Accurate
TECHNOLOGY INC.
Linear Digital Measuring Systems

Single Axis Position Control Unit (PCU)

User's Manual

Version 2.040

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SAFETY WARNING

Before installing ProScale products, turn off the machine and disconnect it from its power source to avoid injury.

SAFETY WARNING

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Introduction

The Accurate Technology Position Control Unit (PCU) provides an aftermarket customer or OEM with a low cost solution for the automated positioning of a single axis on a machine.

In its primary mode of operation, the PCU is designed to operate with a motor contactor controlling a single or poly-phase motor to position a mechanical load to a prescribed location. The PCU utilizes continuous motion to approach the target location and then pulses the motor contactor to provide fine positioning control.

The simplified operation of the system is outlined as follows:

1. User enters a setpoint (target) position into the controller and presses the GO button.
2. The controller determines the direction of travel based on the current position of the mechanical load and activates the appropriate direction relay output.
3. The load travels in the direction of the setpoint target position, sampling its current position approximately 10 times per second.
4. When the load reaches a programmed boundary outside the setpoint known as the “Coast Tolerance” parameter, the motor output is deactivated and the load is allowed to coast. The PCU then pulses the motor output to provide a “stepping” action to execute fine load positioning. When the load is within a “target window”, the PCU disables the motor output and begins monitoring for load position drift. If the load drifts outside the prescribed tolerance, an error message is presented to the operator.

New Features in Firmware Version 2

- Backlash Compensation – Automatic backlash compensation is now available to remove excess play in the lead screw of the machine. An approach direction can be programmed to allow the axis to position from the same direction at all times. The amount of backlash to be removed is also programmable.
- Multiple positioning attempts – The PCU can be programmed to make numerous attempts to position the axis if the initial positioning attempt fails.
- Fine Positioning Control - The PCU can be configured in one of two modes for fine positioning. The default mode uses a stepping function. In this mode, the PCU positions the axis using a continuous motion until the axis reaches the coasting tolerance. Then the motor is pulsed in small time increments until the axis has reached its position. The second mode is used in conjunction with a user supplied variable frequency inverter. In this mode, the PCU activates its fast speed output which drives the inverter at a higher rate of speed. When the coasting tolerance is reached, the PCU activates its slow speed output which drives the inverter at a slower rate. This slower rate is used to creep into the target position.
- Conveyor Control Analog Output - A 0 to 10 volt DC output is available for use in controlling the speed of a conveyor if the machine is so equipped. The output can be configured with upper and lower limits to control the maximum output defined by the user. This output is typically used in conjunction with a variable frequency inverter to control the speed of the conveyor.
- Expanded Configuration Capability - Numerous other parameters are now user configurable to enhance the system's overall performance and flexibility.
- **Version 2.04**
    - Programmable relay output that can be used for external position drift indicator, axis lock function or conveyor feed activation.
    - Password protection has been added to secure the programming and offset menus.
    - Capability to re-initialize factory programming values.

1.0 Installation of PCU

The PCU is a panel-mounted device that is installed into a customer provided opening on the machine. The cutout dimensions for the opening are 92mm x 92mm (3.625 in x 3.625 in). The unit requires approximately 120mm (4.725 in) of depth including room for the rear connector and wiring.

The PCU mounts through the panel from the front and is held in position by two side mounted spring clips (provided). All connections are completed at the rear of the unit. This requires that either rear access to the unit must be available or that the wiring must be completed prior to installing the enclosure into the panel.

Locate the PCU on the machine in a place that is convenient to the operator. Typically, this should be at approximate eye-level and should not be obstructed by any moving parts or other impairments on the machine

1.1 Electrical Connections

The PCU incorporates two plug-in type connectors. The first is a 6-pin modular telephone connector that interfaces the unit with the provided ProScale position encoder. The second connector is a 16-position unplugable terminal strip that provides power and electrical connections to the PCU. The listing below provides the connector terminal identification.

Terminal 1 – 18 to 24 VDC positive power input.
Terminal 2 – Power supply ground.
Terminal 3 – Motor On/Fast Output N/O.
Terminal 4 – Motor On/Fast Output Common.
Terminal 5 – Motor Slow Output N/O.
Terminal 6 – Motor Slow Output Common.
Terminal 7 – Forward direction N/O.
Terminal 8 – Forward direction Common.
Terminal 9 – Reverse direction N/O.
Terminal 10 – Reverse direction Common.
Terminal 11 – Limit Switch Input +24 VDC in.
Terminal 12 – Limit Switch Input Ground
Terminal 13 – Conveyor Feed Speed Control Analog Output.
Terminal 14 – Ground.
Terminal 15 – Programmable Output N/O.
Terminal 16 – Programmable Output Common.

All relay outputs are rated for 250VAC @ 3 amps or 30VDC @ 3 amps (resistive). Do not exceed the current capacity of the relays or permanent damage may occur. The relays are not intended to directly drive a motor system but rather interface with a higher capacity motor contactor/starter that will control the load.

1.1.1 Electrical Connector Descriptions

Terminals 1 and 2 – 18 to 24 VDC power input @ 200 mA. Provides main power for the PCU electronics and relay drive. Do not exceed 26 VDC on terminal 1. Do not apply an AC voltage between terminals 1 and 2.

Terminals 3 and 4 – Motor On/Fast Output. This normally open relay output closes while the PCU is driving the motor output in a continuous motion mode.

Terminals 5 and 6 – Motor Slow Output. This normally open relay output closes while the PCU is positioning the axis within the Coasting Tolerance if the *Position Mode* programming option is selected. See pages 6, 10 and 23 for details on this option.

Terminals 7 and 8 – Forward Direction Output. This normally open relay output activates when the direction of axis travel is positive AND the Motor On Output is active. See Note 1.

Terminals 9 and 10 – Reverse Direction Output. This normally open relay output activates when the direction of axis travel is negative AND the Motor On Output is active. See Note 1.

Terminal 11 – Limit Switch/Emergency Stop Input +24 VDC. This input is used to connect one or more limit switches and/or emergency stop switch to the PCU. Switches should be wired in series for proper operation. One side of the switch circuit is connected to the positive terminal of an external positive 24 VDC supply. The other side of the switch circuit is connected to terminal 11 on the PCU.

Terminal 12 – Limit Switch/Emergency Stop Input Ground. This is the negative input for the limit switch input. This input should be connected to the negative terminal of an external 24 VDC power supply.

Terminal 13 – Conveyor Speed Feed Control Analog Output. Provides a DC signal from 0 to 10 volts to accommodate a VF inverter speed control of the conveyor belt if applicable. See pages 7 for details.

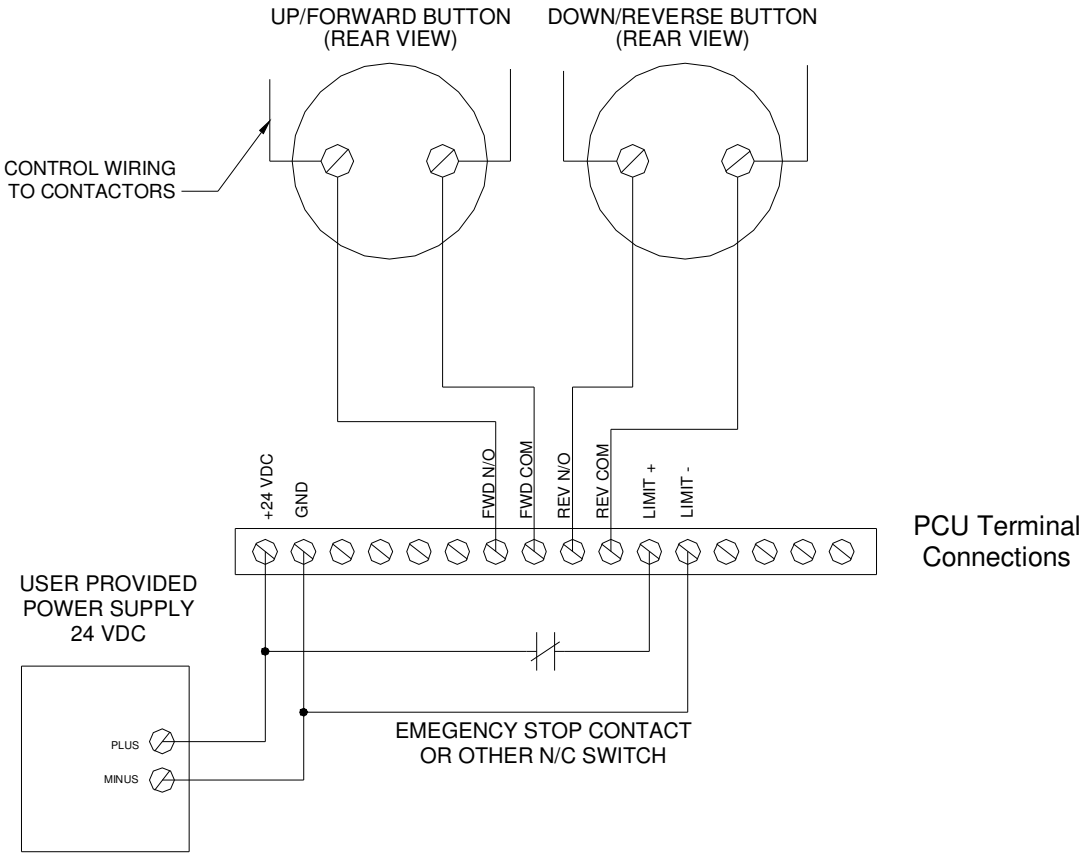
Terminal 14 – DC Ground.

