

# **DP-*HF***

## **ADVANCED VIA FILL**

**MODEL V1.0**

**SOFTWARE VERSION**

**SERIAL NUMBER**

**D.O.M.**

**5/4/08**

**CIRCUIT AUTOMATION, INC.**

**5292 SYSTEM DRIVE**

**HUNTINGTON BEACH, CA 92649 USA**

**1.714.763.4180 PHONE**

**1.714.763.4181 FAX**

**[WWW.CIRCUITAUTOMATION.COM](http://WWW.CIRCUITAUTOMATION.COM)**

**©CIRCUIT AUTOMATION INC. 5/16/09 REV 2**

# TABLE OF CONTENTS

<b>Conventions</b> .....	5
Installation.....	6
Work Area.....	6
Floor Plan.....	6
Unloading and Unpacking .....	7
Machine Installation .....	8
Background.....	11
Background of Vacuum Concepts .....	11
<b>SAFETY</b> .....	12
<b>Intended Use</b> .....	12
<b>Vacuum Pump</b> .....	16
<b>Controls</b> .....	18
<b>Screen Menu</b> .....	18
<b>SETUP Screen</b> .....	19
Run Screen .....	20
<b>Vacuum</b> .....	21
<b>Manual I/O</b> .....	22

## TABLE OF FIGURES

Figure 1 DP-HF Front Elevation.....	4
Figure 2 DP-HF Plan View.....	6
Figure 3 Frame bolting.....	7
Figure 4 Adjustable leveling feet.....	8
Figure 5 Control Screen.....	18
Figure 6 Set-Up Screen.....	19
Figure 8 Vacuum Control Screen.....	21
Figure 9 Manual Control and Inputs.....	22
Figure 13 Panel Handling in CLAMPED position.....	24
Figure 15 Locked position.....	25
Figure 17 Slide control Pressure Regulators.....	26
Figure 18 Slide OUT position.....	26
Figure 19 Slide moving IN.....	27
Figure 20 Side Door Open /Close Gauge and Regulators.....	27
Figure 21 Side Door.....	28

---

## Introduction

The DP-*HF* Advanced Via Filling machine is designed to fill a variety of sizes and types of via holes with specially formulated plugging pastes. The machine has been used to apply both non-conductive and conductive pastes in holes on printed circuit board substrates. Incorporating 25 years of design and manufacturing expertise in coating and drying liquid photoimageable soldermask on the surface of the substrate, this machine applies the paste inside of the holes without inclusion of unwanted air or contaminants.

This manual is intended as a training and reference source for anyone who operates and/or maintains this equipment. It gives the correct procedures for the installation, start-up, operation, maintenance and shut down and cleaning of the DP-*HF*.



**Figure 1 DP-HF Front Elevation**

---

## WARRANTY

Circuit Automation warrants that all products sold shall be free from defects in workmanship and material when used *within* the service and scope for which they were designed. Such warranty shall apply for a period of one year after shipment of the product. If, at any time within this period it is determined that the product was defective at time of shipment, Circuit Automation, at its option, shall furnish replacements or repair the product. It is understood that the liability of Circuit Automation shall be limited to such repair or replacement and that Circuit Automation shall not be liable for any direct or consequential damages arising out of any defects or from any cause whatsoever. This warranty does not cover deterioration from normal wear and tear.

Neither the DP-*HF* nor any part thereof should be returned to Circuit Automation without written authorization from Circuit Automation.

This warranty is effective only under the condition that the DP-*HF* coater is installed in accordance with Circuit Automation specifications.

Additionally the warranty is null and void if the coater is abused or operated contrary to the instructions, or if alterations or major repairs are made by other than authorized Circuit Automation representatives or by written permission from Circuit Automation.

Notwithstanding the above and regardless of the circumstance Circuit Automation's total liability for any and all claims, losses, or damages arising out of any cause whatsoever shall not exceed the purchase price of the DP-*HF* coater. In no event shall Circuit Automation be liable for any incidental or consequential damages, whether arising from contract, negligence, strict liability, or warranty.

**THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

## CONVENTIONS

In this manual, left and right always refer to orientations facing the machine. The "front" of the DP-*HF* is the side with the control panel. The other side is the "back". Circuit Automation's standard machine is often called a right-handed machine in that, when facing the front side of the machine, the load/unloading station is on the right-hand side. Figure 1 above shows a right-handed machine. When a specific switch or control is referred to, it will appear in emphasis font, e.g., **MODE**. The specific position of a switch will be italicized, e.g., *Slide In*.

# INSTALLATION

Planning before you receive your via filling machine will allow you to set up the machine and have it operating in the shortest possible time.

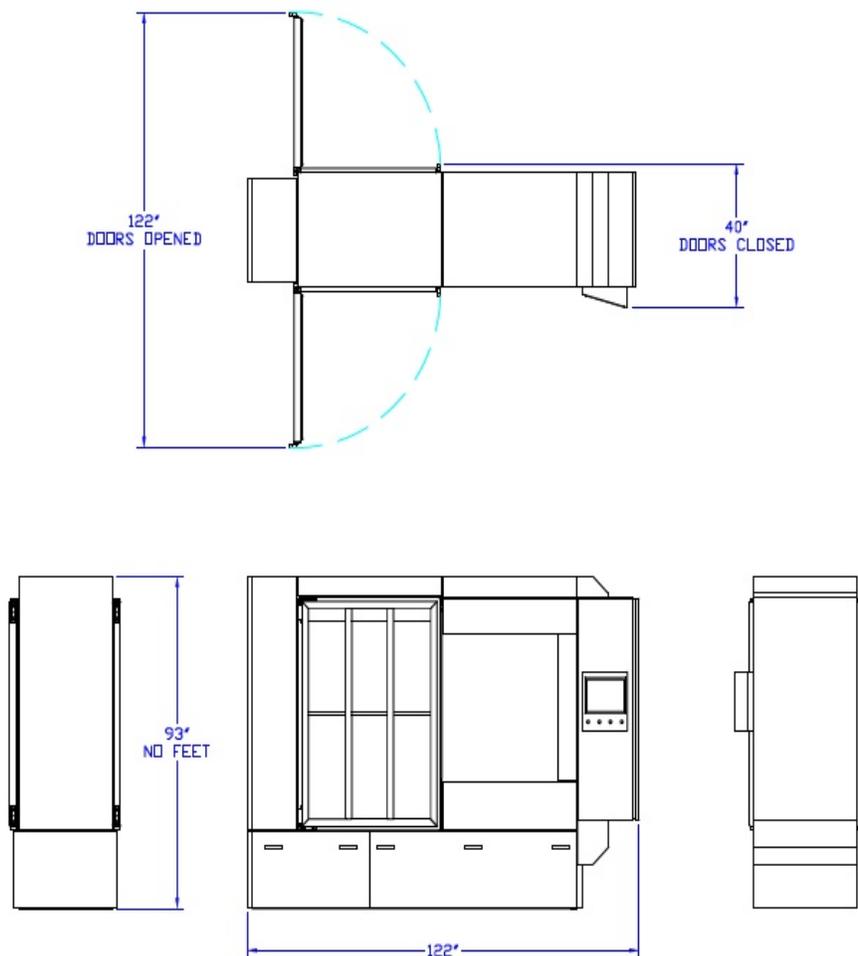
## WORK AREA

The work area should be equipped with proper lighting to meet specifications. Dust and humidity control measures will reduce coating defects from contamination and enhance the results obtained from the coating process.

Although the DP-HF is equipped with levelers, the work area should be as level as possible. Surfaces that are not level may result in future difficulties.

