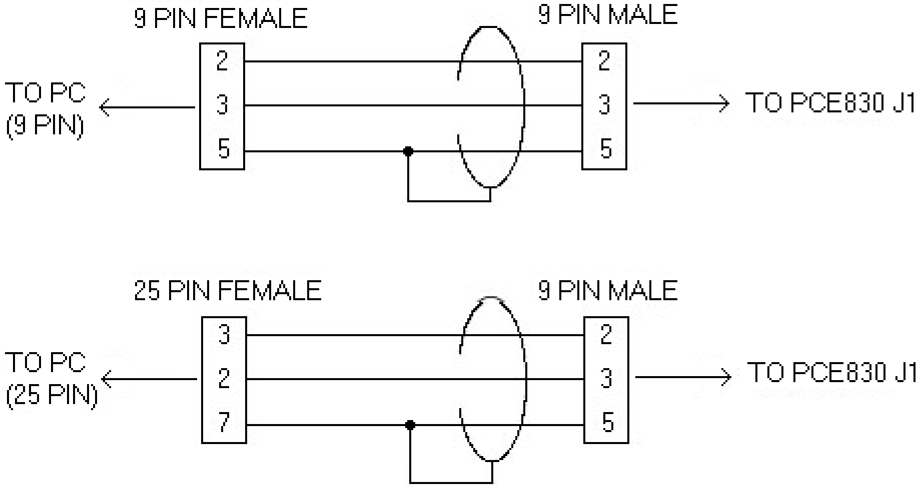
Pinouts vary among computer manufacturers. Check the hardware reference manual for your machine before wiring.

Cabling Diagram A 6-foot (1.8 m) RS-232 Cable with 9 pin connectors and a 9 pin to 25-pin adapter is available from Pacific Scientific. The Pacific Scientific order number is RS-232-5600.



9 CONTACT FEMALE D SUBMINATURE CONNECTOR

TYPICAL CABLES



Shielded wiring is recommended for the serial communications cable to minimize potential errors from electrical noise.

2.2.2.2. RS-485/RS-422 CONNECTIONS

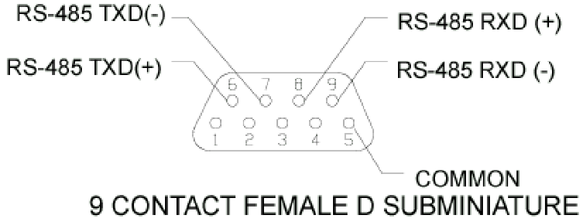
RS-485 / RS-422 Connections

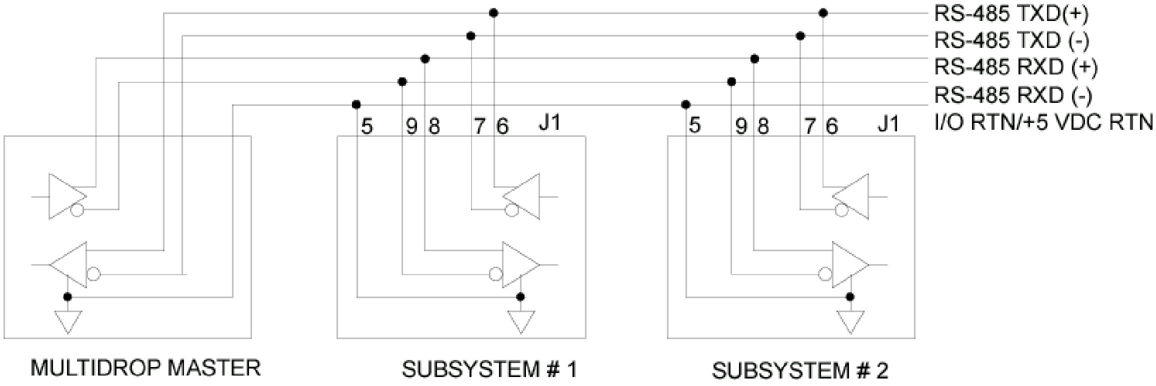
Up to 32 PCE830s can be connected in parallel to a multidrop master. The PCE830s must each have a unique address, set in software. Once the address is set, the Axis Selection function in 800Tools must be used to select the designated axis address. Then, either the RS-232 or RS-485 link can be used to communicate with the selected axis.

For example, the RS-232 link can be used to completely setup and test an individual axis before connecting it into the multi-axis configuration.

RS-485/RS-422 connections to J1 are shown below. A multidrop interconnection diagram, showing multiple axes connected to a single host is also shown.

Connection Diagram



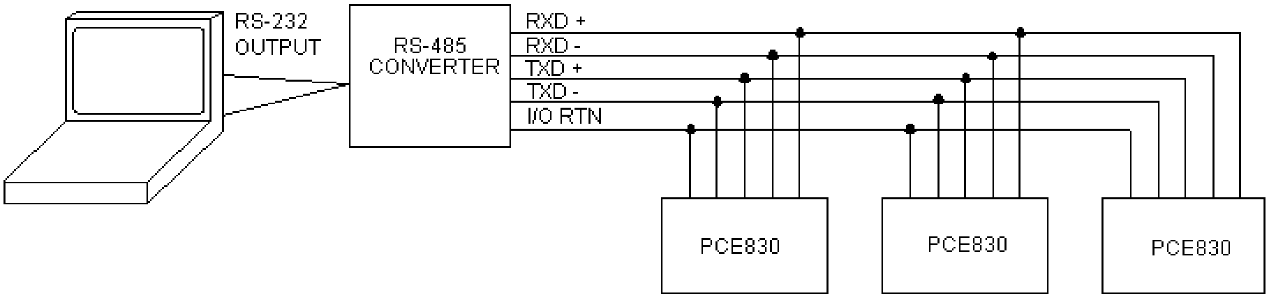


RS-232 to RS-485 Converter Installation

It is often convenient to use an RS-232 to RS-485/RS-422 converter so an RS-232 port (available on all PCs) can be used to connect to multiple axes. The figure below shows a typical installation, using the B & B Model 422 RS-232 to RS-422 adapter. RS-232 to RS-485/RS-422 adapters are available from many sources.

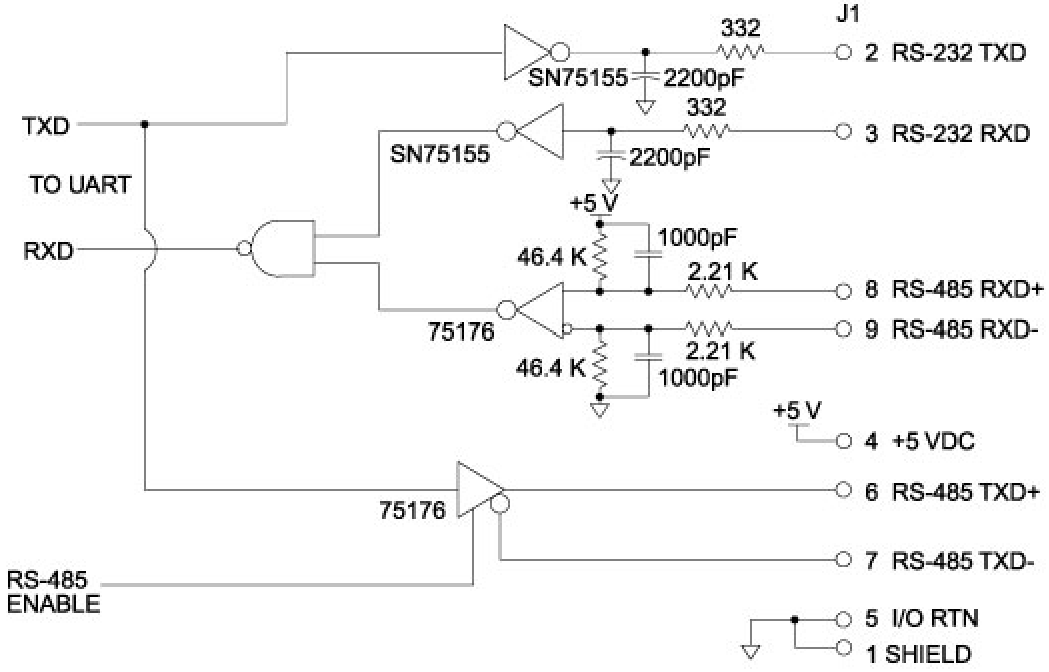
An adapter can be powered from the serial port +5 VDC output on J1-4 as long as the load current on J1-4, J2-14, and J3-10 total less than 250 mA.

Installation Diagram



PCE830 Serial Communications Transceiver Schematic

Installation Diagram

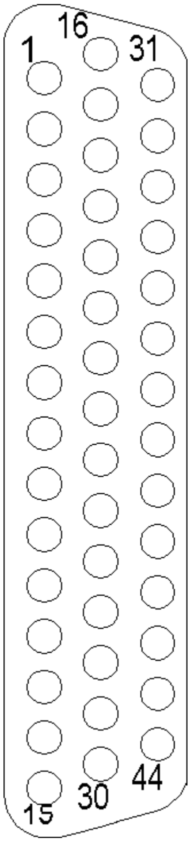


2.2.3. Command I/O

J2 44 Position D subminiature female

Pin	Description	Pin	Description
J2-1	Analog Command Input (+)	J2-23	No Connect
J2-2	Analog Command Input (-)	J2-24	Relay Output (+) (Out4)
J2-3	I/O RTN	J2-25	Relay Output (-) (Out4)
J2-4	Analog Output1 (DACMonitor1)	J2-26	No Connect
J2-5	Analog Output2 (DACMonitor2)	J2-27	No Connect
J2-6	Analog Current Limit Input	J2-28	Analog Input 2
J2-7	I/O RTN	J2-29	Analog Input 3
J2-8	Encoder Output Channel A	J2-30	I/O RTN
J2-9	Encoder Output Channel $\overline{A}$	J2-31	Input 1 (Fault Reset)
J2-10	Encoder Output Channel B	J2-32	Input 2 (CwInh)
J2-11	Encoder Output Channel $\overline{B}$	J2-33	Input 3 (CcwInh)
J2-12	Encoder Output Channel Z	J2-34	Input 4 (Reg1)
J2-13	Encoder Output Channel $\overline{Z}$	J2-35	Input 5 (Reg2)
J2-14	+5VDC (Output)	J2-36	Input 6
J2-15	I/O RTN/ +5VDC RTN	J2-37	Enable Input
J2-16	I/O RTN	J2-38	Input RTN
J2-17	Command Encoder Input Channel A (Step)	J2-39	+24VDC Output RTN
J2-18	Command Encoder Input Channel $\overline{A}$ (Step)	J2-40	+24VDC (Output)
J2-19	Command Encoder Input Channel B (Dir)	J2-41	Out1, 2, 3 Supply (Input)
J2-20	Command Encoder Input Channel $\overline{B}$ (Dir)	J2-42	Out1 ($\overline{\text{Fault}}$)
J2-21	No Connect	J2-43	Out2 ($\overline{\text{Brake}}$)
J2-22	No Connect	J2-44	Out3

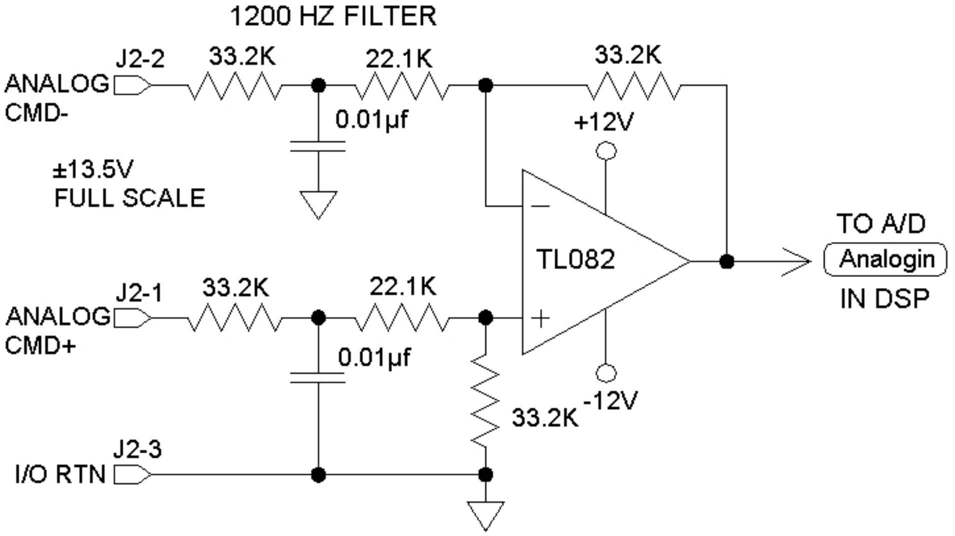
J2 Diagram The figure below illustrates the pin-out for the 44-pin connector. It shows the front view looking at the PCE830.



Command I/O

Analog CMD
J2-1, 2
(+), (-) Inputs

These inputs accept the analog command from the user. This is a differential input to an A/D. It has a maximum single ended input range with respect to I/O RTN on either input of ± 21V and an input impedance of 50 kΩ. The full-scale differential command input range is ± 13.5V. The offset and single pole low pass bandwidth of this signal is adjustable via a software setup parameter. When used as a motion command the gain from this input is also adjustable via a software setup parameter.



Always connect I/O RTN (J2-3) to the signal ground of the source. Failure to do so may result in erratic operation.

I/O RTN
J2-3, 7, 15, 16

This terminal is signal common for the analog and non-optically isolated digital inputs and outputs. These pins are internally connected in the drive.

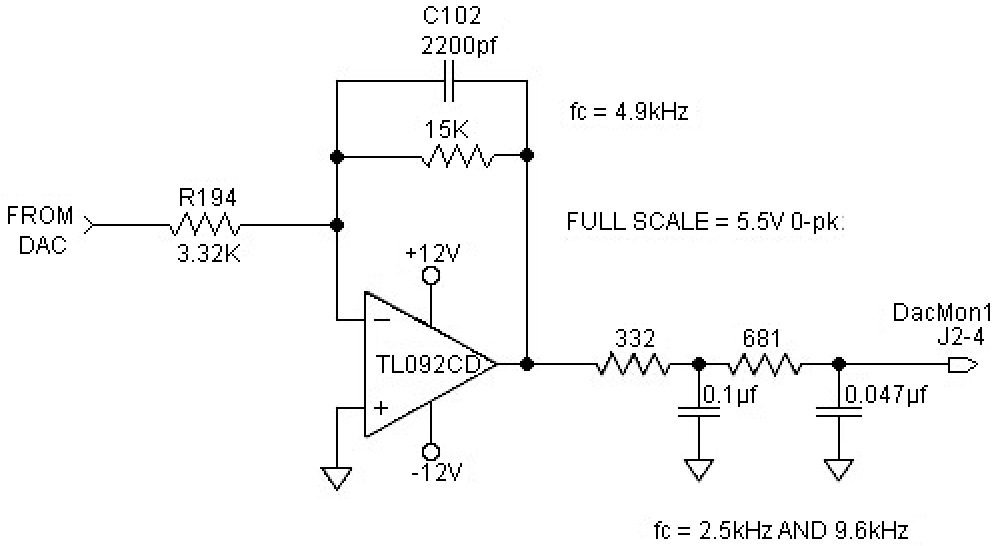
For protection against line surges, one of the I/O RTN pins must be connected to Earth ground. Pacific Scientific recommends making this connection at an earth ground point in the cabinet reserved for single point grounding of all I/O Returns (drives and supplies).

DAC Monitor
J2-4, 5
1, 2 Outputs

These analog outputs are general-purpose monitor points. The output range is ±5.5V with a resolution of 11V/65536 = 0.168 mV. The source impedance is 1 kΩ, which yields a maximum short circuit to I/O RTN current of ± 5 mA. These outputs are updated every 250 mS. There is a 2.5 kHz, 4.8 kHz and a 9.6 kHz analog Low Pass Filter on these outputs.

Each DAC Monitor can be mapped by software to be one of a number of internal variables. The scale factor and the frequency of a single low pass filter pole are software adjustable on each output by the DM1Gain, DM1F0 and DM2Gain, DM2F0 software parameters for DAC Monitor 1 and 2 respectively. Variables marked with a "*" are not range clamped and are allowed to wrap around when the signal exceeds the output DAC's voltage range. The other variables will clamp at maximum when they exceed the analog voltage range. The table on the following page lists the defined signal mappings.

DAC MON



DAC Monitor List Table

DMxMap	Variable	Description	DAC Out Units (DMxGain = 1)
0	AnalogOutx	Actual Analog Output Command	V/V
1	VelFB	Measured Velocity (DM2 Default)	1 V/kRPM
2	VelCmdA	Actual Velocity Command (VelCmdA)	1 V/kRPM
3	VelErr	Velocity Error	1 V/kRPM
4	FVelErr	Compensated Velocity Error	1 V/kRPM
5	Position	Measured Position*	1 V/Rev
6	PosError	Position Error*	1 V/Rev
7	PosCommand	Commanded Position*	1 V/Rev
8	Icmd	Commanded Torque Current	1 V/A
9	IFB	Measured Torque Current (DM1 Default)	1 V/A
10	AnalogIn	Filtered A/D Input	1 V/V
11	EncFreq	Encoder Frequency	1 V/Hz
12	EncPos	Encoder Position*	10 V/4096 Cnts
13	ItFilt	Filtered Output Current Amplitude	1 V/100%
14	HSTemp	Measured Heat Sink Temperature	1 V/°C
15		Commutation Electrical Angle*	1 V/Cycle
16	IU	Motor Phase U Output Current	1 V/A
17	IV	Motor Phase V Output Current	1 V/A
18	IW	Motor Phase W Output Current	1 V/A
19		Motor Phase U Voltage Duty Cycle	1 V/100%
20		Motor Phase V Voltage Duty Cycle	1 V/100%
21		Motor Phase W Voltage Duty Cycle	1 V/100%
22	VBus	Drive Bus Voltage	1 V/V
23	ResPos	Resolver Absolute Position*	1 V/Rev
24		Commanded non-torque current	1 V/A
25		Measured non-torque current	1 V/A
26		Torque Voltage Duty Cycle	1 V/100%
27		Non-torque Voltage Duty Cycle	1 V/100%
28	VelCmd	Velocity Command (VelCmd)	1 V/kRPM
29	DigitalCmdFreq	Digital Command Frequency	1 V/Hz
30	I^2*t	I^2*t Filtered Current	1 V/%Ipeak^2

*These variables are allowed to wrap around when the signal exceeds the output voltage range.

Analog Current Limit
J2-6

This input limits the current flow to the motor when a voltage is applied with respect to I/O RTN.

Outputs

J2-8, 9, 10, 11
CHAOUT
$\overline{\text{CHAOUT}}$
CH B Out
$\overline{\text{CHBOUT}}$

These two output pairs are differential TTL incremental position signals generated by the Resolver feedback electronics. These outputs are quadrature encoded to emulate an optical encoder. The resolution of these signals, i.e. the emulated line count, is set by the EncOut parameter. These outputs are buffered by 26LS31 type RS-422 compatible line drivers. Maximum recommended load current is ± 20 mA, which corresponds to a minimum line-to-line load resistance of 100 Ω. This drive capacity corresponds to ten RS-422 compatible inputs such as the PCE830 encoder inputs. These outputs are indefinitely short circuit proof to I/O RTN.

J2-12, 13
CH Z OUT
$\overline{\text{CHZOUT}}$

These two terminals function as a differential, TTL marker pulse. The output pulse occurs once per motor shaft revolution starting at resolver position = 0 and its width is approximately one quadrature encoder width. This output comes from a 26LS31 type RS-422 compatible line driver. Maximum recommended load current is ± 20 mA, which corresponds to a minimum line-to-line load resistance of 100 Ω. This drive capacity corresponds to ten RS-422 compatible inputs such as the PCE830 encoder inputs. This output is indefinitely short circuit proof to I/O RTN.

J2-14, J2-15
+5VDC, I/O RTN/
+5VDC RTN

These two connections provide an auxiliary power supply for the user. This output is 5VDC ±5% and is short circuit protected at 1 A nominal. The maximum load limit for all connections to this supply is 250 mA. The +5VDC RTN (J2-15) is connected to I/O RTN (J2-3, J2-7, J2-16, J2-30).

Encoder Inputs

CH A IN, CH $\overline{A}$ IN, CH B IN, CH $\overline{B}$ IN,
Step +, Step -, Dir +, Dir -,
Step Up +, Step Up -, Step Dn +, Step Dn -

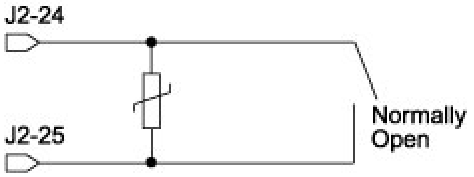
J2-17, 18, 19, 20

These inputs are used as a quadrature encoder, step and direction, or up and down count format incremental signal source. The decoding mode is set by the EncMode parameter. The scale factor of this incremental position command input is fully adjustable with software parameters. Full decoding speed or more noise immune slow speed decoding is software selectable.

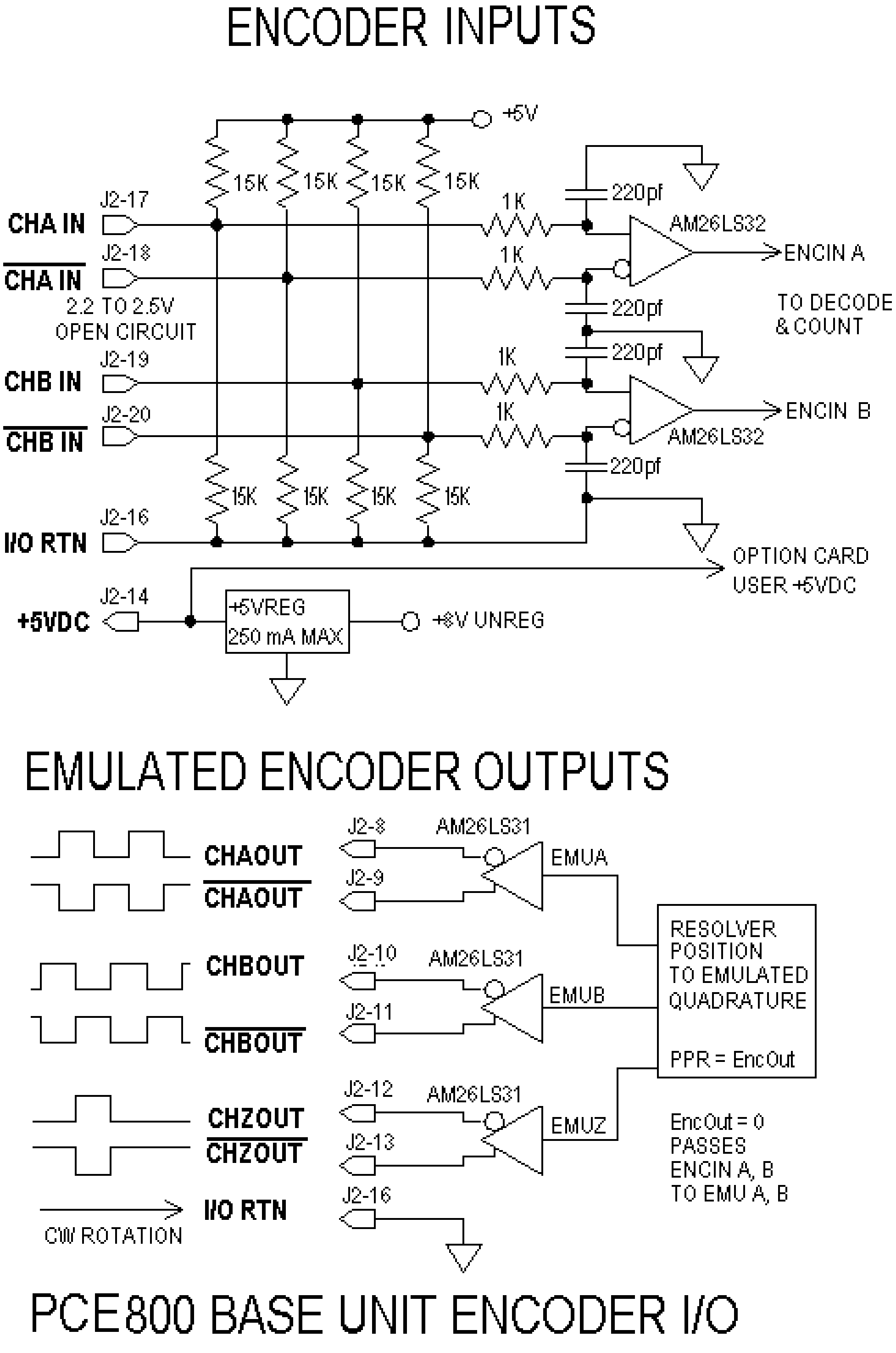
These two input pairs are differential and are detected by 26LS32 type RS-422 compatible line receivers. As differential inputs, the recommended common mode range is < ±7V with respect to I/O RTN and the guaranteed differential voltage logic thresholds are > ±0.2V. Recommended drivers should be able to source and sink 3 mA to/from these inputs. Each of these inputs has internal bias networks to allow easy connection to single ended sources. When an input is open circuited it will bias itself to between 2.2v and 2.5V, thus the remaining input pair terminal will have a single ended guaranteed logic low for inputs < 2.0V and a guaranteed logic high for inputs 2.7V. These levels are compatible with a TTL driver combined with a pull up resistor. Pull up resistor should be 470Ω.

Relay Outputs
J2-24, 25

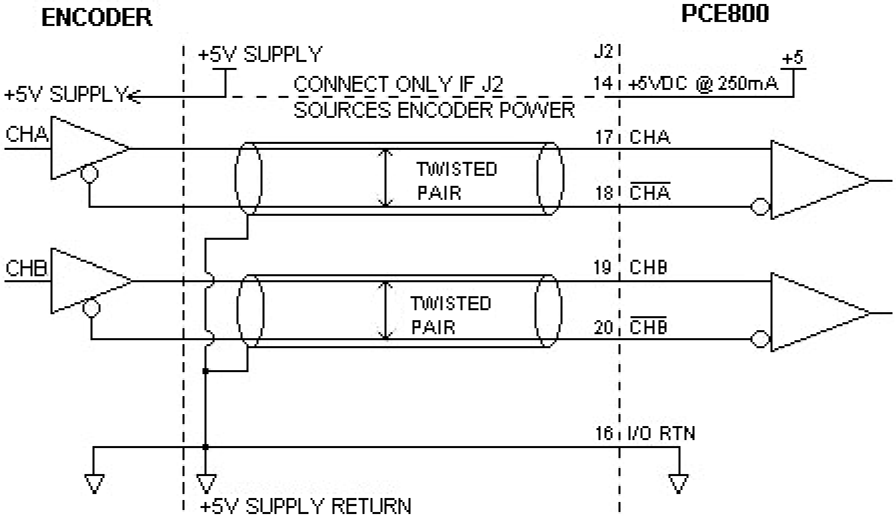
These relay outputs are normally open. They are rated for 1 Amp at 30VDC. These relays may be opened/closed by Out4. When the drive has no control power the relay is open.



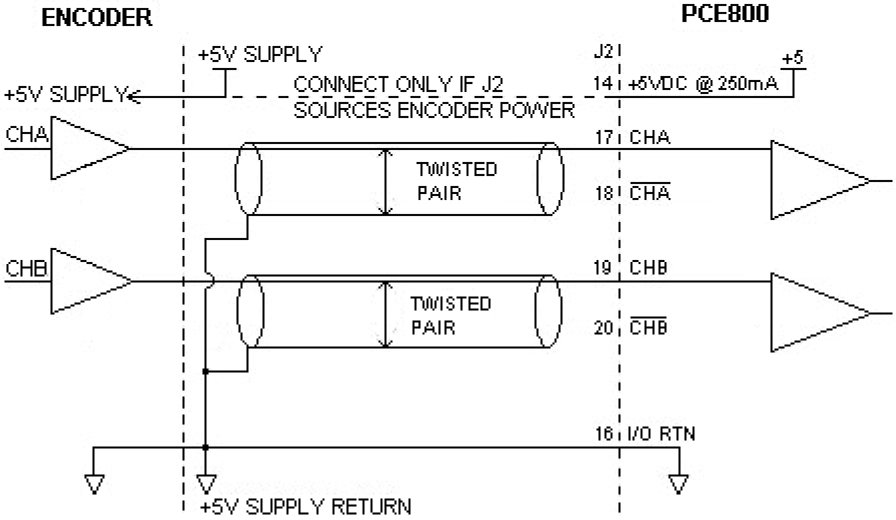
J2 Encoder I/O Interface Schematic



Using TTL differential line drivers



Using TTL single-ended drivers



Auxiliary Analog Inputs J2-28, 29

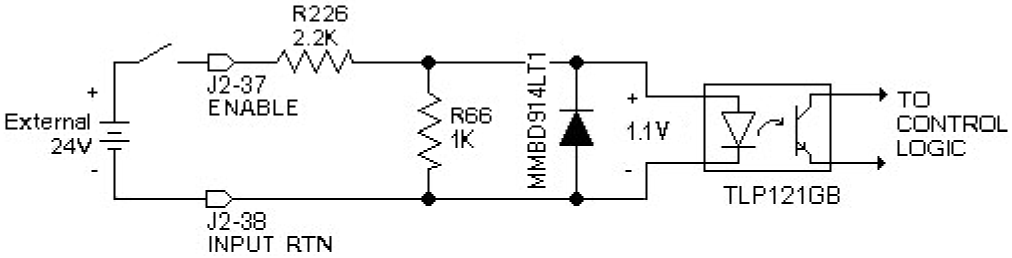
Not Used.

Inputs 1-6 J2-31, 32, 33, 34, 35, 36

These six optically isolated I/O connections are user programmable discrete 24 V inputs. These inputs share a floating return (J2-38) with the Enable Input (J2-37). A minimum drive capability of 4 mA is required to fully power the opto. The user must supply 10V to 30V to these inputs.

5 V inputs CANNOT be used.

Each of the inputs is set and read by software every 2 mSec. Each one can be configured to be any of the available functions and the configuration can be changed on the fly via digital communications. Your default configuration is stored in the non-volatile memory. The present state of each of these lines can be read via digital communications. The logic polarity of these signals is also software programmable. That is, an input can be defined to be active low or active high. For edge triggered functions the active edge is programmable.

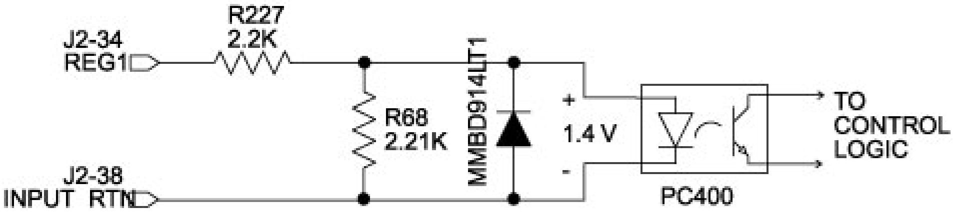


Logic State	InpX with respect to Input RTN
Low	0V to +2V
Undefined	+2V to + 10V
High	+10V to + 30V

The list below describes the subset of the available functions and the mappings used as the factory defaults for each of the inputs.

Fault Reset Input	**Input 1**: This input is used to reset the amplifier following a fault. This input is programmed active high so that an open circuited input does not activate the function. During Fault Reset active the output stage is disabled and the reset condition will be held in hardware for approximately 0.1 sec after Fault Reset is returned inactive.
CwInh Input	**Input 2**: This input prevents further motion in the clockwise shaft motion direction. This input is programmed active high so that an open circuited input does not activate the function. If the shaft is already moving in the clockwise direction, then the motor will decelerate to zero velocity with the maximum torque allowed by the user set output current limits. This input will have no effect on motion in the counterclockwise direction. This input is useful for a clockwise over travel limit switch.
CcwInh Input	**Input 3**: Analogous to the CwInh input, except that this input prevents counterclockwise motion.
Reg1 Input	**Input 4**: This high speed input latches motor position within 50 µsec after a transition.
Reg2 Input	**Input 5**: Analogous to Reg1 input.
Input Mapped Off	**Input 6**: Input Mapped Off

Reg1 Input J2-34

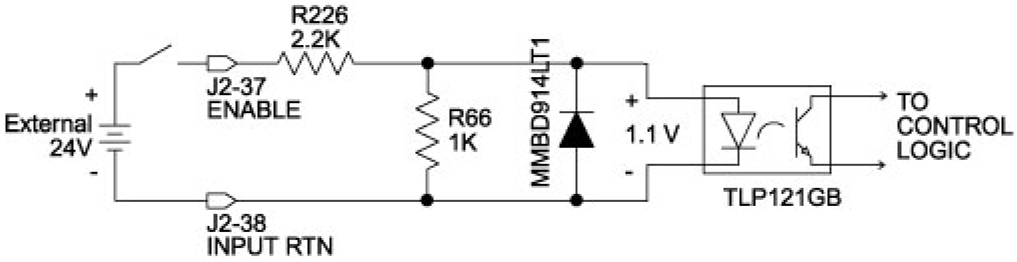


Probe inputs have a 50-µsec latch time.

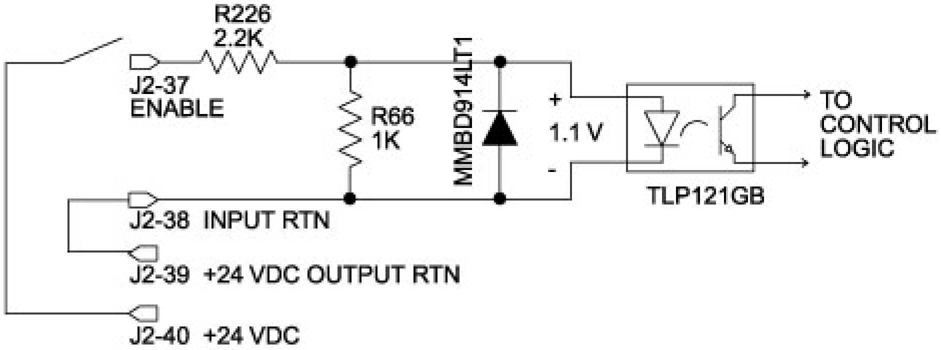
Enable Input J2=37

This optically isolated input is used to enable the drive and is active high. The output stage is disabled when this input is inactive. A minimum drive capability of 4 mA is required. You must supply 10V to 30V to drive this input. This input is filtered with a 1 mSec time constant low pass filter to prevent false triggering from noise. The Enable input shares a floating return (J2-38) with Inputs 1 through 6.

5 V input CANNOT be used.



If the drive's 24V supply is being used, connect as shown below.



Input RTN
J2-38

This terminal is the floating common return for the six optically isolated digital inputs and the optically isolated Enable input.

+24 VDC RTN,
+24 VDC (Output)
J2-39, J2-40

These two connections provide an auxiliary floating power supply for the user. This output is 24VDC ± 10 % and is short circuit protected at 100 mA nominal. The maximum load limit for all connections to this supply is 80 mA. + 24VDC RTN is not connected to Input RTN.

Out1, 2, 3
Supply (Input)
J2-41

The PCE830 requires an external 12VDC - 24VDC power source for the outputs. This power source must be capable of supplying at least 150 mA.

Outputs
J2-42, 43, 44

These optically isolated outputs are current sourcing at 0 to 50 mA maximum. External output supply should be limited to 30V. These outputs are short circuit protected. Current folds back to about 25 mA during a short circuit. The external output supply (J2-41) is shared by the three outputs.

V_{ON}	1.9V at 25 mA 2.25V at 50 mA
I_{OFF}	5 µA
Response time	1 msec
Clamp voltage	40V (nominal)

Each of the outputs is set and written to by software every 2 mSec. Each one can be configured to be any of the available functions and the configuration can be changed on the fly via digital communications. The user’s default configuration is stored in the non-volatile memory. The present state of commanded outputs can be read via digital communications. The logic polarity of these signals is also software programmable. That is, an output can be defined to be active low or active high. For edge triggered functions the active edge is programmable.

The list below describes the subset of the available functions and the mappings used as the factory defaults for each of the outputs.

$\overline{\text{Fault}}$ Output

Output 1: This output is low when the drive is faulted or has no control power. This line can be used to indicate a problem with the drive.

$\overline{\text{Brake}}$ Output

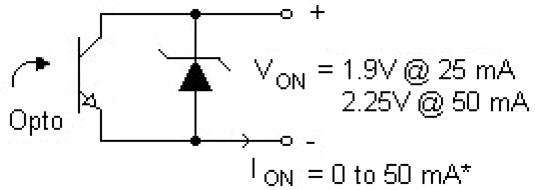
Output 2: This output is low when the control power is off, or when control voltage is on and the drive is disabled (Enabled = 0). This output is pulled high otherwise. This output is intended to drive a normally open relay that in turn powers a mechanical brake on the motor shaft for applications that require a positive shaft lock when the servo drive is off.

Output Mapped Off

Output 3: Output Mapped Off

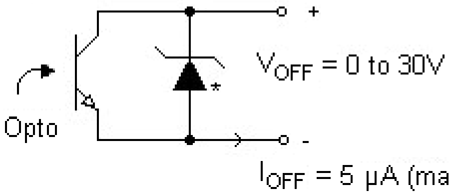
Outputs

ON State



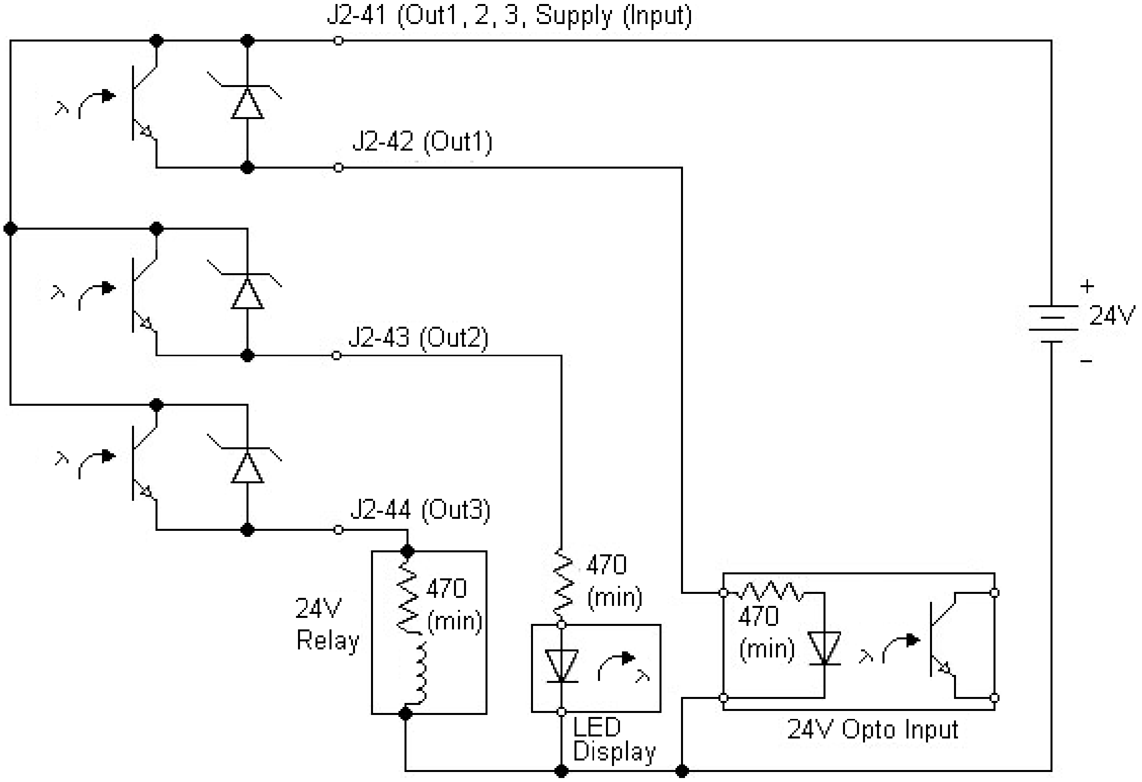
*During short circuit folds back to 25 mA

OFF State

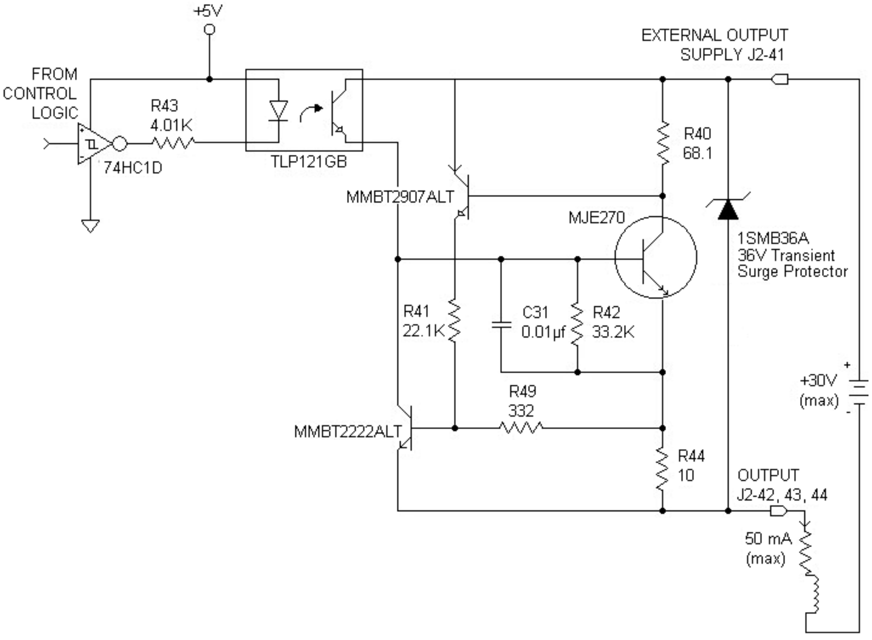


*36V Transient Surge Protector clamps @ 40V nominal

Outputs Driving Typical Loads



Output Schematic



2.2.4. Base Servo Drive User I/O Connections

J3 FEEDBACK 15 Position D subminiature female

Pin	Description
1	RESOLVER S1 SIN + (Input) / Hall 1
2	RESOLVER S3 SIN - (Input) / Hall 2
3	RESOLVER S2 COS + (Input) / Hall 3
4	RESOLVER S4 COS - (Input)
5	SHIELD (I/O RTN)
6	RESOLVER R1 EXCITATION (Output)
7	RESOLVER R2 EXCITATION RTN (Output)
8	MOTOR PTC (Input)
9	MOTOR PTC RTN (Input)
10	+5VDC
11	I/O RTN
12	FEEDBACK ENCODER CHANNEL A (+)
13	FEEDBACK ENCODER CHANNEL A (-)
14	FEEDBACK ENCODER CHANNEL B (+)
15	FEEDBACK ENCODER CHANNEL B (-)

Feedback

Resolver
S1, S2, S3, S4 Inputs
J3-1, 2, 3, 4

These connections provide the inputs for the resolver's sine/cosine outputs. Differential inputs with 75Vμsec common mode impulse range and 25 kΩ input impedance.

This only applies if a Resolver feedback device is being used.

Hall1, Hall2, Hall3
J3-1, 2, 3

These three single-ended hall channel sensor inputs are detected by +5VDC CMOS compatible commutation signals with 60° spacing. These inputs are each internally pulled-up to +5VDC via a 10 kΩ resistor. These input signals are low pass filtered in hardware at 10 kHz.

This only applies if a Hall feedback sensor is being used.

Resolver R1 Excitation, R2 Excitation RTN Outputs J3-6, 7

These connections provide the resolver excitation output. 9.2V rms at 6510.42 Hz 75 mA rms maximum load. These outputs are fully short circuit protected to I/O COMMON or to each other at room temperature (25°C), but at ambient temperatures above 50°C, shorts longer than 5 minutes may cause damage.

Motor PTC, PTC RTN Inputs J3-8, 9

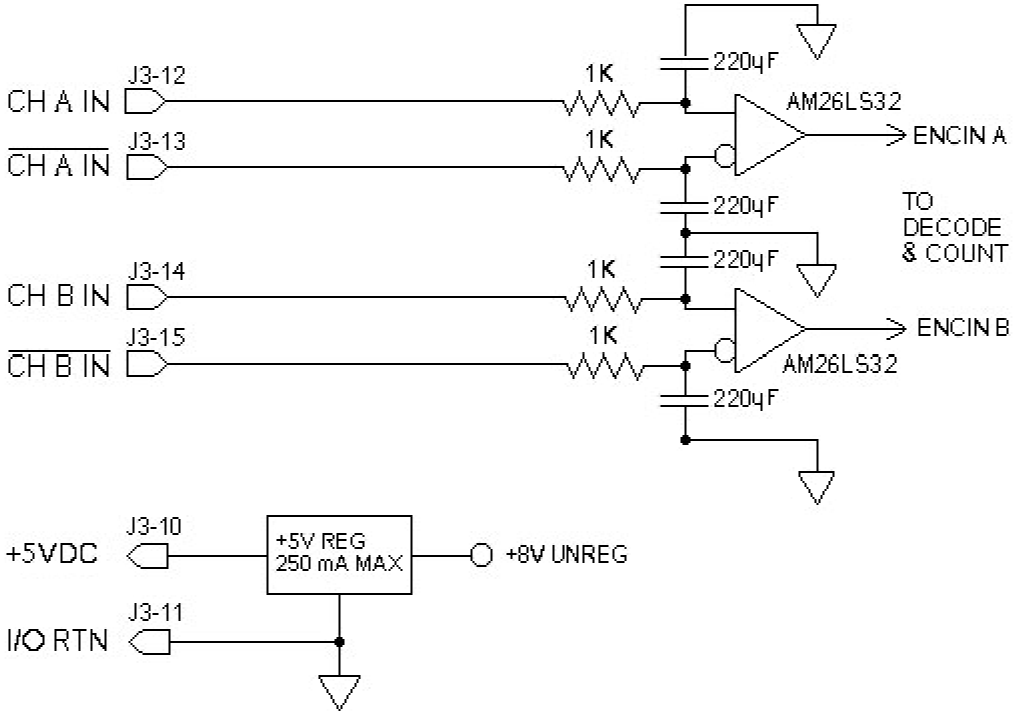
These two inputs are intended to connect to a positive temperature coefficient thermostat or normally closed thermostatic switch imbedded in the motor windings. When the resistance between these terminals becomes greater than 6.2 kΩ the drive will fault and indicate a Motor Over Temperature fault. This circuit directly interfaces with Pacific Scientific's standard motor PTC.

PTC RTN is connected to I/O RTN.

Encoder Inputs J3-12, 13, 14, 15

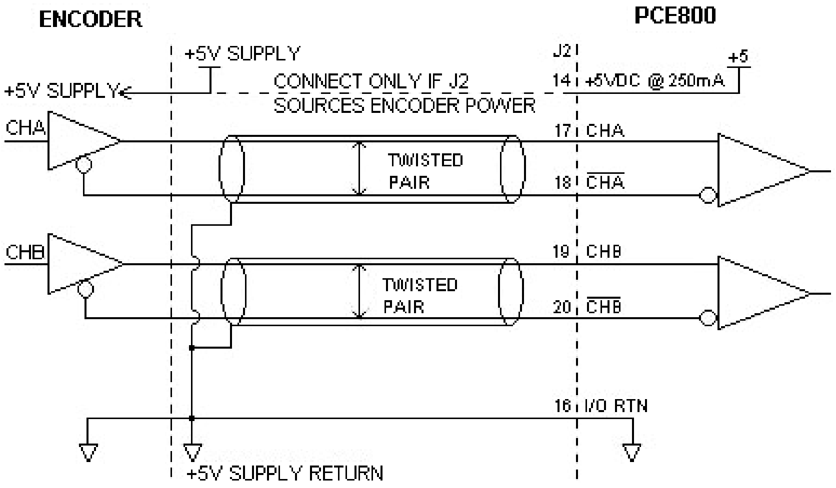
CH A, $\overline{\text{CH A}}$, CH B, $\overline{\text{CH B}}$

These differential inputs expect quadrature encoder feedback signals. These two input pairs are differential and are detected by 26LS32 type RS-422 compatible line receivers. As differential inputs, the recommended common mode range is 7V with respect to I/O RTN and the guaranteed differential voltage logic thresholds are ± 0.2V. Recommended drivers should be able to source and sink > 3 mA to/from these inputs.



An adapter can be powered from the serial port +5VDC output on J1-4 as long as the load current on J1-4, J2-14, and J3-10 total less than 250 mA.

Using TTL Differential Line Drivers



2.3. Mappable I/O Functions

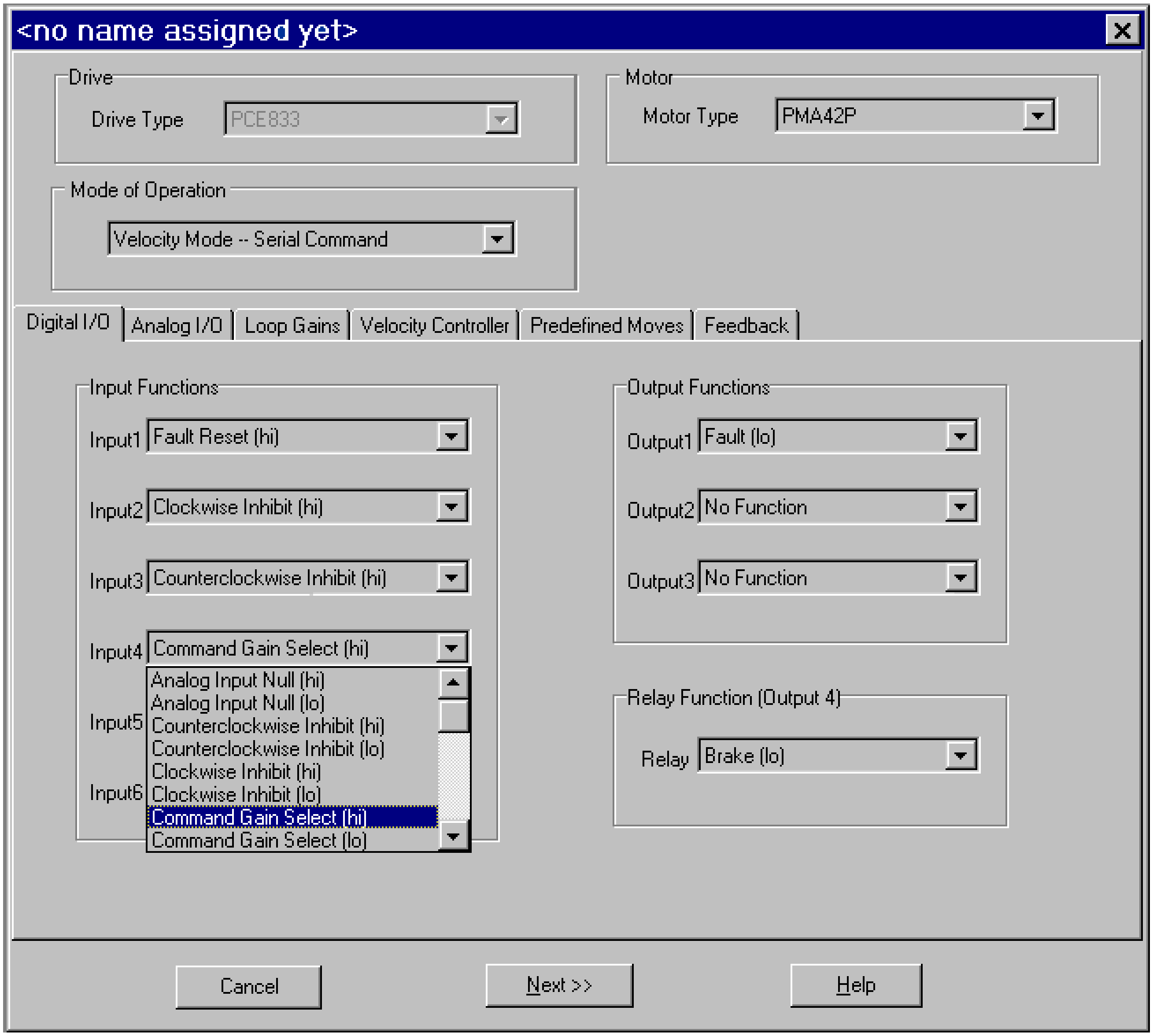
The PCE830 has six user mappable inputs (J2-31 to J2-36), three user mappable outputs (J2-42 to J2-44), and one mappable relay output (J2-24, 25) which are available for users to interface to external devices; proximity switch, PLC, LED.

Inputs Table (InpMapX) The following table lists the mappable input functions available for the Digital Inputs.

Mappable Input Function	Description
Analog Input Null	Nulls the analog input by setting ADOffset to old ADOffset minus AnalogIn
Counterclockwise Inhibit (default)	Inhibits motor motion in the counterclockwise direction when asserted
Clockwise Inhibit □(default)	Inhibits motor motion in the clockwise direction when asserted
Command Gain Select	Switches the analog input scale factor between CmdGain and CmdGain2
Enable 2	Second enable function
Fault Reset (default)	Resets drive faults
Gearing On	Turns electronic gearing on
Home Switch Input	Home switch input for a homing move
Move Select Bit 0, 1, 2	Determines the active move
No Function	Turns off mappable input functionality
Position Mode Select	Switches the active mode of operation to position mode
Run Stop	Selects between normal operation and setting the velocity command to zero
Start Move	Initiates the preset move as defined by the current state of the MoveSelectBit inputs
Velocity Command Source	Selects between VelCmd and VelCmd2

Procedure To assign a mappable input function to a digital input, perform the following steps.

1. Click on **Create New Configuration** or **Edit Exisiting Configuration** button.
2. Select the appropriate **Motor and Drive Type** and the **Mode of Operation**. Click **Next**.
3. Click on the **Digital I/O** tab. Select the input that is being assigned a function.
4. Select the desired function from the drop-down list-box.



<no name assigned yet>

Drive
Drive Type: PCE833

Motor
Motor Type: PMA42P

Mode of Operation: Velocity Mode -- Serial Command

Input Functions
Input1: Fault Reset (hi)
Input2: Clockwise Inhibit (hi)
Input3: Counterclockwise Inhibit (hi)
Input4: Command Gain Select (hi)

Output Functions
Output1: Fault (lo)
Output2: No Function
Output3: No Function

Relay Function (Output 4)
Relay: Brake (lo)

Active hi/lo Each of the digital inputs can be defined as either active high or active low. If the mappable input function (bit) is configured as active high (low) and if the input is **HIGH** (**LOW**), the mappable input function (bit) is asserted. For example, if Fault Reset is configured as active high, when the input is high, Fault Reset is asserted.

Analog Input Null

In Analog Torque Mode or Analog Velocity Mode, the Command voltage can be nulled to:

- Reduce drift at zero volt command.
- Set 50% analog offset for commanding bi-directional motion with a single polarity adjustable voltage command source.

Related Parameter(s)

See **AnalogIn** and ADF0 in On-Line Help.

Setup

1. Connect the Analog command source to J2-1 and J2-2.
2. Activate the input momentarily to offset the command for zero motion.
3. To reduce drift, command zero volts and remove small offsets with the null.
4. To set bi-directional motion with a single polarity input, convert a 0V to 10V analog command to ±5V by commanding 5.0V on the analog input when you null the analog input. Use Command Gain (CmdGain) to scale the input voltage for appropriate output.

Command Gain Select

In Torque Mode or Velocity Mode (except Serial Velocity), the command scale can be switched between **CmdGain** value and **CmdGain2** value for:

- A Direction input that changes polarity of a jog command.
- A complex motion input that changes speed.
- An input to command zero motion.

Setup

1. Click the **Edit Drive Configuration Online** button.
2. Change the value of **CmdGain2** to the desired value:

For Direction, set CmdGain2 = (- CmdGain).

To Change speed, set CmdGain2 = NonZero value.

To hold zero command, set CmdGain2 = 0.

When you activate the **Command Gain Select** input, the command will switch from a scale of **Command Gain CmdGain** to a scale of **CmdGain2**.

Related Parameter(s)

See **CmdGain**, **CmdGain2**, and **BlkType**(**Operation Mode**) in On-line Help.

Gearing On

In Position Mode, the Digital Command source can be turned on by activating **Gearing On** input, and turned off by deactivating the **Gearing On** input. Deactivate Gearing On to:

- Perform a Homing Move
- Perform a move to a flying shear start position
- Hold zero speed until next input

An Absolute Move will abort Gearing (Gearing On = 0)

Setup

1. Click on the **Digital I/O** tab. Setup a **Start Move** input and **Move Select Bit** inputs for starting the move.
2. Click on the **Predefined Moves** tab. Setup a **Home** move.
   OR
   Setup an **Absolute** move to Position 0 or the known start position.
3. To hold zero speed the **Gearing On** input is all that is needed.

Related Parameter(s)

See **EncMode**, **DigitalCmd**, and **DigitalCmdFreq in** in on-line Help.

Position Mode Select

In Torque Mode or Velocity Mode, the mode can be switched between Torque and Position, or Velocity and Position. After switching to **Position Mode** the drive performs:

- Electronic Gearing
- Predefined Moves
- Hold Position

Setup

1. For Electronic Gearing, provide a Digital Command Source such as an encoder or step and direction signals.

   Click the **Edit Drive Configuration OnLine** button.

   Set **EncMode** to the type of Digital Command Source provided.
2. To define moves, click on the **Predefined Moves** tab, and the **Digital I/O** tab to define **MoveSelectBits** and **StartMove** inputs.
3. To Hold Position, activate the input.

Related Parameter(s)

See **CmdGain**, **VelCmd** and **BlkType**(**Operation Mod**e) in on-line Help.

Run Stop

In any operating mode, the command source can be switched to 0 rpm for Clutch/Brake with *NO* holding torque. **StopTime** sets the amount of time before disabling the motor after the **RunStop** function is activated. This allows for a controlled stop. In Velocity Mode or Position Mode, use **DecelLmt** to decelerate the motor before it disables.

Setup

1. Click the **Edit Drive Configuration Online** button.
2. Change the value of **StopTime.** When you activate the **RunStop** input, the command switches from operating speed to 0 rpm, and the drive disables after **StopTime**.

Related Parameter(s)

See **StopTime** in on-line Help.

Velocity Command Source

In Torque Mode, the command source can be switched between **VelCmd** and **VelCmd2** for:

- Torque inhibit if VelCmd2 = 0.
- Torque preset select if VelCmd2 is non-zero.

In Velocity Mode, the command source can be switched between **VelCmd** and **VelCmd2** for:

- Clutch/Brake with holding torque if VelCmd2 = 0.
- Velocity preset select if VelCmd2 is non-zero.

In Position Mode, the command source can be switched between VelCmd and VelCmd2 for:

- Switching between electronic gearing follower and velocity preset command.

Setup

1. Click the **Edit Drive Configuration OnLine** button.
2. Change **VelCmd2** to the desired preset value.
3. Activate the input mapped for **Velocity Command Source** to select the **VelCmd2** value.

Related Parameter(s)

See **VelCmd**, **VelCmd2**, **BlkType**(**Operation Mode**) in on-line Help.

Outputs Table (OutMapX)

The following table lists the mappable output functions available for the Digital and Relay Outputs.

Mappable Output Function	Description
Brake (default)	Indicates when the motor is not powered and a mechanical brake is needed to hold the motor.
Electrical Revs	Square wave whose frequency is equal to the motor electrical frequency.
Enabled	Indicates whether power can flow to the motor.
Excess Position Error	Asserted when there is excess following error for an extended period of time (following error limit is defined by PosErrorMax).
Fault (default)	Indicates whether the drive has faulted and is disabled.
Mechanical Revs	Square wave whose frequency is equal to the resolver's electrical frequency which is typically equal to the mechanical Rev/sec.
Move Done	Indicates that a move is complete.
No Function	Turns off mappable output functionality.
Zero Speed	Activated when the motor's speed goes below the speed threshold set by the parameter ZeroSpeedThresh.

