Product Information Report

Instrumentation Tube Fittings

Overview

Instrumentation tube fittings are designed as leak-free connections for process, power and instrumentation applications.

They have been specifically designed for use on instrumentation, process and control systems, analyzers and environmental equipment employed in chemical, petroleum, power generating, and pulp and paper plants. They are also extensively used in other fields where a high-quality tube fitting is required.

Features/Benefits

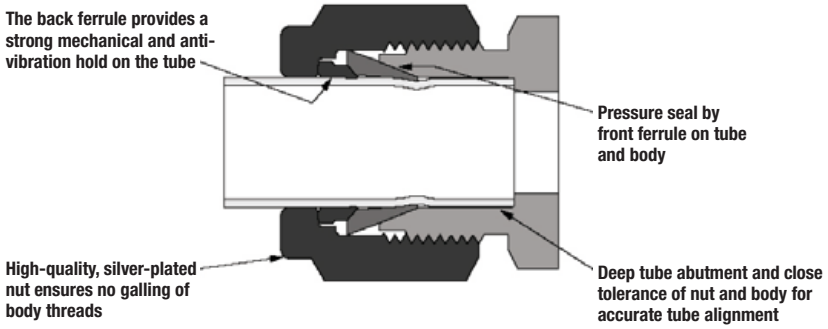
- **Corrosion resistance**: Repeated tests and field applications have shown they resist corrosion better because of their superior hardening process.
- **Stress corrosion resistance**: Instrumentation ferrules also resist stress corrosion cracking. Tests run in chloride, sulfide and caustic environments showed that the stainless steel ferrules are superior to traditionally hardened ferrules and untreated stainless steel ferrules.
- **Unlimited applications**: Broad range of configurations. Whether it is a union, elbow, tee or any size combination, there is a shape to fit your need.
- **No additional cost to you**: All ferrules are available as a standard feature at no additional cost.
- **Only the most popular fittings**: Double ferrule fittings are noted throughout the world for their reliability and high quality. This makes them among the most specified instrumentation fittings available today.

Applications

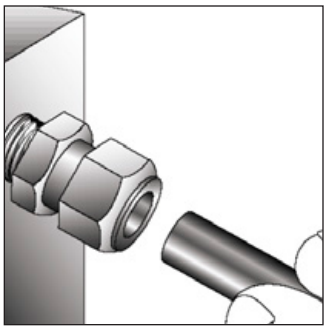
- Pulp and paper mills
- Instrumentation and control equipment
- Power generating equipment
- Environmental testing euipment

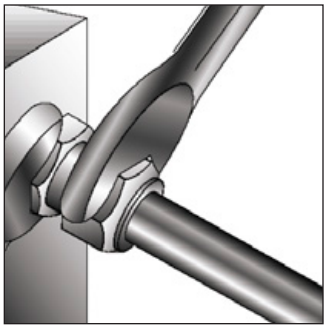
Nomenclature

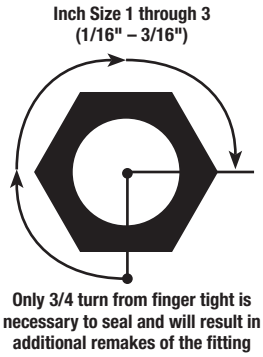
Instrumentation Tube Fittings are supplied complete and ready to use. The front ferrule swages onto the tube as it moves down the body seat creating a pressure/vacuum-tight seal on both tube and body by the interface pressure and surface finish of mating components.
The back ferrule then moves into the cone of the front ferrule, forming into the tube and creating a strong mechanical hold on it.

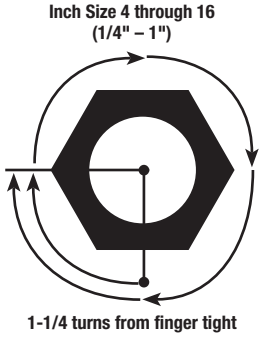


Assembly Instructions





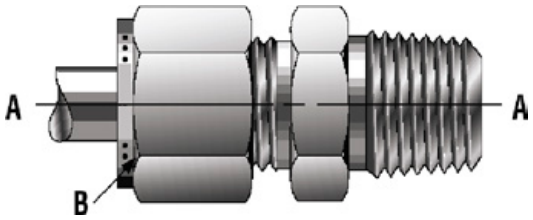




1. Instrumentation Tube Fittings are sold completely assembled and ready for immediate use. Simply insert the tube as illustrated until it bottoms in the fitting body. (If the fitting is disassembled, note that the small tapered end of the ferrule(s) go into the fitting body.)
2. Tighten nut finger-tight. Then tighten nut with wrench an additional 3/4 to 1-1/4 turns (depending on size). Hold fitting body with a second wrench to prevent body from turning. It is helpful to mark the nut to verify the number of turns.