Terminals 15 and 16 – This normally open relay output is used as a programmable output. See pages 7 and 8 for details.

Note 1 – The PCU is designed to automatically detect if the motor is turning the wrong direction when a move is executed and “swap” the functionality of the forward and reverse relays to compensate for reverse motor rotation.

1.1.2 Wiring Example for Retrofit Operation of Manual Motor Control

The diagram below illustrates a typical wiring example when the PCU is being installed on a machine that currently utilizes a manual UP/DOWN pushbutton operation to activate an AC drive motor via motor contactors.



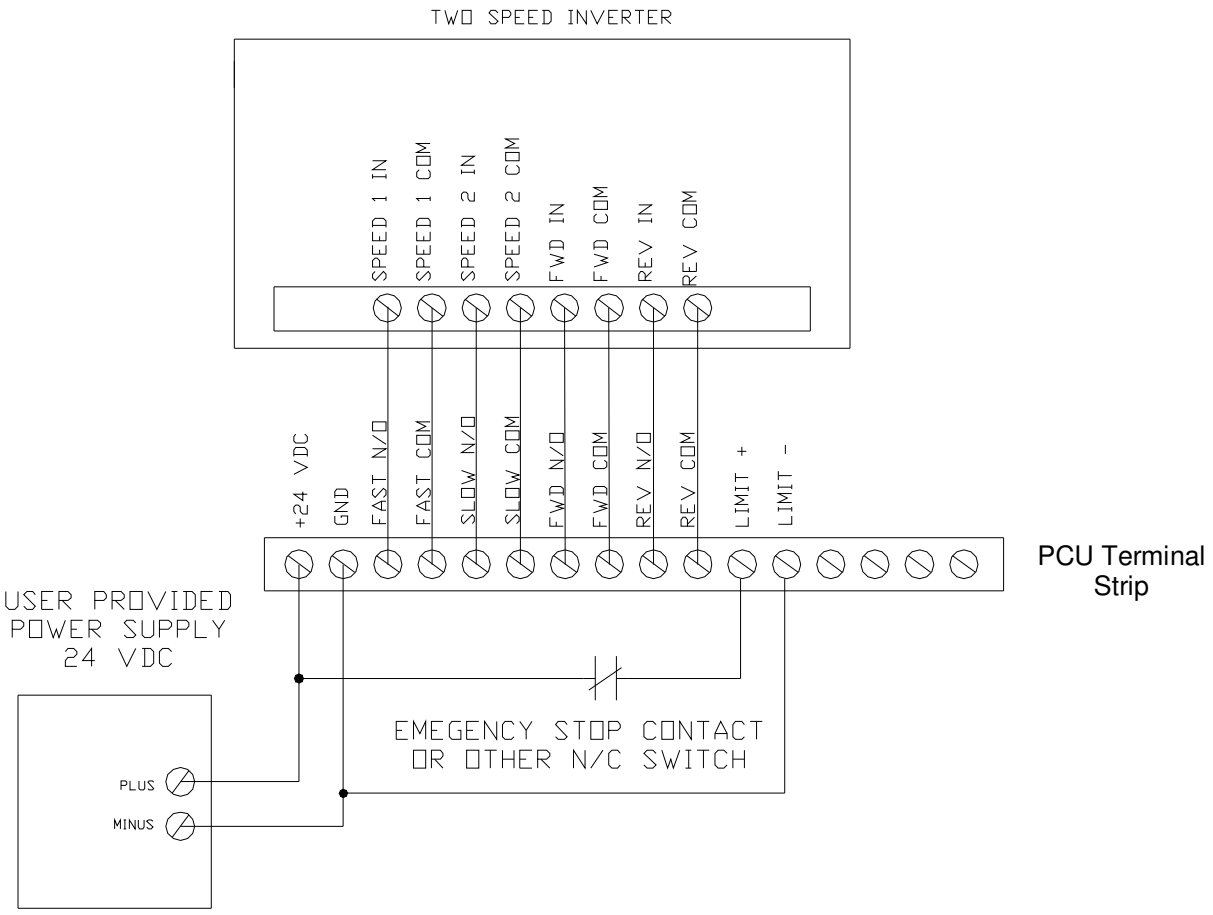
The PCU requires a user provided 24 VDC power supply to operate. In some cases, this can be derived from existing machine power, if available. If no 24 VDC power is supplied within the machine, an additional power supply will be needed. This can be either an open frame industrial power supply available from many electrical supply distributors or an optional plug-in power supply available from Accurate Technology, Inc.

A pair of wires are connected between the Forward relay contacts and the UP/FORWARD push-button contacts. An additional pair of wires are connected between the Reverse relay contacts and the DOWN/REVERSE push-button contacts.

A limit switch can be installed as shown in the diagram above. If no limit switch is used, connect a jumper between the ground terminal (2) and limit switch – (12). Connect a second jumper between +24 VDC input (1) and limit switch + (11). **The limit switch circuit must be enabled by either connection method or the PCU will not allow motion activation to occur.**

1.1.3 Wiring Example for Two Speed Inverter Motor Control

The diagram below illustrates the connections between PCU and a generic two speed variable frequency inverter to run the motor output.