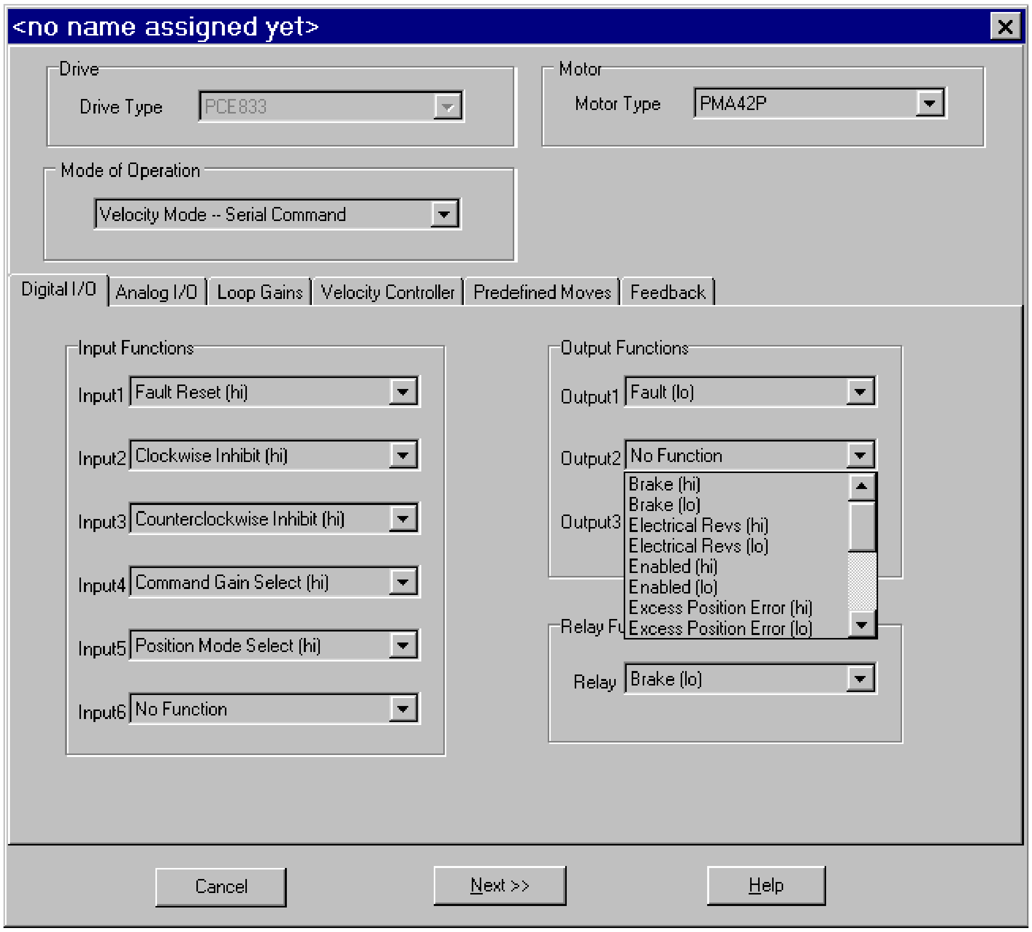
Active hi/lo

Each of the digital outputs can be defined as either active high or active low. If the mappable output function (bit) is configured as active **HIGH** (**LOW**), when the function (bit) is asserted, the output is **HIGH** (**LOW**). For example, if Move Done is configured as active high, when the move is complete, the output goes high.

Procedure

To assign a mappable output function to a digital output:

1. Click either the **Create New Configuration** or **Edit Exisiting Configuration** button.
2. Select the appropriate **Motor and Drive Type** and the **Mode of Operation**. Click **Next**.
3. Click the **Digital I/O** tab. Select the output or relay that is being assigned a function.
4. Select the desired function from the drop-down list-box.



<no name assigned yet>

Drive
Drive Type PCE833

Motor
Motor Type PMA42P

Mode of Operation
Velocity Mode -- Serial Command

Input Functions
Input1 Fault Reset (hi)
Input2 Clockwise Inhibit (hi)
Input3 Counterclockwise Inhibit (hi)
Input4 Command Gain Select (hi)
Input5 Position Mode Select (hi)
Input6 No Function

Output Functions
Output1 Fault (lo)
Output2 No Function
Output3

Relay Fu
Relay Brake (lo)

Excess Position Error

In Position Mode, indicates synchronization failure for:

- Warning the master when out of synchronization
- Preventing a position error fault from disabling the drive

Setup

1. Click the **Edit Drive Configuration OnLine** button.
2. Change **PosErrorMax** to the appropriate Motor Counts as a trip threshold (Motor Counts = 65536 counts/rev).

Related Parameter(s)

See **PosErrorMax**, **KPP**, and **KVFF** in on-line Help.

Move Done

When executing Predefined Moves, the Move Done output activates when the motor feedback reaches the final move position. **InPosLimit** sets the window of motor counts to determine if the motor is near final position. A smaller window (InPosLimit = 2) provides more accurate results and takes longer to settle. Use the **MoveDone** output to tell the master control that the drive is finished with the move and in final position.

Setup

1. Click the **Edit Drive Configuration OnLine** button.
2. Change **InPosLimit** to the appropriate Motor Counts as a trip threshold (Motor Counts = 65536 counts/rev, 6 counts = 1/10000 rev).

Related Parameter(s)

See **InPosLimit in** on-line Help.

Zero Speed

In any Operating Mode, the **Zero Speed Output** can be used to indicate:

- If the motor is near zero speed when **ZeroSpeedThresh** is near 0.
- If the motor is at speed when **ZeroSpeedThresh** is set near target speed.

Setup

1. Click the **Edit Drive Configuration OnLine** button.
2. Change **ZeroSpeedThresh** near but not past the desired target speed. There is velocity ripple that can cause output bounce if the threshold is set too close to the target.

Related Parameter(s)

- See **ZeroSpeedThresh** in on-line Help.

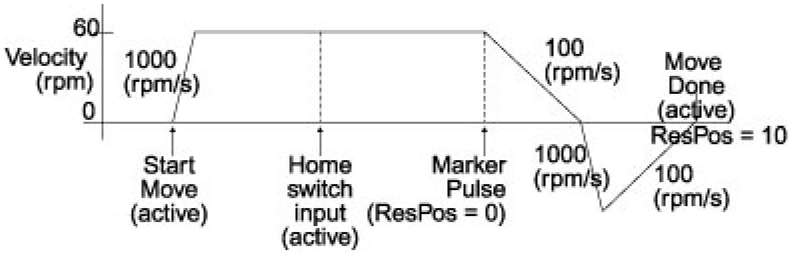
Application Examples

The following are a few application example setups for the PCE830.

Homing

- Typically motion control applications require the machine to be homed to a predefined starting position, prior to performing its normal operations. Generally, a mechanical home switch or a marker pulse is referenced (off an encoder) to provide the homing reference position.
- A motor (with a resolver) drives a load through a 0.5 inch/rev lead screw. To home the machine, the load is required to move at 30 in/min in the clockwise direction. This is in the direction toward a proximity switch (which will be used as the home switch). After the switch is triggered, the load continues to move in the same direction until a marker pulse is seen. In this case, the marker pulse is from the resolver (ResPos = 0). The motor then decelerates to a complete stop to a position beyond the marker pulse and then reverses direction back toward the marker pulse coming to rest at resolver position of ResPos = 10. The drive then activates an output to signal a PLC that the move is done.
- First calculate the speed of the motor while it's advancing toward the home switch:
- Run Speed = 2 rev/in * 30 in/min = 60 rpm

Motion Profile



Procedure

1. Create a new configuration and select **Position Mode - Predefined Moves** as the mode of operation.
2. Click the **Digital I/O** tab. Set up a **Home Switch Input**, a **StartMove** input, and a **MoveSelectBit**. Set up a **MoveDone** output.
3. Click the **Predefined Moves** tab. Setup a **Home** move using the following parameters:

Move Type: Home
Run Speed: 60 rpm
Accel Rate: 1000 rpm
Decel Rate: 100 rpm
Distance Offset: 10 counts
Reg Select: n/a
Homing Mode: Home Switch + Marker Pulse
Home Direction: Clockwise

Clutch/Brake

A thermal cut and seal machine uses an analog input signal to command a geared motor (gear ratio 10:1) to spin a pinch roller that feeds material into the thermal cutter and sealer. There is a 2.5 volt signal available to command speed. The roller has a diameter of 3.82 inches and must advance roughly 24 inches of material in 1 second. A PLC provides an input to emulate a clutch/brake operation commanding zero velocity and stopping motor motion. A second input from the PLC also reverts the drive to maintain motor position during the cut and seal process. The cycle is then repeated.

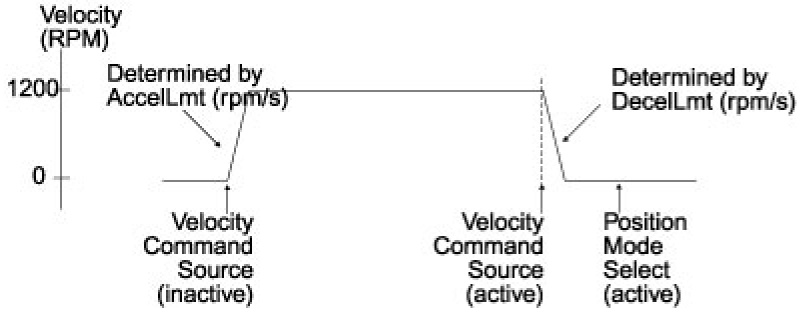
First calculate the required **CmdGain** to provide the necessary speed for the 1 second move:

Roller Circumference =
p * Roller Diameter = p * 3.82 inch = 12 inch

Distance for motor to move =
10 * (24 inch move / 12 inch/rev) = 20 revs

Velocity = 20 rev/sec (1200 rpm) =
CmdGain (krpm/V) * AnalogIn (V)
CmdGain = 1.2 Krpm / 2.5V = 0.48 Krpm/V

Motion Profile



Procedure

1. Create a new configuration and select Velocity Mode as the mode of operation.
2. Click the **Digital I/O** tab. Select **Velocity Command Source** as the function on Input4 to switch between the sources of two unique velocity commands.
3. Select **Position Mode Select** as the function on Input5 to switch between velocity and position modes of operation. This step is optional depending upon whether your application can tolerate a small amount of drift when commanding zero velocity as an analog input. When using this mode of operation during the brake mode VelCmd is equal to zero.
4. Set VelCmd2 = zero. The direction of the velocity move will be controlled by the polarity of the value entered.
5. Set **AccelLmt** and **DecelLmt** to the desired clutch activation acceleration and brake activation deceleration respectively.

VelCmd ***is the velocity commanded through the analog input, encoder frequency input, or the serial port depending upon the mode of operation selected.*** *VelCmd2* ***is a stored value of velocity that can only be changed serially.***

Gearing (w/ phase correction)

An encoder with a 1024 line count is mounted to a continuous web embosser machine. A PCE830 is setup as a position follower such that for every 1 rev of the encoder the PCE830 commands the follower motor to move 1 rev (ratio of 1:1 in encoder revs to motor revs). The drive will be required to phase advance the follower motor ¼ rev when an input from a PLC occurs. Likewise, the drive will also be required to decrement the follower motor (phase retard) by ¼ rev when another input occurs. These phase advance/retard moves will allow the servo to emboss the imprints into the web ahead or behind where they typically would be without any phase adjustment.

First calculate the required gearing ratio between the master encoder and the slave motor. A 1024 line count encoder will output 4096 quadrature counts per encoder revolution.

1 motor rev = 65536 resolver counts (**PulsesOut**)
1 encoder rev = 4096 encoder counts (**PulsesIn**)

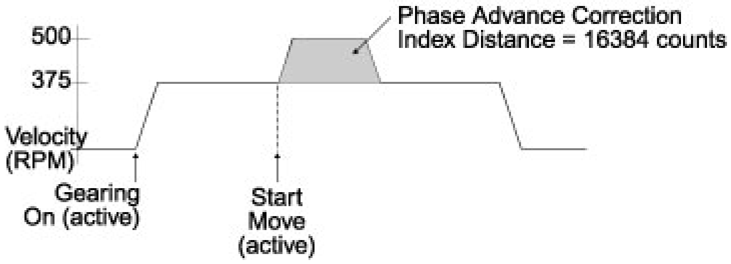
PulsesOut cannot exceed 32767. Divide **PulsesIn** and **PulsesOut** by four to maintain the desired ratio. The new values should then be:

PulsesOut = 16384
PulsesIn = 1024

The phase advance and phase retard index move distances must also be calculated. The motor must perform an index move of ¼ rev (65536/4 = 16384 counts). Therefore, program two preset incremental moves of **Distance** =16384 counts and –16384 counts. Phase correction moves are commanded on top of gearing. To prevent backward motion of the follower, ensure that RunSpeed < DigitalCmdFreq.

It may be necessary to refine the tuning of the system in order to reduce the steady state position following error (position lag). Steady state position following error can be minimized by increasing the velocity feedforward gain (Kvff). Setting *Kvff* ***to 100% reduces this error to zero. However, at the expense of potential excessive overshoot. Therefore, your system may require that*** *Kvff* ***be set to a value less than 100% (typically around 70%-80%). For additional information on tuning refer to Section 2.5, Tuning.***

Motion Profile



Procedure

1. Create a new configuration and select **Position Mode – Electronic Gearing** as the mode of operation.
2. Set desired number of commanded motor **Pulses Out** per the number of encoder **Pulses In**.
3. Click the **Digital I/O** tab. Select **Gearing On** as the function for the input to initiate gearing.
4. Select **Start Move** as the function on the input used to initiate a preset incremental move.
5. Click the **Predefined Moves** tab. Define an **Incremental** move for the phase advance index move.
6. Create a second incremental move for the phase retard index move.

Registration Moves

Registration marks can be used to perform preset registration moves based upon activation of a registration input. Typically, these moves can be used to advance a product a predefined distance after activation of a proximity sensor input. All registration inputs must be tied to a dedicated registration input on either Input 4 (J2-34) or Input 5 (J2-35).

A conveyor processing material is being driven by a one inch diameter roller (directly coupled to a motor) incrementing at a constant speed of 1000 rpm. There are marks on the material spaced evenly every eight inches on the conveyor. These marks are detected by a proximity sensor interfaced into Input 4 on the PCE830 as a registration input. Once the sensor is activated, the motor advances the conveyor one more inch before coming to a complete stop within 75 milliseconds. After the motor has come to a complete stop, the drive activates an output signaling a nearby PLC that the registration move is complete. The PLC initiates the cycle to repeat itself.

Calculate Move Parameters

First, calculate distance to move (Distance Offset) after sensing registration input:

Roller Circumference = π * Roller Diameter
= π * 1 inch = 3.1415 inch

Distance for motor to move = 1 inch move / 3.1415 inch/rev
= 0.31832 revs

Distance Offset = 0.31832 motor rev * 65536 counts/motor rev
= 20861 counts

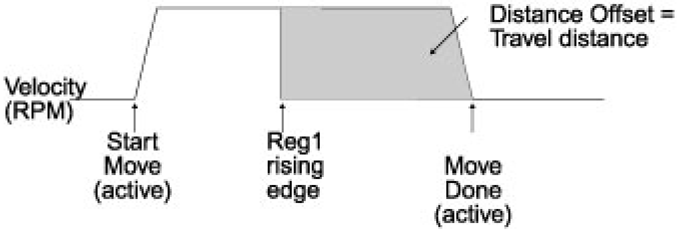
Next, calculate the minimum deceleration rate necessary to ensure coming to a complete stop within the 75 millisecond specification.

Decel Rate = 2 * 0.31832 revs * 60 / (0.075 seconds)2
= 6791 rpm/s

Finally, calculate the minimum distance the motor should move to ensure the registration input is seen every cycle.

Distance = 8 inch * 0.31832 rev/inch * 65536 counts/rev
= 166892 counts

Motion Profile



Procedure

1. Create a new configuration and select **Position Mode - Predefined Moves** as mode of operation.
2. Click the **Digital I/O** tab. Select **Start Move** as the function on Input3 to initiate a preset move.
3. Select **Move Select Bit 0** as the function on Input4 to setup a preset move based upon an external input.
4. Select **Move Done** as the function on Out3.
5. All registration moves must be tied to a dedicated registration input on either Input 4 (J2-34) or Input 5 (J2-35). Select **No Function** for either Input 4 or Input 5 on the **Digital I/O** tab.
6. Click the **Predefined Moves** tab. Setup an **Incremental Registration** move. The registration move is the number of counts set in the **Distance Offset** window. This move is activated by the user as active on the rising or falling edge of this input.

Distance Offset:	20861 counts
Run Speed:	1000 rpm
Reg Select:	Reg 1 (Inp4)
Accel Rate:	10000 rpm/s
Reg 1 Active Edge:	Rising Edge
Decel Rate:	10000 rpm/s (> min 6791 rpm/s)
Distance:	200000 counts (> min 166892 counts)

Jog Moves

A motor is mechanically linked to a pulley (with a 1.91 inch diameter) which drives a conveyor at 50 inch/sec. The motor rotates the pulley at a constant speed to feed products past a scanning station. Occasionally, the drive will be required to run the conveyor at two additional speeds (100 inch/sec and 25 inch/sec) to meet production needs and running different products through the scanning station.

First calculate the required motor velocity(s) to advance the conveyor:

Pulley Circumference =
π * Pulley Diameter = π * 1.91 inch = 6 inch (1 motor rev)

Velocity1 =
(50 inch/sec) * (1 rev/6 inch) * (60 sec/min) = 500 rpm

Velocity2 =
(100nch/sec) * (1 rev/6 inch) * (60 sec/min) = 1000 rpm

Velocity3 =
(25 inch/sec) * (1 rev/6 inch) * (60 sec/min) = 250 rpm

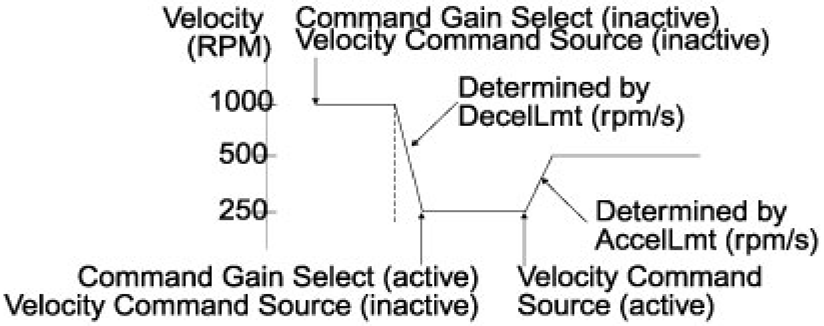
VelCmd2 is a storable serial velocity command that will be used to set the speed for Velocity1. Velocity2 and Velocity3 will obtained by use of the analog input on the PCE830. Either the user can provide their own external analog signal OR make use of the drives ability to produce an analog offset (using **ADOffset**). For this example, **ADOffset** is set to 1 volt. This is used to calculate the appropriate scaling factor to scale this analog signal into a speed reference.

Velocity2 = 1000 rpm =
CmdGain (krpm/V) * (AnalogIn (V) + ADOffset (V))
CmdGain = 1.0 krpm / 1.0 V = 1.0 krpm/V

Velocity3 = 250 rpm =
CmdGain2 (krpm/V) * (AnalogIn (V) + ADOffset (V))
CmdGain2 = 0.25 krpm / 1.0 V = 0.25 krpm/V

If an external analog signal is provided to vary the analog input, then a wide range of jogging speeds are possible.

Motion Profile



Procedure

1. Create a new configuration and select **Velocity Mode — Analog Command** as the mode of operation.
2. Click the **Digital I/O** tab. Select **Command Gain Select** as the fucntion for the input to be used to select scaling/polarity of incoming analog command signal.
3. Select **Velocity Command Source** as the function of the input to be used to set serial velocity command.
4. Click the **Velocity Controller** tab. Set **Offset Voltage** as desired analog signal command *OR* provide appropriate incoming external analog signal with the appropriate voltage (the latter may be preferred as it permits variable speeds to be achieved).
5. Click the **Edit Drive Configuration Online** button. Set **CmdGain** and **CmdGain2** to the desired values for scaling and polarity.
6. Set **VelCmd2** to desired speed (a setting of 0 rpm represents a STOP input)

VelCmd2 ***is NOT tied to the analog input signal coming into the drive.***

2.4. Selecting Modes of Operation

The PCE830 has three distinct modes of controlling the motor shaft and three distinct sources for the shaft command:

Modes

- Torque Control
- Velocity Control
- Position Control

Commands

- Analog Command
- Incremental Digital Pulse Command
- Serial Port Command

Mode of Operation	Command Source
Position Mode - Predefined Moves	Digital Inputs
Position Mode - Step and Direction	Step and Direction
Position Mode - Electronic Gearing	External Encoder
Velocity Mode - Analog Command	Differential Analog Input
Velocity Mode - Frequency Command	Frequency/Pulse
Velocity Mode - Serial Command	RS-232/RS-485
Torque Mode - Analog Command	Differential Analog Input
Torque Mode - Frequency Command	Frequency/Pulse

Each of the drive's operating modes can be easily set up using **Create New Configuration** or **Edit Existing Configuration** buttons of 800Tools. The following sections give the details on these operating modes and their command source.

Refer to Section 2.7, Servo Loop Parameters for control block diagrams and additional information on velocity and position loops.

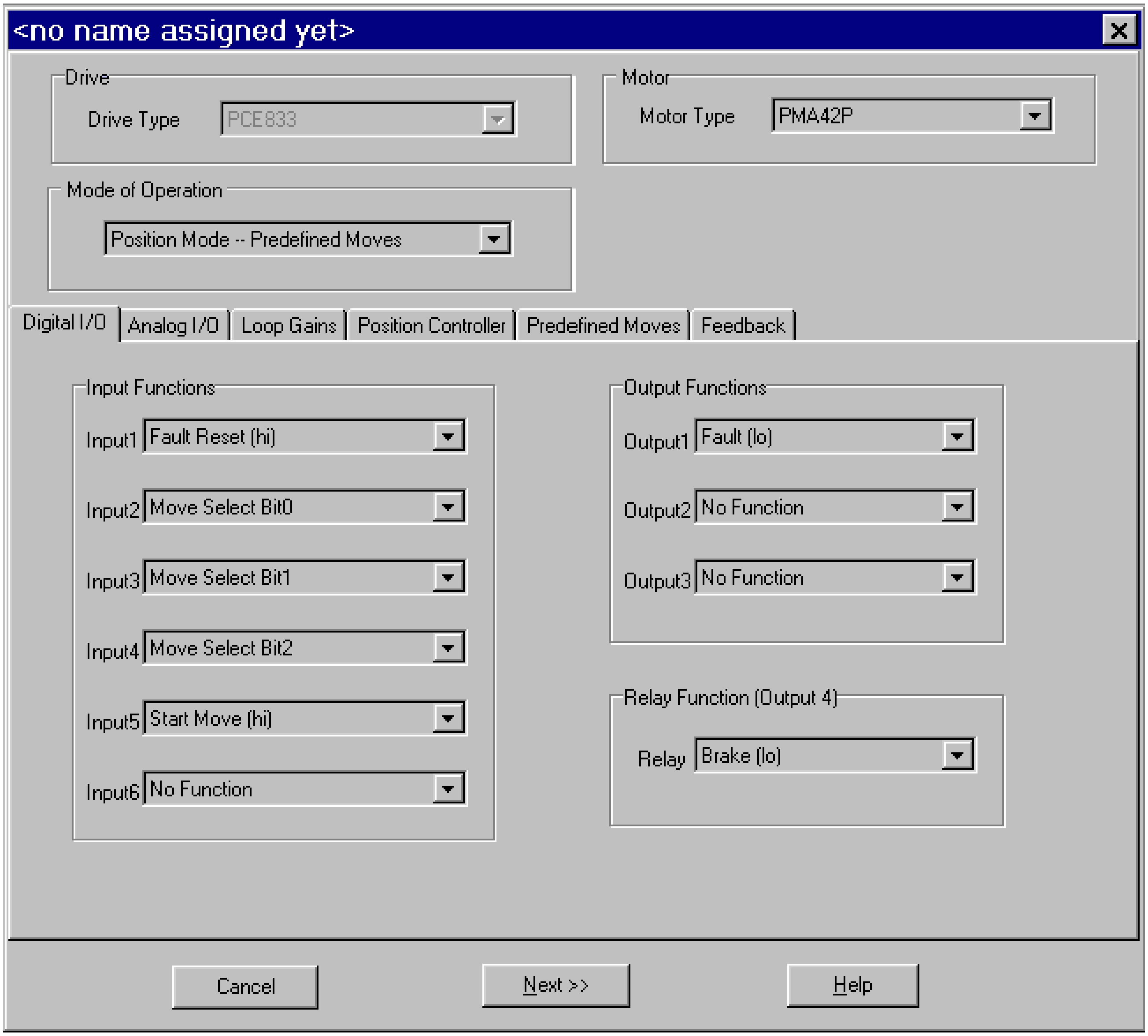
2.4.1. Position Mode - Predefined Moves

This mode allows the user to define up to 8 distinct moves. The predefined moves may be selected and then triggered using the digital inputs on J2-31 through J2-36.

Procedure

1. Create a new configuration and select **Position Mode - Predefined Moves** as the mode of operation.
2. Click the **Digital I/O** tab to define **MoveSelectBits** and a **StartMove** input.

Digital I/O Tab



Drive
Drive Type PCE833

Motor
Motor Type PMA42P

Mode of Operation
Position Mode -- Predefined Moves

Input Functions
Input1 Fault Reset (hi)
Input2 Move Select Bit0
Input3 Move Select Bit1
Input4 Move Select Bit2
Input5 Start Move (hi)
Input6 No Function

Output Functions
Output1 Fault (lo)
Output2 No Function
Output3 No Function

Relay Function (Output 4)
Relay Brake (lo)

Selecting a Move

The active move is selected based on the binary state of the **MoveSelectBit**(s) and initiated by a change of state on the **StartMove**. The table below indicates which predefined move will be activated upon a **StartMove** state change.

Move #	MoveSelectBit2	MoveSelectBit1	MoveSelectBit0
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

ActiveMove = 4*(MoveSelectBit2) + 2*(MoveSelectBit1) +1*(MoveSelectBit0)

Move Types

The following table lists the move types available:

Move Type	Description
Hold Position	The motor aborts motion and holds position.
Velocity	The motor ramps up/down to a predefined runspeed.
Incremental	The motor travels a predefined distance.
Absolute	The motor travels to a predefined position relative to the home (0) position. (Turns gearing off)
Incremental Registration	The motor starts an incremental move. If a transition occurs on the registration input before the move is complete, the motor moves to the latched position + Distance Offset.
Absolute Registration	The motor starts an absolute move. If a transition occurs on the registration input before the move is complete, the motor moves to the latched position + Distance Offset. (Turns gearing off)
Home	The motor searches for a home reference, establishes a home position, and returns to the home position. (Turns gearing off)

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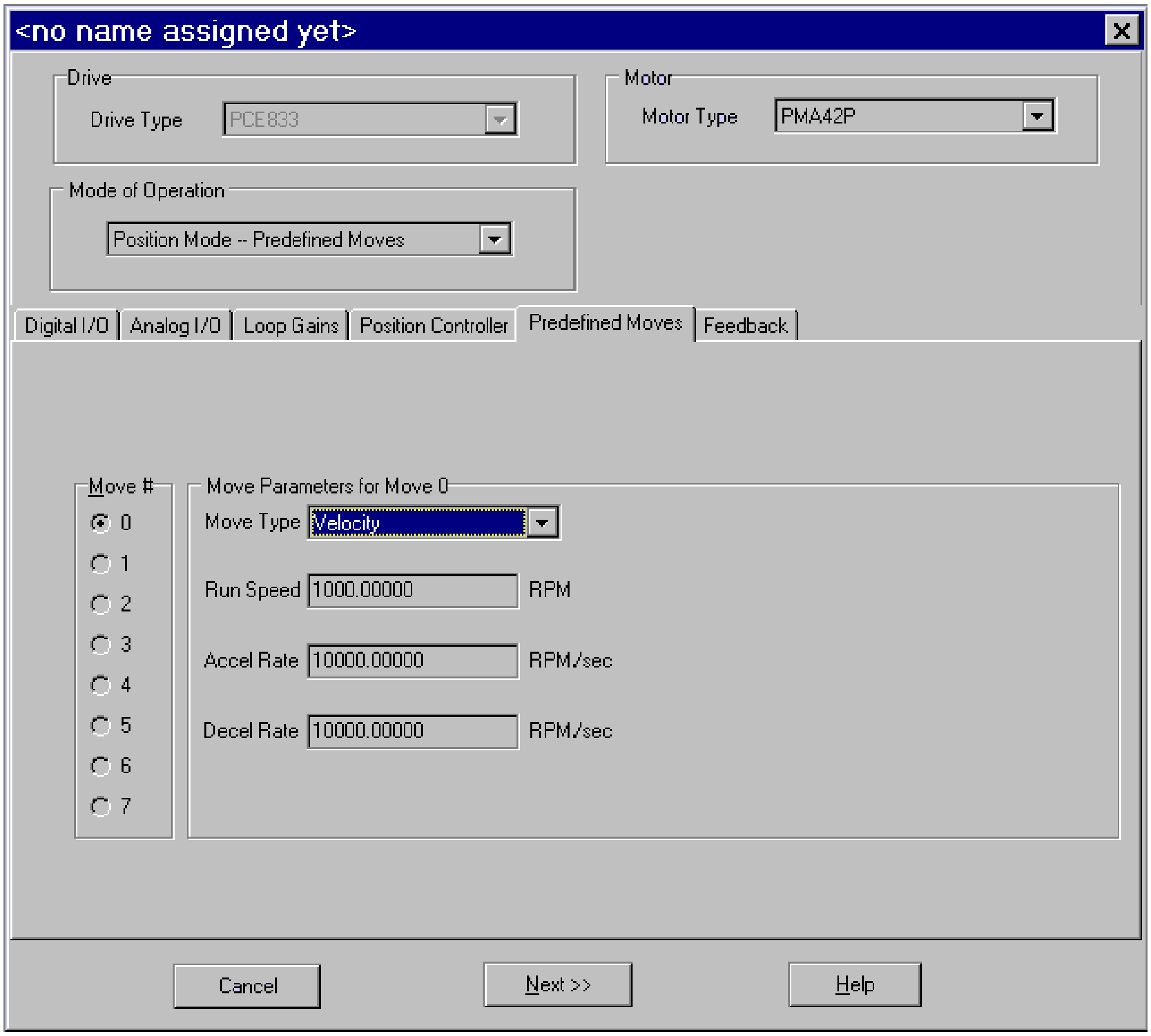
3. Click on the **Predefined Moves** tab to configure the parameters associated with each of the predefined moves.

Velocity Move



<no name assigned yet>

Drive

Drive Type: PCE833

Motor

Motor Type: PMA42P

Mode of Operation: Position Mode -- Predefined Moves

Move #
● 0
○ 1
○ 2
○ 3
○ 4
○ 5
○ 6
○ 7

Move Parameters for Move 0

Move Type: Velocity

Run Speed: 1000.00000 RPM

Accel Rate: 10000.00000 RPM/sec

Decel Rate: 10000.00000 RPM/sec

Homing The homing functionality of the PCE830 allows the user to establish a home position based on four different home references. The table below lists each of the references used for homing, and describes how each establishes the home position.

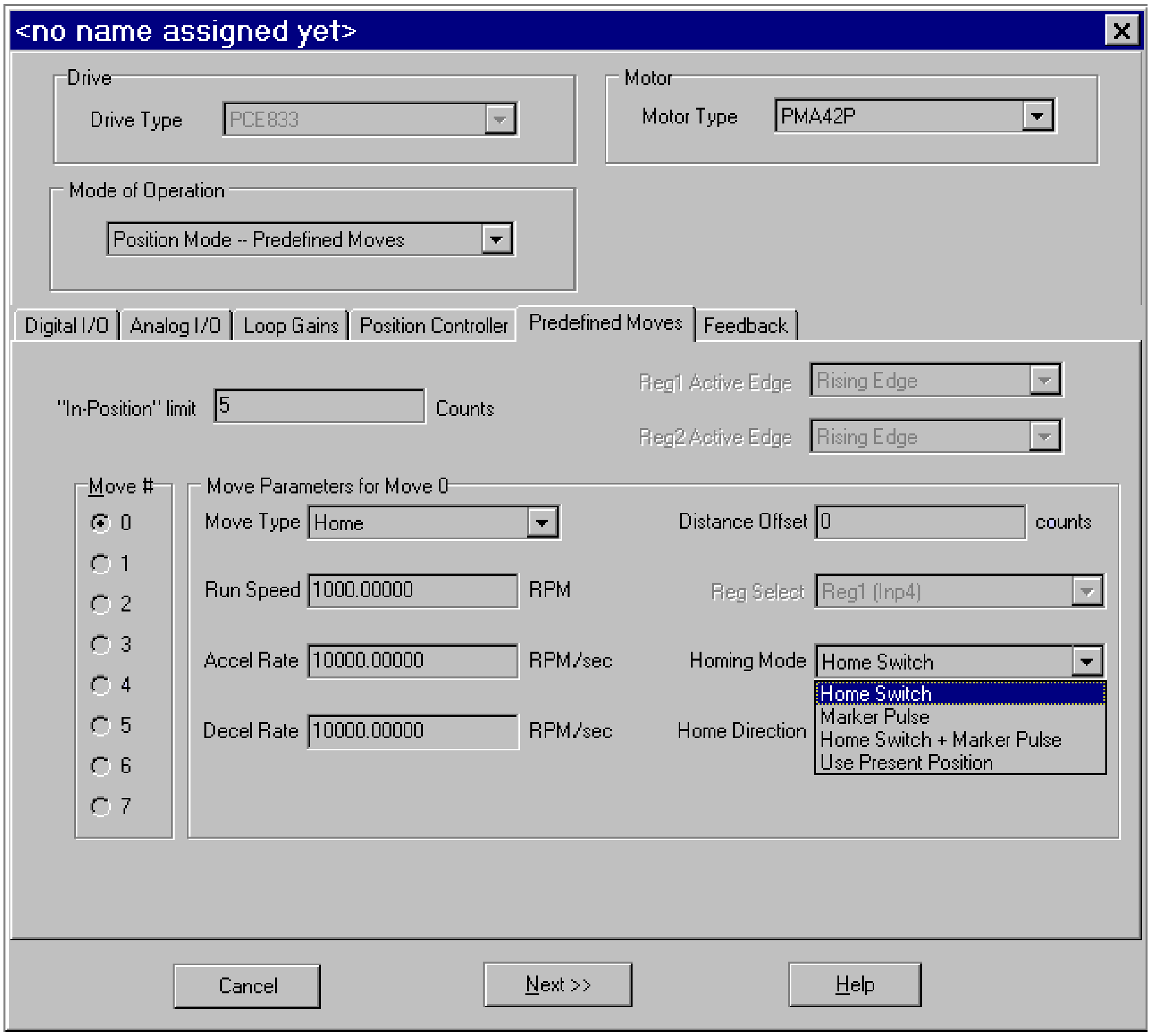
Home reference	Description
Home Switch	Transition of Home Switch(Requires one of the Digital Inputs to be mapped to the HomeSwitch function.)
Marker Pulse	Internal resolver marker pulse*
Home Switch + Marker Pulse	Transition of Home Switch then marker pulse
Use Present Position	Current position is established as home position

If using encoder feedback, the physical Z channel from the encoder is used as the marker pulse. Select Reg1 (Inp4) if the encoder Z channel is to be connected to digital Input4 or Reg2(Inp5) when connecting to digital Input5. Make sure the mapping for the input used is set to No Function.

Marker Pulse Using Resolver If using resolver feedback, all home moves to a marker pulse will be based on resolver position equal to zero (ResPos = 0).

Marker Pulse Using Encoder If using encoder feedback, all home moves to a marker pulse will be based off the marker pulse output from the encoder. This channel must be physically wired to one of the two dedicated registration inputs, Input 4 (J2-34) or Input 5 (J2-35). Select this input using the **Reg Select** pull-down tab. The **Active Edge** (rising edge or falling edge) must also be defined for the registration input.

Home Move Parameters



<no name assigned yet>

Drive
Drive Type: PCE833

Motor
Motor Type: PMA42P

Mode of Operation: Position Mode -- Predefined Moves

"In-Position" limit: 5 Counts

Reg1 Active Edge: Rising Edge

Reg2 Active Edge: Rising Edge

Move #: ● 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7

Move Parameters for Move 0

Move Type: Home

Run Speed: 1000.00000 RPM

Accel Rate: 10000.00000 RPM/sec

Decel Rate: 10000.00000 RPM/sec

Distance Offset: 0 counts

Reg Select: Reg1 (Inp4)

Homing Mode: Home Switch

Home Direction

Procedure

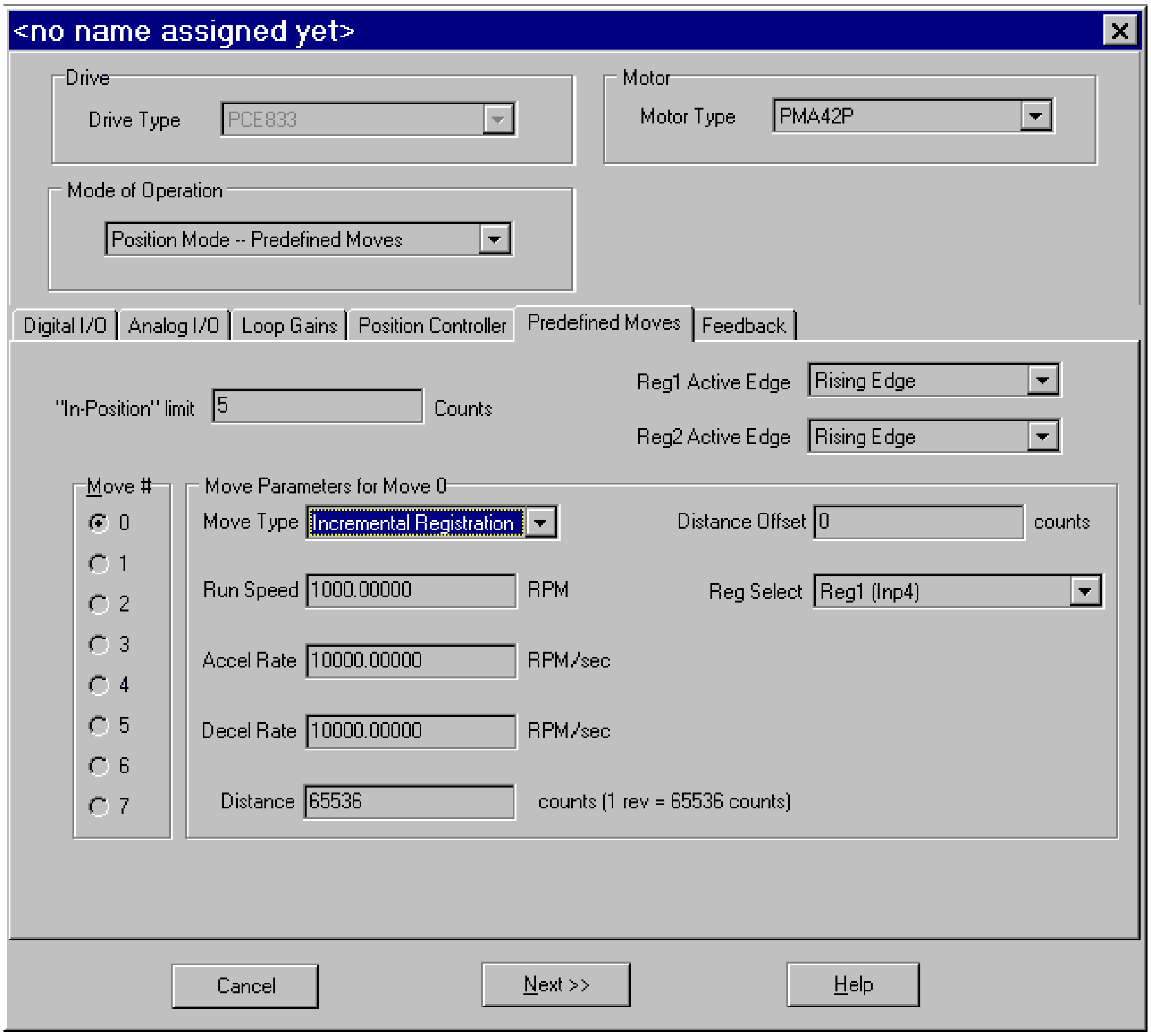
1. Select **Home** as the Move Type.
2. Select the **Homing Mode** (Home Switch, Marker Pulse, Home Switch + Marker Pulse, Use Present Position) to determine the reference for homing.
3. Select **Home Direction** of motor rotation for home move as clockwise or counterclockwise.
4. Define the **Distance Offset** position the motor should move to after the home switch input has been detected.
5. If **Home Switch** was selected, click on the **Digital I/O** tab. Select **Home Switch** Input as the function for the desired input.

Home Position = Position of Home Reference + Distance Offset

Position = Position - Home Position

The motor then performs an absolute move to the home position.

Registration Move Parameters



Drive
Drive Type: PCE833

Motor
Motor Type: PMA42P

Mode of Operation: Position Mode -- Predefined Moves

"In-Position" limit: 5 Counts

Reg1 Active Edge: Rising Edge

Reg2 Active Edge: Rising Edge

Move #: ● 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7

Move Parameters for Move 0

Move Type: Incremental Registration

Distance Offset: 0 counts

Run Speed: 1000.00000 RPM

Reg Select: Reg1 (Inp4)

Accel Rate: 10000.00000 RPM/sec

Decel Rate: 10000.00000 RPM/sec

Distance: 65536 counts (1 rev = 65536 counts)

Procedure

1. Select either Incremental or **Absolute Registration** as the Move Type.
2. Select **Reg1** (**Inp4**) or **Reg2** (**Inp5**) as the registration input.

Verify that there is No Function defined for the registration input.

3. Select the **Active Edge** for the registration input.
4. Set the **Distance** to the desired value.
5. Set the **Distance Offset** to the desired value. This is the distance that the motor will travel upon registration.

2.4.2. Position Mode - Step and Direction

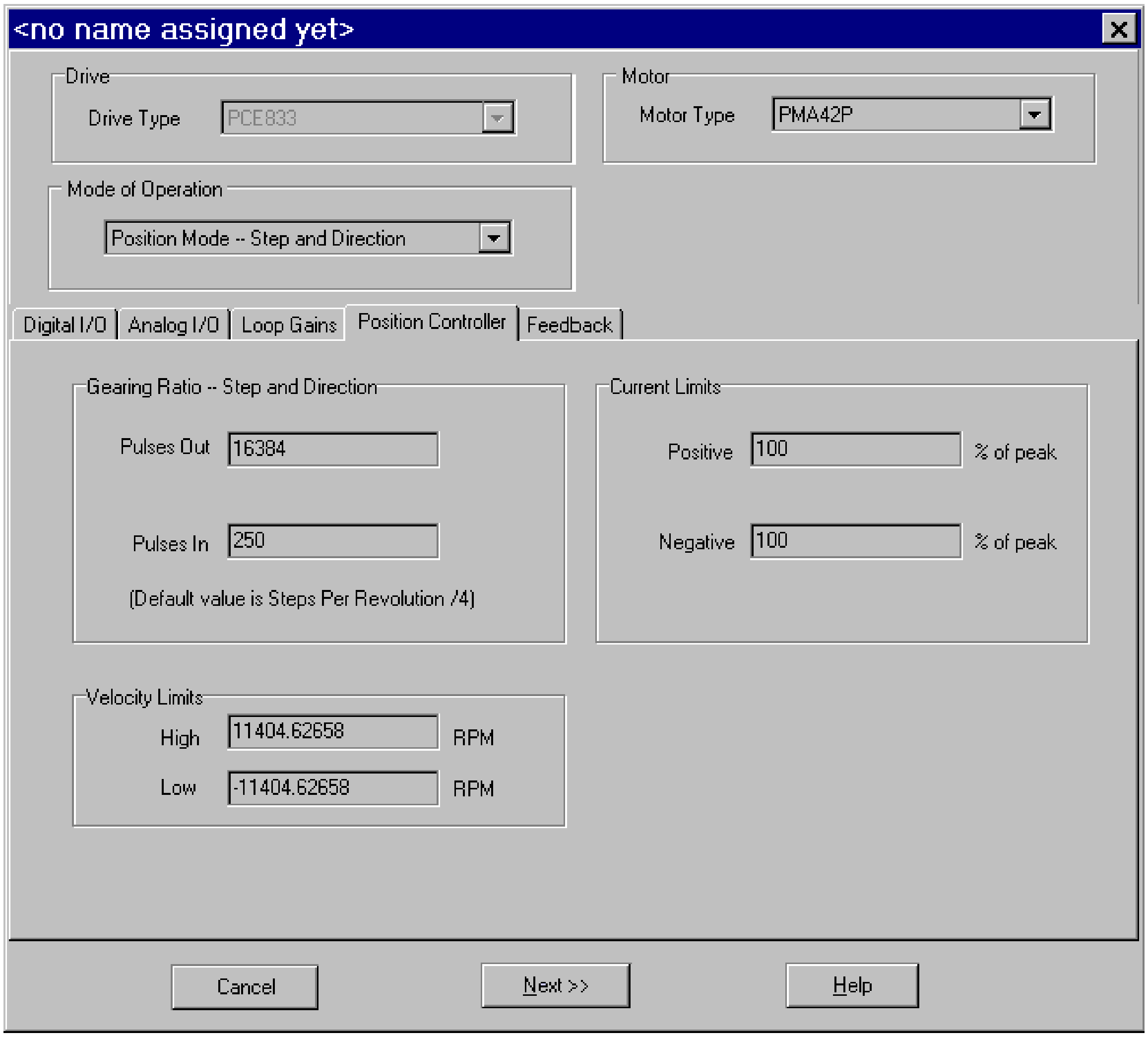
This mode allows the PCE830 to be controlled by a stepper indexer feeding it with step and direction signals on J2-17 through J2-20. Predefined moves are also available in this mode.

Procedure

1. Select **Position Mode - Step and Direction** from the Mode of Operation dropdown list box.
2. Specify the number of steps per motor revolution. This number must be evenly divisible by four. Divide this number by four and fill in **Pulses In** in the **Parameters Edit** screen. For industry standard step sizes, select from the table below.

Steps/Rev	Motor Mechanical Deg/Step
200 (Full)	1.8
400 (Half)	0.9
1000 (1/5)	0.36
2000 (1/10)	0.18
5000 (1/25)	0.072
25000 (1/125)	0.0144
50000 (1/250)	0.0072

Step and Direction



<no name assigned yet>

Drive

Drive Type: PCE833

Motor

Motor Type: PMA42P

Mode of Operation: Position Mode -- Step and Direction

Gearing Ratio -- Step and Direction

Pulses Out: 16384

Pulses In: 250

(Default value is Steps Per Revolution /4)

Current Limits

Positive: 100 % of peak

Negative: 100 % of peak

Velocity Limits

High: 11404.62658 RPM

Low: -11404.62658 RPM

2.4.3. Position Mode - Electronic Gearing

This mode configures the PCE830 to follow external encoder signals applied to the encoder inputs on J2-17 to J2-20. Predefined moves are also available in this mode.

Procedure

1. Select **Position Mode - Electronic Gearing** from the Mode of Operation dropdown list box.
2. Enter the number of motor resolver counts (PulsesOut) (1/65536 of a rev) that you want the motor to move for the specified number of input encoder quadrature counts (PulsesIn).

Example

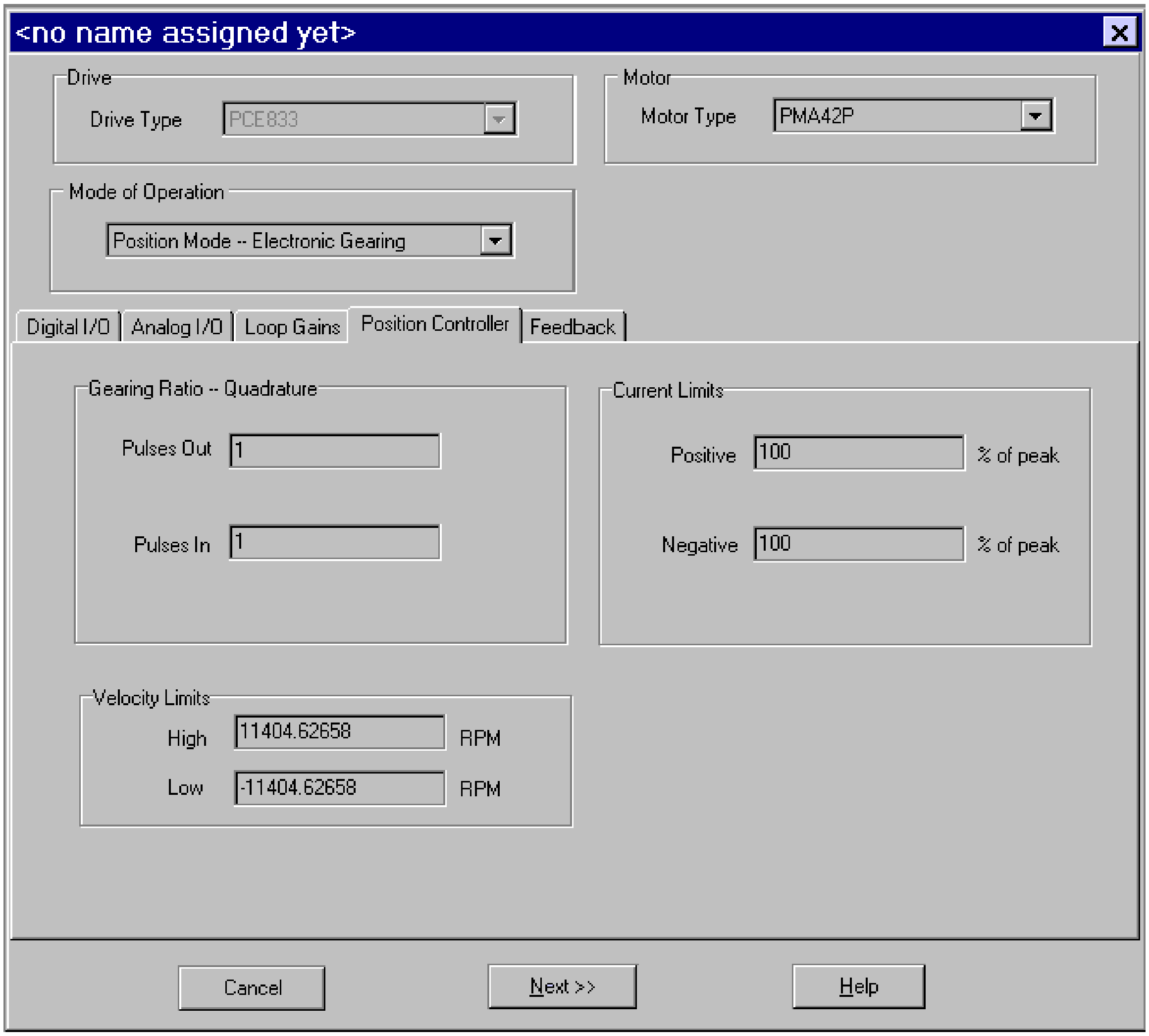
If the input encoder line count (PulsesIn) is 1024 (4096 quadrature counts per encoder revolution) and the motor should make one revolution for every encoder revolution, then:

1 rev = 65,536 resolver counts per

1 rev = 4096 encoder counts.

Because 65,536 is greater than the maximum value for PulsesOut, divide both numbers by four. This results in 16,384 motor resolver counts for 1024 input encoder counts.

Electronic Gearing



Drive
Drive Type: PCE833

Motor
Motor Type: PMA42P

Mode of Operation: Position Mode -- Electronic Gearing

Gearing Ratio -- Quadrature
Pulses Out: 1
Pulses In: 1

Current Limits
Positive: 100 % of peak
Negative: 100 % of peak

Velocity Limits
High: 11404.62658 RPM
Low: -11404.62658 RPM

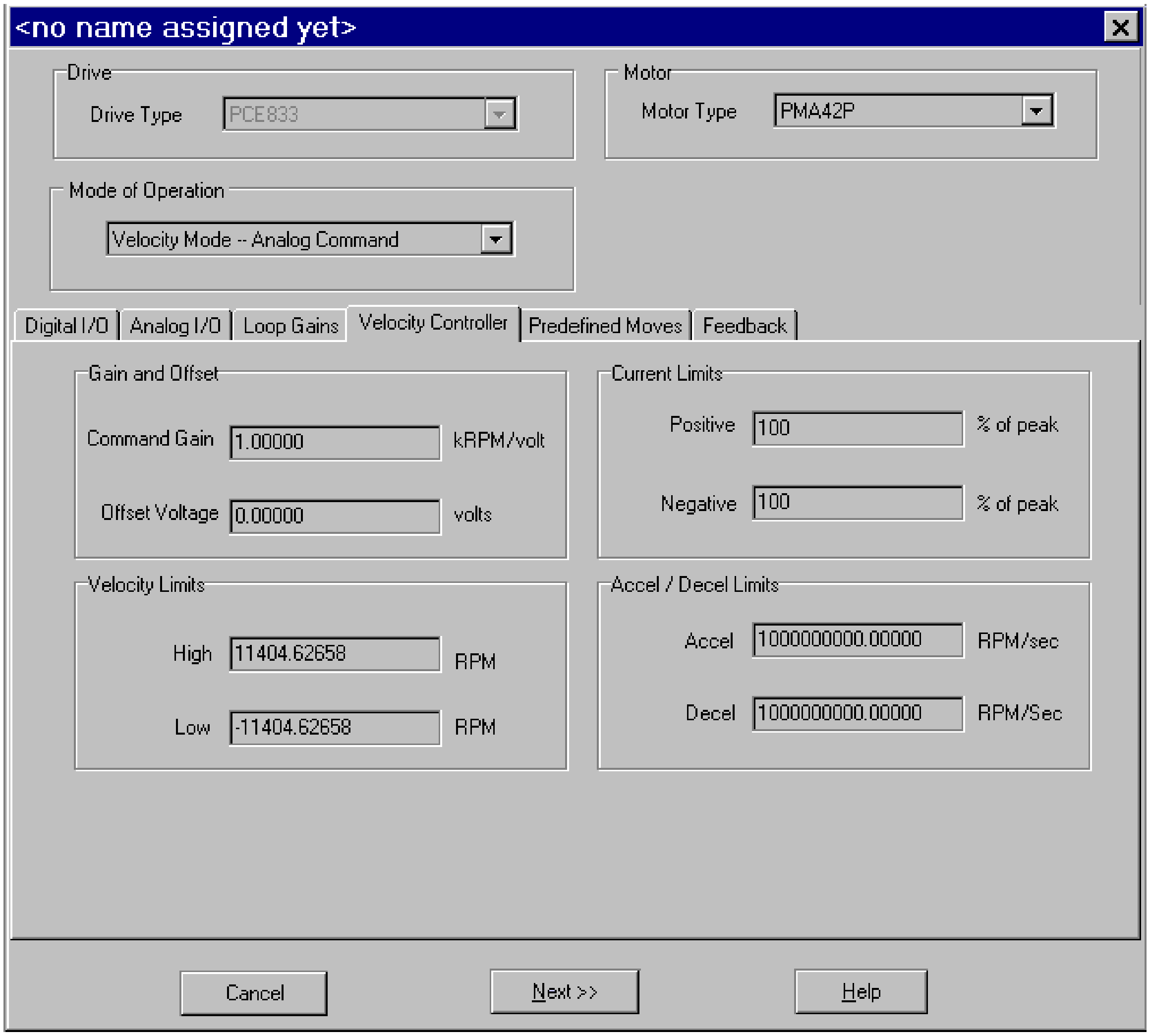
2.4.4. Velocity Mode - Analog Command

This mode allows the differential analog voltage between terminals J2-1 and J2-2 to set the motor's shaft velocity. The output shaft velocity per input volt is set by the CmdGain parameter in kRPM/V and should be set by the user to the desired value.

Procedure

1. Select **Velocity Mode - Analog Command** from the Mode of Operation dropdown list box.
2. Set **CmdGain** to the desired value.
   Motor Velocity[kRPM] = AnalogIn[V]*CmdGain[kRPM/V]

Velocity Controller



Drive

Drive Type: PCE833

Motor

Motor Type: PMA42P

Mode of Operation: Velocity Mode -- Analog Command

Gain and Offset

Command Gain: 1.00000 kRPM/volt

Offset Voltage: 0.00000 volts

Current Limits

Positive: 100 % of peak

Negative: 100 % of peak

Velocity Limits

High: 11404.62658 RPM

Low: -11404.62658 RPM

Accel / Decel Limits

Accel: 1000000000.00000 RPM/sec

Decel: 1000000000.00000 RPM/Sec

2.4.5. Velocity Mode - Frequency Command

This mode is the same as the Velocity Mode Analog Command except that the command input comes from the Incremental Command inputs on J2-17 through J2-20. The frequency on these input terminals is the variable **DigitalCmdFreq** and is substituted for the AnalogIn input to the CmdGain scaling. The units on **CmdGain** are krpm/kHz.

Motor Velocity[krpm] = EncFreq[kHz]*CmdGain[kRPM/kHz]

2.4.6. Velocity Mode - Serial Command

This mode is the same as the Velocity Mode Analog Command except that the command input is the value of **Velocity Command** (**VelCmd**) set over the serial port.

VelCmd ***is a non-volatile parameter and when the PCE830/40 servo powers up in this mode, the initial value of the velocity command is this non-volatile value***.

Changing **VelCmd** over the serial port then sets a new volatile velocity command. Changing the non-volatile velocity command requires the additional step of issuing the **NVSave** command.

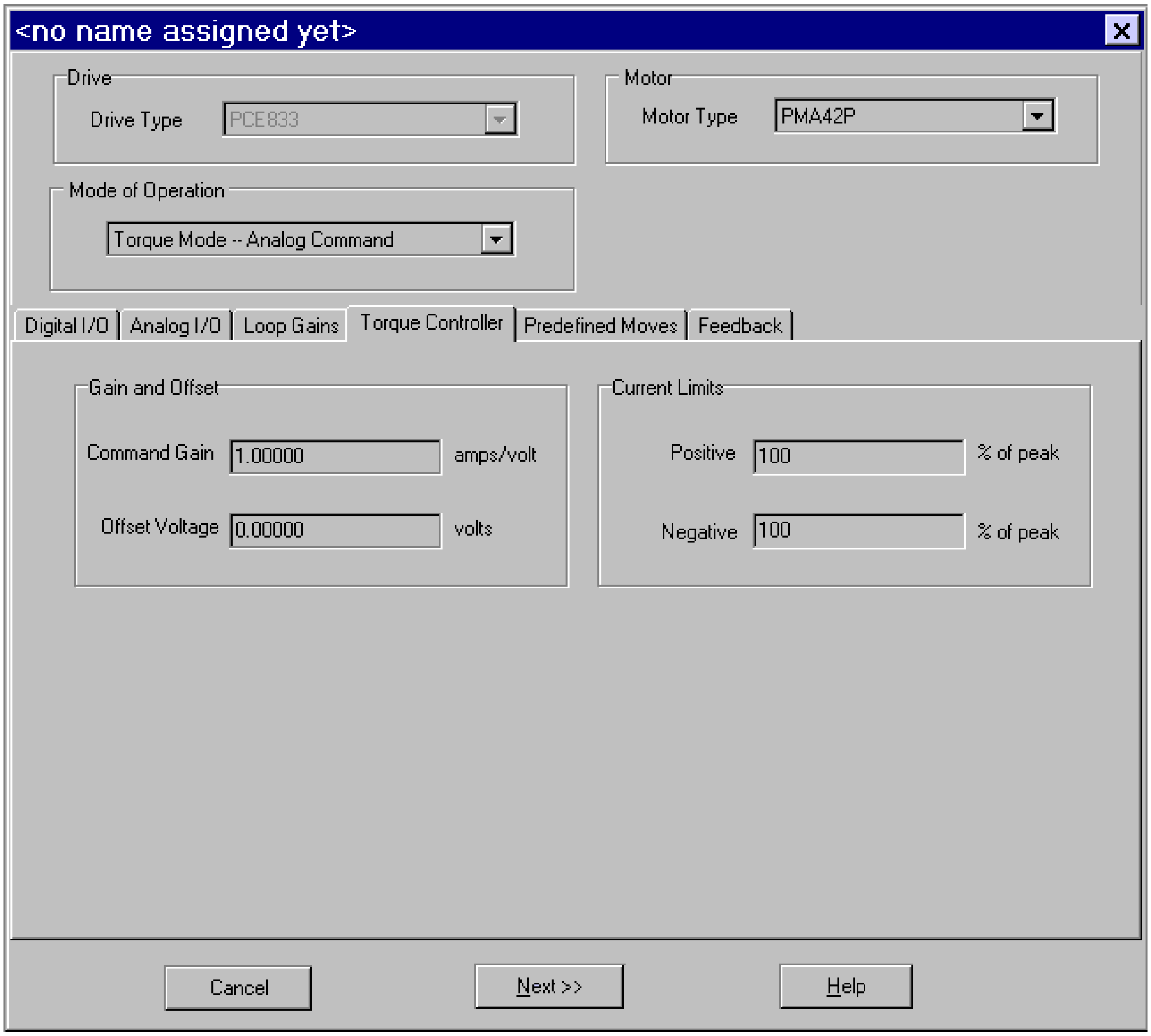
2.4.7. Torque Mode - Analog Command

This mode allows the differential analog voltage between terminals J2-1 and J2-2 to set the motor's current. Since torque command = Current command (Icmd) *Kteff, controlling current is equivalent to controlling torque. The analog input directly controls motor shaft torque. The output current amplitude in amps per input volt is set by the CmdGain parameter directly in Amp/V and should be set by the user to the desired value.

