

CONNECTOR & CONDUCTOR CERTIFICATION

STATION #1

FASTENERS

NOTE: The graphic printed on the test sheet is for informational purposes only. Use the actual test kit part to determine the correct dimensions.



TOOLS NEEDED:

- Scale (U.S. & Metric)
- Thread Gauges (U.S. & Metric)
- Bolt Template

LAMINATED CHARTS:

- 3 Laminated Bolt Thread Charts

C & C JP TEST STATION 1 - LAMINATE 1 OF 3

Machine Screw Sizes UNC and UNF

Nominal Size Tap	Recommended Tap Drill		Nominal Size Tap	Recommended Tap	
	Drill	Dec.		Drill	Dec.
0-80	3/64	0.0469	1/4-20 1/4-28	7 3	0.2010 0.2130
1-64	53	0.0595	5/16-18	F	0.2570
1-72	53	0.0595	5/16-24	I	0.2720
2-56	50	0.0700	3/8-16	5/16	0.3125
2-64	50	0.0700	3/8-24	Q	0.3320
3-48	47	0.0785	7/16-14	U	0.3680
3-56	46	0.0810	7/16-20	25/64	0.3906
4-40	43	0.0890	1/2-13	27/64	0.4219
4-48	42	0.0935	1/2-20	29/64	0.4531
5-40	38	0.1015	9/16-12	31/64	0.4844
5-44	37	0.1040	9/16-18	33/64	0.5156
6-32	36	0.1065	5/8-11	17/32	0.5312
6-40	33	0.1130	5/8-18	37/64	0.5781
8-32	29	0.1360	3/4-10	21/32	0.6562
8-36	29	0.1360	3/4-16	11/16	0.6875
10-24	26	0.1470	7/8-9	49/64	0.7656
10-32	21	0.1590	7/8-14	13/16	0.8125
12-24	16	0.1770	1-8	7/8	0.8750
12-28	15	0.1800	1-12	59/64	0.9219

Metric Screw Sizes

Metric Tap Size	Drill Size mm	Metric Inch Equiv.	Drill Tap Size	Size mm	Inch Equiv.
M16 x 1.5	14.5	0.5709	M1.6 x 0.35	1.25	0.0492
M18 x 2.5	15.5	0.6102	M1.8 x 0.35	1.45	0.0571
M18 x 1.5	16.5	0.6496	M2 x 0.4	1.6	0.063
M20 x 2.5	17.5	0.689	M2.2 x 0.45	1.75	0.0689
M20 x 1.5	18.5	0.7283	M2.5 x 0.45	2.05	0.0807
M22 x 2.5	19.5	0.7677	M3 x 0.5	2.5	0.0984
M22 x 1.5	20.5	0.8071	M3.5 x 0.6	2.9	0.1142
M24 x 3	21	0.8268	M4 x 0.7	3.3	0.1299
M24 x 2	22	0.8661	M4.5 x 0.75	3.7	0.1457
M27 x 3	24	0.9449	M5 x 0.8	4.2	0.1654
M27 x 2	25	0.9843	M6 x 1	5	0.1968
M30 x 3.5	26.5	1.0433	M7 x 1	6	0.2362
M30 x 2	28	1.1024	M8 x 1.25	6.7	0.2638
M33 x 3.5	29.5	1.1614	M8 x 1	7	0.2756
M33 x 2	31	1.2205	M10 x 1.5	8.5	0.3346
M36 x 4	32	1.2598	M10 x 1.25	8.7	0.3425
M36 x 3	33	1.2992	M12 x 1.75	10.2	0.4016
M39 x 4	35	1.378	M12 x 1.25	10.8	0.4252
M39 x 3	36	1.4173	M14 x 2	12	0.4724
			M14 x 1.5	12.5	0.4921
			M16 x 2	14	0.5512

C & C JP TEST| STATION 1 - LAMINATE 2 OF 3

AMERICAN NATIONAL COARSE THREADS

Size of Threads and Threads per Inch	Major Diameter D Inches	Pitch Diameter E Inches	Minor Diameter K Inches	Commercial Tap Drill to Produce Approx. 75% Full Thread	Decimal Equivalent of Tap Drill Inches
10 x 24	0.1900	0.1629	0.1359	No. 25	0.1495
12 x 24	0.2160	0.1889	0.1619	No. 16	0.1770
1/4 x 20	0.2500	0.2175	0.1850	No. 7	0.2010
5/16 x 18	0.3125	0.2764	0.2403	F	0.2570
3/8 x 16	0.3750	0.3344	0.2938	3/16	0.3125
7/16 x 14	0.4375	0.3911	0.3447	U	0.3680
1/2 x 13	0.5000	0.4500	0.4001	27/64	0.4219
9/16 x 12	0.5625	0.5084	0.4542	31/64	0.4844
5/8 x 11	0.6250	0.5660	0.5069	17/32	0.5312
3/4 x 10	0.7500	0.6850	0.6201	21/32	0.6562
7/8 x 9	0.8750	0.8028	0.7307	49/64	0.7656
1 x 8	1.0000	0.9188	0.8376	7/8	0.8750
1-1/8 x 7	1.1250	1.0322	0.9394	63/64	0.9844
1-1/4 x 7	1.2500	1.1572	1.0644	1-7/64	1.1094
1-3/8 x 6	1.3750	1.2667	1.1585	1-7/32	1.2187
1-1/2 x 6	1.5000	1.3917	1.2835	1-11/32	1.3437
1-3/4 x 5	1.7500	1.6201	1.4902	1-9/16	1.5625
2 x 4-1/2	2.0000	1.8557	1.7113	1-25/32	1.7812
2-1/4 x 4-1/2	2.2500	2.1057	1.9613	2-1/32	2.0312
2-1/2 x 4	2.5000	2.3376	2.1752	2-1/4	2.2500
2-3/4 x 4	2.7500	2.5876	2.4252	2-1/2	2.5000
3 x 4	3.0000	2.8376	2.6752	2-3/4	2.7500
3-1/4 x 4	3.2500	3.0876	2.9252	3	3.0000
3-1/2 x 4	3.5000	3.3376	3.1762	3-1/4	3.2500
3-3/4 x 4	3.7500	3.5876	3.4262	3-1/2	3.5000
4 x 4	4.0000	3.8376	3.6762	3-3/4	3.7500

AMERICAN NATIONAL FINE THREADS

Formerly ASME Special for sizes 1-12; SAE Standard for sizes 1/4 in and larger

0 x 80	0.0600	0.0519	0.0438	3/64	0.0469
1 x 72	0.0730	0.0640	0.0550	No. 53	0.0595
2 x 64	0.0860	0.0759	0.0657	No. 50	0.0700
3 x 56	0.0990	0.0874	0.0758	No. 45	0.0820
4 x 48	0.1120	0.0985	0.0849	No. 42	0.0935
5 x 44	0.1250	0.1102	0.0955	No. 37	0.1040
6 x 40	0.1380	0.1218	0.1055	No. 33	0.1130
8 x 36	0.1640	0.1460	0.1279	No. 29	0.1360
10 x 32	0.1900	0.1697	0.1494	No. 21	0.1590
12 x 28	0.2160	0.1928	0.1696	No. 14	0.1820
1/4 x 28	0.2500	0.2268	0.2036	No. 3	0.2130
5/16 x 24	0.3125	0.2854	0.2584	I	0.2720
3/8 x 24	0.3750	0.3479	0.3209	O	0.3820
7/16 x 20	0.4375	0.4053	0.3725	25/64	0.3906
1/2 x 20	0.5000	0.4675	0.4350	29/64	0.4531
9/16 x 18	0.5625	0.5264	0.4903	33/64	0.5156
5/8 x 18	0.6250	0.5889	0.5528	37/64	0.5781
3/4 x 16	0.7500	0.7094	0.6688	11/16	0.6875
7/8 x 14	0.8750	0.8286	0.7822	13/16	0.8125
1 x 14	1.0000	0.9536	0.9072	15/16	0.9375
1-1/8 x 12	1.1250	1.0709	1.0167	1-3/64	1.0469
1-1/4 x 12	1.2500	1.1959	1.1417	1-11/64	1.1719
1-3/8 x 12	1.3750	1.3209	1.2667	1-19/64	1.2969
1-1/2 x 12	1.5000	1.4459	1.3917	1-27/64	1.4219

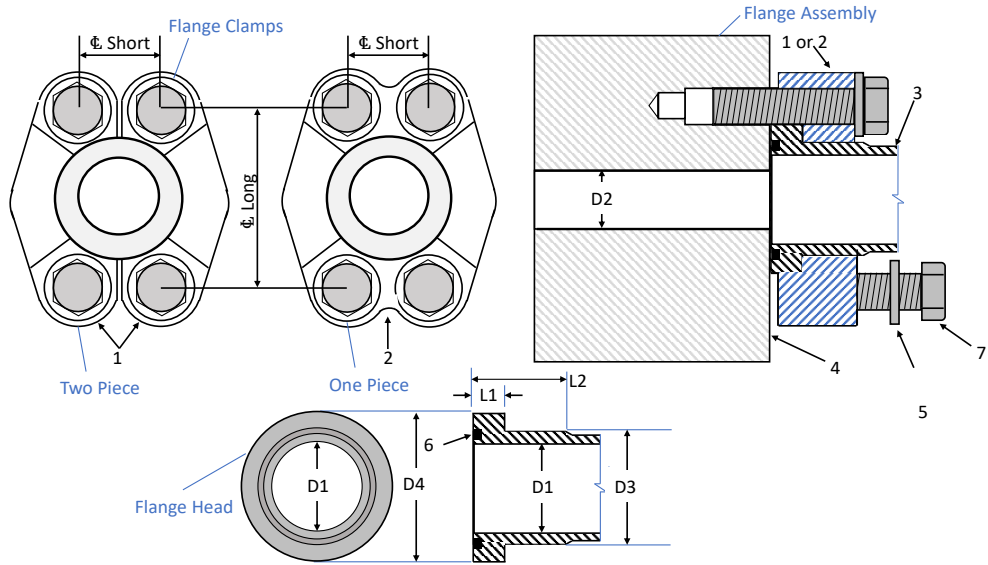
C & C JP TEST STATION 1 LAMINATE 3 OF 3

Code 61 & 62 (Split and One-Piece Clamps)

This connection is commonly used in fluid power systems. There are two pressure ratings. Code 61 is referred to as the "standard" series and Code 62 is the "6000 psi" series. The design concept for both series is the same, but the bolt hole spacing and flanged head diameters are larger for the higher pressure, Code 62 connection.

The female (port) is an unthreaded hole with four bolt holes in a rectangular pattern around the port. The male consists of a flanged head, grooved for an O-Ring, and either a captive flange or split flange halves with bolt holes to match the port. The seal takes place on the O-Ring, which is compressed between the flange head and the flat surface surrounding the port. The threaded bolts hold the connection together.

