



INNOVATION. **PRECISION.** EXCELLENCE.

BI2000 Board Inverter

Owner's Manual

Revision F

Precision Valve & Automation
6 Corporate Drive
Halfmoon, NY 12065





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1. Introduction

Before you operate this system, read the operation and setup manual. This will help you to become familiar with the product and ensure successful operation.

If any questions or problems arise, contact PVA's Technical Support department.

1.1 PVA Contact Information

Main Office

PVA

6 Corporate Drive

Halfmoon, NY 12065

Tel +1-518-371-2684

Fax +1-518-371-2688

Website: <http://www.pva.net>

Email: info@pva.net

Technical Support

Tel +1-844-734-0209

Email: cs@pva.net

1.2 Document History

Revision	Revision Date	Reason for Changes
REV F	February 2020	SoftStart Initial Setup Updated
REV E	January 2020	Template updated
REV D	September 2017	Screens updated
REV C	July 2016	Maintenance updated
REV B	June 2016	Template update and chain/conveyer added
REV A	January 2003	Initial release for Unitronics PLC

Note: All photographs and CAD model representations in this document are a “general representation” of the system and its components. The actual appearance of the system and its components can differ based upon customer specific configuration.

1.1 Safety

Certain warning symbols are affixed to the machine and correspond to notations in this manual. Before operating the system, identify these warning labels and read the notices described below. Not all labels may be used on any specific system.



Always wear approved safety glasses when you operate or work near the workcell.



Before you operate the system, read and understand the manuals provided with the unit.



Never put hands or tools in areas with this symbol when the machine is in operation. A dangerous condition may exist.



Read and understand the manuals provided with the unit before any repairs or maintenance is done. Only a qualified individual should do service.



Use caution when there are pressurized vessels. Find and repair any leaks immediately. Always wear appropriate safety equipment when you work with pressurized vessels or vessels that contain chemicals



Shear hazard from moving parts. Avoid contact.



Do not remove protective guarding.



In situations where inattention could cause either personal injury or damage to equipment, a warning notice is used.



Do not smoke near the PVA UV cure machine. Always have a fire extinguisher available for emergency use.



Before performing any repairs or maintenance to the system, turn off power and lock out the power disconnect switch.



Warning notices are used to emphasize that hazardous voltages, current, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use. Only qualified personnel should enter areas designated with this symbol.



Laser light source present. Do not stare directly into the beam. Do not use in the presence of highly reflective surfaces



Pinch hazard from moving parts. Avoid contact.



Hot surface. Avoid contact.



Warning, Ultraviolet (UV) light hazard. Do not look directly at the UV light source.

1.2 Notices and Warnings

- Wear safety glasses, gloves, and long-sleeved clothing when working with automated industrial equipment.
- Read and understand all operating manuals before using this equipment.
- Do not disable the safety features of the machine.
- Lock-out and tag-out the air and power supplies before any service is done.
- Reduce the air pressure to 0 psi before any hoses are removed.
- Make sure all replacement parts are correctly rated for use.
- Always remain clear of all moving parts when the system is in operation.

1.3 Personal Protective Equipment

Operators must use eye protection because material contents are under pressure. Always wear gloves when handling materials and solvents. Refer to MSDS sheets on the material being dispensed for other precautions.

1.4 Environmental

1.4.1 Noise Levels

The audible noise level of the board inverter is below 65 dBA.

1.4.2 Materials/Chemicals

There are no dangerous materials or chemicals used in the operation of the machine.

1.5 Transportation, Operation, and Storage

1.5.1 Handling and Transportation

Handling and transportation should be done with minimal vibration and shock to the system. An air-ride truck is recommended for roadway transport.

1.5.2 Storage

All enclosures and connector covers should be closed tightly. The system should be covered if dust or other airborne debris is present in the storage area.

1.5.3 Temperature and Humidity

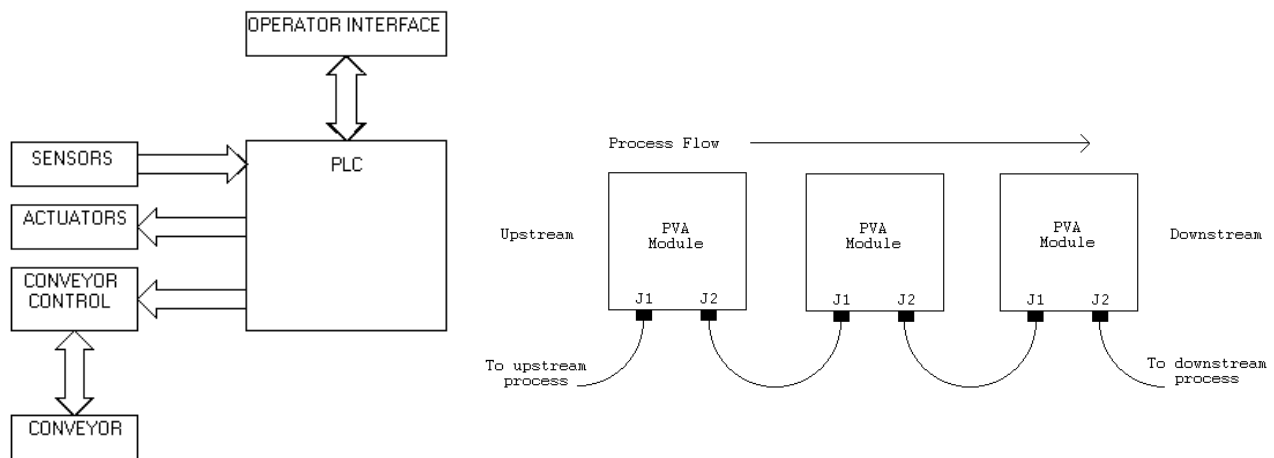
Operation and storage should be done at 40–105°F (4–41°C) and low humidity. Do not let condensation collect on the machine. Install the system on a level surface, away from standing water, possible over spray, and overhead leaks.

1.6 Description of Components

The PVA Board Inverter can process and invert multiple boards. It is SMEMA (Surface Mount Equipment Manufacturers Association) rated for easy integration into a production line. The unit is designed to operate with PVA workcells.

The operator can control the system with the user interface. The machine status and error messages are displayed on the LCD screen and the light tower (optional). Operators must be trained or have read the manual.

Any uses other than listed above could result in a dangerous condition and cannot be protected against by the safety features installed on the system.