Certain minimal clearance must be maintained for safe operation and service of the equipment. This includes adequate walk-around space and room for the electrical, air pressure, and ventilation lines to be installed.

### Floor Plan



**Figure 2 DP-HF Plan View**

Figure 2 shows the footprint of the DP-*HF*. Locate the DP-*HF* so that there is at least four feet (1.2 meters) of clear area front and back, and so that there are no obstructions to walking completely around the machine. Note the swing radii of the doors. Enough room needs to be included to allow these to be fully opened without interference.

## UNLOADING AND UNPACKING

The DP-*HF* is shipped bolted to a wood frame, wrapped in bubble pack and stretch wrap. Accessories and small parts are wrapped separately and packed inside the machine or next to the machine. Machines shipped via ocean freight will be containerized. Machines shipped via airfreight will be crated.

A forklift capable of lifting two tons (1800 kg) and having forks spaced at least 48" apart (1.2m) will be needed to move the machine.

To remove the DP-*HF* from the skid, open the lower access covers and remove the bolts at each corner of the unit. This machine is designed for six levelers. Next to each leveler foot is a separate hole where the machine can be lag screwed to the pallet. This gives the option to ship the machine with the leveling pads installed and retracted with the machine securely bolted to the pallet with the lag screws.



**Figure 3 Frame bolting**

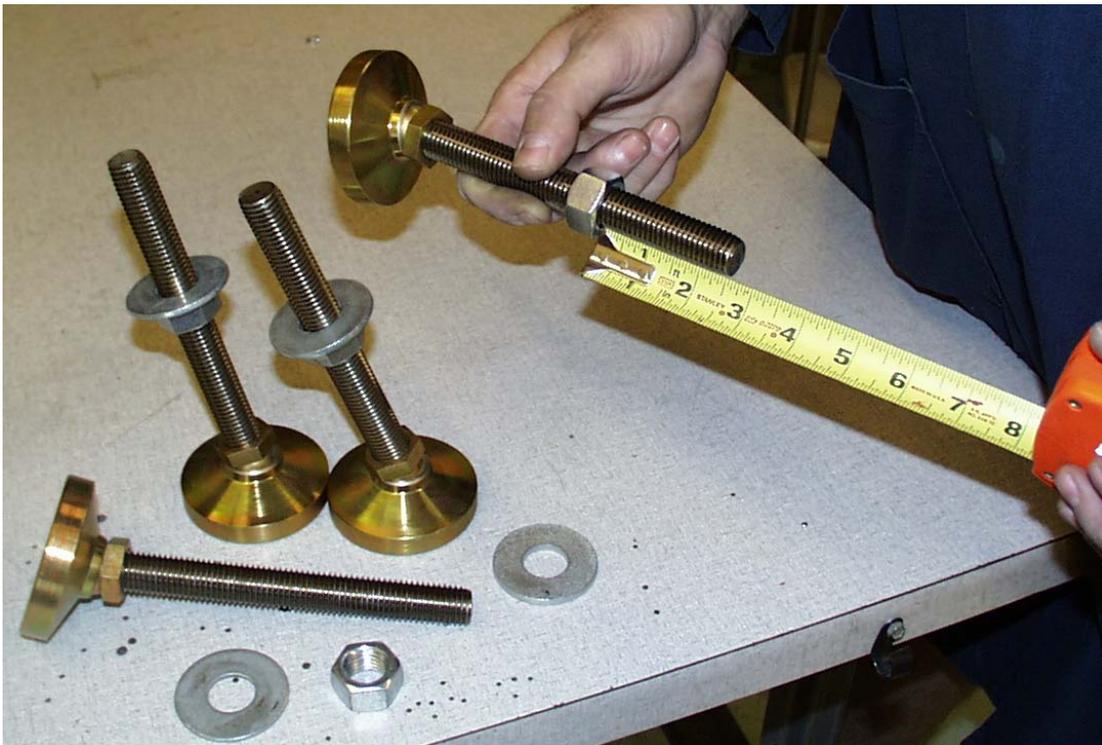
**NOTE:** Four lower covers must be removed to allow access to one of the lag bolts and leveling pads.

The DP-*HF* may now be lifted off the skid. The DP-*HF* has a rigid steel frame that allows it to be moved with a forklift. Position the blades of the forklift at least four feet (1.2m) apart. The coating section end is much heavier than the load station end. Consequently, the DP-*HF* should be lifted with one blade about one foot (30cm) from the left end (facing the front) and the other blade about one foot to the right of the left end of the coating section. After lifting the machine from the wooden skid, carefully adjust the adjustable leveling feet. The machine may now be moved into the installation location. Do not push the machine on the floor while sitting on the leveling feet as they might be damaged.



**CAUTION:** *THE DP-HF HAS A HIGH CENTER OF GRAVITY AND ASYMMETRICAL WEIGHT DISTRIBUTION. USE CARE WHEN REMOVING THE MACHINE FROM THE SKID AND MOVING THE MACHINE INTO POSITION.*

**NOTE:** Before installing the leveling feet adjust the bottom nuts so that all feet are the same length.



**Figure 4** Adjustable leveling feet

## MACHINE INSTALLATION

Examine the coater carefully for damage and remove all other securing and packing materials. Remove split collars from the Thompson shafts.

Confirm that the DP-HF is level by placing a machinist's level at the center of the ground steel plate that forms the base of the filling section. Remove the drip tray prior to leveling the machine. Adjust the leveling feet as required and secure them with the nuts provided.

## **SAFETY INFORMATION FOR ELECTRICAL EQUIPMENT USED FOR HIGH VOLTAGE INSTALLATION.**

This manual contains valuable information concerning the installation and use of this equipment. In order to avoid problems it is necessary that qualified staff perform the maintenance work, prescribed inspections and checks.

### **IN CASE OF DOUBT, DISCONNECT THE EQUIPMENT IMMEDIATELY.**

The DP-HF is factory wired for **480V, 3Ø, 30A 50/60 Hz** electrical service, and requires **10cfm @ 100 psi (5 m<sup>3</sup>/hr @ 7 bar)** compressed air.

This machine is designed to be used in a high voltage industrial installation. This equipment contains dangerous parts and sometimes moving or rotating parts that can cause serious damage to product, or people. Care needs to be exhibited at all times. This machine is equipped with a 7.4 hp vacuum pump that is capable of drawing the vacuum chamber down to 26" Hg. There should be no unauthorized removal of coverings, safety guards, interlock mechanisms or other safety related devices.



*CAUTION: INCOMING AIR SHOULD BE CLEAN AND DRY. UNDER NO CIRCUMSTANCES SHOULD AN OILER BE INSTALLED IN THE INCOMING LINE.*

Electrical power connection is made inside the electrical cabinet on left end of the machine. The air connection is made with the 1/4" quick disconnect provided.

Before connecting power to the DP-HF, ensure that ON/OFF switch (located on the control panel) is *Off* and that the CIRCUIT BREAKER (located on the electrical cabinet) is *Off* (turn fully counterclockwise).



*CAUTION: IF THE ELECTRICAL CURRENT IS SUBJECT TO FLUCTUATION, A SPIKE SUPPRESSOR IS RECOMMENDED TO PROTECT THE DP-HF'S COMPUTER CONTROLLERS.*

The DP-HF must be vented for removal of evacuated air from the vacuum. A one inch (25.4mm) round pipe is provided above the load station. Connect to building exhaust.

Connect the foot switch to the plug in connector under the electrical cabinet.