*SAE J518, JIS B 8363, ISO/DIS 6162 and DIN 20066 are interchangeable, except for bolt sizes



Nominal Size	1	2	3	4	5	D2	
	Two-piece flange clamp	One-piece flange clamp	Flanged head	Mounting face	Flat Washer	D2 must not be greater than D1	
						mm	in
13	0.50				M8	11.5 - 13.0	0.44 - 0.50
19	0.75				M10	17.7 - 19.2	0.69 - 0.75
25	1.00				M10	24.1 - 25.6	0.94 - 1.00
32	1.25				M10	30.5 - 32.0	1.19 - 1.25
38	1.50				M12	36.7 - 38.2	1.44 - 1.50
51	2.00				M12	49.5 - 51.0	1.94 - 2.00

Nominal Size	1	2	3	4	5	D2	
	Two-piece flange clamp	One-piece flange clamp	Flanged head	Mounting face	Flat Washer	D2 must not be greater than D1	
						mm	in
13	0.50				M8	11.5 - 13.0	0.44 - 0.50
19	0.75				M10	17.7 - 19.2	0.69 - 0.75
25	1.00				M10	24.1 - 25.6	0.94 - 1.00
32	1.25				M10	30.5 - 32.0	1.19 - 1.25
38	1.50				M12	36.7 - 38.2	1.44 - 1.50
51	2.00				M12	49.5 - 51.0	1.94 - 2.00

Nominal Size		O-ring code (6)	D1		D3		D4	
mm	in		mm	in	mm	in	mm	in
13	0.50	210	13.0	0.50	23.9	0.941	30.2	1.189
19	0.75	214	19.2	0.75	31.8	1.252	38.1	1.500
25	1.00	219	25.6	1.00	38.1	1.500	44.45	1.750
32	1.25	222	32.0	1.25	43.2	1.701	50.8	2.000
38	1.50	225	38.2	1.50	50.3	1.980	60.35	2.376
51	2.00	228	51.0	2.00	62.2	2.449	71.4	2.811

Nominal Size		O-ring code (6)	D1		D3		D4	
mm	in		mm	in	mm	in	mm	in
13	0.50	210	13.0	0.50	23.9	0.941	31.75	1.250
19	0.75	214	19.2	0.75	31.8	1.252	41.30	1.626
25	1.00	219	25.6	1.00	38.1	1.500	47.65	1.876
32	1.25	222	32.0	1.25	43.7	1.720	54.00	2.126
38	1.50	225	38.2	1.50	50.8	2.000	63.50	2.500
51	2.00	228	51.0	2.00	66.5	2.618	79.40	3.126

7									
Nominal Size		Screw Thread		Screw Torque		∅ Long		∅ Short	
mm	in	Metric	U.S.	Nm	ft-lb	mm	in	mm	in
13	0.50	M8	5/16 - 18	32	24	38.1	1.500	17.5	0.688
19	0.75	M10	3/8 - 16	70	52	47.6	1.875	22.2	0.875
25	1.00	M10	3/8 - 16	70	52	52.4	2.062	26.2	1.031
32	1.25	M10	7/16 - 14	70	52	58.7	2.312	30.2	1.188
38	1.50	M12	1/2 - 13	130	96	69.9	2.750	35.7	1.406
51	2.00	M12	1/2 - 13	130	96	77.8	3.062	42.9	1.688

7									
Nominal Size		Screw Thread		Screw Torque		∅ Long		∅ Short	
mm	in	Metric	U.S.	Nm	ft-lb	mm	in	mm	in
13	0.50	M8	5/16 - 18	32	24	40.5	1.594	18.2	0.718
19	0.75	M10	3/8 - 16	70	52	50.8	2.000	23.8	0.937
25	1.00	M12	7/16 - 14	130	96	57.2	2.252	27.8	1.093
32	1.25	M12	1/2 - 13	130	96	66.7	2.625	31.8	1.250
38	1.50	M16	5/8 - 11	295	218	79.4	3.125	36.5	1.437
51	2.00	M20	3/4 - 10	550	407	96.8	3.812	44.5	1.750

For more detailed information, refer to ISO 6162-1

For more detailed information, refer to ISO 6162-2

CONNECTOR & CONDUCTOR CERTIFICATION

STATION #2

FITTING IDENTIFICATION

NOTE: The graphic printed on the test sheet is for informational purposes only. Use the actual test kit part to determine the correct dimensions.



TOOLS NEEDED:

- Scale
- Thread Gauges (U.S. and Metric)
- Flashlight
- Magnifying Glass

LAMINATED CHARTS:

- 6 Laminated Charts

C & C JP TEST STATION 2 - LAMINATE 1 OF 6

SAE Thread Guide

Dash Size	NPTF		NPSM		SAE 45° Auto Refrig.		SAE 37° (JIC) Hydraulic		SAE O-Ring Boss		SAE Invert Flare		ORFS/ORS	
	Thread OD	Thread ID	Thread OD	Thread ID	Thread O.D.	Thread I.D.	Thread OD	Thread ID	Thread OD	Thread ID	Thread OD	Thread ID	O-ring Groove	Thread ID
-02	1/8 - 27		1/8 - 27		5/16 - 24		5/16 - 24		5/16 - 24		5/16 - 24			
-03					3/8 - 24		3/8 - 24		3/8 - 24		3/8 - 24			
-04	1/4 - 18		1/4 - 18		7/16 - 20		7/16 - 20		7/16 - 20		7/16 - 24			9/16 - 18
-05					1/2 - 20		1/2 - 20		1/2 - 20		1/2 - 20			
-06	3/8 - 18		3/8 - 18		5/8 - 18		9/16 - 18		9/16 - 18		5/8 - 18			1 1/16 - 16
-07					1 1/16 - 24						1 1/16 - 18			
-12	3/4 - 14		3/4 - 14		1 1/16 - 14		1 1/16 - 12		1 1/16 - 12		1 1/16 - 16			1 3/16 - 12
-14					1 1/4 - 12		1 3/16 - 12		1 3/16 - 12					
-16	1 - 11 1/2		1 - 11 1/2		1 3/8 - 12		1 5/16 - 12		1 5/16 - 12					1 7/16 - 12
-20	1 1/4 - 11 1/2		1 1/4 - 11 1/2		1 5/8 - 12		1 5/8 - 12		1 5/8 - 12					1 1 1/16 - 12
-24	1 1/2 - 11 1/2		1 1/2 - 11 1/2				1 7/8 - 12		1 7/8 - 12					2 - 12
-32	2 - 11 1/2		2 - 11 1/2				2 1/2 - 12		2 1/2 - 12					
-40	2 1/2 - 8		2 1/2 - 8				3 - 12		3 - 12					
-48	3 - 8		3 - 8				3 1/2 - 12		3 1/2 - 12					

Thread Size Chart

Metric Thread Guide

Fitting Size	DIN "L" Swivel Female Thread Size	DIN "S" Swivel Female Thread Size	DIN "L" Male Stud Thread Size	DIN "S" Male Stud Thread Size	Male BSPP Thread Size	BSP Swivel Female Thread Size	French Swivel Female Gaz Series	French Swivel Female Metric Series	French Male Stud Metric Series	French Male Stud Gaz Series
4	-	-	-	-	1/4 - 19	1/4 - 19	-	-	-	-
6	M12 x 1.5	M14 x 1.5	M12 x 1.5	M14 x 1.5	3/8 - 19	3/8 - 19	-	M12 x 1	M12 x 1	-
8	M14 x 1.5	M16 x 1.5	M14 x 1.5	M16 x 1.5	1/2 - 14	1/2 - 14	-	M14 x 1.5	M14 x 1.5	-
10	M16 x 1.5	M18 x 1.5	M16 x 1.5	M18 x 1.5	5/8 - 14	5/8 - 14	-	M16 x 1.5	M16 x 1.5	-
12	M18 x 1.5	M20 x 1.5	M18 x 1.5	M20 x 1.5	3/4 - 14	3/4 - 14	-	M18 x 1.5	M18 x 1.5	-
13	-	-	-	-	-	-	M20 x 1.5	-	-	M20 x 1.5
14	-	M22 x 1.5	-	M22 x 1.5	-	-	-	M20 x 1.5	M20 x 1.5	-
15	M22 x 1.5	-	M22 x 1.5	-	-	-	-	M22 x 1.5	M22 x 1.5	-
16	-	M24 x 1.5	-	M24 x 1.5	1 - 11	1 - 11	-	M24 x 1.5	M24 x 1.5	-
17	-	-	-	-	-	-	M24 x 1.5	-	-	M24 x 1.5
18	M26 x 1.5	-	M26 x 1.5	-	-	-	-	M27 x 1.5	M27 x 1.5	-
20	-	M30 x 2	-	M30 x 2	1 1/4 - 11	1 1/4 - 11	-	M27 x 1.5	M27 x 1.5	-
21	-	-	-	-	-	-	M30 x 1.5	-	-	M30 x 1.5
22	M30 x 2	-	M30 x 2	-	-	-	-	M30 x 1.5	M30 x 1.5	-
25	-	M36 x 2	-	M36 x 2	1 1/2 - 11	1 1/2 - 11	-	M33 x 1.5	M33 x 1.5	-
27	-	-	-	-	-	-	M36 x 1.5	-	-	M36 x 1.5
28	M36 x 2	-	M36 x 2	-	-	-	-	M36 x 1.5	M36 x 1.5	-
30	-	M42 x 2	-	M42 x 2	2 - 11	2 - 11	-	M39 x 1.5	M39 x 1.5	-
33	-	-	-	-	-	-	M45 x 1.5	-	-	M45 x 1.5

How to Measure Non-Threaded Connections

Four Bolt Flange — First measure the port hole diameter using the caliper. Next, measure the longest bolt hold spacing from center-to-center or measure the flange head diameter.

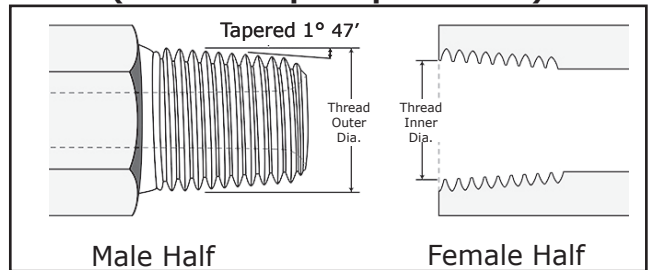
Dash Numbers

Most fluid piping system sizes in the United States are measured by dash numbers. These are universally used abbreviations for the size of the component expressed as the numerator of the fraction with the denominator always being 16. For example, a -04 port is 4/16 or 1/4-inch. Dash numbers are usually nominal (in name only) and are abbreviations that make ordering of components easier.

This connection is still widely used in fluid power systems, even though it is not recommended by the National Fluid Power Association (N.F.P.A.) for use in hydraulic applications. The thread is tapered and the seal takes place by deformation of the threads.

Measure the thread diameter and subtract 1/4-inch to find the nominal pipe size.

NPTF (National Pipe Tapered Fuel)

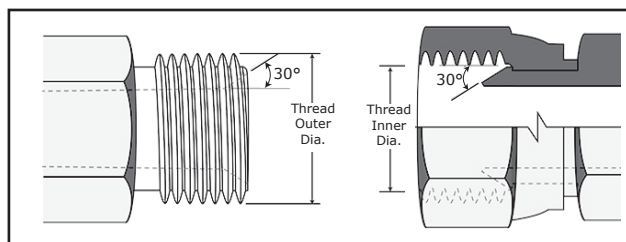


Inch Size	Dash Size	Nominal Thread Size	Male Thread OD (inch)		Female Thread ID (inch)	
			Fraction	Decimal	Fraction	Decimal
1/8	02	1/8 - 27	13/32	0.41	3/8	0.38
1/4	04	1/4 - 18	17/32	0.54	1/2	0.49
3/8	06	3/8 - 18	11/16	0.68	5/8	0.63
1/2	08	1/2 - 14	27/32	0.84	25/32	0.77
3/4	12	3/4 - 14	1 1/16	1.05	1	0.98
1	16	1 - 11 1/2	1 5/16	1.32	1 1/4	1.24
1 1/4	20	1 1/4 - 11 1/2	1 21/32	1.66	1 19/32	1.58
1 1/2	24	1 1/2 - 11 1/2	1 29/32	1.90	1 13/16	1.82
2	32	2 - 11 1/2	2 3/8	2.38	2 5/16	2.30

This connection is sometimes used in fluid power systems. The female half has a straight thread and an inverted 30° seat. The male half of the connection has a straight thread and a 30° internal chamfer. The seal takes place by compression of the 30° seat on the chamfer. The threads hold the connection mechanically.