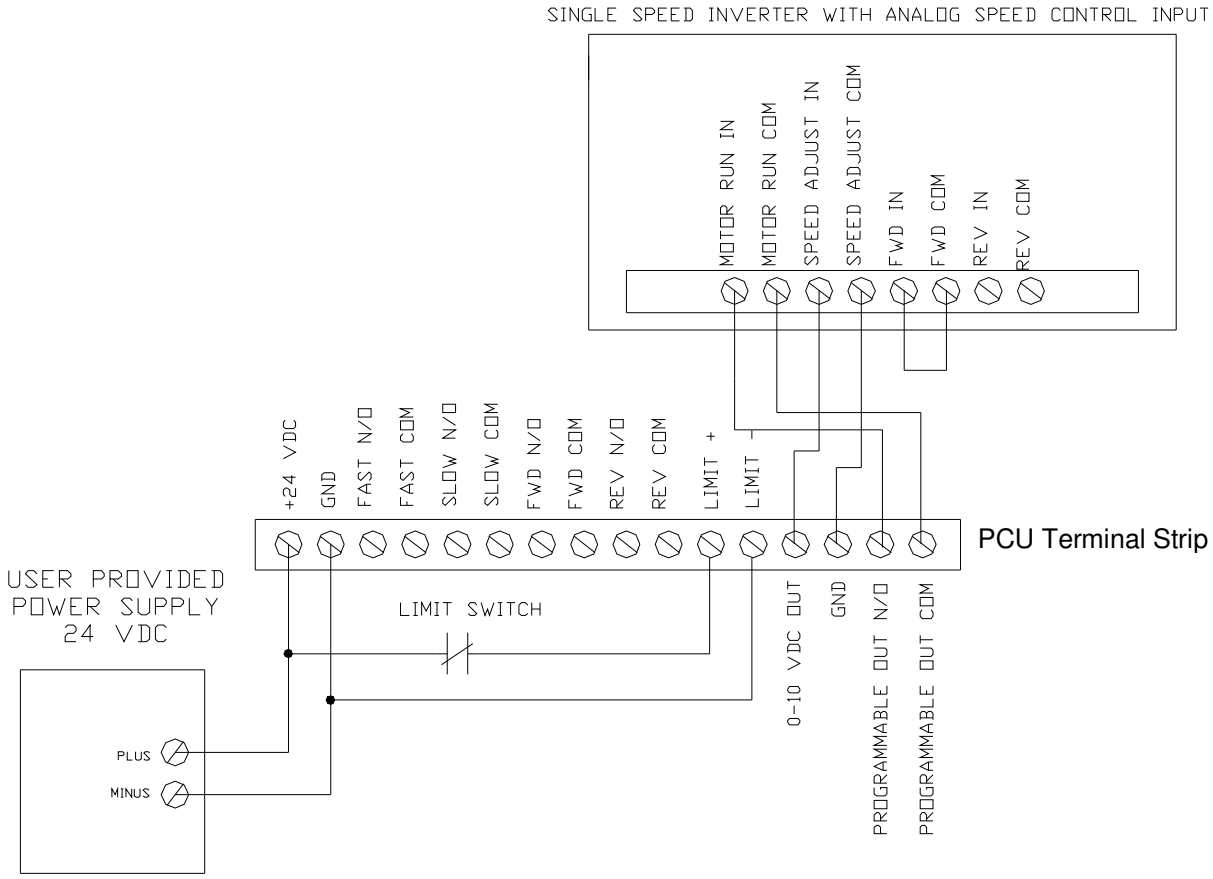


In this example, the fast and slow outputs of the PCU respectively are connected to the speed 1 and speed 2 inputs on the variable frequency inverter. The forward and reverse outputs of PCU connect directly to the forward and reverse inputs of the inverter.

Speed 1 of the inverter is programmed for a faster velocity to allow the axis to be positioned rapidly. Speed 2 of the inverter is programmed for a slower velocity to allow the axis to be positioned very accurately.

1.1.4 Wiring Example for Conveyor Feed Operation

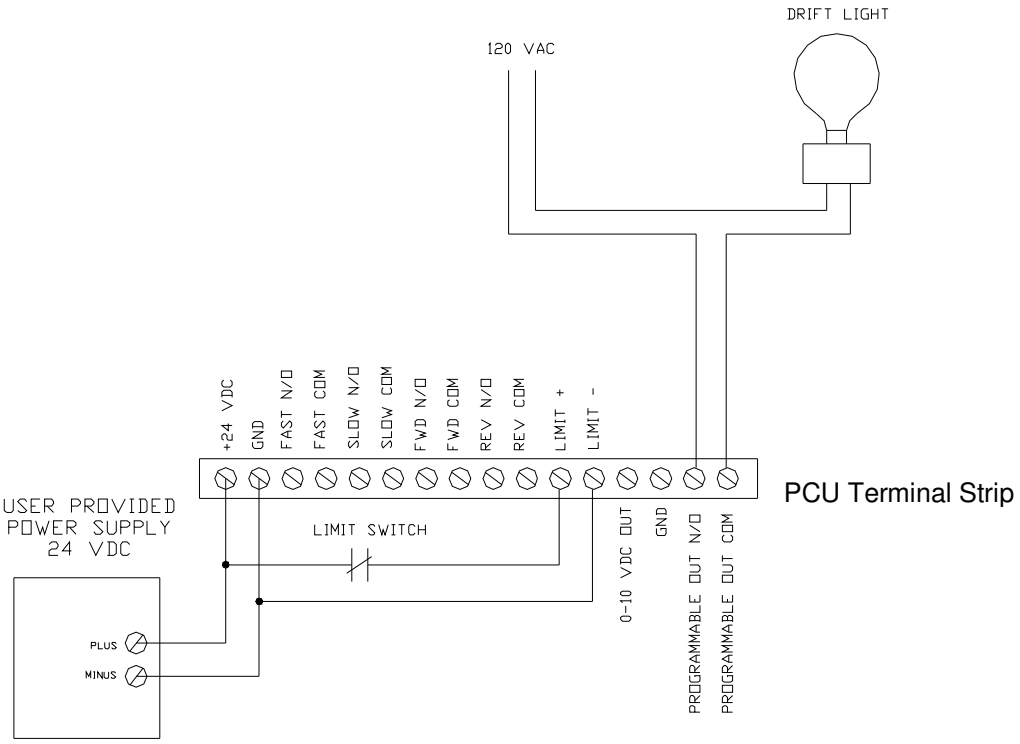
The diagram below represents the connection between the PCU and a generic variable frequency inverter with external analog speed control input for use in operation with a machine conveyor system.



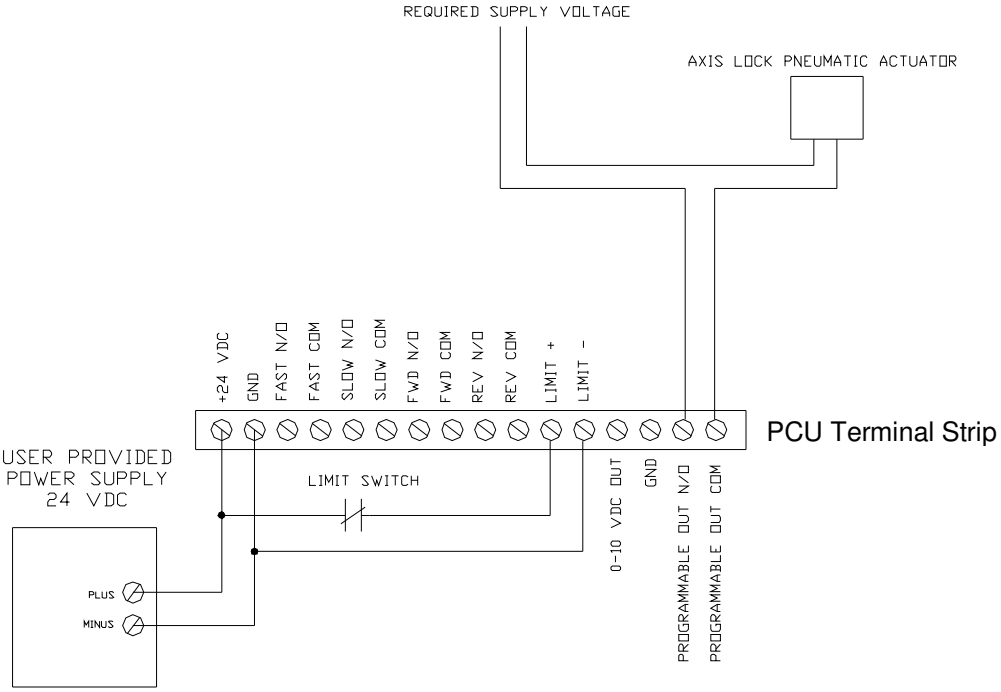
In this application, the PCU energizes a normally open relay whenever the conveyor output is to become active. An analog output voltage from 0 to 10 V DC is used to control the desired speed of the inverter.

Conveyor output control can be activated from either the position monitoring menu (See page 17) or from the feed option menu (See page 21).