After completing the utilities hook-up, turn power on to the DP-*HF* by turning the CIRCUIT BREAKER *On*. Then turn the SYSTEM ON/OFF *ON*. The PLC and servo amplifier LED indicators will illuminate to indicate power to the machine.

## Background

### Background of Vacuum Concepts

By definition, a vacuum is a volume of space that contains fewer atoms than a similar volume under normal atmospheric pressure. Vacuum is measured in units of *torr*, which is equivalent to the pressure exerted by a one-millimeter thick layer of mercury under a gravity field of one Earth normal gravity. Zero torr is a total vacuum, defined as a volume containing no atoms whatsoever, and 760 torr is standard sea level atmospheric pressure. The DP-HF machine has chosen to display the vacuum level in inches of mercury (inHg) as a standard unit. 1 torr is equivalent to 29.91 inHg.

To create a vacuum, a volume must first be completely sealed. Vacuum pumps can then remove atoms to create a vacuum in that volume. There are several types of vacuum pumps, with each type having its own specific method of removing atoms. A positive displacement pump seals off a volume of air and forces that air out of the vacuum chamber. This type of pump is most effective for rough vacuums, and usually has a lowest achievable pressure of around 28 inHg.

Circuit Automation has introduced the concept for a Vacuum Chamber for printed circuit board manufacturing. A vacuum chamber is designed as an integral part of soldermask application process. Due to the shrinking feature sizes in PCB manufacturing, increased track height, reduced spaces between traces, soldermask via plugging, and the requirement for increased coating thickness for ENIG applications, air entrapment has become a major manufacturing issue. Traditional mixing of two part epoxy soldermask inks and application techniques has entrained and entrapped air into the mask. The entrapped air causes problems and defects upon further processing either by the vacuum in the exposure process or by creating "volcanoes" in the final baking process.

This vacuum pump works on the claw principle.

The components are dimensioned such, that on the one hand there is never contact between the two claws or between a claw and the cylinder, on the other hand the gaps are small enough to keep the clearance loss between the chambers low.

In order to avoid the suction of solids, the vacuum pump is equipped with a screen in the suction connection. To avoid reverse rotation after switching off, the vacuum pump is equipped with a non-return valve. The vacuum pump compresses the inlet gas absolutely oil-free. A lubrication of the pump chamber is neither necessary nor allowed.

# SAFETY

## Intended Use

Definition: For the purpose of these instructions, “handling” the vacuum pump and the entire machine, means the transport, storage, installation, commissioning, influence on operating conditions, maintenance, troubleshooting and overhaul of the vacuum pump.

The DP-HF is intended for industrial use. Only qualified personnel shall handle and operate it.

The allowed media and operational limits and the installation prerequisites of the vacuum pump shall be observed both by the manufacturer of the machinery into which the vacuum pump is to be incorporated and by the operator.

The maintenance instructions shall be observed.

Prior to handling the vacuum pump system, these operating instructions shall be read and understood. If anything remains to be clarified, please contact your Circuit Automation representative.

## Safety Notes

The vacuum pump system has been designed and manufactured according to the state-of-the-art. Nevertheless, residual risks may remain. These operating instructions inform about potential hazards where appropriate. Safety notes are tagged with one of the keywords DANGER, WARNING, AND CAUTION as Follows:



### **DANGER**

**Disregard of this safety note will always lead to accidents with fatal or serious injuries.**



### **WARNING**

**Disregard of this safety note may lead to accidents with fatal or serious injuries.**



### **CAUTION**

Disregard of this safety note may lead to accidents with minor injuries or property damage.

## **INSTALLATION AND COMMISSIONING**

MAKE SURE THAT THE ENVIRONMENT OF THE VACUUM PUMP IS NOT POTENTIALLY EXPLOSIVE

MAKE SURE THAT THE FOLLOWING AMBIENT CONDITIONS WILL BE COMPLIED WITH:

AMBIENT TEMPERATURE 0.40° C (32- 104°F)

AMBIENT PRESSURE: ATMOSPHERIC

MAKE SURE THAT THE ENVIRONMENTAL CONDITIONS COMPLY WITH THE PROTECTION CLASS OF THE DRIVE MOTOR

MAKE SURE THAT THE MACHINE IS LEVEL

MAKE SURE THAT IN ORDER TO WARRANT A SUFFICIENT COOLING THERE WILL BE ADEQUATE CLEARANCE AROUND THE MACHINE

MAKE SURE THAT NO HEAT SENSITIVE PARTS (PLASTICS, WOOD, CARDBOARD, PAPER, ELECTRONICS) WILL TOUCH THE SURFACE OF THE VACUUM PUMP



### **CAUTION**

During operation, the surface of the vacuum pump may reach temperatures of more than 70° C (159° F) Risk of Burns!

MAKE SURE THAT THE VACUUM PUMP WILL NOT BE TOUCHED INADVERTENTLY DURING OPERATION

MAKE SURE THAT THE SIGHT GLASS (76) OF THE SYNCHRONIZING GEAR WILL REMAIN ACCESSIBLE

#### SUCTION CONNECTION



#### **CAUTION**

Intruding foreign objects or liquids can destroy the vacuum pump.

MAKE SURE THAT THE INLET FILTER IS INSTALLED AND CLEANED REGULARLY

MAKE SURE THAT THE SUCTION LINE FITS TO THE SUCTION CONNECTION PROPERLY

MAKE SURE THAT THE CONNECTIONS ARE TIGHT

#### GAS DISCHARGE

MAKE SURE THAT THE DISCHARGE LINE FITS TO THE GAS DISCHARGE OF THE VACUUM PUMP.

MAKE SURE THAT THE DISCHARGE EXHAUST IS CONNECTED TO THE BUILDING EXHAUST SYSTEM

MAKE SURE THAT THE LINE SIZE OF THE DISCHARGE LINE OVER THE ENTIRE LENGTH IS AT LEAST 1" (25.4MM) PIPE.



#### **CAUTION**

Exhaust discharge pipe may be hot! Risk of burns!

## CONNECTING ELECTRICALLY



### **WARNING**

Risk of electrical shock, risk of damage to equipment.

Qualified personnel that knows and observes the following regulations must only execute electrical installation work:

- IEC 364 OR CENELEC HD 384 OR DIN VDE 0100, respectively,
- IEC-Report 664 or DIN VDE 0110



### **CAUTION**

Operation in the wrong direction of rotation can destroy the vacuum pump in short time.

Prior to starting-up, it must be made sure that the vacuum pump is operated in the proper direction.

DETERMINE THE INTENDED DIRECTION OF ROTATION WITH THE ARROW

“BUMP” THE DRIVE MOTOR

WATCH THE FAN WHEEL OF THE DRIVE MOTOR AND DETERMINE THE DIRECTION OF ROTATION JUST BEFORE THE FAN WHEEL STOPS

IF THE ROTATION MUST BE CHANGED:

SWITCH ANY TWO OF THE DRIVE MOTOR WIRES

AS SOON AS THE VACUUM PUMP IS OPERATED UNDER NORMAL OPERATING CONDITIONS:  
MEASURE THE DRIVE MOTOR CURRENT AND RECORD IT AS REFERENCE FOR FUTURE  
MAINTENANCE AND TROUBLESHOOTING WORK



### **CAUTION**

This vacuum pump is designed for operation under the conditions described below.  
In case of disregard risk of damage or destruction of the vacuum pump and adjoining plant components!

Risk of injury!

The vacuum pump must only be operated under the conditions described below.

