

COMPLETE STUD WELDING

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SECTION 4

CD WELD STUDS GENERAL INFORMATION & TECHNICAL DETAILS

FOR INQUIRIES, TO PLACE ORDERS,
SERVICE AND TECHNICAL SUPPORT CONTACT
ANY OF THE FOLLOWING:

OFFICE: 216.904.4008

EMAIL: SALES@COMPLETESTUDWELD.COM

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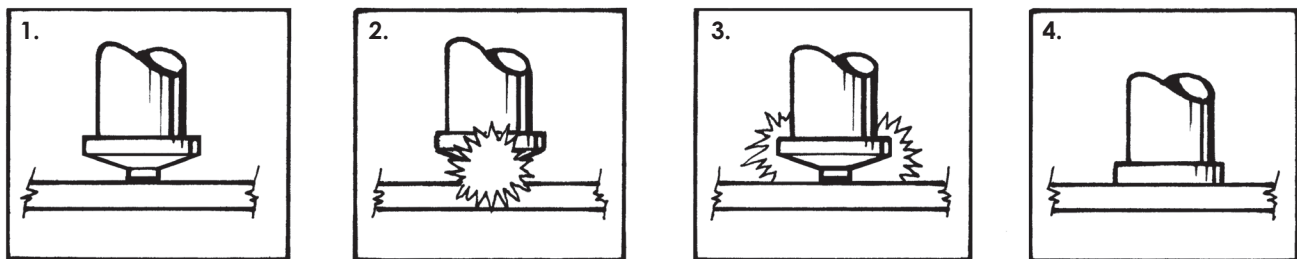
CD Weld Studs

General Information & Technical Details

CAPACITOR DISCHARGE (CD) STUD WELDING PROCESS DESCRIPTION

Process Description:

Capacitor Discharge (CD) Stud Welding involves the same basic principles and metallurgical aspects as any other arc welding procedure. When the weld gun is activated, a special precision weld tip initiates a controlled electric arc from the welder capacitor bank which melts the end of the stud and a portion of the base metal. The stud is held in place as the molten metal solidifies instantly accomplishing a high quality fusion weld.



1. The weld gun and stud are positioned against the work.
2. Stored energy is discharged through special weld "timing" tip and stud starts downward.
3. The stud is forced into the pool of molten metal.
4. Metal solidifies and weld is completed in milliseconds.

Process Advantages:

Base & Stud Material Compatibility - CD Stud Welding is compatible with just about any weldable material, and permits the welding of dissimilar metals. See Chart on the next page for further details.

Reverse-Side Marking - CD Stud Welding is generally used to weld smaller diameter studs to thin base metals, especially where reverse side marking is not permissible. Since the entire weld cycle is completed in milliseconds, welds can be made to thin material without pronounced distortion, burn-through, or reverse side discoloration. See CD Stud Reverse-Side Marking Guide.

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COMPATIBILITY OF BASE METAL & CD STUD MATERIAL COMBINATIONS

BASE WELD MATERIAL	STUD MATERIAL			
	MILD STEEL	STAINLESS	ALUMINUM	BRASS
	1008, 1010, 1015, 1018	302, 304, 305	1100, 5086, 6063	70-30, 65-35
MILD STEEL: 1006 through 1030	Excellent	Excellent	—	Excellent
MEDIUM CARBON STEEL: 1030 through 1050	Good *	Good *	—	Good *
GALVANIZED SHEET DUCT OR DECKING	Excellent	Excellent	—	—
STRUCTURAL STEEL:	Excellent	Excellent	—	Excellent
STAINLESS STEEL: 405, 410, 430, AND 300 SERIES, EXCEPT 303	Excellent	Excellent	—	Excellent
LEAD FREE BRASS; ELECTROLYTIC COPPER; ROLLED COPPER	Excellent	Excellent	—	Excellent
MOST ALUMINUM ALLOYS OF THE 1100, 3000, 5000, AND 6000 SERIES **	der	—	Excellent	—
ZINC ALLOYS (die cast)	Good *	Good *	Excellent	Good *

* Good: Generally Full Strength results, depending upon the combination of stud size and base metal.

** Other materials such as 7000 Series Aluminum, titanium alloys, Inconel, etc. can be welded under specified conditions.

