



# Utilizing Pneumatics in a FIRST Robotics Competition Robot

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# What is a pneumatic system?

- A pneumatic system converts air pressure to mechanical energy
- Has three components, storage, solenoids, and actuators

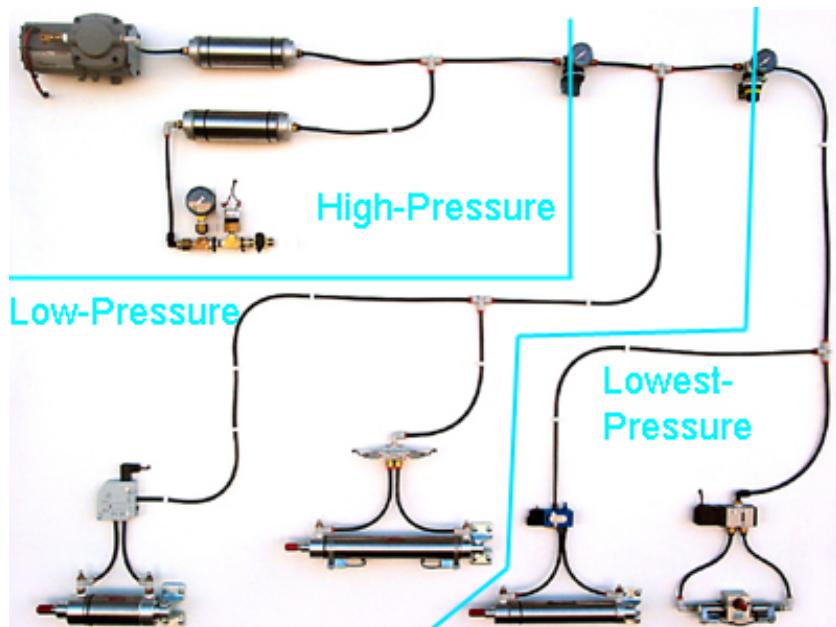
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## System Overview



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## Starting with the air

- All air used comes from a compressor
- A compressor can be either on-board or off the robot
- Any compressor can be used as long as it meets these specs:
  - Nominal 12V
  - 1.05 cfm
  - 125psi Min working pressure

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# Potential Options for a Compressor

- 2010 KOP and Earlier
  - Thomas Compressor
- 2011-13 KOP
  - Viair Compressor
  - VIAIR 00090



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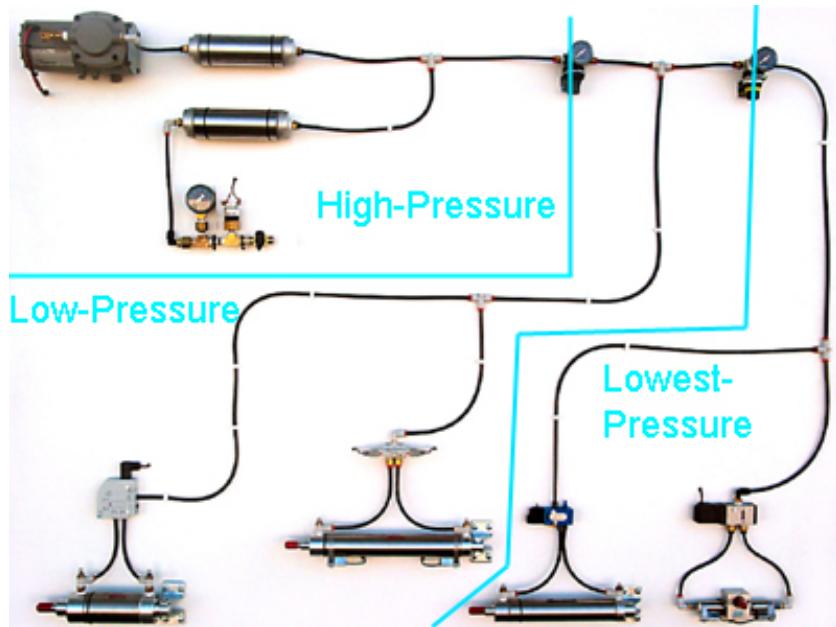


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## High Pressure and Storage

- Air is stored at 120psi
- Air can be stored in any pressure Vessel rated for 125psi Working Pressure
- You must have a pressure transducer, blow-off valve, and dump valve

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15-44 cu. In.