## **VACUUM PUMP**

THE VACUUM PUMP SYSTEM IS INTENDED FOR  
SUCTION

AIR AND OTHER DRY, NON-AGGRESSIVE, NON-TOXIC AND NON-EXPLOSIVE GASES

THE MAXIMUM TEMPERATURE OF THE INLET GAS: 40°C (104°F)

THE VACUUM PUMP SYSTEM IS INTENDED FOR THE PLACEMENT IN A NON-POTENTIALLY  
EXPLOSIVE ENVIRONMENT.

THE VACUUM PUMP IS THERMALLY SUITABLE FOR CONTINUOUS OPERATION.

THE VACUUM PUMP IS ULTIMATE PRESSURE PROOF.



### **CAUTION**

During operation, the surface of the vacuum pump may reach temperatures of more than 70°C (158°F).

Risk of burns!



### CAUTION

The vacuum pump emits noise of high intensity in a narrow band.

Risk of damage to the hearing.

Persons staying in the vicinity of DP-HF over extended periods shall wear ear protection.

MAKE SURE THAT ALL PROVIDED COVERS, GUARDS; HOODS, ETC. REMAIN MOUNTED DURING OPERATION.

MAKE SURE THAT PROTECTIVE DEVICES WILL NOT BE DISABLED

MAKE SURE THAT COOLING AIR INLETS AND OUTLETS WILL NOT BE COVERED OR OBSTRUCTED AND THAT THE COOLING AIRFLOW WILL NOT BE AFFECTED ADVERSELY IN ANY OTHER WAY.

VACUUM DOOR

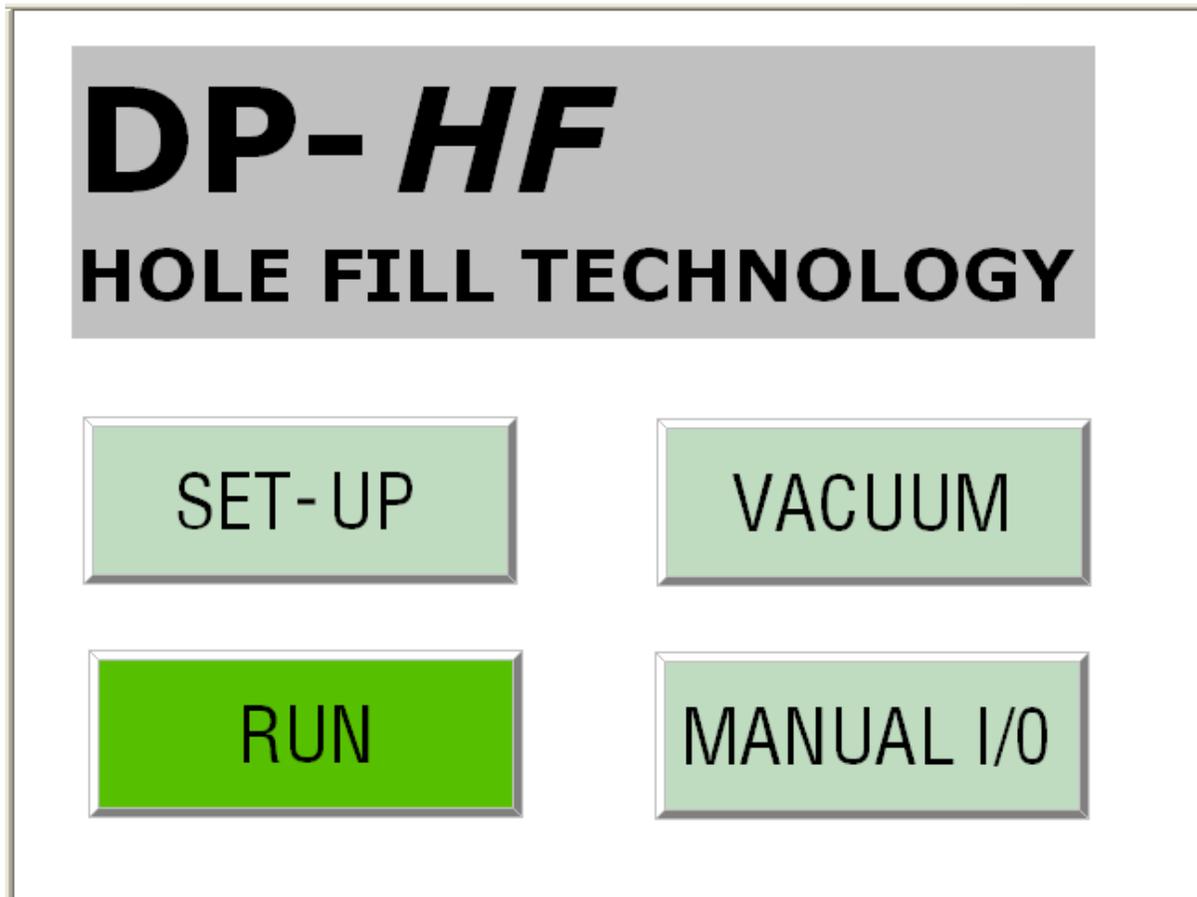


### WARNING

Risk of Serious injury

Qualified personnel required to disassemble or adjust the door. The door is extremely heavy. 350 lbs. (160kg) and could cause serious injury if dropper.

## Controls Screen Menu



**Figure 5 Control Screen**

The DP-HF has intuitive controls. The control system allows for 4 primary choices of control:

- Setup : Initial settings and testing modes
- Run : Main screen for operation
- Vacuum : Individual controls for settings and controls
- Manual I/O : Manual switches and operations.