1.1.5 Wiring Example for External Position Drift Indicator



1.1.6 Wiring Example for Axis Lock Brake System



1.2 ProScale Encoder Installation

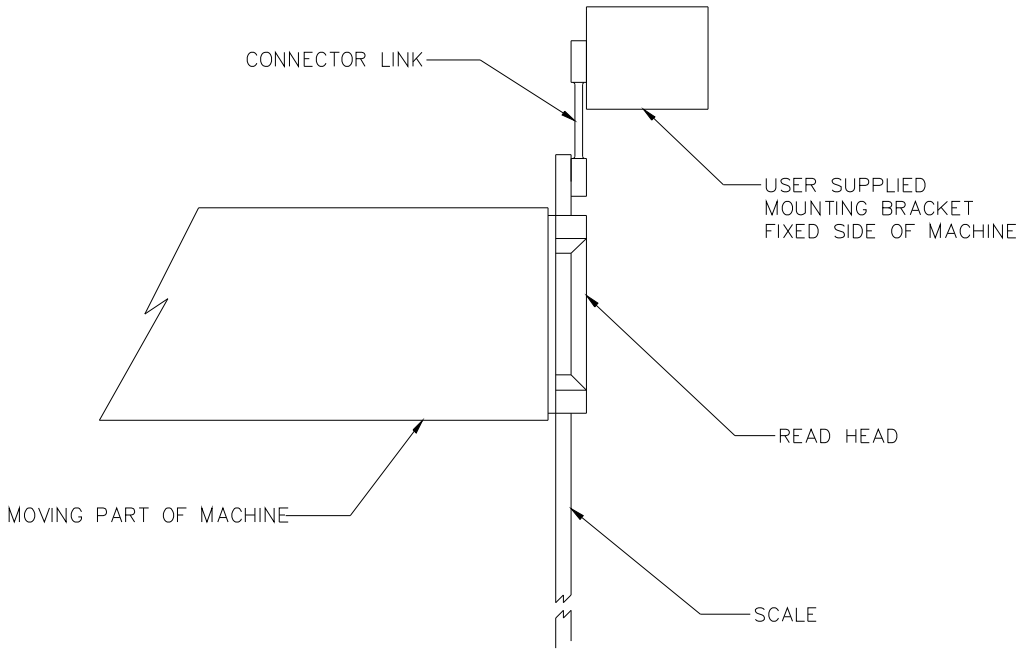
The ProScale position encoder consists of two parts. The first is the encoder scale. This is an aluminum-extruded spar that has a green encoder substrate laminated to it. The encoder scale provides the measurement capability relative to a user defined datum or origin. The second part is the read head. This unit slides on the aluminum extrusion and electronically measures the current position along the encoder substrate.

Most applications will utilize the model 150 scale assembly. This scale provides either a 10 inch (254mm) or 18 inch (457mm) measuring range. Typically, the encoder scale is mounted to the machine in a fixed manner while the read head mounts to the moving part of the machine.

The encoder scale mounts using a provided flexible link connector. One end of the link mounts to the machine via a customer provided mounting bracket. The other end of the link connects to the encoder scale via the drilled and tapped hole at the end of the scale.

The read head is secured to the moving part of the machine via 3 mounting holes and 6/32 (or similar) screws.

The diagram below illustrates a generic encoder installation.



Care should be taken when installing the encoder scale and read head. To reduce excessive wear and assure accurate measurement, the encoder scale should be mounted as parallel as possible to the direction of travel.

Although the above diagram shows the read head secured to the moving part of the machine, an alternative installation would allow for the scale to move and the read head to be fixed. The actual installation method chosen depends on the particular application.

After the encoder system has been installed, route the read head wiring through the machine and connect it to the PCU via the modular connector. Avoid routing the encoder wiring parallel to high voltage or high frequency cables as this may cause interference in reading the encoder data signals.

2.0 Special Features of the PCU

2.1 Backlash Compensation

Backlash compensation is used to remove excess play or motion from the lead screw driving the load. This typically occurs when the direction of motion has been changed. To accomplish this, the load is always positioned from the same direction regardless of the starting location.

In the case of a vertical axis, the load is always positioned in the rising direction. If the starting position is above the target position, the axis will move downward passed the target position by the programmed amount of backlash compensation. The axis is then positioned in a rising direction from that point.

If the starting position is already below the target position, the axis will move directly to the target position and no backlash compensation will be completed.

The approach direction is programmable and may be configured by the user depending on the application being used. The amount of backlash compensation used is a configurable parameter. The use of backlash compensation may be disabled by the user.

2.2 Slow Speed/Stepping Final Positioning

The PCU can operate either one of two modes. The first mode uses a stepping operation to pulse the motor into its final position. The second operation is used in conjunction with a two speed variable frequency inverter.

When the stepping action is used, the PCU operates the motor at continuous speed until the coasting tolerance is reached. The PCU then pulses the motor contactor to step the axis into position. This process uses the existing motor and contactor system. No additional hardware is needed. The size of each step is programmable in milliseconds

When a two speed variable frequency inverter is available for use in the system, the PCU activates the fast motion output which will run the inverter at a higher pre-programmed speed. When the axis reaches the coasting tolerance, the slow speed output of the PCU is activated which runs the inverter at a slower pre-programmed speed. This provides a very fluid motion positioning system but requires the use of an inverter to complete the motion task.

This operating mode is controlled by the use of the *Positioning Mode* parameter under the system programming. If the *Positioning Mode* option is set to zero, the

stepping operation is active. If the *Positioning Mode* option is set to one, then the slow speed option is active.

2.3 Repositioning Attempts

When a new set-point is issued to the PCU, the unit will attempt to position the axis within the programmed tolerance. If the final position exceeds the programmed tolerance, then the PCU will attempt to reposition the load again automatically. The number of repositioning tries is programmable by the user.

After the number of repositioning attempts has been exhausted, the PCU will indicate the axis is out of position.

2.4 Scaling Factor

In certain situations, it may be desirable to have the encoder position represented by a multiplying factor. One example is when a machine consists of two moving sides that are on a common screw and only one side is to be monitored for position. In this case, a scaling factor of two is configured for the PCU and yields a position that is twice the distance of the actual motion.

Scaling factors can also be represented by values less than one. For example, a scaling factor of 0.5 will yield position information that is half as much as the actual distance traveled.

2.5 Analog Output for Conveyor Operation

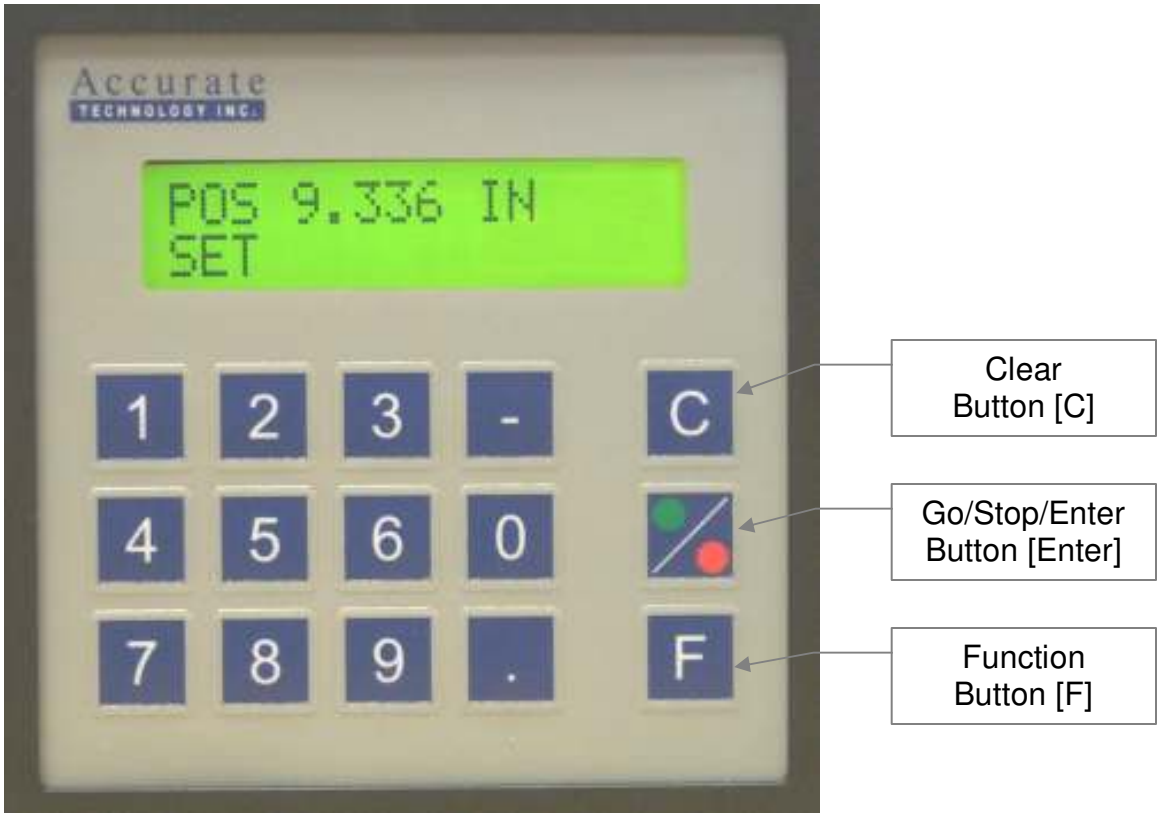
The PCU supports an analog output that will provide a 0 to 10 volt DC signal that can be used to drive the analog input of a variable frequency inverter. This analog signal can be used to control the feed rate of a conveyor system if used on an applicable machine.

