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Pneumatic System Design Considerations

Pneumatic systems as a whole can be simple, but this simplicity can be deceptive when it comes to selecting components. For instance, there are thousands of types, sizes, and variations of cylinders and valves, from off-the-shelf versions to custom designs. The sheer number of choices can be overwhelming, especially when options such as sensors are added to the mix. So how do you know what is right for your application? Since every application is different, that's a hard one to answer. But the following section discusses a few considerations that can be helpful when selecting the right components for your pneumatic system. And taking the time to choose the right components for the job will ensure good performance, lower expenses, improve cycle rates, and prolong equipment life.

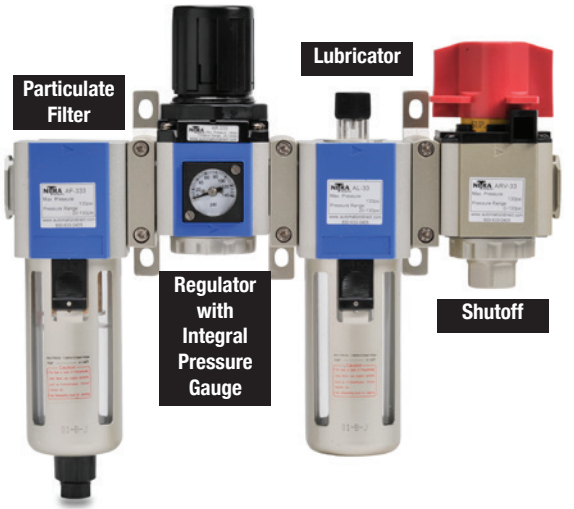
Compressed Air Supply

Adequate sizing of compressors and feed lines is the first place to start to ensure proper system operation. Consistent plant air pressure with suitable flow allows pneumatic devices to operate as designed, as low or varying air pressure can negatively impact the final product and overall machine sequence. For example, a manufacturing plant was experiencing low air pressure in its facility at the end of the day shift, causing one of the machines to fault due to low air pressure in its pneumatic actuation system. The problem was found to be high-volume air consumers nearby, namely blow guns being used to clean machines at the end of each day. Insufficient capacity at the air compressor, or undersized plant air supply tubing and piping is a common issue and one to look out for. If air consumption is a major concern for your factory, check out our Interactive Air Consumption Calculator at http://go2adc.com/airco.

Air Flow Control

Once consistent and correct pneumatic system air pressure and flow is established, plant supply air should be connected to a manual, lockable air dump valve at each use point. This lockout, tag-out capability is important for isolating a machine—or a module of a large machine—for changeover, maintenance or tooling changes. A filter regulator should also be installed at the air dump valve. The filter removes dust particles and water that can cause wear and operation problems for pneumatic system components. A regulator is required to throttle to the design air pressure at the use point, typically 60 to 90 psi, as the plant air supply is usually higher, about 100 to 130 psi. Operating at the design pressure as opposed to plant pressure will reduce wear on pneumatic components.

An electric soft start valve downstream of the regulator allows air pressure to gradually increase at start-up, preventing sudden banging or slamming of cylinders at power up. This is especially important if 4-way, 2-position valves are used because a 2-position valve spool maintains its position after power off and the removal of air. When power and air is reapplied, air will return to the cylinder. If all of the air was exhausted, then no air would be available on the other side of the cylinder. This makes speed control with flow controls non-functional. The uncontrolled speed of the cylinder could cause a high-speed stroke, commonly ending with a bang. When soft start valves are correctly applied, a machine will typically return to its home position slowly and smoothly at power up.



Lubricators should be used sparingly and only when necessary. Most modern pneumatic components come lubricated from the factory and do not need oil. However, pneumatic motors on air tools and other equipment do require a lubricator and one should be supplied in these instances.

Cylinder Types

Pneumatic cylinders are a popular way to clamp, position, and transfer parts in automated equipment and although there are many types of cylinders, their construction is fairly similar from one to another. Take a moment and review the Pneumatic Cylinders article (at http://go2adc.com/airbasics) to get a basic understanding of what cylinders are and how they operate. Understanding the basics helps to know how different applications affect the cylinder and piston rod.

The first step in choosing a cylinder is deciding whether to use the single- or double-acting version. Single-acting cylinders use compressed air to move the load in one direction and double-acting cylinders use compressed air for movement in both directions. With single-acting cylinders, air is supplied to only one side of the piston and a spring (or, in some cases, gravity) returns the piston to its original position once air pressure is removed. And while double-acting cylinders use more air (both for the extend and retract), they are well suited for loads that require both pushing and pulling.
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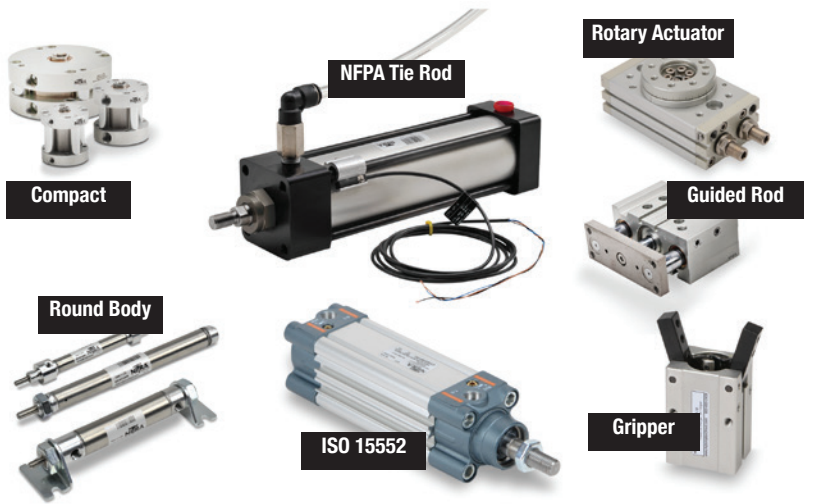


In both cases, force calculations can get complicated. In single-acting cylinders with a spring, the spring force opposing the push or pull increases as the stroke progresses. And in double-acting cylinders, push and pull forces are not equal, as rod area must be accounted for in force calculations. Often, manufacturers' catalogs will list extend and retract force values for both double-acting and single-acting cylinders, with and without springs, in order to simplify these calculations and help with selecting the proper cylinder type.

