

Operating pneumatic cylinders - Solenoids

There are two ways to connect and operate pneumatic solenoid valves to trigger pneumatic cylinder movement using the current control system. One option is to hook the solenoids up to a Spike relay; to learn how to utilize solenoids connected in this manner in code see the article on [Relays](#). The second option is to connect the solenoids to a solenoid breakout board on top of a NI 9472 Digital Sourcing module in the cRIO (slot 3). To use these solenoids in code, use the WPILib "Solenoid" and/or "Double Solenoid" classes, detailed below.

Solenoid Overview

The pneumatic solenoid valves used in FRC are internally piloted valves. For more details on the operation of internally piloted solenoid valves, see this [Wikipedia article](#). One consequence of this type of valve is that there is a minimum input pressure required for the valve to actuate. For many of the valves commonly used by FRC teams this is between 20 and 30 psi. Looking at the LEDs on the 9472 module itself is the best way to verify that code is behaving the way you expect in order to eliminate electrical or air pressure input issues.

Single acting solenoids apply or vent pressure from a single output port. They are typically used either when an external force will provide the return action of the cylinder (spring, gravity, separate mechanism) or in pairs to act as a double solenoid. A double solenoid switches air flow between two output ports (many also have a center position where neither output is vented or connected to the input). Double solenoid valves are commonly used when you wish to control both the extend and retract actions of a cylinder using air pressure. Double solenoid valves have two electrical inputs which connect back to two separate channels on the solenoid breakout.

Note on port numbering

The port numbers on the Solenoid class range from 1-8 as printed on the Solenoid Breakout Board. The NI 9472 indicator lights are numbered 0-7 for the 8 ports, which is different numbering than used by the class or the Solenoid Breakout Board silk screen.

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Single Solenoids in WPILib

```
exampleSolenoid = new Solenoid(1);  
exampleSolenoid = new Solenoid(1, 1);  
exampleSolenoid.set(true);  
exampleSolenoid.set(false);
```

Single solenoids in WPILib are controlled using the Solenoid class. To construct a Solenoid object, simply pass the desired port number or module and port number to the constructor. To set the value of the solenoid call set(true) to enable or set(false) to disable the solenoid output.

Double Solenoids in WPILib

```
exampleDouble = new DoubleSolenoid(1,2);  
exampleDouble = new DoubleSolenoid(1, 1, 2);  
exampleDouble.set(DoubleSolenoid.Value.kOff);  
exampleDouble.set(DoubleSolenoid.Value.kForward);  
exampleDouble.set(DoubleSolenoid.Value.kReverse);
```

Double solenoids are controlled by the DoubleSolenoid class in WPILib. These are constructed similarly to the single solenoid but there are now two port numbers to pass to the constructor, a forward channel (first) and a reverse channel (second). The state of the valve can then be set to kOff (neither output activated), kForward (forward channel enabled) or kReverse (reverse channel enabled).