Figures 1 and 2: Functional Block Diagram and SMEMA Cables and Process Flow

1.6.1 Hazards Due to Contact

The board inverter is designed to minimize injury from contact with the machine. In certain modes of operation, you can enter the work area while the module is in operation. Only a qualified person should do this. Examine warning labels.

2. Setup

WARNING: These procedures should be done by a qualified person in accordance with this manual and applicable safety regulations. A “qualified person” is defined as “a person or persons who, by possession of a recognized degree or certificate or professional training, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.” (ref. ANSI/ASME B30.2-1983.)

2.1 Installation

1. Plug the machine into an appropriate power source as shown by the Machine Specific Information section of the Operating Guide or the legend plate on the machine. The electrical service should be correctly grounded and the power source “clean”. If there is high power equipment operating off the same source, a line conditioner may be necessary. Machine errors can be caused by poor quality power.

WARNING: Failure to comply with electrical specifications can damage the machine and injure personnel. Electrical hookup must be made by a qualified electrician and comply with any local standards.

2. Connect the ¼” NPT female fitting at the rear of the machine to a source of clean, dry air. A hose of ¼” inside diameter is sufficient.



Figure 3: Main Air Attachment

3. Close any access doors and engage the “**Emergency Stop**” button.
4. Turn the red air lockout valve to “**SUP**”.
5. Make sure any SMEMA cables are correctly connected.
6. Turn the main power to switch “**ON**”.

2.2 Air Pressure Regulator

1. To adjust the system air pressure, pull up on the regulator knob so the orange ring can be seen.

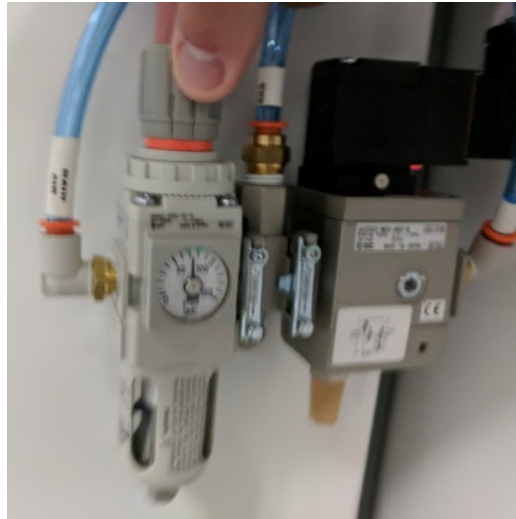


Figure 4: Pull Up on the Regulator to Adjust

2. Turn the knob clockwise to increase the pressure or counterclockwise to decrease the pressure.
3. Wait for the pressure to adjust as shown on the dial.
4. Push the regulator knob down to lock the pressure at the current value.

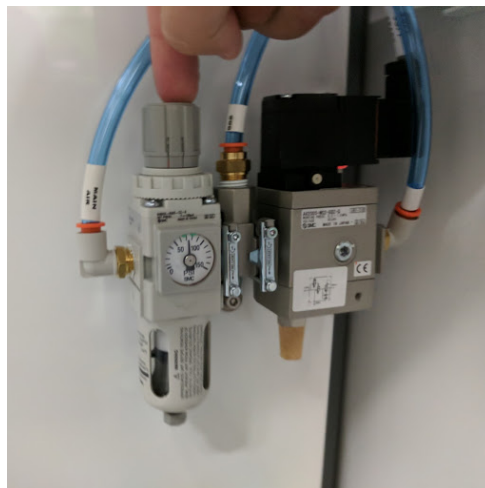


Figure 5: Push Down to Lock

2.3 Safety Devices and Guarding

Note: The safety features should NEVER be bypassed, disabled or tampered with. Precision Valve & Automation, Inc. is not responsible for any damages incurred because of alteration or destruction of any safety features.

2.3.1 Safety Circuit

The machine main power is controlled by the safety circuit with a safety relay and additional safety devices. The safety relay has a redundant and self-checking circuit, which means two parallel relay circuits work together electrically with the safety devices. The tripping contacts of the relays are connected in series to make sure the safety circuit will disconnect the power even if one of the relays fails. The self-checking circuit has positive guided contacts, mechanically forced to operate together. If one of the redundant relays fails, the power contacts are opened. The safety devices monitor the state of the Emergency Stop button and other safety mechanisms. When one or more of the safety devices have opened, the power is stopped.

2.3.2 Work Area Access

The work area is enclosed with Lexan guarding or safety glass.

2.3.3 Door

The top of the machine is protected by a door. The door is monitored by a non-defeatable limit switch. The *Door Bypass* key is for maintenance access only.

2.4 Light Tower Operation

Three stacked indicator lights and a buzzer are used to indicate the status of the machine. The lights are visible from all sides of the machine and operate as follows:

- The **green** light is on when the machine is in Auto Cycle and producing parts. It is off at all other times.
- The **amber** light is on when the machine is in Auto Cycle, but cannot operate because of an external material handling problem (no incoming parts or no room to unload parts).
- The **red** light is on steady when the machine is not in Auto Cycle due to operator intervention. It will flash when the machine is in cycle, but the cycle has stopped because of a machine problem. It will be off at all other times.
- The **buzzer** will cycle with the red light during machine errors.

State	Red	Amber	Green	Buzzer
Cycle Stop	ON	OFF	OFF	OFF
Auto Cycle	OFF	ON	OFF	OFF
In Cycle	OFF	OFF	ON	OFF
Machine Error	FLASH	OFF	OFF	FLASH

Figure 6: Light Tower & Buzzer Status

2.5 Interface Overview

The operator interface terminal (OIT) has touch screen icons and buttons on the display that are related to the shown icons. A keyboard or keypad will be shown when a related value or text field is selected.



Figure 7: Pump Components

3. Operation

3.1 Startup Procedure

1. Check the air pressure.
2. Close the door.
3. Engage the **“Emergency Stop”** button.
4. Use the main power red rotary switch to turn on the system power.
5. Disengage the **“Emergency Stop”**.

3.2 Shutdown

Do not shut down the machine down with parts in it.

1. Wait for all boards to clear the module.
2. Press **“ESC”** on the OIT. Wait for the Cycle Stop screen to appear.
3. Engage the **“Emergency Stop”** button.

CAUTION: If maintenance will be done, lockout and tagout the machine.

3.3 Cycle Stop

This is the default machine state. All other modes are accessed from this screen. To shut down the machine or select a different operating mode, you must return to Cycle Stop.