Upper and lower feed rates are programmable into the system where the lower feed rate represents zero volts and the upper feed rate represents ten volts. The current output level can be controlled from either the feed rate option menu or from the position control menu when the axis is in-position.

3.0 System Operation

The PCU has been designed for ease of use and simplicity while providing all of the necessary features needed for basic motion positioning.

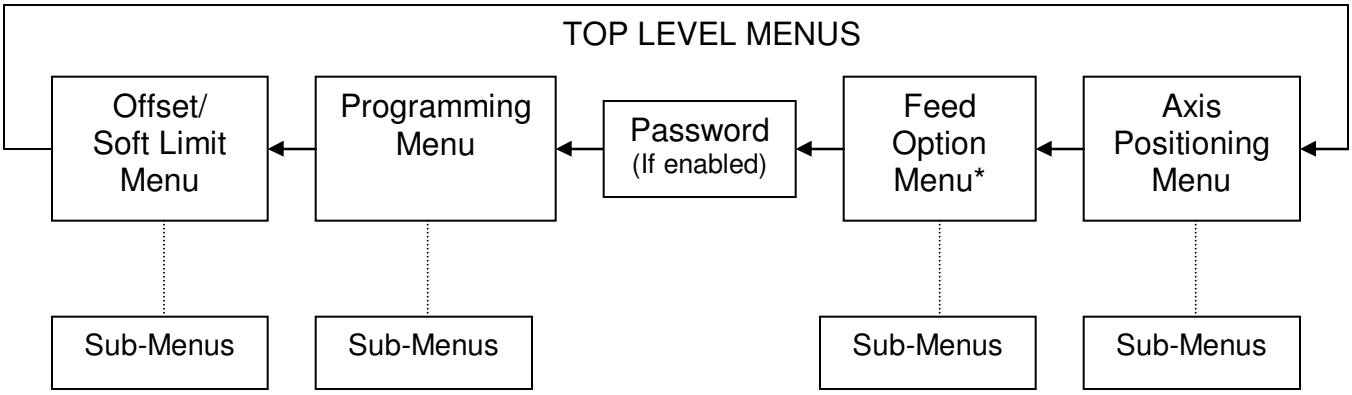
The PCU incorporates a 2 line by 16-character backlit LCD display with a 15-button keypad as the primary man-machine interface. The picture below illustrates the control panel for the PCU.



The keypad consists of a total of 15 keys, 10 numeric, minus, decimal point, Clear [C], Go/Stop/Enter [Enter] and Function [F].

3.1 Menu System

The PCU provides user functionality via a series of menus that control system operation and programming. There are 4 top-level options that the user can chose from with each main option having sub-menus for each operation. The diagram below displays a representation of this functionality.

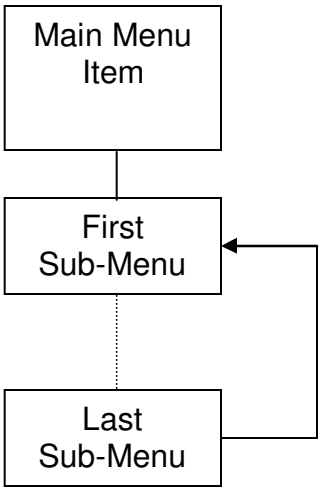


** This menu is only available if the programmable output is configured to 2.*

3.2 Menu Navigation

Two principle keys are used while navigating through the menu system of the PCU. The first is the Function key [F]. The Function key is used to move from one menu to the next. When the last menu is reached, pressing the [F] key will loop back to the first menu.

When a top-level menu is being displayed, press and **hold** the Go/Stop/Enter button [Enter] to select the menu option. Once this has been completed, pressing the [F] key will now cycle through the sub-menus under the selected main menu as shown below.



To exit from the sub-menu system, **press AND hold** the [F] key for approximately 1.5 seconds. The system will return to the top-level menu listing showing the **next** available top-level menu.

The [Enter] key is also used when entering data into the PCU. The user inputs the specified data and presses the [Enter] key to accept it. In programming mode, the user must press the [Enter] key to store the data otherwise the changes are discarded.

NOTE: *The programming password is initially disabled (Password set to 000).*

3.3 Operating Menus

This section covers the individual top-level menus and each of their sub-menus. It describes the functionality and provides information on available keypad input.

3.3.1 Position Control Menu

This menu controls the fundamental positioning operation of the PCU and is the first menu to appear after power-up. The initial menu is shown below:

```
POS  8.734 IN
SET
```

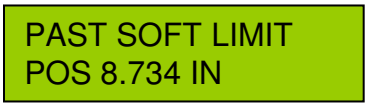
This screen provides real-time display of the current encoder position. The current position is shown on the top line and labeled POS. To automatically position the axis with the PCU, the user enters the new position on the keyboard as shown below. If an error is made while entering the setpoint, press the Clear [C] key. To enter a negative setpoint, press the minus [-] key at any time.

```
POS  8.734 IN
SET 6.375
```

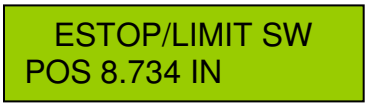
The new setpoint or target position is shown on the second line and labeled with SET. To begin the move, press the Go/Stop/Enter [Enter] button.

```
CLEAR MACHINE
GO TO START
```

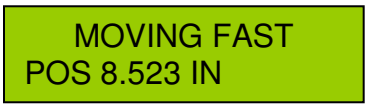
The screen above is displayed to indicate that the PCU has verified that the desired target position is within range and that no other errors exist. It warns the operator to clear the machine first and then press the [Enter] key. To abort the motion operation from this screen, press and hold the Function [F] key. Any errors are displayed with separate message screens as shown on the next page.



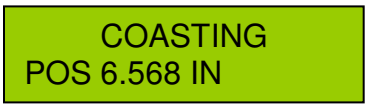
If the desired setpoint is outside the programmed upper or lower limits, the PCU will display this screen indicating that an out-of-bounds condition was detected. To return to the main position menu, press the [F] key once.



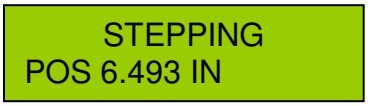
If the limit switch circuit is not secure (closed to ground), the PCU will indicate an emergency stop/limit switch warning message. To return to the main position menu, press the [F] key once.



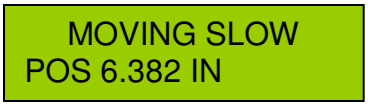
If no initial errors are detected and the setpoint is valid, the screen shown above will be displayed after the “Clear Machine” screen. As the axis moves, the current position will be displayed on the second line of the LCD. This screen will continue to be displayed until the axis is within its coast range (see page 23), the user presses the Go/Stop/Enter key to abort the motion or an error is detected.



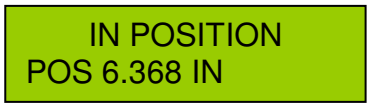
When the axis is within its coast range, the PCU will turn off the motor control output and allow the axis to coast.



When the axis has stopped moving, the PCU will pulse the motor output (*Position Mode* = 0) for a period of time depending on the direction of travel and the pulse time programmed for that direction. See page 24 for details on the pulse setting. This pulsing action will continue until the load is within the in-position tolerance or has exceeded the target position (plus tolerance distance.)