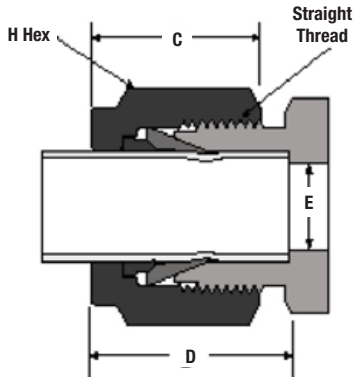
For maximum reusability, mark the fitting and nut before disassembly. Before re-tightening, make sure the assembly has been inserted into the fitting until the ferrule seats in the fitting. Re-tighten the nut by hand. Rotate the nut with a wrench to the original position by lining up the previous marks. A noticeable increase in mechanical resistance will be felt indicating the ferrule is being re-sprung into sealing position.

Only after several remakes will it become necessary to advance the nut slightly past the original position. This advance (indicated by B) need only be 10° to 20° (less than 1/3 of a hex flat).



Note: Lubrication of the nut is required for proper assembly on all fittings Size No. 20 and above.

Dimensional Information



Note: Dimensions C and D are shown in the finger-tight position.

Size No.	Tube O.D. (Inches)	Straight Thread	C* (Inches)	H (Hex) (Inches)	E (Dia.) (Inches)	D* Tube Insertion Depth (Inches)
1	1/16	10–32	0.43	5/16	0.052	0.34
2	1/8	5/16–20	0.60	7/16	0.093	0.50
3	3/16	3/8–20	0.64	1/2	0.125	0.54
4	1/4	7/16–20	0.70	9/16	0.187	0.60
5	5/16	1/2–20	0.73	5/8	0.250	0.64
6	3/8	9/16–20	0.76	11/16	0.281	0.67
8	1/2	3/4–20	0.87	7/8	0.406	0.90
10	5/8	7/8–20	0.87	1	0.500	0.96
12	3/4	1–20	0.87	1-1/8	0.625	0.96
14	7/8	1-1/8–20	0.87	1-1/4	0.750	1.03
16	1	1-5/16–20	1.05	1-1/2	0.875	1.24
20	1-1/4	1-5/8–20	1.52	1-7/8	1.090	1.61
24	1-1/2	1-15/16–20	1.77	2-1/4	1.340	1.96
32	2	2-5/8–20	2.47	2-3/4	1.810	2.65

**Average Value*

Dimensions for reference only, subject to change.

Technical Information

Materials

Instrumentation tube fittings are available as standard in Heat Code Traceable, 316 stainless steel and brass. Straight fittings are machined from cold finished bar stock and shaped bodies are machined from close grain forgings. The raw materials used fully conform to the chemical requirements listed in the table below.

Tubing

Instrumentation tube fittings can be used with a wide variety of tubing materials and a broad range of tube wall thicknesses. Fittings seal equally well on both thin wall and heavy wall tubing. Tubing and fitting materials should be selected to be compatible with the fluid media. Due to thermal expansion characteristics and chemical stability, the tubing should be of the same material as the fitting, with the exception of brass fittings and copper tubing.

Torque

Instrumentation tube fittings do not twist the tubing during installation. The ferrule design assures that all make and remake motion is transmitted axially to the tubing. Since no radial movement of the tubing occurs, the tubing is not stressed. The mechanical integrity of the tubing is maintained.

No Distortion

In make-up, there is no undue force in an outward direction to distort the fitting body or ferrules and cause interference between the ferrules and nut. This assures that the nut will back off freely for disassembly and permits a greater number of easy remakes.

Sealing

Positive, reliable connections with these fittings have been qualified by exhaustive tests and over four decades of experience in the manufacture of quality tube fittings.