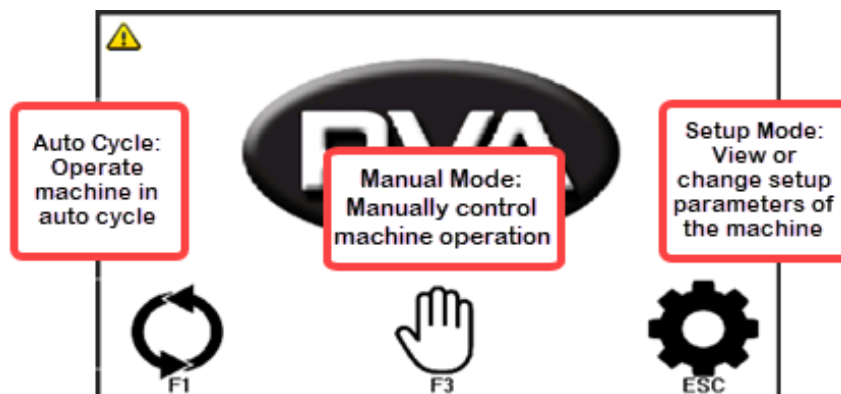


Figure 8: Cycle Stop

3.4 Auto Cycle

Auto Cycle is the normal operating mode for the PVA board inverter. In Auto Cycle, the machine operates as part of a production line and interfaces with any adjacent machines.

1. Select Auto Cycle from Cycle Stop.
2. Push the **"ESC"** button to leave Auto Cycle and return to Cycle Stop.

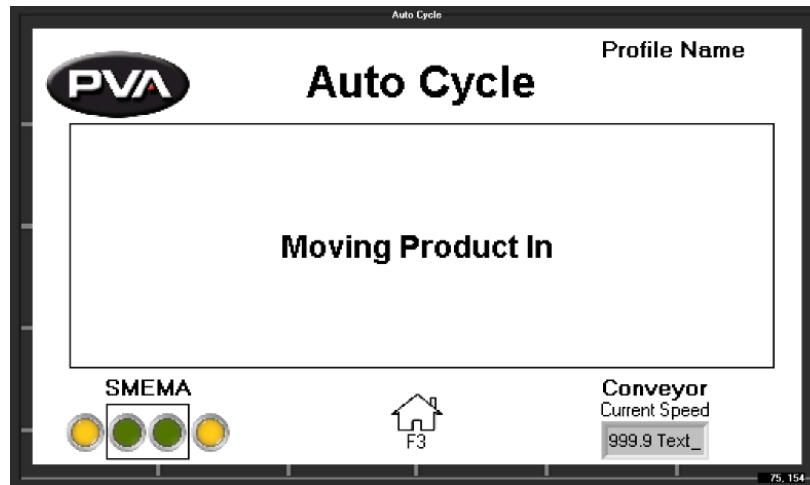


Figure 9: Auto Cycle

Note: The board inverter will wait for the boards to exit if there are boards in the inverter when the "ESC" button is pushed.

3. To change the settings shown in Auto Cycle, go to Setup Mode.
4. The Profile is shown above the screen name. Go to Setup mode to change the profile.
5. The current conveyor speed is shown.
6. The text field shows information about board handling and processing.
7. The SMEMA indicators show the signals being sent and received. Output from the system are in the box, external signals are outside of the box.

3.5 Manual Mode

In Manual mode, the operator has control of the conveyor, flipper, and SMEMA signals.

1. Select Manual mode from Cycle Stop.
2. Use the **"Left"**, and **"Right"** arrow buttons to scroll through the screens.

3.5.1 Conveyor Operation

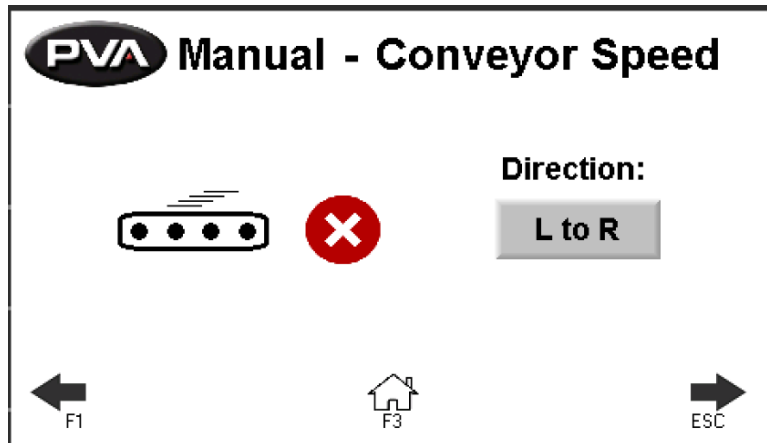


Figure 10: Manual Mode, Conveyor Speed

1. Use the **Red X** or the **Green Checkmark** button to toggle the conveyor "On" or "Off".
2. Select the **Direction:** button to toggle between **L to R** (left to right) or **R to L** (Right to Left). The default direction is downstream.

3.5.2 Board Stops

- To manually extend or retract the board stops, select the **Red X** or the **Green Checkmark** button.