Cylinder Sizing

Interactive Cylinder Bore Calculator:

Minimum Bore Required (inches) = 3.78 = $\sqrt{\frac{4 \times 900}{\pi \times 80\ \text{PSI}}}$

◀ Enter Force Required (lbs)

◀ Select System Pressure

Next largest NITRA cylinder available: 4 inch
Next largest NITRA metric cylinder : 4 inch

Our Interactive Cylinder Bore Calculator at http://go2adc.com/borecalc can make cylinder sizing easier. The load is the primary consideration when determining cylinder type and piston size. The piston area (force factor) multiplied by the air pressure in the cylinder gives the available force. A general rule is to select a force factor that will produce a force 25% greater than the load to help compensate for friction and losses. Pneumatic systems are quite forgiving in terms of oversizing, but using components that are too big adds unnecessary expenses in terms of both purchase price and energy consumption.
The bore size (force factor) determines force at a given pressure. The operating pressure, which in a plant can typically range from 10 to 150 psi, is the first consideration when selecting a bore size. The next step in choosing the bore size is the amount of force that the application requires. Suppliers often provide charts to assist with calculating bore size.

If the bore diameter is between sizes, fluid-power experts recommend rounding up to the next size. It's also important to remember the bore diameter squares the thrust delivered.

(Cylinder sizing cont.)

For example, a two-inch diameter cylinder has four times the power of a one-inch diameter unit. Therefore, doubling the bore quadruples the thrust.

In addition to load, designers must also take into account the speed at which the load will move. When compressed air flows through a system, there are pressure losses due to friction against the tube wall, flow around bends, and restrictions in valves and fittings (to name a few issues). Higher speeds result in greater pressure loss as the air must flow faster through the valves, tubing and ports. Attaining higher speeds also requires that the cylinder deliver more force in a shorter amount of time. A force that exceeds the load by 50% or more may be required to reliably move a load at high speeds. For example, a typical air compressor might supply air to a system at 100 psi. In an application with a slow-moving load, the actual pressure available at the piston might be reduced to no less than 90 psi. With that same load moving at a much faster rate, the available pressure could drop as low as 70 psi.

Pressure losses can be remedied by increasing pressure, but this must be done with caution: Too much pressure creates stress on the cylinder and could possibly damage the cylinder, as well as the load. In these instances, it's better to go with a larger cylinder. Also keep in mind that raising system pressure means the compressor must work harder, increasing energy consumption of the overall pneumatic system.

Cylinder Accessories

Flow Control Valves

Even when a cylinder is sized properly, it may stroke too fast and require use of a flow control, typically by controlling flow of air leaving the cylinder. This also reduces noise problems caused by cylinders banging and reduces rapid exhaust racket. These flow controls are typically mounted directly to the cylinder, but can also be mounted inline near the cylinder, or at the valve if the tubing length between the valve and cylinder is less than about 3 feet. Specifying cylinders with built-in cushions can help provide long-term performance in high-speed pneumatic motion applications. The cushions allow a cylinder to stroke at high speed and only slow down near the end of stroke for a quiet, low-impact stop. Adjustable pneumatic cushions are often the best solution, comprised of specially designed end caps with built-in flow controls. Mufflers can also be used to quiet cylinder or valve exhaust noise, and they are often a simple and low -cost solution.

Cylinder position switches are extremely helpful in sequencing operations and prevent starting the stroke of one cylinder before the previous cylinder's stroke is complete. Using timers to control a sequence instead of position sensors should be avoided in this and most cases. One stuck or slow cylinder during an automated sequence can cause a machine crash, costing much more than the cost of buying, installing and programming end-of-stroke sensors.

Control Valves

Once the cylinders are selected, you should now have a good idea of the flow rate and pressure of compressed air needed. With this information, you can select control valves. Items to consider in valve selection are size (flow capacity), type and actuation method.

Valves

Valve Type

Choosing the right type of valve for the job required is not as difficult as it may seem. For cylinder control, the simplest method is to use a 3-way valve for a single-acting cylinder and a 4-way valve for a double-acting cylinder. Systems can be much more complex if needed, but let's focus on a basic system for now. The form factor of the valve can vary a great deal and many people have a variety of preferences. It's usually best to make sure the valve has the needed performance characteristics before locking into a particular form factor.