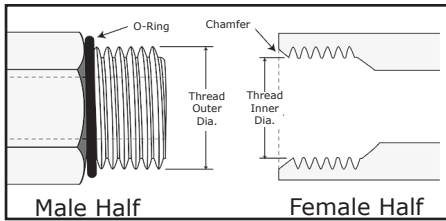
Note: A properly chamfered NPTF male will also seal with the NPSM female.

NPSM (National Pipe Straight Mechanical)



Inch Size	Dash Size	Nominal Thread Size	Male Thread OD (inch)		Female Thread ID (inch)	
			Fraction	Decimal	Fraction	Decimal
1/8	02	1/8 - 27	13/32	0.41	3/8	0.38
1/4	04	1/4 - 18	17/32	0.54	1/2	0.49
3/8	06	3/8 - 18	11/16	0.68	5/8	0.63
1/2	08	1/2 - 14	27/32	0.84	25/32	0.77
3/4	12	3/4 - 14	1 1/16	1.05	1	0.98
1	16	1 - 11 1/2	1 5/16	1.32	1 1/4	1.24
1 1/4	20	1 1/4 - 11 1/2	1 21/32	1.66	1 19/32	1.58
1 1/2	24	1 1/2 - 11 1/2	1 29/32	1.90	1 13/16	1.82
2	32	2 - 11 1/2	2 3/8	2.38	2 5/16	2.30

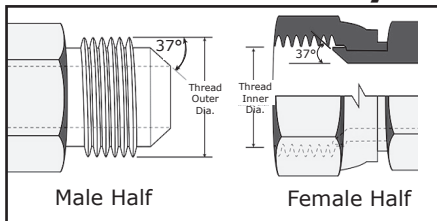
SAE J514 Straight Thread O-ring Boss (ORB)



This port connection is recommended by the NFPA for optimum leakage control in medium and high-pressure hydraulic systems. The male connector has a straight thread and an O-ring. The female port has a straight thread, a machined surface (minimum spotface) and a chamfer to accept the O-ring. The seal takes place by compressing the O-ring into the chamfer. The threads hold the connection mechanically.

Inch Size	Dash Size	Nominal Thread Size	Male Thread OD (inch)		Female Thread ID (inch)	
			Fraction	Decimal	Fraction	Decimal
1/8	02	5/16 - 24	5/16	0.31	9/32	0.27
3/16	03	3/8 - 24	3/8	0.38	11/32	0.34
1/4	04	7/16 - 20	7/16	0.44	13/32	0.39
5/16	05	1/2 - 20	1/2	0.50	15/32	0.45
3/8	06	9/16 - 18	9/16	0.56	17/32	0.51
1/2	08	3/4 - 16	3/4	0.75	11/16	0.69
5/8	10	7/8 - 14	7/8	0.88	13/16	0.81
3/4	12	1 1/16 - 12	1 1/16	1.06	1	0.98
1	16	1 5/16 - 12	1 5/16	1.31	1 1/4	1.23
1 1/4	20	1 7/8 - 12	1 7/8	1.63	1 9/16	1.54
1 1/2	24	1 7/8 - 12	1 7/8	1.88	1 13/16	1.79
2	32	2 1/2 - 12	2 1/2	2.50	2 7/16	2.42

SAE J514 37°* Hydraulic



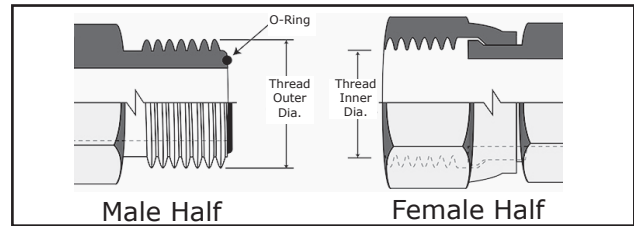
This connection is very common in fluid power systems. Both the male and female halves of the connections have 37° seats. The seal takes place by establishing a line contact between the

male flare and the female cone seat. The threads hold the connection mechanically. **Caution:** In the -02, -03, -04, -05, -08 and -10 sizes, the threads of the SAE 45° flare and the SAE 37° flare are the same. However, the sealing surface angles are not the same.

Inch Size	Dash Size	Nominal Thread Size	Male Thread OD (inch)		Female Thread ID (inch)	
			Fraction	Decimal	Fraction	Decimal
1/8	02	5/16 - 24	5/16	0.31	9/32	0.27
3/16	03	3/8 - 24	3/8	0.38	11/32	0.34
1/4	04	7/16 - 20	7/16	0.44	13/32	0.39
5/16	05	1/2 - 20	1/2	0.50	15/32	0.45
3/8	06	9/16 - 18	9/16	0.56	17/32	0.51
1/2	08	3/4 - 16	3/4	0.75	11/16	0.69
5/8	10	7/8 - 14	7/8	0.88	13/16	0.81
3/4	12	1 1/16 - 12	1 1/16	1.06	1	0.98
1	16	1 5/16 - 12	1 5/16	1.31	1 1/4	1.23
1 1/4	20	1 7/8 - 12	1 7/8	1.63	1 9/16	1.54
1 1/2	24	1 7/8 - 12	1 7/8	1.88	1 13/16	1.79
2	32	2 1/2 - 12	2 1/2	2.50	2 7/16	2.42

*This connection was formerly known as JIC.

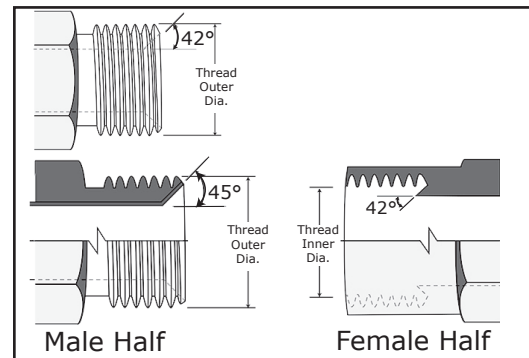
ORS/ORFS SAE J1453 O-ring Face Seal



This connection offers the very best leakage control available today. The male connector has a straight thread and an O-ring in the face. The female has a straight thread and a machined flat face. The seal takes place by compressing the O-ring onto the flat face of the female, similar to the split flange type fitting. The threads hold the connection mechanically.

Inch size	Dash size	Nominal Thread size	Male Thread OD (inch)		Female Thread ID (inch)	
			Fraction	Decimal	Fraction	Decimal
1/4	04	9/16 - 18	9/16	0.56	17/32	0.51
3/8	06	11/16 - 16	11/16	0.69	5/8	0.63
1/2	08	13/16 - 16	13/16	0.82	3/4	0.75
5/8	10	1 - 14	1	1.00	15/16	0.93
3/4	12	13/16 - 12	1 13/16	1.19	1 1/8	1.11
1	16	1 7/16 - 12	1 7/16	1.44	1 3/8	1.36
1 1/4	20	1 11/16 - 12	1 11/16	1.69	1 5/8	1.61
1 1/2	24	2 - 12	2	2.00	1 15/16	1.92

SAE J512 Inverted

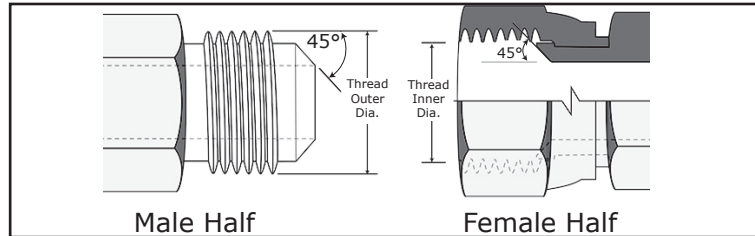


This connection is frequently used in automotive systems. The male connector can either be a 45° flare in the tube fitting form or a 42° seat in the machined adapter form. The female has a straight thread with a 42° inverted flare. The seal takes place on the flared surfaces. The threads hold the connection mechanically.

Inch Size	Dash Size	Nominal Thread Size	Male Thread OD (inch)		Female Thread ID (inch)	
			Fraction	Decimal	Fraction	Decimal
1/8	02	5/16 - 28	5/16	0.32	9/32	0.28
3/16	03	3/8 - 24	3/8	0.38	11/32	0.34
1/4	04	7/16 - 24	7/16	0.44	13/32	0.40
5/16	05	1/2 - 20	1/2	0.50	15/32	0.45
3/8	06	5/8 - 18	5/8	0.63	9/16	0.57
7/16	07	1 1/16 - 18	1 1/16	0.69	5/8	0.63
1/2	08	3/4 - 18	3/4	0.75	23/32	0.70
5/8	10	7/8 - 18	7/8	0.88	13/16	0.82
3/4	12	1 1/16 - 16	1 1/16	1.06	1	1.00

SAE J512 45°

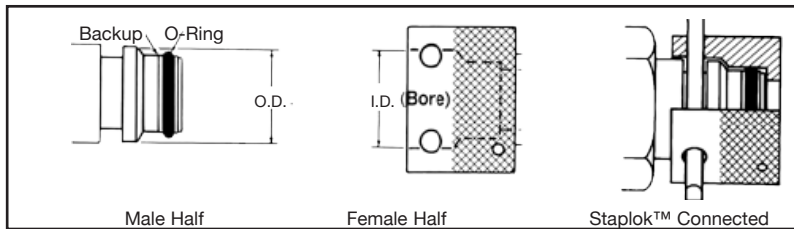
This connection is commonly used in refrigeration, automotive and truck piping systems. The connector is frequently made of brass. Both the male and female connectors have 45° seats. The seal takes place between the male flare and the female cone seat. The threads hold the connection mechanically.



Caution: In the -02, -03, -04, -05, -08 and -10 sizes, the threads of the SAE 45° flare and SAE 37° flare are the same. However, the sealing surface angles are not the same.

Inch Size	Dash Size	Nominal Thread Size	Male Thread OD (inch)		Female Thread ID (inch)	
			Fraction	Decimal	Fraction	Decimal
1/8	02	5/16 - 24	5/16	0.31	9/32	0.27
3/16	03	3/8 - 24	3/8	0.38	11/32	0.34
1/4	04	7/16 - 20	7/16	0.44	13/32	0.39
5/16	05	1/2 - 20	1/2	0.50	15/32	0.45
3/8	06	5/8 - 18	5/8	0.63	9/16	0.57
1/2	08	3/4 - 16	3/4	0.75	11/16	0.69
5/8	10	7/8 - 14	7/8	0.88	13/16	0.81
3/4	12	1 1/16 - 14	1 1/16	1.06	1	0.99
7/8	14	1 1/4 - 12	1 1/4	1.25	1 5/32	1.16
1	16	1 3/8 - 12	1 3/8	1.38	1 9/32	1.29

SAE J1467



This is a radial O-Ring seal connection developed in Germany and commonly used for hydraulic applications in underground mines. The male contains an exterior O-Ring and backup ring, plus a groove to accept the "staple". The female has a smooth bore with two holes for the staple. A "U" shaped retaining clip or staple is inserted through the two holes, passing through the groove in the male to lock the connection together. The seal takes place by contact between the O-Ring in the male and the smooth bore of the female. Many manufacturer's of hose ends and fittings provide products based on this design which is commonly referred to as Staplok. Staplok is a registered trademark of Aeroquip Corporation.