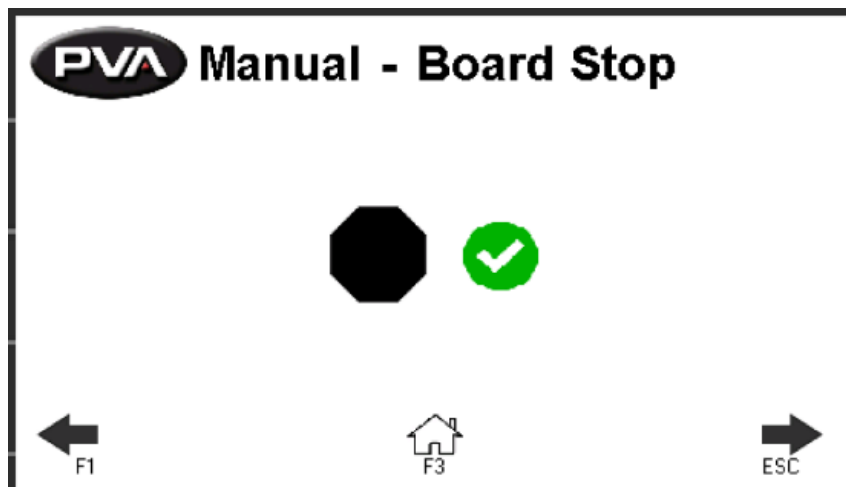


Figure 11: Manual Mode, Board Stop

3.5.3 Rotate

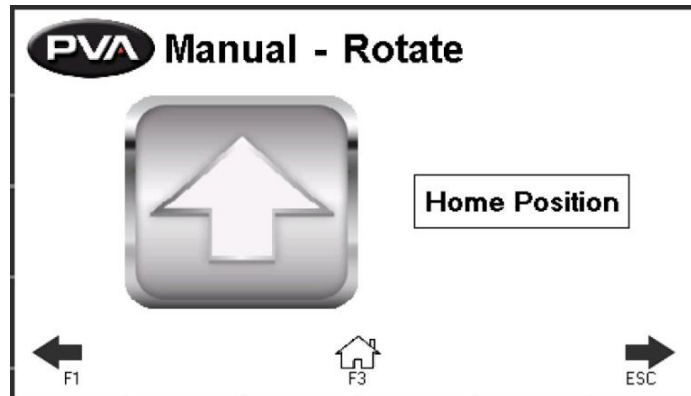


Figure 12: Manual Mode, Rotate

- To manually rotate the cage, push the “Square Arrow Button” on-screen. The arrow direction shows the current position.
 - When the arrow is Up the cage is in the home position (0 degrees)
 - When the arrow is Down the cage is in the flip position (180 degrees)

3.5.4 SMEMA

You can view the status of the SMEMA input from the machine selected. To toggle the SMEMA output on and off, push the related light on the screen.

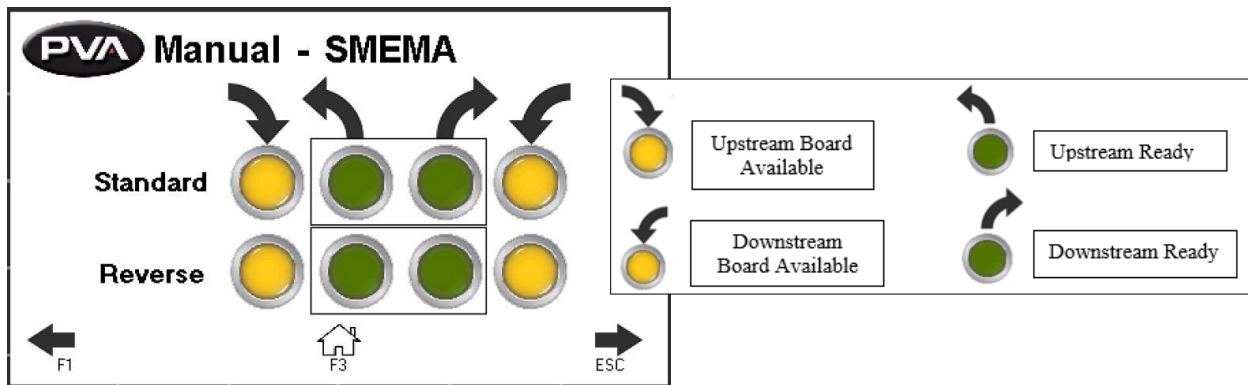


Figure 13: Manual Mode, SMEMA

3.5.5 PIP Status

View the status of the part in place (PIP) input from the machine.

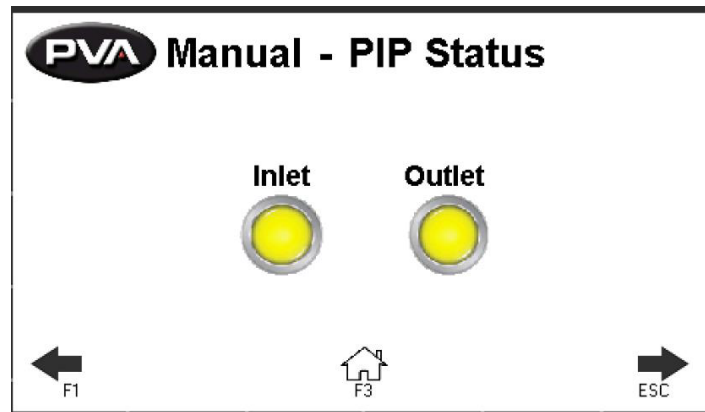


Figure 14: Manual Mode, PIP Status

3.5.6 Shutters

This screen only applies to systems with shutters. To manually open or close the shutters select the **Green Checkmark** or **Red X**.

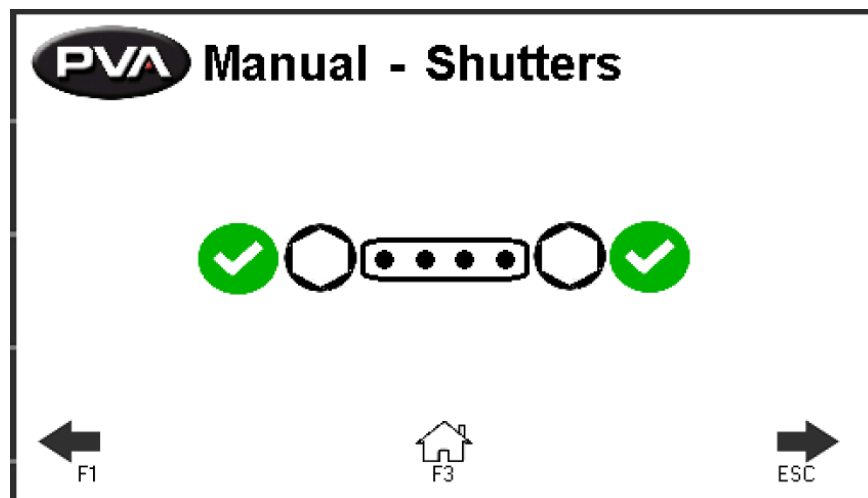
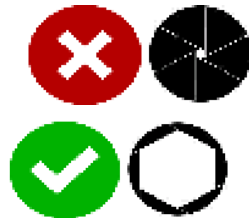


Figure 15: Shutters

3.5.7 Conveyor Width Adjust

This screen only applies to systems with automatic width adjust.

- To manually adjust the conveyor width, go to the Conveyor Width screen.
- Select the width value and use the keypad shown to enter a new width.
- Select the **Target** symbol to move the conveyor to the set width.
- Select the **Home** icon to home the conveyor.