Valve Sizing

Once the function of the valve has been determined, look at the required flow capacity. The usual first step is to use the air cylinder bore, stroke and cycle rate to determine a flow rate in standard cubic feet per minute (SCFM). Many valve suppliers will list a flow rate at a particular inlet pressure and pressure drop. Others will list this value as a factor Cv, which

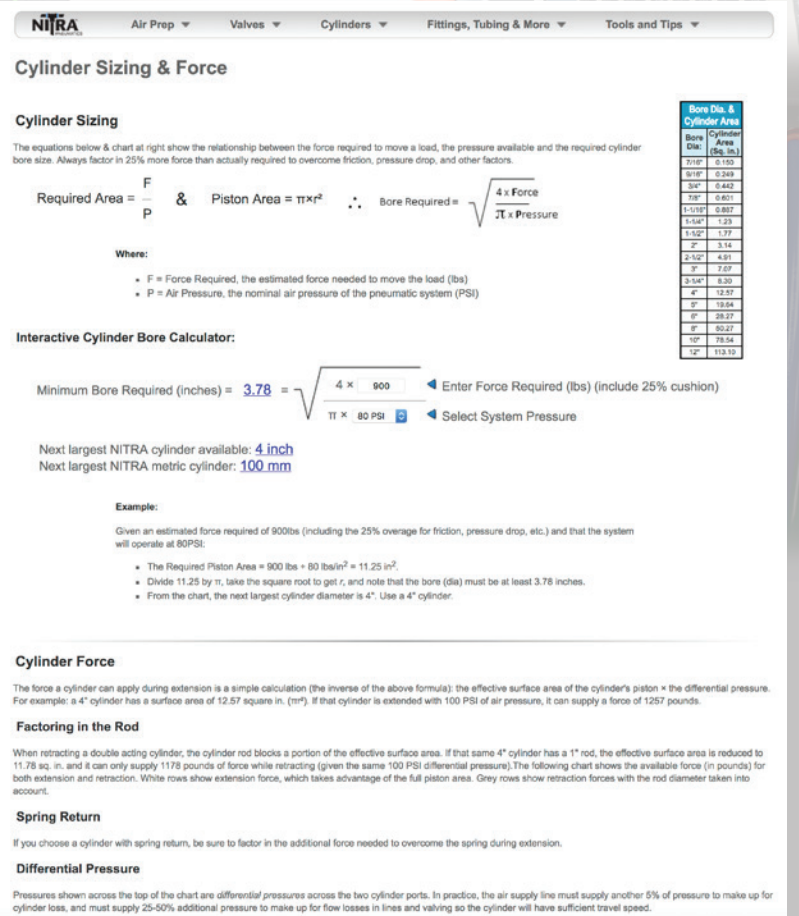
has no units. For a more thorough explanation, check out our Interactive Cv Calculator at http://go2adc.com/cvcalc. A simple thing to remember is that a larger Cv value will allow a higher flow rate of air through the valve. Key points to remember in valve sizing are that undersized valves may restrict flow and not allow a system to work properly. Oversized valves often cost more and will use more air. Keep in mind that air consumption is a major portion of the expense for a pneumatic system.

If air consumption is a major concern for your factory, check out our Interactive Air Consumption Calculator at http://go2adc.com/airco.

Valve Actuation

How will the valves be operated? Manual valves could be push button, lever or foot pedal activated. The more common method is to use electric solenoids to operate the valve. Solenoids are available in a variety of both AC and DC voltage ratings to fit just about any need. Match the solenoids up with your electrical control system. In less common situations, an air piloted valve may be required. When air pressure is applied to a pilot port, the valve switches. This is a good way to switch very large valves while using very little electrical power – use a small solenoid valve to send air to the pilot port of the large valve.

These are just a few of the many items to consider when designing a successful pneumatic system. Other factors, such as energy efficiency, can affect overall system design as well. But regardless of the design, watch out for the common issues and always be sure to supply, prep and distribute the air properly. When properly applied, your pneumatic devices and actuators will have a long life with limited operational issues along the way, and with minimal required maintenance.



NITRA Air Prep Valves Cylinders Fittings, Tubing & More Tools and Tips

Cylinder Sizing & Force

Cylinder Sizing

The equations below & chart at right show the relationship between the force required to move a load, the pressure available and the required cylinder bore size. Always factor in 25% more force than actually required to overcome friction, pressure drop, and other factors.

$$\text{Required Area} = \frac{F}{P} \quad \& \quad \text{Piston Area} = \pi \times r^2 \quad \therefore \quad \text{Bore Required} = \sqrt{\frac{4 \times \text{Force}}{\pi \times \text{Pressure}}}$$

Where:

- F = Force Required, the estimated force needed to move the load (lbs)
- P = Air Pressure, the nominal air pressure of the pneumatic system (PSI)

Bore Dia. & Cylinder Area	
Bore Dia:	Cylinder Area (Sq. in.)
7/16"	0.150
9/16"	0.249
3/4"	0.442
7/8"	0.601
1-1/16"	0.887
1-1/4"	1.23
1-1/2"	1.77
2"	3.14
2-1/2"	4.91
3"	7.07
3-1/4"	8.30
4"	12.57
5"	19.64
6"	28.27
8"	50.27
10"	78.54
12"	113.10

Interactive Cylinder Bore Calculator:

Minimum Bore Required (inches) = 3.78 = $\sqrt{\frac{4 \times 900}{\pi \times 80\ \text{PSI}}}$ ◀ Enter Force Required (lbs) (include 25% cushion) ◀ Select System Pressure

Next largest NITRA cylinder available: 4 inch
Next largest NITRA metric cylinder: 100 mm

Example:

Given an estimated force required of 900lbs (including the 25% overage for friction, pressure drop, etc.) and that the system will operate at 80PSI:

- The Required Piston Area = 900 lbs ÷ 80 lbs/in^2 = 11.25 in^2.
- Divide 11.25 by π, take the square root to get *r*, and note that the bore (dia) must be at least 3.78 inches.
- From the chart, the next largest cylinder diameter is 4". Use a 4" cylinder.

Cylinder Force

The force a cylinder can apply during extension is a simple calculation (the inverse of the above formula): the effective surface area of the cylinder's piston × the differential pressure. For example: a 4" cylinder has a surface area of 12.57 square in. (πr^2). If that cylinder is extended with 100 PSI of air pressure, it can supply a force of 1257 pounds.