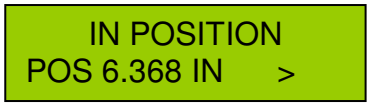


If the PCU is programmed for slow speed operation (*Position Mode* = 1), the slow speed output relay will activate when the coasting range is reached. When a variable frequency inverter is used, this output will trigger the slow speed setting on the inverter and the PCU will use this continuous slow speed motion for the final axis positioning. This option can only be used in conjunction with a two speed variable frequency inverter. When the slow speed operation is enabled, the stepping output functionality is disabled.



When the PCU has reached or exceeded its in-position tolerance, PCU will evaluate if the current position of the axis is within the programmed in-position tolerance (see page 22) of the target position. If it is, the PCU will display the screen shown above indicating that the axis is in position. If the current position exceeds the target position by the in-position tolerance, the PCU will attempt to reposition the axis. The number of attempts to reposition the axes is programmable. If the number of positioning attempts is exhausted, the PCU will indicate an out of position error message.

To return to the main positioning menu, press the [F] key.



While the PCU is in its position monitoring mode, the user can activate the conveyor but pressing the [ENTER] button. Each press of the [ENTER] button will turn on or off the conveyor. The user may also control the speed of the conveyor a pressing the one or two digit keys on the keypad. The amount of speed change is controlled by the *Feed Rate Increment* parameter in the programming mode.

*The conveyor status and feed rate can also be controlled under the feed rate main menu. See page 21 for details.

** This menu is only available if the programmable output is configured to 2.*

To return to the main positioning menu, press the [F] key.

NOT IN POSITION
POS 6.347 IN

Once the axis has been positioned successfully, the PCU will begin monitoring the axis for drift. If the axis drifts outside of the programmed in-position tolerance of the setpoint for more than 3 seconds, the PCU will indicate that the axis is not in position and will flash the LCD backlight as a visual indicator. The user has the option to either move the axis into position by hand or to abort the motion. If the user operates the axis manually, the PCU will continue to monitor the current axis position and evaluate the in-position tolerance. When the axis is within tolerance, the "In Position" message will be displayed and the LCD backlight will stop flashing. To return to the position main menu, press the [F] key.

3.3.1.1 Axis Errors

MOTOR STALLED!
POS 7.329 IN

While the axis is moving, the PCU continually monitors for errors that could cause damage to the machine or its associated parts. If the axis stops moving for the time defined by the *Stall Time* programming parameter, the PCU detects the error, shuts down the Motor On output and indicates that the motor has stalled. This could be caused from a number of reasons. The axis could be stalled because of an obstruction in the machine, a mechanical failure could have occurred, excess backlash may be present in the lead screw or the ProScale encoder could have become disconnected from the mechanical load. In any case, a thorough investigation should be completed before the PCU is used again to position the axis. To return to the main menu, press the [F] key once.

ESTOP/LIMIT SW
POS 7.439 IN

If the limit switch circuit is activated (opened) while the axis is moving, the Motor outputs are immediately turned off and the above error message is displayed. To return to the main menu, press the [F] key once.

MOTOR DIR CHANGE
POS 7.439 IN

When the PCU initially starts moving the axis, it monitors that the distance to the target setpoint is getting smaller. If the distance to target gets larger, the axis is moving in the wrong direction. Instead of modifying the motor wiring, the PCU

reverses the functionality of the Forward and Reverse relay outputs to make the motor turn in the proper direction. When this error occurs, the PCU shuts off the Motor On output and indicates a motor direction change message. Press the [F] key to return to the main menu and start the motion again. The axis should now move in the proper direction.

3.3.1.2 Use of Long ProScale Encoders with the PCU

The PCU can operate with ProScale encoders over 17 inches long. ProScale encoders in excess of 17 inches in length are built using multiple scale encoder panels, placed end to end, to form the overall length of the scale. Each encoder panel (the green part of the scale) has a measurement period of approximately 17 inches (433 mm) in which the measurement process is absolute. This means that the read head knows exactly where it is along any single scale panel regardless of cycling power to the system.

As the readhead moves along the scale, it passes from one scale panel section to another. In this case, the PCU keeps track of the transition from panel to panel and accumulates the total distance representing the position of the read head along the overall length of the scale.

If power is removed from the PCU and the axis is moved manually, it is possible that the read head may transition from one scale panel to another causing the accumulated position to be off by one or more scale panel periods.

To accommodate for this possibility, the user can manually add or subtract individual scale periods to the accumulated position to correct the problem. This is done using the following procedure. Note that this can only be done while in the Position Control Menu:

- If the PCU is displaying a position that is **greater** than the actual position by a multiple of 17 inches (433 mm), press and hold the Clear [C] key for one second and then press the **2** key. Each depression of the **2** key will subtract one scale period from the accumulated position being displayed. If the accumulated position is off by one period, this operation will correct the error without having to modify the current position of the PCU.

- If the PCU is displaying a position that is **less** than the actual position by a multiple of 17 inches (433 mm), press and hold the Clear [C] key for one second and then press the **1** key. Each depression of the **1** key will add one scale period to the accumulated position being displayed. If the accumulated position is off by one period, this operation will correct the error without having to modify the current position of the PCU.

This procedure should only be completed when power has been removed from the PCU and the axis has been moved manually over some distance of the encoder scale. This functionality only provides gross adjustments of one scale period (17 inches/433 mm). To set the actual position of the axis (datum) during initial installation, use the Offset/Soft Limit menu outlined on page 28.

3.3.2 Feed Option Menu*

This menu system is only available if programmable output is configured to 2. See page 27.

The feed option menu controls the conveyor activation output and speed control. There are two sub menus within this main menu option. Press and **hold** the [Enter] key to use this menu option.

This option controls the current state of the conveyor output. Initially, the feed output is off. Pressing the [ENTER] button toggles the conveyor output from off to on. Subsequent key presses of the start button will alternate the current state of the conveyor output. The LCD display shows the current status of the conveyor output.

To move to the next sub-menu, press the [F] key.

This sub-menu controls the current feed rate of the conveyor analog output. This value can be any amount between the minimum and maximum feed rates defined in the programming mode.

To establish a new current feed rate, enter the new value and press the [ENTER] key. If a feed rate is entered that is outside of the define minimum and maximum rates, the PCU will indicate an error.

The units for this parameter are generic. They relate directly to the minimum maximum feed rates defined in programming mode.

Press the [F] key to move back to the feed control sub menu.

Press and hold the [F] key at any time inside this menu system to return to the next top-level menu.

3.3.3 Programming Menu

```
   PROGRAM MENU
GO=SELECT F=NEXT
```

This menu system allows the user to configure the PCU with specific tolerances and attributes for a particular installation. Press and **hold** the [Enter] key to use this menu option.

```
   0 = MM  1 = INCH
0
```

This field sets the current operating units. Enter 0 for millimeters or 1 for inches. Note that changing from one type of measurement units to another will automatically convert all tolerances to the proper units. Press the [Enter] key to accept. Press the [F] key once to move to the next option.

```
  USE LONG SCALES
0
```

This parameter indicates if long scales should be used. If this parameter is set to zero, then only scales less than 17in. will be accommodated. If this parameter is set to one, then scales longer than 17in. will be supported. Set this parameter to one only if long scales are to be used. Press [Enter] to accept the new value, press [F] once to move to the next option.

```
   IN-POSITION TOL
0.020
```

This field sets the in-position tolerance used when executing an axis positioning operation. This tolerance is added to and subtracted from the specified setpoint target to create a “window” of positioning tolerance. If the final position of the axis falls within this window, the PCU will indicate that the axis is in position. If the axis is outside of this window, the system will indicate an out of position error. The specific value used for this entry depends on the tolerances required by the user and the working condition (wear) of the machine. In addition, once the axis is positioned either by the PCU or manually by the user, the PCU will monitor the current position for axis drift. This tolerance is also used to determine the amount of allowable axis drift. This value should always be positive. Press [Enter] to accept the new value, press [F] once to move to the next option.