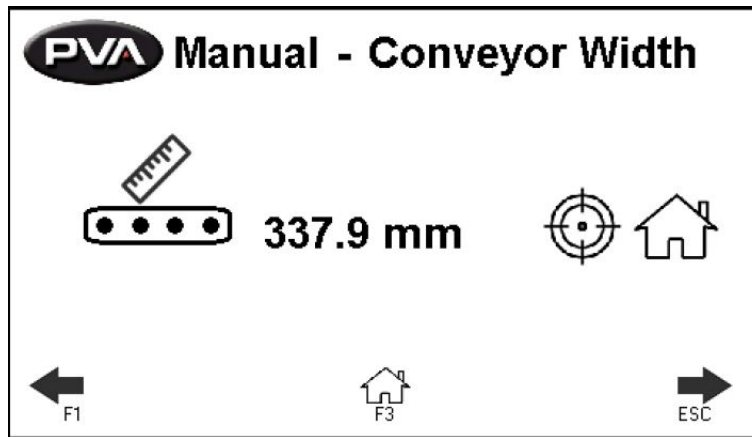


Figure 16: Conveyor Width

3.1 Setup Mode

In setup mode, the operator can set the options for the PVA board inverter. The profile name is shown at the top of the screen. You will make changes to the profile shown.

1. Select the Setup icon or the “ESC” button from Cycle Stop.
2. Use the Use the **+** - **Page** icons or the **F2** and **F4** keys to scroll through the profiles. The profile name is shown at the top of the screen. You can have a maximum of 30 profiles.
3. Use the “**Left**”, and “**Right**” arrow buttons to scroll through the screens or the “F1” and “ESC” hardware keys.
4. Push the “**Home**” button or the **F3** key to return to Cycle Stop. When you leave Setup mode, all changes will be saved.

The profile that will run in Auto Cycle is the one shown on the screen.

3.1.1 Flip Process

The screen below shows all available flip options, the arrows will change based on the board in and out directions selected.

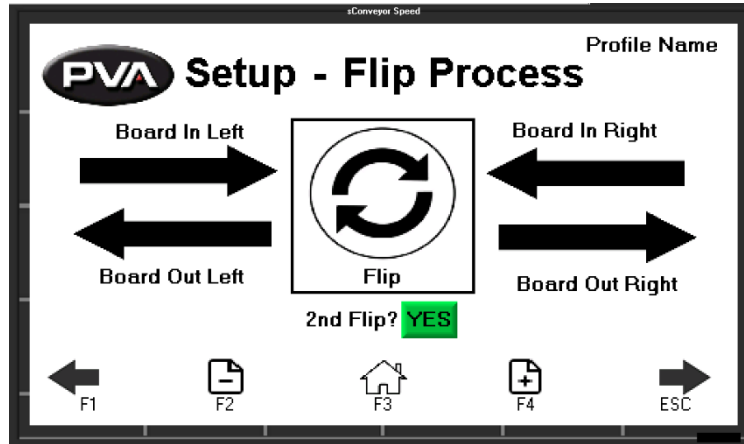


Figure 17: Flip Roll Cage

1. Select the **"Board In"** arrow (top) to switch between **"Board In Left"** and **"Board In Right"**. Only the selected **"Board In"** arrow will be shown, so when the **"Board In Left"** arrow is shown, the **"Board In Right"** arrow will be hidden.
2. Select the **"Board Out"** arrow (bottom) to switch between **"Board Out Left"** and **"Board Out Right"**. Only the selected **"Board Out"** arrow will be shown, so when the **"Board Out Left"** arrow is shown, the **"Board Out Right"** arrow will be hidden.

3.1.2 Board Flip

Select the square flip icon in the center of the screen to set the board flip option to "Flip" or "No Flip". This setting will be used in Auto Cycle for the profile shown.

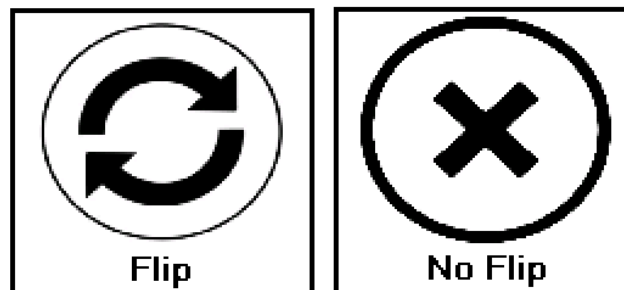


Figure 18: Board Flip Icons

3.1.3 Board Second Flip

Select the **2nd Flip** icon to toggle between “**Yes**” and “**No**” for the second flip board process.

3.1.4 Conveyor Width

This is an optional setting. Not all modules will have this option.

1. Use the arrows on the screen or the “**F1**” and “**ESC**” button to scroll to the Setup-Conveyor Width screen.
2. Select the indicator to toggle this feature on and off.

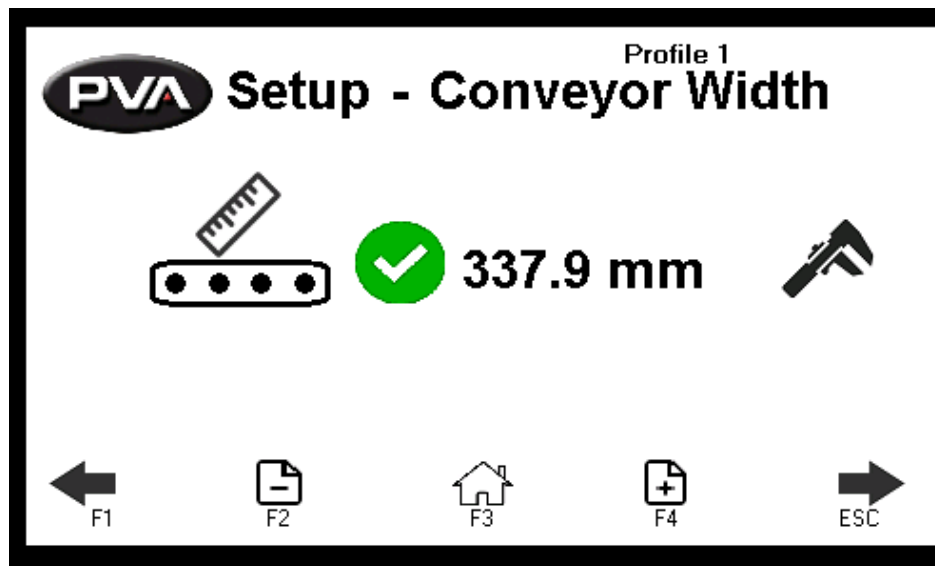


Figure 19: Conveyor Width

3. Put the board on the conveyor.
4. Select **Auto Width Adjust** icon to auto adjust the conveyor.
5. Use the Manual Width Adjust handle to make any necessary changes.
6. Select “**Save**” to keep and use the new value.
7. Use the Use the **+ - Page** icons or the F2 and F4 keys to scroll through the profiles. The profile name is shown at the top of the screen.