Procedure

1. Select **Torque Mode - Analog Command** from the Mode of Operation dropdown list box.
2. Set **CmdGain** to the desired value.

Torque Controller



Drive Type: PCE833

Motor Type: PMA42P

Mode of Operation: Torque Mode -- Analog Command

Command Gain: 1.00000 amps/volt

Offset Voltage: 0.00000 volts

Positive: 100 % of peak

Negative: 100 % of peak

2.4.8. Torque Mode - Frequency Command

This mode is the same as the Torque Mode Analog Command except that the command input comes from the Incremental Position Command inputs on J2-17 through J2-20. The frequency on these input terminals is the variable **DigitalCmdFre**q and is substituted for the **AnalogIn input** to the **CmdGain** scaling. The units on **CmdGain** become Amp/kHz.

Icmd = CmdGain[A/kHz]*Digital Command Frequency

Icmd = Icmd*Kteff

2.5. Tuning

Please read this section completely before tuning the drive. Refer to Section 2.7, Servo Loop Parameters for additional information.

The Tuning Wizard (see page 2-12) of 800Tools is recommended to simplfy drive tuning. It provides:

- ***An easy way to set default tuning parameters***
- ***An easy way to change tuning parameters***
- ***Displays bandwidth and phase margin based on the inertia ratio you input***

Tuning parameters are used to optimize system performance. The system is ultimately limited by the machine mechanics and power available from the driving motor. This chapter will review the tuning process. In general, start with the most significant limiting factor and increase the limit as high as possible.

The hierarchy of tuning limits follows this sequence:

- Position loop bandwidth is limited by velocity loop bandwidth.
- Velocity loop bandwidth is limited by current loop bandwidth and mechanical system natural resonant frequency.
- Current loop bandwidth is limited by the drive electronics.

2.5.1. Current Loop Settings

Proportional Gain (KIP)	Proportional Current Loop Gain (**KIP**) is set to provide 1000 Hz current loop bandwidth. The current loop bandwidth is independent of the mechanical system. **KIP** is preset by 800Tools to the correct value based on motor model.
Default	KIP[V/A] = 6.28 * MotorInductance[mH], for 1000 Hz Current BW
Adjust	Preset by 800Tools, do not change. For unsupported motor models only, use formula described.
Limits	1000 Hz to 1500 Hz

2.5.2. Velocity Loop Settings

Proportional Gain (KVP)

The Proportional Velocity Loop Gain (**KVP**) is set based on two variables. Pacific Scientific selects a default bandwidth (**BW**) of 75 Hz to reduce the unknown to one variable. The system inertia is the second variable. Pacific Scientific chooses a default system inertia that is twice the motor inertia. Pacific Scientific assumes the load inertia and motor inertia are a 1:1 ratio as default. This default configuration should cover applications that have a load:motor inertia ratio from 0:1 to approximately 6:1 without user adjustment. You are allowed to set inertia ratio in the **New Configuration** window of 800Tools. If you set the inertia ratio too high, the motor will buzz and vibrate the shaft. The motor current feedback will oscillate from +peak to -peak, and this can be seen with the softscope.

Integral Gain (KVI)

The Integral Velocity Loop Gain (**KVI**) is set based on the default velocity **BW** of 75 Hz. **KVI** is used to reduce steady state error from the velocity loop. KVI removes velocity error when you are holding zero speed, or running at constant speed. Pacific Scientific sets **KVI** to a stable default value when the load inertia is less than a 6:1 ratio to the motor inertia. When the load inertia is larger than 6:1, and the inertia ratio parameter is at default 1:1, you can see velocity overshoot and oscillation in the motor motion.

Anti-Resonance Filters (ARF0/ARF1)

The Anti-Resonance Filters, **ARF0** and **ARF1** are used as separate low pass filters in the velocity loop to filter out undesired high frequency velocity loop noise. The defined filter frequency is the crossover frequency for the low pass filter. The filters reduce resonance problems by filtering the noise that excites mechanical resonances at 20dB/decade above the defined frequency. Each filter individually adds 45° of electrical phase shift (lag) to the velocity loop at the defined frequency. This phase lag can become part of the cause for mechanical resonance if the mechanical natural resonant frequency is lower than the velocity loop crossover (In Band). In band resonances are very unlikely for a well designed mechanical system.

Default

$$KPV[A/rad/s] = \frac{75[Hz]*6.28*(J_m(\text{Inertia Ratio} + 1))[Lb\text{-}in\text{-}s^2]}{MotorKteff[^{Lb\text{-}in}/A]}$$

KVI[Hz] = 75[Hz] / 15

motorKteff[Lb-in/A] = 0.08454 * Ke[v/krpm] * 0.866

ARF0[Hz] = 75[Hz] * 2

ARF1[Hz] = 75[Hz] * 10

Adjust

Increasing KVP will increase performance and response

Decreasing KVP will reduce performance and response

Increasing KVI increases stiffness, and reducing KVI increases sponginess

Increasing ARF's reduces effect of filter on high frequency noise and allows higher velocity loop BW

Limits

Velocity loop BW should be 0 to 400 Hz. Velocity loop BW is also limited by ARF0 and ARF1.
Inertia_ratio should be < 100:1

KVI should be 15 times < velocity loop BW, look for velocity oscillation or overshoot. Range 0 to 636 Hz.

ARF0 should be ³ velocity BW * 2 and < 1,000,000[Hz]

ARF1 should be ³ velocity BW * 2 and < 1,000,000[Hz]

ARF0 and ARF1 filter values should increase proportionally with Veloicy loop BW. The default BW is 75 Hz, assuming an inertia ratio of 2*JM. If you increase BW using KVP, you should also increase the filters with the following relation:

New ARFx = (Default ARFx)*K

K = (New KVP*2)/(Default KVP*M)

M = (Inertia_ratio+1)

Contact factory for notch filter information (used for In Band resonances).

2.5.3. Position Loop Settings

Proportional Gain (KPP)

The Proportional Position Loop Gain (**KPP**) is set based on velocity **BW** of 75Hz. The velocity command from the position loop is generated from position error and **KPP**. For larger values of **KPP**, the velocity command is larger for a given position error. **KPP** provides position synchronization with a small constant position error while following a position command frequency. The position error will be proportional to the speed command by the value of **KPP**. If **KPP** is set too large compared to velocity **BW**, you can see velocity overshoot or oscillation, similar to a large **KVI**.

Feedforward Gain (KVFF)

The Velocity Feedforward Gain (**KVFF**) is used in applications that require near zero position error. **KVFF** is implemented in parallel with **KPP** to inject additional velocity command without requiring position error. If KVFF = 100 percent, the position command frequency is sent directly to the velocity loop as an open loop command. Instead of driving velocity with position error on top of zero speed, **KVFF** allows us to drive velocity with position error on top of target speed with nominally zero error. **KVFF** typically causes overshoot, and only helps in applications that require position synchronization, like electronic gearing.

Default

KPP[Hz] = 75[Hz] / 5

KVFF[%] = 0[%]

Adjust

Increasing KPP reduces position error, decreasing KPP increases position error.

Increasing KVFF reduces position error and increases overshoot.

Limits

KPP should be < velocity BW/5 and 100 Hz maximum

KPP ranges from 0 to 100 Hz

KVFF should be < 200% and typically < 100%

KVFF ranges from 0 to 200 %

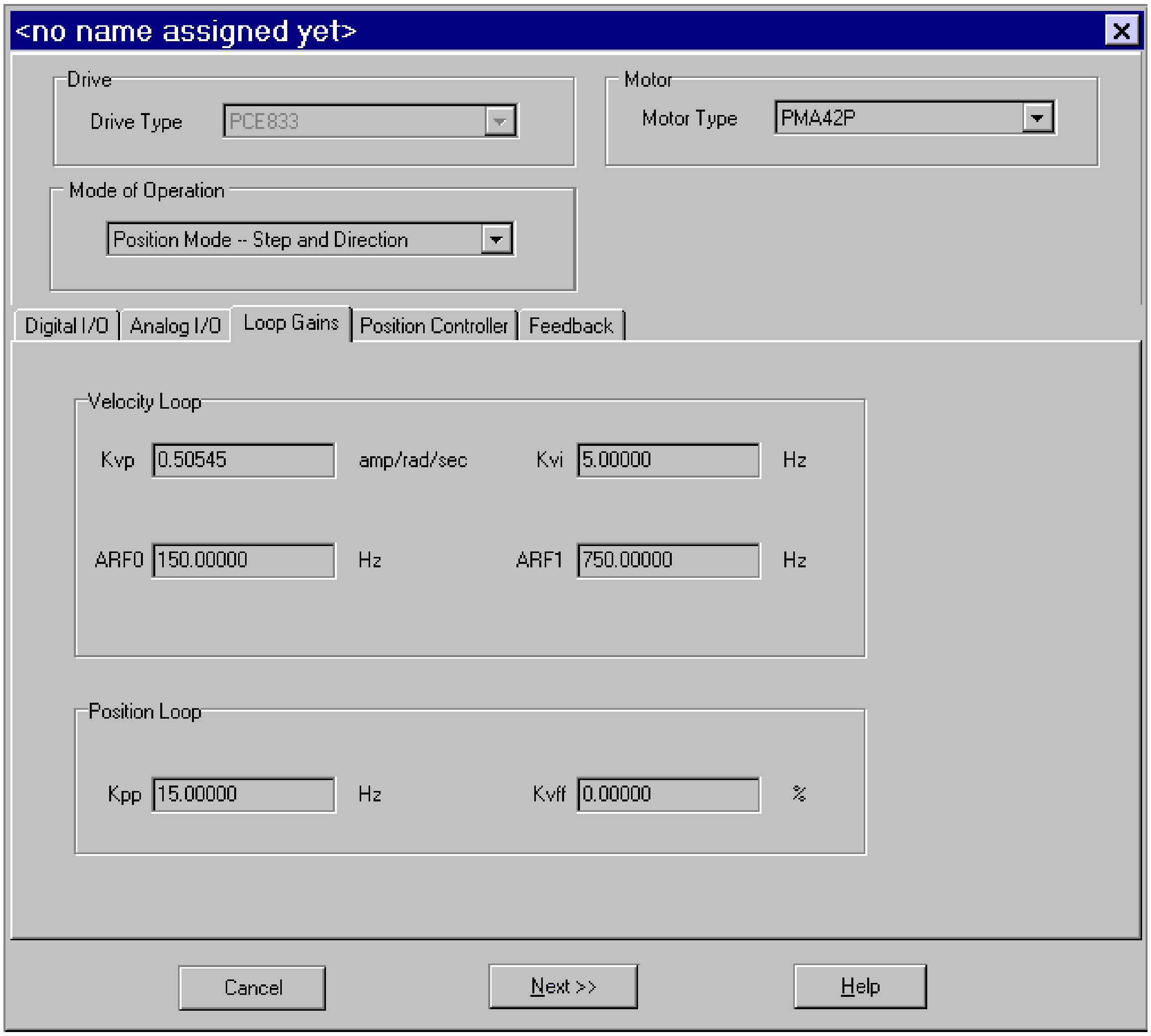
2.5.4. Manual Tuning with SoftScope

Refer to Section2.7, Servo Loop Parameters for additional details.

Velocity Loop

Procedure

1. **Create New Configuration** for correct motor and drive models using 800Tools. Use the default setup, including inertia ratio of 1:1 for the Step and Direction mode of operation.
2. In the **LoopGains** tab of the parameter edit window set **KVI**, **KPP**, and **KVFF**:



<no name assigned yet>

Drive

Drive Type PCE833

Motor

Motor Type PMA42P

Mode of Operation

Position Mode -- Step and Direction

Velocity Loop

Kvp 0.50545 amp/rad/sec

Kvi 5.00000 Hz

ARF0 150.00000 Hz

ARF1 750.00000 Hz

Position Loop

Kpp 15.00000 Hz

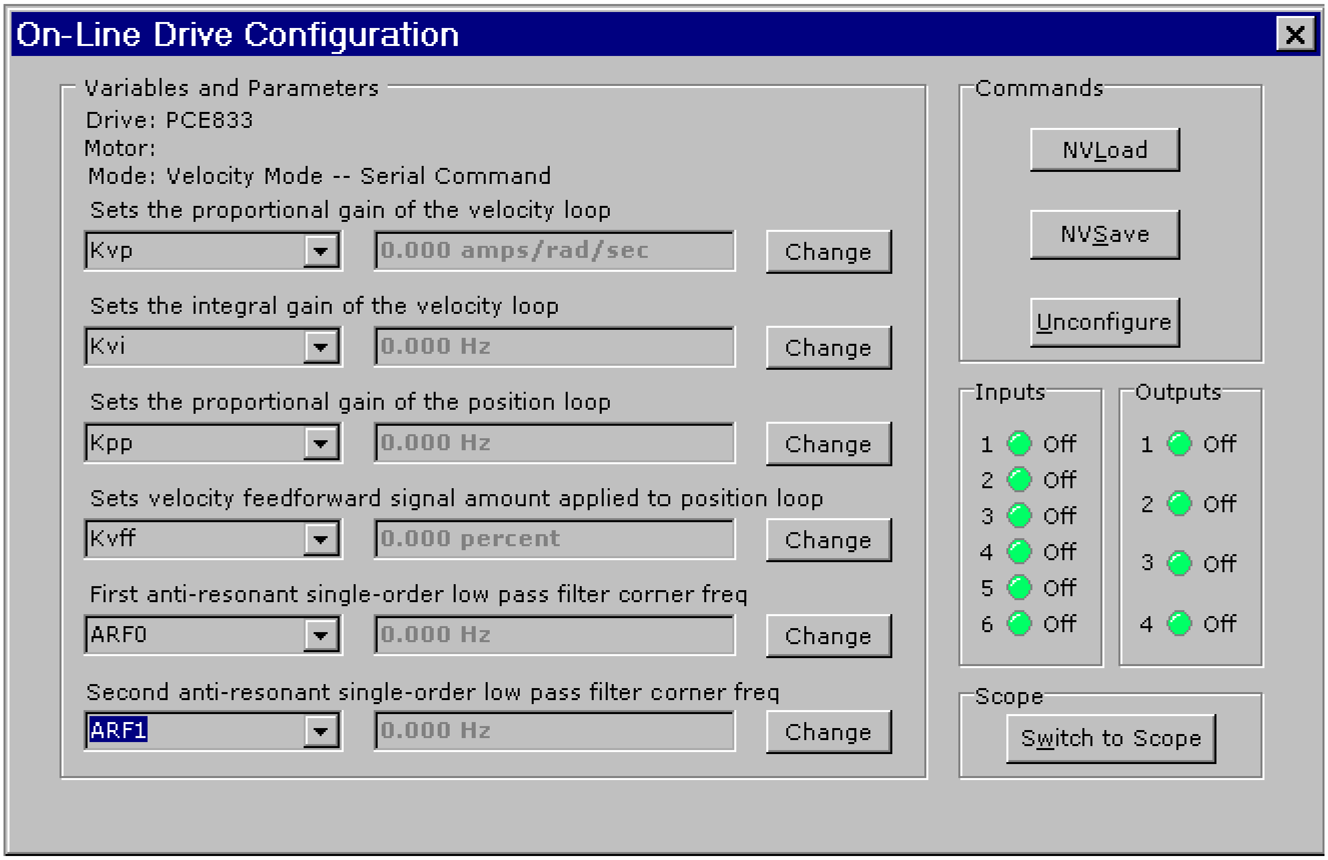
Kvff 0.00000 %

Set KVI = 0

Set KPP = 0

Set KVFF = 100

3. In the **Predefined Moves** tab of the **Parameter Edit** window, set **Move0** as Incremental with default profile settings.
4. Save the Configuration to disk and download to the drive.
5. Click **Edit Drive Configuration Online**. In the **Variables and Parameters** window, type **KVP** in the first box, **KVI** in the second box, **KPP** in the third box, **KVFF** in the fourth box, and **StartMove** in the fifth box.


On-Line Drive Configuration

Variables and Parameters

Drive: PCE833

Motor:

Mode: Velocity Mode -- Serial Command

Sets the proportional gain of the velocity loop

Kvp 0.000 amps/rad/sec

Sets the integral gain of the velocity loop

Kvi 0.000 Hz

Sets the proportional gain of the position loop

Kpp 0.000 Hz

Sets velocity feedforward signal amount applied to position loop

Kvff 0.000 percent

First anti-resonant single-order low pass filter corner freq

ARF0 0.000 Hz

Second anti-resonant single-order low pass filter corner freq

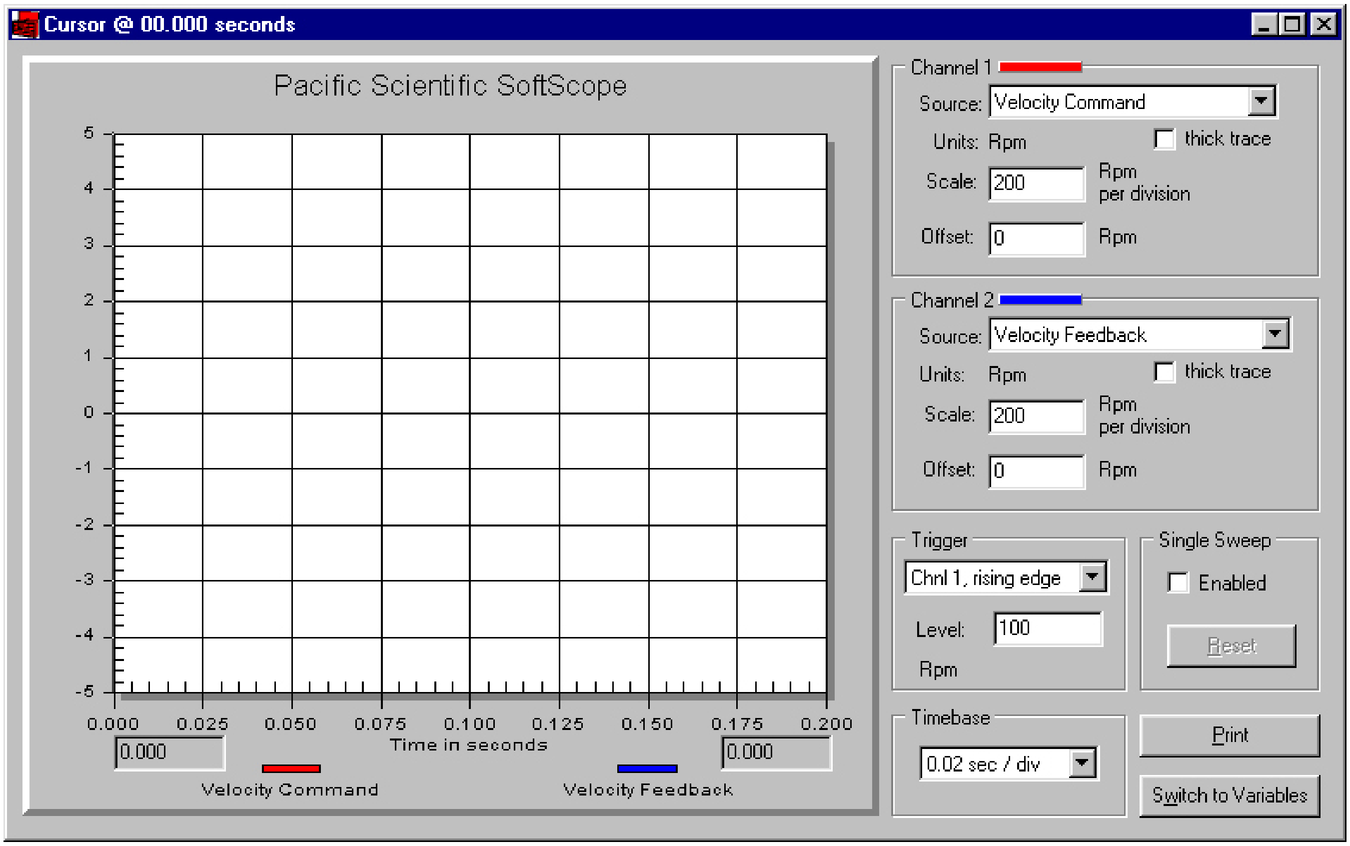
ARF1 0.000 Hz

Inputs	
1	Off
2	Off
3	Off
4	Off
5	Off
6	Off

Outputs	
1	Off
2	Off
3	Off
4	Off

6. Click **Switch to Scope** and the Oscilloscope appears.

7. Setup Channel 1 for **Velocity Command** and Channel 2 for **Velocity Feedback**. Set the Scales at **200 rpm/div**. Set the Trigger to **Chn1 rising edge** at **100 rpm level**. Set the **Timebase** to **0.02 sec/div**.



Cursor @ 00.000 seconds

Channel 1
Source: Velocity Command
Units: Rpm ☐ thick trace
Scale: 200 Rpm per division
Offset: 0 Rpm

Channel 2
Source: Velocity Feedback
Units: Rpm ☐ thick trace
Scale: 200 Rpm per division
Offset: 0 Rpm

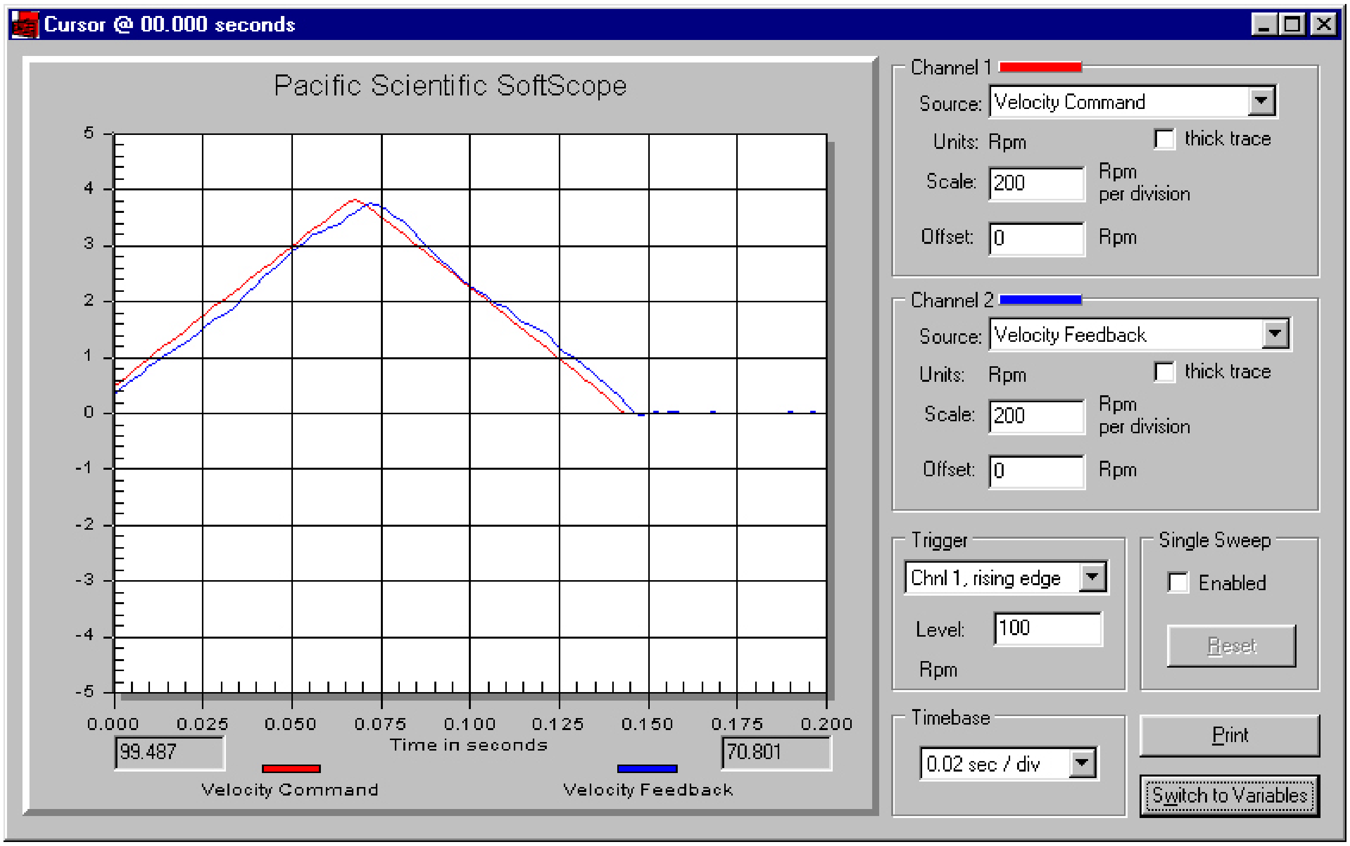
Trigger
Chnl 1, rising edge
Level: 100 Rpm

Single Sweep
☐ Enabled

Timebase
0.02 sec / div

8. Use the **Switch to Variables** button to command an index move and the **Switch to Scope** button to monitor progress.

9. In the Variables window, change the **StartMove** variable from 0 to 1 to start a move. This can be mapped as an input, but you can not change it in software if it is mapped. Slowly increase **KVP** between move commands, using the change button.



Cursor @ 00.000 seconds

Pacific Scientific SoftScope

Channel 1 🟥
Source: Velocity Command
Units: Rpm ☐ thick trace
Scale: 200 Rpm per division
Offset: 0 Rpm

Channel 2 🟦
Source: Velocity Feedback
Units: Rpm ☐ thick trace
Scale: 200 Rpm per division
Offset: 0 Rpm

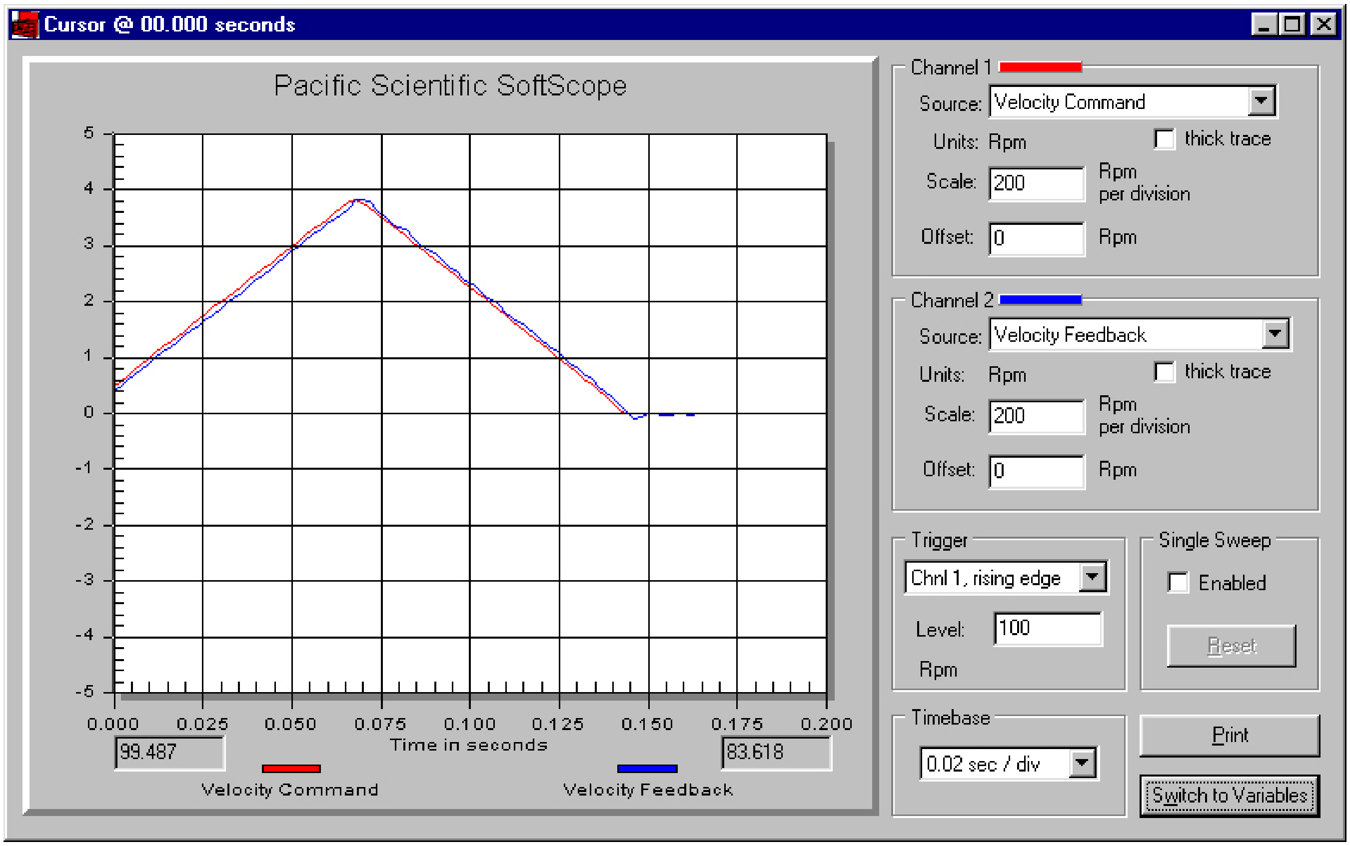
Trigger: Chnl 1, rising edge
Level: 100 Rpm

Single Sweep: ☐ Enabled

Timebase: 0.02 sec / div

99.487 🟥 Velocity Command
70.801 🟦 Velocity Feedback

10. In the Scope window, monitor **Velocity Feedback** to see how it follows the command. Look for velocity error at speed changes. Increase **KVP** to optimize performance and miminize velocity error. If the motor starts to buzz, **KVP** is too large. Disable the drive and reduce **KVP** 20%.



Cursor @ 00.000 seconds

Pacific Scientific SoftScope

99.487

83.618

Channel 1

Source: Velocity Command

Units: Rpm

☐ thick trace

Scale: 200 Rpm per division

Offset: 0 Rpm

Channel 2

Source: Velocity Feedback

Units: Rpm

☐ thick trace

Scale: 200 Rpm per division

Offset: 0 Rpm

Trigger

Chnl 1, rising edge

Level: 100 Rpm

Single Sweep

☐ Enabled

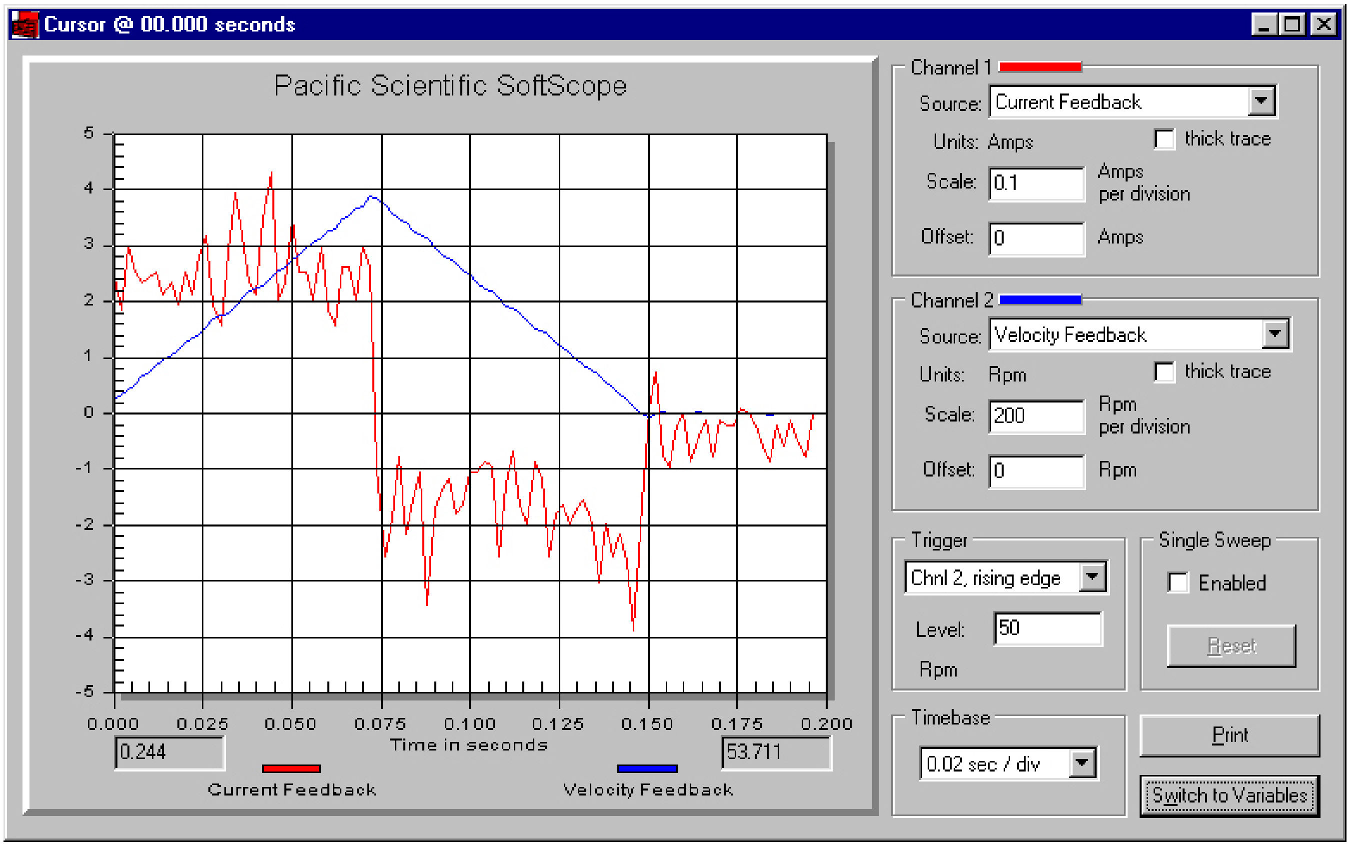
Timebase

0.02 sec / div

TIP

You can get more information by monitoring **Current Feedback** instead of **Velocity Command**. When monitoring current, look for oscillations or spikes that are not related to profile rate changes. If these current oscillations are greater than ± 5% of peak rated current, **KVP** is too large. Also, if the current is oscillating, it reduces available rated current used to drive the profile.

After **KVP** is optimized, slowly increase **KVI** up to a maximum of 5. Look for overshoot or oscillation during moves and reduce **KVI**, if unstable. Set KVFF = 0 and slowly increase **KPP** to a maximum of 15. Look for overshoot or oscillation, and reduce, if unstable.



Cursor @ 00.000 seconds

Channel 1 🟥
Source: Current Feedback
Units: Amps ☐ thick trace
Scale: 0.1 Amps per division
Offset: 0 Amps

Channel 2 🟦
Source: Velocity Feedback
Units: Rpm ☐ thick trace
Scale: 200 Rpm per division
Offset: 0 Rpm

Trigger: Chnl 2, rising edge
Level: 50 Rpm

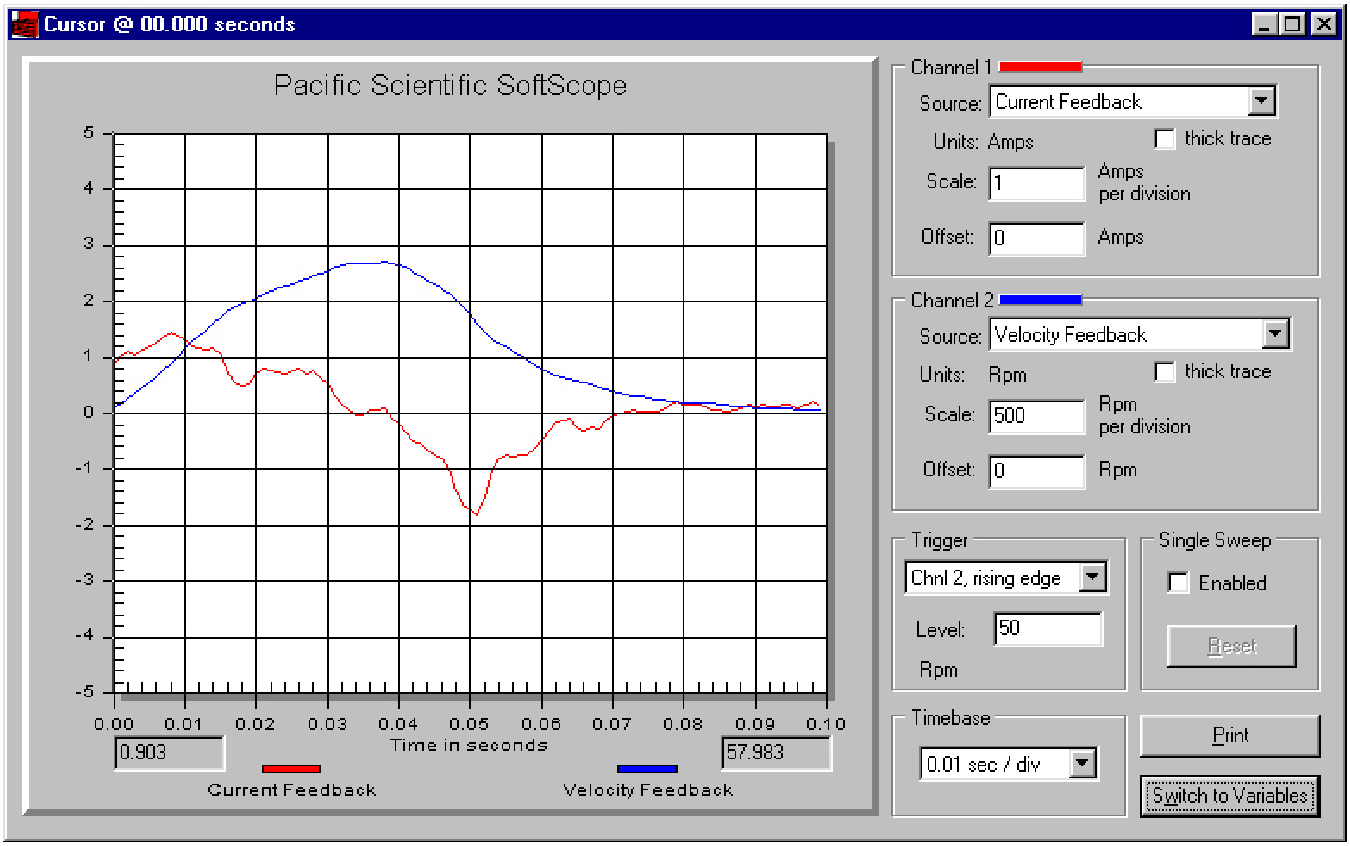
Single Sweep: ☐ Enabled

Timebase: 0.02 sec / div

0.244 — Current Feedback
53.711 — Velocity Feedback

In this waveform, the current feedback is extremely low and the ripple shown is acceptable (normal) because it is much less than ± 5% of peak rated current.

Overdamped



Cursor @ 00.000 seconds

Channel 1
Source: Current Feedback
Units: Amps
☐ thick trace
Scale: 1 Amps per division
Offset: 0 Amps

Channel 2
Source: Velocity Feedback
Units: Rpm
☐ thick trace
Scale: 500 Rpm per division
Offset: 0 Rpm

Trigger: Chnl 2, rising edge
Level: 50 Rpm

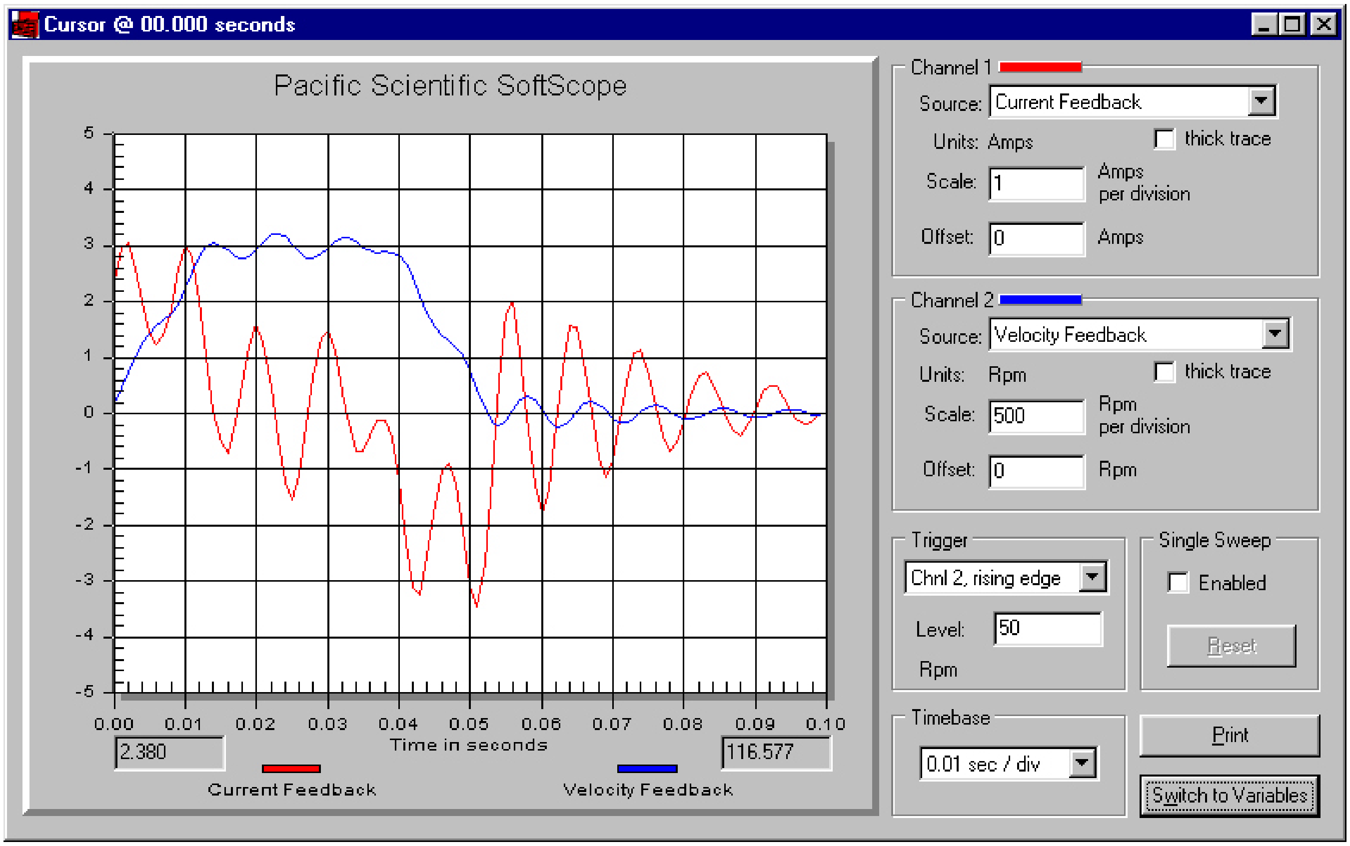
Single Sweep: ☐ Enabled

Timebase: 0.01 sec / div

Current Feedback: 0.903
Velocity Feedback: 57.983

The overdamped (undershooting) velocity loop does not respond to velocity changes (disturbances) quickly. It has soft, smooth motion. It requires extra time to settle. Increasing **KVI** and/or **KVP** brings the system closer to critically-damped. Remember, when increasing **KVP**, the **ARF*x*** filters may need to be increased proportionally.

Underdamped



2.380

116.577

Channel 1

Source: Current Feedback

Units: Amps

☐ thick trace

Scale: 1 Amps per division

Offset: 0 Amps

Channel 2

Source: Velocity Feedback

Units: Rpm

☐ thick trace

Scale: 500 Rpm per division

Offset: 0 Rpm

Trigger: Chnl 2, rising edge

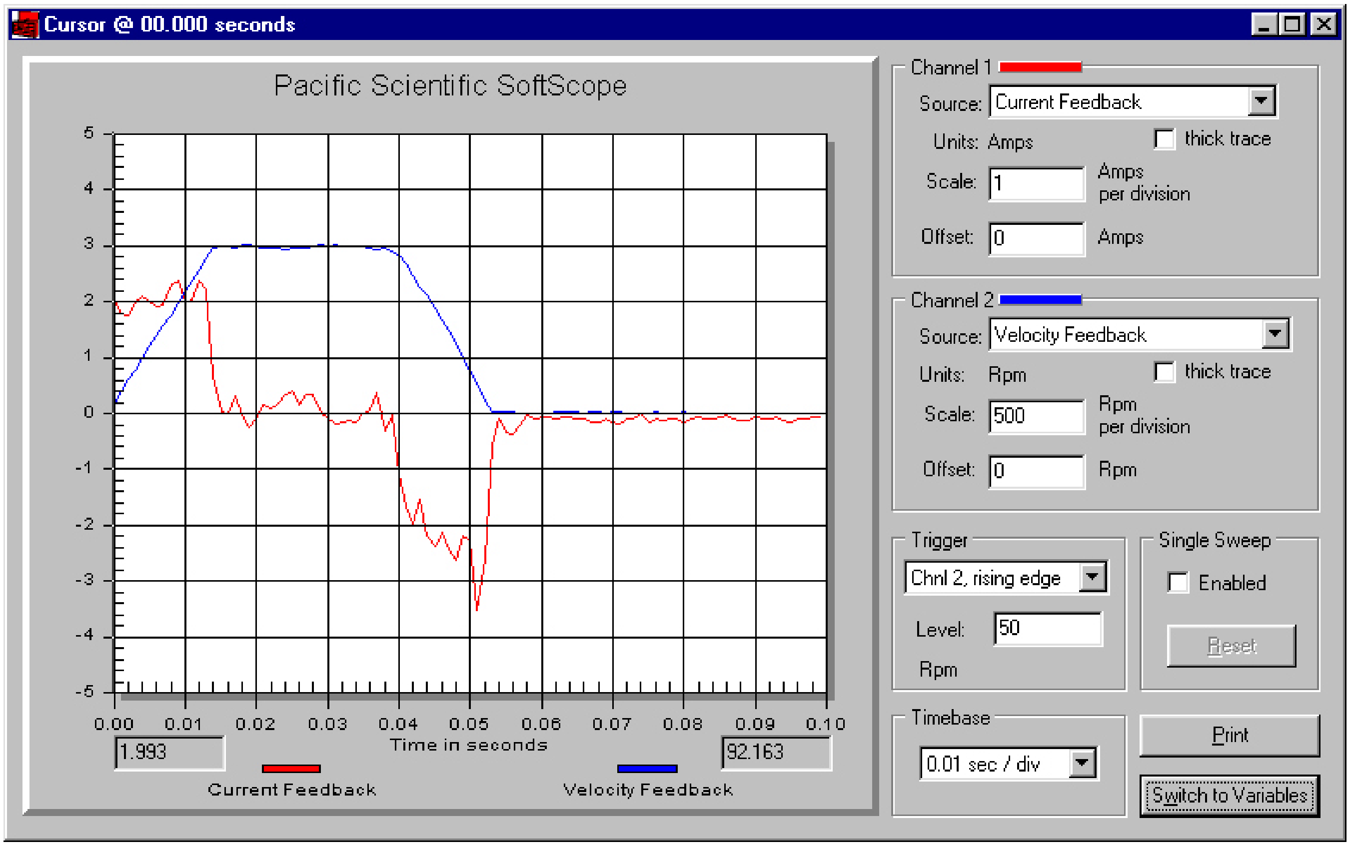
Level: 50 Rpm

Single Sweep: ☐ Enabled

Timebase: 0.01 sec / div

The underdamped (overshooting) velocity loop is an unstable waveform. It has wasted oscillatory motion. It requires extra time to settle. Decreasing **KVI** and/or increasing **KVP** brings the system closer to critically-damped. Remember, when increasing **KVP**, the **ARF*x*** filters may need to be increased proportionally. In this waveform, the oscillating current is a result of the **ARF*x*** filters being set too low.

Critically Damped



Cursor @ 00.000 seconds

1.993

92.163

Channel 1
Source: Current Feedback
Units: Amps
☐ thick trace
Scale: 1 Amps per division
Offset: 0 Amps

Channel 2
Source: Velocity Feedback
Units: Rpm
☐ thick trace
Scale: 500 Rpm per division
Offset: 0 Rpm

Trigger
Chnl 2, rising edge
Level: 50 Rpm

Single Sweep
☐ Enabled

Timebase
0.01 sec / div

The critically-damped velocity loop follows the command without overshoot or undershoot. It has the shortest settling time and no wasted motion. Get as close to this waveform as possible.

2.5.5. High Inertial Load

Refer to Section 2.7, Servo Loop Parameters for additional details.

The maximum inertia for any given system is predominantly limited by the required system performance and the mechanical system.

Inertia affects system performance in two ways.

1. It limits response because torque is required to accelerate an inertial load. Larger inertia requires larger torque to accelerate. Acceleration is a measure of performance, and is limited by the motor and drive combination. If the load-to-motor inertia ratio is very large, you will not be able to accelerate the load inertia quickly, which limits response to speed changes or speed disturbances.
2. Large inertial loads limit available continuous torque because the velocity loop gain needs to be larger for larger inertial loads. Large values of velocity loop gain amplify velocity feedback noise as current commands. The current ripple, due to velocity feedback noise, increases measured rms current and component temperature.

Inertia affects the mechanical system by requiring a proportionally stiff load-to-motor coupling to maintain a given system bandwidth. A directly-coupled load can have higher inertia ratios than a belt system due to the stiffness of the coupling device. When coupling stiffness is lowered, the system’s natural resonant frequency is lowered. If the system’s natural resonant frequency is lowered close to the velocity bandwith crossover frequency, the mechanical system may be excited by noise in the velocity loop. Under certain conditions, the mechanical system resonates.

2.5.6. Mechanical Resonance

Excitation

There is always a mechanical natural resonant frequency. It is only a problem if it becomes excited. To reduce the possibility of excitation, mechanical systems should be designed with very high natural resonant frequencies. If the natural resonant frequency is much greater than the servo loop bandwidth, there are no problems. The mechanical natural resonant frequency is dependent on drive train coupling stiffness and load + motor inertia ratio.

In order to increase the mechanical system natural resonant frequency, either decrease total system inertia or increase coupling stiffness.

Inertia Ratio

When the motor current is commanded sinusoidally above the mechanical system's natural resonant frequency, the load can decouple from the motor and no longer follows the motor. When the commanded frequency is at the mechanical resonant frequency, the load is moving exactly opposite from the command (approximately 180° phase lag) and the movement can become violent. If the load decouples (command frequency > resonant frequency), the mechanical system looks like only a motor system to the drive. In a servo velocity loop, total inertia and loop gain determine system bandwidth. When the system jumps from fully loaded (coupled) to unloaded (decoupled), the bandwidth jumps from BW to BW*Inertia ratio. If the inertia ratio is 10:1 and the fully loaded bandwidth is 75 Hz, the decoupled BW becomes 750 Hz. The system is unstable for any BW more than the drive's limit of 400 Hz. We could either reduce the fully-loaded BW to 40 Hz by reducing gain or reduce the inertia ratio to 5:1 to resolve the issue of resonance. This method allows the system to ride through the resonance without going unstable because the decoupled bandwidth remains below 400 Hz.

Filtering

There is another method to resolve the issue of resonance. Anti-Resonance Filters are used to prevent noise from exciting a resonance frequency. This method works very well if the resonant frequency is much greater than the operating velocity loop bandwidth. You can estimate where to place the filters by measuring the current feedback oscillation frequency using the softscope.

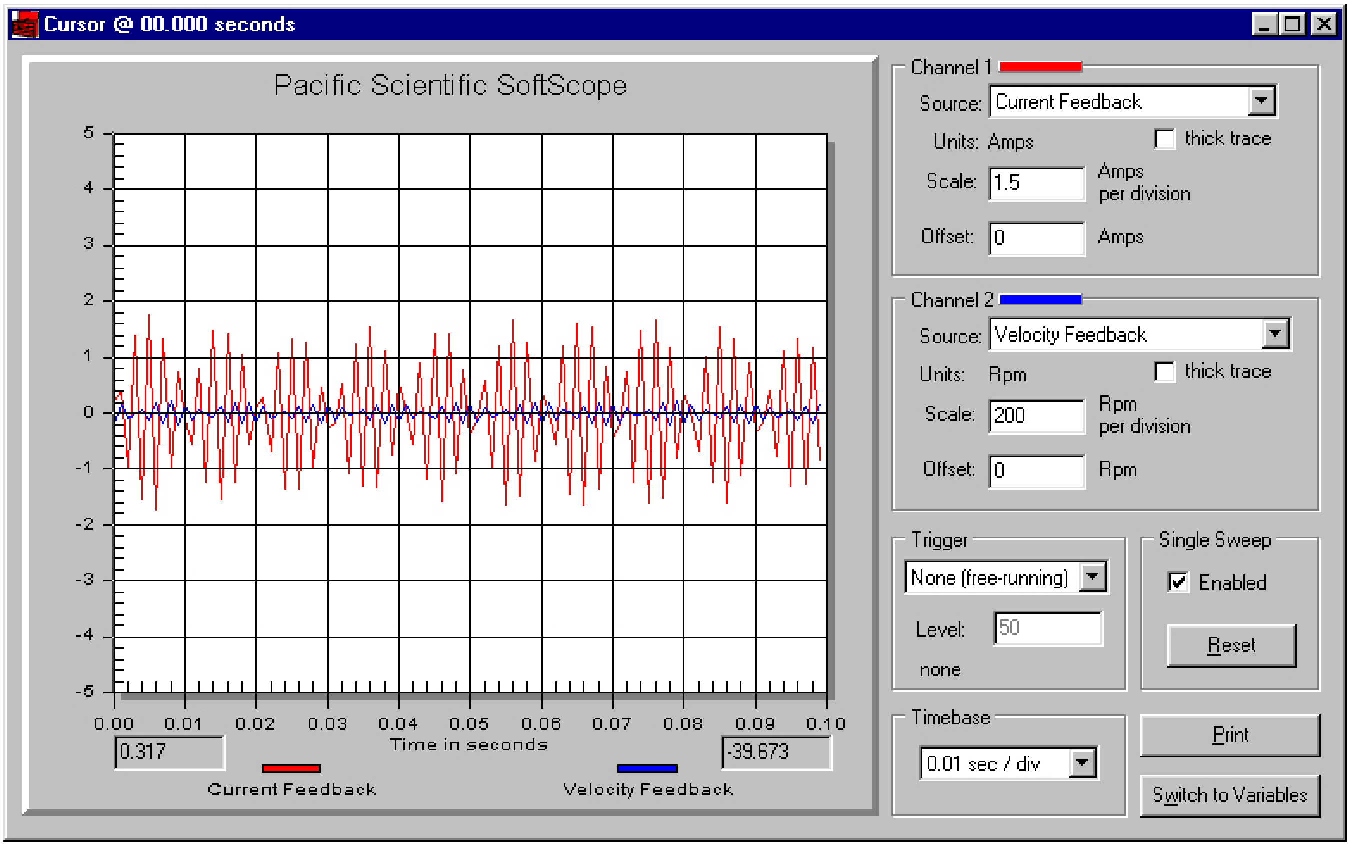
Example

To get a fair estimate, set:

KPP = 0
KVI = 0
KVFF = 100
KVP = (25[Hz]*MotorInertia*6.28/Kteff)
ARF0 = ARF1 = 10,000

With the motor enabled and holding zero speed, slowly increase KVP.

Monitor current feedback with the softscope. When the current begins to oscillate > 5% of the drive IPeak, capture the waveform and disable the drive. Measure the positive peak to next positive peak cycle time (Tc) of the current feedback waveform (Frequency = 1/Tc). It is easier to count the number of peaks in 10 divisions and divide into total time.



0.317
-39.673

Channel 1
Source: Current Feedback
Units: Amps
☐ thick trace
Scale: 1.5 Amps per division
Offset: 0 Amps

Channel 2
Source: Velocity Feedback
Units: Rpm
☐ thick trace
Scale: 200 Rpm per division
Offset: 0 Rpm

Trigger
None (free-running)
Level: 50
none

Single Sweep
☑ Enabled

Timebase
0.01 sec / div

This screen capture is not a true representation of the signal waveform due to the sample resolution. However, counting the peaks over 10 divisions provides adequate results in most cases.

Procedure

In this example there is an oscillation of 450 Hz.

1. Set ARF0 = ARF1 = 450 Hz/2.0 = 225 Hz.
2. Monitor current again. If oscillation is gone, increase KVP to excite it again and repeat the procedure. If oscillation is the same frequency, reduce ARF0 and ARF1 to further reduce the amplitude of the oscillation.
3. Repeat until either the oscillation gets worse or the oscillation frequency changes to match the filter frequency. In either case, KVP needs to be reduced and/or ARFs need to be increased.

2.5.7. Inertia and Bandwidth

Overview

The velocity loop bandwidth (BW) is very useful information when setting KVI and KPP parameters. These parameters are totally dependent on the value of the velocity loop bandwidth. Unfortunately, BW is not readily available. It must be calculated based on the total system inertia. The total system inertia value is the most difficult number to acquire. Once the inertia is known, the BW equation is easy to solve.

Bandwidth

BW is the range of frequencies where the motor adequately follows the command. As the BW is increased, the system response is increased. A higher frequency command is a faster-changing command. Think of feedback error as a command. Higher BW systems respond to feedback disturbances faster. How do you calculate BW?