Factoring in the Rod

When retracting a double acting cylinder, the cylinder rod blocks a portion of the effective surface area. If that same 4" cylinder has a 1" rod, the effective surface area is reduced to 11.78 sq. in. and it can only supply 1178 pounds of force while retracting (given the same 100 PSI differential pressure). The following chart shows the available force (in pounds) for both extension and retraction. White rows show extension force, which takes advantage of the full piston area. Grey rows show retraction forces with the rod diameter taken into account.

Spring Return

If you choose a cylinder with spring return, be sure to factor in the additional force needed to overcome the spring during extension.

Differential Pressure

Pressures shown across the top of the chart are *differential pressures* across the two cylinder ports. In practice, the air supply line must supply another 5% of pressure to make up for cylinder loss, and must supply 25-50% additional pressure to make up for flow losses in lines and valving so the cylinder will have sufficient travel speed.

Energy Efficient Pneumatic Systems

Reducing energy consumption is a priority in almost every industrial facility. Because pneumatic systems are abundant throughout manufacturing and account for a large share of a plant's power costs, it is extremely important that they run efficiently.

Some people have the mindset that pneumatic systems are inherntly inefficient, therefore overlooking opportunities for energy savings. There are ways to improve the efficiency of pneumatic systems using tactics that range from better engineering decisions to maintenance of existing systems.

Minimize Leaks

Leaks are common and expensive in pneumatics systems. Statistics from the U. S. Department of Energy show the average manufacturing plant loses 30 to 35% of its compressed air due to leakage. The good news is many leaks can be prevented or repaired.

Of the many points between the compressor and the load where leaks occur, valves and seals are two main areas for improvement. Deteriorated seals should be the first area to examine and remedy.

Another consideration with leakage is proper valve selection. Selecting the best valve for the job can prevent unnecessary leakage and cost. It is important to look at total air leakage over the whole operation being performed in order to determine which type of valve will optimize the energy usage.

Compressor Enhancements

After fixing leaks, compressors are the next biggest area for improvement. U.S. Dept. of Energy reported that manufacturers spend over $5 billion each year on energy for compressed air systems. Detailing the methods for increasing compressor efficiency is beyond the scope of this document. However, the Dept. of Energy offers guidelines for determining the cost of compressed air in a plant, as well as tips on how to reduce compressor energy usage.

Optimizing Pressure

As compressed air flows through typical circuits, air pressure drops due to changes in demand, and line and valve-flow resistance. Many of these losses are simply because the distance between the compressor or supply point and the actuator is longer than necessary. Designs that use the shortest tubing possible can reduce energy consumption as well as cycle times.

Another way to eliminate unnecessary consumption is ensuring actuators use only the pressure needed to perform a task. Sometimes, operators on the plant floor increase supply pressure in the belief that it improves performance. However, all this does is waste energy and money. Regulators that control pressure to individual pneumatic cylinders will increase energy efficiency, in many instances generating savings of up to 40%.

Regulate the Return Stroke

Another way to conserve energy is by supplying the correct pressure for an actuator's return stroke. Most applications only move a load in one direction. However, many machines use the same pressure for both the working and return strokes. For example, a material-handling system that pushes boxes from one conveyor to another needs high cylinder force only in one direction. The working stroke may demand 100 psi to move a box, but the low-force return stroke only

requires 10 psi. Using the same pressure in both directions wastes energy. By reducing pressure for the extract stroke to only what is needed, the machine is not subjected to unnecessary vibrations and shock while saving energy.

Another option for improving efficiency in processes with shorter strokes is to use a spring return actuator. For the return stroke, the spring—or sometimes merely the weight of the mechanism—takes the cylinder back to the starting position.

A typical case where single-acting, spring-return cylinders can reduce energy demand involves presses. In this type of application, a cylinder pushes two items together, such as a bearing into a housing or a plug into a hole. The job demands a significant amount of force to press the parts together but only a small amount to retract. This makes it a good candidate for energy savings by using a single-acting cylinder.

Proper Sizing

It's important to take the time upfront to correctly size the pneumatic system's components. Smaller control valves will require the air compressor to work harder simply to get the proper pressure to the actuators, creating a long-term demand for more energy.

Another common problem comes from oversizing the cylinders more than necessary. Some oversizing is necessary to compensate for pressure fluctuations and air losses; however, components that are far too large account for one of the biggest energy losses in a pneumatics system.

To assist with the many calculations and considerations that go into properly sizing components—such as if the load is rolled or lifted—there are software packages, online calculators, and even an iPhone app that can assist with component sizing. By spending a little more time understanding the system's true requirements, the savings can be substantial.

Hit the 'OFF' Switch

Shutting down a machine when it's not working seems like an obvious way to save energy. While some elements of a system, such as air bearings, can require pressure even when the machine is off, the required compressed airflow is usually much less than that needed during normal operations. These facilities can benefit from an automatic air reduction control package to lower the air pressure to the necessary levels when the machine isn't working.

Save Energy, Save Money

In the past, businesses were mainly concerned only with their pneumatic systems performing their job correctly. The good news is that with some time dedicated to determining the actual requirements of the pneumatic system and selecting the right components, plants can expect improvements in both energy efficiency and productivity.

Hydraulic Systems Provide Reliable High Power Motion

Compared to pneumatics, hydraulic systems use incompressible fluid (typically oil) at much higher pressure to produce movement. The higher system pressure allows actuators to produce much higher forces or torques, and the incompressible fluid allows for very precise positioning in actuators. Hydraulic systems also operate in a much smoother way with steadiness throughout the motion, whereas a pneumatic system can be described as somewhat quick and jerky.

Hydraulic actuators and motors can also be utilized in dangerous environments where an electric motor-driven device would be unsafe due to potential sparks.

While hydraulic systems can be complex, it is possible to build a durable, powerful system for many industrial applications with a few basic components. The main components are a fluid reservoir, pump, filters, control valves, actuators, pipes or hoses, and fittings.