COASTING TOL
0.075

This field sets the axis coasting tolerance used when the PCU positions the axis. This tolerance is either added to or subtracted from the specified setpoint target, depending on the direction of travel, to determine when the Motor On output should be turned off while the axis is in motion. The PCU will then pulse the motor output to “step” the motor into position. The value of this setting must be determined empirically and should be such that the coasting action ends close to the setpoint without overshooting it. This value should always be positive. Press [Enter] to accept the new value, press [F] once to move to the next option.

USE BACKLASH
0

This parameter controls the use of backlash compensation. If this parameter is set to one, backlash compensation will be executed. If the parameter is zero, backlash compensation will not be executed. When backlash compensation is enabled, the axis will always be positioned from the same direction as programmed by the approach direction parameter. See page 11 for additional details. Press [Enter] to accept the new value, press [F] once to move to the next option.

BACKLASH TOL
0.200

When backlash compensation is enabled and the approach direction is not equal to the direction of travel, the axis will overshoot the target position by this programmed amount and then approach the target position from the current direction. The amount of backlash tolerance will be directly related to the amount of backlash that is in the drive system. Press [Enter] to accept the new value, press [F] once to move to the next option.

APPROACH DIR
0

When backlash compensation is active, the approach direction will determine from which direction the axis will always be positioned. The value of the approach direction will be related to the specific application. The range for this parameter is either one or zero. Press [Enter] to accept the new value, press [F] once to move to the next option.

POSITION MODE
0

This parameter controls whether stepping or slow speed operation is used for fine position adjustment. If this parameter is set to zero, position stepping is used. If this parameter is one, slow speed positioning is used. Note: For slow speed positioning to be available, a two speed variable frequency inverter must be used with the system. Press [Enter] to accept the new value, press [F] once to move to the next option.

POSITION RETRIES
3

This parameter controls the number of additional positioning attempts that the system will make to achieve the defined setpoint. If after the defined number of attempts have been reached and the system is still not in position, the PCU will abort the motion operation and generate an out of position message. The maximum value for this parameter is 10. Press [Enter] to accept the new value, press [F] once to move to the next option.

NEG STEP (MS)
100

This parameter is used to configure the pulse-on time of the motor output when executing “step” positioning in the **negative** direction of travel. This value is set in milliseconds of on-time. Although the setting can be configured to 0, the minimum value should be no less than 20 milliseconds. The actual value programmed must be determined empirically based on the mechanical parameters of the machine. Press [Enter] to accept the new value, press [F] once to move to the next option.

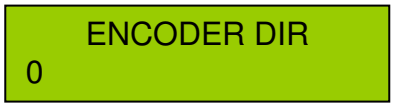
POS PULSE (MS)
100

This parameter is used to configure the pulse-on time of the motor output when executing “step” positioning in the **positive** direction of travel. This value is set in milliseconds of on-time. Although the setting can be configured to 0, the minimum value should be no less than 20 milliseconds. The actual value programmed must be determined empirically based on the mechanical parameters of the machine. Press [Enter] to accept the new value, press [F] once to move to the next option.

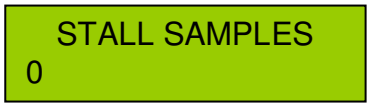
The minimum feed rate parameter represents the minimum analog output for the conveyor feed speed. This parameter represents a 0 V DC output. The units for this parameter are generic and can be used to represent feet per minute, meters per minute or some other relative representative units. Press [Enter] to accept the new value, press [F] once to move to the next option.

The maximum feed rate parameter represents the maximum analog output for the conveyor feed speed. This parameter represents a 10 V DC output. The units for this parameter are generic and can be used to represent feet per minute, meters per minute or some other relative representative units. Press [Enter] to accept the new value, press [F] once to move to the next option.

The feed rate increment parameter controls the amount of speed adjustment that is made when the one and two digits are pressed on the keypad while in the position monitoring mode. When the 1 digit is pressed, the feed rate is increased by the feed rate increment. When that two digit is pressed the feed rate is decremented by the feed rate increment. Press [Enter] to accept the new value, press [F] once to move to the next option.



This option configures the encoder direction being used by the PCU. Depending on the orientation of the encoder scale and read head, the encoder may report a negative direction of travel when the machine is moving in a positive direction. To reverse the encoder readout without physically rotating the encoder, change this parameter setting from 0 to 1 or 1 to 0. Press [Enter] to accept the new value, press [F] once to move to the next option.



This programming parameter is used to control how stall sampling is executed on the PCU. When this parameter is set to zero, stall sampling is executed on every encoder sample that is received. When this value is set to one, stall calculations are done every other encoder sample. When this value is set to 2, stall calculations are done every two encoder samples, etc. Change this parameter in

applications where the axis moves at a very slow rate of speed. This will prevent inadvertent stalls from being detected. Press [Enter] to accept the new value, press [F] once to move to the next option.

STEPS TO STALL
5

This programming parameter is used to control how many motor steps must be executed without motion before the PCU detects a stall condition. This is used during the stepping phase of axis positioning. When more than the programmed number of *Steps to Stall* has been executed without any discernible motion detected, the PCU will determine that the motor is in a stall condition and disable the motor output.

Caution should be taken when setting this parameter. If too large of a value is programmed, damage to the machine may occur because excess pulses are required to detect the stall.

Press [Enter] to accept the new value, press [F] once to move to the next option.

STALL TIME (MS)
3000

This parameter controls the amount of time that must expire without detectable motion of the axis during continual motor motion before the PCU disables the motor output. This amount of time is rated in milliseconds.

Care should be taken in programming this parameter. If the value of this parameter is too large, damage to the machine may occur because the stall condition will not be recognized soon enough. If this parameter is set too small, excess backlash in the lead screw may cause inadvertent stall conditions to be detected. Press [Enter] to accept the new value, press [F] once to move to the next option.

STEP DELAY (MS)
300

This parameter controls the minimum amount of the delay that will occur between steps during the stepping phase of axis positioning. When the PCU executes a step, the unit will detect when the axis has completed its coasting phase and will wait the programmed step delay, in milliseconds, before executing the next step. Press [Enter] to accept the new value, press [F] once to move to the next option.

SCALE FACTOR
1.000

The scale factor parameter is used to control the measurement ratio reported by the ProScale encoder. Values greater than one will multiply the actual encoder position by the defined value. Values less than one will be a fraction of the original encoder actual position. For example, to double the actual encoder position, use a scaling factor of 2.0. To half the actual encoder position, use a scaling factor of 0.5.

This feature may be useful on machines that use a common screw to move two portions of the machine together. This allows only one side of the machine to be monitored for position yet provides a doubled position output.

Press [Enter] to accept the new value, press [F] once to move to the beginning option.

NOTE: Press and hold the [F] key at any time inside this menu system to return to the next top-level menu.

PROG OUT MODE
0

This parameter controls the function of the programmable output. There are 3 possible selections:

- 0 = Drift Indicator Output [Default].
- 1 = Axis Lock Output.
- 2 = Conveyor Output.

Drift Indicator – Activates if the current position drifts from the designated setpoint. Pressing the [F] key while drifted will reset (turn off) the output. See page 8 for wiring details.

Axis Lock – Activated after the PCU has reached the entered setpoint. This is used to activate an electric or pneumatic brake system. Pressing the [F] key while positioned will reset (turn off) the output. See page 8 for wiring details.

Conveyor Output – Used to activate the conveyor feed on a machine that is so equipped. See page 7 for wiring details.

PASSWORD 3 DIGITS
000

By default, the programming password is disabled. This allows easy traversal through the menu system during system setup. After configuration is complete, the user may wish to enable the password protection to prevent unauthorized programming changes.

To enable the password protection, program any 3 digit password other than 000. All three digits must be entered or the changes will not be accepted. To again disable the password security, program a password of 000.

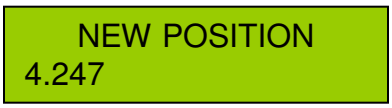
Once a password is programmed, only the Axis Positioning menu and the Feed Option menu* are available to the operator. A valid password must first be entered at the password screen followed by pressing [Enter] to gain access to the programming and offset menus.