3.1.5 Profile Naming

1. Use the arrows on the screen or the "**F1**" and "**ESC**" button to scroll to the Setup-Rename Profile screen.
2. Use the **+ - Page** icons or the F2 and F4 keys to scroll through the profile names. You can have a maximum of 30 profiles.

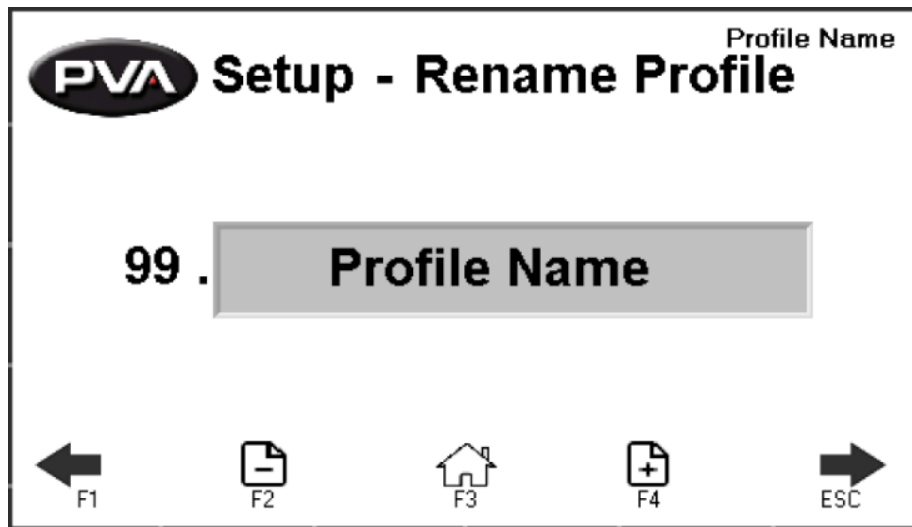


Figure 20: Rename Profile

3. Select the name you want to change.
4. The keyboard will be shown, type the new name and select enter. The new name will be saved. Profile names are limited to 15 characters.

4. Fault Recovery

Several errors can cause a fault condition:

- **“Emergency Stop”** is engaged
- The door is open
- Low air pressure (option)
- Board processing failure
- Homing failure

The sections below show examples of some errors. For a complete list of error messages, refer to Section 4.3.

WARNING: If the “Emergency Stop” was engaged because of a system failure, do not disengage the “Emergency Stop” button. Shutdown the system and have qualified personnel repair the machine.

4.1 Board Removal

After a fault, if there is a board in the inverter it must be removed. There are two ways to remove a board.

4.1.1 Manual Board Removal

1. Engage the **“Emergency Stop”** Button.
2. Open the Door.
3. Use your hand to rotate the roll cage, if necessary.
4. Slide the board out of the conveyor.

4.1.2 Conveyor Board Removal

1. Go to Manual mode.
2. Set the conveyor direction to the necessary setting, either upstream or downstream.
3. Set the conveyor to on. The board will exit the conveyor in the set direction.
4. Turn the conveyor off.

4.2 Open Door or “Emergency Stop” Recovery Procedure

If the “**Emergency Stop**” button is engaged or there is a machine error, do this procedure. Do not continue if the “**Emergency Stop**” was engaged because of a system failure instead, shutdown the system and have it repaired by qualified personnel.

1. Disengage the “**Emergency Stop**” button or close the doors as necessary.

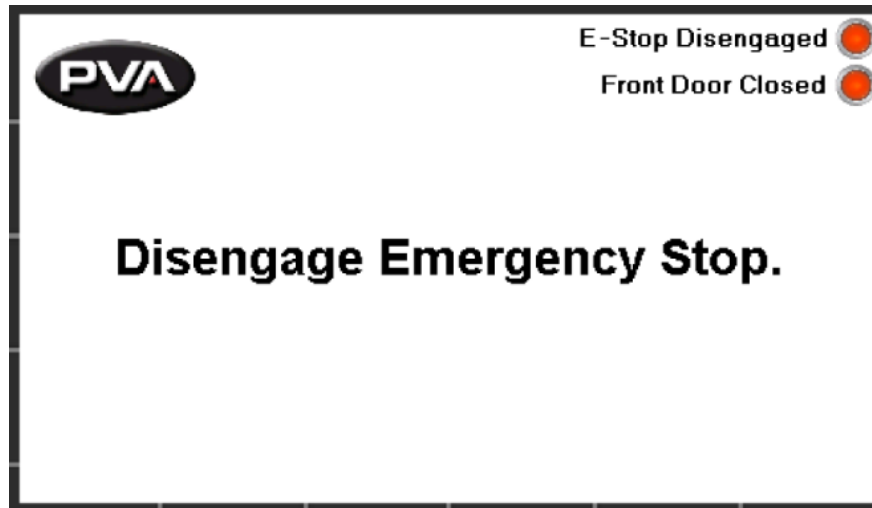


Figure 21: Emergency Stop

2. Follow the on-screen display, push the “**POWER ON**” button to restore control power.
3. Operate the system as normal.

4.2.1 Recovery Procedure for Board Processing Failure

A board processing failure can result from a board jam, or if the board is longer than the inverter can handle and the infeed and outfeed sensor are on at the same time.



2. Remove the board.



Figure 22: Board Processing Failure

3. When the Cycle Stop screen is shown, operate normally.

4.2.2 Recovery Procedure for a Rotation Error

When the roll cage cannot do a complete rotation (180°) there is a Rotation Error. This can be caused by low air pressure.