Since the primary medium of a hydraulic system is hydraulic fluid, there needs to be a place to store it. A fluid reservoir is a tank that holds the fluid, protects it from contaminants, removes air, and helps cool the fluid.

Pumps generate the flow of hydraulic fluid so that it can be useful in producing energy. Normally, the pumps are controlled by an electric motor. However, combustion engines are sometimes used to operate hydraulic pumps on vehicles or other mobile systems.

Filters remove contaminants from hydraulic fluid to prevent seal breakdown and heat buildup from unnecessary friction. This sounds simple, but hydraulic system filtration is very important, and without proper filtration, the system will fail prematurely due to fluid contamination, causing wear and heat buildup in the system. A proper hydraulic filtration system is required for smooth operation and a reliable system.

Valves control the flow of fluid throughout the system and direct the fluid to where it is supposed to go. Control valves are available in manual, piloted, and solenoid-operated styles.

The final vital components of these systems are hydraulic actuators, which translate the flow of fluid into mechanical motion or torque. Most of the time, when we think of hydraulic actuators, we are thinking about hydraulic cylinders, which are linear actuators. Hydraulic motors are another type of actuator that converts the flow of hydraulic fluid into rotational motion.

What types of applications use hydraulic power?

For applications that require more than just simple movement of light or medium-weight objects, where pneumatics can be used; hydraulics are often chosen for industrial or commercial applications such as:

- Elevators or lifts
- Hoppers
- Rams
- Industrial presses
- Industrial clamps
- Large industrial shears
- Automatic transmissions
- Hydraulic log splitters

Power Your Hydraulic System

Power Units

Hydraulic power units are the lifeblood of a hydraulic system. All-in-one units generate the pressure and flow of hydraulic fluid throughout the system. Power units include a reservoir, pump, filter, and many other combined accessories integrated into one unit.

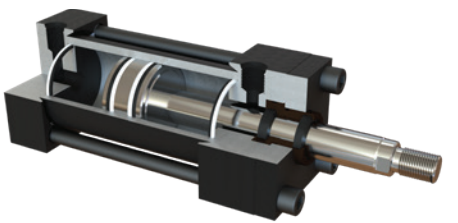
Hydraulic Power Unit Heat Exchangers

Heat exchangers for hydraulic power units improve the longevity of the unit and the overall system by reducing heat buildup during higher duty cycles. This lowers the fluid temperature, allowing the fluid and all hydraulic components to last longer.

Hydraulic Solenoid Valves

Hydraulic solenoid valves are control devices that alter fluid flow throughout the system and direct the fluid to where it is needed to control actuators.

Hydraulic Cylinders

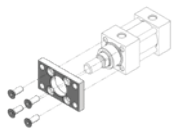


Hydraulic cylinders are the driving force behind hydraulic power when linear motion is desired. Double-acting cylinders have two ports - one in the head and one in the end cap. Directing pressurized fluid to the end cap will cause the rod to extend. Directing pressurized fluid to the head will cause the rod to retract.

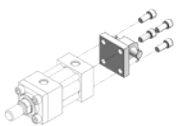
Cylinder Mounting Options

There are many options when it comes to mounting methods. Many of these are field-installable.

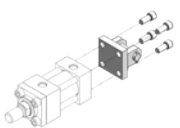
Flange Mount



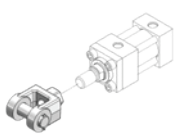
Pivot Eye Mount



Clevis Mount



Rod Clevis Mount



Cylinder Forces

- Cylinder force is calculated by multiplying the fluid pressure times the net piston area. Use the tables below to estimate the cylinder force.
- To increase the operating life of cylinders and other components, use the lowest system pressure (with an adequate safety margin) that will provide the needed force for your application.
- Any side load on the piston rod will reduce service life. Make every effort in machine design to minimize side loads.

PUSH - Extend Stroke - Cylinder Forces in Pounds								
Cylinder Bore Size (in)	Hydraulic Working Line Pressure (PSI)							
	500	750	1000	1250	1500	2000	2500	3000
1-1/2	884	1325	1767	2209	2651	3534	4418	5301
2	1571	2356	3142	3927	4712	6283	7854	9425
2-1/2	2454	3682	4909	6136	7363	9818	12272	14726

PULL - Retract Stroke - Cylinder Forces in Pounds									
Cylinder Bore Size (in)	Cylinder Rod Diameter (in)	Hydraulic Working Line Pressure (PSI)							
		500	750	1000	1250	1500	2000	2500	3000
1-1/2	5/8	730	1095	1460	1825	2191	2921	3651	4381
	1	491	736	982	1227	1473	1964	2454	2945
2	1	1178	1767	2356	2945	3534	4712	5891	7069
	1-3/8	828	1243	1657	2071	2485	3313	4142	4970
2-1/2	1	2062	3093	4123	5154	6185	8247	10308	12370
	1-3/8	1712	2568	3424	4280	5136	6848	8560	10272

General-Purpose Valves

A valve, simply put, is a device that controls the passage or flow of fluid through a structure such as a pipe or duct. Fluid can mean many things, including compressed air, inert gases, oil, and water. Valves can be seen in many installations throughout the process industry, controlling the direction and/or flow of fluids. Valves can be on or off, allowing or halting the flow, or may control the fluid volume through a pipe. Types of valves include solenoid process valves, directional control solenoid valves, air pilot valves, and manual air valves.

Solenoid process valves use an electrical actuator to move the valve from one position to another. They allow or halt flow through a pipe essential to the process. Solenoid process valves are available in individual stacking or manifold styles and as media-separated process valves.

Modular valves are a type of process valve that can be stacked together to create an assembly of many valves in a bank.

