How It Works

A pneumatic solenoid valve is an electro-mechanical device that, when it is energized or de-energized, either opens or closes a valve orifice. It is designed to control the flow of liquid or gaseous substances. Pneumatic solenoids control air flow to many of the systems in Haas machines. Solenoids have many different configurations. This document tells you about the different types of pneumatic solenoids and also includes pneumatic solenoid troubleshooting information. The image below shows the basic operation of a solenoid.

![Solenoid operation diagram](image)

Solenoid Valve Troubleshooting

**Caution:** Before you test solenoids, make sure the machine is safe to operate. Operate the solenoid under conditions that do not damage the machine. For example, remove the tool from the spindle before you test the solenoid for the Tool Release Piston (TRP). Make sure that the control is not set in a condition to prevent operation. For example, make sure the the control is not running a program that might conflict with the solenoid.

Always follow this troubleshooting guide before you replace a solenoid valve. Look at the solenoid information in the following sections for more specific operation and troubleshooting information on the solenoid you are working on.

- Many symptoms can be caused by an incorrect air line size, incorrect air pressure supply, or low air pressure. Low air is sometimes caused by machine operation before the air supply is correct if the air compressor has been off. Make sure the machine receives the correct air pressure and flow. Make sure the shut off valve is completely open.
- Turrets on ST model lathes, TRPs, and Side-Mount Tool Changer Pockets have specific troubleshooting steps. Refer to [diy.haascnc.com](http://diy.haascnc.com) for further troubleshooting information on the following.
- Many solenoids will not shift correctly without correct air pressure and back pressure. Test the solenoid in the system. Do not expect the solenoid to operate correctly if the outlets are not connected to the system.
- If you command the solenoid to open or close without the correct air pressure, the solenoid can go into an intermediate state.
state that may not correct itself when the machine has correct air pressure. To move the solenoid out of the intermediate state, close the air valve and power off the machine.

Note: Do not use the machine before the air supply to the machine is correct.

- Turn on the machine and use the control to activate the solenoid. You can write a simple program in MDI mode to command the electrical output to the solenoid.
- Go to the I/O tab on the diagnostics screen on the control. Make sure the state of the output changes when it is commanded. If the state does not change, troubleshoot and fix the problem before you continue.
- Listen for a clicking or buzzing noise from the coil area of the solenoid. The coil area of the solenoid is the black plastic area on most solenoids. You can also feel the clicking if you place your finger on the solenoid. If there is not a clicking sound when the solenoid is commanded, make sure the solenoid valve is connected correctly and that the electrical supply is correct. Inspect the solenoid cables to make sure they are not damaged. Make sure the solenoid receives the correct voltage. The measured voltage must be 120 VAC.

Note: Do not use the machine before the air supply to the machine is correct.

If the solenoid still does not operate correctly, disconnect the solenoid from the machine and connect it to a known electrical source. If the solenoid operates correctly, the machine has an electrical problem. Do not replace the solenoid. If the solenoid receives the correct voltage and does not operate correctly, check the solenoid coil for continuity. If there is no continuity, replace the solenoid. If the coil has continuity, go to the correct section for your solenoid.

- If there is coolant leaking from any solenoid, the problem is the TSC check valve in the spindle head.

Many symptoms can be caused by contamination or debris in the solenoid. If the solenoid leaks after you tested it for correct air and power, manually activate it with a 2 mm allen key. Cycle the valve to release any contamination or debris that may have been stuck in the valve. If the solenoid still does not operate correctly, remove the solenoid and inspect the ports for contamination or debris. Clean the solenoid with compressed air while cycling it. Some solenoids (i.e. Asco) have the capability to be disassembled in the field. See the Cleaning ASCO Brand Solenoids section in this document. Replace the solenoid if the ports are covered in contamination or debris that cannot be removed.
PRECAUTIONS

- WIRE DAMAGE

Prevent damage to the wires.
- Only hold the body of the solenoid. Do not hold the wires to lift the solenoid.
- Do not cut the ties that hold the wires to the solenoid body. If you cut the ties, the wire can bend. This causes internal damage to the wire.

- ELECTRICAL

- Do not push a probe into the connector pins. This damages the pins.
- Only measure voltage output to the solenoid with the solenoid in-circuit.
- Prevent unwanted machine motion. Make sure you know the function of the solenoid before you energize it.

- MAINTENANCE

- Keep the air lines clean and dry. Contamination can prevent the movement of the internal components in the solenoid.
- Examine the air lines for leakage and contamination. Do this each time you do work related to the solenoid.