16 cu. In.



115.5 cu. In.

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## More on Storage

- Greater storage generally means less time the compressor runs
- Consider how many cylinders and their size
  - A  $\frac{3}{4}$ " Bore with 2in stroke cylinder has a volume of .8836 in<sup>3</sup>
  - With one kit storage tank you can fire that cylinder less than 36 times

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# Dump Valve, Pressure Reg., and Blow-Off Valve

- Commonly assembled inline with Brass
- All have to be on high pressure side, before 60psi regulator



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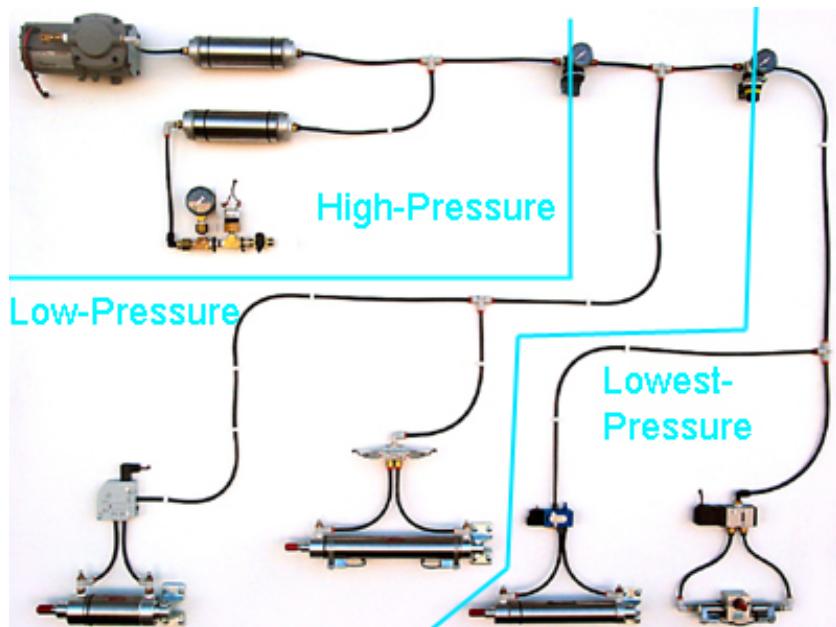


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## Low Pressure Side

- Starts at 60psi Regulator
- Can be 60psi or lower
  - Too low a pressure can cause solenoids to not actuate

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# Solenoids

- Solenoid rules:
  - Max 1/8" NPT Port Dia
  - Max CV of .32
  - Min working pressure 125psi\*
- Can either be 12V or 24V

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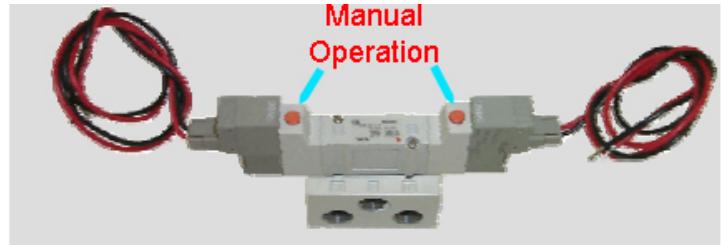


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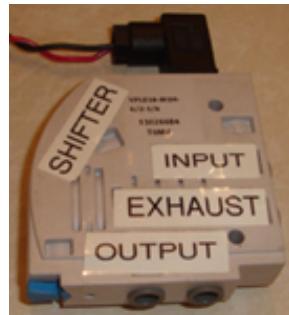
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Festo Valve  
2011 KOP  
24V



SMC Valve  
Previous KOP  
12V



Festo Valve  
Previous KOP  
12V

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## Controlling Solenoids

- Solenoids are wired to Crio Solenoid Breakout Board
- Board is wired for 12V or 24V

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## Things to Consider when choosing a solenoid

- Voltage: 24V vs 12V?
- Single vs Double?
- Use a manifold?
- Does it stay within FIRST rules?