Basic Fitting Material	Bar Stock Specifications	Forging Specifications	Common Tubing Specification
Brass	CA-360 QQ-B 626 ALLOY 360 ASTM B16 ALLOY 360 CA-345 ASTM B453 ALLOY 345 BS970 316-S31 DIN 4401 ASME SA479-316	CA-377 QQ-B 626 ALLOY 377 ASTM B124 ALLOY 377 BS2872 CZ122	ASTM B75 ASME SB75 (TEMPER 'O')
316 Stainless Steel	ASME SA479 TYPE 316-SS BS970 316-S31 DIN 4401	ASME SA182 316 BS970 316-S31 DIN 4401	ASME SA213 ASTM A213 ASTM A249 ASTM A269 MIL-T-8504 MIL-T-8506

Technical Information (cont.)

General Tubing Selection Criteria

The most important consideration in tubing selection is the compatibility of the tubing material with the media to be contained. Table 1 lists materials and their associated general application. It also lists the maximum and minimum operating temperatures for the various tubing materials.

In addition, these fittings are designed to work on like materials. Stainless steel fittings should be used only with stainless steel tubing, aluminum fittings with aluminum tubing, etc. The practice of mixing materials is strongly discouraged. The only exception is brass fittings with copper tubing. Dissimilar materials in contact may be susceptible to galvanic corrosion. Also, different materials have different levels of hardness and this can adversely affect the fittings ability to seal on the tubing.

Table 1

Tubing Material	General Application	Recommended Temperature Range
Stainless Steel	High-pressure, high-temperature generally corrosive media	–425°F to +1,200°F (–254°C to +649°C)[1]
Carbon Steel	High-pressure, high-temperature oil, air, some speciality chemicals	–65°F to +800°F (–54°C to +426.5°C)[2]
Copper	Low-temperature, low-pressure water, oil, air	–40°F to +400°F (–40°C to +204.5°C)
Aluminum	Low-temperature, low-pressure water, oil, air, some speciality chemicals	–40°F to +400°F (–40°C to +204.5°C)
Monel 400™	Recommended for sour gas applications Well suited for marine and general chemical processing applications	–400°F to +800°F (–240°C to + 426.5°C)
Alloy C276	Excellent corrosion resistance to both oxidizing and reducing media and excellent resistance to localized corrosion attack	–320°F to +1,000°F (–195.5°C to 538°C)
Carpenter 20™	Applications requiring resistance to stress corrosion cracking in extreme conditions	–400°F to +800°F (–240°C to + 426.5°C)
Alloy 600	Recommended for high-temperature applications with generally corrosive media	–205°F to +1,200°F (–131.5°C to +649°C)
Titanium	Resistant to many natural environments such as sea water, body fluids and salt solutions	–320°F to +600°F (–195.5°C to 315.5°C)

[1]For operating temperatures above 800°F (426.5°C), consideration should be given to media. 300 Series stainless steels are susceptible to carbide precipitation which may lead to inter-granular corrosion at elevated temperatures.

[2]Consideration should be given to maximum temperature ratings if fittings and/or tubing are coated or plated.

All temperature ratings based on maximum rated temperatures per ASME/ANSI B31-3 Chemical Plant and Petroleum Refinery Piping Code, 1987 Edition.

The information listed in Table 1 is general in scope. For specific applications, please contact Lawson Products Engineering Department.

Carpenter 20™ is a trademark of Carpenter Technology Corporation.
Monel 400™ is a trademark of International Nickel.

Gas Service

Special care must be taken when selecting tubing for gas service. In order to achieve a gas-tight seal, ferrules in instrument fittings must seal any surface imperfections. This is accomplished by the ferrules penetrating the surface of the tubing. Penetration can only be achieved if the tubing provides radial resistance and if the tubing material is softer than the ferrules.

Thick-walled tubing helps to provide resistance. Tables 2 through 7 indicate the minimum acceptable wall thickness for materials in gas service. The **unshaded** values indicate combination of diameter and wall thickness which is acceptable for gas service.

Acceptable tubing hardness for general applications is listed in Table 9. These values are the maximum allowed by ASTM. For gas service, better results can be obtained by using tubing well below this maximum hardness. For example, a desirable hardness of 80 Rb is suitable for stainless steel. The maximum allowed by ASTM is 90 Rb.

System Pressure

The system operating pressure is important in determining the type, and more importantly, the size of tubing to be used. High pressure installations require strong materials such as steel or stainless steel. Heavy walled softer tubing such as copper may be used if chemical compatibility exists with the media. However, the higher strength of steel or stainless steel permits the use of thinner tubes without reducing the ultimate rating of the system. Tube fitting assemblies should never be pressurized beyond the recommended working pressure.