Directional control solenoid valves are used to direct flow in a fluid-powered mechanical system. They control actuators, e.g., cylinders and other devices, and are available in various body styles and operating characteristics.

Air pilot valves are used where air pressure control is preferred over electrical control. These valves are ideal in applications where flammable materials exist (no risk of electrical sparks), where more torque is required, and where reliable operation in high temperature environments is needed. Manual air valves are ideal for non-electrical operator-controlled applications. They are available in many convenient sizes and types, including foot pedal valves, toggle and rotary style hand levers, push/pull valves, pushbutton, selector switches, key switches, and even limit switch actuators.

Installed process valve

Modular Process Valve Assembly

Manifold Mounted Process Valve Bank

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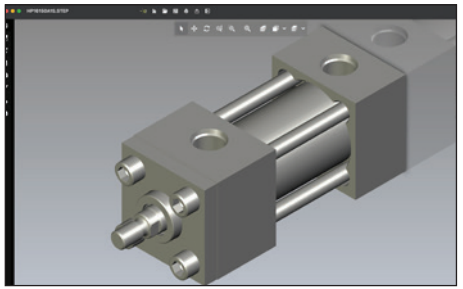

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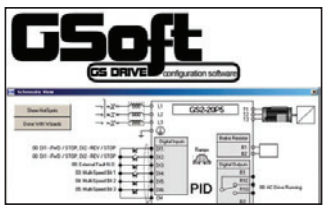

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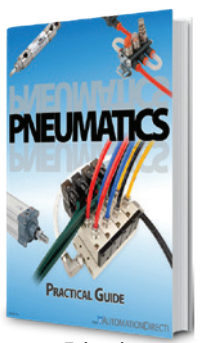

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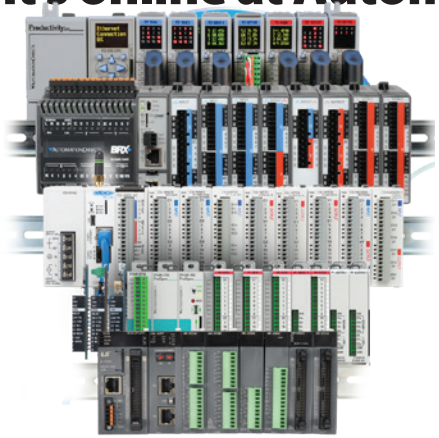
If it's in your cabinet . . .
. . . it's online at AutomationDirect.com



- LS Electric PLCs
- Productivity1000 micro-modular PLCs
- Productivity2000 micro-modular PLCs
- Productivity3000 modular PLCs
- Productivity®Open Arduino-compatible industrial controller
- ProductivityCODESYS
- Do-more® BRX, H2 and T1H series PLCs
- CLICK® and CLICK PLUS micro brick PLCs
- I/O expansion modules available include discrete, analog, temperature and high-speed (depending on model)
- DirectLOGIC® components still available for maintaining legacy systems

Programmable Controllers

- C-more® operator interface HMI touch panels in various sizes up to 22 inches with wide screen options available
- C-more headless HMI - same functionality as C-more touch panels without display size restrictions
- Low-cost C-more Micro text and touch panels - 3- and 4-inch models
- C-more and C-more Micro HMI design software free to download
- ViewMarq® LED message displays
- ATLAS® industrial monitors

HMI/Operator Interface

- IO-Link master modules, hubs, and a variety of IO-Link enabled devices
- Distributed I/O with Modbus TCP, EtherNet/IP, Modbus RTU, DeviceNET communication options
- Various combinations of discrete (AC, DC, relay, high-speed) and analog inputs and outputs available

Universal Field I/O

- Industrial managed and unmanaged Ethernet switches
- StrideLinx VPN routers and cloud services for secure remote access
- Pocket Portal IIoT remote I/O
- MQTT gateways
- Modbus gateways
- Network adapters/ converters
- PoE injectors
- Copper and fiber optic Ethernet cables

Communications

AC and DC Drives

- DURAPULSE® variable frequency AC drives up to 300hp, featuring GS10, GS20, GS20X, GS30, and GS4 series
- Toshiba AS3 AC VFDs up to 300 hp
- IronHorse variable frequency drives up to 30hp featuring ACN and ACG series
- WEG CFW100, CFW320 and CFW500 AC drives up to 150hp, depending on series
- WEG CFW500 drives up to 20hp, IronHorse® AC drives up to 30hp and DURAPulse GS20X drives up to 10hp available in a NEMA 4X enclosure
- IronHorse DC drives up to 30 hp
- Drive accessories
- Soft starters up to 480A

Motors and Motor Controls

- IronHorse general purpose AC motors up to 300hp
- Stainless steel and white epoxy washdown AC motors
- Stainless steel AC motors
- IronHorse Farm Duty up to 10hp
- IronHorse three-phase ODP motors up to 50hp
- U.S. Motors inverter duty AC motors up to 10hp
- Marathon inverter duty AC motors up to 100hp
- Marathon permanent magnet AC motors up to 10hp
- Marathon single-phase AC motors up to 5hp
- DC motors up to 2hp
- Motor controls and contactors up to 300hp
- WEG general purpose AC motors and AC brake motors up to 20 hp
- Toshiba Severe Duty AC Motors up to 100hp
- MGM IEC and IEC brake motors up to 5 hp

GO! TOP RATED ★★★★★ BY CUSTOMERS **What our current customers think: www.automationdirect.com/reviews**