Caution: Do not loose the password once it has been enabled. There is no way to recover the password without re-entering programming mode. Contact Accurate Technology if the password is lost for assistance.

*The Feed Option menu is only available if the programmable output is configured to 2.

3.3.4 Offset/Soft Limit Menu

This top-level menu allows the user to set the current position of the PCU to any desired value and configure the operating soft limits used when executing an automated axis movement. Press and **hold** the [Enter] button to access this menu system. Press the [F] key once to move back to the Positioning Menu.



This screen allows the user to change the current position being displayed by the PCU. This operation sets the datum or offset and allows the PCU to be calibrated to any position along the normal operating range of the ProScale encoder. Once this configuration has been completed, the offset is stored in non-volatile memory. This operation does NOT need to be executed every time the PCU is powered. This configuration needs to be modified only when the machine configuration has been changed such as replacement of sanding belts or drum on a wide-belt sanding system. Enter the new present position and press the [Enter] key. The PCU will now reflect this position as the current position. Press the [F] key once to move to the next option.

This option indicates the current lower operating limit of the axis when an automated move is executed. If the user attempts to move to a setpoint target that is less than the low soft limit (using the Position Control Menu), the PCU will indicate a soft limit error message. The value chosen for this parameter must be determined specifically by the particular application. This value can also be negative but MUST be less than the upper soft limit (see next section). After entering a new lower soft limit, press the [Enter] key to store the new value to memory. Press the [F] key to move to the next option.

WARNING: It is extremely important that the low soft limit be set properly. If an invalid setting is entered, safeguards that the PCU offer to protect the machine from damage may be circumvented.

This option indicates the current upper operating limit of the axis when an automated move is executed. If the user attempts to move to a setpoint target that is more than the upper soft limit (using the Position Control Menu), the PCU will indicate a soft limit error message. The value chosen for this parameter must be determined specifically by the particular application. This value MUST be greater than the low soft limit (see previous section). After entering a new upper soft limit, press the [Enter] key to store the new value to memory. Press the [F] key to move to the New Position menu.

WARNING: It is extremely important that the upper soft limit be set properly. If an invalid setting is entered, safeguards that the PCU offer to protect the machine from damage may be circumvented.

NOTE: Press and hold the [F] key at any time inside this menu system to return to the Position Control Menu.

4.0 Initial Setup

This section provides an outline to follow when preparing to use the PCU for the first time. This assumes that all installation activities have been completed and the machine/PCU is powered and ready.

4.1 Encoder Direction

The first step in system setup is to verify the correct encoder direction operation. Manually operate the axis and note the change in position display on the PCU from the Position Control Menu. If the axis is being moved in the positive direction, the PCU should also reflect this position change direction. If the PCU is displaying position change in the opposite direction of axis motion, change the ENCODER DIRECTION parameter in the programming menu to the opposite value (0 or 1). Verify that the PCU is now indicating the proper position change.

4.2 Datum Calibration

Datum calibration configures the PCU to display the appropriate current position relative to a fixed machine reference. Once the datum or current position is set, no further re-calibration is needed unless physical machine parameters are changed such as belt or drum changes on sanding systems.

The PCU datum change can be completed using one of two methods. These are:

- Physical Measurement
- Empirical Measurement

Physical measurement requires that a caliper, gauge or other precision device be used to measure the physical distance between the load being positioned by the PCU and the machine reference point. In some cases, this may be difficult because of space or measurement distance limitations.

Empirical measurement involves machining a part at an arbitrary position, measuring the dimension of the part and using the measured dimension as the datum distance.

Choose the appropriate measurement method that best suits your application. Once an accurate measurement has been completed, enter the OFFSET/SOFTLIMIT menu. The initial screen will show the current position of the PCU. Enter the measured position and press the [ENTER] key. The PCU will now use the measured position as its current position.

4.3 Soft Limit Configuration

Soft limits are used by the PCU to limit the travel of the axis to prescribed boundaries. It is EXTREMELY IMPORTANT to correctly program the soft limits to prevent possible catastrophic damage to the machine.

To set the lower soft limit, enter the OFFSET/SOFTLIMIT menu and move to the second function. Enter the lowest permissible position that the axis can move to and press the [ENTER] key to store the value.

Press the [F] key to move to the upper soft limit. Enter the highest permissible position that the axis can move to and press the [ENTER] key to store the value.

4.4 Initial Parameter Configuration

The PCU provides factory default values for all configuration parameters on initial power-up. Prior to executing the first position movement, the following parameters should be reviewed based on the particular application.

4.4.1 In-Position Tolerance

As described in the programming section of this manual, this parameter is used to determine if the axis is within a tolerance “window” of the desired setpoint target. The default setting for this parameter is +/-.010” (.254 mm). The actual setting used will vary based on the application requirements and the mechanical condition of the machine. Set this parameter accordingly, keeping in mind that if the parameter is too small, excessive “out of position” error messages will be generated.

4.4.2 Coast Tolerance

The coast tolerance is used to determine when the PCU should turn off the drive motor and allow the axis to coast close to the final position. The default value is .100” (2.54 mm). The actual setting will vary based on the drive system of the axis, coefficient of friction and the mass of the load being positioned. Unless a known coast distance has already been determined, use the default value for the initial position test.

4.4.3 Units of Operation

The PCU will operate in either decimal inches or millimeters. Although this parameter can be changed at any time, initially configuring this parameter to the desired units of operation is recommended. The default value is 1 (inches).

4.4.4 Backlash Compensation

It is strongly recommended that backlash compensation should be enabled on most machines. This will reduce loading error that may become apparent due to excess backlash in the lead screw system of the machine. In addition, the backlash compensation tolerance should also be configured to guarantee that the machine drive backlash is completely removed when a motion is executed.

Compensation tolerance will vary depending on the machine. It is recommended that the tolerance be set slightly larger than the amount of measured backlash in the machine. This guarantees backlash removal and reduces the amount of time required to execute the motion.

In addition, the approach direction for the application should be set properly. The appropriate approach direction will depend on the application being applied. In the case of a vertical axis, it is typically advantageous to have the load always approach the target in an upwards direction.

4.4.5 Positioning Mode

As indicated earlier, the PCU can be configured in one of two positioning modes. The first uses a stepping operation to execute the fine positioning of the axis. The second mode must be used in conjunction with a two speed variable frequency inverter. In this second mode of operation, the PCU uses its fast motor output to activate a higher speed setting of the inverter for the gross axis movement. When the axis reaches the coasting tolerance, the PCU activates the slow motor output to run the inverter at the slower speed.

4.5 Executing the Initial Move

From the Position Control menu, enter a desired target position for the axis to move to. The target position should be approximately 1 inch (2.54 cm) from the current position to allow the axis to reach maximum velocity. After entering the target position, press the [ENTER] button. Assuming the target position is within the soft limits and the limit switch circuit is normal, the PCU should warn the user to clear the machine and press GO [ENTER] to continue.

The axis should begin to move either toward the setpoint target or away from it. If the axis moves away from it, the PCU will detect the error within approximately 1.5 seconds and abort the motion. The PCU will automatically compensate for the motor direction change on subsequent moves. Re-execute the motion again and note that the axis should be moving toward the setpoint target.

When the axis reaches the coasting tolerance position, the PCU will turn off the motor and allow the axis to coast to a stop. If the coast tolerance is set properly, the axis should come to rest near the setpoint target. If the axis stops too soon, reduce the value of the coast tolerance. If the axis overshoots the setpoint target, increase the coast tolerance.

Iterate this process of moving the axis and checking the coasting distance several times to optimize the coast tolerance setting. The coasting distance should also be checked at different positions along the range of the axis travel. This will determine if the load friction is varying greatly causing an impact on the consistency of the axis coasting.

Once this initial “tuning” phase has been completed, the PCU is ready for normal operation.

5.0 Re-Initializing Factory Values

In the event that the user desires to restore the factory values to the PCU, complete the following:

1. Remove power from the PCU.
2. Press and hold the Clear [C] key while re-applying power.
3. The LCD display will indicate “Defaulting Parameters”
4. Release the Clear [C] key. The PCU has been restored to factory default values.

Notes