2-PORT SOLENOIDS

A: MAC, SMC, and Festo Brand

1. Port 1 is usually the input port.
2. Port 2 is usually the outlet port.
3. Port 3 can have a plug to make this a 2-port solenoid. This is the configuration for some air-purge solenoids.

B: ASCO Brand

1. Port 1 is usually the input port.
2. Port 2 is usually the outlet port.
1. When the solenoid is de-energized, the air flow stops at port 1.
2. When the solenoid is energized, the air flows through port 1 and out through port 2.
3. If the power fails, air flow stops. The solenoid goes back to its de-energized position.

The air-purge solenoid is energized on a timed cycle. If too much contamination collects inside the solenoid, leaks from the outlet port can occur. You can manually energize some brands of solenoids. This has no effect on the time cycle.

The air-purge solenoid is installed below the air/water separator. The air-purge solenoid removes moisture and contamination. The installed solenoid is on its side to collect contamination and moisture from the air system in the input pipe. The contamination and moisture stay in the pipe until they are released.

ASCO 2-Port solenoid valves are most commonly used for the air system purge. These solenoids are also used in the Coolant Refill and TAB options.

**Note:** MAC 3-Port poppet style solenoid valves are also used for the air system purge. There is a plug on port number 3 when MAC 3-way poppet style solenoid valves are used. If there is a leak from one of the ports on a MAC 3-Port poppet style solenoid valve, push the manual activation button multiple times to clear out any debris in the solenoid. If this does not work, remove the solenoid and clean it with compressed air while cycling the solenoid. If a MAC purge solenoid replacement is necessary, do not substitute a different MAC solenoid. Use the approved replacement solenoid.

If these solenoids leak air when the solenoid is not activated, it is likely that debris holds the plunger in an open position. Follow this procedure to clean the ASCO 2-Port solenoid valve:

**Cleaning ASCO Brand Solenoids**

- Remove the red cap [1].
- Push the solenoid coil assembly [2] down to compress the spring inside.
- Remove the specification plate [3] by sliding off.
- Disassemble the valve subassembly [5].
- Clean the parts with compressed air. Be sure to remove all debris from inside the valve.
- Apply a thin coat of silicone grease to the body gasket [6].
- Assemble the components in the opposite order they were removed.
3-PORT SOLENOIDS

3-Port poppet style solenoid valves are the most common solenoid valves used on Haas machines. These illustrations show how a normally-closed MAC 3-Port poppet style solenoid valve operates:

**Solenoid Operation : Normally-Closed Application**

Black arrows illustrate air pressure from the air supply. Grey arrows illustrate exhaust flow from the machine.

1. When the solenoid is de-energized, the incoming air stops at port 1. Pressure that remains in port 2 is released through port 3.
2. When the solenoid is energized, the pneumatic valve opens. Air flows in through port 1 and out of port 2. Port 3 is closed.
3. If there is no power to the solenoid, incoming air flow stops. The valve goes back to the de-energized position.

**Solenoid Operation : Normally-Open Application**

1. When the solenoid is de-energized, incoming air flows in through port 3 and out through port 2.
2. When the solenoid is energized, the air flow stops at port 3. Remaining air pressure from port 2 is released through port 1.
3. If there is no power to the solenoid, the incoming air flow is resumed and the valve goes back to the de-energized position.
3-Port Solenoid Troubleshooting

Disconnect the output hose from port number 2 on the solenoid valve. Activate the solenoid. If air exits from the output port number 2, the solenoid is operating correctly. Do not replace the solenoid. Continue to troubleshoot the solenoid if air does not exit output port number 2 when it is activated. With the output hose disconnected, use the manual activation button on the top of the solenoid valve to manually activate the solenoid:

- Disconnect the solenoid from the electrical connector.
- Check for air that escapes from the ports.
- Push the manual activation button multiple times. Air should only exit from the output port number 2.
- If there is not a blast of air from the output port number 2 when you push the manual activation button, verify there is air pressure at port 1. If there is pressure at port 1, the solenoid is damaged. If there is a blast of air from the output port number 2, debris was removed from the valve by repeated manual activation, or there is an electrical problem with the machine or the solenoid. If the machine has an electrical problem, find the cause of the problem. If the solenoid has an electrical problem, replace it.

**Make sure the solenoid valve does not have leaks:**

Feel and listen to the exhaust port [2] of the solenoid.

If there is a constant air releasing from the exhaust port, the internal piston is stuck and releases air through the exhaust port [2] and outlet port [1].

**Note:** There must never be a constant stream of air from the exhaust port.

Stop the air supply to the solenoid and remove the solenoid. Use compressed air to thoroughly clean the solenoid.