2. Remove the board.
3. When the Cycle Stop screen is shown, operate normally.

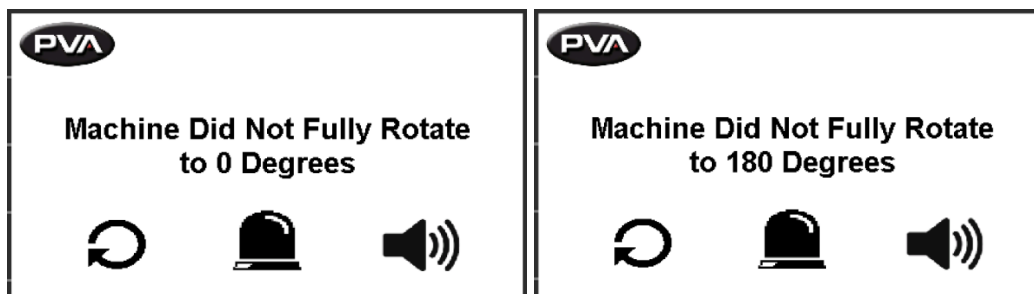


Figure 23: Rotation Errors

4. If you continue to have this error, make sure the air pressure is in the necessary range.

4.3 Error Messages

The following are all the possible error messages generated by the PLC program.

MSG #	Description
0	Disengage Emergency Stop
0a	Close Door (*If Door Bypass Off)
1	Rotate 0 Failure: Remove Board
2	Rotate 180 Failure: Remove Board
3	Board Stop Did Not Extend
4	Board Stop Did Not Retract
5	Board Failed to Reach Stops
6	Inlet Shutter Failed to Open
7	Inlet Shutter Failed to Close
8	Outlet Shutter Failed to Open
9	Outlet Shutter Failed to Close
10	Conveyor Adjust Drive Fault

Figure 24: Error Messages

5. Maintenance

Interval	Action
Weekly	• Clean the sensors with a lint-free damp cloth.
Monthly	• Make sure the conveyor belts are not worn. • Apply grease to the chain. • Check the pressure regulator for water and drain if necessary. • Make sure the shock absorbers are tight and apply grease.

5.1 Conveyor Belt Replacement

Note: Not all systems have conveyor belts, some have chains.

1. Lockout the power supply.
2. Remove the old conveyor belt from the pulley wheels.
3. Install the belt on the pulley wheels farthest from the motor.

Note: Make sure there are no twists in the belt.

4. Install the belt around the large pulley wheel, then around the other wheels.
5. Rotate the pulley wheels several turns by hand to make sure the belt is correctly seated.

5.2 Board Sensor Adjustment

Use a small screwdriver to turn the adjustment screw as necessary.



Figure 25: Board Sensor Adjustment Screw

5.3 Board Thickness Adjustment

This procedure will adjust the distance between the chains, there should be a 1mm gap between the board and the chain. The gap between the upper and lower conveyor chain is adjustable from 0.28" to 0.154" to reduce product movement during rotation. To adjust the opening size, perform the procedure below.

Note: Make sure you know the current orientation of the roll cage so that you can adjust the chain correctly.

Note: Adjust both sides of the conveyor evenly.

1. Engage the **Emergency Stop** button.
2. Turn the main air pressure to "**Off**".
3. Loosen the four shoulder bolts at the end of the turnbuckle. There are four bolts at each end of the conveyor and each end is adjusted independently.

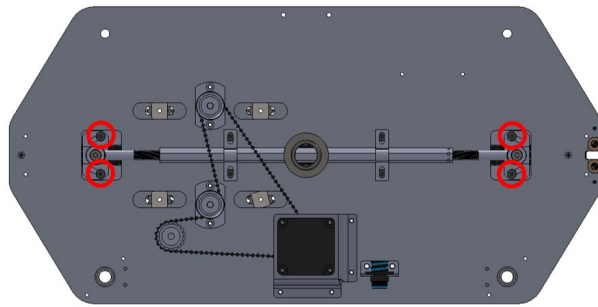


Figure 26: Loosen the Bolts Shown

4. Use a ½" wrench to turn the turnbuckle.

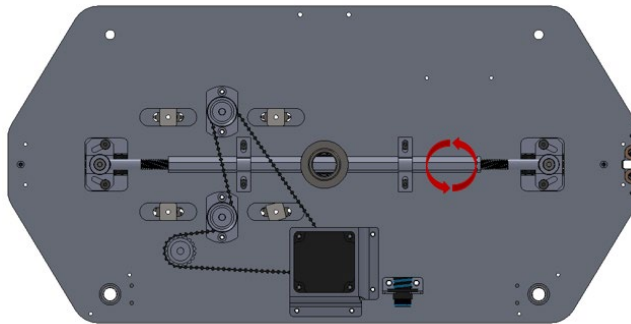


Figure 27: Turnbuckle Adjustment

5. With the shoulder bolts loose, rotate the turnbuckle clockwise to increase the gap or counterclockwise to reduce the gap.

6. When the gap is correct, tighten the four shoulder bolts at the end of the turn buckle.
7. Repeat the procedure for the rear conveyor rail.

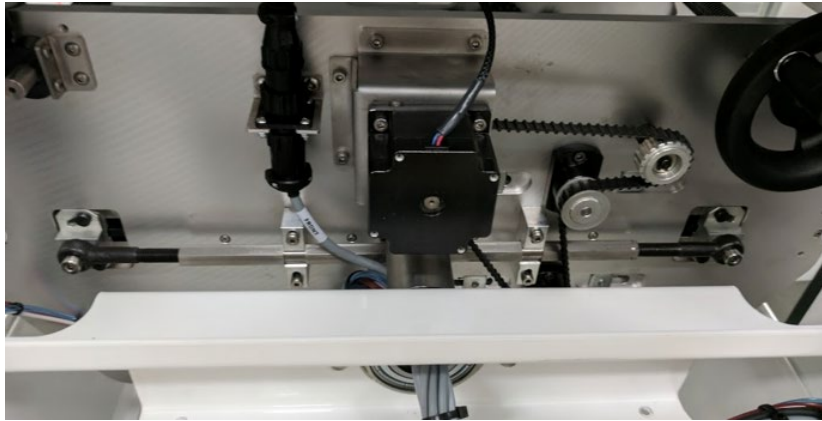


Figure 28: Conveyor Adjustment

5.4 Rotary Adjustment

5.4.1 Rotation Angle

There are two shock absorbers that locate the roll cage. One shock is used at each position (0 degrees and 180 degree); both shock absorbers are at the back of the machine.

1. Engage the **"Emergency Stop"** button.
2. Turn the main air pressure to **"Off"**.
3. To decrease the angle of rotation, turn shock absorbers clockwise. To increase the angle of rotation, turn the shock absorbers counterclockwise.
4. Lock the shock absorbers with the hex locking nut after each adjustment.



