

## Pneumatic Fittings

Pneumatic fittings are parts used to connect sections of pipe, tube, and hose in pneumatic (pressurized gas) systems. Compared to **hydraulic fittings**, pneumatic fittings are typically characterized by tighter seals and lower pressure requirements. They are frequently used in pneumatic logic control systems and instrumentation.

### Pneumatic Pipes, Tubes, and Hoses

It is important to distinguish what types of vessels are being connected in the system to determine what fittings are appropriate.

- **Hoses** are flexible vessels that are constructed of multiple layers of different materials. Fittings for hoses are often not permanent, since the hose itself is often replaced in time due to wear.
- **Pipes** are rigid vessels constructed of one solid material. Generally, pipes are defined by their inner diameter dimension.
- **Tubes** are fairly rigid vessels constructed of one solid material. Generally, tubes are defined by their outside diameter dimension.

## Types of Fittings

Pneumatic fittings are distinguished based on the connection type and function it performs.

### Connection Type

Pneumatic fittings are attached via a number of different connection methods, each with its own conveniences and advantages.

#### Ball and Sleeve Fittings

Ball and sleeve fittings connect an outer sleeve to an inner (ball) fitting. The sleeve retracts to connect and disconnect the two ends of the fitting. Some ball and sleeve fittings function as push-to-connect fittings which are convenient for applications requiring frequent disconnection and reconnection of the hose section.



#### Compression Fittings

Compression fittings include all types of fittings which use compressive force to connect the vessel to the fitting.

- **Standard compression fittings** use metal gaskets, rings, or ferrules which form a seal on the vessel through compression. The compression is typically made by tightening a nut onto the fitting over the piping and ferrule, compressing and securing the vessel inside. Standard compression fittings do not require tools to assemble, making them convenient for quick field installations.



- **Bite-type fittings** are compressive fittings with a sharpened ferrule that "bites" the vessel when compressed and provides the seal. Bite-type fittings, like standard compressive fittings, require no special tools to assemble, but provide a stronger, higher pressure connection.
- **Mechanical grip fittings** are two-ferrule assemblies. The back ferrule grips the vessel while pressing up against the front ferrule, which spring-loads the front ferrule and creates a seal between the piping and fitting body. These fittings can be reassembled multiple times without damaging components or piping. They have good resistance to mechanical vibration.
- **Flare fittings** consist of a body with a flared or coned end. Special flaring tools are used to install the vessel inside the flared end, providing a deep seal. Flare fittings can handle higher pressures and a wider range of operating parameters than standard compression fittings.



### Crimp Fittings

Crimp fittings involve placing hose over a tubular end and crimping against it with a sleeve, ring, or crimp socket. These fittings typically require crimping tools or machines to make the connections.



### End Fittings

End fittings provide specific surfaces for connecting vessels in pneumatic systems.

- **Clamp ends** are fittings which allow hoses or tubes to be clamped over the part.
- **Plain ends** are fittings with surfaces which allow pipes or tubes to be connected by adhesive, solder, welding, or other permanent means.

### **Push-to-Connect**

Push-to-connect fittings have ends that are designed to accept tubing by pushing it into the end. These fittings typically disconnect via some type of collar retraction. These connections are convenient for sections of the system requiring frequent disconnection and reconnection.



### **Threaded Fittings**


Threaded fittings have screw threads (built-in grooves) on their inner (female) or outer (male) surfaces designed to accept connections with matching threads. Threads which provide a simple connection but no guaranteed seal are called straight threads. Tapered threads are designed to provide a tight seal which is important for pneumatic applications. These precise threads create a "dry fit", meaning they seal without the need for an additional sealant, which is important in applications where sealant addition could cause contamination or corrosion.

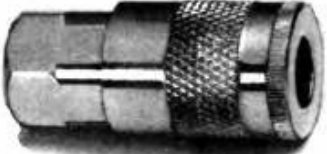
**Design Tip:** Especially in the case of pneumatic fittings, straight threads should be improved by adding a coating or seal tape (Teflon). In applications where adding a coating could cause contamination or corrosion, use tapered threads.





## **Function**


There are a vast number of types of fittings installed in pneumatic systems which perform different functions. The most common types are described in the table below:

<b>Adapter</b>	Connects two dissimilar pipes to each other via solvent welding, soldering, or threading.	
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<b>coupling</b>	Connects two similar pipes to each other via solvent welding, soldering, or threading.	
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<b>Union</b>	Couplings which can be disconnected without cutting. Their connection (typically threading) allows for easy release.	
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<b>Cap</b>	Covers the end of a section, attaching around the pipe via a weld, thread, solvent, or solder.	
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<b>Plug</b>	Closes off flow at the end of a section, attaching inside the pipe via a weld, thread, solvent, or solder.	
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### Fittings which add or change direction