Tables 2 through 7 list the maximum suggested working pressure of various tubing sizes by material. Acceptable tubing diameters and wall thicknesses are those for which a rating is listed. Combinations which do not have a pressure rating are not recommended for use with instrument fittings.

Maximum Allowable Working Pressure Tables

- All working pressures have been calculated using the maximum allowable stress levels in accordance with ANSI B31.3, Chemical Plant and Petroleum Refinery Piping Code, 1987 Edition.
- All calculations are based on a maximum outside diameter and minimum wall thickness.
- All working pressures are at 72°

Table 2 – 316 or 304 Stainless Steel (Seamless)

Tube O.D. (Inches)	Wall Thickness (Inches)															
	0.010	0.012	0.014	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.156	0.188
1/16	5600	6900	8200	9500	12100	16800										
1/8						8600	10900									
3/16						5500	7000	10300								
1/4						4000	5100	7500	10300							
5/16							4100	5900	8100							
3/8							3300	4800	6600							
1/2							2500	3500	4800	6300						
5/8								3000	4000	5200	6100					
3/4								2400	3300	4300	5000	5800				
7/8								2100	2800	3600	4200	4900				
1									2400	3200	3700	4200	4700			
1-1/4										2500	2900	3300	3700	4100	4900	
1-1/2											2400	2700	3000	3400	4000	4500
2												2000	2200	2500	2900	3200

Table 3 – 316 or 304 Stainless Steel (Welded)

Tube O.D. (Inches)	Wall Thickness (Inches)															
	0.010	0.012	0.014	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.156	0.188
1/16	4600	5900	7000	8100	10300	14300										
1/8						7300	9300									
3/16						4700	6000	8700								
1/4						3400	4400	6400	8700							
5/16							3400	5000	6900							
3/8							2800	4100	5600							
1/2							2100	3000	4100	5300						
5/8								2500	3400	4500	5200					
3/4								2100	2800	3700	4200	4900				
7/8								1800	2400	3100	3600	4200				
1									2100	2700	3100	3600	4000			
1-1/4										2100	2400	2800	3100	3500	4200	
1-1/2											2000	2300	2600	2900	3400	4200
2												1700	1900	2100	2500	3000

Maximum Allowable Working Pressure Tables (cont.)

- All working pressures have been calculated using the maximum allowable stress levels in accordance with ANSI B31.3, Chemical Plant and Petroleum Refinery Piping Code, 1987 Edition.
- All calculations are based on a maximum outside diameter and minimum wall thickness.
- All working pressures are at 72°

Table 4 – Carbon Steel (Seamless)

Tube O.D. (Inches)	Wall Thickness (Inches)											
	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.165	0.180
1/8	8100	10300										
3/16	5200	6700	9700									
1/4	3800	4900	7100	9700								
5/16		3800	5500	7700								
3/8		3100	4500	6200								
1/2		2300	3300	4500	6000							
5/8		1800	2600	3500	4600	5100						
3/4			2200	2900	3800	4400	5100					
7/8			1800	2500	3200	3700	4300					
1			1600	2100	2800	3200	3700	4100				
1-1/4				1700	2200	2500	2900	3200	3700	2800		
1-1/2					1800	2100	2400	2700	3000	3400	3800	4000
2						1600	1800	2000	2200	2500	2800	3000

Table 5 – Copper (Seamless)

Tube O.D. (Inches)	Wall Thickness (Inches)									
	0.010	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120
1/16	1700	3800	5400	6000						
1/8			2800	3600						
3/16			1800	2300	3500					
1/4				1700	2600	3500				
5/16				1300	2000	2800				
3/8				1100	1600	2300				
1/2				800	1200	1600	2200			
5/8					900	1300	1700	2000		
3/4					800	1000	1400	1600	1900	
7/8					600	900	1100	1300	1600	
1					600	800	1000	1200	1400	1500

Table 6 – Aluminum (Seamless)

Tube O.D. (Inches)	Wall Thickness (Inches)				
	0.035	0.049	0.065	0.083	0.095
1/8	8700				
3/16	5600	8100			
1/4	4100	5900			
15/16	3200	4600			
3/8	2600	3800			
1/2	1900	2800	3800		
5/8	1500	2200	2900		
3/4		1800	2400	3200	
7/8		1500	2100	2700	
1		1300	1800	2300	2700