## SETUP Screen

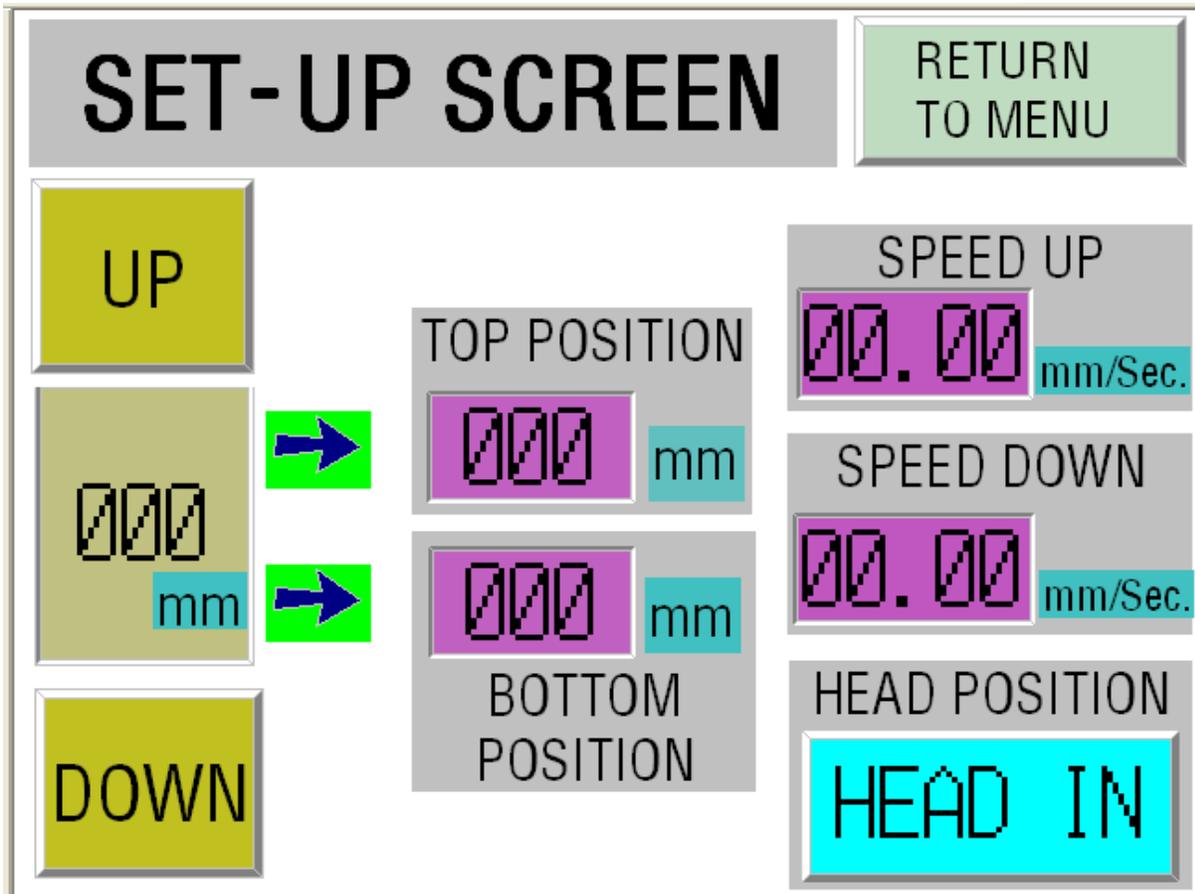


Figure 6 Set-Up Screen

The Set-Up Screen adjusts the position of the filling head platform. This can be accomplished by Manually pressing the **Up or Down** switch to find the proper starting and or stopping position for the filling head. When the proper position is defined, then by pressing the arrow key  the position is saved in the **TOP POSITION OR BOTTOM POSITION**. By pressing on the number portion of the screen, a key pad will arise allowing the number to be typed in and saved.

**SPEED UP** This is the transverse speed of the filling head assembly. This machine is designed only to fill in the Down mode; the speed **up** is a convenience speed relative to the thickness of the work. This speed can be utilized to reduce the cycle time of the equipment, especially if the unit is operating with a low or no Vacuum setting.

**SPEED DOWN** This is the reset speed.

### HEAD POSITION

Indicates the relative position on the fill heads and used to either **Open or Close** the Heads.

# Run Screen

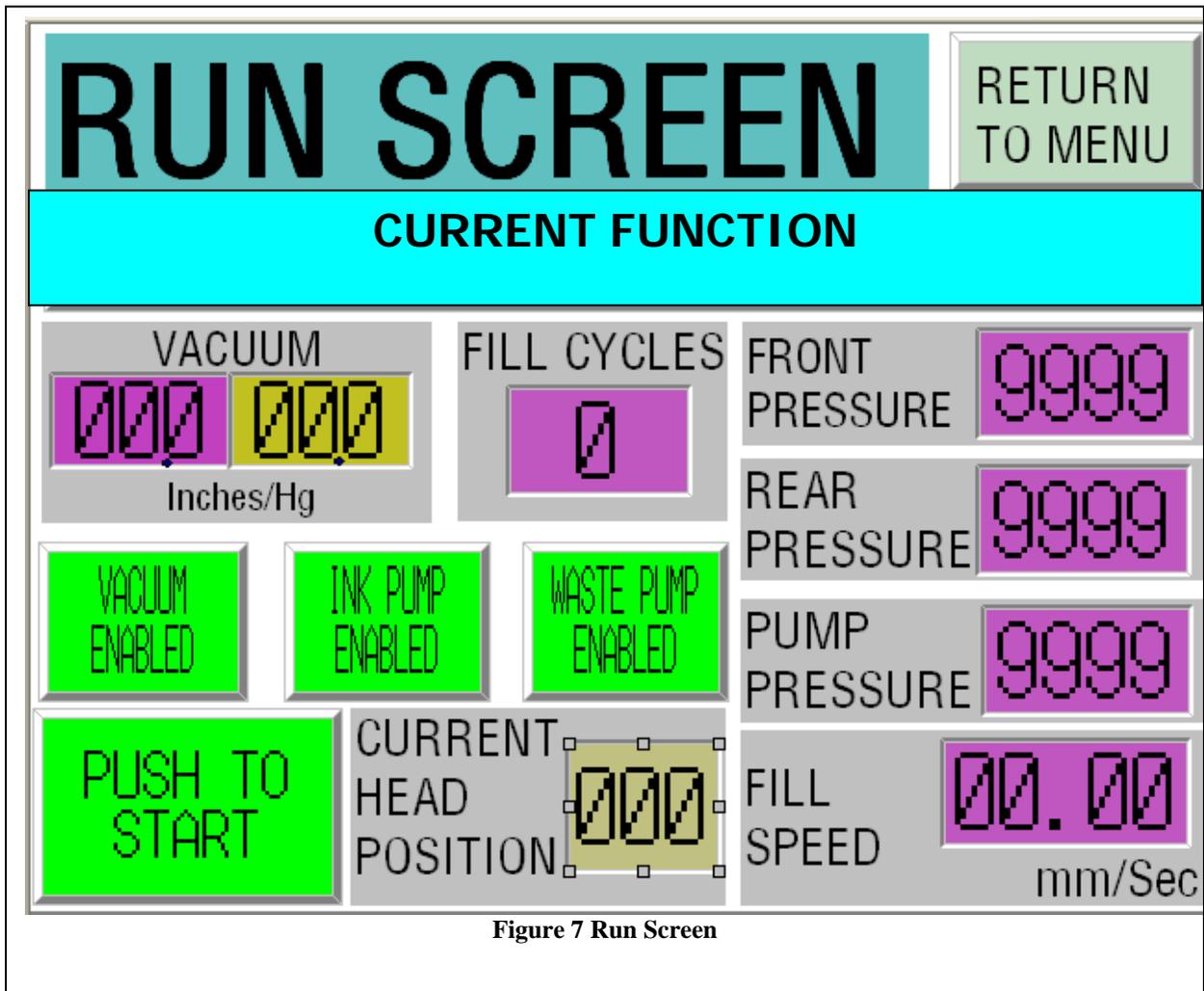


Figure 7 Run Screen

This screen controls the machine during filling operation. It allows for controlling all the functions concerning the functional running of cycles.