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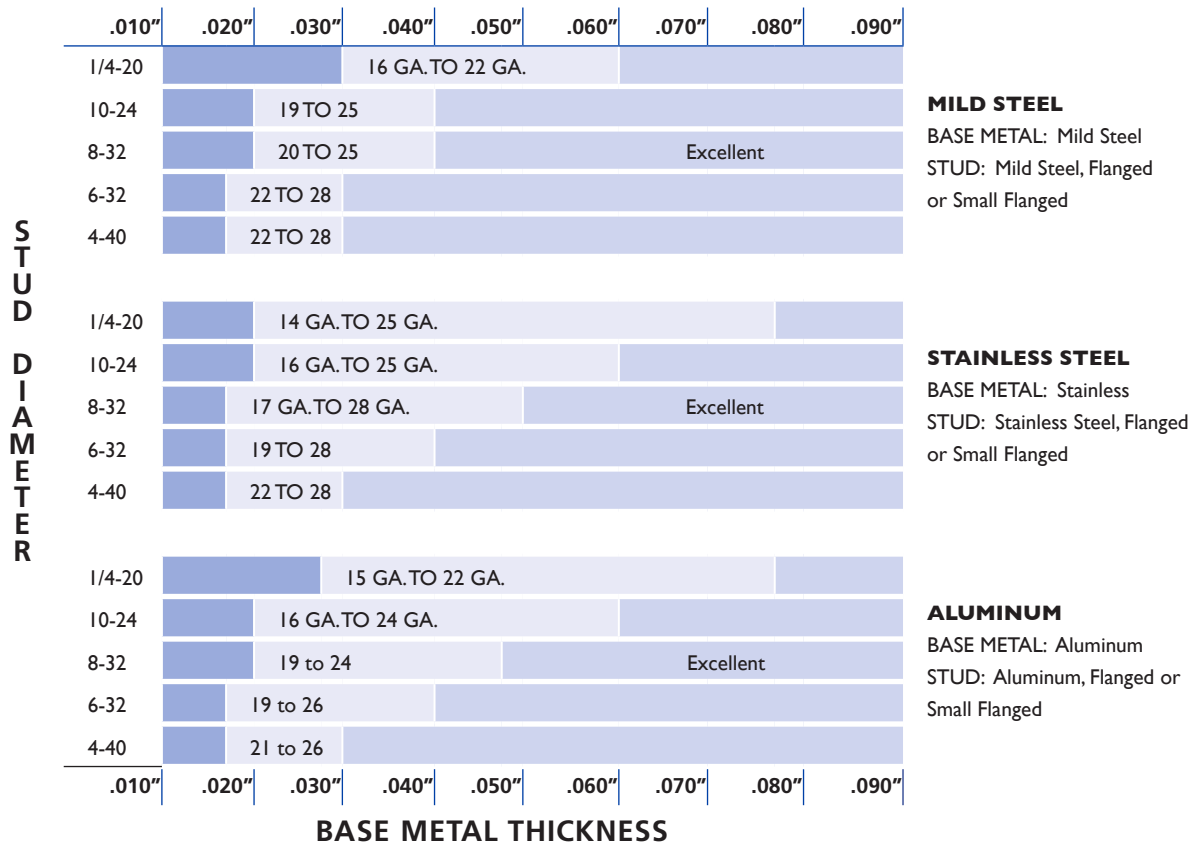
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CD STUD REVERSE-SIDE MARKING GUIDE

The charts below will be of help in determining the best combination of stud weld base size and base metal thickness. The terms on the charts are defined as follows:

UNACCEPTABLE	Unacceptable Marking, Base Metal Failure.
ACCEPTABLE	Visible Marking(s), Excellent Weld.
EXCELLENT	No Marking, Excellent Weld.

Additional factors that can influence the degree of reverse-side marking are tip size, weld voltage, spring pressure and the CD process used (i.e. Contact versus Gap).



CD Weld Studs

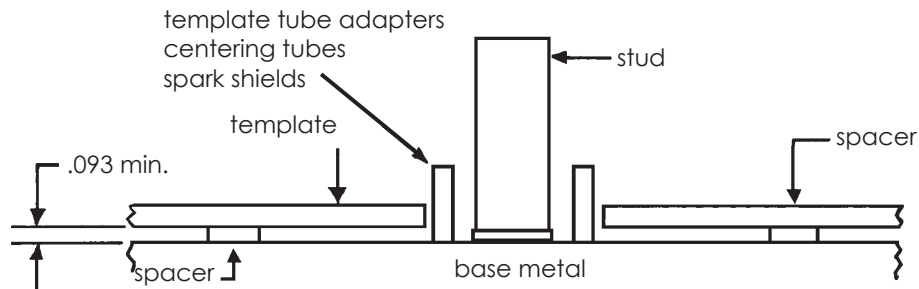
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CD WELD STUD LOCATING OPTIONS

Template Method:

This method of templating is recommended by **Complete Stud Welding** for use with gun attachments called "Template Tube Adaptors," "Centering Tubes" and "Spark Shields."

