

# PRESSURE AND FLOW FITTINGS TUTORIAL



The purpose of this document is to serve as a tutorial on pressure and vacuum fittings commonly used with **FLUKE CALIBRATION** products. The scope of this tutorial is limited to applications commonly encountered. This tutorial should not be used as an engineering technical note but rather as a general guide applying to flow and pressure calibration applications. As with any pressurized system, it is the operator's responsibility for following safe use practices.

There are six basic types of fittings commonly used with FLUKE CALIBRATION products and hardware:

- Tapered pipe thread (NPT, PT, BSPT, ISO-T)
- Straight thread or O-Seal (ISO-S, BSPP, SAE-S)
- Flare Fittings (AN (JIS) 37°)
- Compression fittings (Swagelok® / Gyrolok®)
- Coned-and-threaded (DH200 / 500, Autoclave, HIP)
- Face seal (VCR, VCO)

These fittings are available in different sizes and are used in a variety of different applications and industries.

In our products we have a general scheme of using a type of fitting for a given type of application.

## CONNECTION / INTERFACE TO EXTERNAL FITTINGS, PRESSURE UP TO 10 MPa

**Tapered pipe thread (or NPT – National Pipe Tapered)** is the most common pressure fitting used throughout the industry. We use this fitting on the majority of our pressure products up to 20 MPa (3 000 psi) to connect with devices outside of the instrument (i.e.: supply gas inlet, test port, exhaust port, vent port). There are a few exceptions where we use smaller size NPT fittings up to 70 MPa (10 000 psi). It is very common to use an adaptor to go from NPT to some other type of fitting; these are readily available from most local suppliers. NPT fittings require use of a thread sealer such as Teflon® tape. A note on pressure ratings: NPT fittings are capable of much higher pressures given that certain engineering considerations are applied. For purposes of

this tutorial, pressure ratings will be given for recommended typical applications.

## PRESSURES UP TO 10 MPa

**Swagelok® fittings or compression type tube fittings** are common throughout the industry. We use this type of fitting on the inside of products that see pressures of 10 MPa (1 500 psi) or less. Two common sizes are 1/4 inch and 1/8 inch (4T and 2T). These are convenient to use and leak tight, but are not good for multiple make-and-break connections. After several uses, the tendency is for the body to “flare out” and lose the ability to seal.

## CONNECTION / INTERFACE TO EXTERNAL FITTINGS, PRESSURE ABOVE 10 MPa

**DH200 / DH500 are high pressure “gland and collar”** connections used both inside and outside as interconnection hardware. This fitting is unique in that it is used with a 1/4 inch diameter tube which has a coned and threaded tip. These are less common throughout industry simply due to the fewer number of high pressure applications. Some people may refer to these as “Autoclave fittings” see [http://www.snap-tite.com/Snaptite\\_AED/AED\\_VFT/products/technical\\_information/coned\\_threaded\\_connections/index.html](http://www.snap-tite.com/Snaptite_AED/AED_VFT/products/technical_information/coned_threaded_connections/index.html) for details. They are very good for multiple make-and-break connections. DH500 has a larger gland and collar (as compared to DH200) and is rated for pressures to 400 MPa (60 000 psi). The smaller version DH200 is rated for pressures to 140 MPa (20 000 psi).

## CONNECTION / INTERFACE TO EXTERNAL FITTINGS, FLOW

**The VCR Metal gasket face seal fitting** is used with flow products (molbloc/molbox) to interconnect with other flow hardware. It is widely used in the semiconductor industry, offering high purity and leak free connections for applications involving critical vacuum and positive pressure. A soft Viton o-ring is typically used in place of the metal face seal to facilitate frequent make-and-break connections. However, this is not applicable for high purity applications – a metal gasket must be used.

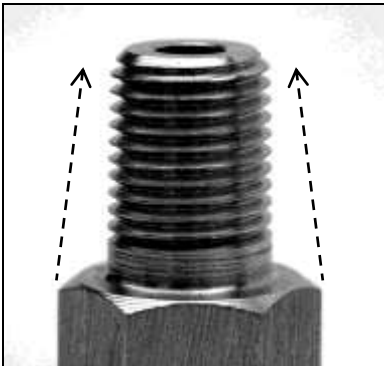
## APPLICATION CONSIDERATIONS

When designing or assembling a system, it is recommended practice to minimize the number of connections and to be consistent with the type and size of fittings as much as possible. Each connection point represents a potential source for a leak. Using fittings of varying inside diameters could create a flow restriction and resulting pressure drop.