Inch Size	Dash Size	Nominal Thread Size	Male Thread OD (inch)		Female Thread ID (inch)	
			Fraction	Decimal	Fraction	Decimal
1/4	04	-	9/32	0.586	19/32	0.597
3/8	06	-	25/32	0.783	51/64	0.794
1/2	08	-	15/16	0.940	61/64	0.951
3/4	12	-	19/64	1.137	19/64	1.148
1	16	-	1 17/32	1.529	1 35/64	1.540
1 1/4	20	-	1 13/16	1.806	1 13/16	1.817
1 1/2	24	-	2 5/32	2.163	2 11/64	2.174
2	32	-	2 33/64	2.517	2 17/32	2.528

† Measure to the closest 1/64-inch.

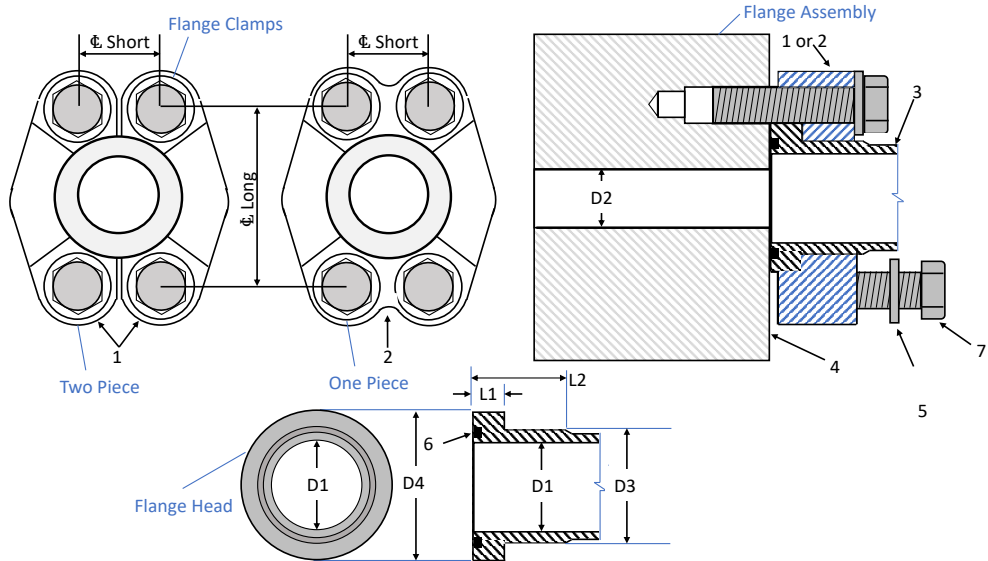
C & C JP TEST STATION 2 LAMINATE 5 OF 6

Code 61 & 62 (Split and One-Piece Clamps)

This connection is commonly used in fluid power systems. There are two pressure ratings. Code 61 is referred to as the "standard" series and Code 62 is the "6000 psi" series. The design concept for both series is the same, but the bolt hole spacing and flanged head diameters are larger for the higher pressure, Code 62 connection.

The female (port) is an unthreaded hole with four bolt holes in a rectangular pattern around the port. The male consists of a flanged head, grooved for an O-Ring, and either a captive flange or split flange halves with bolt holes to match the port. The seal takes place on the O-Ring, which is compressed between the flange head and the flat surface surrounding the port. The threaded bolts hold the connection together.

*SAE J518, JIS B 8363, ISO/DIS 6162 and DIN 20066 are interchangeable, except for bolt sizes.



Nominal Size	ISO and SAE Code 61 Flange Data							
	1	2	3	4	5	D2		
	Two-piece flange clamp	One-piece flange clamp	Flanged head	Mounting face	Flat Washer	D2 must not be greater than D1		
mm						in	mm	in
13						0.50	M8	11.5 - 13.0
19	0.75	M10	17.7 - 19.2	0.69 - 0.75				
25	1.00	M10	24.1 - 25.6	0.94 - 1.00				
32	1.25	M10	30.5 - 32.0	1.19 - 1.25				
38	1.50	M12	36.7 - 38.2	1.44 - 1.50				
51	2.00	M12	49.5 - 51.0	1.94 - 2.00				

Nominal Size	ISO and SAE Code 62 Flange data							
	1	2	3	4	5	D2		
	Two-piece flange clamp	One-piece flange clamp	Flanged head	Mounting face	Flat Washer	D2 must not be greater than D1		
mm						in	mm	in
13						0.50	M8	11.5 - 13.0
19	0.75	M10	17.7 - 19.2	0.69 - 0.75				
25	1.00	M10	24.1 - 25.6	0.94 - 1.00				
32	1.25	M10	30.5 - 32.0	1.19 - 1.25				
38	1.50	M12	36.7 - 38.2	1.44 - 1.50				
51	2.00	M12	49.5 - 51.0	1.94 - 2.00				

Nominal Size		O-ring code (6)	D1		D3		D4	
mm	in		mm	in	mm	in	mm	in
13	0.50	210	13.0	0.50	23.9	0.941	30.2	1.189
19	0.75	214	19.2	0.75	31.8	1.252	38.1	1.500
25	1.00	219	25.6	1.00	38.1	1.500	44.45	1.750
32	1.25	222	32.0	1.25	43.2	1.701	50.8	2.000
38	1.50	225	38.2	1.50	50.3	1.980	60.35	2.376
51	2.00	228	51.0	2.00	62.2	2.449	71.4	2.811

Nominal Size		O-ring code (6)	D1		D3		D4	
mm	in		mm	in	mm	in	mm	in
13	0.50	210	13.0	0.50	23.9	0.941	31.75	1.250
19	0.75	214	19.2	0.75	31.8	1.252	41.30	1.626
25	1.00	219	25.6	1.00	38.1	1.500	47.65	1.876
32	1.25	222	32.0	1.25	43.7	1.720	54.00	2.126
38	1.50	225	38.2	1.50	50.8	2.000	63.50	2.500
51	2.00	228	51.0	2.00	66.5	2.618	79.40	3.126

7									
Nominal Size		Screw Thread		Screw Torque		Long		Short	
mm	in	Metric	U.S.	Nm	ft-lb	mm	in	mm	in
13	0.50	M8	5/16 - 18	32	24	38.1	1.500	17.5	0.688
19	0.75	M10	3/8 - 16	70	52	47.6	1.875	22.2	0.875
25	1.00	M10	3/8 - 16	70	52	52.4	2.062	26.2	1.031
32	1.25	M10	7/16 - 14	70	52	58.7	2.312	30.2	1.188
38	1.50	M12	1/2 - 13	130	96	69.9	2.750	35.7	1.406
51	2.00	M12	1/2 - 13	130	96	77.8	3.062	42.9	1.688

7									
Nominal Size		Screw Thread		Screw Torque		Long		Short	
mm	in	Metric	U.S.	Nm	ft-lb	mm	in	mm	in
13	0.50	M8	5/16 - 18	32	24	40.5	1.594	18.2	0.718
19	0.75	M10	3/8 - 16	70	52	50.8	2.000	23.8	0.937
25	1.00	M12	7/16 - 14	130	96	57.2	2.252	27.8	1.093
32	1.25	M12	1/2 - 13	130	96	66.7	2.625	31.8	1.250
38	1.50	M16	5/8 - 11	295	218	79.4	3.125	36.5	1.437
51	2.00	M20	3/4 - 10	550	407	96.8	3.812	44.5	1.750