Figure 29: Shock Absorber

5. Apply grease to the shock absorbers as necessary.

5.4.2 Soft Start Adjustment

The soft start is attached to the main air pressure regulator and regulates the time it takes for the roll cage's pneumatic manifold to reach pressure. If the pneumatic manifold is pressurized too quickly, the roll cage will rotate aggressively and slam into the hard stops. This could damage the equipment or an operator.

Note: The soft start is set by PVA. It is not necessary to adjust it unless the soft start is replaced.

1. To adjust the soft start, engage the **"Emergency Stop"**.
2. Turn the main air supply to **"Off"**.
3. On the bottom of the soft start, turn the brass set screw clockwise until it is completely closed.
4. Turn the set screw counterclockwise, no more than 1/16th of a turn from the closed position.

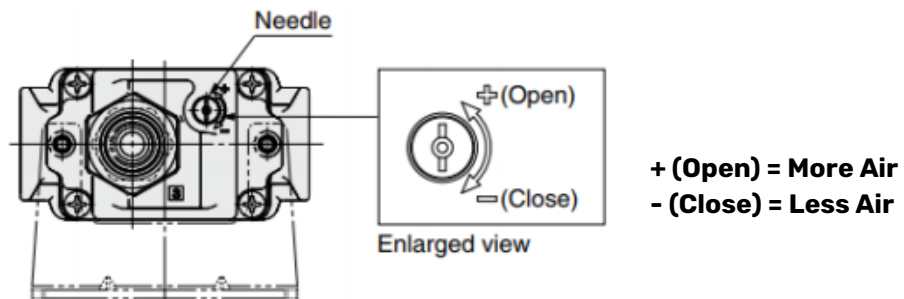


Figure 30: Soft Start Adjustment

Note: The soft start should always be adjusted before the rotary speed is set.

5.4.3 Rotary Speed Adjustment

Both ports on the rotary actuator have a quick exhaust flow control to adjust the rotary speed.

1. To adjust the speed of the rotary motion, turn the needle valve of the flow control.
2. Turn the needle valve clockwise (in) to decrease the speed of rotary motion.
3. Turn the needle valve counterclockwise (out) to increase the speed of rotary motion.

Note: The flow controllers regulate the exhaust air from the cylinder, not how much air enters the cylinder. Be careful when you adjust the speed of the rotary motion. A small adjustment makes a large difference in speed.

5.5 Width Adjustment

To adjust the width of the rear conveyors on units that do not have the “Auto Adjust” option, perform the procedure below.

Note: This is for systems that do not have automatic width adjust.

1. Engage the **“Emergency Stop”** button.
2. Turn the main air pressure to **“Off”**.
3. Turn the adjustment lock counterclockwise to loosen it.



Figure 31: Adjustment Lock

4. Turn the adjustment handle counterclockwise to increase the width or clockwise to decrease the width of the of the conveyor.



Figure 32: Width Adjustment Handle

5. When the necessary width is achieved, turn the adjustment lock clockwise to tighten.

5.6 Main Air Regulator

- Make sure there is no water in the bottom, drain as necessary.

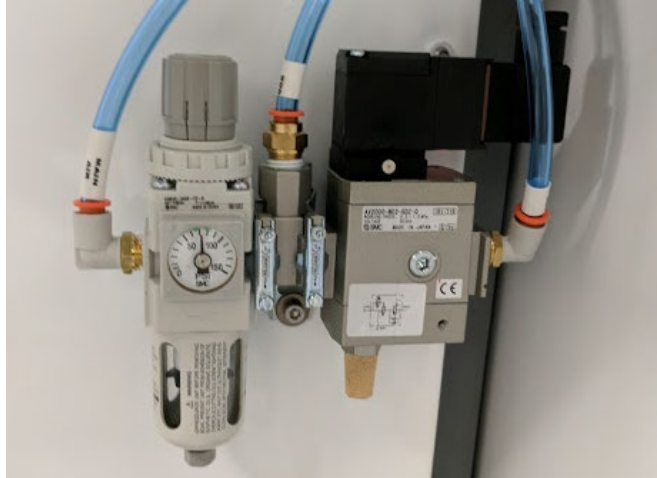


Figure 33: Main Air Regulator

6. Troubleshooting

Troubleshooting Problem	Possible Cause	Corrective Action
The machine is On and the operator interface has no power	• Cables are loose or not connected • A fuse is blown	• Examine the cable connections and tighten loose connections • Check the FU-1 fuse in the electrical enclosure
Board does not transfer to or from adjacent station	• The SMEMA connection is broken • A module in the line is turned off • A fuse is blown	• Examine the cable connections and tighten loose connections • Turn the module on • Check fuses FU-3 and FU-4 in the electrical enclosure
The part-in-place sensor fails	• A cable is loose or not connected • The sensor is positioned incorrectly • The sensor is out of adjustment	• Examine the cable connections and tighten loose connections • Move the sensor • Adjust the sensor
Conveyor does not operate or communication error	• Conveyor belt stuck to rails • Chain does not operate smoothly • Cable is loose or not connected • Control relay not on, or Power On light not on • A fuse is blown	• Clean or replace belt • Apply lubricant to the chain • Examine the cable connections and tighten loose connections • Check the system voltage and electrical connections • Check fuses FU-10 and FU-11 in the electrical enclosure
Pneumatic position failure	• No air pressure • The air lines are kinked or torn • The sensor is positioned incorrectly • The position sensor is out of adjustment • The rotary is out of adjustment	• Make sure main air regulator and main air are both "On" and have pressure • Repair or replace the lines • Replace the sensor • Move the sensor • Adjust the rotary



7. Notes



8. Warranty

PVA Warranty Policy

PVA warrants the enclosed product against defects in material or workmanship on all components for one year from the date of shipment.

The warranty does not extend to components damaged due to misuse, negligence, or installation and operation that are not in accordance with the recommended factory instructions. Unauthorized repair or modification of the enclosed product, and/or the use of spare parts not directly obtained from PVA (or from factory authorized dealers) will void all warranties.

All PVA warranties extend only to the original purchaser. Third party warranty claims will not be honored at any time.

Prior to returning a product for a warranty claim, a return authorization must be obtained from PVA's Technical Support department. Authorization will be issued either via the telephone, facsimile, or in writing upon your request.

To qualify as a valid warranty claim, the defective product must be returned to the factory during the warranty period. Upon return, PVA will repair (or replace) all components found to be defective in material or workmanship.

(Retain this for your records)

Product Information

PRODUCT:

SERIAL NUMBER:

DATE OF PURCHASE:

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