Cleanliness requirements of the test system should also be considered. Fittings and interconnections used in one fluid media should typically not be used with another system until they are thoroughly cleaned. This can be especially critical in "oxygen clean" applications, or when using liquid contaminated fittings with a gas system. Consider the material properties of the connections; brass is typically not recommended for high purity applications.

Pressure ratings for fittings and tubing are highly dependant upon the mechanical integrity of the tubing and the number of engaged threads and torque on a fitting. The pressure capability of a component is based on calculated stress for new, undamaged materials. Capability is the maximum pressure that the system or a component can withstand. The component must maintain an established safety factor of 2 or 3 in comparison with the burst pressure and yield strength of the material. The pressure values given in the following pages are guidelines only and NOT intended for engineering or design purposes. As with any pressurized system, it is the operator's responsibility to follow established safety practices.

## NPT (NATIONAL PIPE TAPERED) FITTINGS



NPTM

### COMMON NAMES

NPT, Tapered Pipe Thread, Pipe Thread

### SIZES

4NPTF = 1/4 in. female, 2NPTM = 1/8 in. male. These are the two common sizes used products. ("F" denotes Female, "M" denotes Male)

### KEY FEATURES

Shaft is slightly tapered from the base narrowing towards the end. This taper is exaggerated and noted with the dashed lines on the picture.

### HOW IT SEALS

Seal is made by an interference fit on the leading edges of the first few rows of threads. Requires use of a thread sealant such as Teflon<sup>®</sup> tape or Teflon paste.

### DESIGN BENEFITS

A common industrial fitting with a wide variety of adaptors available. Rugged and good for multiple make and break connections. However, incorrect use can lead to galling or other damage of mating threads.

### PRESSURE LIMITATIONS

(Ratings based on 316 SS)

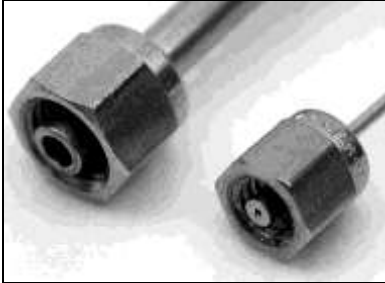
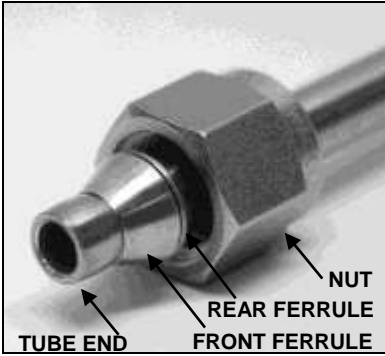
4NPT Some Manufacturers rate it at 55 MPa (8 000 psi), but we typically use up to 20 MPa (3 000 psi)

2NPT Some manufacturers rate it at 70 MPa (10 000 psi), but we typically use up to 40 MPa (6 000 psi) with some special applications to 70 MPa (10 000 psi).

### ASSEMBLY INSTRUCTIONS

Screw in until tight. This is the only fitting where you must use a thread sealer such as Teflon tape to prevent leaks. Do not confuse or try to use with SAE straight thread fittings

## COMPRESSION FITTINGS



### COMMON NAMES

"Tube fittings", "Compression fittings", Swagelok<sup>®</sup>, Gyrolok<sup>®</sup>, CPI, A-LOK<sup>®</sup>

### SIZES

4T = 1/4 in.; 2T = 1/8 in.; 1T = 1/16 in. These are the common sizes used with our products. Many other sizes are available.

### KEY FEATURES

Front and rear ferrules are "swaged" (compressed into) to the tube, deforming it slightly, making a permanent hold to the tube. Some manufacturers use a single ferrule design.

### HOW IT SEALS

Seals by compressing the sloped portion of the front ferrule against the machined shoulder of the mating body, and also seals along the outer surface of tube extending below the ferrules.

### DESIGN BENEFITS

Good for leak-free pressure and medium vacuum applications. Quick to assemble; widely available. Recommended for permanent installations. Multiple make-and-breaks operations often deform the mating body due to over torque leading to leaks.

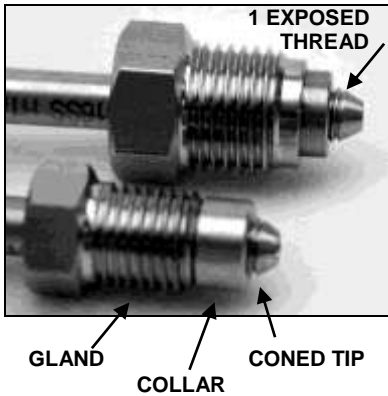
### PRESSURE LIMITATIONS

Pressure limitations are primarily a function of tube size and wall thickness. See manufacturers' specifications.