Software

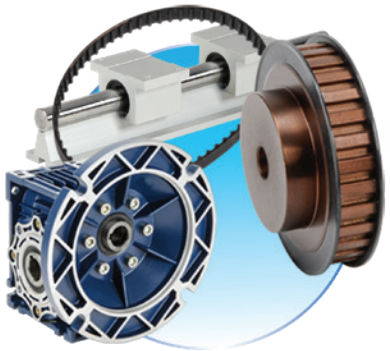
- Free PLC programming software (download)
- Configuration software packages for a variety of process instruments
- Free motion control systems' configuration software (download)
- Free HMI programming software (download)
- Free AC drive configuration and programming (built-in PLC) software (download)

Process

- Temperature and process controllers
- Digital and process panel meters
- Temperature sensors and transmitters
- Infrared pyrometers
- Pressure sensors and gauges
- Level sensors and controllers
- Flow sensors and transmitters
- Signal conditioners
- Pipeline valves
- Solenoid /media separated process pipeline valves
- Current to pneumatic (I/P) transducers
- Vibration switches and transmitters
- Trumeter graphical panel meters
- Cloud data logger with I/O
- Hour meters and counters

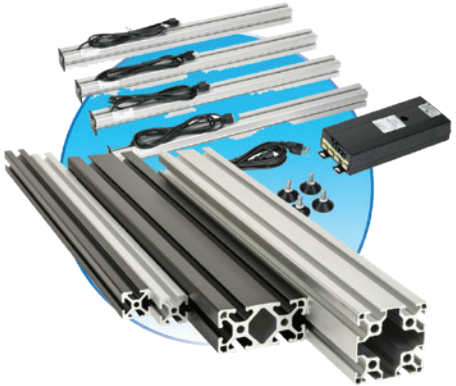
Safety

- ReeR MOSAIC safety controllers
- IDEM® and Dold® safety relays
- Speed/Standstill safety relay modules
- WEG safety contactors
- Safety laser scanners
- Magnetic safety switches
- Magnetic coded safety switches
- RFID coded safety switches
- Light curtains from Contrinex, ReeR and Datalogic
- Two-Hand controls
- Trapped key interlocks
- Safety enabling switches
- Safety mats and edges
- Safety bumpers
- Programmable and configurable safety relays
- Intrinsically safe isolators
- Hazardous location devices
- Safety enabling switches
- IDEM Z-Range safety devices
- IDEM Universal Gate Boxes



Power Transmission

- Worm gearboxes
- Stainless steel worm gearboxes
- Helical gearboxes
- Precision gearboxes
- Timing belts and pulleys
- Couplings and bushings
- Shafting and shaft supports
- igus polymer bearings
- GAM rack and pinions
- Linear bearings and rail



Structural Frames/Rails

SureFrame cut-to-length aluminum T-slotted rails make constructing a frame or machine easy and quick.

NO CUT CHARGES

- Complete assortment of hardware and accessories to complete your slotted rail project
- You specify length and cut angles for each piece
- No cut fees
- Select sizes and weights available in UV-resistant black anodized
- Ergoswiss lifting columns
- Free 2-day delivery on all orders over $49

Relays & Timers

- Electro-mechanical relays
- Intrinsically safe relays
- Phase monitoring relays
- Alternating relays
- Optocoupler relays
- Pump seal failure relays
- Voltage monitoring relays
- Slim interface relays
- Power relays
- Solid state relays
- Hazardous location relays
- Timer relays
- Multi-Function Digital Counter / Timer / Tachometers
- Force-guided relays

Tools

- Southwire multimeters and testers
- Southwire, Wiha, and Wera nutdrivers
- Sensor tester
- Wera, Wiha, and MEGAPRO screwdrivering tools
- Wera wrenches, ratchets and sockets
- Southwire, Wiha, JOKARI, and AutomationDirect pliers and stripping tools
- SapiSelco cable ties
- RUKO hole cutting tools
- RUKO grinders and burrs
- Crimping tools from AutomationDirect, Southwire, Wiha, and Z+F
- Tool cases and bags
- Master Appliance heat guns
- Wall Lenk soldering irons and guns

Circuit Protection

- Eaton and Gladiator UL 489 miniature circuit breakers
- AutomationDirect, Gladiator, and Fuji UL 489 molded case circuit breakers
- Eaton and Gladiator UL1077 supplementary protectors
- Edison fuses, fuse holders and fuse blocks
- Socomec, Gladiator® and Bryant® disconnect switches
- Bryant UL 508 manual motor controllers
- Socomec manual transfer switches
- E-T-A, Gladiator, and WAGO electronic circuit protectors
- Merz rotary cam switches

Identification

- Code brand scanners, including 1D, 2D and DPM images; scanners can read all common barcodes.
- Datalogic rugged handheld barcode scanners
- Contrinex RFID devices use radio frequencies to read and transmit data without the need for line of sight.
- AutomationDirect Standalone RFID R/W units provide fast and long range communication with RFID tags
- Datalogic smart vision sensors make a decision based on a captured image, very useful for applications requiring presence and/or orientation object detection.
- ifm machine mount barcode scanners and cameras
- Swivellink mounting systems
- Wenglor vision lighting

Motion Control

- ProductivityMotion controller
- LS Electric® XGB Motion-Centric PLC with EtherCAT®
- SureServo®2 drives and motors, up to 15kW
- LS Electric® servo drives and motors up to 7.5kW (including EtherCAT® models)
- Stepper and servo gearboxes
- SureStep® stepper drives and NEMA motors
- Stepper motor linear actuators
- Leadshine® stepper drives
- Encoders
- CUI Devices® kit encoders
- XYZ gantry components, including linear slides and actuators