For more detailed information, refer to ISO 6162-1

For more detailed information, refer to ISO 6162-2

C & C JP TEST STATION 2 - LAMINATE 6 OF 6

Conversion Chart

Fraction > Decimal > mm

Fraction	Decimal	mm	Fraction	Decimal	mm	Fraction	Decimal	mm	Fraction	Decimal	mm
1/64	0.016	0.397	1 1/64	1.016	25.797	2 1/64	2.016	51.197	3 1/64	3.016	76.597
1/32	0.031	0.794	1 1/32	1.031	26.194	2 1/32	2.031	51.594	3 1/32	3.031	76.994
3/64	0.047	1.191	1 3/64	1.047	26.591	2 3/64	2.047	51.991	3 3/64	3.047	77.391
1/16	0.063	1.588	1 1/16	1.063	26.988	2 1/16	2.063	52.388	3 1/16	3.063	77.788
5/64	0.078	1.984	1 5/64	1.078	27.384	2 5/64	2.078	52.784	3 5/64	3.078	78.184
3/32	0.094	2.381	1 3/32	1.094	27.781	2 3/32	2.094	53.181	3 3/32	3.094	78.581
7/64	0.109	2.778	1 7/64	1.109	28.178	2 7/64	2.109	53.578	3 7/64	3.109	78.978
1/8	0.125	3.175	1 1/8	1.125	28.575	2 1/8	2.125	53.975	3 1/8	3.125	79.375
9/64	0.141	3.572	1 9/64	1.141	28.972	2 9/64	2.141	54.372	3 9/64	3.141	79.772
5/32	0.156	3.969	1 5/32	1.156	29.369	2 5/32	2.156	54.769	3 5/32	3.156	80.169
11/64	0.172	4.366	1 11/64	1.172	29.766	2 11/64	2.172	55.166	3 11/64	3.172	80.566
3/16	0.188	4.763	1 3/16	1.188	30.163	2 3/16	2.188	55.563	3 3/16	3.188	80.963
13/64	0.203	5.159	1 13/64	1.203	30.559	2 13/64	2.203	55.959	3 13/64	3.203	81.359
7/32	0.219	5.556	1 7/32	1.219	30.956	2 7/32	2.219	56.356	3 7/32	3.219	81.756
15/64	0.234	5.953	1 15/64	1.234	31.353	2 15/64	2.234	56.753	3 15/64	3.234	82.153
1/4	0.250	6.350	1 1/4	1.250	31.750	2 1/4	2.250	57.150	3 1/4	3.250	82.550
17/64	0.266	6.747	1 17/64	1.266	32.147	2 17/64	2.266	57.547	3 17/64	3.266	82.947
9/32	0.281	7.144	1 9/32	1.281	32.544	2 9/32	2.281	57.944	3 9/32	3.281	83.344
19/64	0.297	7.541	1 19/64	1.297	32.941	2 19/64	2.297	58.341	3 19/64	3.297	83.741
5/16	0.313	7.938	1 5/16	1.313	33.338	2 5/16	2.313	58.738	3 5/16	3.313	84.138
21/64	0.328	8.334	1 21/64	1.328	33.734	2 21/64	2.328	59.134	3 21/64	3.328	84.534
11/32	0.344	8.731	1 11/32	1.344	34.131	2 11/32	2.344	59.531	3 11/32	3.344	84.931
23/64	0.359	9.128	1 23/64	1.359	34.528	2 23/64	2.359	59.928	3 23/64	3.359	85.328
3/8	0.375	9.525	1 3/8	1.375	34.925	2 3/8	2.375	60.325	3 3/8	3.375	85.725
25/64	0.391	9.922	1 25/64	1.391	35.322	2 25/64	2.391	60.722	3 25/64	3.391	86.122
13/32	0.406	10.319	1 13/32	1.406	35.719	2 13/32	2.406	61.119	3 13/32	3.406	86.519
27/64	0.422	10.716	1 27/64	1.422	36.116	2 27/64	2.422	61.516	3 27/64	3.422	86.916
7/16	0.438	11.113	1 7/16	1.438	36.513	2 7/16	2.438	61.913	3 7/16	3.438	87.313
29/64	0.453	11.509	1 29/64	1.453	36.909	2 29/64	2.453	62.309	3 29/64	3.453	87.709
15/32	0.469	11.906	1 15/32	1.469	37.306	2 15/32	2.469	62.706	3 15/32	3.469	88.106
31/64	0.484	12.303	1 31/64	1.484	37.703	2 31/64	2.484	63.103	3 31/64	3.484	88.503
1/2	0.500	12.700	1 1/2	1.500	38.100	2 1/2	2.500	63.500	3 1/2	3.500	88.900
33/64	0.516	13.097	1 33/64	1.516	38.497	2 33/64	2.516	63.897	3 33/64	3.516	89.297
17/32	0.531	13.494	1 17/32	1.531	38.894	2 17/32	2.531	64.294	3 17/32	3.531	89.694
35/64	0.547	13.891	1 35/64	1.547	39.291	2 35/64	2.547	64.691	3 35/64	3.547	90.091
9/16	0.563	14.288	1 9/16	1.563	39.688	2 9/16	2.563	65.088	3 9/16	3.563	90.488
37/64	0.578	14.684	1 37/64	1.578	40.084	2 37/64	2.578	65.484	3 37/64	3.578	90.884
19/32	0.594	15.081	1 19/32	1.594	40.481	2 19/32	2.594	65.881	3 19/32	3.594	91.281
39/64	0.609	15.478	1 39/64	1.609	40.878	2 39/64	2.609	66.278	3 39/64	3.609	91.678
5/8	0.625	15.875	1 5/8	1.625	41.275	2 5/8	2.625	66.675	3 5/8	3.625	92.075
41/64	0.641	16.272	1 41/64	1.641	41.672	2 41/64	2.641	67.072	3 41/64	3.641	92.472
21/32	0.656	16.669	1 21/32	1.656	42.069	2 21/32	2.656	67.469	3 21/32	3.656	92.869
43/64	0.672	17.066	1 43/64	1.672	42.466	2 43/64	2.672	67.866	3 43/64	3.672	93.266
11/16	0.688	17.463	1 11/16	1.688	42.863	2 11/16	2.688	68.263	3 11/16	3.688	93.663
45/64	0.703	17.859	1 45/64	1.703	43.259	2 45/64	2.703	68.659	3 45/64	3.703	94.059
23/32	0.719	18.256	1 23/32	1.719	43.656	2 23/32	2.719	69.056	3 23/32	3.719	94.456
47/64	0.734	18.653	1 47/64	1.734	44.053	2 47/64	2.734	69.453	3 47/64	3.734	94.853
3/4	0.750	19.050	1 3/4	1.750	44.450	2 3/4	2.750	69.850	3 3/4	3.750	95.250
49/64	0.766	19.447	1 49/64	1.766	44.847	2 49/64	2.766	70.247	3 49/64	3.766	95.647
25/32	0.781	19.844	1 25/32	1.781	45.244	2 25/32	2.781	70.644	3 25/32	3.781	96.044
51/64	0.797	20.241	1 51/64	1.797	45.641	2 51/64	2.797	71.041	3 51/64	3.797	96.441
13/16	0.813	20.638	1 13/16	1.813	46.038	2 13/16	2.813	71.438	3 13/16	3.813	96.838
53/64	0.828	21.034	1 53/64	1.828	46.434	2 53/64	2.828	71.834	3 53/64	3.828	97.234
27/32	0.844	21.431	1 27/32	1.844	46.831	2 27/32	2.844	72.231	3 27/32	3.844	97.631
55/64	0.859	21.828	1 55/64	1.859	47.228	2 55/64	2.859	72.628	3 55/64	3.859	98.028
7/8	0.875	22.225	1 7/8	1.875	47.625	2 7/8	2.875	73.025	3 7/8	3.875	98.425
57/64	0.891	22.622	1 57/64	1.891	48.022	2 57/64	2.891	73.422	3 57/64	3.891	98.822
29/32	0.906	23.019	1 29/32	1.906	48.419	2 29/32	2.906	73.819	3 29/32	3.906	99.219
59/64	0.922	23.416	1 59/64	1.922	48.816	2 59/64	2.922	74.216	3 59/64	3.922	99.616
15/16	0.938	23.813	1 15/16	1.938	49.213	2 15/16	2.938	74.613	3 15/16	3.938	100.013
61/64	0.953	24.209	1 61/64	1.953	49.609	2 61/64	2.953	75.009	3 61/64	3.953	100.409
31/32	0.969	24.606	1 31/32	1.969	50.006	2 31/32	2.969	75.406	3 31/32	3.969	100.806
63/64	0.984	25.003	1 63/64	1.984	50.403	2 63/64	2.984	75.803	3 63/64	3.984	101.203
1	1.000	25.400	2	2.000	50.800	3	3.000	76.200	4	4.000	101.600

CONNECTOR & CONDUCTOR CERTIFICATION

STATION #3

MEASUREMENTS



TOOLS NEEDED:

- Digital Caliper
- 12" Scale
- Protractor
- Calculator With Solar Cell
- Thread Gauge Kit
- Flashlight
- Magnifying Glass

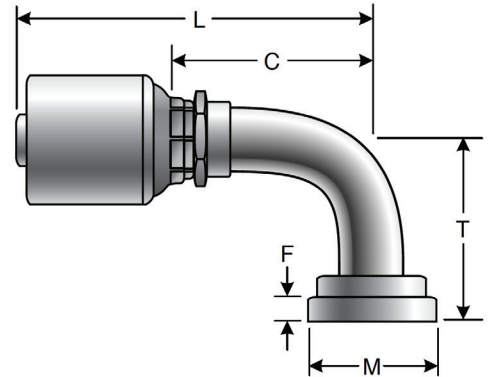
LAMINATED CHARTS:

- 3 Hose End Dimensional Charts

Hose Ends and Dimensions

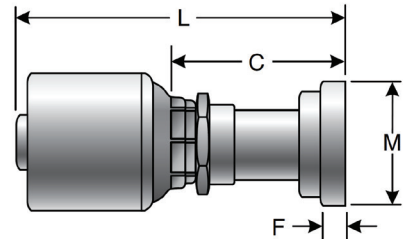
90° Code 61 Flange

Flange end	Hose Size	M	Length	C
-8	-8	1.19	3.59	2.11
-12	-8	1.50	3.6	2.13
-12	-10	1.50	3.94	2.46
-12	-12	1.50	4.54	2.53
-16	-12	1.75	4.72	2.71
-16	-16	1.75	5.48	3.25



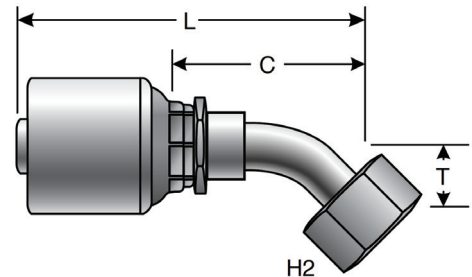
Straight Code 61 Flange

Flange end	Hose Size	M	Length	C
-8	-8	1.19	3.15	1.67
-12	-8	1.50	3.15	1.67
-12	-12	1.50	3.86	1.85
-16	-12	1.75	3.5	1.49
-16	-16	1.75	4.13	1.9



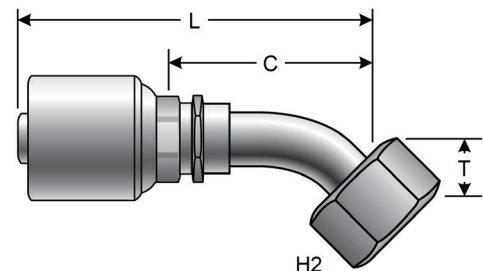
45° Bent Tube Female 37° Flare Swivel

Swivel End	Hose Size	Length	C
7/16 - 20	-4	2.74	1.72
9/16 - 18	-4	2.69	1.67
9/16 - 18	-6	3.05	1.95
3/4 - 16	-8	3.42	1.95
7/8 - 14	-8	3.81	2.34
1-1/16 - 12	-12	5.09	3.08



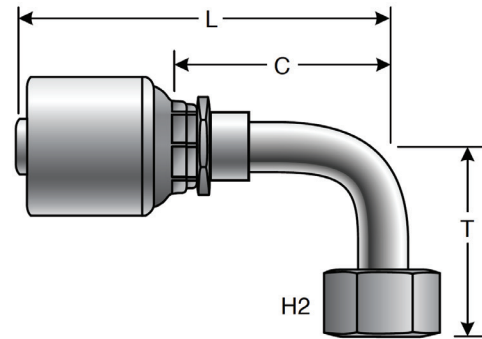
45° Bent Tube Female ORFS Swivel

Swivel End	Hose Size	Length	C
9/16 - 18	-4	2.57	1.54
11/16 - 16	-4	2.70	1.67
11/16 - 16	-6	2.75	1.65
13/16 - 16	-8	3.50	2.03
1 - 14	-8	3.98	2.5
1-3/16 - 12	-12	4.66	2.65

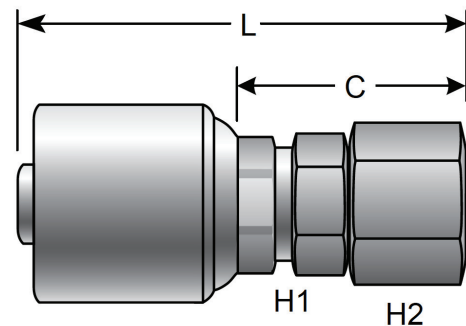


Hose Ends and Dimensions

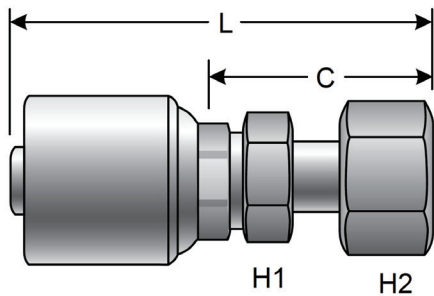
90° Bent Tube Female 37° Flare Swivel			
Swivel End	Hose Size	Length	C
7/16 - 20	-4	2.48	1.76
1/2 - 20	-4	2.25	1.23
9/16 - 18	-6	3.01	1.91
3/4 - 16	-6	3.31	2.21
3/4 - 16	-8	3.04	1.3