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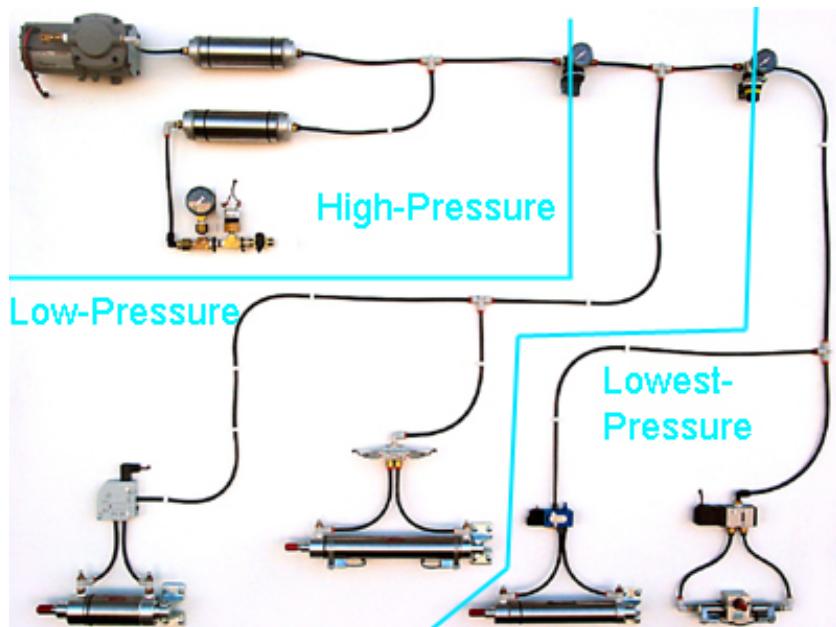


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## Cylinders

- Bimba gives teams 3 free cylinders!
- Things to consider when selecting a cylinder
  - Force required
  - Distance device needs to be moved
  - Space available

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# How to calculate the force of a cylinder

- Take your working pressure, WP, in psi
- Bore of cylinder, B, in in<sup>2</sup>
- For extension Force = WP\*B
  - So with 60psi WP and 3/4in Bore cylinder
    - Force =  $60 * (\pi * (.75/2)^2) = 26.5\text{lbf}$
- For retraction you need to subtract area of the shaft
  - So for the same setup

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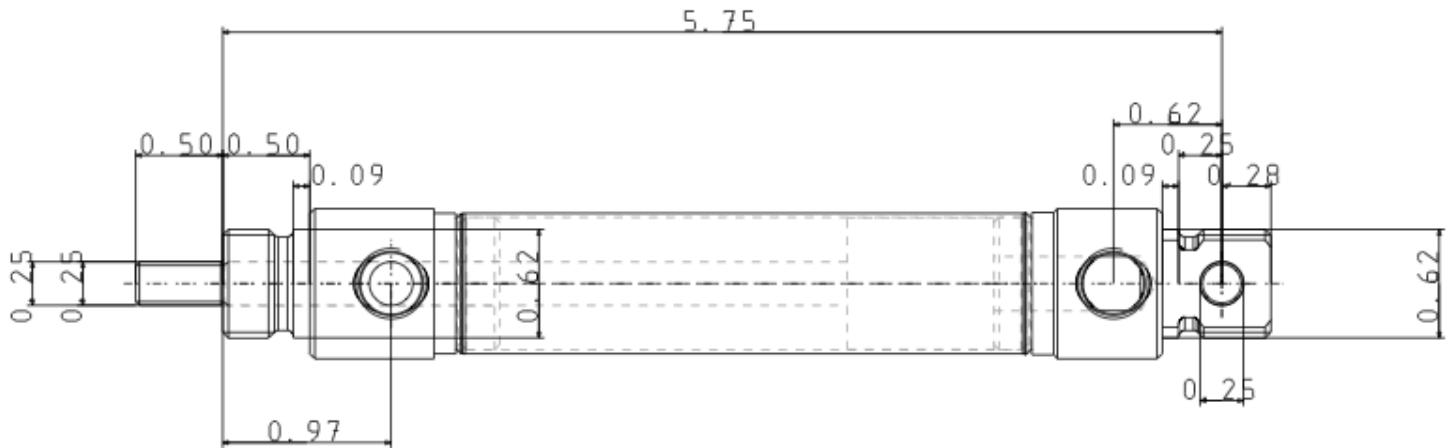
## Cylinder Length

- Stroke, the distance the cylinder's shaft will extend from its starting point
  - You specify the stroke when selecting a cylinder
- A cylinder is larger and longer than its bore and stroke length
  - Always refer to the cylinder's datasheet for dimensions



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Cylinder specs: 2in stroke,  $\frac{3}{4}$ " bore, double acting, with rear pivot. Part # 042-DP