TOP RATED
BY CUSTOMERS

FREE Technical Support
Located in USA

Sensors

- Proximity sensors
- Photoelectric sensors
- Limit switches
- Precision limit switches
- Inclination sensors
- Laser sensors
- Color and contrast sensors
- Light grids
- Encoders
- Current and voltage sensors
- Position indicators
- Ground fault sensors
- Pressure sensors and gauges
- Temperature sensors, switches, transmitters, and thermometers
- Liquid level sensors
- Flow sensors
- Ultrasonic sensors
- Fork sensors
- Linear position sensors
- Vibration sensors

Pushbuttons, Switches and Lights

- KILLARK® hazardous location control stations
- IDEM emergency stops
- Fuji 16mm plastic pilot devices
- Fuji®, Schmersal, and Eaton metal/ plastic 22 and 30mm pilot devices
- IP69K-rated pilot devices from Schmersal
- Captron IP69K capacitive pilot devices
- Patlite, Pfannenberg, and WERMA audible and visual signal beacons
- WERMA and Patlite stacklights
- Molex pendant switches
- Foot switches
- Alarms, horns and buzzers

Valves

- General-purpose process valves
- Modular process valves
- Manifold process valves
- Stacking process valves
- NSF Cert water valves
- Potable water valves
- Pipeline/process valves
- Solenoid valves

Hydraulics

- Hydraulic power units
- NFPA style hydraulic cylinders with many mounting options
- Hydraulic solenoid valves

Pneumatics

- Tubing, hose and fittings in a wide variety of configurations
- Air cylinders and position switches
- Solenoid valves (including ISO 5599 valves)
- Rodless air cylinders
- Modular solenoid valves (Ethernet or hardwired)
- Air preparation and air relief valves
- Pushbutton valves
- Total Air Prep (TAP) all-in-one units
- Rotary actuators and grippers
- Pressure switches, transmitters, and transducers
- Pneumatic pushbuttons and limit switches
- Electro-pneumatic systems
- Vacuum products; suction cups, ejectors, spring plungers

Power Products

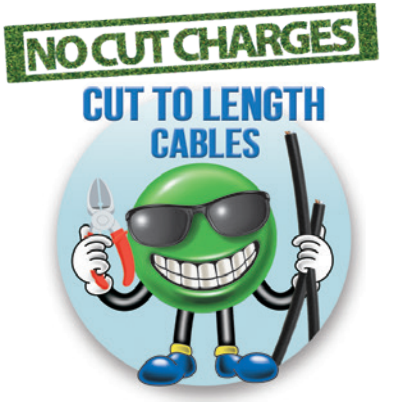
- Acme Electric®, Hammond and Murrelektronik transformers
- AchieVe, BLOCK, LUTZE, RHINO, and WAGO power supplies
- SureStep and International Power linear power supplies
- Roxburgh and Eaton line filters and surge protectors
- Roxburgh power outlets
- Hammond drive isolation transformers
- Edison®, and Penn Union power distribution blocks
- Bryant® electrical plugs, connectors and receptacles, and other wiring devices
- AcuAMP® AC current transformers
- Socomec multifunction power meters
- Trumeter graphical panel meters
- Surge protection devices

Water (Potable) Components

- Regulators
- Solenoid valves
- Hand valves
- Check valves
- Push-to-connect water fittings
- Tubing
- Hose
- Hose clamps

Wiring Solutions

- Konnect-It® and DINnectors® terminal block systems
- Bryant power wiring devices
- Wire duct and tubing
- Standard and sanitary cable entry systems for enclosures
- Wire end connectors, cable glands, sanitary cable glands, connectors and fittings
- ZIPport® connectors
- Murrelektronik and ZIPport multi-port distribution blocks
- Sensor cables
- General- and special-purpose cable ties
- Epson portable label printers
- Electrical tape



Cut to length cables

All of our cable is available cut to your specified lengths so you can eliminate waste and purchase only what you need - **plus it's cut for free and shipped FAST!!**

- Portable cords
- Power cables
- Tray-rated cables
- Low voltage control & signal cables
- 600V control cables
- Food and beverage (FDA approved) cables
- Motor and VFD supply cables
- Data & Communication cables
- Process & instrumentation cables
- Thermocouple and RTD extension wire/cable

Minimum lengths of 10ft unless otherwise indicated

SCE SAGINAW CONTROL & ENGINEERING
HAMMOND MANUFACTURING
WIEGMANN
INTEGRA ENCLOSURES
STAHLIN A ROBROY ENCLOSURES BRAND
ATTABOX A ROBROY ENCLOSURES BRAND
QUADRITALIA

Enclosures

- Over 6,300 NEMA rated enclosures from Saginaw, Hammond, Wiegmann, Integra, Quadritalia , Attabox and Stahlin
- Many types of metallic and non-metallic enclosures
- Modular enclosures
- Data communication racks
- Sanitary enclosures
- HMI enclosure suspension arm systems
- Heating, cooling and climate control
- Lighting
- Wide selection of enclosure accessories

Bulk Electrical Hook-up/Building Wire

AutomationDirect has a large selection of quality electrical wire that meets all NFPA and NEC requirements, sold in prespooled lengths at great prices.

- MTW machine tool wire
- TFFN fixture wire
- THHN general purpose building wire
- AWM appliance wire
- DLO power cable
- HAR Harmonized wire

- Honest up-front pricing (no gimmicks)
- Quick delivery - order today, it ships fast!
- Top technical support as rated consistently by our customers
- FREE shipping on orders over $49

AutomationDirect.com has been a leader in providing affordable, quality industrial control products to the U.S. and Canada for more than two and a half decades.

As a privately-held efficiently run company, we take pride in serving our customers the way they want to be served - honestly and fairly. We do everything we can to accomplish this day in and day out.

Fast Shipping of In-stock Products · FREE Shipping - Orders over $49 2-day shipping · FREE Technical Support Located in USA · TOP RATED BY CUSTOMERS · 45-day Money-Back Guarantee 45 day

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