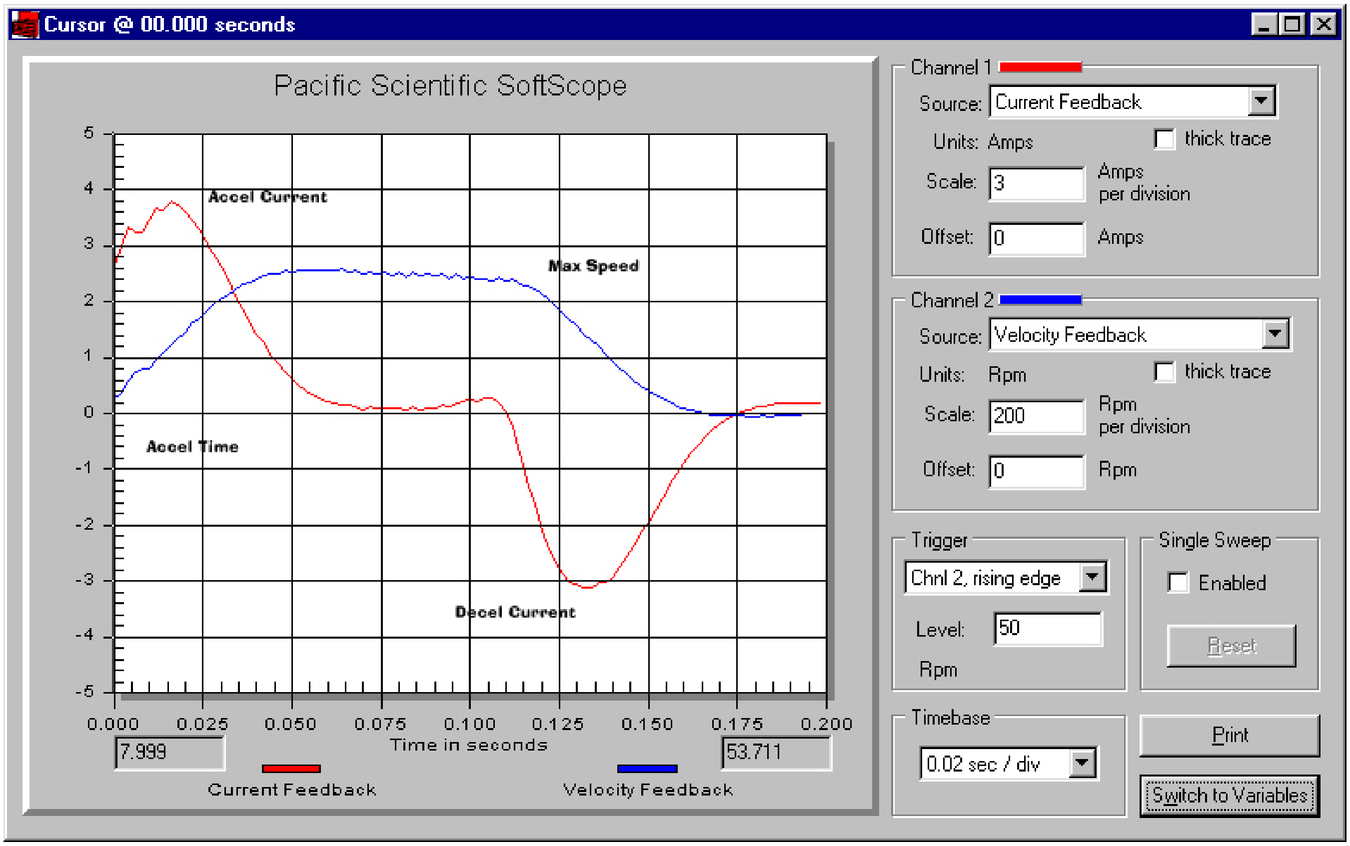
BW[Hz] = KVP * Kteff / (6.28 * Jt[Lb-in-s2])

Kteff[Lb-in/A] = Ke[V/krpm] * 0.08454 * 0.866

Inertia

There are two ways to calculate total system Inertia.

1. Measure all the mechanical parts separately. Using a software sizing package similar to Optimizer, enter all the mechanical data. The sizing package should have a data point for total reflected system inertia.
2. During installation of the prototype machine (when you are going to test the drive anyway), perform the standard motor/drive setup. You need to be able to create stable motor motion to perform this test. If the motor is unstable, read through the tuning section to determine how to make it stable. Setup an index move. The move has to be aggressive to create substantial accel current to increase the signal-to-noise ratio. Run the index move and use the softscope to monitor the velocity and current feedbacks.



Cursor @ 00.000 seconds

Current Feedback: 7.999

Velocity Feedback: 53.711

Channel 1

Source: Current Feedback

Units: Amps ☐ thick trace

Scale: 3 Amps per division

Offset: 0 Amps

Channel 2

Source: Velocity Feedback

Units: Rpm ☐ thick trace

Scale: 200 Rpm per division

Offset: 0 Rpm

Trigger: Chnl 2, rising edge

Level: 50 Rpm

Single Sweep: ☐ Enabled

Timebase: 0.02 sec / div

From the scope traces, record accel current, traverse current, decel current, traverse max velocity, and time to accel to traverse velocity.

Factor out friction and load force from the current

Inertial Current[A] = accel current - traverse current

Polarity matters

or

Inertial Current[A] = (accel current - decel current)/2
note: polarity matters

Inertial Current[A] = (3.8*3 + 3.2*3)/2 = 10.5[A]

Inertial Torque[Lb-in] = Inertial Current[A] * Kteff[Lb-in/A]

Inertial Torque[Lb-in] = 10.5*2.28 = 23.94[Lb-in]

Determine acceleration rate

AccelRate[rpm/s] = traverse velocity[rpm] / acceltime

AccelRate[rad/s^2] = AccelRate[rpm/s] * 0.10467

AccelRate[rad/s^2] = (2.5*200/0.05)*0.10467 = 1046.7 [rad/s^2]

Determine Inertia

Inertia[Lb-in-s^2] = Inertial Torque[Lb-in] / AccelRate[rad/s^2]

Inertia[Lb-in-s^2] = 23.94/1046.7 = 0.0229 [Lb-in-s^2]

By calculating mechanical system = 0.024 [Lb-in-s^2]

2.6. Diagnostics and Protection Circuits

The drive is fully protected against normal abuse and has two LEDs on the front panel to indicate drive status. The servo drive has the following specific protections:

- Output motor short-circuit protection line-to-line and line-to-neutral.
- Interface to Pacific Scientific's standard motor PTC or a normally-closed thermostat to sense motor over temperature.
- Internal monitoring of the power stage heat sink temperature for drive over temperature.
- Bus over voltage detection.
- Bus under voltage fault with adjustable threshold.
- Incorporating the measured heat sink temperature, there is an excessive current I*t fault. This fault limits the peak current time and intelligently changes the continuous current fault trip, dependent on the measured heat sink temperature, to limit the continuous output current.
- Control voltage under voltage detection.

- The user +5V output is short circuited to I/O RTN protected.
- The user +24V output is short-circuit protected.
- All control outputs are short-circuit protected to I/O RTN.
- When a drive is powered up without valid parameters, the power stage cannot be enabled and no damage occurs to the drive.

Fault Generation

The following sequence occurs when the protection circuits generate a fault.

- The fault source is latched.
- The output stage is disabled.
- The Fault mappable output function is activated.
- The LED indicates the appropriate fault code.

Faults are cleared by activating the Fault Reset input or by turning the 120/240VAC Control Power OFF and ON again.

Drive Status LEDs

See the following table for a detailed list of drive status LED codes.

Drive Status	**Fault LED (Red)**	**Power LED (Green)**
Faulted	If FaultCode < 6, Blinking If FaultCode ³ 6, On	On
Enabled	Off	On
Disabled	Off	Blinking
Unconfigured	Blinking	Blinking
Unplugged	Off	Off

If FaultCode < 6, the red LED blinks the faultcode at a frequency of 1 Hz (on and off in 1 sec). It is then off for 2 seconds before blinking the sequence again.

Nuisance over current trips may occur under the following condition:

> ***Control power is ON and drive is enabled but bus power mains are switched OFF. When AC bus power comes on, motor current briefly exceeds the command to clear the saturated current loop integrator. Usually this is not a problem, but in some motor-drive combinations (especially when the motor inductance is low), the current overshoot can trip the overcurrent detector. To avoid this problem, do ONE of the following:***
>
> - ***Switch ON the control power and bus power simultaneously.***
> - ***If control power remains ON while bus voltage is down, put the drive in the Disable state. DO NOT enable the drive until after the bus voltage comes up. The bus voltages comes up within 20 msec of AC bus power being switched ON. Bus voltage can be monitored using the variable, VBUS.***

2.6.1. FaultCode List

If FaultCode < 6 , the Fault LED blinks the value of FaultCode. For example, if FaultCode = 2, the Fault LED blinks twice, pausse for 2 seconds, then repeats the sequence. There is a 2- second pause between each Fault LED sequence.

Fault LED	**FaultCode**	**Fault Description**
Blinking	1	Velocity feedback (VelFB) over speed*
	2	Motor over temperature
	3	User +5V low
	4	Continuous current fault
	5	Drive over current (instantaneous)

**To further identify this fault, see software variable ExtFault.*

Fault LED	**FaultCode**	**Fault Description**
On	6	Control ±12V under voltage
	7	Not Assigned
	9	Bus over voltage detected by DSP, External Regen Fault
	10	Not Assigned
	11	Bus under voltage* (Only if VBus < VBusThresh)
	12	Ambient temperature too low
	13	Encoder alignment failed*
	14	Software and non-volatile memory versions not compatible
	15	Hardware not compatible with software version
	16	Unconfigured drive fault
	17	Two AInNull events too close together
	18	Position following error fault
	19	Parameter memory error*
	20	Initialization fault*
	21	Drive over temperature
	22	Resolver Fault

**To further identify this fault, see software variable ExtFault.*

ExtFault The following table lists the values for ExtFault.

ExtFault	ExtFault Description
1	Absolute Resolver Overspeed. |VelFB| > 21038 RPM
2	Variable Resolver Overspeed. |VelFB| > max(VelLmtxx)*1.5
3	Calibration data corrupted*
4	Excessive DC offset in current feedback sensor*
5	DSP incompletely reset by line power dip*
8	Excessive dc offset in Analog Command A/D*
9	Not Assigned
10	DSP stack overflow*
12	Software and control card ASIC incompatible*
13	Actual Model not same as stored in NV memory*
14	Unable to determine power stage*
15	Drive non-volatile parameters corrupt*
16	RAM failure*
17	Calibration RAM failure*
18	Encoder alignment: no motion fault
19	Encoder alignment: excessive motion fault
20	Encoder alignment: motor not settled
21	Encoder alignment: test failed
22	Encoder alignment: motion overflow fault
23	Hall Commutation: invalid configuration
24	Hall Commutation: overspeed
25	Hall Commutation: invalid hall state
26	Hall Commutation: invalid hall transition
27	I*t Drive
28	I^2*t Motor

**These fault states CANNOT be reset with the Fault Reset function. They require the line control power to be turned OFF and ON again.*

2.6.2. Fault LED Troubleshooting

A table of faults and their possible causes is listed below.

If FaultCode < 6 , the Fault LED blinks the value of FaultCode. For example, if FaultCode = 2, the Fault LED blinks twice. If Faultcode ≥6 the Fault LED remains ON.

FaultCode	Possible Cause
1	Loose or open circuit wiring to the resolver feedback connector J3.
	Actual motor speed exceeded 1.5 * (Max Of |VelLmtLo| or|VelLmtHi|) or 21,038 RPM which is the over speed trip level.
	For Encoder velocity feedback (RemoteFB = 2) check that EncIn is set properly.
2	Loose or open circuit wiring to motor PTC thermal sensor (J3-8, J3-9).
	High ambient temperature at motor.
	Insufficient motor heat sinking from motor mounting.
	Operating above the motor’s continuous current rating.
3	Short-circuited wiring on the output (J2-25).
4	Mechanically-jammed motor.
	Motion profile acceleration too high.
	Machine load on the motor increased by friction.
	Wiring problem between drive and motor yielding improper motion.
	Drive and/or motor under-sized for application.
5	Motor power wiring (TB1-4, 5, or 6) short circuit line-to-ground/neutral.
	Motor power cable length is enough longer than the data sheet specification to cause excessive motor line-to-earth ground/neutral capacitance.
	Internal motor winding short circuit.
	Insufficient motor inductance causing output over current faults.
	KIP or KII improperly set causing excessive output current overshoots.

See HSTemp, ItFilt, and ItF0 for information on measuring the thermal margin in an application.

Fault LED ON The Fault LED remains ON when FaultCode ≥ 6.

FaultCode	Possible Cause
6	Insufficient control AC voltage on TB1-1 to TB1-2.
	External short on signal connector.
	Internal drive failure.
7	Not Assigned.
9	Disconnected external regeneration resistor on TB1.
	External regeneration resistor ohmage too large yielding Bus OverVoltage fault.
	External regeneration resistor short circuit.
	Motor AC power input voltage too high.
10	Not Assigned.
11	Check the measured bus voltage, VBus, and the fault threshold, VBusThresh, to make sure they are consistent.
12	Ambient temperature is below drive specification. Drive's internal temperature sensor has a wiring problem.
13	Encoder Alignment failure. See ExtFault for additional information.
14	Not Assigned.
15	Attempt to upgrade the drive's software unsuccessful. Contact factory for upgrade details.
	Resolver wiring error. Remove J2 and J3 connectors. Turn AC power OFF and ON again. If FaultCode = 2, correct resolver excitation wiring.
	Internal failure. Return to factory for repair.
16	Unconfigured drive (Red and Green LEDs blinking after power up) was fully configured with the drive motor power enable active. This fault is reset or the control AC power turned OFF and ON again to get the drive-motor operating.
17	The AInNull function was re-activated too soon after going inactive. This can be caused by switch bounce on the input pin mapped to activate AInNull.
18	The motor is either stalled or partially jammed.
	The value for PosErrorMax is set too sensitive for the loop tuning and commanded motion profiles.
19	Glitch while last saving the NV parameters. Corrupted NV memory contents. Hardware problem with the NV memory. Download parameters to restore drive operation.
20	Initialization Failure. See ExtFault for additional information.
21	High drive ambient temperature. Restriction of cooling air due to insufficient space around unit.
	Operating above the drive's continuous current rating.
	See HSTemp, ItFilt, and ItF0 for information on measuring thermal margin in an application.
22	Resolver signal is lost or intermittent. Check resolver cable.

2.7. Servo Loop Parameters

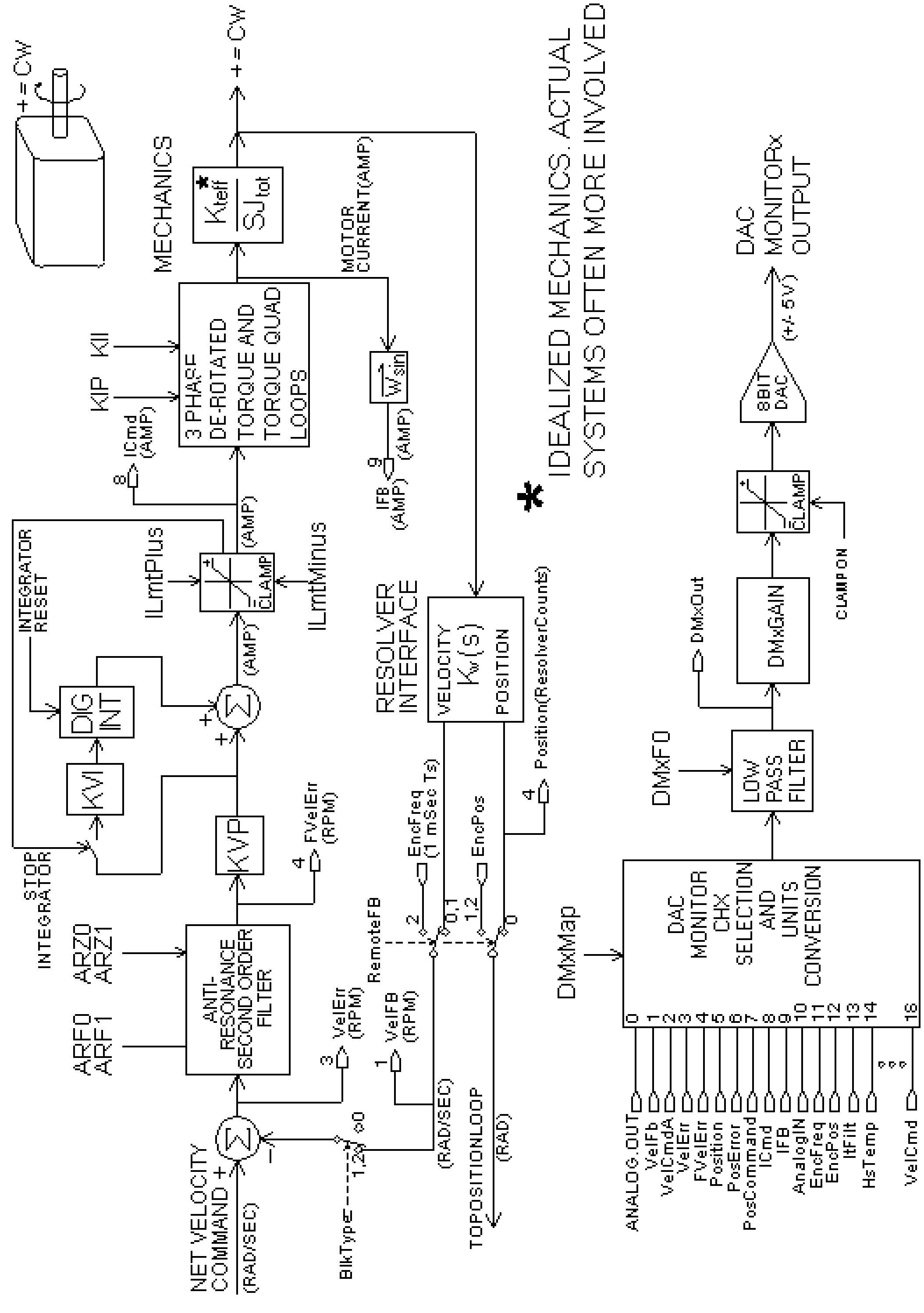
This section describes setting parameters associated with the velocity and position loops. In many cases, satisfactory operation is achieved using either the **Create New Configuration** or **Edit Existing Configuration** buttons. However, in some cases you must adjust the control loop parameters due to large mismatches between motor and load inertia, mechanical resonance, backlash, etc. This appendix provides guidance for handling these situations.

The two anti-resonant zeroes (ARZ0 and ARZ1) are assumed to both be off (set to zero) for this discussion.

2.7.1. Velocity Loop

Velocity loop bandwidth is the key indicator of system performance. Systems with fast settling time must have high velocity loop bandwidth. Conversely, if the velocity loop bandwidth is low, attempting to achieve fast settling time by increasing the position loop bandwidth, KPP, leads to overshoot and ringing.

Velocity Loop



Velocity Loop Bandwidth

The velocity loop bandwidth (f_{vc}) is given by the equation:

$$f_{vc}(Hz)=\frac{KVP*K_T{}^{\sqrt{3}}\!/_2}{2\pi*J_{TOT}}=0.138*KVP*\frac{K_T}{J_{TOT}}$$

where:

KVP is the velocity loop proportional gain in amps/(rad/sec)

K_T is the 0-peak line-line motor torque constant in lb-in/amp

J_{TOT} is the total inertia (motor total + load total) in lb-in-sec2.

(Any consistent set of units for K_T, J_{TOT} (such as MKS), that yield K_T/J_{TOT} in rad/sec2/amp work.)

The motor torque constant is the value of K_T peak published in the *Pacific Scientific Motion Control Solutions* catalog.

f_{vc} is the unity gain open-loop crossover frequency of the idealized rigid single mass system. See hardware specifications for maximum f_{vc} value.

Default Bandwidth

The Create New Configuration and Edit Existing Configuration buttons set KVP to achieve a velocity loop bandwidth of 75 Hz. 800Tools assumes there is a matched load on the motor shaft and the motor has no mechanical brake or other secondary devices installed.

f_{vc} Velocity Loop Bandwidth (Hz) = 75 Hz (default)

Load Inertia

From the formula for bandwidth, you can see that bandwidth changes inversely with total inertia. If the load inertia equals the motor plus resolver inertia, the velocity loop bandwidth is half the values shown. If the load inertia is ten times the motor plus resolver inertia, the bandwidths are one-eleventh these values. Clearly, KVP must be increased to compensate for increased load inertia, if bandwidth is to be maintained. Typically, load inertia up to 3 (motor + resolver) give acceptable performance without further optimization.

The most common servo setup problem is adding large load inertia without a corresponding increase in KVP.

The value of KVP to achieve a desired bandwidth can easily be calculated as:

$$KVP=\frac{2\pi*f_{vc}*J_{TOT}}{K_{TRMS}{}^{\sqrt{3}}\!/_{2\sqrt{2}}}=10.26*f_{vc}*\frac{J_{TOT}}{K_{TRMS}}$$

Example Calculation

For example, to achieve 75 Hz bandwidth with a PMA22 motor having 20 to 1 load inertia = 0.011 lb-in-sec2:

J_{TOT}[1] = 0.00039 + 0.011 = 0.01139 lb-in-sec2

K_T[2] = 4.31 lb-in/amp

$$KVP = 10.26 * 75 * \frac{0.01139}{4.31} = 2.03$$

800Tools can also be used to make the calculation. Simply enter the total inertia in place of the motor-plus-resolver inertia when using the Create New Configuration or Edit Existing Configuration buttons and 800Tools calculates the appropriate value for KVP to achieve 75 Hz bandwidth.

There is no specific answer to the general question, “What should the bandwidth be?” In general, the higher the velocity loop bandwidth, the faster the settling time and the better the rejection of torque disturbances (increased stiffness). Typically, velocity loop bandwidths range from 30 Hz to 100 Hz. However, too high a bandwidth can lower the damping of resonance in mechanical linkages, causing excessive ringing and/or wear in coupled mechanics. Remember, it is the resulting motion at the end of any mechanical linkages that typically matters, not the response at the motor shaft.

Problems With High Load Inertia

It would seem from the above, that setting KVP is simply a matter of increasing its value to compensate for load inertia. Unfortunately, the following problems often interfere, particularly when the load inertia is large compared with the motor’s inertia:

1. Mechanical resonance between motor and load cause high frequency oscillation.
2. Backlash between motor and load effectively unload the motor over a small angle. Within this small angle, the increased bandwidth results in oscillation.
3. Ripple in the velocity feedback signal results in large motor ripple current, if KVP is large.

As a general rule, any system with KVP set higher than 5 times the medium bandwidth setting requires adjustment to the default ARF0 and ARF1 settings.

---

[1] Motor-plus-resolver inertia (0.00039 lb-in-sec2) for the PMA22 motor is found in the catalog or 800Tools' motor data screen.

[2] K_T is found in the catalog as K_{TRMS} (4.31 lb-in/amp) or by using the Back EMF Constant, K_E (31.2 Volts/kRPM), shown on 800Tools' motor data screen in the following formula:

$K_{T\ RMS} = K_{E\ RMS} * 1.06/\sqrt{3}$ (volts/krpm).

$K_{T\ 0\text{-}PK} = K_{T\ RMS} * 0.707$

Resonance

Mechanical resonance is caused by springiness between motor inertia and load inertia. This may result from belts, flexible couplings, or the torsional stiffness of shafts. **In general, the stiffer the couplings, the higher the resonance frequency and the easier it is to tune the system for good performance.**

If the velocity loop breaks into an oscillation at a frequency well above the calculated velocity loop bandwidth, a resonance problem may exist. A second symptom is that the frequency of oscillation is relatively constant even with changes to ARF0 and ARF1.

Anti-resonance Filters

Two digital anti-resonant low-pass filters ARF0 and ARF1 are included in the velocity loop. Their purpose is to lower the gain above f_{vc}, especially at any resonant frequency $> f_{vc}$ so oscillations do not occur. Recommended values are:

f_{vc} (Hz)	**25**	**75**	**200**
ARF0 (Hz)	100	150 (default)	1500
ARF1 (Hz)	200	750 (default)	$1\text{x}10^5$

If the velocity loop bandwidth cannot be raised to an acceptable value without encountering a resonant oscillation, follow the procedure below.

Procedure

1. Set both ARF0 and ARF1 to 400 Hz and set KVP low enough to prevent oscillation.
2. Increase KVP slowly until oscillation at the resonant frequency just begins. Reduce KVP slightly until the oscillation just stops. Compute the velocity loop bandwidth using the formula given at the beginning of this section. If the velocity loop bandwidth is less than .25 times the value of ARF0 and ARF1, proceed to Step 3. Otherwise, go to Step 4.
3. Decrease both ARF0 and ARF1 by 20% and go back to Step 2.
4. The velocity loop bandwidth should now be approximately one quarter the value of ARF0 and ARF1. For margin, reduce KVP, ARF0, and ARF1 by 20%.

Backlash

Some backlash may be unavoidable, especially when gear reduction is used. If backlash is present, the inertia match must be good (load inertia should be roughly equal to motor inertia) for good servo performance. Gearing reduces the inertia reflected to the motor by the square of the gear reduction from motor to load. Select a gear ratio to give the required match.

Current Ripple

The velocity feedback signal in standard PCE830 drives operating with the standard 20 arcmin resolver can have up to 3% p-p ripple. The resulting motor torque current ripple, with no ARF0/ARF1 filtering, is calculated using the following formula:

$$\text{Current ripple (amps p-p)} = \frac{3}{100} * \text{Speed (RPM)} * \frac{2\pi}{60} * \text{KVP}$$

$$\approx 0.03 * \text{Speed (RPM)} * \text{KVP}$$

There can be cause for concern when this p-p number exceeds 40% of the drive's or motor's current rating. Monitor the motor current using DAC Monitors on J2-4 to insure that actual ripple current with ARF0/ARF1 filtering is not excessive.

Motor current ripple is often reduced by lowering the ARF0, ARF1 low-pass filter break frequencies. This benefit is limited by velocity loop bandwidth and stability constraints. Velocity feedback ripple, and motor current ripple, can also be reduced by specifying a higher accuracy resolver.

KVI

The parameter, KVI, sets the "lag-break" frequency of the velocity loop. KVI is equal to the frequency in Hz where the velocity loop compensation transitions from predominantly integral characteristics to predominantly proportional characteristics. Drive rejection of torque disturbances increase as KVI increases. Default values for KVI are:

f_{vc} (Hz)	**25**	**75**	**200**
KVI (Velocity Loop Lag-Break Freq. (Hz))	1.7	5.0 (default)	13.3

If the drive is used within a position loop (either with BlkType = 2 or when using an external position drive and BlkType = 1), KVI should be equal to or less than 0.1 times the velocity loop bandwidth. If no position loop is used, KVI can be set to 0.25 times the velocity loop bandwidth (or higher, if some ringing can be tolerated). In general, the response to a velocity command step (or truncated ramp) has velocity overshoot for non-zero values of KVI.

2.7.2. Position Loop

When BlkType is set equal to 2, a position loop is configured outside the velocity loop. **The velocity loop must be set up and evaluated in terms of bandwidth BEFORE attempting to setup the position loop.**

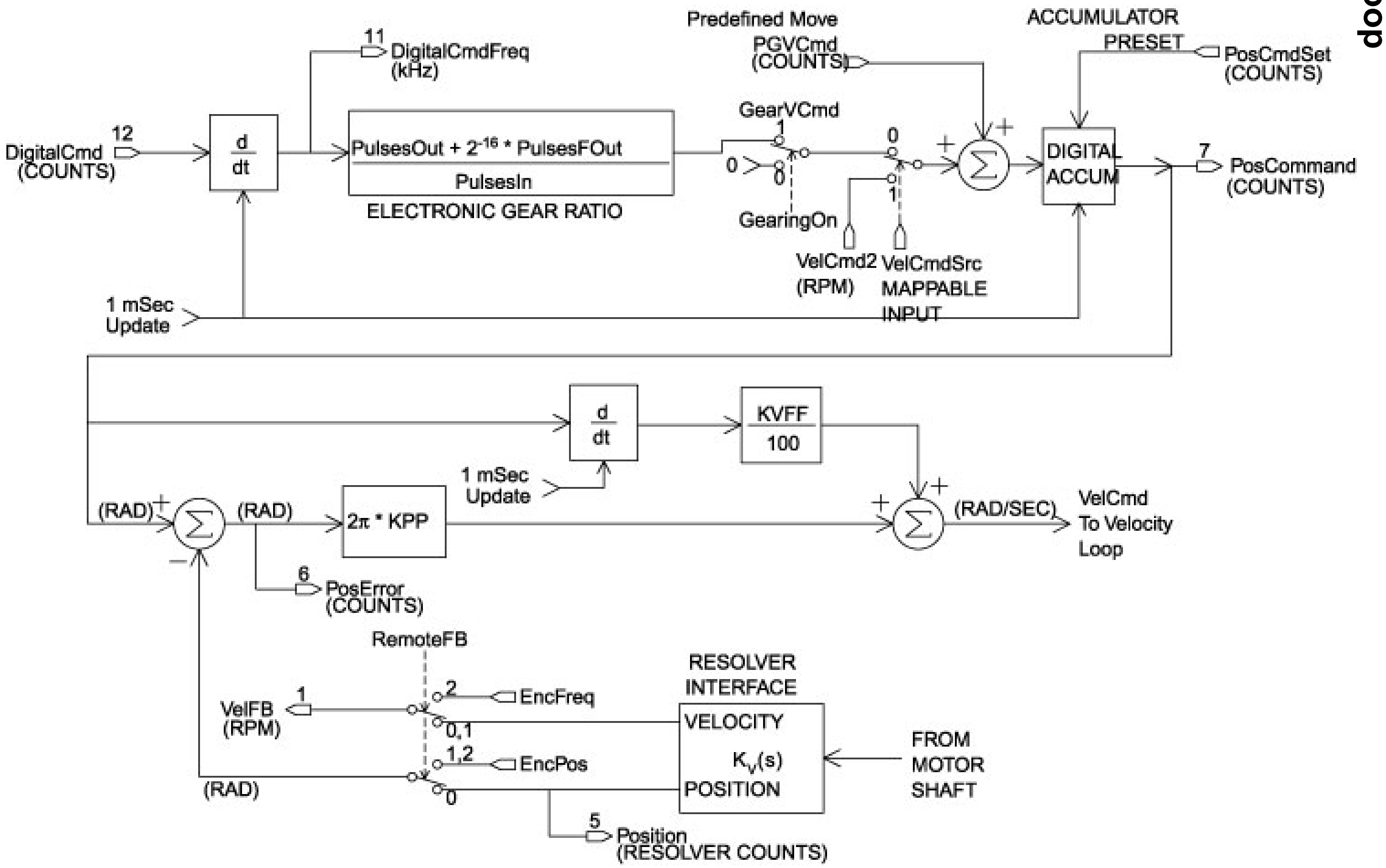
KPP

The position loop proportional gain, KPP, determines the settling time of the position loop. KPP is the bandwidth of the position loop (in Hz), assuming an ideal velocity loop. Recommended values for KPP are:

f_{vc} (Hz)	**25**	**75**	**200**
KPP (Position Loop Bandwidth (Hz))	5	15 (default)	50

In general, the higher the value of KPP, the faster the settling time. However, trying to set KPP to a high value with inadequate velocity loop bandwidth results in overshoot and ringing. A good trade off is to set KPP to 0.2 times the velocity loop bandwidth. Slightly higher values can be used if overshoot can be tolerated.

Position Loop



KVFF

KVFF is the velocity feed forward gain. In the absence of velocity feed forward (KVFF = 0), the commanded velocity is proportional to the position (following) error. This means that the actual position lags the commanded position by a value proportional to the speed. The error is smaller for larger values of KPP.

The following table gives a sample of the following error magnitude.

Speed (RPM)	KPP (Hz)	Following Error (revolutions)
1000	10	0.27
2000	10	0.53
5000	10	1.33
1000	20	0.13
2000	20	0.27
5000	20	0.66

The following error can easily exceed one complete motor revolution. In many electronic gearing applications, such following errors are not acceptable (real gears DO NOT have following errors!) Stepper systems also DO NOT have such errors.

Feed forward takes advantage of the fact that the PCE830 DSP knows the frequency of the encoder or step inputs and knows how fast the motor should be going at a given instant. All or part of this velocity can be added to the velocity command to reduce following error. If KVFF is set to 100 (%), the steady-state following error reduces to zero.

Overshoot

Setting KVFF equal to 100% can result in position overshoot. Somewhat lower values may be required, if this is a problem. KVFF set to 70%-80% typically achieves the fastest step response with no overshoot. Setting KVFF to less than 100% gives steady state following error when running at a constant speed.

2.7.3. Advanced Velocity Loop Tuning

Continuous Time Transfer Function Approximation

The transfer function for the velocity loop compensation block is:

$$\frac{FVelErr}{VelErr}(s)=\frac{\left(\frac{s}{\omega_z}\right)^2+\frac{1}{Q_z}\frac{s}{\omega_z}+1}{\left(\frac{s}{\omega_f}\right)^2+\frac{1}{Q_f}\frac{s}{\omega_f}+1}$$

$$\frac{ICmd}{VelErr}(s)=\frac{\left(\frac{s}{\omega_z}\right)^2+\frac{1}{Q_f}\frac{s}{\omega_z}+1}{\left(\frac{s}{\omega_f}\right)^2+\frac{1}{Q_f}\frac{s}{\omega_f}+1}$$

Definitions for the terms used in the equations above are:

For ARx0 > 0 both roots are real and:

$$\omega_z=2\pi\sqrt{(ARx0)(ARx1)}$$

$$Q_z=\frac{\sqrt{(ARx0)(ARx1)}}{ARx0+ARx1}$$

For ARx0 < 0 roots are a complex pair and:

$$\omega_z=-2\pi\,ARx0$$

$$Q_z=ARx1$$

When ARZ0 and ARZ1 are both 0, the numerator of $\frac{FVelErr}{VelErr}$ ***reduces to 1.***

If ARZ0 or ARZ1 is individually 0, the numerator reduces to $\frac{s}{2\pi\,ARZx}+1$.

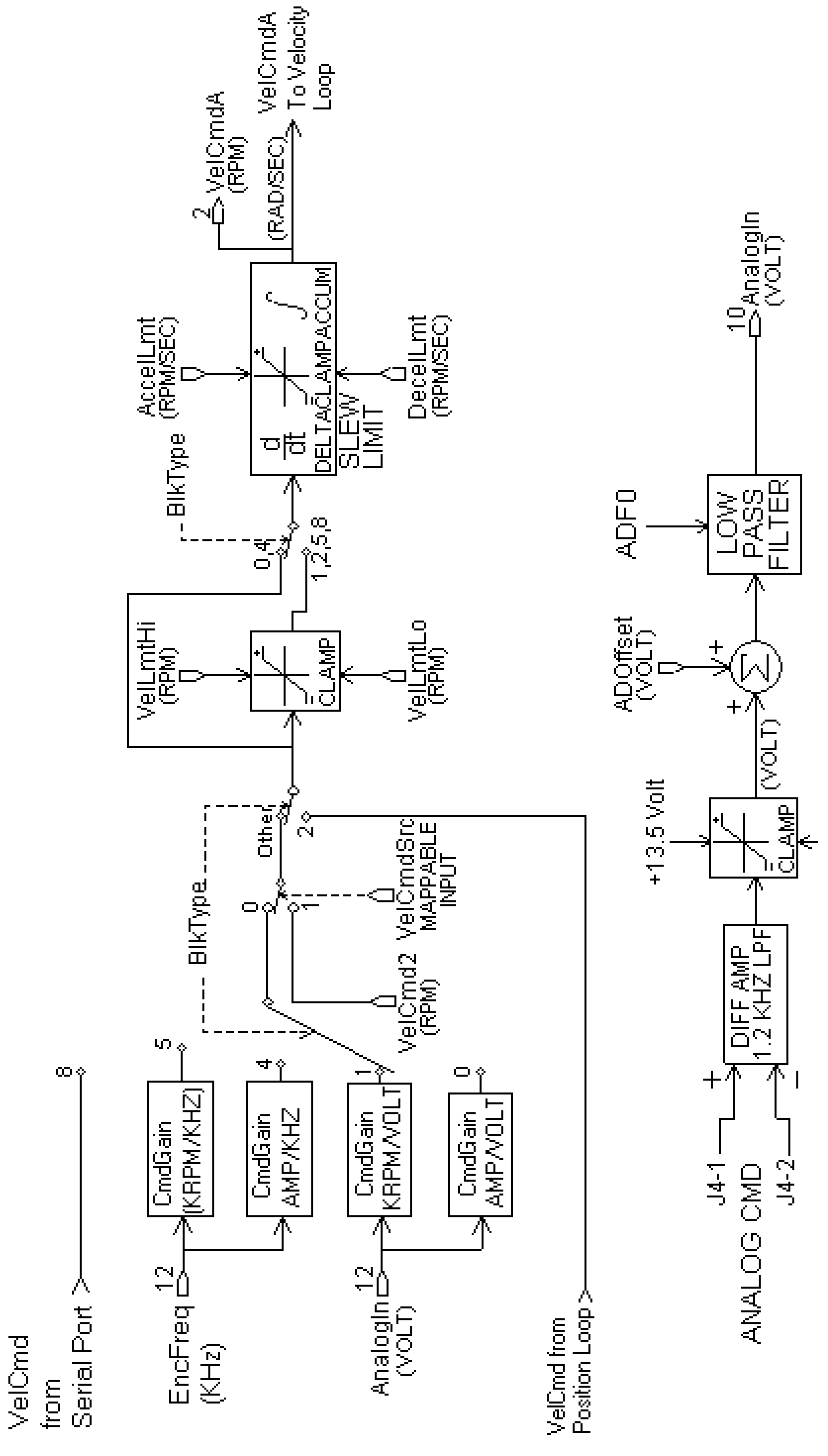
Discrete Time Transfer Function

The velocity loop compensation is actually implemented as a digital discrete time system function on the DSP. The continuous time transfer function is converted to the discrete time domain by a backward Euler mapping:

$$s\rightarrow\frac{1}{T_S}(1-z^{-1})$$

where $T_S = 250\ \mu\text{sec}$.

Mode Selection and Command Processing



2.8. Comcoder or Encoder Feedback Setup

The PCE830 servo drive can commutate a motor using any one of the following feedback devices:

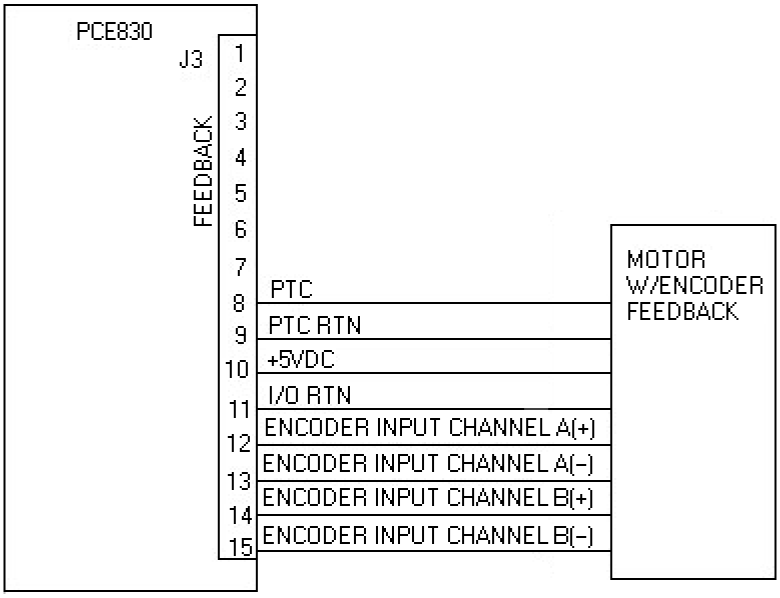
- Resolver
- Incremental Encoder
- Comcoder (hall/encoder).

2.8.1. *Configuring the PCE830 for a Motor with an Incremental Encoder*

Using an Incremental Encoder

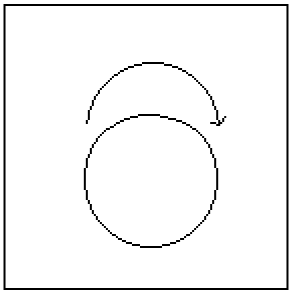
To wire an incremental encoder for primary feedback on the PCE830:

1. Connect the encoder signals, PTC and Encoder +5V supply as shown in the diagram below:



2. Click the **Edit Drive Configuration Online** button and select the variable, **EncPos**.

3. With the motor disabled, rotate the shaft in the clockwise direction as viewed from the shaft end (as shown in the picture below).



4. If **EncPos** decreases as the shaft is rotated, swap A and $\overline{A}$ connections and repeat Step 3.
5. Click the **Create New Configuration** button. Select the proper motor, drive, and desired mode of operation. Click **Next**.
6. Click the **Feedback** Tab. Select **Incremental Encoder** as the **Commutation Source**.
7. Enter the correct encoder line count.
8. Click **Save to File** and give the configuration a name.
9. Click **Download to Drive** to send the complete configuration to the drive.
10. After the download is complete, click **YES** to save the configuration to non-volatile memory.
11. Turn AC power OFF and ON again.

Incremental encoders are not absolute feedback devices. An alignment procedure must be performed. The motor should perform its encoder alignment check upon power up AND assertion of the hardware enable.

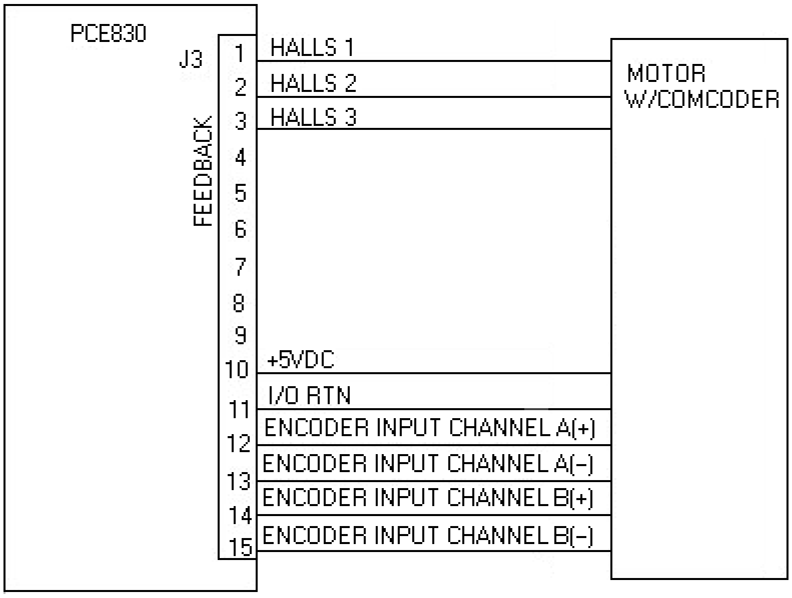
For additional information on incremental encoder alignment, consult the online help of the PCE830 software “Encoder Alignment Overview” or contact Pacific Scientific Applications Engineering for assistance.

2.8.2. Configuring the PCE830 for a Motor With a Comcoder

Using a Comcoder

To wire-up a comcoder (hall/encoder) for primary feedback on the PCE830 perform the following:

1. Connect the comcoder as shown in the diagram below:



2. Click the **Edit Drive Configuration Online** button and select the variable **HallState**.
3. With the motor disabled, rotate the shaft slowly in the clockwise direction. Verify that **HallState** repeats the following sequence (... 6, 4, 5, 1, 3, 2, …).
4. If **HallState** does not sequence in this manner, swap any two hall sensor phases and repeat step 3.
5. Click the **Create New Configuration** button. Select the proper motor, drive, and desired mode of operation. Click **Next**.
6. Click the **Feedback** tab. Select **Comcoder (Hall/Encoder)** as the **Commutation Source**.
7. Enter the correct encoder line count.
8. Click **Save to File** and give the configuration a name.
9. Click **Download to Drive** to send the complete configuration to the drive.
10. After the download is complete, click **YES** to save the configuration to non-volatile memory.
11. Turn AC power OFF and ON again.

When the hardware enable is asserted, the motor initially uses the hall signals for commutation. After the first hall state transition occurs, the drive adjusts the commutation angle and starts commutation off the encoder. To ensure the adjusted commutation angle is within 5 electrical degrees of the correct angle, the PCE830 limits the maximum velocity and maximum acceleration rate at which the motor can rotate until this transition occurs because the motor is still not properly aligned during this period.

For additional information on the **Comcoder (Hall/Encoder)** alignment process, contact Pacific Scientific Application Engineering for assistance.

2.9. Simple ASCII Protocol

This applies to firmware version 2.00 and higher.

The PCE830 supports a simple ASCII protocol for serial communications with devices like PLCs or other electronics capable of handling ASCII strings.

The simple ASCII protocol command formats are given below. The notation is:

{ } indicates optional field.

<> indicates one character.

[ ] indicates a string of characters.

Each character is sent using its ASCII representation.

Command Message Format

<STX> {[Addr]} [CmdCode] [PDID] [=Value] {[:CS]} <CR>

Description of Fields

STX = Framing character denoting start of message.

Addr = Address of drive (0-255). Optional field.

CmdCode = R for read, W for Write, C for Command.

PDID = The ID number of the variable/parameter. To distinguish floats from integers, 10000 was added to PDID of integers.

Value = Value (data) to be written to parameter/variable. Only used for W (write) messages.

CS = Checksum. Optional field.

CR = Framing character denoting end of message.

Reply Message Format

<STX> [RspCode] {[Value]} {[:CS]} <CR>

Description of Fields

STX = Framing character denoting start of message.

RspCode = V if Value (data) is returned. E is error is returned.

Value = Value of variable/parameter.

CS = Checksum. This optional field is used only if the command message used a checksum.

CR = Framing character used to denote end of message.

If the command message is valid:

1. The reply to a read returns the value of the variable/parameter.
2. The reply to a write command also returns the value of the variable/parameter after it was written.
3. The reply to a command is simply an echo of the message received.

Examples

1. Write Move1Distance (Integer #10100) a value of -6553600 without using the optional Address field:

   Command Sent: "<STX> W 10100 = -6553600 :214 <CR>"

   Message Received: "<STX>V-6553600:38<CR>"

2. Read Move1Distance (Integer #10100) without using the optional Address field:

   Command Sent: "<STX> R 10100 :190 <CR>"

   Message Received: "<STX>V-6553600:38<CR>"

3. Write Move1RunSpeed (Float #98) a value of 60.0 RPM with the Address field:

   Command Sent: "<STX> 255 W98 = 60.0 :31 <CR>"

   Message Received: "<STX>V59.9992:9<CR>"

4. Read Move1RunSpeed (Float #98) with the Address field.

   Command Sent: "<STX> 255 R98:185 <CR>"

   Message Received: "<STX>V59.9992:9<CR>"

5. Execute NVSave (Command #1).

   Command Sent: "<STX> C1 <CR>"

   Message Received: "<STX>C1<CR>"

Guidelines

1. The Serial ASCII Protocol ignores white space between fields.
2. The Checksum is the decimal sum (modulo 256) of all the characters from after the initial framing character (STX), up to and including the ":" character.
3. Due to floating point conversions, a floating-point value sent to the drive may not be exactly equal to the value received from the drive.
4. Address 0 is a global address. All drives process a message sent to address 0, but will NOT reply. Address 255 is a default address. All drives process messages sent to Address 255 and return a reply. When multi-dropping PCE830 drives, assign a unique address (between 1-254, inclusive) to each drive.

Pacific Scientific strongly recommends the use of the optional CS (checksum) field for safe and reliable operation of the PCE830.

2.9.1. Pre-defined Identifiers

Values for Error Codes

ReadOnly	65
Bounds_Error	66
No_Such_Command	67
Variable_Not_Implemented	68

Identifier Codes for Commands

NVLoad	0
NVSave	1
Unconfigure	2

Identifier Codes for Integer Variables

CfgD	10001
ILmtMinus	10002
ILmtPlus	10003
DM1Map	10005
Enable	10006
Enabled	10007
EncIn	10008
EncPos	10009
FaultCode	10010
Inp1	10012
Inp2	10013
Inp3	10014
Inp4	10015

Inp5	10016
Inp6	10017
Inputs	10018
KpEnc	10019
KiEnc	10020
KdEnc	10021
ElecAngTau	10022
EncAlignTime	10023
EncAlignTestDist	10024
EncAlignRampIcmd	10025
Out1	10026
Out2	10027
Out3	10028
Out4	10029
Outputs	10030
PosCommand	10031
PosError	10032
ResPos	10033
Position	10034
PulsesIn	10035
PulsesOut	10036
EncOut	10037
EncMode	10038
PoleCount	10039
Model	10041
AxisAddr	10042
ItThresh	10043
FwV	10044
BlkType	10045
HwV	10049
CommEnbl	10050
ExtFault	10051
Motor1	10052
CwInh	10053
CcwInh	10054
PulsesFOut	10055
PosCmdSet	10056
DM2Map	10057
FaultReset	10061
RunStop	10062

CommSrc	10063
Enable2	10064
RemoteFB	10065
InpMap1	10066
InpMap2	10067
InpMap3	10068
InpMap4	10069
InpMap5	10070
InpMap6	10071
OutMap1	10072
OutMap2	10073
OutMap3	10074
OutMap4	10075
VelCmdSrc	10076
Brake	10077
MfgLock	10078
AInNull	10083
PosErrorMax	10084
Fault	10085
Motor2	10090
DigitalCmd	10091
Move0Type	10092
Move0Distance	10093
Move0Dwell	10095
Move0DistOffset	10096
Move0HomeDir	10097
Move0HomeMode	10098
Move1Type	10099
Move1Distance	10100
Move1Dwell	10102
Move1DistOffset	10103
Move1HomeDir	10104
Move1HomeMode	10105
Move2Type	10106
Move2Distance	10107
Move2Dwell	10109
Move2DistOffset	10110
Move2HomeDir	10111
Move2HomeMode	10112
Move3Type	10113

Move3Distance	10114
Move3Dwell	10116
Move3DistOffset	10117
Move3HomeDir	10118
Move3HomeMode	10119
Move4Type	10120
Move4Distance	10121
Move4Dwell	10123
Move4DistOffset	10124
Move4HomeDir	10125
Move4HomeMode	10126
Move5Type	10127
Move5Distance	10128
Move5Dwell	10130
Move5DistOffset	10131
Move5HomeDir	10132
Move5HomeMode	10133
Move6Type	10134
Move6Distance	10135
Move6Dwell	10137
Move6DistOffset	10138
Move6HomeDir	10139
Move6HomeMode	10140
Move7Type	10141
Move7Distance	10142
Move7Dwell	10144
Move7DistOffset	10145
Move7HomeDir	10146
Move7HomeMode	10147
ActiveMoveType	10148
ActiveDistance	10149
InPosLimit	10150
ActiveDwell	10151
ActiveDistOffset	10152
ActiveHomeDir	10153
ActiveHomeMode	10154
ActiveMove	10155
StartMove	10156
MoveDone	10157
MoveSelectBit0	10158

MoveSelectBit1	10159
MoveSelectBit2	10160
GearingOn	10161
Move0RegSelect	10162
Move1RegSelect	10163
Move2RegSelect	10164
Move3RegSelect	10165
Move4RegSelect	10166
Move5RegSelect	10167
Move6RegSelect	10168
Move7RegSelect	10169
Reg1ResolverPosition	10170
Reg1EncoderPosition	10171
Reg2ResolverPosition	10172
Reg2EncoderPosition	10173
Reg1ActiveEdge	10174
Reg2ActiveEdge	10175
ActiveRegSelect	10176
HomeSwitch	10177
HallState	10178
HallOffset	10179
DriveStatus	10180

Identifier Codes for Float Variables

AnalogIn	0
AnalogOut1	1
EncFreq	2
Velocity	3
ARF0	4
ARF1	5
Kvi	6
ItF0	7
Kpp	8
Kvp	9
Kvff	10
DM1F0	11
ADF0	12
ADOffset	13
Ipeak	14
DM1Gain	15
CmdGain	16
CommOff	17
ItFilt	18
VelCmd	19
VelErr	20
Icmd	21
IFB	22
FVelErr	23
DM1Out	24
VelFB	25
DM2Out	26
Kip	27
AnalogOut2	30
StopTime	31
DM2Gain	32
Kii	33
DM2F0	35
VelCmd2	36
VelCmdA	37
HSTemp	38
IU	39
IV	40
IW	41

IqCmd	42
VBusThresh	43
Vbus	44
AccelLmt	45
DecelLmt	46
VelLmtHi	48
VelLmtLo	49
B1	50
B2	51
K1	52
K2	53
ARZ0	54
ARZ1	55
EncInF0	56
ItThreshA	83
VBusFTime	84
CmdGain2	90
ZeroSpeedThresh	91
DigitalCmdFreq	94
Move0RunSpeed	95
Move0AccelRate	96
Move0DecelRate	97
Move1RunSpeed	98
Move1AccelRate	99
Move1DecelRate	100
Move2RunSpeed	101
Move2AccelRate	102
Move2DecelRate	103
Move3RunSpeed	104
Move3AccelRate	105
Move3DecelRate	106
Move4RunSpeed	107
Move4AccelRate	108
Move4DecelRate	109
Move5RunSpeed	110
Move5AccelRate	111
Move5DecelRate	112
Move6RunSpeed	113
Move6AccelRate	114
Move6DecelRate	115

Move7RunSpeed	116
Move7AccelRate	117
Move7DecelRate	118
ActiveRunSpeed	119
ActiveAccelRate	120
ActiveDecelRate	121
IntgStopThresh	122
I2tThresh	123
I2tF0	124
I2tFilt	125
AnalogILmt	126
AnalogILmtGain	127
AnalogILmtFilt	128
AnalogILmtOffset	129
ActualILmtPlus	130
ActualILmtMinus	131

Values for InpMapX (10066-10071)

Convert value from hex to decimal for Serial ASCII Protocol

No_Function	0x0000
Fault_Reset_Inp_Hi	0x8001
Fault_Reset_Inp_Lo	0x0001
RunStop_Inp_Hi	0x8002
RunStop_Inp_Lo	0x0002
Enable2_Inp_Hi	0x8003
Enable2_Inp_Lo	0x0003
VelCmdSrc_Inp_Hi	0x8004
VelCmdSrc_Inp_Lo	0x0004
CW_Inhibit_Inp_Hi	0x8005
CW_Inhibit_Inp_Lo	0x0005
CCW_Inhibit_Inp_Hi	0x8006
CCW_Inhibit_Inp_Lo	0x0006
AInNull_Inp_Hi	0x8007
AInNull_Inp_Lo	0x0007
PosBlk_Select_Inp_Hi	0x8008
PosBlk_Select_Inp_Lo	0x0008
CmdGain_Select_Inp_Hi	0x8009
CmdGain_Select_Inp_Lo	0x0009
Start_Move_Inp_Hi	0x800A
Start_Move_Inp_Lo	0x000A
Move_Select_Bit0_Inp_Hi	0x800B
Move_Select_Bit0_Inp_Lo	0x000B
Move_Select_Bit1_Inp_Hi	0x800C
Move_Select_Bit1_Inp_Lo	0x000C
Move_Select_Bit2_Inp_Hi	0x800D
Move_Select_Bit2_Inp_Lo	0x000D
Gearing_On_Inp_Hi	0x800E
Gearing_On_Inp_Lo	0x000E
Home_Switch_Inp_Hi	0x800F
Home_Switch_Inp_Lo	0x000F

Values for OutMapX (10072-10075)

Convert value from hex to decimal for Serial ASCII Protocol

No_Function	0x0000
Fault_Out_Hi	0x8001
Fault_Out_Lo	0x0001
Enabled_Out_Hi	0x8002
Enabled_Out_Lo	0x0002
Brake_Out_Hi	0x8003
Brake_Out_Lo	0x0003
MechRev_Out_Hi	0x8004
MechRev_Out_Lo	0x0004
ElecRev_Out_Hi	0x8005
ElecRev_Out_Lo	0x0005
Zero_Speed_Out_Hi	0x8006
Zero_Speed_Out_Lo	0x0006
Excess_PosErr_Out_Hi	0x8007
Excess_PosErr_Out_Lo	0x0007
Move_Done_Out_Hi	0x8008
Move_Done_Out_Lo	0x0008

Values for Pre-defined Move Types

(10092, 10099, 10106, 10113, 10120, 10127, 10134, 10141, 10148

Move_Type_None	0
Move_Type_Velocity	1
Move_Type_Incremental	2
Move_Type_Absolute	3
Move_Type_Home	4
Move_Type_Incr_Reg	5
Move_Type_Abs_Reg	6

Values for Homing Moves

(10098, 10105, 10112, 10119, 10126, 10133, 10140, 10147, 10154)

Home_Mode_Switch	0
Home_Mode_Marker	1
Home_Mode_Switch_And_Marker	2
Home_Mode_Present_Position	3

Values for CommSrc

(Communication Source, 10063)

Commsrc_Resolver	0
Commsrc_Encoder	1
Commsrc_Hall_Encoder	2

Values for DriveStatus

(DriveStatus, 10180)

DriveStatus_Unconfigured	0
DriveStatus_Faulted	1
DriveStatus_Enabled	2
DriveStatus_Disabled	3

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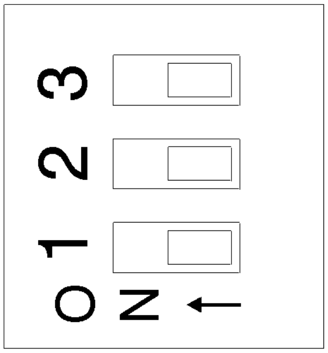
3. PCE840

The PCE840 SERCOS contains all the hardware and firmware necessary to connect to a SERCOS network. Wire the PCE840 according to the Wiring Diagram on page 1-3. This section defines switch settings and lists the SERCOS IDNs the PCE840 supports.

3.1. Setting up Intensity and Baud Rate Using SW4

Definition Switch SW4 is used to select the SERCOS baud rate and the fiber optic light intensity (power level).

Switch SW4 The following diagram shows the location of switch S4.



Intensity Level

SW4-1	Fiber Optic Light Intensity Level
ON	High power transmission
OFF	Low power transmission (default)

Baud Rate

Baud Rate	SW4-2	SW4-3
2 Mbaud (default)	OFF	OFF
4 MBaud	OFF	ON
8 MBaud	ON	OFF
16 MBaud	ON	ON

3.2. Setting up Serial Addresses Using Switches SW5 and SW6

Definition

The two hexademical rotary switches SW5 and SW6 are used to set the axis address for each PCE840 on the SERCOS ring.

Procedure

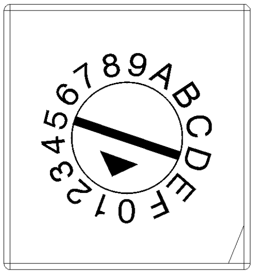
The following diagram shows the location of switch SW5 and SW6. The view shows the location of the switches looking at the front of the PCE840.

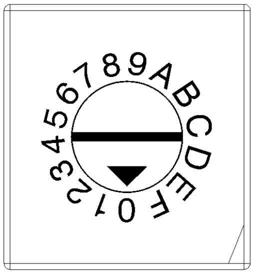
Each PCE840 must have a unique serial address.

Switch SW5 and SW6

The diagram below shows the SW5 and SW6 switch settings.

The 8-bit address consists of two hexadecimal digits. The low and high digits are determined by the position of SW5 and SW6.





The axis address is set to 1 by default at the factory.

Procedure

1. Remove power from the PCE840 servocontroller.
2. Refer to the table below to set the PCE840 to the appropriate address.

Address Table

Address	SW6	SW5	Address	SW6	SW5
0*	0	0	18	1	2
1	0	1	19	1	3
2	0	2	20	1	4
3	0	3	21	1	5
4	0	4	22	1	6
5	0	5	23	1	7
6	0	6	24	1	8
7	0	7	25	1	9
8	0	8	26	1	A
9	0	9	27	1	B
10	0	A	28	1	C
11	0	B	29	1	D
12	0	C	30	1	E
13	0	D	31	1	F
14	0	E	32	2	0
15	0	F	…	…	…
16	1	0	…	…	…
17	1	1	255*	F	F

*Repeater Application Only
**Not Allowed for SERCOS Applications

3. Re-connect power to the PCE840.
4. Repeat steps 1 through 4 for other units on the ring. Make sure to give the other units unique addresses.

3.3. Identification Numbers (IDNs)

Introduction

This is the list of SERCOS IDNs which are supported by the PCE840. For additional information on each IDN please consult a SERCOS specification or Section 3.8, IDN Attributes.