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## Other Pneumatic Accessories

- Rotary cylinder
- Flow control fittings
- Vibration Isolators
- Vacuum (Venturi Device)



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# How to effectively use Pneumatics

- #1, Ensure a pneumatic cylinder is best suited for the application
  - Remember cylinders are “digital”
    - They have an extended and closed position, nothing in between
  - Consider where else you will be using pneumatics

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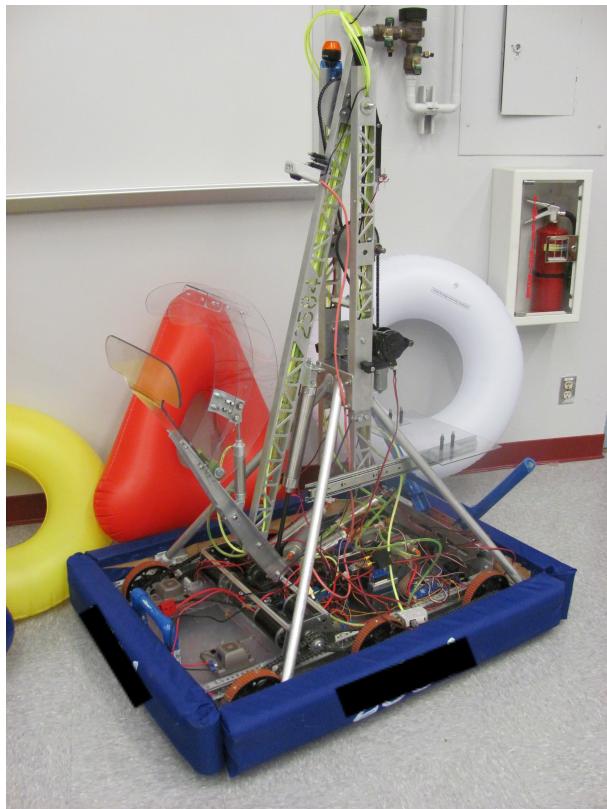


- #2, Carefully plan the layout
- Know where you will mount your compressor
- Know where your storage tanks will reside
- Know where your solenoids will go
  - Try to use a manifold if possible
- Plumbing a pneumatics system is like wiring
  - Do it slowly and carefully, more time spent setting it up will likely mean less time troubleshooting

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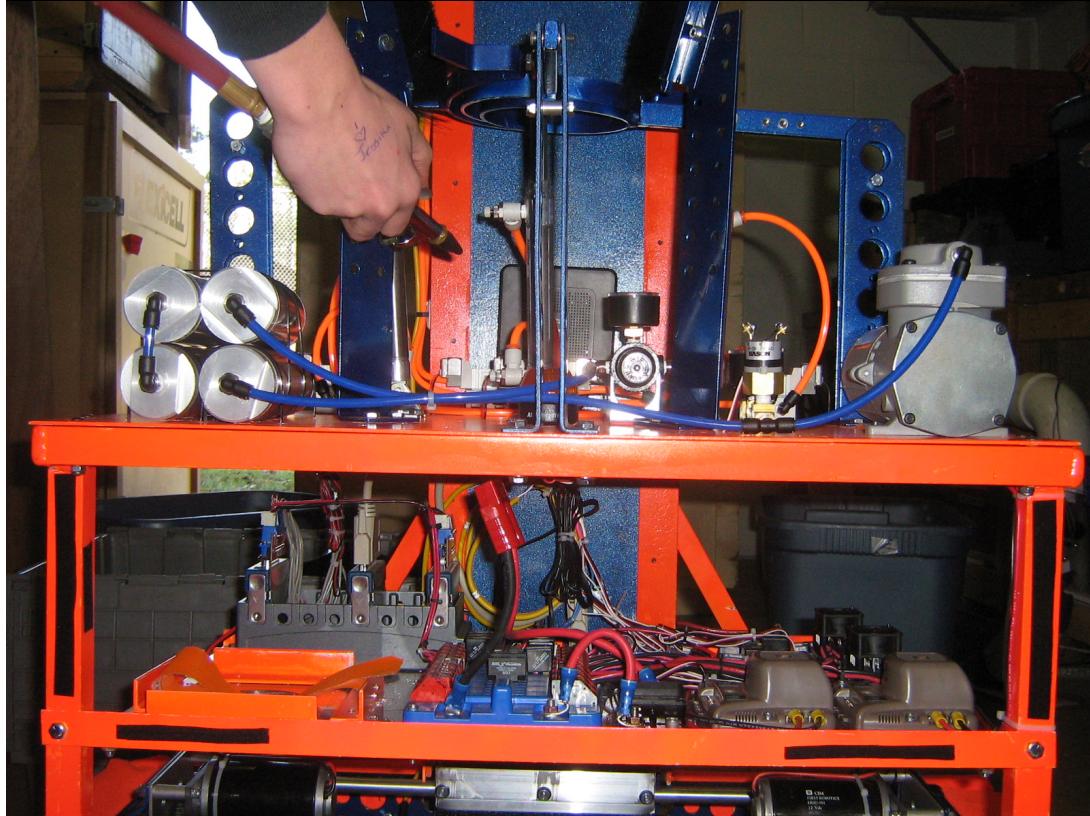
## “Bad” Setup