## Vacuum

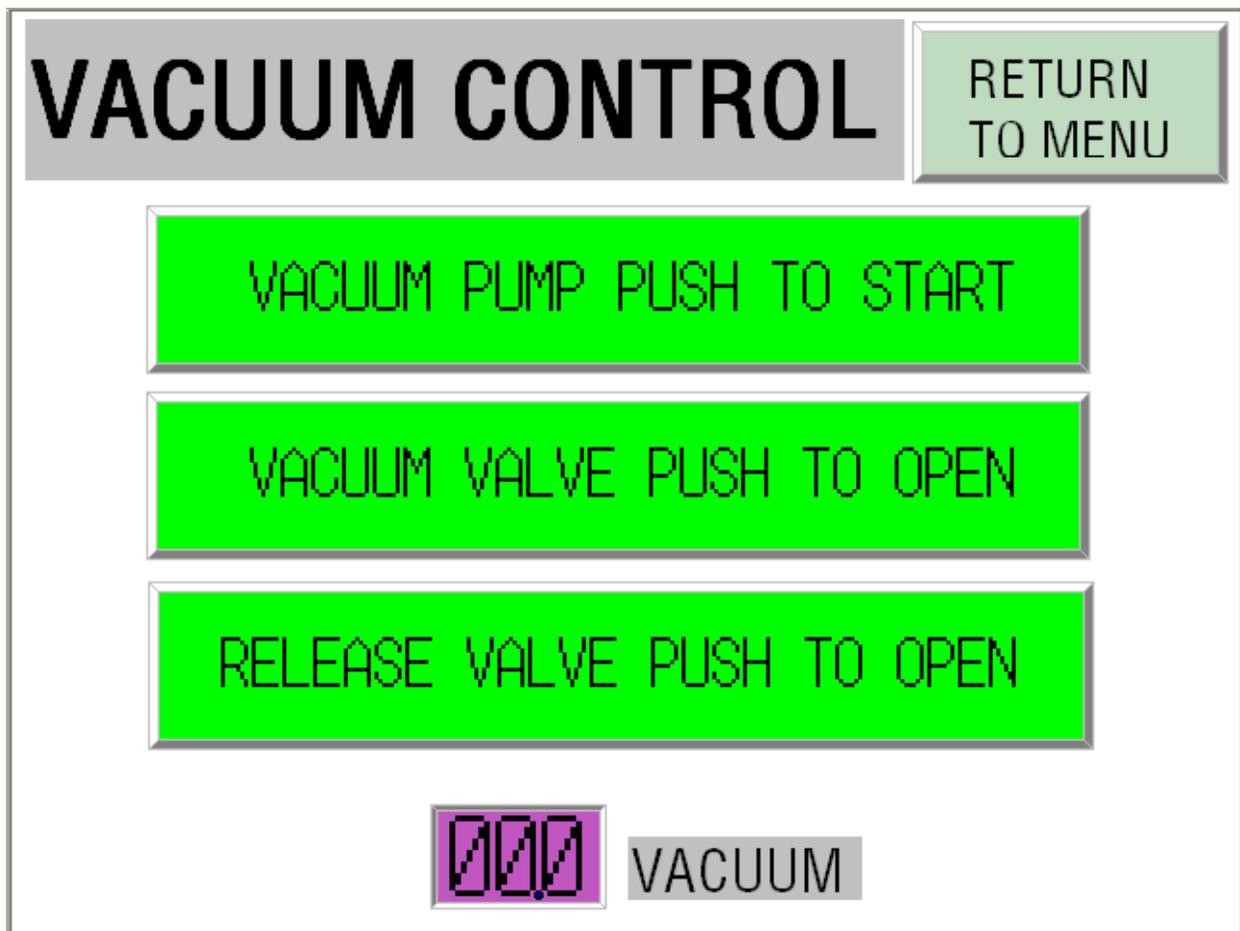


Figure 8 Vacuum Control Screen

## Manual I/O

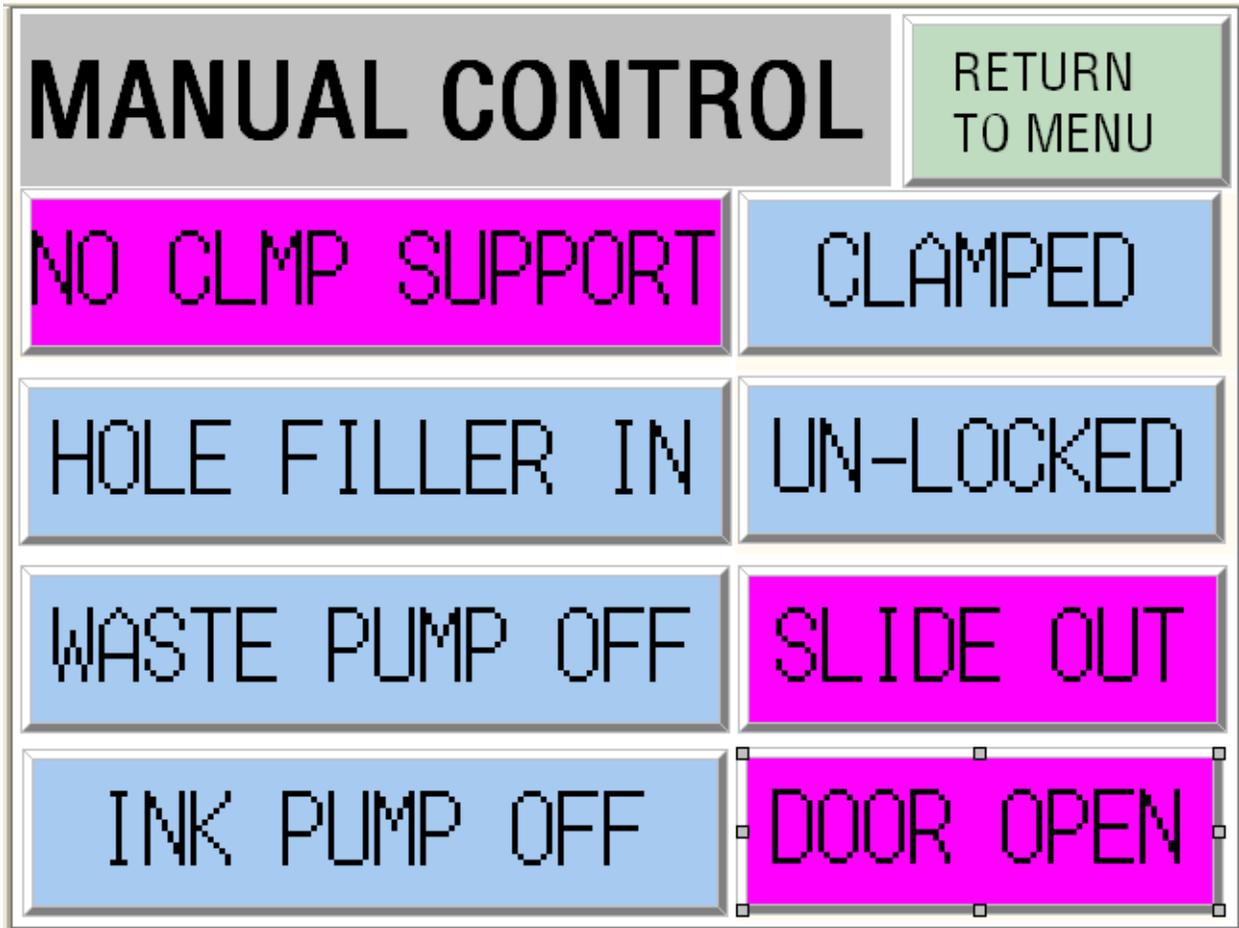


Figure 9 Manual Control and Inputs

## Manual I/O

**Note:** This machine utilizes “smart” manual controls. The sophistication of the machines precludes the operator from being able to manually affect all controls at any given period of time. With total control, the operator could create motions with unintended consequences and cause crashes. For example, The “Slide” cannot be moved *in or out* while the “Door” is closed. To assist the operator, the color of the button changes from blue to purple indicating switches and controls that are interrelated.

### No Clamp Support

The clamp support system (see fig 10) is a pneumatic device located on the right side of the Load Chamber. This support is designed to support the shuttle transport system when it is in its full-extended mode and aid in loading and unloading the panels. In *Manual Mode*, the device may be cycled for test purposes. When the device is in *No Clamp Support* mode, the shuttle may be cycled. When the device is in *Clamp Support* then the shuttle



**Figure 10 Shuttle Support System**

### **Hole Filler In/Out**

This switch engages the pressure heads and moves them towards the panel. When *Hole filler Out* is depressed, the pressure heads will retract.

### **Waste Pump On/Off**

Depressing *On* will turn the waste pump on which will remove waste paste from the receiver head. This is a pneumatically driven pump designed to scavenge the paste that is pushed through the panel and saved.