List of supported IDNs

1	Control Unit Cycle Time (TNcvc)
2	Communication Cycle Time (Tscvc)
3	Shortest AT Transmission Starting Time (T1min)
4	Transmit/Receive Transition Time (TATMT)
5	Minimum Feedback Processing Time (T4min)
6	AT Transmission Starting Time (T1)
7	Feedback Acquisition Capture Point (T4)
8	Command Value Valid Time (T3)
9	Position of Data Record in MDT
10	Length of Master Data Telegram
11	Class 1 Diagnostic
14	Interface Status
15	Telegram Type Parameter
16	Configuration List of AT
17	IDN List of all Operation Data
18	IDN List of Operation Data for CP2
19	IDN List of Operation Data for CP3
21	IDN List of Invalid Operation Data for CP2
22	IDN List of Invalid Operation Data for CP3
24	Configuration List of the MDT
25	IDN List of all Procedure Commands
28	MST Error Counter
29	MDT Error Counter
30	Manufacturer Version
32	Primary Operation Mode
36	Velocity Command Value
40	Velocity Feedback Value
41	Homing Velocity
42	Homing Acceleration
43	Velocity Polarity Parameter
44	Velocity Data Scaling Type
45	Velocity Data Scaling Factor
46	Velocity Data Scaling Exponent
47	Position Command Value
51	Position Feedback Value 1 (Motor Feedback)

IDNs (continued)

52	Reference Distance 1
55	Position Polarity Parameter
76	Position Data Scaling Type
77	Linear Position Data Scaling Factor
78	Linear Position Data Scaling Exponent
79	Rotational Position Resolution
80	Torque Command Value
82	Positive Torque Limit Value
83	Negative Torque Limit Value
84	Torque Feedback Value
85	Torque Polarity Parameter
88	Receive to Receive Recovery Time (TMTSY)
89	MDT Transmission Starting Time (T2)
90	Command Value Proceeding Time (TMTSG)
95	Diagnostic Message
96	Slave Arrangement
99	Reset Class 1 Diagnostic
100	Velocity Loop Proportional Gain (KVP)
101	Velocity Loop Integral Action Time (KVI)
103	Modulo Value
104	Position Loop Kv Factor (KPP)
106	Current Loop Proportional Gain 1 (KIP)
107	Current Loop Integral Action Time 1 (KII)
110	Amplifier Peak Current
127	Communications Phase 3 Transition Check
128	Communications Phase 4 Transition Check
129	Manufacturer Class 1 Diagnostic
130	Probe Value 1 Positive Edge
131	Probe Value 1 Negative Edge
132	Probe Value 2 Positive Edge
133	Probe Value 2 Negative Edge
140	Controller Type
142	Application Type
143	SYSTEM Interface Version
147	Homing Parameter
148	Drive-Controlled Homing Procedure Command
159	Monitoring Window
160	Acceleration Data Scaling Type
161	Acceleration Data Scaling Factor
162	Acceleration Data Scaling Exponent

IDNs (continued)

169	Probe Control Parameter
170	Probing Cycle Procedure Command
185	Length of the Configurable Data Record in the AT
186	Length of the Configurable Data Record in the MDT
187	IDN List of Configurable data in the AT
188	IDN List of Configurable data in the MDT
189	Following Distance (PosErrorMax)
192	IDN List of Backup Operation Data
263	Load Working Memory Procedure Command
264	Backup Working Memory Procedure Command
301	Allocation of Realtime Control Bit 1
303	Allocation of Realtime Control Bit 2
305	Allocation of Realtime Status Bit 1
307	Allocation of Realtime Status Bit 2
400	Home Switch
401	Probe 1
402	Probe 2
403	Position Feedback Value Status
405	Probe 1 Enable
406	Probe 2 Enable
409	Probe 1 Positive Latched
410	Probe 1 Negative Latched
411	Probe 2 Positive Latched
412	Probe 2 Negative Latched
32800	DSP Debug Address
32801	DSP Debug Word
32802	DSP Debug Dword
32803-32806	ARM Debug Variables
32807	Pole Count
32809	Filter Value for ADF0
32810	DM1F0
32811	DM2F0
32812	DM1Gain
32813	DM2Gain
32814	DM1Map - Mux Select
32815	DM2Map - Mux Select
32816	EncOut (Encoder Output)
32817	InpMap1
32818	InpMap2
32819	InpMap3

IDNs (continued)

32820 InpMap4
32821 InpMap5
32822 InpMap6
32823 EncInFilt
32824 RemoteFB
32826 CommOff
32827 EncMode
32828 EncIn (Encoder Input)
32829 ITThresh
32830 StopTime
32831 VBusThresh
32832 VelLmtHi
32833 VelLmtLo
32835 CoastTime
32836 CommEnbl
32837 Motor 1 Name
32838 Motor 2 Name
32840 Kvff
32841 ARZ0
32842 ARZ1
32843 ARF0
32844 ARF1
32845 Firmware version
32846 Encoder Data Scaling Method
32847 Encoder Modulo Value
32853 CommSrc (Commutation Source)
32857 ResPos (Resolver Position)
32858 Last Fault
32859 Last ExtFault
32860 OutMap1
32861 OutMap2
32862 OutMap3
32863 OutMap4
32866 Analog Input Voltage Offset (ADOffset)
32870 I^2*t Motor Protection Threshold Value (I^2*tFilt)
32871 I^2*t Motor Protection Low Pass Filter Value (I^2tF0)
32872 I^2*t Motor Current Value
32875 State of Hall Sensors (HallState)
32876 Offset Angle for Hall Sensors (HallOffset)
32878 Digital Command Counts (DigitalCmd)

IDNs (continued)

32879 Digital Command Frequency (DigitalCmdFreq)
32880 AnalogOut1
32881 AnalogOut2
32882 Analog Current Limit Value (AnalogILmt)
32883 Analog Current Limit Gain (AnalogILmtGain)
32884 Analog Current Limit Filter (AnalogILmtFilt)
32885 Analog Current Limit Offset (AnalogILmtOffset)
32886 Actual Positive Current Limit (ActualILmtPlus)
32887 Actual Negative Current Limit (ActualILmtMinus)
34817 PCE840 Input Bit #1
34818 PCE840 Input Bit #2
34819 PCE840 Input Bit #3
34820 PCE840 Input Bit #4
34821 PCE840 Input Bit #5
34822 PCE840 Input Bit #6
34824 PCE840 Input Port (Inputs)
34825 AnalogIn
34826 EncPos (Encoder Position)
34833 PCE840 Output Bit #1
34834 PCE840 Output Bit #2
34835 PCE840 Output Bit #3
34836 PCE840 Output Bit #4
34840 PCE840 Output Port (Outputs)

3.4. System Startup, Configuration and Updates

This section outlines the minimum steps required to bring the PCE840 to phase 4 and how to use 800TOOLS to help minimize setup time. This section also describes how to use the NV functionality available on the drive and how to update the firmware using 800TOOLS.

3.4.1. Bringing the Ring to Phase 4

The PCE840 has been designed to work with all SERCOS-compliant masters. The PCE840 has been tested with several SERCOS masters. Please contact applications engineering for an up-to-date list. This section assumes a SERCOS-compliant master is being used and the following items are avaialable.

- PCE840 Servo Drive
- Appropriate Brushless Motor with nothing attached to the shaft
- PC Running Windows 95/98 or WindowsNT
- 800TOOLS CD
- Motor Power and Feedback Cables (TB1, J3)
- RS-232 Communications Cable (J1)
- DB-44 Connector Mate (J2)
- SERCOS compliant controller.
- SERCOS fiber optic cables (2)
- AC Power Line (480VAC and or 240VAC and or 120VAC)

The steps below outline the minimum requirements for bringing the ring to phase 4. These steps assume a SERCOS compliant master is being used.

1. Set the appropriate baud rate, axis address and transmission level as outlined in Section 3.1, Setting up Intensity and Baud Rate Using SW4.
2. Connect the fiber optic transmitter and receiver to the master.

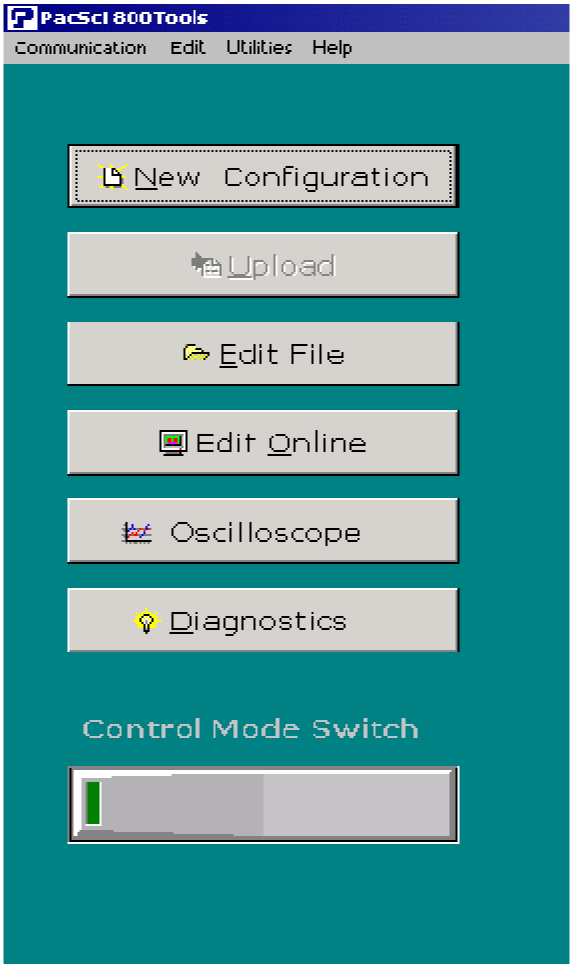
On the PCE840 the light gray connector is the transmitter and dark gray is the receiver.

3. Connect the motor power and feedback cables to both the motor and drive.
4. Connect either 120VAC or 240VAC to TB1-1 and TB1-2 on the PCE840 and 120,240 or 480VAC single or 3 phase to to TB1-3,4 and 5 and apply power to the drive.
5. After going through the boot up sequence, the status display on the drive should display a solid 0 and the green LED should be flashing.
6. At this point, the SERCOS master should be able to initiate a phase run-up to phase 2. Refer to the master documentation for information regarding phase run-up.
7. The status display on the PCE840 should be a solid 2 if the phase run-up was successful.
8. Once the drive is in phase 2, proceed to Section 3.4.2, 800TOOLS PCE840 Setup

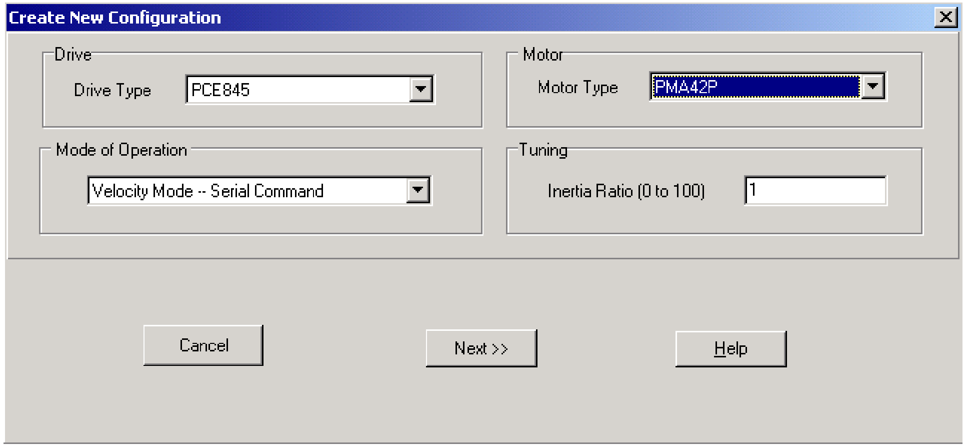
3.4.2. 800TOOLS PCE840 Setup

Although a serial interface is not required to configure and run the PCE840 as a SERCOS slave, the serial interface can be used as both a diagnostics tool and to greatly reduce setup time. Using 800TOOLS, the PCE840 can be configured as either a Torque or Velocity controller. Once configured, motor functionality, tuning and I/O can all be tested with 800TOOLS

1. Install and run 800Tools and the following screen is displayed.



2. Since the drive can only be controlled by one master at a time you need to click on the control mode switch to switch from SERCOS to serial mode. The status bar on the bottom of the 800TOOLS screen indicates the current mode.
3. Once the serial control mode has been selected, click **New Configuration** and the following screen should be displayed.


Create New Configuration

Drive Type: PCE845

Motor Type: PMA42P

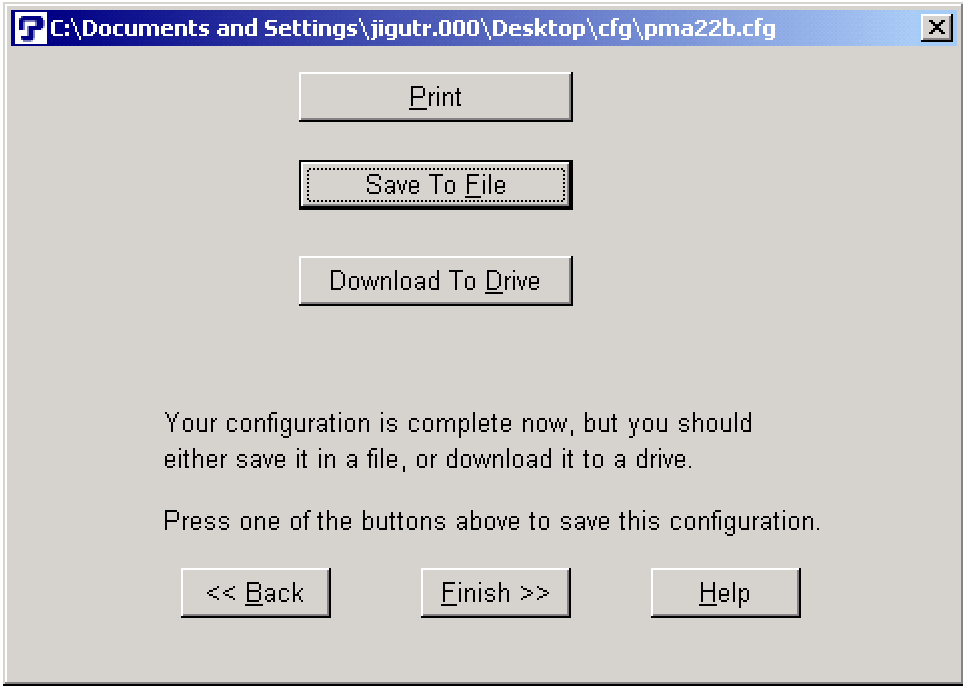
Mode of Operation: Velocity Mode -- Serial Command

Inertia Ratio (0 to 100): 1

4. There is no profile generator in the PCE840. Therefore, there are no positioning modes available.

5. Select the appropriate **Drive Type**, **Mode of Operation** (use **Velocity Mode – Serial Command**) and **Motor Type**. Use an unloaded motor and set the Inertia Ratio to 0.

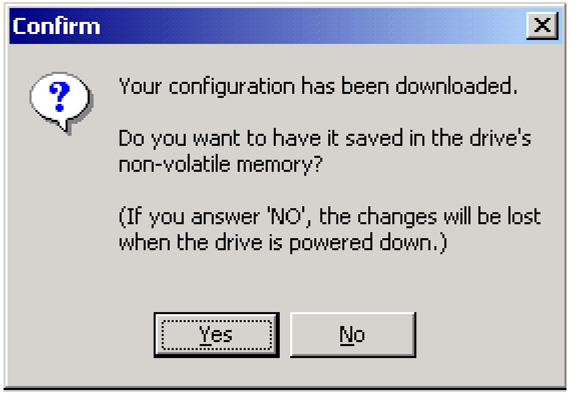
6. Continue by clicking **Next** until the following screen is displayed.


C:\Documents and Settings\jigutr.000\Desktop\cfg\pma22b.cfg

Your configuration is complete now, but you should either save it in a file, or download it to a drive.

Press one of the buttons above to save this configuration.

7. Select **Download To Drive**. Upon completion of the download, the following screen is displayed.

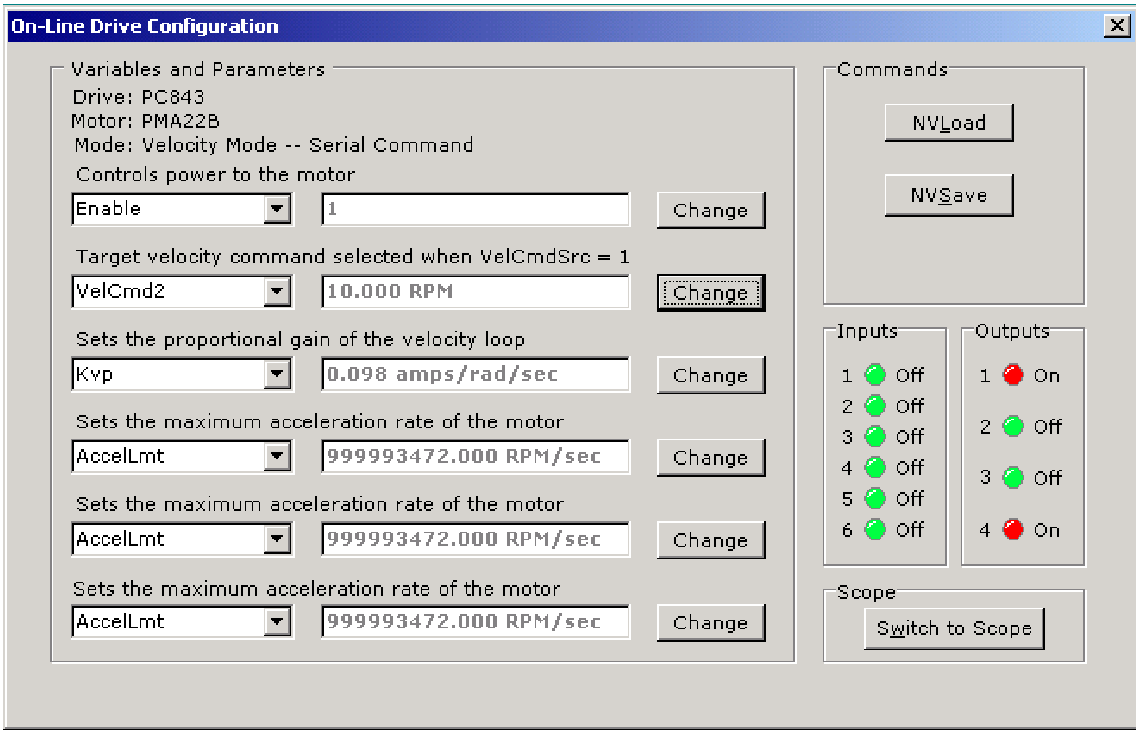

Confirm

Your configuration has been downloaded.

Do you want to have it saved in the drive's non-volatile memory?

(If you answer 'NO', the changes will be lost when the drive is powered down.)

8. Click **No**.
9. Click **Finish** on the next screen. At this point, the main 800TOOLS screen should be displayed. The default tuning parameters for the unloaded motor have now been downloaded to the drive.
10. Select **Edit Online** and the following screen is displayed.


On-Line Drive Configuration

Variables and Parameters
Drive: PC843
Motor: PMA22B
Mode: Velocity Mode -- Serial Command

Controls power to the motor
Enable: 1

Target velocity command selected when VelCmdSrc = 1
VelCmd2: 10.000 RPM

Sets the proportional gain of the velocity loop
Kvp: 0.098 amps/rad/sec

Sets the maximum acceleration rate of the motor
AccelLmt: 999993472.000 RPM/sec

Sets the maximum acceleration rate of the motor
AccelLmt: 999993472.000 RPM/sec

Sets the maximum acceleration rate of the motor
AccelLmt: 999993472.000 RPM/sec

Inputs	
1	Off
2	Off
3	Off
4	Off
5	Off
6	Off

Outputs	
1	On
2	Off
3	Off
4	On

11. Assert the hardware enable on the drive and in the variables screen select and set the software enable to 1.
12. If both the software and hardware enables have been set the green status LED on the PCE840 should be ON.
13. Select **VelCmd2** in the variables screen and set it to a non 0 value.

Performing this step causes motion.

14. If the motion command is successful, switch the control mode back to SERCOS control and bring the ring to phase 4.

The PCE840 requires that certain IDNs (The list is contained in IDN 18) be written for a succesful phase 2 to phase 3 transition. This list currently contains 10 IDNs, which are:

1
2
6
7
8
9
10
15
32
89

The master typically handles setting this list except for IDN 15 and IDN 32. IDN 15 and IDN 32 need to be set by the master in phase 2 before a phase 2 to phase 3 transition can be initiated.

15. Once in phase 4, the parameters that had been previously set with 800Tools and IDN 15 and 32 can all be saved to non-volatile memory. This can be accomplished by writing a 3 to IDN 264, which runs the NVSave procedure command.

16. At this point, the SERCOS master configuration or initialization file(depending on the master being used) can be configured to include only IDN 263 (NVLoad). Cycling power on the drive and writing a 3 IDN 263 in phase 2 enables the NVLoad procedure command that loads the previously-saved parameters.

17. If additional parameters (IDNs) need to be saved to NV memory (refer to IDN 192 for a complete list), bring the ring to phase 4. Set the IDNs to the desired value and perform an NVSave (write a 3 to IDN 264 to initiate the NVSave procedure command). Once the parameters have been saved, cycling power or reseting the ring loads the latests saved parameters, provided an NVLoad(IDN 263) is called in phase 2.

3.4.3. C840 Flash (F/W) Update

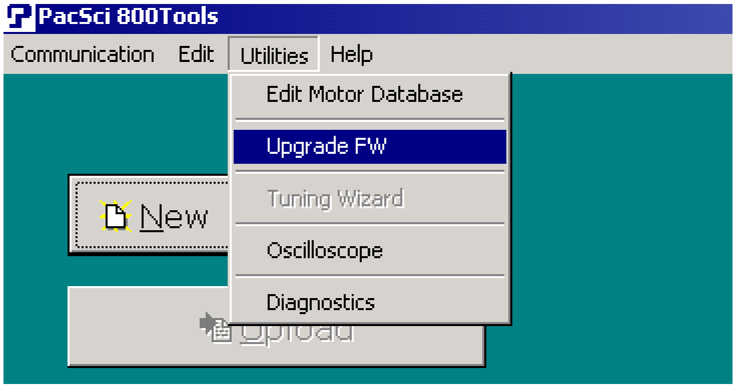
This section explains the steps required to update the SERCOS firmware in the PCE840 drive.

Requirements for performing a Flash update on the drive.

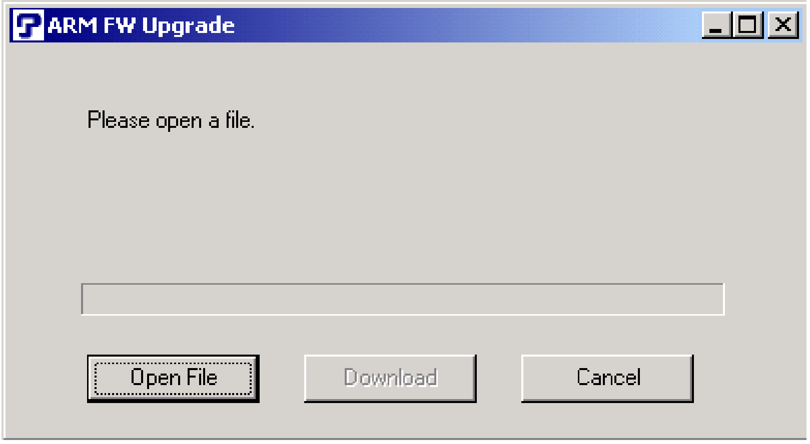
- PC running 800TOOLS
- RS232 cable (pins 2,3 and 5 wired straight through)
- .BIN file containing the latest PCE840 flash.

Steps required

1. Copy the updated BIN file to a directory on the PC that's running 800TOOLS.
2. Set the rotary switches on the drive to address 255 (FF).
3. Cycle power on the drive.
4. After cycling power the status display on the drive should spell out upgrade flash and then display a blinking U until the download is started.
5. Run 800Tools and select **Upgrade FW** from the **Utilities** pull-down menu (shown below).

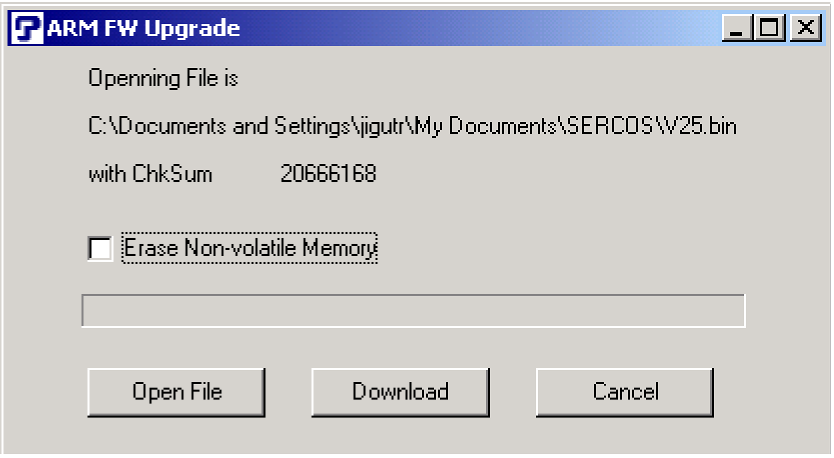


6. Select **Open File** and locate the appropriate .BIN file to download.



Please open a file.

7. After the file has been opened, the following window appears.



Openning File is

C:\Documents and Settings\jigutr\My Documents\SERCOS\V25.bin

with ChkSum 20666168

☐ Erase Non-volatile Memory

8. If you check **Erase Non-volatile Memory**, all previously-saved Non-volatile parameters are lost.

If the upgraded firmware is known to contain changes (scaling, etc.) that have an effect on the NV IDNs, it is recommended that the Non-volatile memory be erased and then saved after the firmware upgrade is complete.

9. Click **Download** to begin the download. The download will take approximately 6 minutes. The status bar will show the progress of the download. When complete, the display on the PCE840 will show a small d (for done).
10. Once the download is complete, return the rotary switches to the desired address and cycle power on the drive.
11. If the Non-volatile parameters where cleared during the download, you can begin at the start of this section for a step-by-step procedure on how to configure and save parameters to the Non-volatile memory on the PCE840.

3.5. Interfaces and Connections

This section describes all the connections to the PCE840 and provides the information required to interface to it.

In the list below, an overbar on a signal name means that the signal is active low logic. For example, $\overline{\text{Fault}}$ indicates the drive is faulted when it is pulled low.

Earth Ground Chassis Ground, M4 x 12 screw with flat and lock washer.

3.5.1. Power Board Connector

TB1 **13 Position Terminal Strip**

Pin	Label	Description
TB1-1	L1C	120/240VAC Control Power
TB1-2	L2C	120/240VAC Control Power
TB1-3	PE	Chassis Ground
TB1-4	L1	380/400/480VAC (Input)
TB1-5	L2	380/400/480VAC (Input)
TB1-6	L3	380/400/480VAC (Input)
TB1-7	+B	+ Bus
TB1-8	R	Regen Transistor
TB1-9	-B	- Bus
TB1-10	PE	Chassis Ground
TB1-11	U	Motor Phase U
TB1-12	V	Motor Phase V
TB1-13	W	Motor Phase W

AC Power

**L1C, L2C (TB1-1, 2)
120VAC / 240VAC
Control Power**

These terminals connect the 120/240 VAC power provided by the user to the drive's control voltage power supply.

Control power L1C, L2C (TB1-1,2) are NOT connected internally to bus power L1, L2 (TB1-4,5).

The control voltage for the PCE840 controllers is input to a switching power supply. This input accepts voltages ranging from 85VAC to 265VAC.

Chassis Ground

PE (TB1-3)

Convenience connector point for the user to connect the drive's control power and bus power to protective earth ground. This pin is directly connected to the chassis and thus to the Chassis Ground Stud. Local electrical code may require using the Earth Ground Chassis stud for this function.

L1, L2, L3 (TB1-4, 5, 6)
380VAC/400VAC/480VAC

These terminals connect the balanced, three-phase 380/400/480 VAC power provided by the user to the drive's power output stage bus to drive the motor.

380/400/480 VAC three-phase mains **MUST** be WYE type with **earthed neutral** for PCE840 to be compatible with CE safety standard EN50178. Earthed neutral WYE-type mains are strongly recommended for all installations.

Single-phase or lower voltage operation is possible for short periods of time to support installation or testing.

Regeneration Interface

+B, R, -B (TB1-7, 8, 9)
+Bus, Regen Resistor, - Bus

These terminals provide the connection points for a resistor to absorb regenerated energy from the motor. A regeneration resistor goes from +B to R. In the PCE843, if a regeneration resistor is not needed, (see Section 6, Using External Regen), +B and R are open. In the PCE845, an internal regen resistor is factory-wired to +B and R. **-Bus (-B) on TB1-9 is usually left open.**

High Voltage! During normal operation +B, R, and -B operate at the bus power voltages. The PCE840 regen operates at about 800VDC. These are dangerous voltages.

Regen Resistors

The table below lists the recommended values for regen resistors. To order 66Ω, 200W regen resistor from Pacific Scientific, use part number PRK-200-66.

Model	Resistance	Regen Resistor Location	External Regen Resistor
PCE843	66Ω	External	66Ω, ±10%, 200W, 1500V min. isolation
PCE845	33Ω	Internal (factory-wired TB1-7 to TB1-8) 100W	External 400W option (see below)

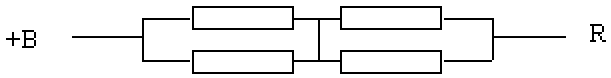
Regen Resistance MUST be in the range as shown below.

Model	Resistance
PC843	60 Ω to 72 Ω
PC845	30 Ω to 36 Ω

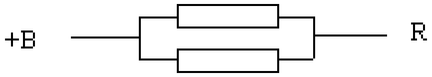
For safety it is recommended that the external resistor be mounted on a grounded panel or use a grounding wire connected to a mounting screw. The terminals of the resistor must not be grounded.

In a few installations, heavy duty regen may be needed. In such cases, it is necessary to increase the regen resistor wattage without changing its ohms. The recommended way to increase regen wattage is shown below:

PCE843 – Wire to +B and R four 66Ω, 200W resistors in series, parallel (66Ω, 800W).



PCE845 – Cut off wires to +B and R from internal regen resistor. Wire to +B and R two 66Ω, 200W resistors in parallel (33Ω, 400W).



Wait 10 minutes after Bus Power is removed for the bus cap voltage to decay to a safe level before touching regen resistor or wiring. The voltage on the bus caps can be monitored with a voltmeter from +BUS (TB1-7) to -BUS (TB1-9).

Motor Power

PE (TB1-10)
Motor Case Ground

This termination provides a convenient point for the motor ground connection and motor power wire shield. Local electrical code may require using the Earth Ground Chassis stud for this function.

U, V, W (TB1-11, 12, 13)
Motor Phase

These three terminations provide the 3-phase power output to the brushless motor. Observe motor polarity on these connections. For example, connect U on the drive to U on the motor.

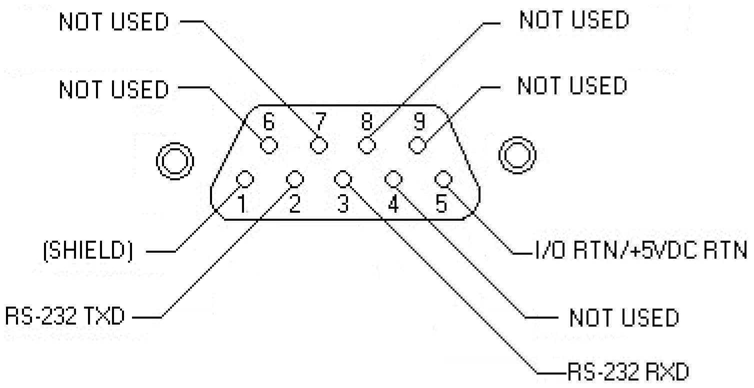
3.5.2. Serial Port

J1

The serial port (J1), utilizes the 9 contact female D subminiature style connector shown below. A brief description of each signal is included in the J1 I/O table on following page. For additional information, please refer to the Serial Communications Transceiver Schematic at the end of this section.

The figure below illustrates the pin-out for the 9-pin connector. It shows the front view looking at the PCE840.

J1 Diagram



I/O Table

Pin Number	Input/Output	Explanation
J1-1	Shield	Common/shield - serial port interface
J1-2	RS-232 TXD	RS-232 transmitter output (from PCE840)
J1-3	RS-232 RXD	RS-232 receiver input (to PCE840)
J1-4	Not used	
J1-5	I/O RTN/+5VDC RTN	Common serial port interface
J1-6	Not used	
J1-7	Not used	
J1-8	Not used	
J1-9	Not used	

The information provided in this section should be used to connect the PCE840 to your computer for firmware upgrades.

3.5.2.1. RS-232 CONNECTIONS

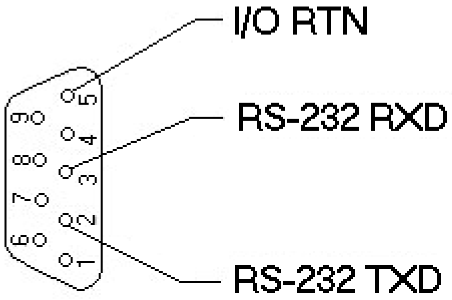
RS-232 Connections

RS-232 connections on J1 are shown below. Cable wiring required for connecting to either 9 or 25 pin serial ports of most computers are also shown.

Pinouts vary among computer manufacturers. Check the hardware reference manual for your machine before wiring.

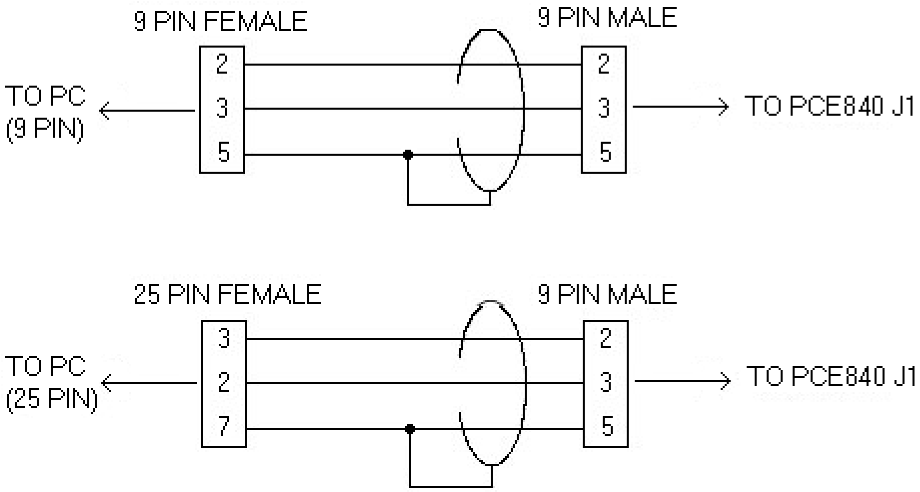
Cabling Diagram

A 6-foot (1.8 m) RS-232 Cable with 9 pin connectors and a 9 pin to 25-pin adapter is available from Pacific Scientific. The Pacific Scientific order number is RS-232-5600.



9 CONTACT FEMALE D SUBMINATURE CONNECTOR

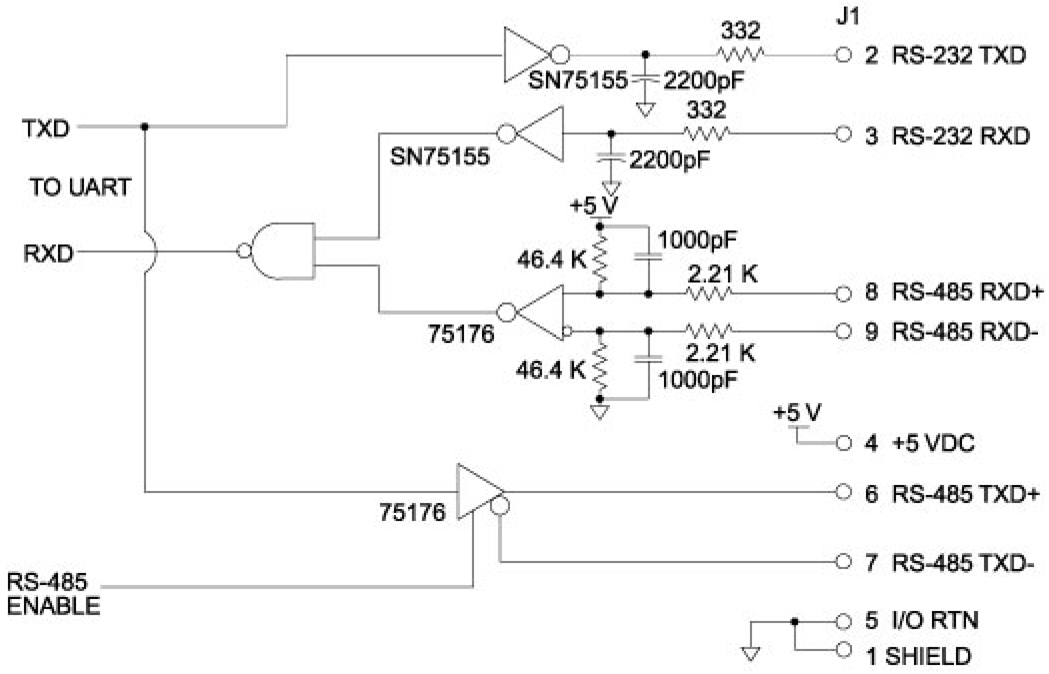
TYPICAL CABLES



Shielded wiring is recommended for the serial communications cable to minimize potential errors from electrical noise.

PCE840 Serial Communications Transceiver Schematic

Installation Diagram

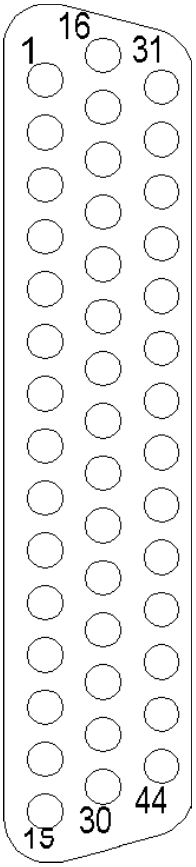


3.5.3. Command I/O

J2 44 Position D subminiature female

Pin	Description	Pin	Description
J2-1	Analog Command Input (+)	J2-23	No Connect
J2-2	Analog Command Input (-)	J2-24	Relay Output (+) (Out4)
J2-3	I/O RTN	J2-25	Relay Output (-) (Out4)
J2-4	Analog Output1 (DACMonitor1)	J2-26	No Connect
J2-5	Analog Output2 (DACMonitor2)	J2-27	No Connect
J2-6	Analog Current Limit Input	J2-28	Analog Input 2
J2-7	I/O RTN	J2-29	Analog Input 3
J2-8	Encoder Output Channel A	J2-30	I/O RTN
J2-9	Encoder Output Channel $\overline{A}$	J2-31	Input 1 (Fault Reset)
J2-10	Encoder Output Channel B	J2-32	Input 2 (CwInh)
J2-11	Encoder Output Channel $\overline{B}$	J2-33	Input 3 (CcwInh)
J2-12	Encoder Output Channel Z	J2-34	Input 4 (Reg1)
J2-13	Encoder Output Channel $\overline{Z}$	J2-35	Input 5 (Reg2)
J2-14	+5VDC (Output)	J2-36	Input 6
J2-15	I/O RTN/ +5VDC RTN	J2-37	Enable Input
J2-16	I/O RTN	J2-38	Input RTN
J2-17	Command Encoder Input Channel A (Step)	J2-39	+24VDC Output RTN
J2-18	Command Encoder Input Channel $\overline{A}$ (Step)	J2-40	+24VDC (Output)
J2-19	Command Encoder Input Channel B (Dir)	J2-41	Out1, 2, 3 Supply (Input)
J2-20	Command Encoder Input Channel $\overline{B}$ (Dir)	J2-42	Out1 ($\overline{\text{Fault}}$)
J2-21	No Connect	J2-43	Out2 ($\overline{\text{Brake}}$)
J2-22	No Connect	J2-44	Out3

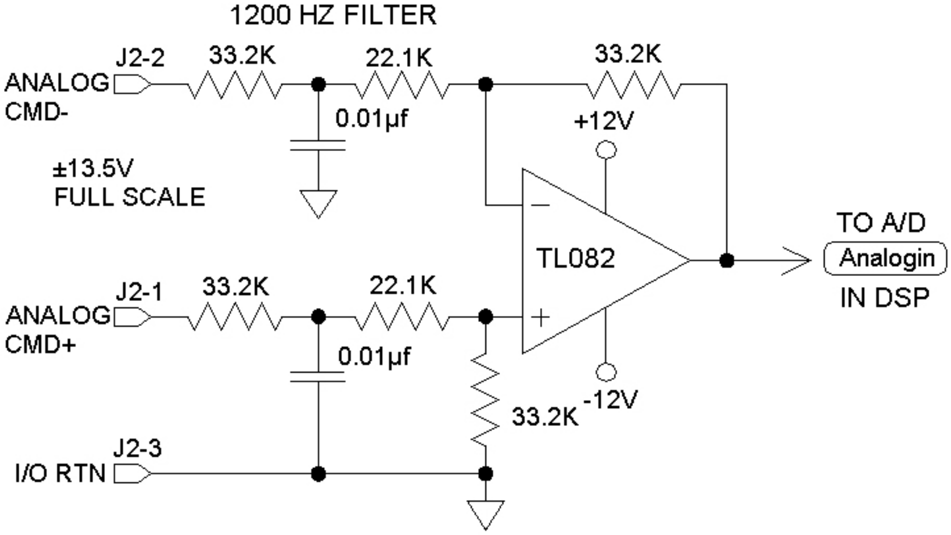
J2 Diagram The figure below illustrates the pin-out for the 44-pin connector. It shows the front view looking at the PCE840.



Command I/O

Analog CMD
J2-1, 2
(+), (-) Inputs

These inputs accept the analog command from the user. This is a differential input to an A/D. It has a maximum single ended input range with respect to I/O RTN on either input of ± 21V and an input impedance of 50 kΩ. The full-scale differential command input range is ± 13.5V. The offset and single pole low pass bandwidth of this signal is adjustable via a software setup parameter. When used as a motion command the gain from this input is also adjustable via a software setup parameter.



Always connect I/O RTN (J2-3) to the signal ground of the source. Failure to do so may result in erratic operation.

I/O RTN
J2-3, 7, 15, 16

This terminal is signal common for the analog and non-optically isolated digital inputs and outputs. These pins are internally connected in the drive.

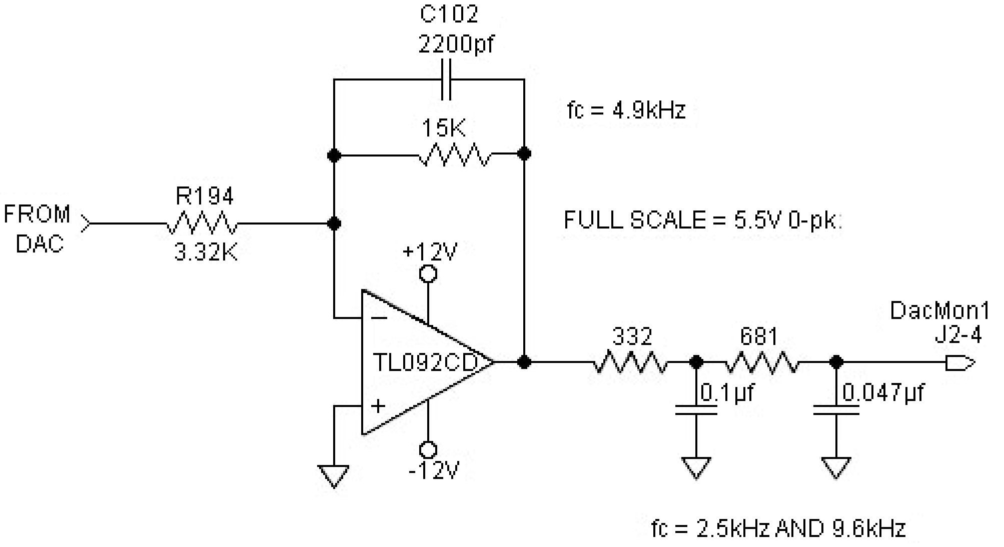
For protection against line surges, one of the I/O RTN pins must be connected to Earth ground. Pacific Scientific recommends making this connection at an earth ground point in the cabinet reserved for single point grounding of all I/O Returns (drives and supplies).

***DAC Monitor* J2-4, 5 1, 2 Outputs**

These analog outputs are general-purpose monitor points. The output range is ±5.5V with a resolution of 11V/65536 = 0.168 mV. The source impedance is 1 kΩ, which yields a maximum short circuit to I/O RTN current of ± 5 mA. These outputs are updated every 250 mS. There is a 2.5 kHz, 4.8 kHz and a 9.6 kHz analog Low Pass Filter on these outputs.

Each DAC Monitor can be mapped by software to be one of a number of internal variables. The scale factor and the frequency of a single low pass filter pole are software adjustable on each output by the DM1Gain, DM1F0 and DM2Gain, DM2F0 software parameters for DAC Monitor 1 and 2 respectively. Variables marked with a “*” are not range clamped and are allowed to wrap around when the signal exceeds the output DAC’s voltage range. The other variables will clamp at maximum when they exceed the analog voltage range. The table on the following page lists the defined signal mappings.

DAC MON



DAC Monitor List Table			
DMxMap	**Variable**	**Description**	**DAC Out Units (DMxGain = 1)**
0	AnalogOutx	Actual Analog Output Command	V/V
1	VelFB	Measured Velocity (DM2 Default)	1 V/kRPM
2	VelCmdA	Actual Velocity Command (VelCmdA)	1 V/kRPM
3	VelErr	Velocity Error	1 V/kRPM
4	FVelErr	Compensated Velocity Error	1 V/kRPM
5	Position	Measured Position*	1 V/Rev
6	PosError	Position Error*	1 V/Rev
7	PosCommand	Commanded Position*	1 V/Rev
8	Icmd	Commanded Torque Current	1 V/A
9	IFB	Measured Torque Current (DM1 Default)	1 V/A
10	AnalogIn	Filtered A/D Input	1 V/V
11	EncFreq	Encoder Frequency	1 V/Hz
12	EncPos	Encoder Position*	10 V/4096 Cnts
13	ItFilt	Filtered Output Current Amplitude	1 V/100%
14	HSTemp	Measured Heat Sink Temperature	1 V/°C
15		Commutation Electrical Angle*	1 V/Cycle
16	IU	Motor Phase U Output Current	1 V/A
17	IV	Motor Phase V Output Current	1 V/A
18	IW	Motor Phase W Output Current	1 V/A
19		Motor Phase U Voltage Duty Cycle	1 V/100%
20		Motor Phase V Voltage Duty Cycle	1 V/100%
21		Motor Phase W Voltage Duty Cycle	1 V/100%
22	VBus	Drive Bus Voltage	1 V/V
23	ResPos	Resolver Absolute Position*	1 V/Rev
24		Commanded non-torque current	1 V/A
25		Measured non-torque current	1 V/A
26		Torque Voltage Duty Cycle	1 V/100%
27		Non-torque Voltage Duty Cycle	1 V/100%
28	VelCmd	Velocity Command (VelCmd)	1 V/kRPM
29	DigitalCmdFreq	Digital Command Frequency	1 V/Hz
30	I^2*t	I^2*t Filtered Current	1 V/%Ipeak^2

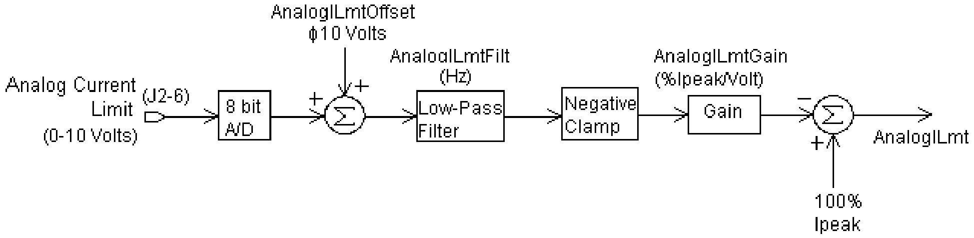
*These variables are allowed to wrap around when the signal exceeds the output voltage range.

Analog Current Limit J2-6

This input limits the current flow to the motor when a voltage is applied with respect to I/O RTN. AnalogIlmtGain must be non-zero, the default is zero.

The analog input is read through an 8 bit A/D converter. The range on the analog input is 0 - 10 volts. AnalogILmtOffset, is added to the voltage read. The sum is then low-pass filtered by AnalogILmtFilt. The filter output is multiplied by a gain, AnalogILmtGain. The input to the multiplier is in volts. The units of AnalogILmtGain are in %Ipeak/volt. And the result is in %Ipeak (percentage of the drive peak output current, see Ipeak). If the result is less than 0, then it is clamped to zero by the negative clamp. The analog current limit, AnalogILmt, is set equal to 100% minus result of the analog input.

The actual (positive and negative) current limits used by the drive are:
ActualILmtPlus = min(ILmtPlus, AnalogILmt)
ActualILmtMinus = max(ILmtMinus, AnalogILmt).



Example:

Assume ILmtPlus = 100%
ILmtMinus = 100%
AnalogILmtOffset = 0 volts
AnalogILmtFilt = 1000 Hz
AnalogILmtGain = 10%/volt

Volts In (J2-6)	AnalogILmt
0	100% - 0% = 100% (full current to motor)
2	100% - 20% = 80%
4	100% - 40% = 60%
8	100% - 80% = 20%
10	100% - 100% = 0% (no current to motor)

Outputs

J2-8, 9, 10, 11
CHAOUT
$\overline{\text{CHAOUT}}$
CH B Out
$\overline{\text{CHBOUT}}$

These two output pairs are differential TTL incremental position signals generated by the Resolver feedback electronics. These outputs are quadrature encoded to emulate an optical encoder. The resolution of these signals, i.e. the emulated line count, is set by the EncOut parameter. These outputs are buffered by 26LS31 type RS-422 compatible line drivers. Maximum recommended load current is ± 20 mA, which corresponds to a minimum line-to-line load resistance of 100 Ω. This drive capacity corresponds to ten RS-422 compatible inputs such as the PCE840 encoder inputs. These outputs are indefinitely short circuit proof to I/O RTN.

J2-12, 13
CH Z OUT
$\overline{\text{CHZOUT}}$

These two terminals function as a differential, TTL marker pulse. The output pulse occurs once per motor shaft revolution starting at resolver position = 0 and its width is approximately one quadrature encoder width. This output comes from a 26LS31 type RS-422 compatible line driver. Maximum recommended load current is ± 20 mA, which corresponds to a minimum line-to-line load resistance of 100 Ω. This drive capacity corresponds to ten RS-422 compatible inputs such as the PCE840 encoder inputs. This output is indefinitely short circuit proof to I/O RTN.

J2-14, J2-15
+5VDC, I/O RTN/
+5VDC RTN

These two connections provide an auxiliary power supply for the user. This output is 5VDC ±5% and is short circuit protected at 1 A nominal. The maximum load limit for all connections to this supply is 250 mA. The +5VDC RTN (J2-15) is connected to I/O RTN (J2-3, J2-7, J2-16, J2-30).

Encoder Inputs

CH A IN, CH $\overline{\text{A}}$ IN, CH B IN, CH $\overline{\text{B}}$ IN,

Step +, Step -, Dir +, Dir -,

Step Up +, Step Up -, Step Dn +, Step Dn -

J2-17, 18, 19, 20

These inputs are used as a quadrature encoder, step and direction, or up and down count format incremental signal source. The decoding mode is set by the EncMode parameter. The scale factor of this incremental position command input is fully adjustable with software parameters. Full decoding speed or more noise immune slow speed decoding is software selectable.

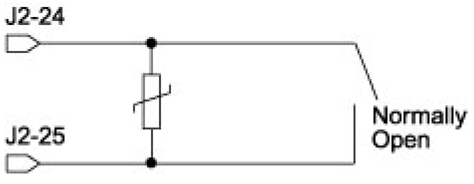
These two input pairs are differential and are detected by 26LS32 type RS-422 compatible line receivers. As differential inputs, the recommended common mode range is < ±7V with respect to I/O RTN and the guaranteed differential voltage logic thresholds are > ±0.2V. Recommended drivers should be able to source and sink 3 mA to/from these inputs. Each of these inputs has internal bias networks to allow easy connection to single ended sources. When an input is open circuited it will bias itself to between 2.2v and 2.5V, thus the remaining input pair terminal will have a single ended guaranteed logic low for inputs < 2.0V and a guaranteed logic high for inputs 2.7V. These levels are compatible with a TTL driver combined with a pull up resistor. Pull up resistor should be 470Ω.

Relay Outputs
J2-24, 25

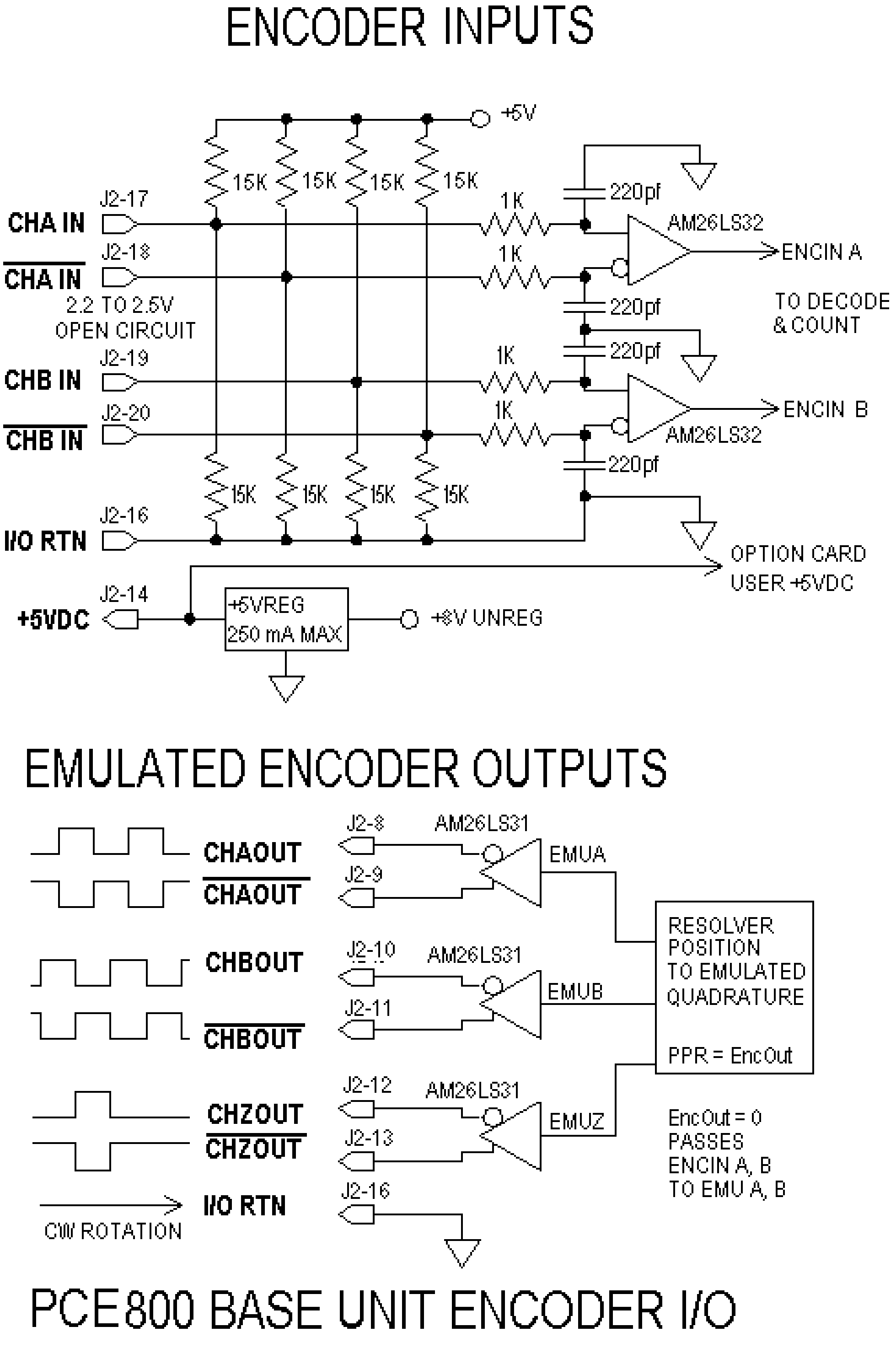
These relay outputs are normally open. They are rated for 1 Amp at 30VDC. These relays may be opened/closed by Out4. When the drive has no control power the relay is open.

$\overline{\text{Brake}}$ Output

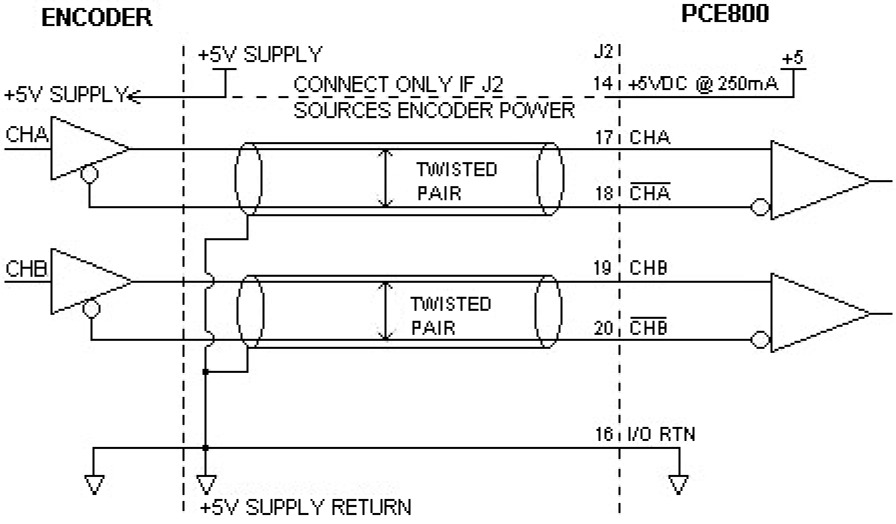
This output is low when the control power is off or when control voltage is on and the drive is disabled (Enable = 0). This output is pulled high otherwise. This output is intended to drive a normally-open relay that, in turn, powers a mechanical brake on the motor shaft for applications that require a positive shaft lock when the servo drive is off.



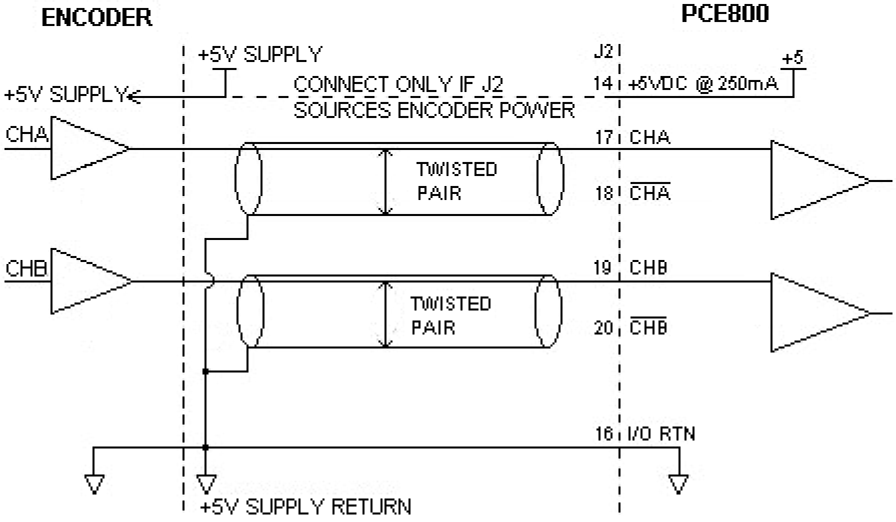
J2 Encoder I/O Interface Schematic



Using TTL differential line drivers



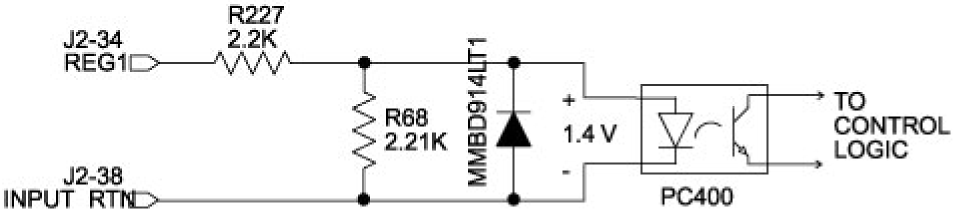
Using TTL single-ended drivers



The list below describes the subset of the available functions and the mappings used as the factory defaults for each of the inputs.