### ASSEMBLY INSTRUCTIONS

After initial assembly is complete, finger-tighten the nut and turn with a wrench. Tighten 3/4 turn for quarter inch tube or larger. Tighten 1-1/4 turn for eighth inch tube or smaller. **CAUTION: Front and rear ferrules must be of same manufacturer – mixed ferrules may not properly "swage" to the tube making it possible for the tube to pull out and cause injury.**

## DH200/DH500 CONNECTIONS



### COMMON NAMES

DH200 / 500 equivalent to:

Autoclave Engineers SF250CX / F250C and HiP LF4 / HF4

### SIZES

Both fittings are used with 1/4 in. OD tube, but with different wall thickness and thread length.

DH200: Gland has 1/2 in. hex head

DH500: Gland has 5/8 in. hex head

### KEY FEATURES

Uses a gland and collar assembly to thrust the coned tip of a 1/4 in. nipple against a machined mating surface. Threaded nipple is a left-hand thread. Female fittings always have a weep hole to check for leaks and to prevent threaded area from becoming pressurized.

### HOW IT SEALS

The pressure seal is made on the small coned surface of the tube tip. The collar allows the gland to thrust the coned tip against the sealing surface. These two surfaces have slightly different angles.

### DESIGN BENEFITS

Excellent choice for high pressure gas or oil applications. Very good for multiple make-and-break connections due to minimal deformation of the coned sealing surface.

### PRESSURE LIMITATIONS

Regardless of the tube wall thickness, DH200 / DH500 end connections are limited to:

DH200: 140 MPa (20 000 psi)

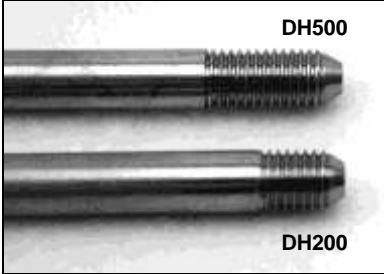
DH500: 400 MPa (60 000 psi)

**CAUTION:** Pressure rating for an assembly is limited by the weakest component. Tube weld assemblies use smaller diameter tubing. In these assemblies the pressure rating is lower than the end connection.

### ASSEMBLY INSTRUCTIONS

Using a prepared coned and threaded tube (nipple), first slide on the gland, then thread a collar onto the tube until one thread is visible between coned tip and collar. This will ensure adequate engagement of the gland with the mating body. Tighten gland with wrench until snug. Our recommendation is 10 Nm for DH200 and 15 Nm for DH500 in standard applications.

## DH200/500 NIPPLES



### SIZES

Only available in 1/4 in. outside diameter (OD) stainless steel (SS) tube – lengths available from 2.75 to 24 in. Custom sizes are available.

### KEY FEATURES

Prepared lengths of tube by the manufacturer with coned and threaded tips. DH500 has a longer threaded tip than DH200.

### DESIGN BENEFITS

Commonly used for interconnections between high pressure devices.

### PRESSURE LIMITATIONS

Regardless of the tube wall thickness, DH200 / DH500 end connections are limited to:

DH200: 140 MPa (20 000 psi)

DH500: 400 MPa (60 000 psi)

**CAUTION:** Pressure rating for an assembly is limited by the weakest component. 1/4 in. OD SS tubing is available with varying inside diameters (ID). The ID determines the pressure rating of the tube. Tube weld assemblies use smaller diameter tubing. In these assemblies the pressure rating is lower than the end connection.

### ASSEMBLY INSTRUCTIONS

Thread is a left-hand (“reverse”) thread. Not recommended to use DH200 collars and glands on DH500 nipples.

## VCR – METAL GASKET FACE SEAL FITTING



### COMMON NAMES

“Face seal”, “VacuSeal™”

### SIZES

1/2 in., 1/4 in. These are the two common sizes used with **our** flow products. Other sizes industrially available.

### KEY FEATURES

Standard fitting for our flow products – commonly used in high purity applications.

### HOW IT SEALS

Seal is made when a gasket or o-ring is compressed between opposing polished annular beads. The metal gasket can only be used once to ensure leak free operations. Teflon gaskets are also available.

### DESIGN BENEFITS

Offers high purity when using a metal gasket; provides leak free operation from vacuum to positive pressure. Unlimited life cycle with disposable gaskets.

### PRESSURE LIMITATIONS

Limit to 100 psi or less when using o-rings.