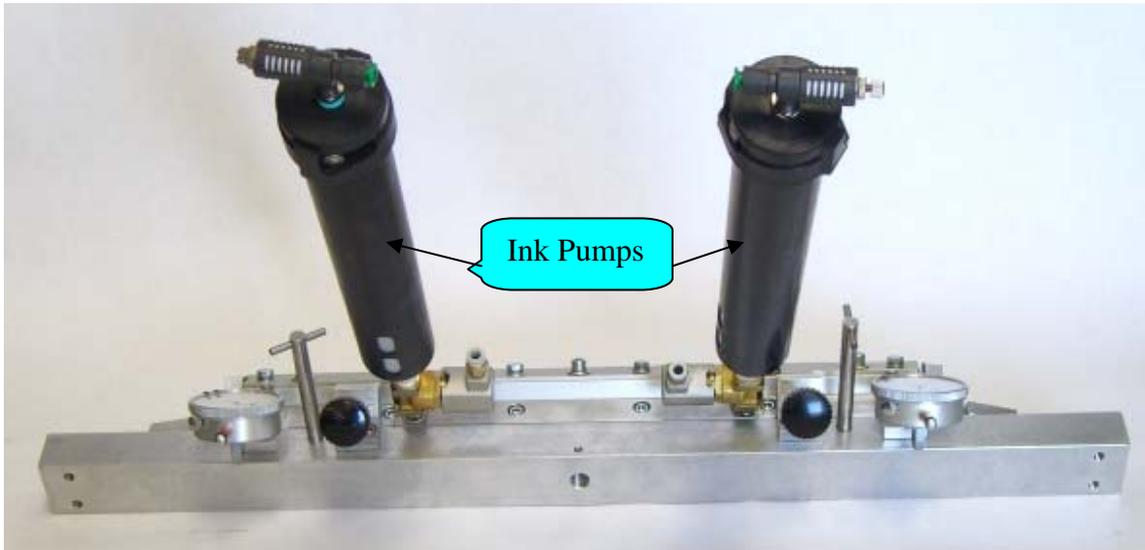
**Figure 11 Waste Pump**



**Figure 12 Waste Collection Vessel**

## Ink Pump On/Off

A manual switch controlling the *On/Off* switch for the ink pump. This unit has two ink cartridges that are controlled by the On and Off switch. This switch controls the On/Off but the actual air pressure utilized is controlled by the ITV switches which are found on



the RUN panel. The Pumps will pump at the preset pressure as long as there is ink in the tubes. Standard DP-HF's utilize two 12" ink tubes.

## Clamp/Unclamp

The *Clamp* is the pneumatic system that opens and closes the panel-hanging device.

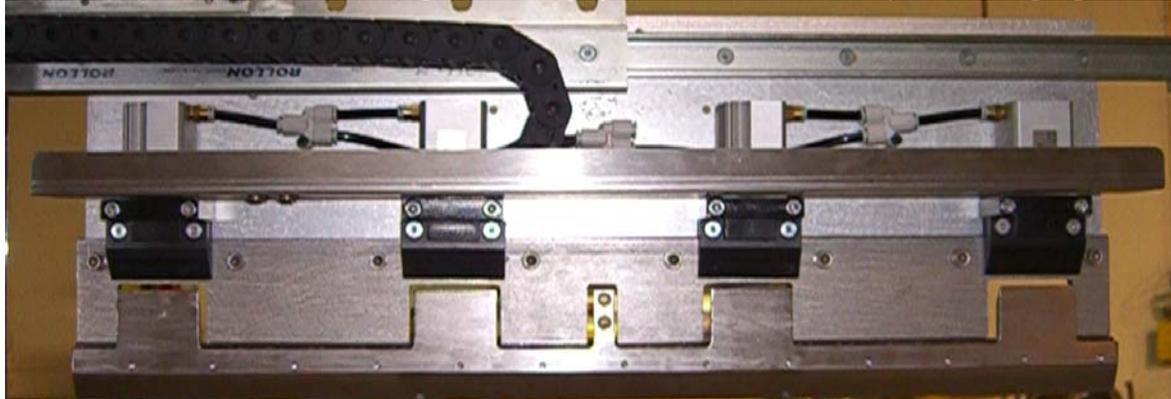


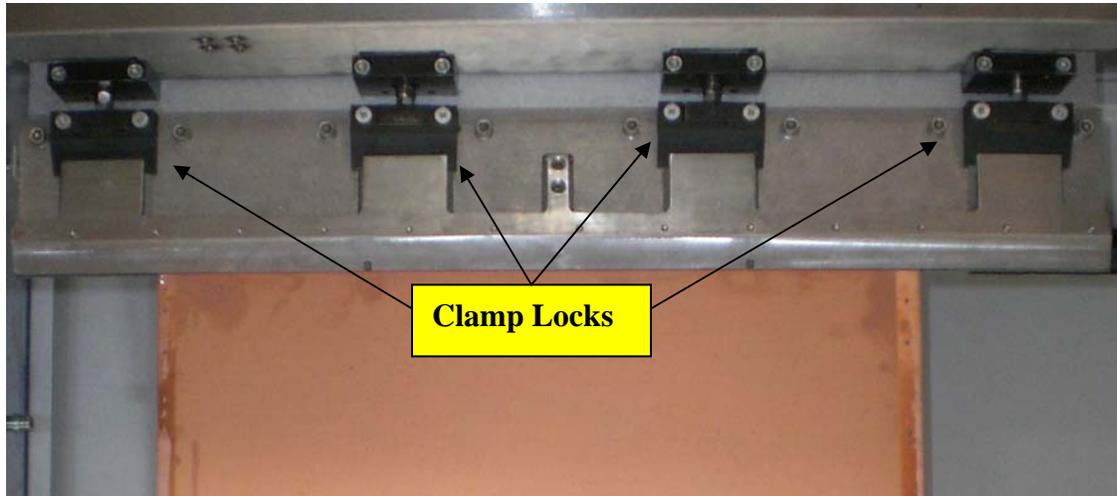
Figure 13 Panel Handling in CLAMPED position



Figure 14 Unclamped position

### **Locked/Unlocked**

Pneumatic system to *Lock or Unlock* the panel hold clamp. For this to function the Clamp/Unclamped must be in the *Clamped* position. These wedge clamps securely hold the panel in place. This machine is fitted with a pin bar, which is utilized to properly align the panel on the clamp.