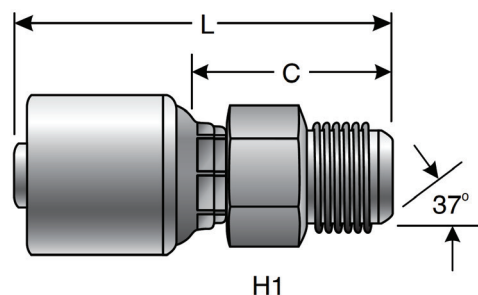
Female 37° Flare Swivel			
Swivel End	Hose Size	Length	C
7/16 - 20	-4	2.20	1.18
1/2 - 20	-4	2.30	1.27
9/16 - 18	-4	2.35	1.32
7/16 - 20	-6	2.94	1.84
1/2 - 20	-6	2.96	1.86
9/16 - 18	-6	2.42	1.29
3/4 - 16	-6	2.63	1.49
7/8 - 14	-6	2.76	1.62
9/16 - 18	-8	3.81	2.33
3/4 - 16	-8	2.88	1.5
7/8 - 14	-8	3.01	1.63
1-1/16 - 12	-8	3.06	1.67



Female ORFS Swivel			
Swivel End	Hose Size	Length	C
9/16 - 18	-4	2.07	1.05
11/16 - 16	-4	2.01	0.99
11/16 - 16	-6	2.27	1.14
13/16 - 16	-8	2.62	1.23
1 - 14	-8	2.76	1.37
1-3/16 - 12	-12	3.65	1.65
1-7/16 - 12	-12	3.48	1.47



Male 37° Flare			
Male End	Hose Size	Length	C
7/16 - 20	-4	2.19	1.16
1/2 - 20	-4	2.19	1.16
9/16 - 18	-4	2.22	1.2
9/16 - 18	-6	2.30	1.2



Hose Ends and Dimensions

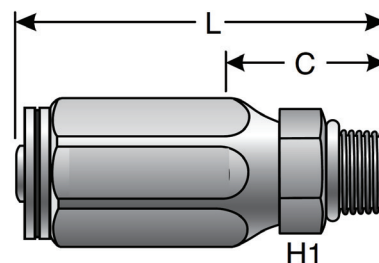
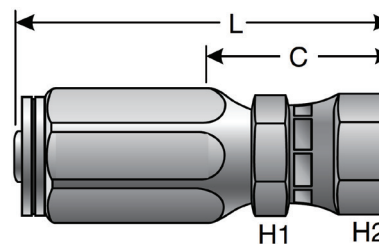
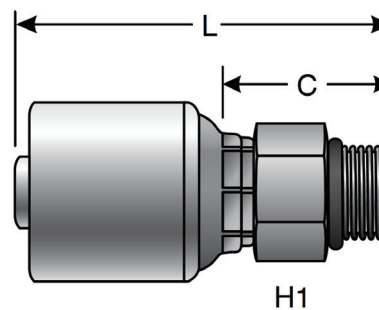
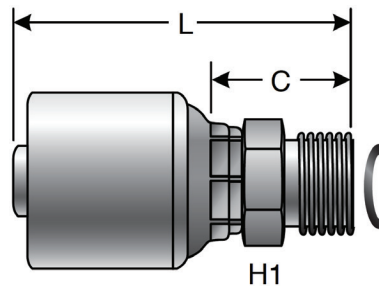
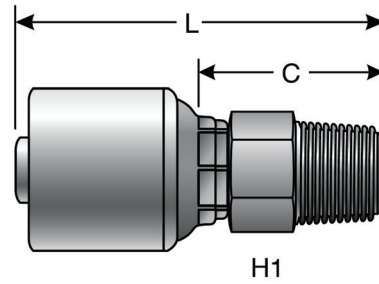
Male NPFT			
Male End	Hose Size	Length	C
1/8 - 27	-4	1.96	0.94
1/4 - 18	-4	2.17	1.14
3/8 - 18	-4	2.17	1.14
3/8 - 18	-6	2.32	1.22
1/2 - 14	-6	2.51	1.42
3/8 - 18	-8	2.72	1.24
1/2 - 14	-8	2.87	1.4
3/4 - 14	-8	2.95	1.47
3/4 - 14	-12	3.46	1.45
1 - 11-1/2	-12	3.77	1.77

Male ORFS			
Male End	Hose Size	Length	C
9/16 - 18	-4	2.07	1.04
11/16 - 16	-6	2.20	1.11
13/16 - 16	-8	2.69	1.21
1-3/16 - 12	-12	3.54	1.54
1-7/16 - 12	-16	4.02	1.78
1-11/16 - 12	-20	4.29	1.97

Male O-ring Boss			
Male End	Hose Size	Length	C
7/16 - 20	-4	1.99	0.96
1/2 - 20	-4	1.99	0.96
9/16 - 18	-4	2.05	1.02
9/16 - 18	-6	2.20	1.11
3/4 - 16	-6	2.28	1.19
7/8 - 14	-6	2.22	1.13
3/4 - 16	-8	2.64	1.16
7/8 - 14	-8	2.68	1.2
1-1/16 - 12	-8	2.91	1.44

FA Female 37° Flare Swivel			
Swivel End	Hose Size	Length	C
7/16 - 20	-4	2.47	1.46
1/2 - 20	-4	2.58	1.57
9/16 - 18	-6	2.80	1.65
3/4 - 16	-6	2.91	1.76
3/4 - 16	-8	3.24	1.89
7/8 - 14	-8	3.34	1.99
1-1/16 - 12	-12	3.45	1.91

FA Male O-ring Boss			
Male End	Hose Size	Length	C
9/16 - 18	-6	2.52	1.24
3/4 - 16	-6	2.59	1.32
3/4 - 16	-8	2.87	1.52
7/8 - 14	-8	3.11	1.76



CONNECTOR & CONDUCTOR CERTIFICATION

STATION #4

HOSE & TUBE

IDENTIFICATION



TOOLS NEEDED:

- Dial Caliper
- Magnet
- Flashlight

LAMINATED CHARTS:

- 4 Hose and Tubing Specifications

C & C JP TEST STATION 4 - LAMINATE 2 OF 4

Steel Tubing Data

Steel tubing is called out by outside diameter and wall thickness. For hydraulic plumbing, use a low carbon seamless steel tubing which can be bent and flared without cracking. Order "hydraulic grade" tubing. Pressure ratings in this table are based on a tubing with tensile strength of 55,000 PSI, and were calculated by Barlow's formula: $P = (2t \cdot S) / O$, in which P = burst strength in PSI, t = wall thickness, S = tensile strength in PSI, and O = outside diameter. This formula may be used to calculate tubing sizes not listed. For pressure rating at other safety factors, take burst PSI and divide by desired design factor.

Tube Dimensions (English)				Carbon Steel			Stainless Steel		
Tube OD	Wall Thickness	Tube ID	ID Area (sq-in)	CS Burst Pressure	WP - 6:1 (psig)	WP - 4:1 (psig)	SS Burst Pressure	WP - 6:1 (psig)	WP - 4:1 (psig)
1/4"	0.035	0.180	0.025	14000	2333	3500	21000	3500	5250
-4	0.042	0.166	0.022	16800	2800	4200	25200	4200	6300
	0.049	0.152	0.018	19600	3267	4900	29400	4900	7350
	0.058	0.134	0.014	23200	3867	5800	34800	5800	8700
	0.065	0.120	0.011	26000	4333	6500	39000	6500	9750
3/8"	0.035	0.305	0.073	9333	1556	2333	14000	2333	3500
-6	0.042	0.291	0.067	11200	1867	2800	16800	2800	4200
	0.049	0.277	0.060	13067	2178	3267	19600	3267	4900
	0.058	0.259	0.053	15467	2578	3867	23200	3867	5800
	0.065	0.245	0.047	17333	2889	4333	26000	4333	6500
1/2"	0.035	0.430	0.145	7000	1167	1750	10500	1750	2625
-8	0.042	0.416	0.136	8400	1400	2100	12600	2100	3150
	0.049	0.402	0.127	9800	1633	2450	14700	2450	3675
	0.058	0.384	0.116	11600	1933	2900	17400	2900	4350
	0.065	0.370	0.108	13000	2167	3250	19500	3250	4875
	0.072	0.356	0.100	14400	2400	3600	21600	3600	5400
	0.083	0.334	0.088	16600	2767	4150	24900	4150	6225
5/8"	0.035	0.555	0.242	5600	933	1400	8400	1400	2100
-10	0.042	0.541	0.230	6720	1120	1680	10080	1680	2520
	0.049	0.527	0.218	7840	1307	1960	11760	1960	2940
	0.058	0.509	0.203	9280	1547	2320	13920	2320	3480
	0.065	0.495	0.192	10400	1733	2600	15600	2600	3900
	0.072	0.481	0.182	11520	1920	2880	17280	2880	4320
	0.083	0.459	0.165	13280	2213	3320	19920	3320	4980
	0.095	0.435	0.149	15200	2533	3800	22800	3800	5700
3/4"	0.049	0.652	0.334	6533	1089	1633	9800	1633	2450
-12	0.058	0.634	0.316	7733	1289	1933	11600	1933	2900
	0.065	0.620	0.302	8667	1444	2167	13000	2167	3250
	0.072	0.606	0.288	9600	1600	2400	14400	2400	3600
	0.083	0.584	0.268	11067	1844	2767	16600	2767	4150
	0.095	0.560	0.246	12667	2111	3167	19000	3167	4750
	0.109	0.532	0.222	14533	2422	3633	21800	3633	5450
1"	0.049	0.902	0.639	4900	817	1225	7350	1225	1838
-16	0.058	0.884	0.614	5800	967	1450	8700	1450	2175
	0.065	0.870	0.594	6500	1083	1625	9750	1625	2438
	0.072	0.856	0.576	7200	1200	1800	10800	1800	2700
	0.083	0.834	0.546	8300	1383	2075	12450	2075	3113
	0.095	0.810	0.515	9500	1583	2375	14250	2375	3563
	0.109	0.782	0.480	10900	1817	2725	16350	2725	4088
	0.120	0.760	0.454	12000	2000	3000	18000	3000	4500
1-1/4"	0.049	1.152	1.042	3920	653	980	5880	980	1470
-20	0.058	1.134	1.010	4640	773	1160	6960	1160	1740
	0.065	1.120	0.985	5200	867	1300	7800	1300	1950
	0.072	1.106	0.961	5760	960	1440	8640	1440	2160
	0.083	1.084	0.923	6640	1107	1660	9960	1660	2490
	0.095	1.060	0.882	7600	1267	1900	11400	1900	2850
	0.109	1.032	0.836	8720	1453	2180	13080	2180	3270
	0.120	1.010	0.801	9600	1600	2400	14400	2400	3600
	0.156	0.938	0.691	12480	2080	3120	18720	3120	4680
	0.188	0.874	0.600	15040	2507	3760	22560	3760	5640

C & C JP TEST STATION 4 - LAMINATE 3 OF 4

SAE DIMENSIONAL AND PERFORMANCE STANDARDS FOR HYDRAULIC HOSE (J517 DATA)

SAE standard hydraulic hose type / application	Compatible Hydraulic fluids	Temp. Range (°F)	Diameter Range (I.D. in)	Max. Operating Range (psi)	Min. Bend Radius (in)	Graphical Representation
100R1 - Steel wire reinforced, rubber coated	Petroleum & water based	-40 to 212	3/16 to 2	580 to 3,625	3.5 to 25	
100R2 - High pressure steel wire, reinforced rubber cover	Petroleum & water based	-40 to 212	3/16 to 2	1,150 to 6,018	3.5 to 25	
100R3 - Double fiber, braid rubber cover – High temp, low pressure	Petroleum & water based	-40 to 212	3/16 to 1-1/4	377 to 1,523	3 to 10	
100R4 - Wire inserted, hydraulic suction and return	Petroleum & water based	-40 to 212	3/4 to 4	36 to 305	5 to 24	
100R5 - Single wire braid, textile cover – Transportation/ DOT	Petroleum & water based	-40 to 212	3/16 to 3-1/16	203 to 3045	3 to 33	
100R6 - Single fiber braid, rubber cover – Transportation	Petroleum & water based	-40 to 212	3/16 to 3/4	305 to 508	2 to 6	
100R7 - Single fiber braid, thermoplastic – Hydraulic	Petroleum, water based, & synthetic	-40 to 212	1/8 to 1	1,015 to 3,045	1 to 12	
100R8 - High pressure, thermoplastic Hydraulic	Petroleum, water based & synthetic	-40 to 212	1/8 to 1	2,030 to 6,090	1 to 12	
100R9	This hose has been removed from the SAE standard.					
100R10	This hose has been removed from the SAE standard.					
100R11	This hose has been removed from the SAE standard.					