<b>Elbow</b>	Changes the direction flow to various angles. The most common angles are 90° and 45°, but 22.5° elbows are also made.	
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<b>Tee</b>	Connects three flow sections in a T-shaped intersection. This allows fluid flow to be combined or split apart.	
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<b>Cross</b>	4-way connections, providing one inlet and three outlets or vice versa.	
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**Fittings which connect pipes of smaller size:**

<b>Reducer</b>	Includes all connections which connect between two or more vessels of different sizes.	
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**Fittings which provide special connections or functions:**

<b>Nipple</b>	Allows two separate fittings to be connected to each other. Standard nipples are straight with male threads on both ends.	
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<b>Valve</b>	Connects vessels together with the addition of a valve for the control of flow.	
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# Specifications

## Sizing

Once the type of fitting required has been determined, the most fundamental aspect of pneumatic fittings can be addressed: proper sizing. Proper sizing is essential to successful fitting selection, as oversized or undersized parts will either be completely incompatible or will seal or connect inadequately.

The two systems of measurement are Metric (mm) and English ("). The first step to proper sizing is selecting the appropriate measurement system for compatibility with the equipment or assembly being fitted.

The sizing of a pneumatic fitting is defined by the size of vessels it connects to. Tubes, hoses, and pipes are sized based on inside diameter (ID) and outside diameter (OD), measured in inches (in) or millimeters (mm). A fitting designed to connect to a tube with a 2" OD is rated as a 2" OD fitting. Inside diameter measures the diameter of the empty portion of the cylinder, while outside diameter includes the thickness of the tubing wall.

## Operation

Pneumatic fittings often are rated for certain temperature and pressure ranges based on what they are designed to handle.

- **Operating pressure range** is the working range of pressures or the pressure ratings at which the fitting was designed to operate, typically measured in pounds per square inch (psi). Operating above or below this rating could cause the fitting to fail (i.e. break, leak, lose its seal).
- **Operating temperature range** is the working range of temperatures or the temperature ratings at which the fitting was designed to operate, measured in degrees Fahrenheit (°F) or degrees Celsius (°C). Operating above or below this rating could cause the fitting to fail.

## Materials

Fitting material is important for determining various physical properties of the part as well as gas compatibility. Material choices include metals, plastics, and composites.

### Metals

- **Aluminum** - lightweight and corrosion resistant. By itself, aluminum has low tensile strength and is used for its corrosion resistance and low density in low pressure applications. It is alloyed with zinc, copper, silicon, manganese, and/or other metals to improve its strength and hardness.

- **Brass** - strong, durable, and corrosion resistant, with high temperature ductility and good conductivity. Brass is an alloy of copper and zinc. It is the most common metal for smaller compression and threaded fitting typical of pneumatic systems because of its machinability and its excellent performance properties.
- **Steel** - durable and strong, with a high resistance to heat. Steel is an alloy of iron and carbon; it is typically alloyed with other metals to improve its corrosion resistance. Galvanized steel is coated with zinc for added rust protection and chemical resistance.
- **Stainless steel** - strong with excellent chemical and corrosion resistance. Stainless steel is an alloy of steel that contains over 10.5% chromium. It has the strength and durability of steel while also providing excellent corrosion resistance, albeit typically at a higher cost.

### Plastics

- **Fluororesins** such as polytetrafluoroethylene (PTFE) and polyvinylidene fluoride (PVDF) are fluorocarbon-based polymers typically used for temperature requirements above 500°F (250°C). They exhibit very good chemical resistance and dielectric properties.
- **Polypropylene** is a thermoplastic material used widely for pneumatic fittings because of its price, broad material compatibility, and durability. It exhibits excellent cold flow, bi-axial strength, and yield elongation properties and can be used in exposed applications because of its resistance to UV, weathering, and ozone.

### Composites

Composite fittings include those made from combinations of materials, such as carbon, fiberglass, and graphite. These materials have high melting points and are used as fittings for applications that require high temperature durability and chemical resistance. They also exhibit low electrical and thermal conductivity.

## **Features**

Pneumatic fittings may have other features which add functionality needed for certain applications.

- **Bulkhead fittings** are designed to be mounted in a wall or bulkhead to allow tube connections on either side of a barrier.
- **Connect-under-pressure fittings** are designed to allow installation or connection of the fitting while the system is under pressure.
- **Expansion joints** and couplings connect sections of tube and provide allowance for movement due to service load, shock, or thermal cycles.
- **Lined fittings** are manufactured with an integral lining. The linings are often made from engineered polymers for use with process materials or in applications such as food processing where media cleanliness is important.
- **Plated fittings** have a plating, surface treatment, or coating which provides enhanced thermal characteristics, chemical durability, corrosion resistance, or other desirable surface characteristics.
- **Pre-insulated fittings** consist of insulating materials or jacket constructions designed to insulate the vessel and media from outside temperatures.
- **Swivel feature** allows one or more fitting ends to rotate or swivel.