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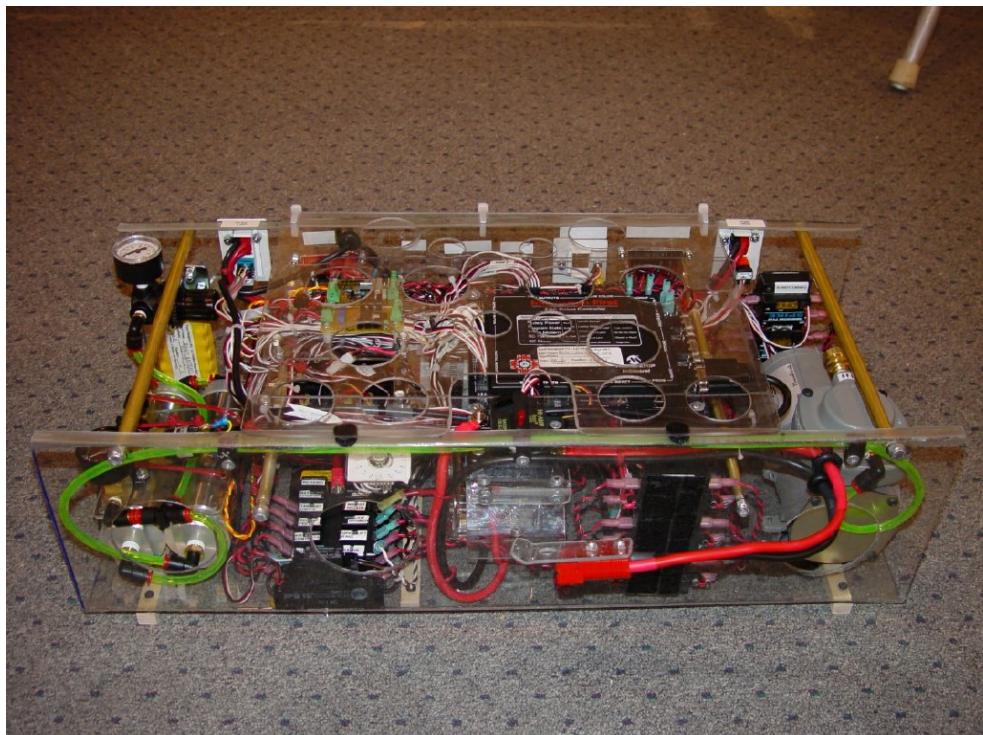
“Good”  
Setup

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“Ok”  
Setup

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## At The Competition

- Inspection
  - Let the inspector do their job
  - Point out components when asked
- Charge your tanks BEFORE a match
- Keep an eye out for leaks

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## Hints and Tips

- Little things that will make your life easier
  - Always cut your tubing so it has “square” ends
  - Use and Properly apply Teflon tape
    - Start wrapping above the first thread and wrap with the threads
  - Use different color tubing for each end of a cylinder
  - Use a manifold
  - Use less brass

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## Things to Consider when deciding whether to use pneumatics

- Weight and Space required
- Force and springiness
- Demand on Battery
- Speed

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# Thanks for listening

Any Questions?

Useful websites:

Bimba.com (Cylinders)

automationdirect.com (Pneumatic Fittings)

freelin-wade.com (Tubing)

Smcusa.com (Solenoids)

Nutrons.com (Presentations)

nationwidebeginning58.org Good overview of pneumatics  
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