C & C JP TEST STATION 4 - LAMINATE 4 OF 4

SAE DIMENSIONAL AND PERFORMANCE STANDARDS FOR HYDRAULIC HOSE (J517 DATA) CONT.

SAE standard hydraulic hose type / application	Compatible Hydraulic fluids	Temp. Range (°F)	Diameter Range (I.D. in)	Max. Operating Range (psi)	Min. Bend Radius (in)	Graphical Representation
100R12 - Heavy duty, high impulse, four spiral wire reinforced, rubber cover – Hydraulic	Petroleum & water based	-40 to 250	3/8 to 2	2,538 to 4,060	5 to 25	
100R13 - Heavy duty, high impulse, four & six spiral steel wire reinforced, rubber cover – Hydraulic	Petroleum & water based	-40 to 250	3/4 to 2	5,075	9.5 to 25	
100R14 - High temperature, corrosive fluids, Polytetrafluorethylene (PTFE) lined hydraulic hose, single stainless steel braid	Petroleum, water based, & synthetic	-65 to 400	3/16 to 1-1/4	609 to 1,523	1.5 to 16	
100R15 - Heavy duty, ultrahigh pressure, six spiral steel wire reinforced, rubber cover – Hydraulic	Petroleum based	-40 to 250	3/8 to 1-1/2	6,090	6 to 21	
100R16 - Compact, high pressure, two-braided wire reinforced rubber cover – Hydraulic hose cover	Petroleum & water based	-40 to 212	1/4 to 1-1/4	1,813 to 5,800	2 to 8	
100R17 - Compact, maximum operating pressure, one and two steel braided wire reinforced rubber cover – Hydraulic	Petroleum & water based	-40 to 212	3/16 to 1	3,045	2 to 6	
100R18 - Thermoplastic, synthetic fiber reinforcement, and a hydraulic fluid & weather resistant thermoplastic cover – Hydraulic	Petroleum, water based, synthetic	-40 to 212	1/8 to 1	3,045	1 to 10	
100R19 - Compact, maximum operating pressure, one and two-braided steel wire, reinforced rubber cover – Hydraulic	Petroleum & water based	-40 to 212	3/16 to 1	4,060	2 to 6	

CONNECTOR & CONDUCTOR CERTIFICATION

STATION #5

DIAGNOSTICS

NOTE: Only the information shown on the drawings is to appear on the test hoses. Holes drilled in hose and fitting are for tagging - not to be considered defects.



TOOLS NEEDED:

- Dial Caliper

LAMINATED CHARTS:

- 2 Skive and Crimp Data

C & C JP TEST STATION 5 - LAMINATE 1 OF 2

Hydraulic Hose With Skive Type 2-Piece Couplings **Important**

To assure a quality assembly, check the first assembly of each run. Measure the crimp O.D. and the crimp length and compare them with the figures listed in the "crimp diameter" column. If the ACTUAL crimped dimensions are within .005" of the specified crimp dimension, you have made a good setup (the crimp tolerance of + or - .010" covers running variation).

ALL DIMENSIONS ARE IN INCHES

Hose size	Hose type	Stem type	Ferrule		Skive Length Tol +/- 1/32	Crimp Diameter Tol +/- .010	Skive Diameter	Crimp Length
			Product No.	Catalog Desc.				
-3	3G2AT	3PC	7266-0007	3XC2F2	3/4	0.655	TO WIRE	FULL
-4	4G2AT	4PC	0034	4XC2F2	13/16	0.655	TO WIRE	FULL
-5	5G2AT	5PC	0038	5XC2F2	13/16	0.760	TO WIRE	FULL
-6	6G2AT	6PC	0033	6XC2F2	13/16	0.775	TO WIRE	FULL
-8	8G2AT	8PC	0002	8XC2F2	1 1/8	0.970	TO WIRE	FULL
-10	10G2AT	10PC	0810	10XC2F2	1 3/16	1.100	TO WIRE	FULL
-12	12G2AT	12PC	0018	12XC2F2	1 1/16	1.240	TO WIRE	FULL
-16	16G2AT	16PC	0013	16XC2F2	1 1/5	1.585	TO WIRE	FULL
-20	20G2AT	20PC	0022	20XC2F2	2 3/16	2.000	TO WIRE	FULL
-24	24G2AT	24PC	0035	24XC2F2	2 9/32	2.255	TO WIRE	FULL
-32	32G2AT	32PC	0037	32XC2F2	2 3/4	2.900	TO WIRE	FULL

Dash Size	Hose	Stem		Ferrule		Skive/Buf		Crimps			Crimper	
	Description	Size (In.)	Type	Description	Part No.	Length +/- .03 (in.)	Diameter (in.)	Insertion Length +/- .03 (in.)	Crimp Length +/- .03 (in.)	Crimp OD +/- .010 (in.)	Die Set	Approx. Digital Readout
10	G1H	5/8	10G	MegaCrimp	--	--	--	1.12	FULL	1.135	734	4.16
12	G1H	3/4	12G	MegaCrimp	--	--	--	1.50	FULL	1.350	735	5.89
16	G1H	1	16G	MegaCrimp	--	--	--	1.75	FULL	1.760	737 ²	6.65
20	G1H	1 1/4	20G	MegaCrimp	--	--	--	1.75	FULL	2.050	739 ²	4.25
8	G2AT-HMP	1/2	8G	MegaCrimp	--	--	--	1.25	FULL	1.050	733	7.58
10	G2AT-HMP	5/8	10G	MegaCrimp	--	--	--	1.12	FULL	1.170	734	5.89
12	G2AT-HMP	3/4	12G	MegaCrimp	--	--	--	1.50	FULL	1.385	735	8.17
16	G2AT-HMP	1	16G	MegaCrimp	--	--	--	1.75	FULL	1.780	737 ²	8.28
3	G2	3/16	3PC	3PC1FA	80431	--	--	--	FULL	0.655	731	5.25
3	G3	3/16	3PC	3PC1FS	80481	--	--	--	FULL	0.655	731	5.25
3	G4	3/16	3PC	3PC2F-2	80415	0.750	Wire	--	FULL	0.655	731	5.60
4	G5	1/4	4G	MegaCrimp	--	--	--	0.93	FULL	0.740	721	5.75
4	G6	1/4	4G	MegaCrimp	--	--	--	0.93	FULL	0.740	731	10.10
6	G7	3/8	6G	MegaCrimp	--	--	--	0.93	FULL	0.890	722	8.57
6	G8	3/8	6G	MegaCrimp	--	--	--	0.93	FULL	0.890	732	8.57
8	G9	1/2	8G	MegaCrimp	--	--	--	1.25	FULL	1.050	733	7.58
10	G10	5/8	10G	MegaCrimp	--	--	--	1.12	FULL	1.170	734	6.89
12	G11	3/4	12G	MegaCrimp	--	--	--	1.50	FULL	1.385	735	8.17
16	G12	1	16G	MegaCrimp	--	--	--	1.75	FULL	1.790	737 ¹	8.28
20	G13	1 1/4	20G	MegaCrimp	--	--	--	1.75	FULL	2.125	739 ¹	8.64

C & C JP TEST STATION 5 - LAMINATE 2 OF 2

Hose			Stem	Ferrule	Specifications				
Dash Size	Description	Size (in)	Type	Description	Skive Length (in) (+/- 0.03)	Skive Diameter (in)	Crimp Insertion Length (in) (+/- 0.03)	Crimp Length (in) (+/- 0.03)	Crimp Outside Diameter (in) (+/- 0.01)
4	G1	0.25	4G	One-Piece	NONE	NONE	0.93	FULL	0.705
4	G1	0.25	4G	One-Piece	NONE	NONE	0.93	FULL	0.705
6	G1	0.37	6G	One-Piece	NONE	NONE	0.93	FULL	0.860
6	G1	0.37	6G	One-Piece	NONE	NONE	0.93	FULL	0.860
8	G1	0.5	8G	One-Piece	NONE	NONE	1.25	FULL	1.010
10	G1	0.62	10G	One-Piece	NONE	NONE	1.12	FULL	1.135
12	G1	0.75	12G	One-Piece	NONE	NONE	1.50	FULL	1.350
4	G2	0.25	4G	One-Piece	NONE	NONE	0.93	FULL	0.740
4	G2	0.25	4G	One-Piece	NONE	NONE	0.93	FULL	0.740
6	G2	0.37	6G	One-Piece	NONE	NONE	0.93	FULL	0.890
6	G2	0.37	6G	One-Piece	NONE	NONE	0.93	FULL	0.890
8	G2	0.5	8G	One-Piece	NONE	NONE	1.25	FULL	1.050
10	G2	0.62	10G	One-Piece	NONE	NONE	1.12	FULL	1.170
12	G2	0.75	12G	One-Piece	NONE	NONE	1.50	FULL	1.395

CONNECTOR & CONDUCTOR CERTIFICATION

STATION #6

BEND, FLARE, AND INSTALL TUBE



TOOLS NEEDED:

- Fixture for tube attachment
- 3/8" hand bender with 15/16" radius
- 3/8" flare tool
- Tube cutter
- Deburring tool
- Metal file
- Steel framing square
- Felt marking pen

LAMINATED CHARTS:

- 4 Laminated Instruction Sheets

STATION 6 | C & C JP TEST - LAMINATE 1 OF 4

As long as tubing is measured and bent in the same direction, and is measured centerline to centerline, "pickup" will not affect the actual center-to-center measurement.

Nominal Tubing Gain vs. Radius Block Size						
Bend Angle	Tube OD, in					
	1/8	1/4	1/4	5/16	3/8	1/2
	Bend Radius, in					
	9/16	9/16	3/4	15/16	15/16	1 1/2
30°	0	0	0	0	0	1/16
45°	1/16	1/16	1/16	1/16	1/16	1/16
50°	1/16	1/16	1/16	1/16	1/16	1/8
55°	1/16	1/16	1/16	1/8	1/8	1/8
60°	1/16	1/8	1/16	1/8	1/8	3/16
65°	1/8	1/8	1/8	3/16	1/8	1/4
70°	1/8	1/8	1/8	3/16	3/16	5/16
75°	1/8	3/16	3/16	1/4	1/4	3/8
80°	3/16	3/16	3/16	5/16	5/16	7/16
85°	1/4	1/4	1/4	3/8	3/8	9/16
90°	1/4	5/16	5/16	7/16	7/16	11/16

Note: Many manufacturers of tube bending equipment publish gain tables. Often, these tables are based on the design and performance characteristics of the tube bender and not the true calculated value required to perform the bend. As a result, values provided in the gain table may not match the mathematically calculated value, but will be accurate when using both a specific manufacturer's tube bender and associated gain table. The table above illustrates a typical manufacturer's gain table.