Fault Reset Input	**Input 1**: This input is used to reset the amplifier following a fault. This input is programmed active high so that an open circuited input does not activate the function. During Fault Reset active the output stage is disabled and the reset condition will be held in hardware for approximately 0.1 sec after Fault Reset is returned inactive.
CwInh Input	**Input 2**: This input prevents further motion in the clockwise shaft motion direction. This input is programmed active high so that an open circuited input does not activate the function. If the shaft is already moving in the clockwise direction, then the motor will decelerate to zero velocity with the maximum torque allowed by the user set output current limits. This input will have no effect on motion in the counterclockwise direction. This input is useful for a clockwise over travel limit switch.
CcwInh Input	**Input 3**: Analogous to the CwInh input, except that this input prevents counterclockwise motion.
Reg1 Input	**Input 4**: This high speed input latches motor position within 50 µsec after a transition.
Reg2 Input	**Input 5**: Analogous to Reg1 input.
Input Mapped Off	**Input 6**: Input Mapped Off

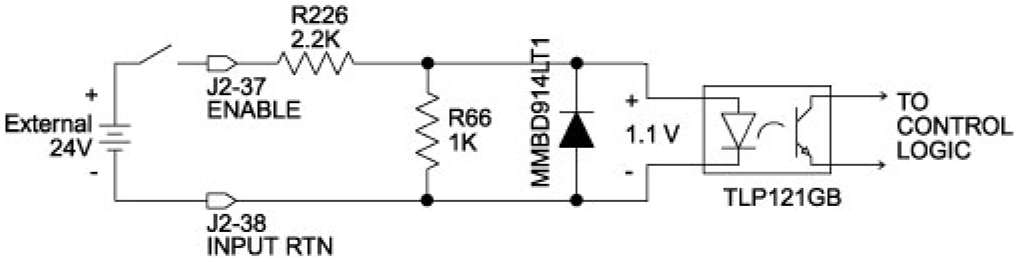
Reg1 Input J2-34



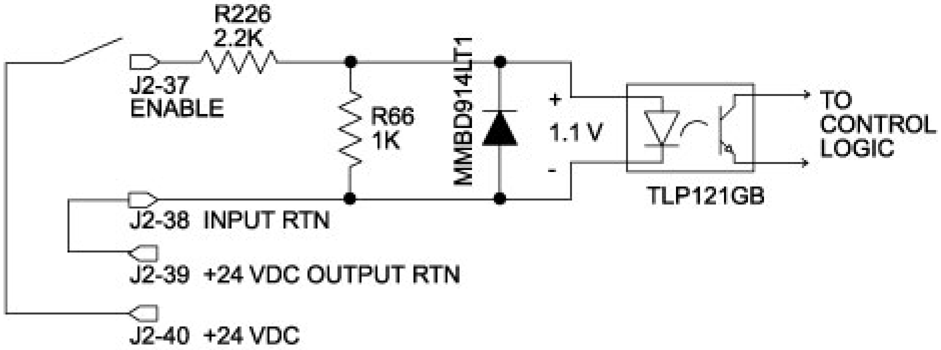
Probe inputs have a 50-µsec latch time.

Enable Input **J2=37**	This optically isolated input is used to enable the drive and is active high. The output stage is disabled when this input is inactive. A minimum drive capability of 4 mA is required. You must supply 10V to 30V to drive this input. This input is filtered with a 1 mSec time constant low pass filter to prevent false triggering from noise. The Enable input shares a floating return (J2-38) with Inputs 1 through 6.

5 V input CANNOT be used.



If the drive's 24V supply is being used, connect as shown below.



Input RTN **J2-38**	This terminal is the floating common return for the six optically isolated digital inputs and the optically isolated Enable input.
+24 VDC RTN, **+24 VDC (Output)** **J2-39, J2-40**	These two connections provide an auxiliary floating power supply for the user. This output is 24VDC ± 10 % and is short circuit protected at 100 mA nominal. The maximum load limit for all connections to this supply is 80 mA. + 24VDC RTN is not connected to Input RTN.
Out1, 2, 3 **Supply (Input)** **J2-41**	The PCE840 requires an external 12VDC - 24VDC power source for the outputs. This power source must be capable of supplying at least 150 mA.

Outputs
J2-42, 43, 44

These optically isolated outputs are current sourcing at 0 to 50 mA maximum. External output supply should be limited to 30V. These outputs are short circuit protected. Current folds back to about 25 mA during a short circuit. The external output supply (J2-41) is shared by the three outputs.

V_{ON}	1.9V at 25 mA 2.25V at 50 mA
I_{OFF}	5 µA
Response time	1 msec
Clamp voltage	40V (nominal)

Each of the outputs is set and written to by software every 2 mSec. Each one can be configured to be any of the available functions and the configuration can be changed on the fly via digital communications. The user's default configuration is stored in the non-volatile memory. The present state of commanded outputs can be read via digital communications. The logic polarity of these signals is also software programmable. That is, an output can be defined to be active low or active high. For edge triggered functions the active edge is programmable.
The list below describes the subset of the available functions and the mappings used as the factory defaults for each of the outputs.

$\overline{\text{Fault}}$ Output

Output 1: This output is low when the drive is faulted or has no control power. This line can be used to indicate a problem with the drive.

Output Mapped Off

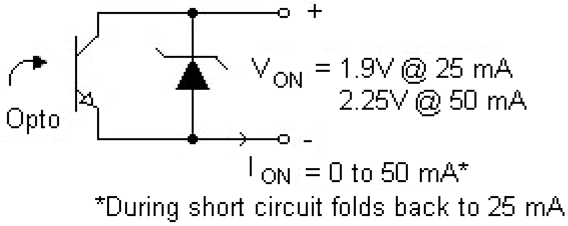
Output 2: Output Mapped Off

Output Mapped Off

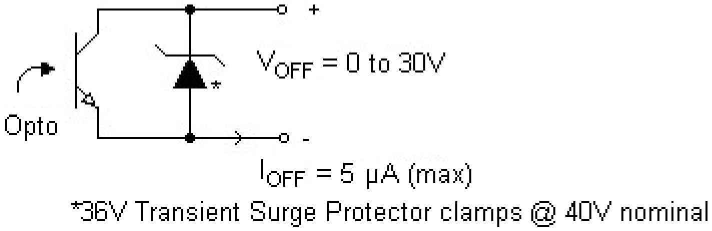
Output 3: Output Mapped Off

Outputs

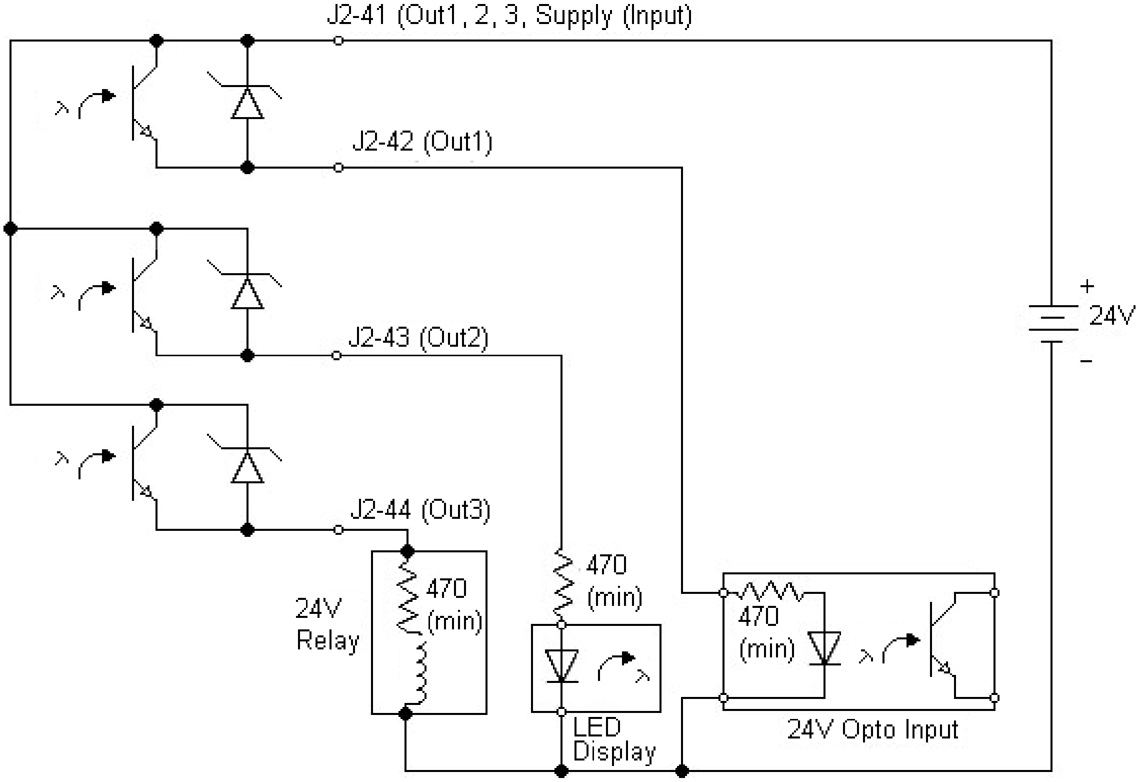
ON State



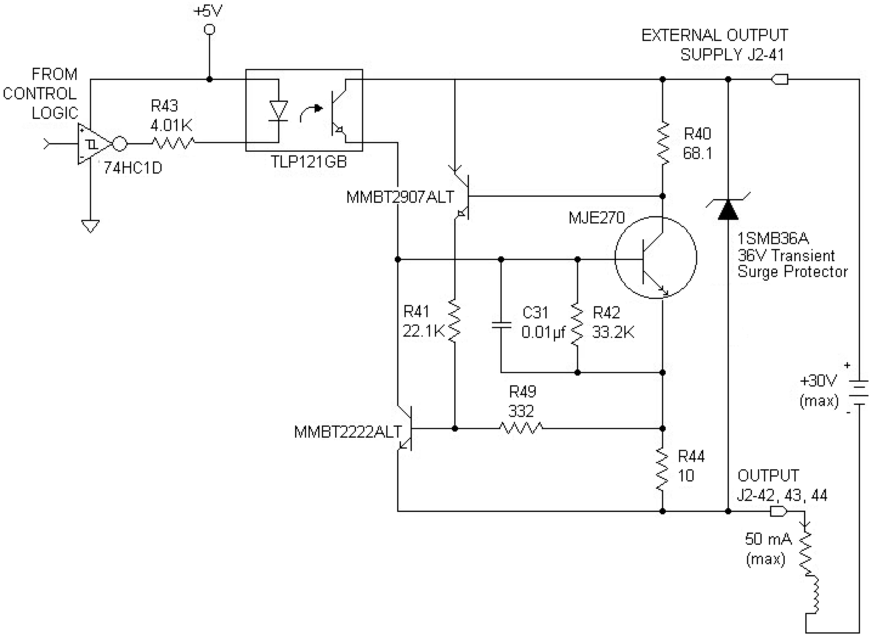
OFF State



Outputs Driving Typical Loads



Output Schematic



3.5.4. Feedback

J3 FEEDBACK 15 Position D subminiature female

Pin	Description
1	RESOLVER S1 SIN + (Input) / Hall 1
2	RESOLVER S3 SIN - (Input) / Hall 2
3	RESOLVER S2 COS + (Input) / Hall 3
4	RESOLVER S4 COS - (Input)
5	SHIELD (I/O RTN)
6	RESOLVER R1 EXCITATION (Output)
7	RESOLVER R2 EXCITATION RTN (Output)
8	MOTOR PTC (Input)
9	MOTOR PTC RTN (Input)
10	+5VDC
11	I/O RTN
12	FEEDBACK ENCODER CHANNEL A (+)
13	FEEDBACK ENCODER CHANNEL A (-)
14	FEEDBACK ENCODER CHANNEL B (+)
15	FEEDBACK ENCODER CHANNEL B (-)

Feedback

Resolver
S1, S2, S3, S4 Inputs
J3-1, 2, 3, 4

These connections provide the inputs for the resolver's sine/cosine outputs. Differential inputs with 75Vμsec common mode impulse range and 25 kΩ input impedance.

This only applies if a Resolver feedback device is being used.

Hall1, Hall2, Hall3
J3-1, 2, 3

These three single-ended hall channel sensor inputs are detected by +5VDC CMOS compatible commutation signals with 60° spacing. These inputs are each internally pulled-up to +5VDC via a 10 kΩ resistor. These input signals are low pass filtered in hardware at 10 kHz.

This only applies if a Hall feedback sensor is being used.

Resolver R1 Excitation,
R2 Excitation RTN
Outputs
J3-6, 7

These connections provide the resolver excitation output. 9.2V rms at 6510.42 Hz 75 mA rms maximum load. These outputs are fully short circuit protected to I/O COMMON or to each other at room temperature (25°C), but at ambient temperatures above 50°C, shorts longer than 5 minutes may cause damage.

Motor PTC, PTC RTN
Inputs J3-8, 9

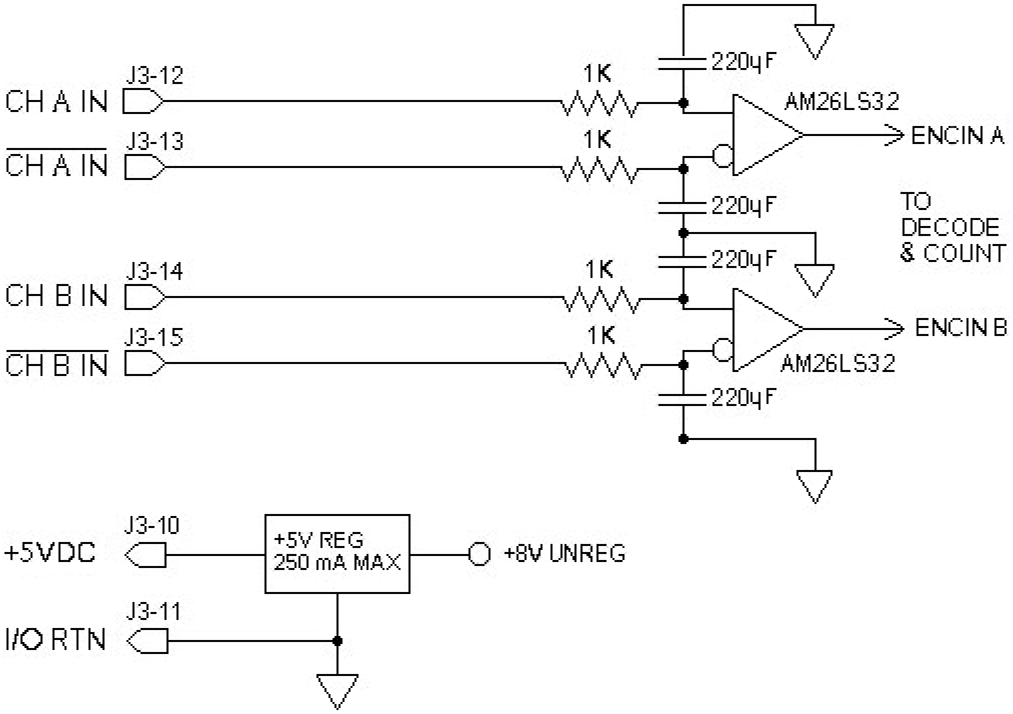
These two inputs are intended to connect to a positive temperature coefficient thermostat or normally closed thermostatic switch imbedded in the motor windings. When the resistance between these terminals becomes greater than 6.2 kΩ the drive will fault and indicate a Motor Over Temperature fault. This circuit directly interfaces with Pacific Scientific's standard motor PTC.

PTC RTN is connected to I/O RTN.

Encoder Inputs
J3-12, 13, 14, 15

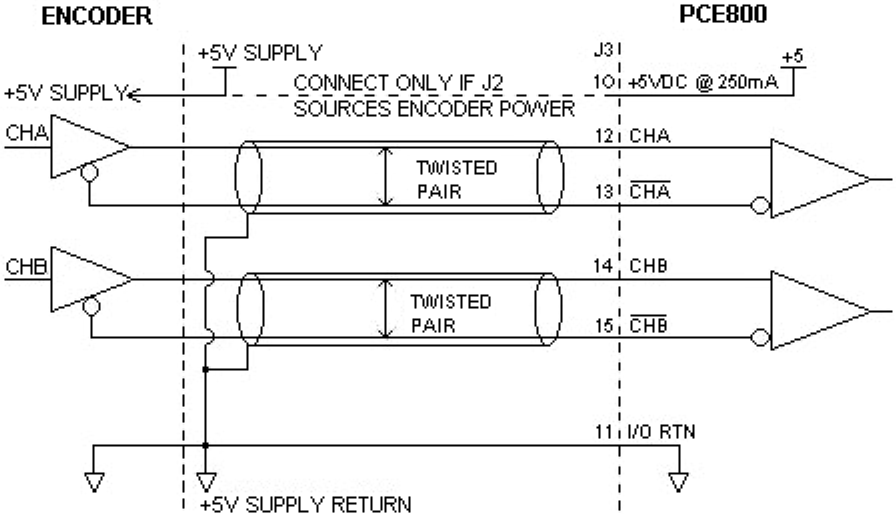
CH A, $\overline{\text{CH A}}$, CH B, $\overline{\text{CH B}}$

These differential inputs expect quadrature encoder feedback signals. These two input pairs are differential and are detected by 26LS32 type RS-422 compatible line receivers. As differential inputs, the recommended common mode range is 7V with respect to I/O RTN and the guaranteed differential voltage logic thresholds are ± 0.2V. Recommended drivers should be able to source and sink > 3 mA to/from these inputs.



An adapter can be powered from the serial port +5VDC output on J1-4 as long as the load current on J1-4, J2-14, and J3-10 total less than 250 mA.

Using TTL Differential Line Drivers



3.6. Inputs and Outputs

The PCE840 has six digital user mappable inputs (J2-31 to J2-36), three digital user mappable outputs (J2-42 to J2-44), and one mappable relay output (J2-24, 25) which are availablefor users to interface to external devices; proximity switch, PLC, LED.

In addition, the PCE840 has one analog input (J2-1, 2) and two analog outputs (J2-4, 5) that can be set to various output functions.

3.6.1. General Purpose Inputs/Outputs

The PCE840 Input and Output pins are optically isolated from the rest of the PCE840 and each other. Below is a table of the applicable IDNs for the PCE840 General Purpose I/O:

IDN(s)	Description	Function
34817-34822	PCE840 Input Bits (1-6)	Read Input Bit (1-6)
34824	PCE840 Input Port	Read Entire Input Port
34833-34836	PCE840 Output Bits (1-4)	Read/Write Output Bits (1-4)
34840	PCE840 Output Port	Read/Write Entire Output Port

Service Channel All of the above IDNs can be read through the SERCOS Service Channel. Reading an input bit would return the value of the bit located in the input port. Reading IDN 34824 would return the value of all the input bits as a single word. Reading an output bit would return the value the PCE840 is attempting to drive on the output pin. Reading IDN 34840 would return the value the PCE840 is attempting to drive on all the output pins.

Example

The PCE840 has 00010101 on its input pins.
The PCE840 is attempting to drive 00001010 on its output pins.
Reading IDN 34824 would return 0x15.
Reading IDN 34817 would return 1 (bit zero - input byte).
Reading IDN 34818 would return 0 (bit one - input byte).
Reading IDN 34821 would return 1 (bit four - input byte).
Reading IDN 34840 would return 0x0A
Reading IDN 34833 would return 0 (bit zero - output byte).
Reading IDN 34834 would return 1 (bit one - output byte).
Reading IDN 34836 would return 0 (bit four - output byte).

Cyclic Channel

The only two PCE840 I/O IDNs that can be placed in the cyclic channel are IDN 34824 (Input Port) and IDN 34840 (Output Port). IDN 34824 (Input Port) can be placed in the AT and returns 2 bytes of data. The AT data would have the input port in the low byte of the return AT data and a zero in the high byte. IDN 34840 (Output Port) can be placed in the MDT and allows the user to write to the output pins once every MST cycle. The low byte of the written data would be placed into the output port, the high byte is ignored.

Realtime Control/ Status

All the input bit IDNs (34817 - 34822) and output bit IDNs (34833 - 34836) can be used through the use of realtime control/status bits.

Use Control Bit IDNs (301 or 303) to update up to two output points within the cyclic channel update time. Writing an output bit IDN into either of the two allocation of control bit IDNs will cause the value of the realtime control bit in the MDT to be placed into that output bit. Example, write one of the output bit IDNs (34833 - 34836) into IDN 301 or IDN 303. Then use the output bit IDN (Ex. 34833) to set the state of the output point. It will be updated within the cyclic channel update time.

Use Status Bit IDNs (305 or 307) to update up to two input points within the cyclic channel update time. Writing an input bit IDN into either of the two allocation of status bit IDNs will cause the value of the input bit to appear in the realtime status bit returned in the AT. Example, write one of the input bit IDNs (34817 - 34822) into IDN 305 or IDN 307. Then use the input bit IDN (Ex. 34817) to read the state of the input point. It will be updated within the cyclic channel update time.

Example

Writing 34817 (PCE840 Input Bit #1) to IDN 305 (Allocation of Realtime Status Bit 1) will cause the value of Input Bit #1 to appear as Status Bit 1 in the cyclic AT status word.

Writing 34822 (PCE840 Input Bit #6) to IDN 307 (Allocation of Realtime Status Bit 2) will cause the value of Input Bit #6 to appear as Status Bit 2 in the cyclic AT status word.

Writing 34834 (PCE840 Output Bit #2) to IDN 303 (Allocation of Realtime Control Bit 2) will cause the value of Control Bit 2 in the cyclic MDT to be written to Output Bit #2.

Writing 34836 (PCE840 Output Bit #4) to IDN 301 (Allocation of Realtime Control Bit 1) will cause the value of Control Bit 1 in the cyclic MDT to be written to Output Bit #4.

Inputs Table (InpMapX) The following table lists the mappable input functions (IDN32817-IDN32822) available for the 6 Digital Inputs. Bit 0 to bit 3 select the function, and bit 15 selects the active state (Active High or Active Low).

Mappable Input Function	Function Number	Description
No Function	0	Turns off mappable input functionality
Fault Reset (default)	1	Resets drive faults
Run Stop	2	Selects between normal operation and setting the velocity command to zero
Enable 2	3	Second enable function
Velocity Command Source	4	Selects between VelCmd and VelCmd2
Clockwise Inhibit (default)	5	Inhibits motor motion in the clockwise direction when asserted
Counterclockwise Inhibit (default)	6	Inhibits motor motion in the counter-clockwise direction when asserted
Analog Input Null	7	Nulls the analog input by setting ADOffset to old ADOffset minus AnalogIn
Position Mode Select	8	Switches the active mode of operation to position mode
Command Gain Select	9	Switches the analog input scale factor between CmdGain and CmdGain2
Home Switch Input	15	Home switch input for a homing move

(InpMapX) Example To map INP1 as HomeSwitch Active High, write value 0x800F to IDN32817. To map INP2 as Enable2 Active Low, write value 0x3 to IDN32818.

Outputs Table (OutMapX) The following table lists the mappable output functions (IDN32860 to IDN32863) available for the 3 Digital and 1 Relay Outputs. Bit 0 to bit 2 select the function, and bit 15 selects the active state (Active High or Active Low).

Mappable Output Function	Function Number	Description
No Function	0	Turns off mappable output functionality
Fault (default)	1	Indicates whether the drive has faulted and is disabled
Enabled	2	Indicates whether power can flow to the motor
Brake (default)	3	Indicates when the motor is not powered and a mechanical brake is needed to hold the motor
Mechanical Revs	4	Square wave whose frequency is equal to the resolver's electrical frequency which is typically equal to the mechanical Rev/sec
Electrical Revs	5	Square wave shose frequency is equal to the motor electrical frequency
Zero Speed	6	Activated when the motor's speed goes below the speed threshold set by the parameter, ZeroSpeedThresh
Excess Position Error	7	Asserted when there is excess following error for an extended period of time (following error limit is defined by PosErrorMax)

Active hi/lo

Each of the digital inputs and outputs can be defined as either active high or active low. If the mappable output function (bit) is configured as active **HIGH** (**LOW**) then when the function (bit) is asserted, the output will be **HIGH** (**LOW**).

(OutMapX) Example

To map OUT1 as Enabled Active High, write value 0x8002 to IDN32860. To map OUT4 as Brake Active Low, write value 0x3 to IDN32863.

Reading/Writing I/O

In order to set a pin as a general purpose input the InpMap IDN must be set to zero. Reading a Input pin would return the value of the input pin. Reading IDN 34824 would return the value of all the input pins as a single word.

Reading an Output pin would return the appropriate bit value located in the Output port. Reading IDN 34840 would return the value of the Output port.

Writinga0or1toIDNs 34833-34836 (Output Pins) will set Output Pins to that value, or writing a value between 0 and 15 to IDN 34863 (Output Port) will set the Output port to that value.

Example

To change the mapping of InpMap1 from General Purpose Input (default) to the Home Switch, perform the following:

1. Write 0x800F to InpMap1 (IDN 32817).
2. Read the first bit of the Input Port (IDN 34824) or read Input 1 (IDN 34817) to monitor the state of the input.

IDN 34817 can only be read using the service channel. IDN 34824 can be read using the service channel or the cyclic channel.

3.6.2. Probe/Registration Functionality

In a typical application, probes are used to define the position of a part or the depth of a hole or cut. When the probe touches the surface, the switch closes and the position data is latched.

Position registration uses the closure of a proximity switch, photo eye, or similar device to signal the latching of position data.

On the PCE840, during probing and registration, position latching is perfomed by the drive.

Guidelines

The PROBE 1 function must reside on Inp4 (J2-34) when probe/registration is in use.

The PROBE 2 function must reside on Inp5 (J2-35) when probe/registration is in use.

The two probe functions work identically, but require additional setup prior to use when compared to other Input functions.

When RemoteFB=1or2(IDN 32824), Probe 2 cannot be used to latch position. Probe 2 is used only as the marker pulse input for homing. Probe 1 can be used to latch position (encoder position). When RemoteFB = 0, Probe 1 and Probe 2 can be used to latch position (resolver position).

Probe Table

Below is a list of IDN s related to the Probe functionality.

IDN	Description	Function
130	Probe 1 Positive Edge	Returns Probe 1 Positive Edge Data
131	Probe 1 Negative Edge	Returns Probe 1 Negative Edge Data
132	Probe 2 Positive Edge	Returns Probe 2 Positive Edge Data
133	Probe 2 Negative Edge	Returns Probe 2 Negative Edge Data
169	Probe Control	Specified which probe edges are active
170	Probe Cycle Command	Allolws the beginning of a probe cycle
401	Probe 1	Returns the current state of Probe 1 pin
402	Probe 2	Returns the current state of Probe 2 pin
405	Probe 1 Enable	Enables the latching of data upon a Probe 1 edge.
406	Probe 2 Enable	Enables the latching of data upon a Probe 2 edge.
409	Probe 1 Positive Latched	Returns a '1' when Probe 1 Positive Edge data has been latched.
410	Probe 1 Negative Latched	Returns a '1' when Probe 1 Negative Edge data has been latched.
411	Probe 2 Positive Latched	Returns a '1' when Probe 2 Positive Edge data has been latched.
412	Probe 2 Negative Latched	Returns a '1' when Probe 2 Negative Edge data has been latched.

Service Channel

All the above IDNs can be accessed through the Service Channel. For the probe function to take place, several IDNs must be set up prior to an event.

IDN 169 **Probe Control Parameters**

Bit Number	Setting
0 – Probe 1 Positive Edge	0 = Positive edge inactive 1 = Positive edge active
1 – Probe 1 Negative Edge	0 = Negative edge inactive 1 = Negative edge active
2 – Probe 2 Positive Edge	0 = Positive edge inactive 1 = Positive edge active
3 – Probe 2 Negative Edge	0 = Negative edge inactive 1 = Negative edge active

IDN 170 **Probing Cyclic Procedure Command.** A probing cycle procedure must be active in order for a probe event to be captured. This is done by writing a 3 to IDN 170. To cancel probeing control, write a 0 to IDN 170.

IDN 405 **Probe 1 Enable**. Probe 1 must be enabled in order to capture a probe 1 event.

Bit Number	Setting
0	0 = Probe 1 Not Enabled 1 = Probe 1 Enabled

IDN 406 **Probe 2 Enable**. Probe 2 must be enabled in order to capture a probe 2 event.

Bit Number	Setting
0	0 = Probe 2 Not Enabled 1 = Probe 2 Enabled

The above three items must be done to capture a probe event. They may be done in ANY order.

Once the above items have been set and the correct edge has occurred on the probe time, probe data will be latched.

Once the probe data are latched and ready to be sent to the Master, the correct Probe Latched bit (IDNs 409 - 412) will return a 1 when read.

- The latched position data can be read through IDNs 130 - 133.
- The initial default data is 0. Data are updated only after a probe event has occurred.
- The probe event can be reset by clearing any of the four control IDNs (IDNs 169, 170, 405/406) and then re-enabling them.

Example

Writing 1 to IDN 169 (Probe Control Parameter) will cause Probe 1 Positive Edge events to be recorded. IDNs 405 and 170 must still be configured.

Writing 1 to IDN 405 (Probe 1 Enable) will enable probe 1.

Writing 3 to IDN 170 (Probe Command) will initiate probing on probe 1 (INP4) and probe 2 (INP5). At this point, if probe 1 (INP4) did not transition (low to high), reading IDN 409 (Probe 1 Positive Latch) will return a 0 indicating a probe did not take place. Reading IDN 130 (Probe 1 Positive Edge Data) will return 0.

After a positive transition on probe 1 (INP4), reading IDN 409 (Probe 1 Positive Latch) will return a 1 indicating a probe had occurred. Reading IDN 130 (Probe 1 Positive Edge Data) will return the latched position. To latch position on probe 1 again, reset IDN 405 by writinga0andthena1toit.

Since probe 2 was not enabled using IDNs 169 and 406, reading probe 2 related IDNs will return 0.

Cyclic Channel

Of all the Probe Input IDNs, only IDNs 130 - 133 (IDNs which return latched position data) can be inserted into the AT. The data returned will either be 0 (no data has been latched) or the last latched data for that probe edge.

Realtime Control/Status Bits

All of the Probe Data Latched IDNs (IDNs 409 - 412) and Probe Enable IDNs (IDNs 405 and 406) can be used through the use of realtime control/status bits. Writing the IDN of a Probe Data Latched into either of the two Allocation of Status Bit IDNs (IDN 305 or IDN 307) will cause the value of that IDN to appear in the realtime status bit returned in the AT. Writing the IDN of the Enable Probe into either of the two Allocation of Control Bit IDNs (IDN 301 or IDN 303) will cause the value of the realtime control bit in the MDT to be placed into that Probe Enable function.

Example

Writing 409 (Probe 1 Positive Data Latched) to IDN 305 (Allocation of Realtime Status Bit 1) will cause the value of Probe 1 Positive Data Latched to appear as Status Bit 1 in the cyclic AT status word.

Writing 412 (Probe 2 Negative Data Latched) to IDN 307 (Allocation of Realtime Status Bit 2) will cause the value of Probe 2 Negative Data Latched to appear as Status Bit 2 in the cyclic AT status word.

Writing 406 (Probe 2 enable) to IDN 303 (Allocation of Realtime Control Bit 2) will cause the value of Control Bit 2 in the cyclic MDT to be written to Probe 2 Enable.

Writing 405 (Probe 1 Enable) to IDN 301 (Allocation of Realtime Control Bit 1) will cause the value of Control Bit 1 in the cyclic MDT to be written to Probe 1 Enable.

Use of the Realtime Control/Status bit IDNs (IDNs 405, 406, 409 - 412) along with the cyclic channel IDNs (130 - 133) results in registration events recorded and acted upon in realtime.

3.6.3. Analog Input

This IDN can be read through either the Service or the Cyclic channel.

IDN 34825

Allows the master to read the Analog Input on the base unit. The value of this IDN is:

AnalogIn (V) = IDN32825/1000.0

IDN 32809

First-order low-pass filter corner frequency for the analog input channel on J2-1,2 (ADF0). This IDN should be set so that:

IDN 32809 (ADF0) = Break Frequency of Analog Input Filter in Hz

3.6.4. Analog Outputs

The analog outputs can be set to various output functions, including a user specified voltage.

The Analog Output function is selected using the DACMAP IDNs (IDNs 32814 and 32815). The DACMAP functions must be ‘OFF’ (IDNs 32814 or 32815 = zero) for user controlled AnalogOut. AnalogOut1 can be written to using IDN 34841. AnalogOut2 can be written to using IDN 34842. The break frequencies for the Analog Outputs’ low-pass filter are IDNs DM1F0 (IDN 32810) and DM2F0 (IDN 32811).

IDN 32810

DM1F0 sets the frequency in Hz of a single pole low-pass filter on the DAC Monitor 1 output (J2-4). This IDN should be set so that:

IDN 32810 = Break Frequency (Hz)

IDN 32811

DM2F0 sets the frequency in Hz of a single pole low-pass filter on the DAC Monitor 2 output (J2-5). This IDN should be set so that:

IDN 32811 = Break Frequency (Hz)

Analog I/O IDNs Below is a list of the Analog Input and Output IDNs:

IDN	Description	Function
32809	ADF0	Break Frequency for AnalogIn in Hz.
34825	AnalogIn	Analog Voltage Input
32810	DM1F0	Break Frequency for AnalogOut 1 in Hz.
32811	DM2F0	Break Frequency for AnalogOut 2 in Hz.
32812	DM1GAIN	Gain for AnalolgOut1 – Scaling varies according to function
32813	DM2GAIN	Gain for AnalogOut2 – Scaling varies according to function
32814	DM1MAP	Selects Variable to be mapped to AnalogOut1
32815	DM2MAP	Selects Variable to be mapped to AnalogOut2
34841	AnalogOut1	Writes AnalogOut1 (if IEN 32814 = 0)
34842	AnalogOut2	Writes AnalogOut2 (if IEN 32815 = 0)

Example User reads IDN 32825 (AnalogIn) to be 130.

Voltage on AnalogIn pin is:

1301000 = 0.13 volts

The analog input is a differential input to an A/D. The full scale differential command input range is ±13V.

3.6.5. DACMap Parameters

IDN 32814 DM1Map selects the signal sent to the DAC Monitor 1 output on J2-4. This IDN should be set so that:

IDN 32814 = Monitor # from the table on the following page.

IDN 32815 DM2Map selects the signal sent to the DAC Monitor 2 output on J2-5. This IDN should be set so that:

IDN 32815 = Monitor # from the table on the following page.

Set the value of the DM1Map and DM2Map (IDNs 32814 and 32815) before setting the values of DM1Gain and DM2Gain (IDNs 32812 and 32813).

IDN 32812 DM1Gain sets the multiplicative scale factor applied to the DM1Map selected signal before outputting on DAC Monitor 1 (J2-4) (DM1Gain). This IDN should be set so that:

IDN 32812 = DM1Gain*100

IDN 32813 DM2Gain sets the multiplicative scale factor applied to the DM1Map selected signal before outputting on DAC Monitor 2 (J2-5) (DM2Gain). This IDN should be set so that:

IDN 32813 = DM2Gain*100

DAC Out Units The table below lists the units when DMxGain = 1.

Monitor #	Variable	Description	DAC Out Units
0	AnalogOutX		0.001 V/V
1	VelFB	Measured Velocity (DM2 Default)	0.001 V/V/kRPM
2	VelCmdA	Actual Velocity Command (VelCmdA)	0.001 V/V/kRPM
3	VelErr	Velocity Error	0.001 V/V/kRPM
4	FVelErr	Compensated Velocity Error	0.001 V/V/kRPM
5	Position	Measured Position*	0.001 V/Rev
6	PosError	Position Error*	0.001 V/Rev
7	PosCommand	Commanded Position*	0.001 V/Rev
8	ICmd	Commanded Torque Current	0.001 V/A
9	IFB	Measured Torque Current (DM1 Default)	0.001 V/A
10	AnalolgIn	Filtered A/D Input	0.001 V/V
11	EncFreq	Encoder Frequency	0.001 V/Hz
12	EncPos	Encoder Position*	0.001 V/4096 counts
13	ItFilt	Filtered Output Current Amplitude	0.001 V/100%
14	HSTemp	Measured Heat Sink Temperature	0.001V/C
15		Commutation Electrical Angle*	0.001 V/Cycle
16	IR	Motor Phase R Output Current	0.001 V/A
17	IS	Motor Phase S Output Current	0.001 V/A
18	IT	Motor Phase T Output Current	0.001 V/A
19		Motor Phase R Voltage Duty Cycle	0.001 V/100%
20		Motor Phase S Voltage Duty Cycle	0.001 V/100%
21		Motor Phase T Voltage Duty Cycle	0.001 V/100%
22	VBus	Drive Bus Voltage	0.001 V/V
23	ResPos	Resolver Absolute Position*	0.001 V/Rev
24		Commanded Non-torque Current	0.001 V/A
25		Measured Non-torque Current	0.001 V/A
26		Torque Voltage Duty Cycle	0.001 V/100%
27		Non-torque Voltage Duty Cycle	0.001 V/100%
28		Velocity Command (VelCmd)	0.001 V/V/kRPM
65536	No change to variable, turn range clamp off.		
65537	No change to variable, turn range clamp off.		

* These variable are allowed to wrap around when the signal exceeds the output voltage range.

DAC monitor outputs have a range of ±5V with a resolution of 10V/256 = 0.039 V.

Example

To view the velocity feedback (VelFB) signal on an oscilloscope (to measure overshoot, rise-time, or other motion performance parameters) do the following:

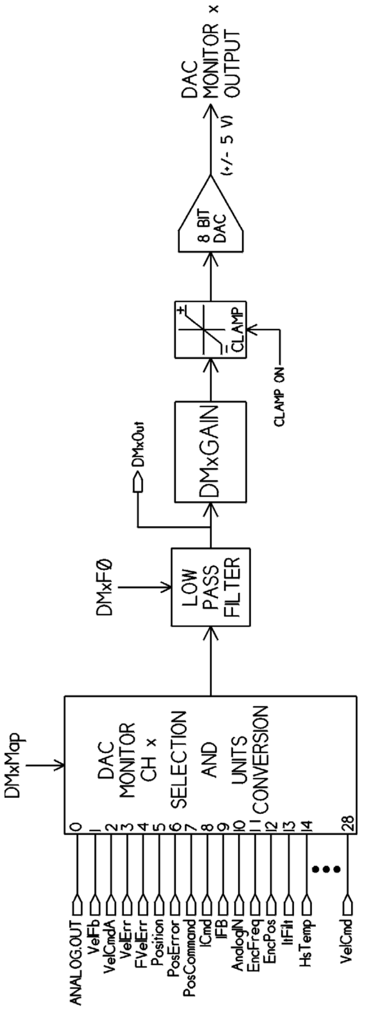
1. Command a 4 KRPM move. VelFB is the default setting for DM2Map (IDN 32815 = 1), therefore use DAC Monitor 2 (J2-5 with respect to pin 5).
2. To filter out noise, set DM2F0 (IDN 32811) to 1000 Hz. DAC Monitor 2 will display an analog signal representing VelFB.
3. Set DM2Gain (IDN 32813). The range of the DAC Monitors is ± 5 volts. Set DM2Gain so that the signal is not clamped and a high resolution signal is maintained.

   For example, set DM2Gain so that 5 KRPM will correspond to 5 volts:

   5 KRPM * 0.001 Volt/KRPM * DM2Gain = 5 Volts.

   This implies that DM2Gain = 1000.
4. Connect the scope probe to DAC Monitor 2 and command a move. The velocity feedback signal should be visible on the scope.

DAC Map Diagram



3.7. Servo Loop Parameters

This section describes setting parameters associated with the velocity and position loops. In many cases, satisfactory operation is achieved using either the Create New Configuration or Edit Existing Configuration buttons. However, in some cases you must adjust the control loop parameters due to large mismatches between motor and load inertia, mechanical resonance, backlash, etc. This appendix provides guidance for handling these situations.

The two anti-resonant zeroes (ARZ0 and ARZ1) are assumed to both be off (set to zero) for this discussion.

3.7.1. Current Loop

IDN 106 Current Loop Proportional Gain (Kip). This IDN should be set so that:

Kip V/Amp = L_{l-1} (in henries) * 2 * π *1000

IDN 106 = Kip (Volts/Amp) * I_{PEAK} * 405.6685e-3

IDN 107 Current Loop Integral Gain (Kii). This IDN should be set so that:

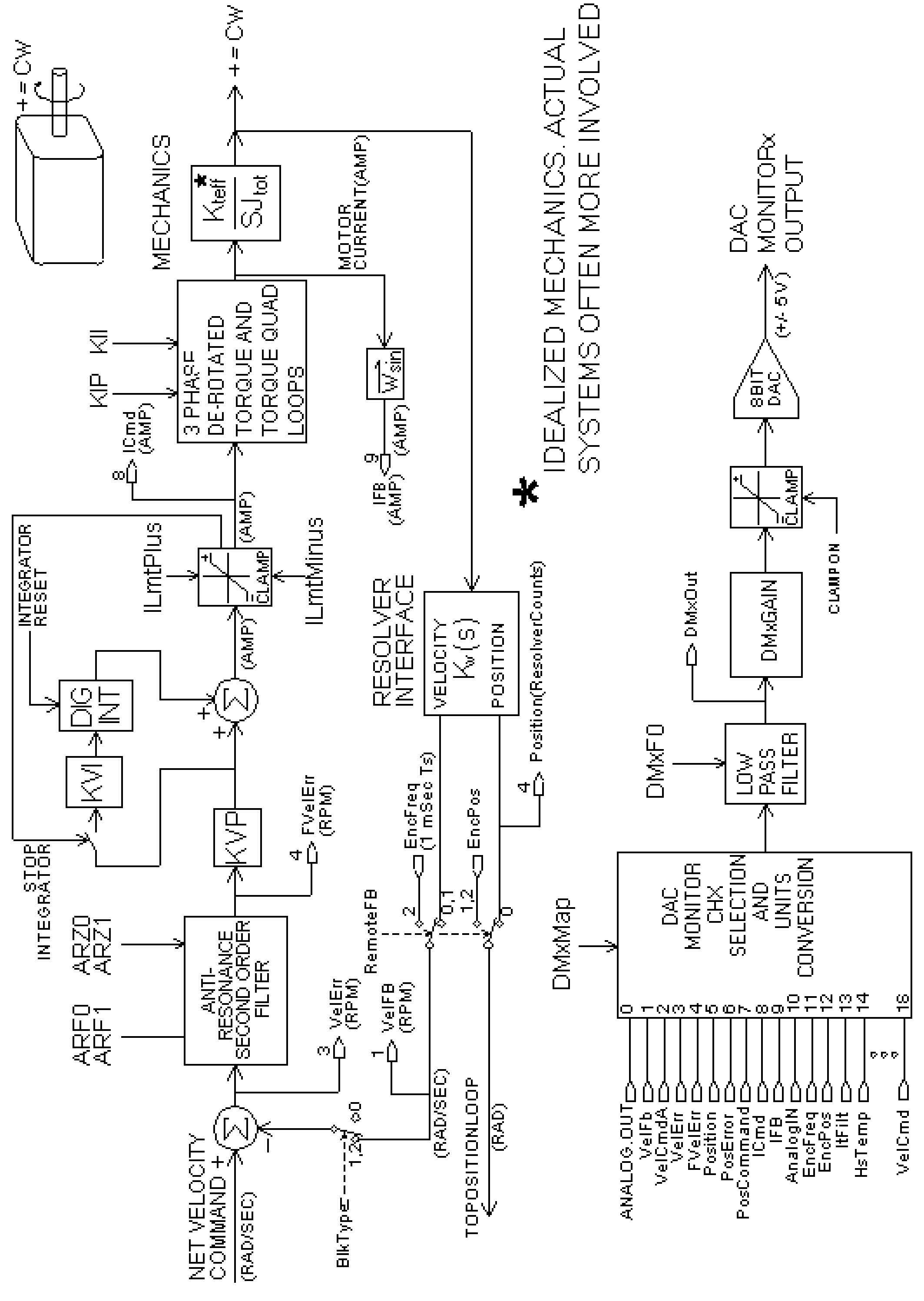
Kii = 50 Hz

IDN 107 = Kii (Hz) * 12.868

3.7.2. Velocity Loop

Velocity loop bandwidth is the key indicator of system performance. Systems with fast settling time must have high velocity loop bandwidth. Conversely, if the velocity loop bandwidth is low, attempting to achieve fast settling time by increasing the position loop bandwidth, KPP, leads to overshoot and ringing.

Velocity Loop



Velocity Loop Bandwidth

The velocity loop bandwidth (f_{vc}) is given by the equation:

$$f_{vc}(\mathrm{Hz}) = \frac{KVP * K_T \sqrt{3}/2}{2\pi * J_{TOT}} = 0.138 * KVP * \frac{K_T}{J_{TOT}}$$

where:

KVP is the velocity loop proportional gain in amps/(rad/sec)

K_T is the 0-peak line-line motor torque constant in lb-in/amp

J_{TOT} is the total inertia (motor total + load total) in lb-in-sec2.

(Any consistent set of units for K_T, J_{TOT} (such as MKS), that yield K_T/J_{TOT} in rad/sec2/amp work.)

The motor torque constant is the value of K_T peak published in the *Pacific Scientific Motion Control Solutions* catalog.

f_{vc} is the unity gain open-loop crossover frequency of the idealized rigid single mass system. See hardware specifications for maximum f_{vc} value.

Load Inertia

From the formula for bandwidth, you can see that bandwidth changes inversely with total inertia. If the load inertia equals the motor plus resolver inertia, the velocity loop bandwidth is half the values shown. If the load inertia is ten times the motor plus resolver inertia, the bandwidths are one-eleventh these values. Clearly, KVP must be increased to compensate for increased load inertia, if bandwidth is to be maintained. Typically, load inertia up to 3 (motor + resolver) give acceptable performance without further optimization.

The most common servo setup problem is adding large load inertia without a corresponding increase in KVP.

KVP

The value of KVP to achieve a desired bandwidth can easily be calculated as:

$$KVP = \frac{2\pi * f_{vc} * J_{TOT}}{K_{TRMS} \sqrt{3}/2\sqrt{2}} = 10.26 * f_{vc} * \frac{J_{TOT}}{K_{TRMS}}$$

Example Calculation

For example, to achieve 75 Hz bandwidth with a PMA22 motor having 20 to 1 load inertia = 0.011 lb-in-sec2:

J_{TOT}[1] = 0.00039 + 0.011 = 0.01139 lb-in-sec2

K_T[2] = 4.31 lb-in/amp

$$KVP = 10.26 * 75 * \frac{0.01139}{4.31} = 2.03$$

IDN 100

Velocity Loop Proportional Gain (Kvp). This IDN shoud be set in the PCE840 so that:

Kvp (Amps/rad/sec) = $2\pi * f_{vc}$ (Hz) * J_{total}/K_{teff} (rad/sec^2/amp)

IDN 100 = Kvp (Amps/rad/sec) / I_{Peak} * 193.38e-6)

where:

J_{total} = Load inertia reflected to the motor shaft + motor inertia (lb-in-s^2)

f_{vc} = velocity loop bandwidth (Hz)

K_{teff} = torque constant (effective)

Problems With High Load Inertia

It would seem from the above, that setting KVP is simply a matter of increasing its value to compensate for load inertia. Unfortunately, the following problems often interfere, particularly when the load inertia is large compared with the motor's inertia:

1. Mechanical resonance between motor and load cause high frequency oscillation.
2. Backlash between motor and load effectively unload the motor over a small angle. Within this small angle, the increased bandwidth results in oscillation.
3. Ripple in the velocity feedback signal results in large motor ripple current, if KVP is large.

As a general rule, any system with KVP set higher than 5 times the medium bandwidth setting requires adjustment to the default ARF0 and ARF1 settings.

---

[1] Motor-plus-resolver inertia (0.00039 lb-in-sec2) for the PMA22 motor is found in the catalog or 800Tools' motor data screen.

[2] K_T is found in the catalog as K_{TRMS} (4.31 lb-in/amp) or by using the Back EMF Constant, K_E (31.2 Volts/kRPM), shown on 800Tools' motor data screen in the following formula:

$K_{T\,RMS} = K_{E\,RMS} * 1.06/\sqrt{3}$ (volts/krpm).

$K_{T\,0\text{-}PK} = K_{T\,RMS} * 0.707$

Resonance

Mechanical resonance is caused by springiness between motor inertia and load inertia. This may result from belts, flexible couplings, or the torsional stiffness of shafts. **In general, the stiffer the couplings, the higher the resonance frequency and the easier it is to tune the system for good performance.**

If the velocity loop breaks into an oscillation at a frequency well above the calculated velocity loop bandwidth, a resonance problem may exist. A second symptom is that the frequency of oscillation is relatively constant even with changes to ARF0 and ARF1.

Anti-resonance Filters

Two digital anti-resonant low-pass filters ARF0 and ARF1 are included in the velocity loop. Their purpose is to lower the gain above f_{vc}, especially at any resonant frequency > f_{vc} so oscillations do not occur. Recommended values are:

f_{vc} (Hz)	ARF0 (Hz)	ARF1 (Hz)
25	100	200
75	100 (default)	750 (default)
200	1500	10^5

ARZ0 (IDN 32841) and ARZ1 (IDN 32842) are generally not needed and should be set to 0, which eliminates them entirely. However, for advanced compensation, ARZ0 and ARZ1 can be used to add lead compensation or used together to add a notch filter.

ARZ0 positive sets the zero frequency in Hz. If ARZ0 is less than zero, ARZ0 sets the underdamped zero pair frequency in Hz and ARZ1 sets the underdamped pair Q.

IDN 32841

First velocity loop compensation zero. This IDN should typically be set to ARZ0 (Hz/100) = 0

The units of ARZ0 are 0.01 Hz.

IDN 32842

Second velocity loop compensation zero. This IDN should typically be set to ARZ1 (Hz/100) = 0

The units of ARZ1 are 0.01 Hz.

IDN 32843

First velocity loop compensation anti-resonance low-pass filter corner frequency. This IDN should typically be set so that:

IDN 32843 = ARF0 (Hz) * 100

= 1000 for Gentle Response
= 15000 for Medium Response
= 150000 for Stiff Response

IDN 32844

Second velocity loop compensation anti-resonance low-pass filter corner frequency. This IDN should typically be set so that:

IDN 32844 = ARF1 (Hz) * 100

= 2000 for Gentle Response
= 75000 for Medium Response
= 10000000 for Stiff Response

Procedure

1. Set both ARF0 and ARF1 to 400 Hz and set KVP low enough to prevent oscillation.
2. Increase KVP slowly until oscillation at the resonant frequency just begins. Reduce KVP slightly until the oscillation just stops. Compute the velocity loop bandwidth using the formula given at the beginning of this section. If the velocity loop bandwidth is less than .25 times the value of ARF0 and ARF1, proceed to Step 3. Otherwise, go to Step 4.
3. Decrease both ARF0 and ARF1 by 20% and go back to Step 2.
4. The velocity loop bandwidth should now be approximately one quarter the value of ARF0 and ARF1. For margin, reduce KVP, ARF0, and ARF1 by 20%.

Backlash

Some backlash may be unavoidable, especially when gear reduction is used. If backlash is present, the inertia match must be good (load inertia should be roughly equal to motor inertia) for good servo performance. Gearing reduces the inertia reflected to the motor by the square of the gear reduction from motor to load. Select a gear ratio to give the required match.

Current Ripple

The velocity feedback signal in standard PCE830 drives operating with the standard 20 arcmin resolver can have up to 3% p-p ripple. The resulting motor torque current ripple, with no ARF0/ARF1 filtering, is calculated using the following formula:

$$\text{Current ripple (amps p-p)} = \frac{3}{100} * \text{Speed (RPM)} * \frac{2\pi}{60} * \text{KVP}$$

$$\approx 0.03 * \text{Speed (RPM)} * \text{KVP}$$

There can be cause for concern when this p-p number exceeds 40% of the drive's or motor's current rating. Monitor the motor current using DAC Monitors on J2-4 to insure that actual ripple current with ARF0/ARF1 filtering is not excessive.

Motor current ripple is often reduced by lowering the ARF0, ARF1 low-pass filter break frequencies. This benefit is limited by velocity loop bandwidth and stability constraints. Velocity feedback ripple, and motor current ripple, can also be reduced by specifying a higher accuracy resolver.

KVI

The parameter, KVI, sets the "lag-break" frequency of the velocity loop. KVI is equal to the frequency in Hz where the velocity loop compensation transitions from predominantly integral characteristics to predominantly proportional characteristics. Drive rejection of torque disturbances increase as KVI increases. Default values for KVI are:

f_{vc} (Hz)	KVI (Velocity Loop Lag-Break Freq. (Hz))
25	1.7
75	5.0 (default)
200	13.3

IDN 101

Velocity Loop Integral Gain (Kvi). This IDN should be set so that:

KVI = f_{vc} (Hz) / 15

IDN 101 = KVI (Hz) * 51.4719

If the drive is used within a position loop (either with BlkType = 2 or when using an external position drive and BlkType = 1), KVI should be equal to or less than 0.1 times the velocity loop bandwidth. If no position loop is used, KVI can be set to 0.25 times the velocity loop bandwidth (or higher, if some ringing can be tolerated). In general, the response to a velocity command step (or truncated ramp) has velocity overshoot for non-zero values of KVI.

3.7.3. Position Loop

When BlkType is set equal to 2, a position loop is configured outside the velocity loop. **The velocity loop must be set up and evaluated in terms of bandwidth BEFORE attempting to setup the position loop.**

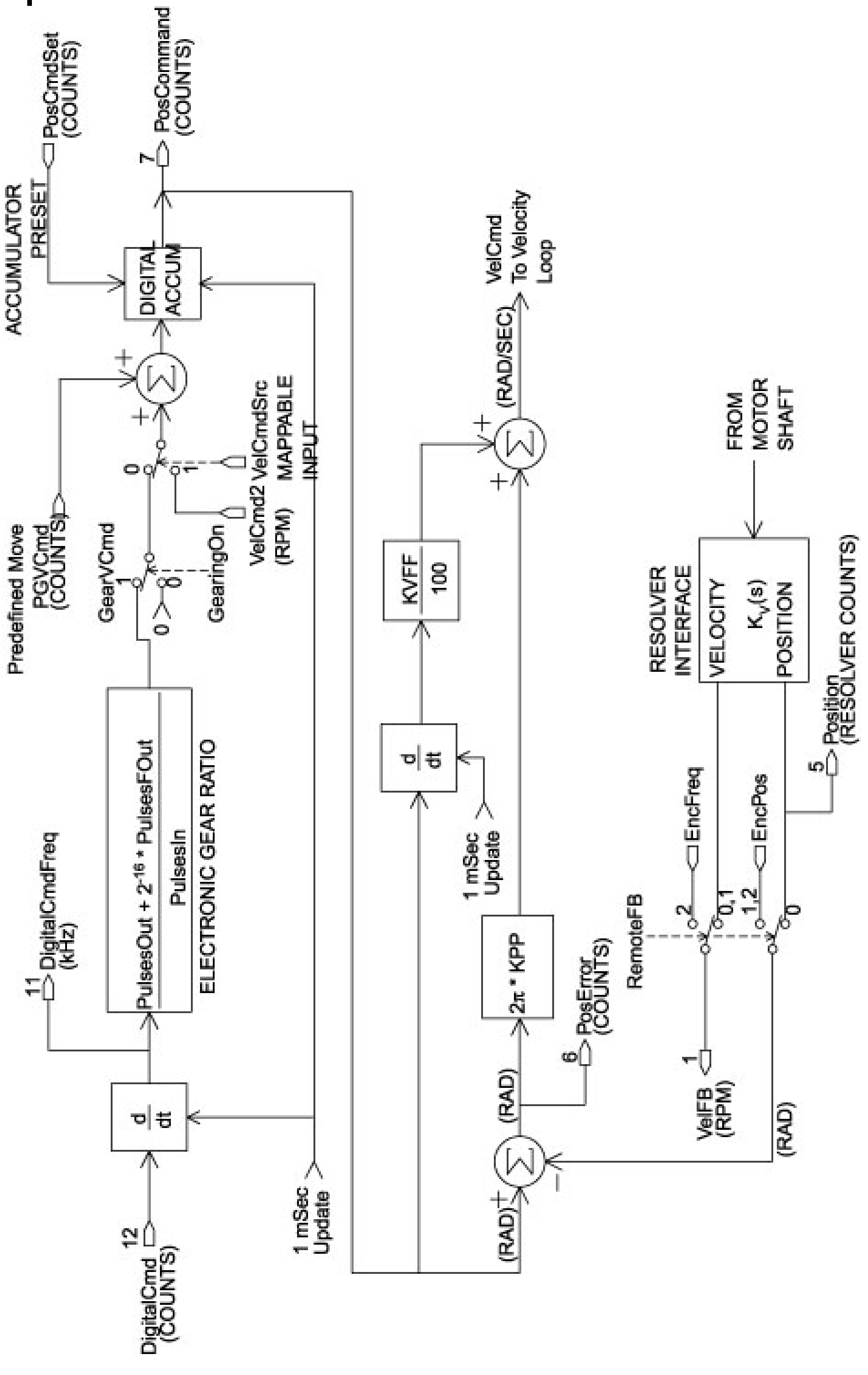
KPP

The position loop proportional gain, KPP, determines the settling time of the position loop. KPP is the bandwidth of the position loop (in Hz), assuming an ideal velocity loop. Recommended values for KPP are:

f_{vc} (Hz)	KPP (Position Loop Bandwidth (Hz))
25	5
75	15 (default)
200	50

In general, the higher the value of KPP, the faster the settling time. However, **trying to set KPP to a high value with inadequate velocity loop bandwidth results in overshoot and ringing**. A good trade off is to set KPP to 0.2 times the velocity loop bandwidth. Slightly higher values can be used if overshoot can be tolerated.

Position Loop



IDN 104 Position Loop Proportional Gain (Kpp). This IDN should be set according to table below. Gain settings are determined by the response type: Gentle, Medium, or Stiff.

Response	f_{vc} (Hz)	IDN 101 (KVI)	IDN 32843 (ARF0)	IDN 32844 (ARF1)	IDN 104 (KPP)
Gentle	25	172	10000	20000	2056
Medium	75	515	15000	75000	6167
Stiff	250	1716	150000	10,000,000	20556

IDN 104 = KPP (Hz) / 2.432e-3
(for Resolver Feedback – IDN 32824 = 0)

IDN 104 = 4 * KPP (Hz) / 2.432e-3
(for Encoder Feedback – IDN 32824 = 1 or 2)

KPP sets the position loop bandwidth for all values of RemoteFB (IDN 32824).

KVFF KVFF is the velocity feed forward gain. In the absence of velocity feed forward (KVFF = 0), the commanded velocity is proportional to the position (following) error. This means that the actual position lags the commanded position by a value proportional to the speed. The error is smaller for larger values of KPP.

The following table gives a sample of the following error magnitude.

Speed (RPM)	KPP (Hz)	Following Error (revolutions)
1000	10	0.27
2000	10	0.53
5000	10	1.33
1000	20	0.13
2000	20	0.27
5000	20	0.66

The following error can easily exceed one complete motor revolution. In many electronic gearing applications, such following errors are not acceptable (real gears DO NOT have following errors!) Stepper systems also DO NOT have such errors.

Feed forward takes advantage of the fact that the PCE840 DSP knows the frequency of the encoder or step inputs and knows how fast the motor should be going at a given instant. All or part of this velocity can be added to the velocity command to reduce following error. If KVFF is set to 100 (%), the steady-state following error reduces to zero.

IDN 32840 This IDN should be set so that:

IDN 32840 = Kvff (%) * 10

Increasing Kvff reduces steady state following error (position loop null error proportional to speed) and gives faster response time. However, if Kvff is too large, it will provide overshoot. Typically Kvff should not be set larger than 80 for smooth dynamics and acceptable overshoot, but should be set to 100 for minimum following error, which may be necessary in some applications.

Overshoot Setting KVFF equal to 100% can result in position overshoot. Somewhat lower values may be required, if this is a problem. KVFF set to 70%-80% typically achieves the fastest step response with no overshoot. Setting KVFF to less than 100% gives steady state following error when running at a constant speed.