**Figure 15 Locked position**

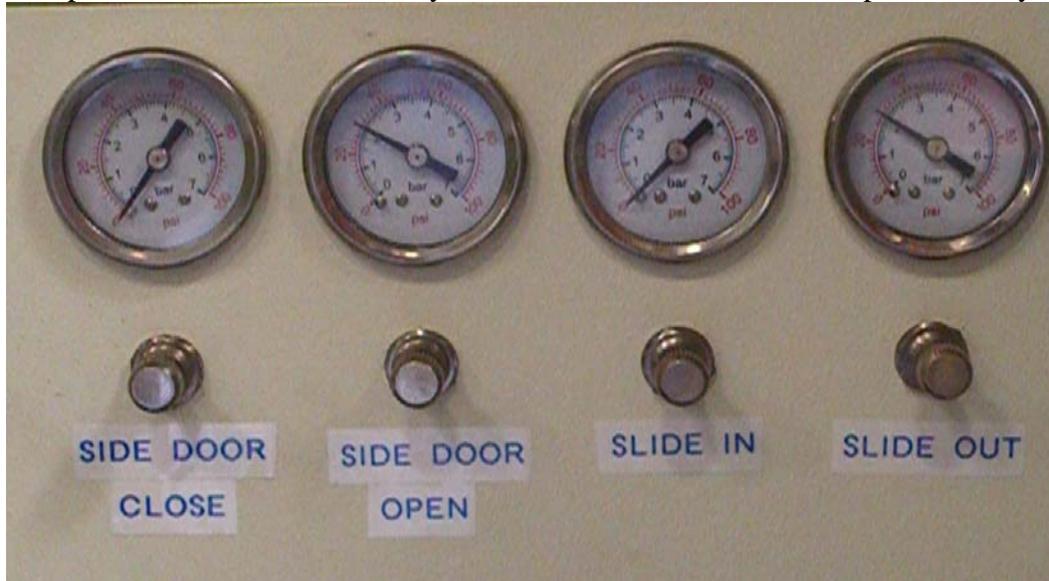


**Figure 16 Unlocked Position of wedges**

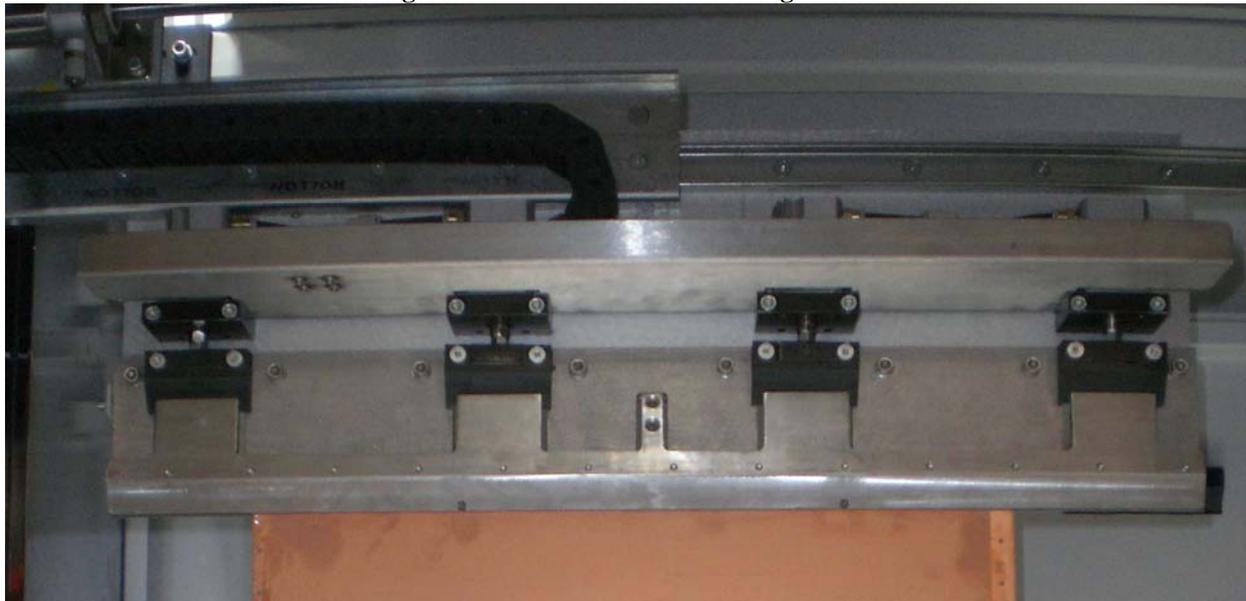
### **Slide In/Out**

The Slide is the mechanism that transports the panel into and out of the filling chamber. This device is driven pneumatically. Located inside of the Pneumatic Control Panel are the regulators and gauges that indicate the pressure to drive the device in and out. The smoothness of the

transport can also be controlled by the flow controls located on the pneumatic cylinders.



**Figure 17 Slide control Pressure Regulators**



**Figure 18 Slide OUT position**



Figure 19 Slide moving IN

### Side Door Open/Close

The *Door* is referring to the pneumatically controlled door that separates the Loading Chamber with the Filling Chamber. This door opens and closes to allow the substrate to enter and leave the chamber.

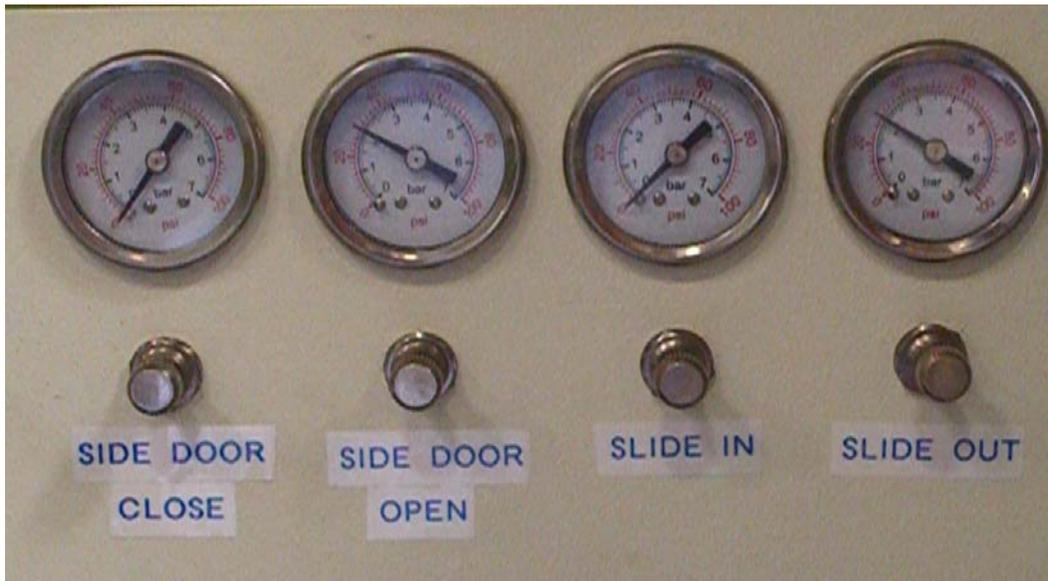
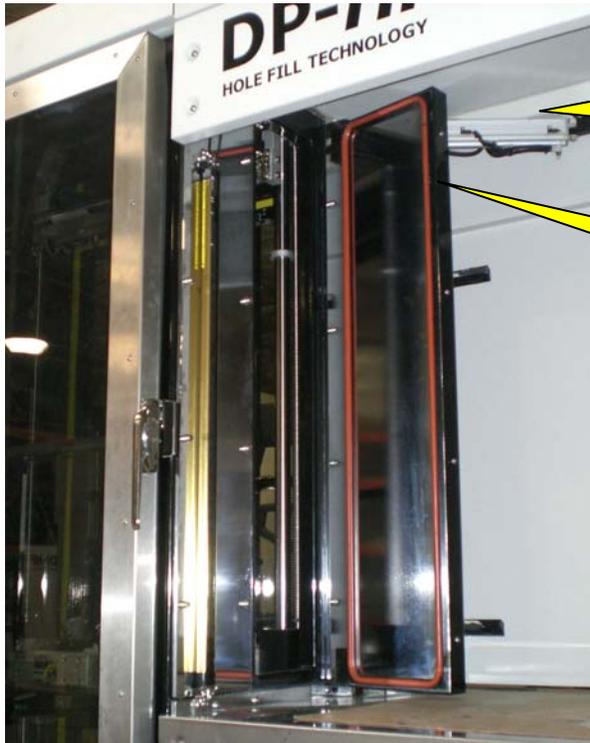


Figure 20 Side Door Open /Close Gauge and Regulators

Located in the Pneumatic Control panels are the gauges and regulators that control the air pressure to open and close the Side Door.



Pneumatic cylinder  
open/close

Side Door

**Figure 21 Side Door**