Pre-measuring Bends

A series of bends may be pre-measured. Measure the first bend the correct length. Compensate for each bend after the first by subtracting the amount of gain from the chart for each 90° of bend to allow for stretch. Always custom measure for the last bend to allow for flaring. Making a 3/8 tube assembly with the first bend at 4 inches and the remaining bends at 4 1/4 inches (subtract gain from desired bend length to mark the measurements before bending).



STATION 6 | C & C JP TEST - LAMINATE 2 OF 4

The Hand Bender: The RADIUS BLOCK OR BENDING BLOCK

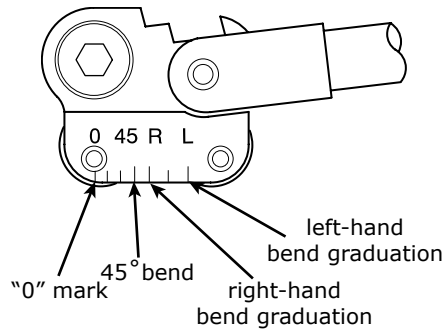


Fig. 1

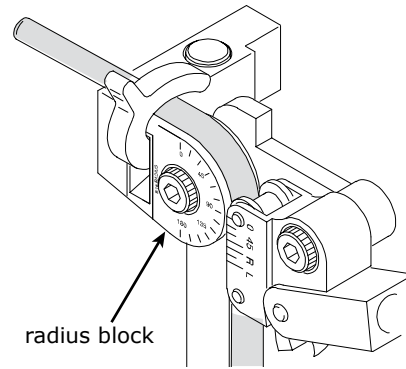


Fig. 2

The radius block, as shown above, is the part of the bender that is a semi-circle block with a round groove on its edge equal to the diameter of the tube to be bent. The radius block also has a flat side, which is fastened to the rigid or holding handle. The tube clamp is usually part of the block or attached to the handle at the block. This radius block has the actual radius of the block stamped on the side. For a 3/8" diameter tube bender, 15/16" radius is the most common block used. The radius block also has numbers and marks stamped at specific points along its edge; these are reference points for various angles.

Clamp

This is affixed to either the radius block and/or the rigid handle and is used to hold the tube in place while bending. This device may be either part of the handle or attached to the handle.

Bending Handle

This handle is attached to the radius block by means of a link. It has a companion groove the same diameter as the tube to be bent. There are marks and numbers stamped on the block end of this handle (see Fig. 2). These are the reference marks used in the bending process.

Terms used in bending

Centerline of the Tubing

The centerline of the tubing is an imaginary line drawn along the radius point of the tube diameter at one end to the radius point of the tube diameter at the other end.

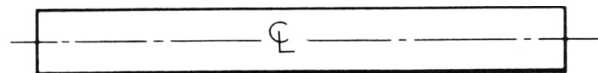


Fig. 3

Changes of Plane and/or Direction

Think of the tube as having an imaginary line drawn on the outside from one end to the other. (See Fig. 3) This could be considered as the main plane of the tubing. Changes of plane are accomplished by rotating the tube in the bender.

Note: On Fig. 1 the marks "L" and "R" are used depending on whether the mark on the tube is measured from the left "L" or from the right "R". See Fig. 4 and Fig. 5.

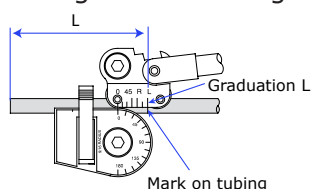


Fig. 4

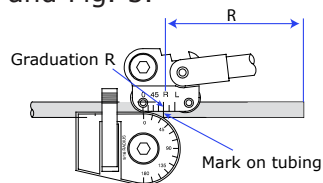
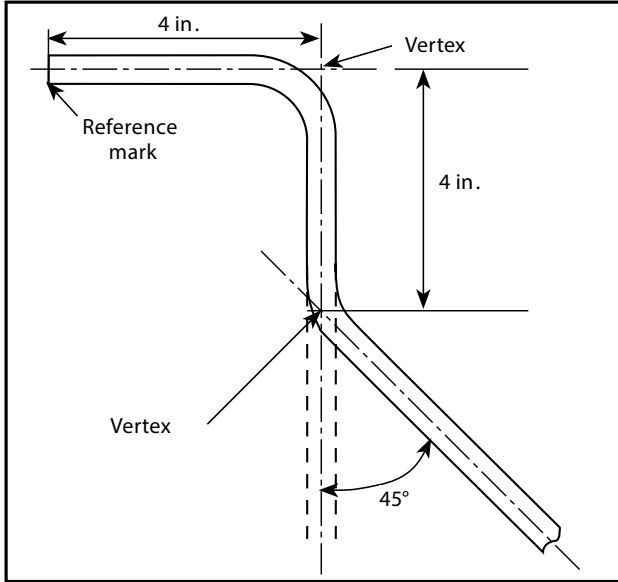


Fig. 5

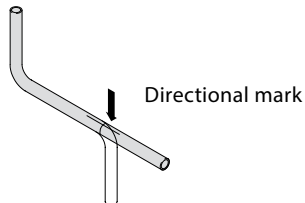
45° Bend Guidelines

Example of the measure-bend method:

A 90° bend 4 inches from the reference mark followed by a 45° bend with 4 inches between bends.



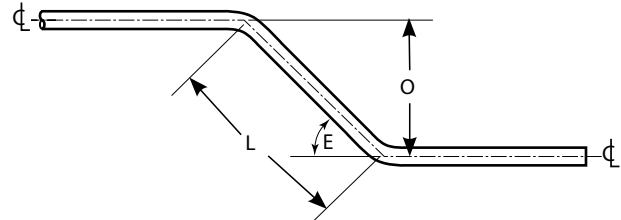
1. Place a reference mark at the end of the tube from which you are beginning the measurements.
2. Measure 4 in from the reference mark to indicate the first desired bend and make a bend mark length.
3. Bend the tube 90°.
4. Make a second bend mark 4 in from the vertex of the 90° bend, away from the reference mark.
5. Place a directional mark over the bend mark to indicate the outside, or heel, of the 45° bend. This will help ensure the bend is made in the intended direction.



6. Bend the tube 45°.

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Offset Bend Formula



The purpose of an offset bend is to change the center line of the run, typically to avoid an obstruction. To determine the length of offset, select the offset angle (E). Then, multiply the offset dimension (O) by the offset bend allowance (A).

$$L = O \times A$$

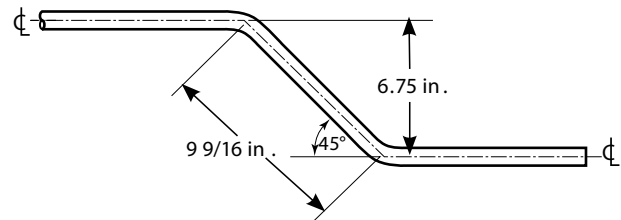
Use the offset calculation as the distance between the bend marks described in Bend Layout.

Offset Bend Angle (E)	Offset Bend Allowance (A)
22 1/2 °	2.613
30 °	2.000
45 °	1.414
60 °	1.154

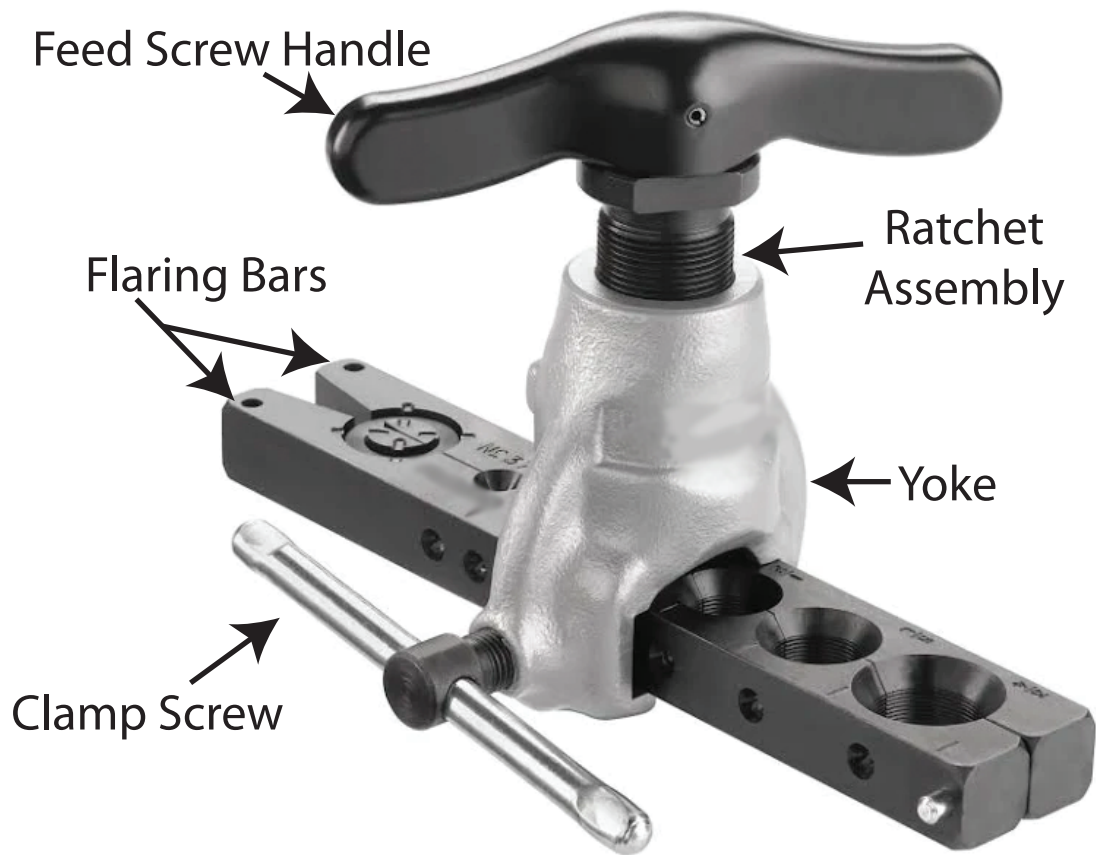
Example

Offset bend angle (E) 45°
 Offset dimension (O) 6.75 in.

$$6.75 \times 1.414 = 9.55 \text{ in, or approximately } 9 \frac{9}{16} \text{ in.}$$



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Operating Instructions:

1. Cut and ream tubing.
2. Back off feed screw handle and clamp screw to permit flaring bars to slide freely through yoke. Slide yoke to hinged end of flaring bars.
3. Insert tube into proper size opening and close flaring bars. Push tube up from bottom of tool until it is even with top of flaring bars.

NOTE! OVERSIZE or UNDERSIZE flares can be made by adjusting tube position slightly above or below the top of flaring bars.

4. Slide yoke forward over tube until arrow on yoke meets line on flaring bars. Tighten clamp screw firmly.
5. Turn the feed screw handle clockwise until pressure kick-out releases. A few additional turns before backing off will burnish flare.
6. Back off feed screw handle as far as it will go. Release clamp screw and slide yoke back. Remove tube. If tube tends to stick, tighten clamp screw against tapered end of bars. This action will force bars open.