3.7.4. Advanced Velocity Loop Tuning

Continuous Time Transfer Function Approximation

The transfer function for the velocity loop compensation block is:

$$\frac{\mathrm{FVelErr}}{\mathrm{VelErr}}(s)=\frac{\left(\frac{s}{\omega_z}\right)^2+\frac{1}{Q_z}\frac{s}{\omega_z}+1}{\left(\frac{s}{\omega_f}\right)^2+\frac{1}{Q_f}\frac{s}{\omega_f}+1}$$

$$\frac{\mathrm{ICmd}}{\mathrm{VelErr}}(s)=\frac{\left(\frac{s}{\omega_z}\right)^2+\frac{1}{Q_f}\frac{s}{\omega_z}+1}{\left(\frac{s}{\omega_f}\right)^2+\frac{1}{Q_f}\frac{s}{\omega_f}+1}$$

Definitions for the terms used in the equations above are:

For ARx0 > 0 both roots are real and:

$$\omega_z=2\pi\sqrt{(\mathrm{ARx0})(\mathrm{ARx1})}$$

$$Q_z=\frac{\sqrt{(\mathrm{ARx0})(\mathrm{ARx1})}}{\mathrm{ARx0}+\mathrm{ARx1}}$$

For ARx0 < 0 roots are a complex pair and:

$$\omega_z=-2\pi\,\mathrm{ARx0}$$

$$Q_z=\mathrm{ARx1}$$

When ARZ0 and ARZ1 are both 0, the numerator of $\frac{FVelErr}{VelErr}$ ***reduces to 1.***

If ARZ0 or ARZ1 is individually 0, the numerator reduces to $\frac{s}{2\pi\,ARZx}+1$***.***

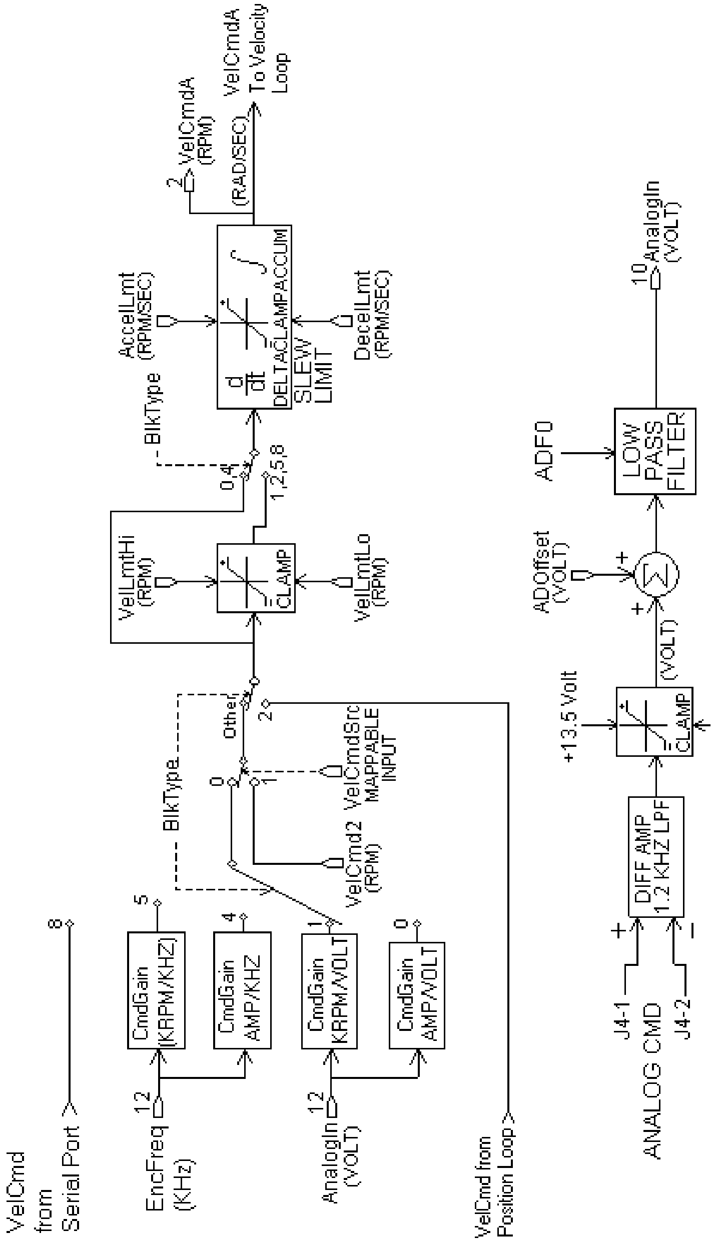
Discrete Time Transfer Function

The velocity loop compensation is actually implemented as a digital discrete time system function on the DSP. The continuous time transfer function is converted to the discrete time domain by a backward Euler mapping:

$$s \rightarrow \frac{1}{T_S}(1-z^{-1})$$

where $T_S = 250$ µsec.

Mode Selection and Command Processing



3.8. IDN Attributes

This section contains a list of Identification Numbers (IDNs) in numerical order for the PCE840.

3.8.1. SERCOS-Specific Parameters

IDN 1: Control Unit Cycle Time

Parameter Data IDN
Unsigned Decimal Number

Sercos Cycle Rate. This is the update rate for AT and MDT IDNs. This value must be at least 1000 (1 mSec) for Velocity mode, and 2000 (2 mSec) for Position mode operation. The maximum value is 64000 (64 mSec).

Conversion Scaling Factor: 1
Data Length: 2 bytes
Units: µs
Minimum Value: 01000
Maximum Value: 64000
Master Read (Phase 2): Always reads 0xFA00 - 64 mSec - Current value.
Master Read (Phase 3 or 4): Value written to this drive while in Phase 2.
Master Write: This IDN can only be written in Phase 2.

IDN 2: Communication Cycle Time

Parameter Data IDN
Unsigned Decimal Number

The values must be the same as IDN 1 – Control unit cycle time.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Units: µs
Minimum Value: 01000
Maximum Value: 64000
Access State: Read/Write in Phase 2
Read-only in Phase 3 and 4

IDN 3: Shortest AT Transmission Starting Time

Parameter Data IDN
Unsigned Decimal Number

Time required by the PCE840 after the MST before it is able to send the AT.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Units: µs
Minimum Value: 20
Maximum Value: 20
Access State: Read-only by Master

IDN 4: Transmit/Receive Transition Time

Parameter Data IDN
Unsigned Decimal Number

Time required by the PCE840 after the end of transmitting the AT before it is ready to receive the MDT from the master.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Units: µs
Minimum Value: 20
Maximum Value: 20
Access State: Read-only by Master

IDN 5: Minimum Feedback Processing Time

Parameter Data IDN
Unsigned Decimal Number

Time required by the PCE840 to acquire and compile the AT data prior to the MST.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Units: µs
Minimum Value: 300
Maximum Value: 300
Access State: Read-only by Master

IDN 6: AT Transmission Starting Time

Parameter Data IDN

Unsigned Decimal Number

The time the PCE840 sends the AT after the end of the MST, as measured in µSec. This value is calculated and written by the Master during Phase 2. The value read back is always the current value.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	µs
Minimum Value:	20
Maximum Value:	64000
Access State:	Read/Write in Phase 2 Read-only in Phase 3 and 4

IDN 7: Feedback Acquisition Capture Point

Parameter Data IDN

Unsigned Decimal Number

The PCE840 shall acquire the AT data at this time. This value is calculated and written by the master during phase 2. The value read back is always the current value.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	µs
Minimum Value:	0
Maximum Value:	63700
Access State:	Read/Write in Phase 2 Read-only in Phase 3 and 4

IDN 8: Command Value Valid Time

Parameter Data IDN

Unsigned Decimal Number

At this moment of time, the PCE840 shall begin using the data received from the master in the MDT. This value is calculated and written by the master during phase 2.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	µs
Minimum Value:	20
Maximum Value:	64000
Access State:	Read/Write in Phase 2 Read-only in Phase 3 and 4

IDN 9: Position Of Data Record In MDT

Parameter Data IDN

Unsigned Decimal Number

Position within the MDT that the drive's data begins. This value is in bytes and must be an odd value. This value is calculated and written by the master during phase 2.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65531
Access State:	Read/Write in Phase 2 Read-only in Phase 3 and 4

IDN 10: Length Of MDT

Parameter Data IDN

Unsigned Decimal Number

The length of the MDT in bytes. This includes data records for all drives. This value is calculated and written by the master during phase 2.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	4
Maximum Value:	65534
Access State:	Read/Write in Phase 2 Read-only in Phase 3 and 4

IDN 11: Class 1 Diagnostic

Parameter Data IDN

Binary Data

This IDN reports back the status of the motor/drive. The fault reported in this IDN causes the PCE840 to disable the drive. Clearing the fault is required before the motor can be enabled. The PCE840 supports the following bits in this IDN:

Bit Number	Description
Bit 15	Manufacturer Specific Fault See IDN 129 for additional information

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0x8000
Access State:	Read-only by the Master

IDN 14: Interface Status

Parameter Data IDN

Binary Data

This IDN reports back the Communication Interface Status. The PCE840 supports the following bits in this IDN:

Bit Number	Description
Bits 0-2	Phase - Indicates current phase

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0x0007
Access State:	Read-only by the Master

IDN 15: Telegram Type Parameter

Parameter Data IDN

Binary Data

This IDN indicates which set of IDNs are to be supported in the AT and MDT. The PCE840 supports the following parameter configurations (0 - 7 inclusive):

Configuration 0:	No AT or MDT IDNs.
Configuration 4:	IDN 47 (Position Command) in the MDT IDN 51 (Position Feedback) in the AT
Configuration 7:	User defined AT and MDT. Refer to IDNs 16 and 24
Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	7
Access State:	Read/Write in Phase 2 Read-only in Phase 3 and 4

IDN 16: Configuration List Of AT

Parameter Data IDN

IDN ID Number List

List of IDNs which are to be included in a User Defined AT. The data contained in this list is governed by the following restrictions:

> Each IDN must be included in the list of Valid AT IDNs (Refer to IDN 187).
> Total number of AT IDNs must be 8 or less.
> Total number of bytes transferred must be 20 or less.

This IDN must be written when IDN 15 = 7. (Custom Telegram)

Conversion Scaling Factor: 1

Data Length: 2 bytes data - Variable Length

Access State: Read/Write in Phase 2
Read-only in Phase 3 and 4

IDN 17: IDN List Of All Operation Data

Parameter Data IDN

IDN ID Number List

The Master receives a list of valid IDNs when this IDN is read. Refer to section 3.3 for a complete listing of supported IDNs.

Conversion Scaling Factor: 1

Data Length: 2 bytes data - Variable Length

Access State: Read-only by the Master

IDN 18: IDN List Of Operation Data For CP2

Parameter Data IDN

IDN ID Number List

List of required operational data which must be received by the PCE840 before a change to phase 3 can proceed. There are 10 IDNs required: 1, 2, 6, 7, 8, 9, 10, 15, 32, and 89. Typically, only IDN15 and IDN32 must be configured by the developer, because most SERCOS masters set the others.

A valid waveshape must exist prior to phase 3. The PCE840 has a default value, which allows access into phase 3. Partially overwriting the waveshape will prevent access into CP3.

Conversion Scaling Factor: 1

Data Length: 2 bytes data - Variable Length

Access State: Read-Only by the Master

IDN 19: IDN List Of Operation Data For CP3

Parameter Data IDN

IDN ID Number List

List of required operational data which must be received by the PCE840 before a change to phase 4 can proceed. The PCE840 does not require any data in CP3.

Conversion Scaling Factor:	1
Data Length:	2 bytes data - Variable Length
Access State:	Read-only by the Master

IDN 21: IDN List Of Invalid Operation Data For CP2

Parameter Data IDN

IDN ID Number List

List of required operational data which has not been received by the PCE840 before a change in phase to phase 3 can proceed.

Conversion Scaling Factor:	1
Data Length:	2 bytes data - Variable Length
Access State:	Read-only by the Master

IDN 22: IDN List Of Invalid Operation Data For CP3

Parameter Data IDN

IDN ID Number List

List of required operational data which has not been received by the PCE840 before a change in phase to phase 4 can proceed.

Conversion Scaling Factor:	1
Data Length:	2 bytes data - Variable Length
Access State:	Read-only by the Master

IDN 24: Configuration List Of MDT

Parameter Data IDN

IDN ID Number List

List of IDNs which are not included in a User Defined AT. The data contained in this list is governed by the following restrictions:

> Each IDN must be included in the list of Valid AT IDNs (Refer to IDN 188).
> Total number of AT IDNs must be 8 or less.
> Total number of bytes transferred must be 20 or less.

This IDN must be written when IDN 15 = 7. (Custom Telegram)

Conversion Scaling Factor:	1
Data Length:	2 bytes data - Variable Length
Access State:	Read/Write in Phase 2 Read-Only in Phase 3 and 4

IDN 25: IDN list of all procedure commands

Parameter Data IDN

IDN ID Number List

List of all COMMAND IDNs supported by the PCE840 (IDN99, IDN127,IDN128, IDN148, IDN170, IDN263, IDN264).

Conversion Scaling Factor:	1
Data Length:	2 bytes data - Variable Length
Access State:	Read-only by the Master

IDN 28: MST Error Counter

Parameter Data IDN

Unsigned Decimal Number

Counts all invalid MSTs in communication phases 3 and 4.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65535
Access State:	Read by the Master Write only 0

IDN 29: MDT Error Counter

Parameter Data IDN

Unsigned Decimal Number

Counts all invalid MDTs in communication phase 4.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65535
Access State:	Read by the Master Write only 0

IDN 30: Manufacturer Version

Parameter Data IDN

Text Data String

The operation data of the manufacturer version contains the constant string “Pacific Scientific.”

Conversion Scaling Factor:	1
Data Length:	1 byte data - Variable length
Access State:	Read-only by the Master

IDN 32: Primary Operation Mode

Parameter Data IDN

Unsigned Decimal Number

The mode of operation is sent by the Master to the PCE840 during Phase 2 with this IDN. Valid modes of operation are velocity, position and torque mode.

Mode 1: Torque Mode - Allows the use of IDN 80 (Torque Command) over the Service Channel to control torque of drive.

Mode 2 : Velocity Mode - Allows use of IDN 36 (Velocity Command) over the Service Channel to control speed of drive.

Mode 3 : Position Mode - Allows use of IDN 47 (Position Command) over the Cyclic and Service Channel to control position of drive.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	1
Maximum Value:	3
Access State:	Read/Write in Phase 2 Read-Only in Phase 3 and 4

IDN 36: Velocity Command Value

Parameter Data IDN

Signed Decimal Number

Gives access to the instantaneous Velocity Command value of the PCE840.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Motor velocity (RPM) / [(IDN 45)*10^(IDN 46)]
Minimum Value:	-2,147,483,647
Maximum Value:	-2,147,483,647
Master Read:	Reads the instantaneous Velocity Command from the PCE840
Master Write:	**Position Mode**: Always overwritten by new Velocity Command generated from the Position Command **Velocity Mode**: Sets the Velocity Command of the PCE840
Access State:	Read/Write in phases 2-4

IDN 40: Velocity Feedback Value

Parameter Data IDN
Signed Decimal Number

Gives access to the instantaneous Velocity Feedback value of the PCE840.

Conversion Scaling Factor: 1
Data Length: 4 bytes
Units: Motor velocity (RPM) / [(IDN 45)*10^(IDN 46)]
Minimum Value: -2,147,483,647
Maximum Value: 2,147,483,647
Master Read: Reads the instantaneous Velocity Feedback from the PCE840

IDN 41: Homing Velocity

Parameter Data IDN
Signed Decimal Number

Sets the velocity a home command is processed at. For example, if IDN 45 = 1, IDN 46 = -3, then LSB weight of IDN 41 = 0.001 RPM.

Conversion Scaling Factor: 1
Data Length: 4 bytes
Units: Motor velocity (RPM) / [(IDN 45)*10^(IDN 46)]
Minimum Value: -2,147,483,647
Maximum Value: 2,147,483,647
Access State: Read/Write in phases 2-4

IDN 42: Homing Acceleration

Parameter Data IDN
Unsigned Decimal Number

Sets the acceleration a home command is processed at. For example, if IDN 161 = 1 and IDN 162 = -3 then LSB weight of IDN 42 = 0.001 RPM/Sec.

Conversion Scaling Factor: 1
Data Length: 4 bytes
Units: Motor velocity (RPM/Sec) / [(IDN 161*10^(IDN 162)]
Minimum Value: 1
Maximum Value: 4,294,967,295
Access State: Read/Write in phases 2-4

IDN 43: Velocity Polarity Parameter

Parameter Data IDN

Binary Data

Defines the polarity of the velocity data (IDNs 36 and 40).

Bit Number	**Bit Setting** (1 = Inverted, 0 = Non-Inverted)
Bit 0	Controls velocity command data
Bit 1	Must be zero
Bit 2	Controls velocity feedback data
Bits 3 – 15	Reserved and must be zero

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0x0
Maximum Value:	0x0005
Access State:	Read/Write in phases 2-4

IDN 44: Velocity Data Scaling Type

Parameter Data IDN

Binary Data

Defines the scaling type for the PCE840. For the PCE840, IDN 44 = 0xA.

Bit Number	**Bit Setting**
Bits 0 - 2	010 : Rotational Scaling
Bit 3	1 : Parameter Scaling
Bit 4	0 : Revolutions
Bit 5	0 : Minutes
Bit 6	0 : At the Motor Shaft

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0xA
Maximum Value:	0xA
Access State:	Read-only by the Master

IDN 45: Velocity Data Scaling Factor

Parameter Data IDN
Unsigned Decimal Number

All velocity data (IDNs 36, 40 and 41) are scaled by the following formula: (IDN 45)*10^(IDN 46).

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 1
Maximum Value: 65535
Access State: Read/Write by the Master

IDN 46: Velocity data scaling exponent

Parameter Data IDN
Signed Decimal Number

All velocity data (IDNs 36, 40 and 41) are scaled using the following formula: (IDN 45)*10^(IDN 46).

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: -32768
Maximum Value: 32768
Access State: Read/Write by the Master

IDN 47: Position Command Value

Parameter Data IDN
Signed Decimal Number

Allows the Master to have access to the instantaneous Position Command value of the PCE840 drive. The value is scaled by IDN 79.

Conversion Scaling Factor: 1
Data Length: 4 bytes
Units: resolver or encoder counts * (65536 / (IDN 79)) (depending on feedback device used)
Minimum Value: -2,147,483,647
Maximum Value: 2,147,483,647
Master Read: Reads the instantaneous Position Command Value
Master Write: Sets the instantaneous Position Command Value. This value will be overwritten by the Position Feedback Data when the drive is not enabled. This value sent over the Service Channel will be overwritten by any applicable cyclic channel data.
Access State: Read/Write in phases 2-4

IDN 51: Position Feedback Value 1

Parameter Data IDN

Signed Decimal Number

Allows the Master to have access to the instantaneous Position Feedback value of the PCE840 drive. The value is scaled by IDN 79.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	resolver or encoder counts * ((IDN 79) / 65536) (depending on feedback device used)
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Master Read:	Reads the instantaneous Position Command Value

IDN 52: Reference Distance 1

Parameter Data IDN

Signed Decimal Number

Programmable Position offset used during Home Commands. The value is scaled by IDN 79.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	resolver or encoder counts * (65536 / (IDN 79)) (depending on feedback device used)
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Master Read:	Read/Write in phases 2-4

IDN 55: Position Polarity Parameter

Parameter Data IDN

Binary Data

Defines the Position Polarity Parameters.

Bit Number	**Bit Setting** (1 = Inverted, 0 = Non-Inverted)
Bit 0	Position Command Data (IDN 47)
Bit 1	Must be zero
Bit 2	Position Feedback Data (IDN 51)
Bit 3	Must be zero
Bit 4	Must be zero

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	5
Access State:	Read in phases 2-4 Write in phase 2

IDN 76: Position Data Scaling Type

Parameter Data IDN

Binary Data

Defines the position scaling type for the PCE840.

Bit Number	Bit Setting
Bits 0 - 2	010 : Rotational Scaling
Bit 3	1 : Parameter Scaling
Bit 4	0 : Degrees
Bit 5	0 : Reserved
Bit 6	0 : At the Motor Shaft
Bit 7	0/1:0=>Absolute Format 1 => Modulo Format (IDN 103)

Only Bit 7 may be changed by the Master while in phase 2. All other bits are Read Only. Trying to change them results in a Service Channel error.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0x0A
Maximum Value:	0x8A
Access State:	Read/Write in phase 2 Read-only in phase 4

IDN 77: Linear Position Data Scaling Factor

Parameter Data IDN

Unsigned Decimal Number

All position data IDNs (IDNs 47, 51, 52, 103, 130, 131, 132, 133, 159, and 189) are scaled according to the formula (IDN 77)*10^(IDN 78).

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	1
Maximum Value:	65535
Access State:	Read-only by the Master

IDN 78: Linear Position Data Scaling Exponent

Parameter Data IDN

Signed Decimal Number

All position data IDNs (IDNs 47, 51, 52, 103, 130, 131, 132, 133, 159 and 189) are scaled according to the formula (IDN 77)*10^(IDN 78).

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	-32,768
Maximum Value:	32,767
Access State:	Read-only by the Master

IDN 79: Rotational Position Resolution

Parameter Data IDN

Unsigned Decimal Number

All position data is scaled using IDN 79. Command IDNs (IDNs 47, 52, 103) are scaled by (65536 / (IDN 79)). Feedback IDNs (IDNs 51, 130, 131, 132, 133, 189) are scaled by ((IDN 79 / 65536). If IDN 79 = 32768 counts per revolution, the position data is scaled by 65536 / 32768=2or32768 / 65536 = ½. If IDN 47 = 1000 units*2=2000 units. If IDN 51 = 3000 units *1/2 = 1500 units.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	percent
Minimum Value:	0
Maximum Value:	2,147,483,647
Access State:	Read/Write in phases 2-4

IDN 80: Torque Command Value

Parameter Data IDN

Signed Decimal Number

Gives access to the instantaneous torque value of the PCE840.

Conversion Scaling Factor:	0.001 Amps (1000 = 1 Amps)
Data Length:	2 bytes
Minimum Value:	-32768
Maximum Value:	32767
Master Read:	Reads the instantaneous current command of the PCE840
Master Write:	**Position and Velocity Mode**: Always overwritten by new current command generated by the velocity loop **Torque Mode**: Sets the current command of the PCE840
Access State:	Read/Write in phases 2-4

IDN 82: Positive Torque Limit Value

Parameter Data IDN

Unsigned Decimal Number

Value of IlmtPlus corresponds to the clockwise direction of the motor and is set in % increments.

Conversion Scaling Factor:	0.1
Data Length:	2 bytes
Units:	percent of peak current rating of the drive
Minimum Value:	0
Maximum Value:	100
Access State:	Read/Write by the Master in phases 2-4

IDN 83: Negative Torque Limit Value

Parameter Data IDN

Unsigned Decimal Number

Value of IlmtPlus corresponds to the counter-clockwise direction of the motor and is set in % increments.

Conversion Scaling Factor:	0.1
Data Length:	2 bytes
Units:	percent of peak current rating of the drive
Minimum Value:	0
Maximum Value:	100
Access State:	Read/Write by the Master in phases 2-4

IDN 84: Torque Feedback Value

Parameter Data IDN

Signed Decimal Number

Gives access to the instantaneous Torque Feedback Value of the PCE840.

Conversion Scaling Factor:	0.001 Amps (1000 = 1 Amps)
Data Length:	2 bytes
Minimum Value:	-32768
Maximum Value:	32767
Access State:	Read-only by the Master

IDN 85: Torque Polarity Parameter

Parameter Data IDN

Binary Data

Defines the Torque Polarity Parameters.

Bit Number	**Bit Setting** (1 = Inverted, 0 = Non-Inverted)
Bit 0	Torque command value
Bit 1	Additive Torque command value – Must be zero
Bit 2	Torque feedback value
Bits 3-15	Reserved and must be zero

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	5
Access State:	Read/Write in phase 2 Read-only by the Master in Phases 3-4

IDN 88: Receive To Receive Recovery Time

Parameter Data IDN

Unsigned Decimal Number

Required time for the PCE840 between the end of the MDT and the beginning of the next MST.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	µs
Minimum Value:	350
Maximum Value:	350
Access State:	Read-only by the Master

IDN 89: MDT Transmission Starting Time

Parameter Data IDN

Unsigned Decimal Number

Value sent by the Master to indicate the starting time in uSec of the MDT. This value is calculated and written by the master during phase 2.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	µs
Minimum Value:	1
Maximum Value:	64000
Access State:	Read/Write by the Master in Phase 2

IDN 90: Command Value Proceeding Time

Parameter Data IDN

Unsigned Decimal Number

Value read by the Master indicating how soon after the MDT the PCE840 can make the received data available for usage.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	µs
Minimum Value:	1
Maximum Value:	64000
Access State:	Read-only by the Master

IDN 95: Diagnostic Message

Parameter Data IDN

Text Data String

The diagnostic messages are generated by the drive as text and stored in the operation data of this IDN. If IDN 129 = 0x0314 (Faultcode = 20 and ExtFault = 3) the diagnostic message will be “Initialization Fault. Calibration data corrupted. Fatal Fault.”

Conversion Scaling Factor:	1
Data Length:	1 byte data - Variable length
Access State:	Read-only by the Master

IDN 96: Slave Arrangement 0

Parameter Data IDN

Binary Data

The PCE840 returns its axis address in both the low and high byte of this IDN. The PCE840 is not capable of supporting multiple motors on a single drive. Valid axis is not capable of supporting multiple motors on a single drive. Valid axis

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0x0101
Maximum Value:	0xFEFE
Access State:	Read-only by the Master

IDN 99: Reset Class 1 Diagnostic

Command Data IDN

Unsigned Decimal Number

Command Procedure IDN : Used to clear recorded faults in the PCE840. Faults, which cause the PCE840 to cycle back to phase 0 are recorded and saved for transmission in phase 2. The PCE840 will automatically notify the Master upon completion of this Command IDN. While this Command IDN is being performed, other service channel IDNs may be processed. Write 3 to IDN 99 to initiate Reset Class 1 Diagnostics (this will reset the fault and disable the drive). Write 0 to IDN 99 to de-activate the fault reset command. The drive cannot be enabled while fault reset is asserted.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	3
Access State:	Read/Write by the Master in phases 2-4

IDN 100: Velocity Loop Proportional Gain

Parameter Data IDN

Unsigned Decimal Number

Allows the master to set the value of kvp (Amp/rad/sec). IDN 100 = kvp / (Ipeak * 193.38e-6).

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65534
Access State:	Read/Write by the Master in phases 2-4

IDN 101: Velocity Loop Integral Gain

Parameter Data IDN

Unsigned Decimal Number

Allows the master to set the value of kvi (Hz). IDN 101 = kvi * 51.4719.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	1
Maximum Value:	65535
Access State:	Read/Write by the Master in phases 2-4

IDN 103: Modulo Value

Parameter Data IDN

Unsigned Decimal Number

If bit 7 of IDN 76 is set to modulo format, the modulo value defines the range that the drive and control must implement. This IDN is scaled by IDN 79.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Modulo value * (65536 / (IDN 79))
Minimum Value:	10
Maximum Value:	2,147,483,647
Access State:	Read/Write in phase 2 Read-only in phases 3 and 4

IDN 104: Position Loop Kp-Factor

Parameter Data IDN

Unsigned Decimal Number

Allows the master to set the value of kpp (Hz). IDN 104 = kpp / 2.4324e-3 (for resolver feedback). IDN104=4*kpp/2.4324e-3 (for encoder feedback).

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65534
Access State:	Read/Write by the Master in phases 2-4

IDN 106: Current Loop Proportional Gain 1

Parameter Data IDN

Unsigned Decimal Number

Allows the master to set the value of kip (Volts/Ampere). IDN 106 = kip * I_{peak} * 405.6685e-3.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	62000
Access State:	Read/Write by the Master in phases 2-4

IDN 107: Current Loop Integral Action Time 1

Parameter Data IDN

Unsigned Decimal Number

Allows the master to set the value of kii (Hz). IDN 107 = kii * 12.868.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65535
Access State:	Read/Write by the Master in phases 2-4

IDN 110: Amplifier Peak Current

Parameter Data IDN

Unsigned Decimal Number

Contains the amplifier peak current.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	mA
Minimum Value:	0
Maximum Value:	4,294,967,295
Access State:	Read-only by the Master

IDN 127: Communication Phase 3 Transition Check

Command Data IDN

Binary Data

Command Procedure IDN used to check whether the PCE840 is ready to proceed into phase 3. This IDN must be performed and successfully completed prior to going into phase 3. If all IDNs identified in IDN 18 have not been completed, or if the waveshape is incomplete, or if this IDN is not performed and the Master goes to phase 3, the PCE840 will declare a fault and go to phase 0.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	3
Access State:	Read/Write by the Master in phase 2

IDN 128: Communication Phase 4 Transition Check

Command Data IDN

Binary Data

Command Procedure IDN used to check whether the PCE840 is ready to proceed into phase 4. This IDN must be performed and successfully completed prior to going into phase 4. If all IDNs identified in IDN 19 have not been completed, or if the waveshape is incomplete, or if this IDN is not performed and the Master goes to phase 4, the PCE840 will declare a fault and go to phase 0.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	3
Access State:	Read/Write by the Master in phase 3

IDN 129: Manufacturer Class 1 Diagnostic

Parameter Data IDN

Binary Data

The data in this IDN contains the current manufacturer specific fault code. If no fault is present in the PCE840, this value will be zero.

The low byte of the data is the Fault Code that is displayed on the PCE840 drive.

The high byte of the data is the Extended Fault Code. If the fault code has an associated extended fault code, it will be displayed here. Most fault codes do not have extended fault codes.

FaultCode	Fault Description
1	Velocity feedback (VelFB) over speed*
2	Motor over temperature
3	User +5V low
4	Continuous current fault
5	Drive over current (instantaneous)
6	Control ±12 V under voltage
7	Not Assigned
9	Bus over voltage detected by DSP, External Regen Fault
10	Not Assigned
11	Bus under voltage* (Only if VBus < VBusThresh)
12	Ambient temperature too low
13	Encoder alignment failed*
14	Software and non-volatile memory versions not compatible
15	Hardware not compatible with software version
16	UnConfigured drive fault
17	Two AInNull events too close together
18	Position following error fault
19	Parameter memory error*
20	Initialization fault*
21	Drive over temperature
22	Resolver Fault

*To further identify this fault see software ExtFault table.

IDN 129 (*Continued*)

ExtFault The following table lists the values for ExtFault.

ExtFault	ExtFault Description
1	Absolute Resolver Overspeed. |VelFB| > 21038 RPM
2	Variable Resolver Overspeed. |VelFB| > max(VelLmtxx)*1.5
3	Calibration data corrupted*
4	Excessive DC offset in current feedback sensor*
5	DSP incompletely reset by line power dip*
8	Excessive DC offset in Analog Command A/D*
9	Not Assigned
10	DSP stack overflow*
12	Software and control card ASIC incompatible*
13	Actual Model not same as stored in NV memory*
14	Unable to determine power stage*
15	Drive non-volatile parameters corrupt*
16	RAM failure*
17	Calibration RAM failure*
18	Encoder alignment: no motion fault
19	Encoder alignment: excessive motion fault
20	Encoder alignment: motor not settled
21	Encoder alignment: test failed
22	Encoder alignment: motion overflow fault
23	Hall Commutation: invalid configuration
24	Hall Commutation: overspeed
25	Hall Commutation: invalid hall state
26	Hall Commutation: invalid hall transition
27	I*t Drive
28	I^2*t Motor
29	DP RAM Test A *
30	DP RAM Test 5 *
31	DP RAM Test Run 1*
32	DP RAM Test Run 0 *

Continued….

IDN 129 (*Continued*)

ExtFault (*Continued*)

ExtFault	ExtFault Description
33	DP RAM Test C *
65	Data Read Only
66	Data Bounds Error
67	Execute no such command
68	RT not Implemented
69	FC not Implemented

*These fault states CANNOT be reset with the Fault Reset function and require the line control power to be turned OFF and ON again.

IDN 130: Probe Value 1 Positive Edge

Parameter Data IDN

Signed Decimal Number

Returns the position value latched by the PCE840 drive when a rising edge of the Probe 1 signal has occurred. The position is either in resolver or encoder counts depending on the feedback device used to close the position loop. This value is scaled using IDN 79.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Probe Value *((IDN 79) / 65536)
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read-only by the Master

IDN 131: Probe Value 1 Negative Edge

Parameter Data IDN

Signed Decimal Number

Returns the position value latched by the PCE840 drive when a falling edge of the Probe 1 signal has occurred. The position is either in resolver or encoder counts depending on the feedback device used to close the position loop. This value is scaled using IDN 79.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Probe Value *((IDN 79) / 65536)
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read-only by the Master

IDN 132: Probe Value 2 Positive Edge

Parameter Data IDN

Signed Decimal Number

Returns the position value latched by the PCE840 drive when a rising edge of the Probe 2 signal has occurred. The position is either in resolver or encoder counts depending on the feedback device used to close the position loop. This value is scaled using IDN 79.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Probe Value *((IDN 79) / 65536)
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read-only by the Master

IDN 133: Probe Value 2 Negative Edge

Parameter Data IDN

Signed Decimal Number

Returns the position value latched by the PCE840 drive when a falling edge of the Probe 2 signal has occurred. The position is either in resolver or encoder counts depending on the feedback device used to close the position loop. This value is scaled using IDN 79.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Probe Value *((IDN 79) / 65536)
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read-only by the Master

IDN 134: Master Control Word

Parameter Data IDN

Unsigned Decimal Number

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65536
Access State:	Read-only by the Master

IDN 135: Drive Status Word

Parameter Data IDN

Unsigned Decimal Number

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65536
Access State:	Read-only by the Master

IDN 140: Controller Type

Parameter Data IDN

Text Data String

Allows the Master to read a TEXT description of the drive model number (PCE843).

Conversion Scaling Factor: 1

Data Length: 1 Byte data - Variable length

IDN 142: Application Type

Parameter Data IDN

Text Data String

Allows the Master to read a TEXT description of the Application (Pacific Scientific Drive).

Conversion Scaling Factor: 1

Data Length: 1 Byte data - Variable length

IDN 143: Application Type

Parameter Data IDN

Text Data String

Allows the Master to read a TEXT description of the SERCOS specification which the PCE840 was designed to : V01.02

Conversion Scaling Factor: 1

Data Length: 1 Byte data - Variable length

IDN 147: Homing parameter

Parameter Data IDN

Binary Data

Defines the HOME parameters used by the PCE840.

Home Mode	**IDN147 Value Hex (Dec)**
Current Position is Home	0x77 (119)
Home to Marker CW Direction	0x34 (52)
Home to Marker CCW Direction	0x35 (53)
Home to Switch CW Direction	0x54 (84)
Home to Switch CCW Direction	0x55 (85)
Home to Positive Edge of Switch then Marker CW Direction	0x14 (20)
Home to Positive Edge of Switch then Marker CCW Direction	0x15 (21)
Home to Negative Edge of Switch then Marker CW Direction	0x16 (22)
Home to Negative Edge of Switch then Marker CCW Direction	0x17 (23)

Only Bits 0, 1, 5 and 6 may be changed by the Master while in phases 2-4. All other bits are Read Only, trying to change them results in a Service Channel error.

Writing 0x77 to IDN 147 makes the current motor position the home (zero) position.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0x0014
Maximum Value: 0x0077
Access State: Read/Write by Master in phases 2-4

IDN 148: Drive controlled homing procedure

Command Data IDN
Binary Data

Command Procedure IDN used to initiate a Home event on the PCE840. During the Home event, all velocity and position data received from the Master is ignored with the exception of Home Velocity (IDN 41) and Home Acceleration (IDN 42). Once the drive has finished the HOME event, the Position Feedback Value Status will be set (IDN 403). The Master must read the new position at this time and begin sending updated Position Commands prior to finishing this Command IDN to avoid Excessive Position Error Faults.

To execute homing more than once, reset IDN 148 by writing 0 and then 3.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0 (deactivate drive controlled homing)
Maximum Value: 3 (activate drive controlled homing)
Access State: Read/Write by the Master in phases 2-4

IDN 159: Monitoring Window

Parameter Data IDN
Unsigned Decimal Number

Sets the Maximum Position Deviation allowed by the PCE840.

Conversion Scaling Factor: 16
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 65535
Access State: Read/Write by the Master in phases 2-4

IDN 160: Acceleration Data Scaling Type

Parameter Data IDN

Binary Data

Defines the scaling type for the PCE840.

Bit Number	Bit Setting
Bits 0-2	010 : Rotational Scaling
Bit 3	1 : Parameter Scaling
Bit 4	0 : Radian
Bit 5	0 : Seconds
Bit 6	0 : At the motor shaft

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0x0A
Maximum Value:	0x0A
Access State:	Read-only by the Master

IDN 161: Acceleration Data Scaling Factor

Parameter Data IDN

Unsigned Decimal Number

Sets the Maximum Position Deviation allowed by the PCE840.

Conversion Scaling Factor:	16
Data Length:	2 bytes
Minimum Value:	1
Maximum Value:	65535
Access State:	Read/Write by the Master in phases 2-4

IDN 162: Acceleration Data Scaling Exponent

Parameter Data IDN

Signed Decimal Number

All acceleration data is scaled by the following formula: (IDN 161)*10^(IDN 162)

Conversion Scaling Factor:	16
Data Length:	2 bytes
Minimum Value:	-32766
Maximum Value:	32765
Access State:	Read/Write by the Master in phases 2-4

IDN 169: Probe Control Parameter

Parameter Data IDN

Binary Data

Defines the PROBE parameters used by the PCE840.

Bit Number	Bit Setting
Bit 0: Probe 1 Positive Edge	0 => Positive edge is not active 1 => Positive edge is active
Bit 1: Probe 1 Negative Edge	0 => Negative edge is not active 1 => Negative edge is active
Bit 2: Probe 2 Positive Edge	0 => Positive edge is not active 1 => Positive edge is active
Bit 3: Probe 2 Negative Edge	0 => Negative edge is not active 1 => Negative edge is active

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 0x0F
Access State: Read/Write by Master in phases 2-4

IDN 170: Probing Cycle Procedure Command

Command Data IDN

Binary Data

Command Procedure IDN used to initiate PROBE events on the PCE840. While this IDN is active, all probe events described in IDN 169, and enabled by IDN 405 and 406 are allowed to be recorded. This command must be activated in order for PROBE events to occur. Please refer to Section 3.5, Interfaces and Connections for additional information.

To activate probing, write 3 to IDN 170.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 3
Access State: Read/Write by Master in phases 2-4

IDN 185: Length Of The Configurable Data Record In The AT

Parameter Data IDN

Unsigned Decimal Number

Maximum number of bytes allowed in the AT as configurable data is 20 bytes.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65535
Access State:	Read-only by the Master

IDN 186: Length Of The Configurable Data Record In The MDT

Parameter Data IDN

Unsigned Decimal Number

Maximum number of bytes allowed in the MDT as configurable data is 20 bytes.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	65535
Access State:	Read-only by the Master

IDN 187: IDN List Of The Configurable Data In The AT

Parameter Data IDN

IDN ID Number List

List of IDNs available for entry into the AT configuration list.

IDN	IDN Description	IDN	IDN Description
40	Velocity Feedback	400	Home Switch
51	Position Feedback	32857	Resolver Position
84	Torque Feedback	32878	Digital Command Counts
130	Probe Value 1 Positive Edge	32879	Digital Command Frequency
131	Probe Value 1 Negative Edge	34824	Input Port
132	Probe Value 2 Positive Edge	34825	Analog Input
133	Probe Value 2 Negative Edge	34826	Encoder Position
189	Following Distance		

Conversion Scaling Factor:	1
Data Length:	2 bytes data – Variable length
Access State:	Read/Write by Master in phases 2-4

IDN 188: IDN List Of The Configurable Data Record In The MDT

Parameter Data IDN
IDN ID Number List

List of IDNs available for entry into the MDT configuration list.

IDN	IDN Description
36	Velocity Command
47	Position Command
80	Torque Command
32880	Analog Output 1
32881	Analog Output 2
34840	Output Port

Conversion Scaling Factor:	1
Data Length:	2 bytes data – Variable length
Access State:	Read-only by the Master

IDN 189: Following Distance

Parameter Data IDN
Signed Decimal Number

Allows the Master to read the current instantaneous Position Error. This value is scaled by IDN 79.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Following Distance * ((IDN 79) / 65536)
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read-only by the Master

IDN 192: IDN list of backup operation data

Parameter Data IDN

IDN ID Number List

List of IDNs stored to and from non-volatile memory.

IDN	IDN Description	IDN	IDN Description
15	Telegram Type Parameter	32818	InpMap2
32	Primary Operation Mode	32819	InpMap3
41	Homing Velocity	32820	InpMap4
42	Homing Acceleration	32821	InpMap5
55	Position Polarity Parameter	32822	InpMap6
76	Position Data Scaling Type	32823	EncInFilt
82	Positive Torque Limit Value	32824	RemoteFB
83	Negative Torque Limit Value	32826	CommOff
100	Velocity Loop Proportional Gain	32828	Encoder Input (EncIn)
101	Velocity Loop Integral Action Time	32829	ITThresh
103	Modulo Value	32830	StopTime
104	Position Loop Kv Factor	32831	VBusThresh
106	Current Loop Proportional Gain 1	32832	VelLmtHi
107	Current Loop Integral Action Time 1	32833	VelLmtLo
140	Controller Type	32835	CoastTime
147	Homing Parameter	32837	Motor 1 Name
159	Monitoring Window	32838	Motor 2 Name
32807	Pole Count	32840	Kvff
32809	Filter Value for ADF0	32841	ARZ0
32810	DM1F0	32842	ARZ1
32811	DM2F0	32843	ARF0
32812	DM1Gain	32844	ARF1
32813	DM2Gain	32846	Encoder Data Scaling Method
32814	DM1Map - Mux Select	32847	Encoder Modulo Value
32815	DM2Map - Mux Select	32853	CommSrc (Commutation Source)
32816	Encoder Output (EncOut)	32866	ADOffset
32817	InpMap1		

Conversion Scaling Factor:	1
Data Length:	2 bytes data
Access State:	Read-only by the Master

IDN 194: Acceleration Command

Parameter Data IDN

Unsigned Decimal Number

Sets the acceleration rate a velocity command is processed at. Acceleration = Deceleration.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Motor acceleration(RPM/sec) / [(IDN 161)*10^(IDN 162)]
Minimum Value:	1
Maximum Value:	4,294,967,295
Access State:	Read/Write in phases 2-4

IDN 263: NVLoad

Command Data IDN

Unsigned Decimal Number

Commmand Procedure IDN used to load saved IDNs from Non-Volatile (NV) memory to the drive's active memory. IDN263 is typically executed in phase 2, eliminating the need to initialize many of the IDNs listed in IDN192. This will reduce the initialization time.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Motor acceleration(RPM/sec) / [(IDN 161)*10^(IDN 162)]
Minimum Value:	0 (False)
Maximum Value:	3 (True)
Access State:	Read/Write in phases 2-4

IDN 264: NVSave

Command Data IDN

Unsigned Decimal Number

Commmand Procedure IDN used to save IDNs to Non-Volatile (NV) memory from the drive's active memory. The master need not write to these IDNs as part of the drive initialization thereby substantially reducing the time required to bring the SERCOS ring to Phase 4.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	
Minimum Value:	0 (False)
Maximum Value:	3 (True)
Access State:	Read/Write in phases 2-4

IDN 301: Allocation Of Realtime Control Bit 1

Parameter Data IDN

Unsigned Decimal Number

The Master sends the number of an IDN whose data is a BIT variable. This BIT variable is then sent in the MDT cyclic Realtime Control Bit 1 data. Please refer to Section 3.5, Interfaces and Connections for additional information. The IDNs which can be used for Realtime Control bits are:

IDN	IDN Description
405	Probe 1 Enable
406	Probe 2 Enable
34833	Output Bit #1
34834	Output Bit #2
34835	Output Bit #3
34836	Output Bit #4

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0 (Off)
Maximum Value:	34836
Access State:	Read/Write by Master in phases 2-4

IDN 303: Allocation Of Realtime Control Bit 2

Parameter Data IDN

Unsigned Decimal Number

The Master sends the number of an IDN whose data is a BIT variable. This BIT variable is then sent in the MDT cyclic Realtime Control Bit 2 data. Please refer to Section 3.5, Interfaces and Connections for additional information. The IDNs which can be used for Realtime Control bits are:

IDN	IDN Description
405	Probe 1 Enable
406	Probe 2 Enable
34833	Output Bit #1
34834	Output Bit #2
34835	Output Bit #3
34836	Output Bit #4

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0 (Off)
Maximum Value:	34836
Access State:	Read/Write by Master in phases 2-4

IDN 305: Allocation Of Realtime Status Bit 1

Parameter Data IDN

Unsigned Decimal Number

The Master sends the number of an IDN whose data is a BIT variable. This BIT variable is then sent in the AT cyclic Realtime Status Bit 1 data. Please refer to Section 3.5, Interfaces and Connections for additional information.

The IDNs which can be used for Realtime Status bits are:

IDN	IDN Description
400	Home Switch
401	Probe 1
402	Probe 2
403	Position Feedback Value Status
409	Probe 1 Positive Latched
410	Probe 1 Negative Latched
411	Probe 2 Positive Latched
412	Probe 2 Negative Latched
34817	Input Bit #1
34818	Input Bit #2
34819	Input Bit #3
34820	Input Bit #4
34821	Input Bit #5
34822	Input Bit #6

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0 (Off)
Maximum Value:	34822
Access State:	Read/Write by Master in phases 2-4

IDN 307: Allocation Of Realtime Status Bit 2

Parameter Data IDN

Unsigned Decimal Number

The Master sends the number of an IDN whose data is a BIT variable. This BIT variable is then sent in the AT cyclic Realtime Status Bit 2 data. Please refer to Section 3.5, Interfaces and Connections for additional information.

The IDNs which can be used for Realtime Status bits are:

IDN	IDN Description
400	Home Switch
401	Probe 1
402	Probe 2
403	Position Feedback Value Status
409	Probe 1 Positive Latched
410	Probe 1 Negative Latched
411	Probe 2 Positive Latched
412	Probe 2 Negative Latched
34817	Input Bit #1
34818	Input Bit #2
34819	Input Bit #3
34820	Input Bit #4
34821	Input Bit #5
34822	Input Bit #6

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0 (Off)
Maximum Value:	34822
Access State:	Read/Write by Master in phases 2-4

IDN 400: Home Switch

Parameter Data IDN

Binary Data

Allows the Master to read the current state of the Home Switch. If more than one input is defined to be the Home Switch, the highest Input (1-6) is the value returned.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

IDN 401: Probe 1

Parameter Data IDN

Binary Data

Allows the Master to read the current state of the Probe 1 switch. The only input pin which can be defined as Probe 1 is Input 4.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

IDN 401: Probe 2

Parameter Data IDN

Binary Data

Allows the Master to read the current state of the Probe 2 switch. The only input pin which can be defined as Probe 2 is Input 5.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

IDN 403: Position Feedback Value Status

Parameter Data IDN

Binary Data

This bit is set by the PCE840 whenever a Home has been successfully completed. This bit starts off CLEARED upon initialization.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

IDN 405: Probe 1 Enable

Parameter Data IDN

Binary Data

This bit must be set by the Master (either by Cyclic or Service Channel) in order for Probe 1 Data to be latched. IDN 169 must specify the valid Probe edges to latch and IDN 170 must also be active for Probe 1 data to be latched. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read/Write by the Master

IDN 406: Probe 2 Enable

Parameter Data IDN

Binary Data

This bit must be set by the Master (either by Cyclic or Service Channel) in order for Probe 2 Data to be latched. IDN 169 must specify the valid Probe edges to latch and IDN 170 must also be active for Probe 2 data to be latched. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read/Write by the Master

IDN 409: Probe 1 Positive Latched

Parameter Data IDN

Binary Data

This bit is used to indicate that Probe 1 Positive Edge data has been latched by the PCE840. Reading IDN 130 will return the Probe data for this event. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

IDN 410: Probe 1 Negative Latched

Parameter Data IDN

Binary Data

This bit is used to indicate that Probe 1 Negative Edge data has been latched by the PCE840. Reading IDN 131 will return the Probe data for this event. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

IDN 411: Probe 2 Positive Latched

Parameter Data IDN

Binary Data

This bit is used to indicate that Probe 2 Positive Edge data has been latched by the PCE840. Reading IDN 132 will return the Probe data for this event. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

IDN 412: Probe 2 Negative Latched

Parameter Data IDN

Binary Data

This bit is used to indicate that Probe 2 Negative Edge data has been latched by the PCE840. Reading IDN 133 will return the Probe data for this event. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

3.8.2. Manufacturer-Specific IDNs

IDN 32800: DSP Debug Address

Parameter Data IDN

Binary Data

Used for Manufacturer Investigations. Master would write an address to access into this IDN.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 0xFFFF
Access State: Read/Write by the Master

IDN 32801: DSP Debug Word

Parameter Data IDN

Binary Data

Used for Manufacturer Investigations. Reading this IDN causes the WORD data located in the address specified in IDN 32800 to be read.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 0xFFFF
Access State: Read-only by the Master

IDN 32802: DSP Debug DWord

Parameter Data IDN

Binary Data

Used for Manufacturer Investigations. Reading this IDN causes the DWORD data located in the address specified in IDN 32800 to be read.

Conversion Scaling Factor: 1
Data Length: 4 bytes
Minimum Value: 0
Maximum Value: 0x0FFFFSFFFF
Access State: Read-only by the Master

IDN 32803 - 32806: ARM Debug Variables

Parameter Data IDN

Binary Data

Used for Manufacturer diagnostics. **DO NOT USE!**

IDN 32807: Pole Count

Parameter Data IDN

Unsigned Decimal Number

Number of motor poles used for motor commutation. For encoder based commutation:

$$\text{Polecount} = \frac{\text{Encoder counts / rev}}{(\text{motor poles / 2})}$$

IDN 32853 (CommSrc) must be set BEFORE IDN 32807. Refer to Section 3.9, Diagnostics and Protection Circuits for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	Motor poles
Minimum Value:	2
Maximum Value:	32766
Access State:	Read/Write by the Master in phase 2 Read/Write in phases 3 and 4

IDN 32809: Filter Values for ADF0

Parameter Data IDN

Unsigned Decimal Number

Sets the filter break frequency for the Analog Input. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	0.01 (100 = 1 Hz)
Data Length:	4 bytes
Units:	Hz
Minimum Value:	1
Maximum Value:	4.17e9
Access State:	Read/Write by the Master

IDN 32810: Filter Values for DM1F0

Parameter Data IDN

Unsigned Decimal Number

Sets the filter break frequency for DACMonitor 1. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	0.01 (100 = 1 Hz)
Data Length:	4 bytes
Units:	Hz
Minimum Value:	1
Maximum Value:	4.17e9
Access State:	Read/Write by the Master

IDN 32811: Filter Values for DM2F0

Parameter Data IDN

Unsigned Decimal Number

Sets the filter break frequency for DACMonitor 2. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	0.01 (100 = 1 Hz)
Data Length:	4 bytes
Units:	Hz
Minimum Value:	1
Maximum Value:	4,294,967,295
Access State:	Read/Write by the Master

IDN 32812: DM1Gain

Parameter Data IDN

Signed Decimal Number

Sets the analog output gain for DacMap 1. Scale factor depends on the setting of DacMap 1. Refer to Dac Monitor Map and Gain Units List. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	0.01 (100 = 1)
Data Length:	4 bytes
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read/Write by the Master

IDN 32813: DM2Gain

Parameter Data IDN

Signed Decimal Number

Sets the analog output gain for DacMap 2. Scale factor depends on the setting of DacMap 2. Refer to Dac Monitor Map and Gain Units List. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	0.01 (100 = 1)
Data Length:	4 bytes
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read/Write by the Master

IDN 32814: DM1Map – Mux Select

Parameter Data IDN

Unsigned Decimal Number

Refer to Dac Monitor Map and Gain Units List. Use the DMxMAP column for the desired function. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 75
Access State: Read/Write by the Master

IDN 32815: DM2Map – Mux Select

Parameter Data IDN

Unsigned Decimal Number

Refer to Dac Monitor Map and Gain Units List. Use the DMxMAP column for the desired function. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 75
Access State: Read/Write by the Master

IDN 32816: EncOut

Parameter Data IDN

Unsigned Decimal Number

Sets the line count of the emulated encoder. Writing 0 to this IDN internally connects the EncIn input pins to the EncOut output buffers.

125, 250, 500, 1000, 2000, 4000, 8000, 16000 lines/rev
128, 256, 512, 1024, 2048, 4096, 8192, 16384 lines/rev

The number of encoder counts per revolution is equal to 4 * encoder line count.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Units: Emulated encoder count
Minimum Value: 0
Maximum Value: 16384
Access State: Read/Write by the Master

IDN 32817: InpMap1

Parameter Data IDN

Binary Data

Refer to Input Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32818: InpMap2

Parameter Data IDN

Binary Data

Refer to Input Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32819: InpMap3

Parameter Data IDN

Binary Data

Refer to Input Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32820: InpMap4

Parameter Data IDN

Binary Data

Refer to Input Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32821: InpMap5

Parameter Data IDN

Binary Data

Refer to Input Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32822: InpMap6

Parameter Data IDN

Binary Data

Refer to Input Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32823: EncInFilt

Parameter Data IDN

Unsigned Decimal Number

Sets the break frequency of the input filters on the Encoder Input pins.

EncMode	Scaling	Encoder Input Filter Setting			
		High	Medium	Low	Lowest
(0) Quadrature	Max. Quadrature Freq.	1600000	800000	400000	200000
(1) StepDir	Max. Step Freq.	800000	200000	100000	50000
(2) Up/Down	Max. Step Freq.	800000	200000	100000	50000
(3) Hold Count	N/A	N/A	N/A	N/A	N/A

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Hz
Minimum Value:	50,000
Maximum Value:	16,000,000
Access State:	Read/Write by the Master

IDN 32824: RemoteFB

Parameter Data IDN

Unsigned Decimal Number

Determines the source of Velocity and Position Feedback. Must be set before IDN32853.

RemoteFB	Velocity Feedback	Position Feedback
0	Resolver	Resolver
1	Resolver	Encoder
2	Encoder	Encoder

Conversion Scaling Factor:	1
Data Length:	4 bytes
Minimum Value:	0
Maximum Value:	2
Access State:	Read/Write by the Master in Phase 2

IDN 32826: CommOff

Parameter Data IDN
Signed Decimal Number

Allows the commutation offset to be set. For Pacific Scientific motors this should be zero. For custom motors, this should be set for proper commutation.

Negative numbers will be returned as the positive equivalent angle (modulo 360).

Conversion Scaling Factor: 0.001
Data Length: 4 bytes
Units: Electrical degrees
Minimum Value: -360,000
Maximum Value: 360,000
Access State: Read/Write by the Master

IDN 32827: EncMode

Parameter Data IDN
Signed Decimal Number

Specifies the type of digital command expected at the incremental position command port.

EncMode	Description
0	Selects Quadrature Encoder Signals
1	Selects Step and Direction Signals
2	Selects Up/Down Count Signals
3	Ignores Signal Input and Locks DigitalCmdPosition

Conversion Scaling Factor: 1
Data Length: 4 bytes
Units: Electrical degrees
Minimum Value: 0
Maximum Value: 3
Access State: Read/Write by the Master

IDN 32828: EncIn

Parameter Data IDN

Unsigned Decimal Number

Allows the line count of input encoder to be defined. Must be set when RemoteFB (IDN 32824) = 1 or 2.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Encoder line count
Minimum Value:	1
Maximum Value:	65535
Access State:	Read/Write in phase 2 Read-only in phases 3 and 4

IDN 32829: ITThresh

Parameter Data IDN

Unsigned Decimal Number

Allows the fault threshold for the IT Fault to be adjusted.

Pacific Scientific Model Family	Minimum Value	Maximum Value
84X	0	64

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	percent
Minimum Value:	0
Maximum Value:	100
Access State:	Read/Write by the Master

IDN 32830: StopTime

Parameter Data IDN

Unsigned Decimal Number

The StopTime variable is associated with the RunStop I/O Function. It determines the maximum time after RunStop transitions to Stop that it will take the drive to disable. This IDN corresponds to an obsolete function. **DO NOT USE!**

Conversion Scaling Factor:	0.001
Data Length:	2 bytes
Units:	Seconds
Minimum Value:	2
Maximum Value:	32,000
Access State:	Read/Write by the Master

IDN 32831: VBusThresh

Parameter Data IDN

Signed Decimal Number

Allows the Bus Undervoltage threshold to be set. If set to a negative number, turns off the bus undervoltage fault.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	Volts
Minimum Value:	-1
Maximum Value:	1,000
Access State:	Read/Write by the Master

IDN 32832: VelLmtHi

Parameter Data IDN

Signed Decimal Number

Maximum value allowed for the velocity command into the velocity block. Also sets the overspeed fault threshold if [*VelLmtHi*] > [*VelLmtLo*]. Overspeed fault set at 1.5 * (max of (*VelLmtHi*, *VelLmtLo*)).

Conversion Scaling Factor:	0.001
Data Length:	4 bytes
Units:	RPM
Minimum Value:	-21,039,000
Maximum Value:	21,039,000
Access State:	Read/Write by the Master

IDN 32833: VelLmtLo

Parameter Data IDN

Signed Decimal Number

Minimum value allowed for the velocity command into the velocity block. Also sets the overspeed fault threshold if [*VelLmtHi*] > [*VelLmtLo*]. Overspeed fault set at 1.5 * (max of (*VelLmtHi*, *VelLmtLo*)).

Conversion Scaling Factor:	0.001
Data Length:	4 bytes
Units:	RPM
Minimum Value:	-21,039,000
Maximum Value:	21,039,000
Access State:	Read/Write by the Master

IDN 32835: Coast Time

Parameter Data IDN

Unsigned Decimal Number

Allows the amount of time the drive will coast for after the bus voltage drops below VBusThresh before generating undervoltage fault.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	Seconds
Minimum Value:	0
Maximum Value:	32
Access State:	Read/Write by the Master

IDN 32836: CommEnbl

Parameter Data IDN

Unsigned Decimal Number

Enables commutation of the motor current based on rotor position. When the drive powers up CommEnbl is set to 1. When CommEnbl is set to 0, the commutation angle of the current flowing in the motor windings is determined by the value of CommOff. When CommEnbl is set to 1, the commutation angle is determined by the sum of CommSrc feedback device electrical angle and the CommOff variable.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read/Write by the Master

IDN 32837: Motor 1 Name

Parameter Data IDN

Binary Data

The Motor variable is a 32-bit long unsigned long integer which is used to identify the waveshape downloaded to the PCE840 controller. By convention the 4 ASCII character abbreviation of the motor name is converted to an integer and downloaded along with the waveshape. For example, if this variable is 0x53494E45 = ‘S’ (0x53) : ‘I’ (0x49) : ‘N’ (0x4E) : ‘E’ (0x45). Used to assign a label to Wave Shape Generation Table created.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Minimum Value:	0
Maximum Value:	0xFFFFFFFF
Access State:	Read/Write in Phase 2 Read-only in Phase 3 and 4

IDN 32838: Motor 2 Name

Parameter Data IDN

Binary Data

The Motor variable is a 32-bit long unsigned long integer which is used to identify the waveshape downloaded to the PCE840 controller. By convention the 4 ASCII character abbreviation of the motor name is converted to an integer and downloaded along with the waveshape. Used to assign a label to Wave Shape Generation Table created.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Minimum Value:	0
Maximum Value:	0xFFFFFFFF
Access State:	Read/Write in Phase 2 Read-only in Phase 3 and 4

IDN 32840: Kvff

Parameter Data IDN

Unsigned Decimal Number

Allows following error to be reduced when running at a constant speed. When the drive is commanded to run at a constant speed, kvff = 1000 will reduce the steady state following error to zero, but will cause overshoot. A value of 700 is typically used.