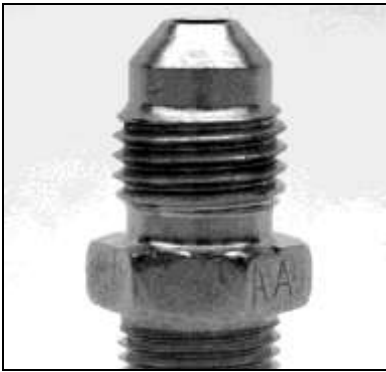
### ASSEMBLY INSTRUCTIONS

A Viton o-ring is typically used in place of a metal gasket to provide a quick, convenient, finger-tight assembly. The o-ring is reusable. Tightening with a wrench is not recommended with o-rings. O-rings not recommended for high purity applications.

### MANUFACTURERS

Parker, Swagelok® (Cajon)

## 37° FLARE FITTINGS / ADAPTORS



### COMMON NAMES

"AN4", 37° Flare Tips, Triple-Lok 37°

### SIZES

Industrially available in 1/16 in. increments. Most common size is 1/4 inch.

### KEY FEATURES

Straight threaded body with a 37° tapered nose. These are the predominant fitting within the US military and aerospace industry. Also commonly used in the automotive industry.

### HOW IT SEALS

Seal occurs on the tapered nose of the fitting and mates with a 37° flared tube end. Gaskets are often used.

### DESIGN BENEFITS

Quick and easy to assemble / disassemble. Not as prone to wear as compared with compression type fittings.

### PRESSURE LIMITATIONS

See manufacturer data.

### SPECIAL NOTES

Not used as a standard fitting on our products, but is offered as an adaptor as shown in the first picture and some lines and fittings kit include these fittings.

## 4NPT X DH200F ADAPTOR



### SIZES

Adaptor available from with either a 1/4 inch or 1/8 inch NPT end. A similar adaptor is available for use with DH500.

### KEY FEATURES

A weep hole on the high pressure end indicates that the adaptor is designed to accept a gland and collar type fitting and not an SAE straight or an NPT fitting.

### PRESSURE LIMITATIONS

Limiting factor is the pipe thread. See ratings for NPT fittings.

## DH200 X 4T ADAPTOR



### SIZES

Available in 1/4 inch or 1/8 inch (4T / 2T) male tube ends.

### PRESSURE LIMITATIONS

Pressure rating is dependant on the attached tube thickness and integrity of the swaged assembly. With all things equal, typical pressure rating is 11 000 psi for use with 1/8 inch size.

### MANUFACTURER

**Fluke Calibration**

## KF25 VACUUM FITTINGS

**SIZES**

40 mm, 25 mm, 16 mm. Used for vacuum and flow applications. Commonly referred to as "KF\_\_" fittings.

**KEY FEATURES**

Large diameter flanged connections.. The number indicates inside diameter in millimeters (mm).

**HOW IT SEALS**

A metal centering ring with an o-ring on the periphery is used to align flanges with each other. A clamp is then used to press the faces of each flange against the o-ring where the seal is made.

**DESIGN BENEFITS**

Provides for a high conductance (low resistance to flow) vacuum path.

**PRESSURE LIMITATIONS**

Recommended for use with vacuum applications; generally not recommended for positive pressures above 1 MPa without special clamps.

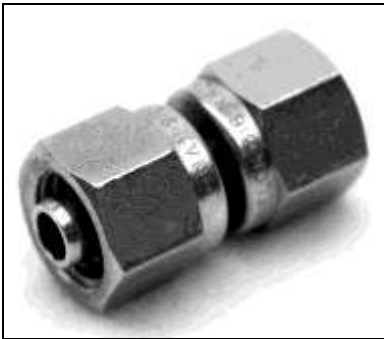
**ASSEMBLY INSTRUCTIONS**

Align centering ring between opposing flanges; apply clamp over lips of both flanges and tighten the wing nut or latch. Special adaptive centering rings for transitioning between various flange sizes are available.

**MANUFACTURER**

Leybold, Nor-Cal, Varian, Pfeifer, BOC Edwards

## PORT CONNECTORS

**SIZES**

¼ inch and 1/8 inch (4P / 2P) are typically used.

**KEY FEATURES**

Port connector is a female-female union.

**PRESSURE LIMITATIONS**

Follow same guidelines as with tube fittings.

**ASSEMBLY INSTRUCTIONS**

When a port connector is ordered or included with an interconnections kit, it arrives as unassembled stem along with one nut and pair of ferrules. User must assemble the pieces to look like the picture at left.

## SAE "STRAIGHT"

**KEY FEATURES**

Straight threads and seals with an o-ring. Unlike an NPT there is NO taper.

**HOW IT SEALS**

O-ring used to form seal.

**ASSEMBLY INSTRUCTIONS**

Looks similar to NPT in size – very easy to confuse if o-ring is missing. Do not attempt to use an SAE fitting with an NPT body.