Table 7 – Monel 400 (Seamless)

Tube O.D. (Inches)	Wall Thickness (Inches)									
	0.010	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120
1/16	5900	12600	17000							
1/8			8600	11000						
3/16			5500	7100	10300					
1/4			4000	5100	7500	10300				
5/16				4000	5900	8100				
3/8				3300	4800	6600				
1/2				2300	3300	4500	5900			
5/8					2800	3700	4900	5700		
3/4					2300	3100	4000	4600	5400	
1						2300	2900	3400	3900	4400

System Temperature

Copper and aluminum are suitable for low temperature media. Stainless steel and carbon steel tubing are suitable for higher temperature media. Special alloys, such as Alloy 600, are recommended for extremely high temperatures (see Table 1). Table 8 lists derating factors which should be applied to the working pressures listed in Tables 2 through 7 for elevated temperature conditions. Simply locate the correct factor in Table 8 and multiply this by the appropriate value in Tables 2 through 7 for the elevated temperature working pressure.

Table 8 – Temperature Derating Factors

Temperature	Copper	Aluminum	316SS	304SS	Steel	Monel 400™
100°F (38°C)	1.00	1.00	1.00	1.00	1.00	1.00
200°F (93°C)	0.80	1.00	1.00	1.00	0.96	0.88
300°F (149°C)	0.78	0.81	1.00	1.00	0.90	0.82
400°F (204.5°C)	0.50	0.40	0.97	0.94	0.86	0.79
500°F (260°C)			0.90	0.88	0.82	0.79
600°F (315.5°C)			0.85	0.82	0.77	0.79
700°F (371°C)			0.82	0.80	0.73	0.79
800°F (426.5°C)			0.80	0.76	0.59	0.76
900°F (482°C)			0.78	0.73		
1,000°F (538°C)			0.77	0.69		
1,100°F (593°C)			0.62	0.49		
1,200°F (649°C)			0.37	0.30		

Example:

3/4" x .095 wall seamless carbon steel tubing has a working pressure of 5,000 PSI at room temperature. If the system were to operate at 600°F (315.5°C), a factor of 77% (or .77) would apply and the "at temperature" system pressure would be:

5,000 PSI x .77 = 3,850 PSI.

Tubing Ordering Suggestions

Tubing for use with instrument fittings must be carefully ordered to insure adequate quality for good performance.

- Each purchase order must specify the nominal O.D. and wall thickness of the material. Ordering to ASTM specifications ensures that the tubing will be dimensionally, physically and chemically within strict limits.
- Also, more stringent requirements may be added by the user. All tubing should be ordered free of scratches and suitable for bending.
- A purchase order meeting the above criteria would read as follows: 1/2" x .049 316 stainless steel, seamless or welded and redrawn per ASTM A-249. Fully annealed, 80 Rb or less. Must be suitable for bending; surface scratches and imperfections (incomplete weld seams) are not permissible.

Table 9 lists specific ordering information for each material.

Table 9 – Tubing Ordering Information

Material	Type	ASTM Tubing Spec.	Condition	Max. Recommended Hardness
Stainless Steel	304, 316, 316L	ASTM-A-269, A-249, A-213, A-632	Fully Annealed	90 Rb
Copper	K or L	ASTM-B75, B68, B88 (K OR L)*	Soft Annealed Temper '0'	60 Max. Rockwell 15T
Carbon Steel	1010	SAE J524b, J525b, ASTM-A-179	Fully Annealed	72 Rb
Aluminum	Alloy 6061	ASTM B-210	T6 Temper	56 Rb
Monel™	400	ASTM B-165	Fully Annealed	75 Rb
Alloy C-276	C-276	ASTM B-622, B-626	Fully Annealed	90 Rb
Alloy 600	600	ASTM B-167	Fully Annealed	90 Rb
Carpenter 20™	20CB-3	ASTM B-468	Fully Annealed	90 Rb
Titanium	Commercially Pure Grade 2	ASTM B-338	Fully Annealed	99 Rb 200 Brinell Typical

WARNING

IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN, OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.
Please contact Lawson Engineering If there are any questions.

**NOTE: B88 Copper tubing to be ordered non-engraved.*