Conversion Scaling Factor:	0.1
Data Length:	2 bytes
Units:	Percent
Minimum Value:	0
Maximum Value:	1,999
Access State:	Read/Write by the Master

IDN 32840: ARZ0

Parameter Data IDN

Unsigned Decimal Number

ARZ0 is the first velocity loop compensation zero. Please refer to Section 3.7, Servo Loop Parameters for additional information.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Hz
Minimum Value:	20
Maximum Value:	100,000
Access State:	Read/Write by the Master

IDN 32842: ARZ1

Parameter Data IDN

Unsigned Decimal Number

ARZ1 is the second velocity loop compensation zero. Please refer to Section 3.7, Servo Loop Parameters for additional information.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Hz
Minimum Value:	20
Maximum Value:	1,000,000
Access State:	Read/Write by the Master

IDN 32843: ARF0

Parameter Data IDN

Unsigned Decimal Number

ARF0 is the first velocity loop compensation anti-resonance low-pass filter corner frequency. Please refer to Section 3.7, Servo Loop Parameters for additional information.

Conversion Scaling Factor:	0.01
Data Length:	4 bytes
Units:	Hz
Minimum Value:	-10,000,000
Maximum Value:	10,000,000
Access State:	Read/Write by the Master

IDN 32844: ARF1

Parameter Data IDN

Unsigned Decimal Number

ARF1 is the second velocity loop compensation anti-resonance low-pass filter corner frequency. Please refer to Section 3.7, Servo Loop Parameters for additional information.

Conversion Scaling Factor:	0.01
Data Length:	4 bytes
Units:	Hz
Minimum Value:	-10,000,000
Maximum Value:	10,000,000
Access State:	Read/Write by the Master

IDN 32845: Firmware Version

Parameter Data IDN

Text

Allows the Master to read a TEXT description of the current versions fo the ARM and the DSP firmware: DSP Version 1.20, ARM version 6.0.

DSP and ARM versions continue to change with each build.

Conversion Scaling Factor:	1
Data Length:	Byte list
Access State:	Read-only by the Master

IDN 32846: Encoder Data Scaling Method

Parameter Data IDN

Binary Data

Sets the working parameters for the Encoder Position.

Bit Number	**Bit Setting** (1=Inverted, 0=Non-Inverted)
Bits 0-2	010 : Rotational Scaling
Bit 3	1 : Parameter Scaling
Bit 4	0 : Degrees
Bit 5	0 : Reserved
Bit 6	0 : At the Motor Shaft
Bit 7	0 : Absolute format 1 : Modulo format (IDN 32847)
Bit 8	0 : Non-Inverted Encoder Data 1 : Inverted Encoder Data

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0x0A
Maximum Value:	0x18A
Access State:	Read/Write in phase 2 Read-only in phases 3 and 4

IDN 32847: Encoder Modulo Value

Parameter Data IDN

Unsigned Decimal Number

Allows the master to set the Encoder Modulo value (IDN 32846).

Conversion Scaling Factor: 1

Data Length: 4 bytes

Minimum Value: 10

Maximum Value: 2,147,483,647

Access State: Read/Write in phase 2
Read-only in phases 3 and 4

IDN 32853: CommSrc

Parameter Data IDN

Unsigned Decimal Number

Selects between resolver, incremental encoder, or hall encoder feedback for motor commutation.

CommSrc	Feedback Device
0	Resolver
1	Encoder
2	Hall Encoder

CommSrc (IDN 32853) must be set BEFORE PoleCount (IDN 32807). RemoteFB (IDN32824) must be set before CommSrc (IDN32853).

Conversion Scaling Factor: 1

Data Length: 4 bytes

Minimum Value: 0

Maximum Value: 2

Access State: Read/Write in all phases

IDN 32857: Resolver Position

Parameter Data IDN

Unsigned Decimal Number

ResPos returns the absolute resolver position within one revolution. The PCE840 has 65536 resolver counts per revolution. This IDN will, therefore, return a value between 0 and 65535. This IDN is NOT affected by Position Modulo (IDN 103).

Conversion Scaling Factor: 1

Data Length: 2 bytes

Minimum Value: 0

Maximum Value: 65535

Access State: Read/Write by the Master in phases 2-4

IDN 32858: Last Fault Parameter Data IDN

Signed Decimal Number

Returns the last fault occurred in the drive. The value of this IDN is NOT cleared by a fault reset command. A user can clear Last Fault by explicity writing 0 to this IDN. See IDN 129 for description of faultcodes.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	22
Access State:	Read-only by the Master in phases 2-4

IDN 32859: Last ExtFault Parameter Data IDN

Signed Decimal Number

Returns the last extended fault occurred in the drive. The value of this IDN is NOT cleared by a fault reset command. A user can clear Last ExtFault by explicity writing 0 to this IDN. See IDN 129 for description of faultcodes.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	69
Access State:	Read-only by the Master in phases 2-4

IDN 32860: OutMap1 Parameter Data IDN

Binary Data

Refer to Output Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32861: OutMap2

Parameter Data IDN

Binary Data

Refer to Output Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32862: OutMap3

Parameter Data IDN

Binary Data

Refer to Output Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32863: OutMap4

Parameter Data IDN

Binary Data

Refer to Output Map List, Function Number Column for the desired function. Set High/Low Polarity bits as required. Please refer to Section 3.5, Interfaces and Connections for additional information.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0xFFFF
Access State:	Read/Write by the Master

IDN 32866: ADOffset

Parameter Data IDN

Signed Decimal Number

Adjusts the steady-state value of the analog command input.

Conversion Scaling Factor:	10,000
Data Length:	4 bytes
Units:	Volts
Minimum Value:	-150,000
Maximum Value:	150,000
Access State:	Read/Write by the Master

IDN 32870: I2tThresh

Parameter Data IDN

Unsigned Decimal Number

Allows I^2*t motor protection threshold value. If I2tFilt exceeds I2tThresh, the drive will fault.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	% of $Ipeak^2$
Minimum Value:	0
Maximum Value:	100
Access State:	Read/Write by the Master

IDN 32871: I2tF0

Parameter Data IDN

Unsigned Decimal Number

I2tF0 sets the low pass filter break frequency for the filter used to implement the I^2*t motor drive thermal protection.

I2tF0 and I2tThresh set the thermal protection for the motor. See IDN 32872 (I2tFilt). If I2tFilt exceeds I2tThresh, the drive will fault.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	Hz
Minimum Value:	1
Maximum Value:	1,000
Access State:	Read/Write by the Master

IDN 32872: I2tFilt

Parameter Data IDN

Unsigned Decimal Number

I2tFilt is the filtered value of the square of the currents flowing in the motor:

I2tFilt = $[(IU^2 + IV^2 + IW^2) * 100/Ipeak^2]$ low pass filtered by I2tF0 (IDN 32871)

When I2tFilt exceeds the threshold value specified by I2tThresh, the drive will fault.

Conversion Scaling Factor:	0.001
Data Length:	4 bytes
Units:	% of $Ipeak^2$
Minimum Value:	0
Maximum Value:	10,000,000
Access State:	Read-only by the Master

IDN 32873: HallState

Parameter Data IDN

Unsigned Decimal Number

HallState indicates the value of the hall sensors. HallState = (4*Hall 3) + (2*Hall 2) + (1*Hall 1)

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	7
Access State:	Read-only by the Master

IDN 32876: Offset Angle for Hall Sensors

Parameter Data IDN

Unsigned Decimal Number

HallOffset sets the offset angle for the hall sensors. Hall signals are to be wired as shown in the Pacific Scientific High Performance Servo Drives Catalog. By default it’s value is set to 0 degrees.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Units:	Electrical degrees
Minimum Value:	0
Maximum Value:	360
Access State:	Read/Write by the Master

IDN 32878: Digital Command Counts

Parameter Data IDN

Signed Decimal Number

DigitalCmd indicates the position of the external command encoder (J2-17 through J2-20) or the accumulation of step inputs if step-and-direction input format is used. By default it’s value is set = 0.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Encoder counts
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read by the Master in all phases

IDN 32879: Digital Command Frequency

Parameter Data IDN

Signed Decimal Number

DigitalCmdFreq indicates the frequency of the digital command signal. It is calculated from delta DigitalCmd at position loop update rate. Although the values returned do not have fractional parts this variable is communicated as a floating-point quantity. By default it’s value is set = 0.

Conversion Scaling Factor:	0.01
Data Length:	4 bytes
Units:	Hz
Minimum Value:	-300,000,000
Maximum Value:	300,000,000
Access State:	Read by the Master in all phases

IDN 32880: AnalogOut1

Parameter Data IDN

Signed Decimal Number

Allows the Master to set the voltage on Analog Output 1 when DacMap 1 equals zero. The scaling for this IDN is 5/128 Volts per least significant bit (lsb).

Conversion Scaling Factor:	0.001
Data Length:	2 bytes
Units:	Volts
Minimum Value:	-5,000
Maximum Value:	4,961
Access State:	Read/Write by the Master

IDN 32881: AnalogOut2

Parameter Data IDN

Signed Decimal Number

Allows the Master to set the voltage on Analog Output 2 when DacMap 2 equals zero. The scaling for this IDN is 5/128 Volts per least significant bit (lsb).

Conversion Scaling Factor:	0.001
Data Length:	2 bytes
Units:	Volts
Minimum Value:	-5,000
Maximum Value:	4,961
Access State:	Read/Write by the Master

IDN 32882: Analog Current Limit

Parameter Data IDN

Unsigned Decimal Number

Allows the Master the current limit set (float value) by the Analog Current Limit input (J2-6)

Conversion Scaling Factor:	0.01
Data Length:	2 bytes
Units:	% of Ipeak
Minimum Value:	0
Maximum Value:	10,000
Access State:	Read-only by the Master

IDN 32883: Analog Current Limit Gain

Parameter Data IDN

Unsigned Decimal Number

AnalogILmtGain allows the Master to set the scale factor (float value) for the Analog Current Limit Input (J2-6).

Conversion Scaling Factor:	0.001
Data Length:	4 bytes
Units:	% of Ipeak/Volt
Minimum Value:	0
Maximum Value:	5,000,000
Access State:	Read/Write by the Master

IDN 32884: Analog Current Limit Filter

Parameter Data IDN

Unsigned Decimal Number

AnalogILmtFilt allows the Master to set the low-pass filter break frequency (float value) on the Analog Current Limit Input (J2-6).

Conversion Scaling Factor:	0.01
Data Length:	4 bytes
Units:	Hz
Minimum Value:	0
Maximum Value:	100,000,000
Access State:	Read/Write by the Master

IDN 32885: Current Limit Offset Voltage

Parameter Data IDN

Signed Decimal Number

AnalogILmtOffset allows the Master to set the offset (in volts) that is added to the Analog Current Limit Input (J2-6).

Conversion Scaling Factor:	0.001
Data Length:	2 bytes
Units:	Volts
Minimum Value:	-10,000
Maximum Value:	10,000
Access State:	Read/Write by the Master

IDN 32886: Actual Positive Current Limit

Parameter Data IDN

Unsigned Decimal Number

AnalogILmtPlus allows the Master to display the actual positive current limit (float value) used by the drive.

Conversion Scaling Factor:	0.01
Data Length:	2 bytes
Units:	% of peak current rating of the drive
Minimum Value:	0
Maximum Value:	10,000
Access State:	Read-only by the Master

IDN 32887: Actual Negative Current Limit

Parameter Data IDN

Unsigned Decimal Number

AnalogILmtMinus allows the Master to display the actual negative current limit (float value) used by the drive.

Conversion Scaling Factor: 0.01
Data Length: 2 bytes
Units: % of peak current rating of the drive
Minimum Value: 0
Maximum Value: 10,000
Access State: Read-only by the Master

IDN 34817: Input Bit #1

Parameter Data IDN

Binary Data

Allows the Master to read the value of the Input Bit 1 located on J2-31.

User must supply Input Power to have Input Circuitry to operate.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 1
Access State: Read-only by the Master

IDN 34818: Input Bit #2

Parameter Data IDN

Binary Data

Allows the Master to read the value of the Input Bit 2 located on J2-32.

User must supply Input Power to have Input Circuitry to operate.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 1
Access State: Read-only by the Master

IDN 34819: Input Bit #3

Parameter Data IDN

Binary Data

Allows the Master to read the value of the Input Bit 3 located on J2-33.

User must supply Input Power to have Input Circuitry to operate.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 1
Access State: Read-only by the Master

IDN 34820: Input Bit #4

Parameter Data IDN

Binary Data

Allows the Master to read the value of the Input Bit 4 located on J2-34.

User must supply Input Power to have Input Circuitry to operate.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 1
Access State: Read-only by the Master

IDN 34821: Input Bit #5

Parameter Data IDN

Binary Data

Allows the Master to read the value of the Input Bit 5 located on J2-35.

User must supply Input Power to have Input Circuitry to operate.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 1
Access State: Read-only by the Master

IDN 34822: Input Bit #6

Parameter Data IDN

Binary Data

Allows the Master to read the value of the Input Bit 6 located on J2-36.

User must supply Input Power to have Input Circuitry to operate.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read-only by the Master

IDN 34824: Input Port

Parameter Data IDN

Binary Data

Allows the Master to read the entire Input Port. The data is returned in the following format:

Bit Number	Description
Bit 0	Input 1
Bit 1	Input 2
Bit 2	Input 3
Bit 3	Input 4
Bit 4	Input 5
Bit 5	Input 6
Bits 8 – 15	undefined

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0x003F
Access State:	Read-only by the Master

IDN 34825: AnalogIn

Parameter Data IDN

Signed Decimal Number

Allows the master to read the Analog Input on the base unit. Refer to the scaling factor document for the correct Analog Input Scaling.

Conversion Scaling Factor:	0.001
Data Length:	4 bytes
Units:	Volts
Minimum Value:	-13,500
Maximum Value:	13,500
Access State:	Read-only by the Master

IDN 34826: EncPos

Parameter Data IDN

Signed Decimal Number

Accumulated Encoder Position.

Conversion Scaling Factor:	1
Data Length:	4 bytes
Units:	Encoder counts
Minimum Value:	-2,147,483,647
Maximum Value:	2,147,483,647
Access State:	Read-only by the Master

IDN 34833: Output Bit #1

Parameter Data IDN

Binary Data

Allows the Master to write the value to Output Bit 1 located on J2-42.

User must supply Output Power to have Output Circuitry to operate.

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	1
Access State:	Read/Write by the Master

IDN 34834: Output Bit #2

Parameter Data IDN
Binary Data

Allows the Master to write the value to Output Bit 2 located on J2-43.

User must supply Output Power to have Output Circuitry to operate.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 1
Access State: Read/Write by the Master

IDN 34835: Output Bit #3

Parameter Data IDN
Binary Data

Allows the Master to write the value to Output Bit 3 located on J2-44.

User must supply Output Power to have Output Circuitry to operate.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 1
Access State: Read/Write by the Master

IDN 34836: Output Bit #4

Parameter Data IDN
Binary Data

Allows the Master to write the value to Output Bit 4 located on J2-45.

User must supply Output Power to have Output Circuitry to operate.

Conversion Scaling Factor: 1
Data Length: 2 bytes
Minimum Value: 0
Maximum Value: 1
Access State: Read/Write by the Master

IDN 34840: PCE840 Output Byte Parameter Data IDN

Binary Data

Allows the Master to read/write the entire Output Port. The data is in the following format:

Bit Number	Description
Bit 0	Output 1
Bit 1	Output 2
Bit 2	Output 3
Bit 3	Output 4
Bit 4 – 15	undefined

Conversion Scaling Factor:	1
Data Length:	2 bytes
Minimum Value:	0
Maximum Value:	0x000F
Access State:	Read/Write by the Master

3.9. Diagnostics and Protection Circuits

The drive is fully protected against normal abuse and has two LEDs on the front panel to indicate SERCOS ring or drive status. The servo drive has the following specific protections:

- Output motor short-circuit protection line-to-line and line-to-neutral.
- Interface to Pacific Scientific's standard motor PTC or a normally-closed thermostat to sense motor over temperature.
- Internal monitoring of the power stage heat sink temperature for drive over temperature.
- Bus over voltage detection.
- Bus under voltage fault with adjustable threshold.
- Incorporating the measured heat sink temperature, there is an excessive current I*t fault. This fault limits the peak current time and intelligently changes the continuous current fault trip, dependent on the measured heat sink temperature, to limit the continuous output current.
- Control voltage under voltage detection.
- The user +5V output is short circuited to I/O RTN protected.
- The user +24V output is short-circuit protected.
- All control outputs are short-circuit protected to I/O RTN.
- When a drive is powered up without valid parameters, the power stage cannot be enabled and no damage occurs to the drive.

Fault Generation

The following sequence occurs when the protection circuits generate a fault.

- The fault source is latched.
- The output stage is disabled.
- The Fault mappable output function is activated.
- The LED indicates the appropriate fault code.

Faults are cleared by activating the Fault Reset input or by turning the 120/240VAC Control Power OFF and ON again.

Fault Code List

The following table lists the PCE840 codes.

FaultCode Hex (Dec)	Fault Description
0x1 (1)	Velocity feedback (VelFB) over speed*
0x2 (2)	Motor over temperature
0x3 (3)	User +5V low
0x4 (4)	Continuous current fault
0x5 (5)	Drive over current (instantaneous)
0x6 (6)	Control ±12V under voltage
0x7 (7)	Not Assigned
0x9 (9)	Bus over voltage detected by DSP, External Regen Fault
0xA (10)	Not Assigned
0xB (11)	Bus under voltage* (Only if VBus < VBusThresh)
0xC (12)	Ambient temperature too low
0xD (13)	Encoder alignment failed*
0xE (14)	Software and non-volatile memory versions not compatible
0xF (15)	Hardware not compatible with software version
0x10 (16)	Unconfigured drive fault
0x11 (17)	Two AInNull events too close together
0x12 (18)	Position following error fault
0x13 (19)	Parameter memory error*
0x14 (20)	Initialization fault*
0x15 (21)	Drive over temperature
0x16 (22)	Resolver Fault

** To further identify this fault, see software variable ExtFault.*

ExtFault The following table lists the values for ExtFault.

ExtFault	ExtFault Description
1	Absolute Resolver Overspeed. |VelFB| > 21038 RPM
2	Variable Resolver Overspeed. |VelFB| > max(VelLmtxx)*1.5
3	Calibration data corrupted*
4	Excessive DC offset in current feedback sensor*
5	DSP incompletely reset by line power dip*
8	Excessive dc offset in Analog Command A/D*
9	Not Assigned
10	DSP stack overflow*
12	Software and control card ASIC incompatible*
13	Actual Model not same as stored in NV memory*
14	Unable to determine power stage*
15	Drive non-volatile parameters corrupt*
16	RAM failure*
17	Calibration RAM failure*
18	Encoder alignment: no motion fault
19	Encoder alignment: excessive motion fault
20	Encoder alignment: motor not settled
21	Encoder alignment: test failed
22	Encoder alignment: motion overflow fault
23	Hall Commutation: invalid configuration
24	Hall Commutation: overspeed
25	Hall Commutation: invalid hall state
26	Hall Commutation: invalid hall transition
27	I*t Drive
28	I^2*t Motor
29	DP RAM Test A*
30	DP RAM Test 5*
31	DP RAM Test Run 1*
32	DP RAM Test Run 0*
33	DP RAM Test C*
65	Data Read Only
66	Data Bounds Error
67	Execute no such command
68	RT not implemented
69	FC not implemented

**These fault states CANNOT be reset with the Fault Reset function. They require the line control power to be turned OFF and ON again.*

3.9.1. Troubleshooting

A table of faults and their possible causes is listed below.

FaultCode Hex (Dec)	**Possible Cause**
0x1 (1)	Loose or open circuit wiring to the resolver feedback connector J3.
	Actual motor speed exceeded 1.5 * (Max Of |VelLmtLo| or|VelLmtHi|) or 21,038 RPM which is the over speed trip level.
	For Encoder velocity feedback (RemoteFB = 2) check that EncIn is set properly.
0x2 (2)	Loose or open circuit wiring to motor PTC thermal sensor (J3-8, J3-9).
	High ambient temperature at motor.
	Insufficient motor heat sinking from motor mounting.
	Operating above the motor's continuous current rating.
0x3 (3)	Short-circuited wiring on the output (J2-25).
0x4 (4)	Mechanically-jammed motor.
	Motion profile acceleration too high.
	Machine load on the motor increased by friction.
	Wiring problem between drive and motor yielding improper motion.
	Drive and/or motor under-sized for application.
	See HSTemp, ItFilt, and ItF0 for information on measuring the thermal margin in an application.
0x5 (5)	Motor power wiring (TB1-4, 5, or 6) short circuit line-to-ground/neutral.
	Motor power cable length is enough longer than the data sheet specification to cause excessive motor line-to-earth ground/neutral capacitance.
	Internal motor winding short circuit.
	Insufficient motor inductance causing output over current faults.
	KIP or KII improperly set causing excessive output current overshoots.
0x6 (6)	Insufficient control AC voltage on TB1-1 to TB1-2.
	External short on signal connector.
	Internal drive failure.
0x7 (7)	Not Assigned.
0x9 (9)	Disconnected external regeneration resistor on TB1.
	External regeneration resistor ohmage too large yielding Bus OverVoltage fault.
	External regeneration resistor short circuit.
	Motor AC power input voltage too high.
0xA (10)	Not Assigned.
0xB (11)	Check the measured bus voltage, VBus, and the fault threshold, VBusThresh, to make sure they are consistent.

FaultCode Hex (Dec)	Possible Cause
0xC (12)	Ambient temperature is below drive specification. Drive's internal temperature sensor has a wiring problem.
0xD (13)	Encoder Alignment failure. See ExtFault for additional information.
0xE (14)	Not Assigned.
0xF (15)	Attempt to upgrade the drive's software unsuccessful. Contact factory for upgrade details.
	Resolver wiring error. Remove J2 and J3 connectors. Turn AC power OFF and ON again. If FaultCode = 2, correct resolver excitation wiring.
	Internal failure. Return to factory for repair.
0x10 (16)	Unconfigured drive (Red and Green LEDs blinking after power up) was fully configured with the drive motor power enable active. This fault is reset or the control AC power turned OFF and ON again to get the drive-motor operating.
0x11 (17)	The AInNull function was re-activated too soon after going inactive. This can be caused by switch bounce on the input pin mapped to activate AInNull.
0x12 (18)	The motor is either stalled or partially jammed.
	The value for PosErrorMax is set too sensitive for the loop tuning and commanded motion profiles.
0x13 (19)	Glitch while last saving the NV parameters. Corrupted NV memory contents. Hardware problem with the NV memory. Download parameters to restore drive operation.
0x14 (20)	Initialization Failure. See ExtFault for additional information.
0x15 (21)	High drive ambient temperature. Restriction of cooling air due to insufficient space around unit.
	Operating above the drive's continuous current rating.
	See HSTemp, ItFilt, and ItF0 for information on measuring thermal margin in an application.
0x16 (22)	Resolver signal is lost or intermittent. Check resolver cable.

3.9.2. Motor Commutation

IDN 32807

Number of motor magnetic poles (Polecount), which is the same as twice the number of motor electrical cycles per mechanical revolution. This IDN should be set so that:

For resolver-based commutation (IDN 32853 = 0):

IDN 32807 (Polecount) = Number of encoder counts / electrical cycle

IDN 32807 = 4 * IDN 32828 / (Motor poles / 2)

For encoder-based commutation, it is required to do an encoder alignment using IDN 32854.

Example

If the application uses resolver-based commutation with an R-series motor, set IDN 32807 = 4 (R-series motors have 4 poles).

If the application uses resolver-based commutation with an S-series motor, set IDN 32807 = 6 (S-series motors have 6 poles).

If the application uses encoder-based commutation with an R-series motor and a 1024 line count encoder, set IDN 32807 = 4 * 1024 / (4/2) = 2048.

CommSrc (IDN 32853) must be set before PoleCount (IDN 32807).

IDN 32826

CommOff sets the origin for the electrical commutation angle. This IDN should be set so that for Pacific Scientific motors:

IDN 32826 (CommOff) = 0

3.9.3. System Protection

Current Limits To protect the motor and drive set the limits to:

IDN 82 Clockwise Current Limit (ILmtPlus). This IDN should be set so that:

ILmtPlus = min (100%, 100% * 5 * I_{cs}/I_{peak})

Where I_{cs} is the motor's rms terminal current rating

IDN 82 = % of I_{peak} * 10
(i.e., for a 9x3 ILmtPlus of 50% or 7.5A, set IDN 82 = 500)

IDN 83 Counter-clockwise Current Limit (ILmtMinus). This IDN should be set so that:

ILmtMinus = min (100%, 100% * 5 * I_{cs}/I_{peak})

Where I_{cs} is the motor's rms terminal current rating

IDN 83 = % of I_{peak} * 10
(i.e., for a 9x3 ILmtMinus of 50% or 7.5A, set IDN 83 = 500)

Application requirements may constrain ILmts even further.

IDN 32829 ItThresh sets the maximum continuous output current as a percentage of I_{peak} before the I*T thermal protection faults the drive. This IDN should be set so that:

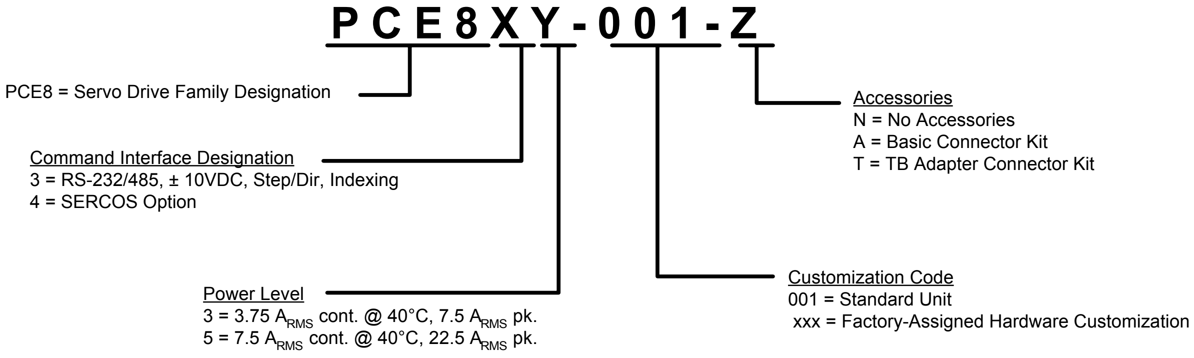
IDN 32829 (ItThresh) = min (60%, 100% * 3 * $I_{MTRcontinuous}/I_{PR}$)

I_{peak} The following table lists the peak current rating for each of the drives in the PCE800 family.

Pacific Scientif Model	I_{peak} (Amps)
8x3	15.0
8x5	30.0

4. MODEL IDENTIFICATION

4.1. Basic Servo Drive Package Order Numbering System



P C E 8 X Y - 0 0 1 - Z

PCE8 = Servo Drive Family Designation

Command Interface Designation
3 = RS-232/485, ± 10VDC, Step/Dir, Indexing
4 = SERCOS Option

Power Level
3 = 3.75 A_{RMS} cont. @ 40°C, 7.5 A_{RMS} pk.
5 = 7.5 A_{RMS} cont. @ 40°C, 22.5 A_{RMS} pk.

Accessories
N = No Accessories
A = Basic Connector Kit
T = TB Adapter Connector Kit

Customization Code
001 = Standard Unit
xxx = Factory-Assigned Hardware Customization

Example Order Numbers

Order #	Model #	Description
PCE833-001-T	PCE833-001-T	7.5 ARMS peak standard servo drive
	CA800-TB	TB adapter PCE830/40 connector kit
	MAE800	*PCE830/40 User Manual*
PCE835-001-A	PCE834-001-A	22.5 A_{RMS} peak standard servo drive
	CA800	Basic PCE830/40 connector kit
	MAE800	*PCE830/40 User Manual*
PCE835-001-N	PCE834-001-N	22.5 A_{RMS} peak standard servo drive
	MAE800	*PCE830/40 User Manual*
PCE845-001-N	PCE845-001-N	22.5 A_{RMS} peak standard servo drive with SERCOS option
	MAE800	*PCE830/40 User Manual*

4.2. PCE800 Technical Documentation

Manual and Documentation

MAE800	*PCE830/40 User Manual*

4.3. PCE800 Accessories

Connector Mate Kits

CA800	15-pin and 44-pin d-subminiature mates for the PCE830/40 servo drive.
CA800-TB	15-pin and 44-pin d-subminiature terminal block adapter mates for the PCE830/40 servo drive.

Regen Resistors

PRK-200-66	External regen resistor kit (66Ω, 200W, Panel mount with cable)

Fan Kits

PFK-120	120VAC Fan
PFK-240	240VAC Fan

5. SPECIFICATIONS

5.1. Output Power Specifications

	PCE8x3	PCE8x5
Peak Output Current (RMS)[1]		
3 seconds, (0 to 40°C) Ambient	$7.5A_{RMS}$	$22.5A_{RMS}$
Continuous Output Current (RMS)[2]		
Convection (0 to 40°C) Ambient[3]	$3.75A_{RMS}$	$7.5A_{RMS}$
Forced Air (0 to 40°C) Ambient[3]	N/A	$11.25A_{RMS}$
Peak Output Power (1 sec)		
Idealized Peak (rectangular torque vs. speed)		
380 VAC	5.1 kW	15.2 kW
400 VAC	5.3 kW	16.0 kW
480 VAC	6.4 kW	19.2 kW
Drive & Motor System Peak (Typical)[4]		
380 VAC	2.8 kW	8.5 kW
400 VAC	3.1 kW	9.3 kW
480 VAC	4.2 kW	12.5 kW

---

[1] To convert A_{RMS} to A(0-pk), multiply A_{RMS} * 1.41.
Peak current (3 sec): PCE8x3 = 10.6A (0-pk), PCE8x5 = 31.8A (0-pk)

[2] Above 40° C ambient, linearly derate to 50° C rating = 0.67*40° C rating.

[3] Forced air rating of requires 3.6" x 1" fan mounted 2" below drive. (PCE8x5 internal fan by itself does not provide sufficient cooling for forced air rating.

[4] Varies with the motor. Maximum peak output power with most motors at 480VAC is between 60% and 70% of Idealized Peak Power.

	PCE8x3	PCE8x5
Continuous Output Power Drive & Motor System		
380VAC		
Convection	2.0 kW	4.3 kW
Forced Air	N/A	6.0 kW
400VAC		
Convection	2.1 kW	4.6 kW
Forced Air	N/A	6.3 kW
480VAC		
Convection	2.6 kW	5.6 kW
Forced Air	N/A	7.9 kW
RMS Line Current @ Continuous Output Power		
380/400/480VAC		
Convection	5.1 A_{RMS}	11.0 A_{RMS}
Forced Air	N/A	15.5 A_{RMS}
Power Stage Efficiency @ P_{cont}	97%	97%
Shunt Regulator Power		
Peak Power (300 mSec)	10 kW	20 kW
Continuous Power** with standard regen resistor	200W	100W (internal) 400W (external)
Maximum External Regen Duty Cycle	6%	6%
Bus Capacitance Energy Absorption		
From 630V Nominal Bus	35J	70J

*** See Section 6, Using External Regen for additional information.*

	PCE8x3	PCE8x5
Output Current Ripple Freq f_s	16 kHz	16 kHz
Minimum Motor Inductance l-l	5 mH	1.7 mH
Maximum Motor Inductance l-l	5H	1.7H
Maximum Motor Power Cable Length	--------50 m/164ft-------	

5.2. Input Power Specifications

The drive is capable of direct line operation. All units are fully isolated and do not require external isolation transformers. The inrush current on the connection to the line is internally limited to a safe level for the drive. There are no voltage selection or ranging switches required to operate within the specified voltage input ranges. It is your responsibility to supply appropriate fuses or circuit breakers in the TB1 AC power motor power lines to comply with local electrical codes.

The control input power required is between 15 and 25 Watt. The AC input motor power depends on output power and the losses in the power stage. The control power input has a single UL/CSA-rated fuse in line with one of the AC line inputs.

PCE800 Control Power Supply

Input Voltage Range (RMS)	85VAC to 265VAC, 47 to 440 Hz single phase or 130VDC to 370VDC	
Ride Through Time For AC Line Drop	90VAC 50 Hz	>0.7 50 Hz cycle
	120VAC 60 Hz	>2.1 60 Hz cycles
	240VAC 60 Hz	>13.3 60 Hz cycles

PCE800 Motor AC Power Supply

Model Number	Voltage Range (RMS)	Phases	Transformer Suggested kVA	Maximum AC Line* kVA
PCE8x3	323VAC to 528 VAC	3	2 to 4 kVA	100 kVA
PCE8x5	323VAC to 528 VAC	3	6 to 12 kVA	300 kVA

**Maximum AC Line is specified to limit the mains surges to the drive.*

Bus Voltage (nominal)

380VAC	507VDC
400VAC	533VDC
480VAC	640VDC

PCE800 Inrush Current & Fusing

Model Number	Inrush Peak Current (cold)	Inrush PulseWidth	Recommended Line Fuse			
			Part Number	Manufacturer	Rating	Size
PCE8x3	175A	1 msec	KTK-20	Bussmann	20A, 600VAC	1.5" x 0.41"
PCE8x5	175A	1.5 msec	KTK-30	Bussmann	30A, 600VAC	1.5" x 0.41"

5.3. Performance Characteristics

Unless otherwise specified, the below specifications are worst-case limits and apply over the specified operating ambient temperature and over the specified operating line voltage.

Motor Current Control

Motor Phase Current Waveform	Back EMF Matched Pseudo Sine
Motor Shaft Torque (Ignoring motor magnetic saturation)	
Peak (hot)[5]	K_t (Nm/A_{RMS})*Drive I_{peak} (A_{RMS})
Instantaneous	K_t (Nm/A_{RMS})* / $IFB\sqrt{2}$
Bandwidth	
Maximum Bandwidth	1.5 kHz
Recommended Bandwidth	1.0 kHz
Bandwidth Variation For Fixed Motor L	± 10%
Bandwidth Variation For ± 25% AC Line Variation	± 2%
Update Period	62.5 µsec
Recommended Motor Electrical Frequency	< 400 Hz

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[5] Multiply by 1.06 for cold K_T (PMA motors).

Analog Command

Maximum Differential Range	±13.5 Volts
Maximum Single Ended Range	±21 Volts
Full Scale Tolerance	±5% (worst case) ±1% (typical)
Linearity	0.1% Full Scale
Monotonic to	< 2^{-16} Full Scale
S/N Ratio Referred to Full Scale	
Full A/D Bandwidth	14 bits
150 Hz A/D Bandwidth	16 bits
10 Hz A/D Bandwidth	18 bits
Offset	Adjustable to 0
Maximum Unadjusted Offset	50 mV
Offset Drift	250 µV/°C typ.
CMRR	> 30 dB @ 60 Hz

Digital Position Commands

Modes	Quadrature Encoder, Step & Direction, or Up & Dn Count
Maximum Input Rate For Fast Decode	
Quadrature Decode Max Line Frequency	800 kHz
Step/Dir Decode Max Step Frequency	800 kHz
Up/Dn Count Max Frequency	800 kHz
Minimum Fast Decode Pulse Width	0.6 µSec
Fast Decode Direction Setup Time	0.6 µSec
Fast Decode Direction Hold Time	0.6 µSec
Relative Timing For Filtered Decode	4, 8, or 16 to 1 e.g., Max Step Freq 800, 200, 100, or 50 kHz

Velocity Loop

Maximum Stable Bandwidth	> 400 Hz
Update Period	250 µSec
Range	0 to 21,000 RPM
Command Resolution	< 0.001 RPM
Velocity Loop Compensation Parameters	
KVP Range (Depends on I_{peak})	0 to 12.6 (I_{peak})(1/rad/sec)
KVP Resolution	16 bit
KVI Range	0 to > 200 Hz
KVI Resolution	16 bit
ARF0* Range	0.01 to > 1e5 Hz
ARF1* Range	0.01 to > 1e5 Hz
ARZ0* Range	0 to > 1e5 Hz or off
ARZ1* Range	20 to > 1e5 Hz or off
CMDGAIN Range	0 to ±15,000 RPM/V 0 to ±10(I_{peak}) V^{-1}
CMDGAIN Resolution	≥ 16 bit mantissa

**ARx0 set to a negative number allows complex poles/zeros. In this case, ARx1 becomes the Q and the corresponding |ARx0| is the frequency in Hz.*

Position Loop

Maximum Stable Bandwidth	> 100 Hz
Update Period	1 mSec
Position Range	0 to ± 32768 Rev
Position Error Range	0 to ± 4500 Rev
Command Resolution	2-16 Rev = 0.33 arc min
Position Loop Compensation Parameters	
KPP Range	0 Hz to > 150 Hz
KPP Resolution	16 bit
KVFF Range	0 to 199.9%
KVFF Resolution	16 bit

General

Max Delay AC Line To Control Supply On	1.0 Sec
Max Delay AC Line To Fully Operational	2.0 Sec

Environmental

Storage Temperature	-40°C to 70°C
Humidity, non-condensing	10% to 90%
Altitude	1500 m (5000 feet)

5.4. Resolver Feedback Specifications

Unless otherwise specified, the below specifications are worst-case limits and apply over the specified operating ambient temperature and over the specified operating line voltage.

Resolver Position Signal

Resolution/Rev	24 bits = 0.0013 arc min
Repeatability	$< \pm 2^{-18}$ Rev = ±0.08 arc min rms
Noise	
No Filtering	$< 2^{-16}$ Rev rms = 0.3 arc min rms
150 Hz Single Pole Filtered	$< 2^{-17}$ Rev rms = 0.16 arc min rms
10 Hz Single Pole Filtered	$< 2^{-19}$ Rev rms = 0.04 arc min rms
DC Offset Temperature Drift	$< 2^{-18}$ Rev/°C = 0.08 arc min/°C
Absolute Accuracy	
Drive only	$\pm 2^{-12}$ Rev = ±5.3 arc min
Drive with 20 arc min resolver	$\pm 2^{-9.75}$ Rev = ±25 arc min
Software Update Time	1 mSec

Resolver Velocity Signal

Resolution	< 0.001 RPM
Quanta	= 0.0143 RPM
Noise	
No Filtering	< 3 RPM rms
150 Hz Single Pole Filtered	< 0.6 RPM rms
10 Hz Single Pole Filtered	< 0.06 RPM rms
DC Accuracy	
Typical @ 25°C	±0.01%
Worst case	±0.05%
Ripple	
Drive only	0.75% p-p at 1000 RPM
Drive with 20 arc min resolver	3% p-p at 1000 RPM
Offset	< 0.0001 RPM
Software Update Time	250 µSec

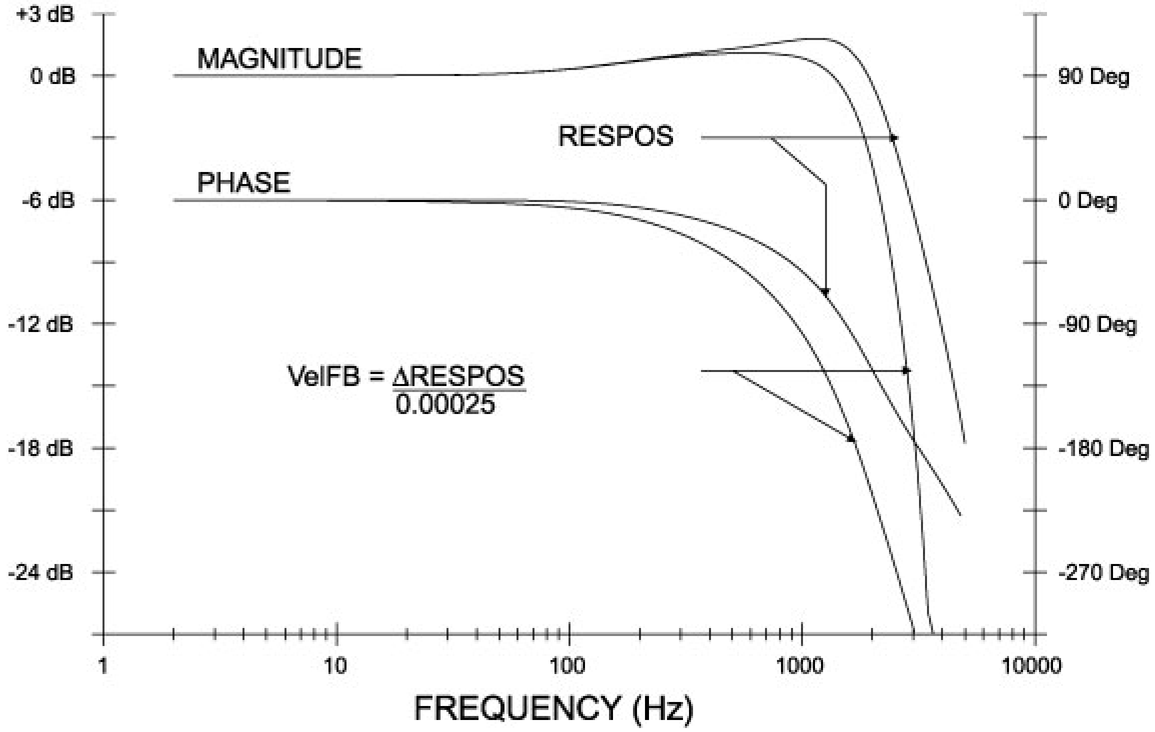
Emulated Encoder Output Signals

Available Resolutions (PPR)	
Binary	128, 256, 512, 1024, 2048, 4096, 8192, 16384
Decimal	125, 250, 500, 1000, 2000, 4000, 8000, 16000
Maximum Output Line Frequency	833 kHz
Max Recommended Speed @ 16384 PPR	2900 RPM
Max Recommended Speed @ 4096 PPR	11600 RPM
Marker Pulse Width	≈ 1 Quadrature Pulse

General

-3 dB Bandwidth	> 1500 Hz
-45° Phase Lag	> 400 Hz
Resolver Excitation Frequency	6510.42 Hz
Max Tracking Rate	> 48600 RPM
Max Recommended Rate	25 kRPM
Max Tracking Acceleration	> 16x106 RPM/sec
Maximum Feedback Cable Length	50 m/164 ft

Nominal Frequency Response



The PCE8300 packaging is totally enclosed, single-axis panel mount. The figure on the next page gives the key dimensions for use in physically mounting the product. When mounting multiple units on one panel, there should be at least 25 mm (1") of air space on the sides and 40 mm (1.5") of air space above and below the unit.

When mounting multiple drives in a row, some customers have found the stiffness of the drive and their mounting panel to be too low. To increase the mounted mechanical integrity, connect to the threaded insert on the top front edge.

The overall drive panel dimensions and mounted depth (not including mating connectors) is listed in the chart below. The extra depth for mating connectors is 1.0" or less.

Dimensions

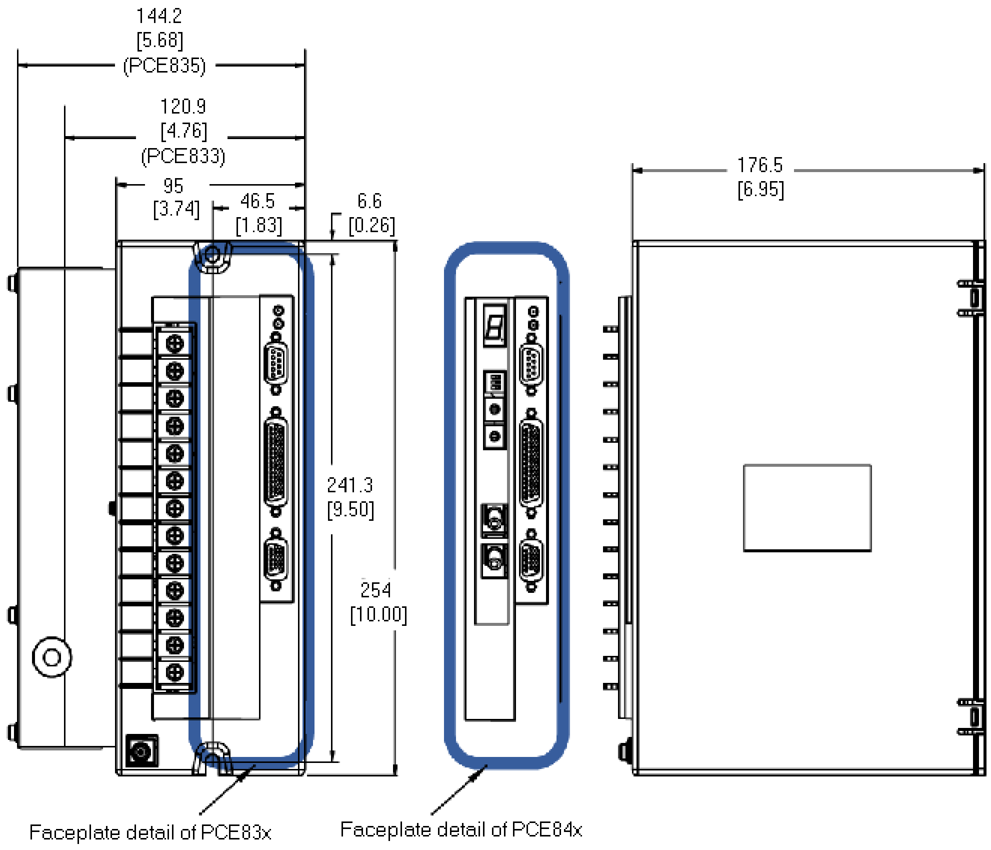
Model	Height	Width	Depth
PCE8x3	254 mm/10.0"	121.7 mm/4.79"	192 mm/7.56"
PCE8x5	254 mm/10.0"	146.7 mm/5.76"	192 mm/7.56"

Weight

Model	Weight
PCE8x3	3.6 kg/7.9 lb
PCE8x5	4.2 kg/9.3 lb

Drive Mechanical Outline

PCE800 Series

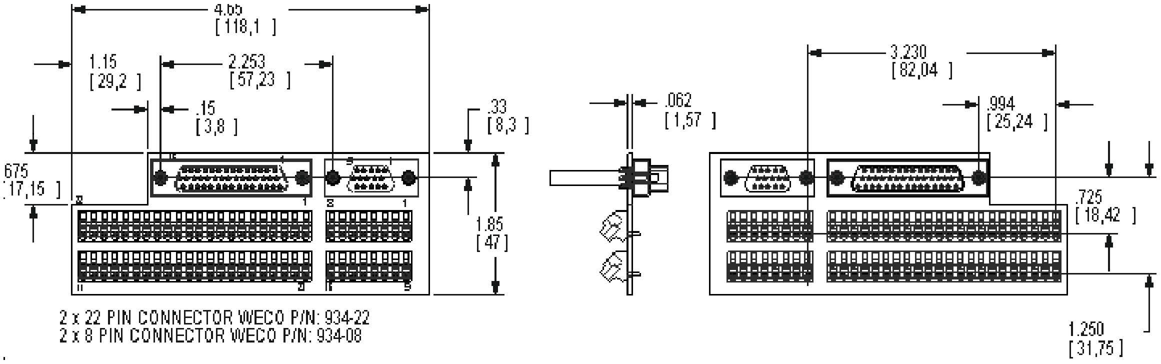


Mounting Guidelines

The figure above provides the key dimensions for use in physically mounting the product.

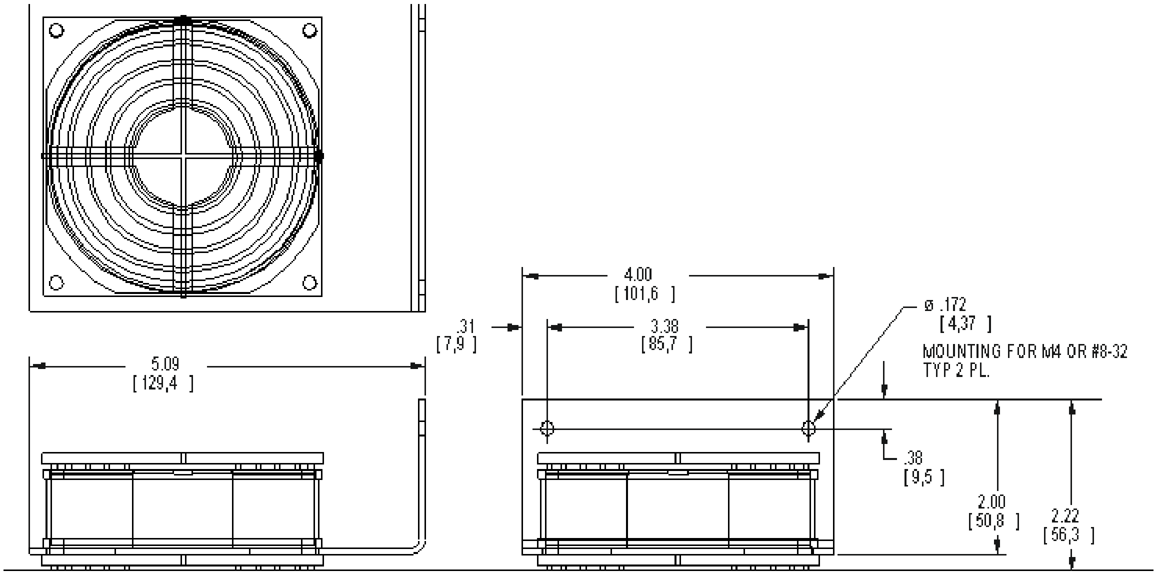
When mounting multiple drives in a row, some customers have found the stiffness of the drive and their mounting panel to be too low. To increase the mounted mechanical integrity, connect to the threaded insert on the top front edge. The extra depth for mating connectors is 1.0" or less.

PCE800 Terminal Block Adapter



2 x 22 PIN CONNECTOR WECO P/N: 934-22
2 x 8 PIN CONNECTOR WECO P/N: 934-08

Fan Option Kit



6. USING EXTERNAL REGEN

An estimated 10% of applications require that the PCE8x3 be equipped with a regen resistor. The regen resistor is built into the PCE8x5.

Need for Regen

The clearest indication that an external regen resistor is needed is that the drive fault on over-voltage when the motor decelerates. The Fault LED is solid on and the variable FaultCode shows ‘over-voltage’ or ‘external regen fault’.

As the motor decelerates, mechanical energy is regenerated back to the drive. Initially this energy goes into the bus capacitors and pumps-up their voltage. With an external regen resistor connected, the pump-up of the bus voltage is clamped at about 830VDC. Without a regen resistor, the voltage can continue to rise and, at about 866VDC, an over-voltage fault occurs.

The need for regen is a strong function of maximum motor speed. Below some speed, roughly (1/3 to 1/4) system rated speed, an external regen resistor is unlikely to be needed. For an explanation of why this is, see the section at the end of this appendix, “Regen Need is a Strong Function of Maximum Motor Speed.”

Estimating Regen R Power

The regen resistor power is pulsed and each pulse is approximately 1msec. The instantaneous regen power is 10KW in the PCE8x3 and 20Kw in the PCE8x5. By counting the average number of regen pulses per second, it is possible to estimate the average power in the regen resistor.

PCE8x3	Average regen R power = Average # of pulses per sec x 10W.
PCE8x5	Average regen R power = Average # of pulses per sec x 20W.

Count regen pulses by counting sawtooth cycles on VBus using the built-in soft scope during regen. The voltage across the regen resistor (TB1-7 to TB1-8) can be observed directly is an oscilloscope capable of a differential measurement of electrically hot signals is available.

Monitoring Bus Voltage

There may be a few applications where bus voltage pump up is excessive, but not high enough to trip the hardware over-voltage fault (866VDC). Bus voltage is considered excessive if it exceeds 780VDC to 800VDC.

The built-in oscilloscope can be used to monitor how much the bus voltage (VBus) pumps up at motor deceleration. If the scope shows the bus voltage reaching 780VDC to 800VDC, connect an external regen resistor to insure long-term reliable operation.

Regen R Characteristics

Pacific Scientific offers an external regen resistor for the PCE800 family (Part #PRK-200-66). It is a 66 Ω, 200W, metal clad, panel mount resistor supplied with a short cable for attachment to the drive.

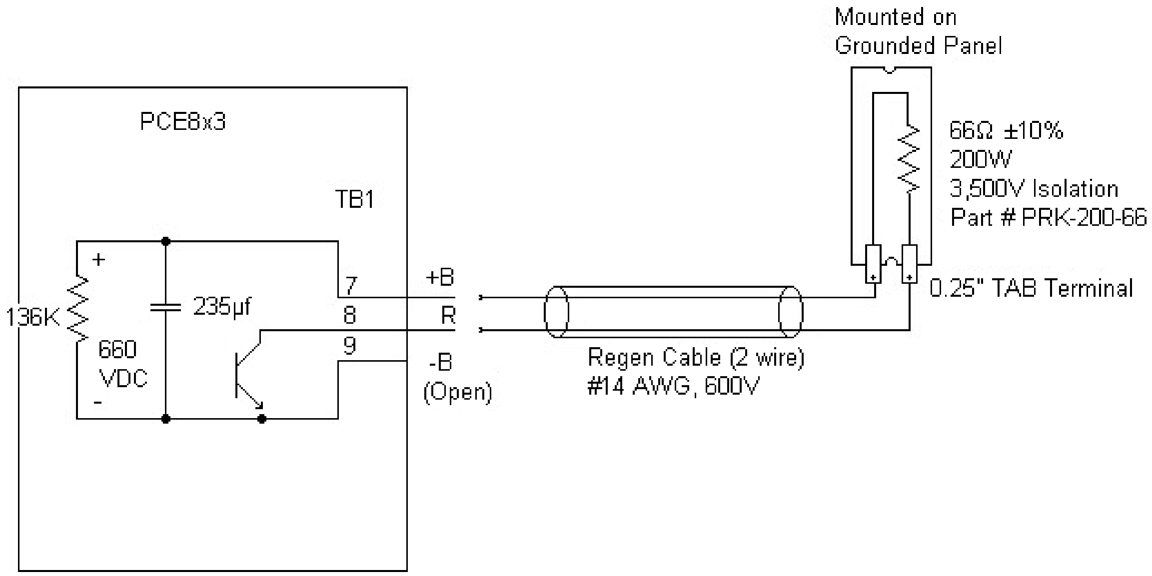
This resistor is used with the PCE8x3's that require a regen resistor. For the small number of PCE8x5 installations where regen power exceeds the 100W rating of the internal regen resistor, two of these resistors wired in parallel (33Ω, 400W combined rating) can replace the internal PCE8x5 regen resistor.

Ohms	66 Ω ± 10%
Watts	200 watts (manufacturer rating 300 watts)
Terminals	0.25 inch standard fast-on
Isolation	3,500 V to case
Cable	2 ft, #14AWG, with spade lugs (for TB1)

Mounting and Wiring

For the PCE8x3, the regen resistor is mounted external to the drive. The PCE8x5 regen resistor is built in and factory-wired to TB1 pins 7 and 8. If an external regen resistor is used with the PCE8x5, the internal regen resistor must be disconnected by removing its wires from TB1. The Pacific Scientific-supplied PCE830/40 regen resistor comes with a cable long enough so it can be mounted adjacent to the drive and wired to the drive.

Regen Mounting



During normal operation, +B, R, and -B operate at the bus power voltages. A 480VAC system operates at about 800VDC. These are dangerous voltages.

Wait 10 minutes after Bus Power is removed for the bus cap voltage to decay to a safe level before touching the regen resistor or wiring. The voltage on the bus caps can be monitored with a voltmeter from +BUS (TB1-7) to -BUS (TB1-9).

Drive Regen Terminals

TB1-7 (marked +B) to TB1-8 (marked R)

The resistor terminals are standard 0.25" fast-ons. The resistor can be mounted any distance from the drive using a customer-supplied cable. Recommended cable wire is #14 AWG, 600V rated, Teflon.

Safety

The terminals of the regen resistor must be shielded from contact as they are electrically connected to the +Bus of the drive. The regen terminals are at dangerous, potentially lethal, voltages whenever the drive bus power is on and for about 10 minutes after bus power is turned off.

To prevent the metal case of the resistor from becoming a safety hazard in the event of internal resistor failure the resistor case should be grounded by attaching it to a grounded panel.

Non-Pacific Scientific Regen Resistors

Customer-supplied regen resistor(s) can be used. Be sure the resistance seen by the drive is within 10% of 66 Ω and the isolation of the resistive element is a minimum of 1,500V and it can support pulses of 800VDC between the terminals.

High Power Regen

In an application with very high average regenerated power, it may be necessary to increase the wattage of the regen resistor. Quick test: ‘Does water boil on the surface of the resistor’?

One way to increase the regen resistor power handling capability is to blow air on it.

A simple way to increase regen power handling capability is to replace a single regen resistor with four similar resistors wired in series-parallel. Series parallel wiring is two pairs wired in series and the two pairs wired in parallel. Use a meter to check the resistance of a combination before attaching it to the drive. The resistance of a series parallel combination should measure the same as each resistor measured separately. Four 200Ω regen resistors wired in series parallel can handle 800W.

Fusing

If the regen transistor in the drive should fail shorted, the power to the external regen resistor increases too far above its ratings. For three-phase, 480VAC bus power, the power in the regen resistor is about 6.2 kW (640VDC across 66 Ω equals 9.7 ADC). After a few minutes, the regen resistor typically opens, but in the meantime, the high heat can cause melting and damage to nearby components. A remote regen resistor mount, such as on top of a cabinet, can minimize the potential damage.

A single 200W regen resistor can (in some cases) be fused, but the fuse type and rating must be carefully chosen. Due to the resistance, a large pulse of current is not available to clear a fuse. While not tested, analysis of fuse time-current curves indicates the following fuses should work with a single 66 Ω regen resistor and a drive operated on a three phase 380VAC to 480VAC line:

Mains Voltage	Part Number	Manufacturer	Rating	Size
480VAC	KTK-5	Bussmann	5A, 600VAC/300VDC	1.5" x 0.41"
380VAC or 400VAC	KTK-4	Bussmann	4A, 600VAC/300VDC	1.5" x 0.41"

For higher DC rating on the fuse (500VDC), the Bussmann KLM may be substituted for the KTK.

Regen Need is a Strong Function of Maximum Motor Speed

If maximum motor speed is not too high, a drive typically does not need regen because the rotational energy is handled by the drive caps and motor resistance. The following example uses a PCE8x3 with a simple inertia load.

Example

If the deceleration time from very high speed to zero speed at full torque takes 100 msec, the peak shaft power at the beginning of the deceleration is estimated at about 4.2 kW (at 480VAC mains). The shape of the power pulse is triangular. The rotational energy to be absorbed is 210 joules (=0.5 x 4,200 watts x 100 msec). The caps in the PCE8x3 are rated to absorb 35 joules. The copper loss of a medium-size motor operating at the drive continuous rating is often in the 40-watt range. At x3 pk current, the motor copper loss is in the 360-watt range. In 100 msec, the motor copper for a full current deceleration absorbs about 36 joules (=360 watts x 100 msec). The balance of 139 joules (= 210 joules - 35 joules - 36 joules) is dissipated in the regen resistor.

Now, reduce the max speed by half. The rotational energy is reduced by four to 53 joules. The deceleration time is reduced by two, so motor copper energy loss is reduced by two to 18 joules. The bus cap absorption energy remains at 35 joules. As a result, the 53 joules of rotational energy is handled by the copper loss and bus caps without the need of a regen resistor. If the max speed was reduced to about one third, the cap alone could handle the rotational energy.

Fraction of Rated Speed	Rotational	Cap Rated	Cu	Regen R
Full	210 j	35 j	36 j	139 j
Half	53 j	35 j	18 j	0 j
Third	23 j	35 j	12 j	0 j

High Inertia

Rotational energy is proportional to inertia. At high speeds, a high inertia means lots of regen R wattage needed. Using the above example, once the speed is low enough so the copper losses (from a full torque acceleration) are the same as the rotational losses, the copper losses also increase in proportion to the inertia. This is because if inertia increases by ‘n’ it takes ‘n’ times longer to decelerate. If the speed is not too high, even with a high inertia, external regen may not be needed. Counter-intuitively, the greatest need for regen is when the decelerating torque is low and the speed is high.

In summary, the need for regen is a strong function of maximum motor speed. Below some speed, roughly (1/3 to 1/4) system rated speed, an external regen resistor is unlikely to be needed.

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