Install the solenoid. If the problem continues, replace the solenoid.
4-PORT, TWO-OUTLET SOLENOIDS

4-Port solenoids must have some back pressure against both of the output ports. This pressure allows the internal mechanism to move correctly. Correct air pressure is necessary for the solenoid to move. If you energize a solenoid without correct air pressure, the internal mechanism can stop between the ports. If this occurs, close the primary air valve on the machine and remove power from the solenoid. This lets the internal mechanism go back to its de-energized position. Open the primary air valve and apply power to the solenoid. If this does not reset the valve, close the primary air valve with power to the solenoid. When the solenoid has power, open the air valve. Make sure the solenoid operates correctly.

4-Port Solenoid

![4-Port Solenoid Diagram]

1. Solenoid coil
2. Port A
3. Port B
4. Electrical cable
5. Exhaust port
6. Input port

4-Port Solenoid - Double Acting Operation

![4-Port Solenoid Double Acting Operation Diagram]

1. When the solenoid is de-energized, incoming air from the input port flows through port B. Pressure that remains flows through port A and is released through the exhaust port.
2. When the solenoid is energized, incoming air from the input port flows out through port A. Pressure that remains flows in through port B and is released through the exhaust port.
3. If there is no power to the solenoid, the solenoid goes back to its de-energized condition.
4-Port Solenoid Operation: Normally-Open Function

In this application, a plug is in one of the ports. This lets the solenoid operate as a 3-Port, normally-open solenoid. Haas machines use these solenoids as an alternative to a 3-port solenoid in some applications.

Note: A plug is in port A.

1. When the solenoid is de-energized, incoming air flows out through port B.
2. When the solenoid is energized, incoming air flow from the input port is stopped at the inlet port. Pressure that remains from port B is released through the exhaust port.
3. If there is no power to the solenoid, it goes back to its de-energized condition.

4-Port Double Acting Operation

4-Port, Dual Coil Solenoid

Note: Low-gear and High-gear coils are never energized at the same time. The only function of these solenoids is to change gears on the Haas transmissions.
4-Port, Dual Coil Solenoid Operation

1. When the high gear is energized, air flows through the inlet and through the high-gear port to push the air cylinder. The air moves the gear to the high-gear position. The low-gear port is connected to the exhaust.
2. When the high gear is de-energized, nothing changes. The solenoid stays in the same position.
3. When the low gear is energized, air flows through the inlet and through the low-gear outlet to push the air cylinder. The air moves the gear to the low-gear position. The high gear port is connected to the exhaust.
4. When the low gear is de-energized, nothing changes. The solenoid stays in its same position.

Note: EC-400 PP machines use a 4- or 5-port solenoid to lift the H-Frame. Do not replace the solenoid with another 4- or 5-port solenoid. The configuration for the pallet lift system was upgraded. Use service kit 93-2248 to replace the solenoid.

4-Port Solenoid Valve Troubleshooting

Make sure the incoming air pressure and flow are correct. Feel and listen to the exhaust port of the solenoid. If there is constant air releasing from the exhaust port, disconnect the non-pressurized line between the cylinder and the solenoid. If the air continues to flow through the exhaust port and/or the non-pressurized line port on the solenoid follow these steps:

1. Disconnect the air supply from the machine and release all the air pressure from the machine.
2. If the solenoid is powered on, power it off.
3. Reconnect the air to the machine.
4. Command the solenoid to activate. If the solenoid continues to leak, disconnect the air supply and release the air pressure with the solenoid still energized. If the solenoid continues to leak, continue troubleshooting the solenoid.

Remove the air supply to the machine and remove the solenoid. Use compressed air to thoroughly clean the solenoid. Install the solenoid and check for leaks. If the solenoid continues to leak, follow these steps.

1. With no power to the solenoid, remove the unpressurized hose that runs between the solenoid and the cylinder.
2. The solenoid has a leak if air is released out of the exhaust.
3. The cylinder has a leak if air is released out of the cylinder return hose.
4. Repeat the test while the solenoid is energized. The other hose between the cylinder and solenoid is now pressurized.
4-Port Solenoid Applications

4-port solenoid valves have more than one output and are used in double-acting cylinder applications. One of the solenoid outputs is used to extend the cylinder and the other solenoid output is used to retract the cylinder. **These solenoid valves require back pressure to shift correctly. Make sure both of the air hoses are connected in the circuit when you troubleshoot them.**

Side-Mount Tool Changer configurations made after July 2015 have a check valve between the manifold and the inlet port of the solenoid valve. The purpose of the check valve is to keep the tool pocket in the pocket-up position when air is not supplied to the machine. The check valve stops the release of air from the cylinder. These illustrations show the pocket-up, pocket-down, and the pocket-up with no air supply conditions of the side-mount tool changer:

<table>
<thead>
<tr>
<th>Pocket-up</th>
<th>Pocket-down</th>
<th>Pocket-up with no air supply</th>
</tr>
</thead>
</table>

- If the pocket slowly drops when the air pressure is removed from the machine, there is a leak in the system. It could be a hose connection, the check valve, the air cylinder, or the solenoid. With air pressure supplied to the machine and the pocket up, disconnect the hose between the bottom of the cylinder and the solenoid.
  1. If air comes out of the bottom cylinder port, the cylinder has a leak.
  2. If air comes out of the exhaust port of the solenoid, the solenoid has a leak.
- If no leaks are found, close the main air valve on the machine, release the pressure from the machine, and disconnect the check valve from the CALM manifold [6] as seen in the **Pocket-up with no air supply** image. If air is coming from the check valve, clean the check valve. If the check valve continues to leak, replace it.
Side-Mount Tool Changer configurations made before July 2015 have a piloted check valve on the top port of the cylinder. These illustrations show the pocket-up, pocket-down, and no air supply conditions of the Side-Mount Tool Changer:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Illustration A" /></td>
<td><img src="image2.png" alt="Illustration B" /></td>
</tr>
</tbody>
</table>

**Note:** In these illustrations, the greyed hoses show where the incoming air pressure is directed.


**B. Pocket-down** - Air pressure [4] goes to the bottom of the cylinder. The connector on the bottom of the cylinder also lets air pressure [3] go to the pilot connection of the check valve [2]. The check valve opens when the air pressure goes to the pilot connection. This defeats the check valve and releases the pressure in the top of the cylinder. This moves the piston up and moves the tool pocket to the down position.

**Pocket-up with no air supply** - To keep the pocket in the up position, the check valve holds the pressure in the top of the cylinder.

**Note:** If the tool pocket [3] falls when the air supply is stopped, do not assume the check valve is defective. It could be either the check valve or the air cylinder.

- If the pocket slowly drops when the air pressure is removed from the machine, there is a leak in the pneumatic system for the Side-Mount Tool Changer. The solenoid operates correctly and cannot cause the leak in this scenario. The leak is located at either the connection between the check valve and the air-cylinder, the check valve itself, or the air-cylinder. To find the source of the leak, do the following steps.
  1. Make sure the main air valve is open and the tool pocket in the pocket up position. Disconnect both hoses from the bottom port of the cylinder. If air leaks out of the bottom cylinder port, the cylinder is leaking. If air leaks between the check valve and the cylinder, repair the leak. If no leak is found, continue to step 2.
  2. With the tool pocket in the pocket-up position, close the main air valve to the machine and vent the air pressure. Remove both hoses that lead to the check valve. If air comes out of one or both of the ports on the check valve, the check valve has a leak. Remove and clean the check valve with compressed air. If the check valve continues to leak, replace it.
5-PORT SOLENOIDS

5-Port solenoids are similar to 4-Port solenoids, but have 2 exhaust ports instead of 1. Correct air pressure is necessary for the solenoid to move. If you energize a solenoid without correct air pressure, the internal mechanism can stop between the ports. If this occurs, close the primary air valve. This lets the internal mechanism go back to its de-energized position. Open the primary air valve. Make sure the solenoid operates correctly.

1. Input port
2. Port 2
3. Exhaust port 3
4. Port 4
5. Exhaust port 5
6. Electrical cable

5-Port Solenoid Operation

1. When the solenoid is de-energized, air flows in the input port and out through one of the ports (2 or 4). The other output port will be connected to its exhaust port.
2. When the solenoid is energized, air flows in through the input port and out the other ports (2 or 4). The other output port will be connected to its exhaust port.
3. If there is no power to the solenoid, the valve goes back to the de-energized position.
Turret Clamp/Unclamp 5-Port Solenoid

1. Input port
2. Clamp port
3. Exhaust port 3
4. Unclamp port
5. Exhaust port 5
6. Electrical cable

4-Way Solenoid - Turret Clamp / Unclamp Solenoid Operation

1. When the solenoid is de-energized, air flows in the input port and out through the clamp port. The unclamp port connects to exhaust port 5.
2. When the solenoid is energized, air flows in through the input port and out through unclamp port. The clamp port connects to exhaust port 3.
3. If there is not power to the solenoid, the valve goes back to the de-energized position.

4-Way Solenoid Valve Troubleshooting

The steps to troubleshoot a 5-port solenoid valve are the same as a 4-port solenoid valve.