These attachments are installed directly onto the gun or used indirectly with a CD foot. These attachments have diameters of 1", 1.25", 1.375" and 30mm. Contact your sales representative for details.



Options	Gun Mount	Foot
Template Tube Adaptor - 1" Dia.	039-839	—
Template Tube Adaptor - 1-1/4" Dia.	039-840	—
Center Tubes - 30mm Dia.	80-40-513	—
Spark Shield - Phenolic 1.156" Dia.	033-769L	028-833
Spark Shield - Brass 1.156" Dia.	033-769B	028-833

Scribe Method:

The operator can scribe a mark in the base metal at the location for the stud to be welded. The scribe mark can either be the center point or can be a circle. With the later, the weld base diameter of the stud would fit within the circle.

EXAMPLES: **X** -Locate stud in center of the X.
○ -Locate stud in center of the circle.

Center Punch Method: Not Recommended

When the CD Stud Welding Process is being used, the special weld tip on the end of all CD Type studs should not be used with center punch marks as a method of locating CD Type studs.

The diameter and length of the special weld tip controls the time duration of the CD Stud Welding Process and is absolutely critical in obtaining welds that develop full fastener strength. Accordingly, the introduction of a center punch mark interferes with the timing of the CD Stud Welding process and will result in weld failures.

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CD WELD STUDS – TECHNICAL DETAILS

Threaded & No Thread CD Weld Studs: Complete Stud Welding has various sizes of externally and internally threaded weld studs and various shapes and size of no thread weld studs. These weld studs are used in various construction, automotive and industrial applications.

Threads: The chart below depicts the thread standards for imperial and metric external and internal threads. Unless requested or quoted otherwise, threads will be quoted based on these common thread standards.

Unless indicated or quoted otherwise, external threads will be a rolled type thread. The strength and surface finish of rolled threads are considered to be superior to cut type threads.

	External Threads	Internal Threads
Imperial Threads - Coarse	UNC-2A	UNC-2B
Imperial Threads - Fine	UNF-2A	UNF-2B
Metric Threads	Class 6g	Class 6H

Auto Feed Quality: All CD weld studs are available in auto feed quality. This allows for usage in auto feed stud welding systems. Auto feed hand guns and weld heads are available with the power source(s) and feeding equipment for incorporation into automated CNC and robotic systems. Auto feed quality should be requested at the time of quotation.

Material: The chart below depicts the common material types with corresponding typical tensile strengths used to produce CD Weld Studs.

Material Type(s)	Typical Tensile Strength	
	Ultimate (psi)	Yield (psi)
Mild Steel C1006 -C1018 range	55,000	35,000
Stainless Steel 18-8 (302HQ & 304)	75,000	30,000
Aluminum Alloy 5356 & 5154	40,000	29,000
Aluminum Alloy 1100	21,000	20,000
Copper Alloy (Brass) CDA 260 & CDA 268	50,000	30,000

Note, all external threaded mild steel CD studs are copper flashed / plated.

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CD WELD STUDS – TECHNICAL DETAILS

Plating: For mild steel studs, copper plating is standard for externally threaded studs. Upon request Nickel, Zinc and other plating's are available.

Annealing: All low carbon steel and stainless steel studs are annealed where required.

Weld Base: CD Studs are available in the Flanged, Small-Flanged and Non-Flanged condition.

Length Reduction: CD Studs have no appreciable length reduction after welding.

Shielding: The CD Process does not utilize ferrules or arc shields as with the ARC Stud Welding Process.

Generally shielding gas is not required.

Welding Position: CD Studs can easily be welded in the down hand, side hand and overhead positions.

Other: For further details please see the following sections:

- CD Stud Welding Guidelines

- CD Stud Weld Inspection - Visual

- CD Stud Weld Inspection - Mechanical (torque values)

- CD Weld Stud Weight Charts

- CD Weld Studs - Standard Stock Sizes

CD Weld Studs

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CD STUD WELDING GUIDELINES

The following guidelines should be followed for producing and maintaining good CD Stud Welds:

- Ensure the stud welding equipment is capable of welding the stud size intended to be welded.
- Ensure the Stud Welding Equipment is in proper working order and that all cable and ground connections are tight.
- Weld surface cleanliness. The surface should be free from excessive oils, grease and other lubricants and from rust, mill scale, and other oxides. These conditions contribute to high electrical resistance in areas of welding and grounding.
- Weld surface imperfections, such as extreme roughness, which can prevent complete fusion in the weld area and or interfere with the time duration of the process, should be avoided.
- The stud axis must be perpendicular to the work surface to obtain complete fusion.
- Proper weld end design of the stud is necessary. The tip size, weld base diameter and face angle must be correct for the application.
- The operator should follow the equipment manufacturer's setup parameters (i.e.. Weld voltage, Spring pressure, Plunge and when using GAP or Drawn Arc Method, Lift).
- Visually inspect all welds for 360 degree weld flash. See next page for illustrations of Good, Cold and Hot welds. If a questionable weld is evident after the welds have been visually inspected, the weld should be mechanically tested.
- Mechanically test 2 welded studs at the start of each shift and change in stud size.
- Mechanical Testing of CD stud welds should be done by bend testing or torque testing. The tests are used to establish welding conditions and qualify production studs. The stud and or weld may be tensile tested and or submitted to other forms of destructive or non-destructive testing as the application requires.
- The bend test should be performed by bending the stud 30 degrees by striking with a hammer or, preferably, bending with a pipe.
- Torque values are given in the subsequent table for various stud materials and stud diameters.

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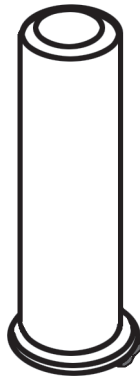
CD STUD WELD INSPECTION – VISUAL

The CD stud weld can be visually inspected by observing the weld flash at the base of the stud. The illustrations and comments below are intended to assist in visually judging the quality of the weld. For assistance, contact your **Complete Stud Welding** Sales Representative.



Good Weld

Full, even, shiny weld flash all around stud.



Cold Weld

No or uneven weld flash around weld stud.



Hot Weld

Large crater, excessive metal expulsion with shiny appearance.

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CD STUD WELD INSPECTION – MECHANICAL – TENSILE / TORQUE STRENGTHS

The following 3 pages of charts contain CD weld stud - Tensile / Torque Strengths. The data was calculated based on the formulas shown below. These formulas and the notes below are considered integral parts of the Tensile/Torque Strength charts that follow.

Tensile Load	$L = SA$
Torque	$T = 0.2 \times D \times L$
META*	$A = \frac{\pi}{4} \times [D - (0.9743/N)]$

A = Mean Effective Thread Area (META)*	D = Nominal Thread Diameter
L = Tensile Load Pounds	N = Threads Per Inch
S = Tensile Stress in PSI	T = Torque in Inch Pounds

* META is used instead of root area in calculating screw strengths because of closer correlation with actual tensile strength. META is based on mean diameter, which is diameter of an imaginary coaxial cylinder whose surface would pass through the thread profile approximately midway between the minor and pitch diameters.

** Please note, in actual practice a stud should not be used at its yield load. A factor of safety must be applied. It is generally recommended that studs be used at no more than 60% of yield. However the factor of safety may vary up or down, depending on the application. **The user will determine the appropriate safety factor.**

*** Please note, Torque figures based on assumption that excessive deformation of thread has not taken relationship between torque/tension out of its proportional range.

Shear values were calculated at 75% of the Ultimate Tensile Load of the stud.

See next 3 pages for charts on Tensile and Torque Strengths

**** & *** Applies to subsequent Tensile / Torque Strength Charts.**

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CD STUD WELD INSPECTION – MECHANICAL – TENSILE / TORQUE STRENGTHS

Low Carbon Steel - 55,000 PSI Min. Tensile, 35,000 PSI Min. Yield					
Thread Size	Yield Load (Lbs.)**	Ultimate Tensile Load (Lbs.)	Yield Torque (inch lbs.)***	Ultimate Torque (inch lbs.)***	Shear Strength (75% of Tensile Load)
4-40	211	332	5	7	249
6-32	318	500	9	14	375
8-32	490	770	16	25	578
10-24	614	964	23	37	723
10-32	700	1,100	27	42	825
1/4-20	1,120	1,760	56	88	1,320
5/16-18	1,820	2,860	114	179	2,145
3/8-16	2,695	4,235	202	318	3,176
M3 - .50	269	423	6	10	317
M4 - .70	469	737	15	23	553
M5 - .80	759	1,192	30	47	894
M6 - 1.00	1,085	1,705	51	81	1,279
M8 - 1.25	1,960	3,080	123	194	2,310
M10 - 1.50	3,106	4,881	245	384	3,661

Stainless Steel - 75,000 PSI Min. Tensile, 30,000 PSI Min. Yield					
Thread Size	Yield Load (Lbs.)**	Ultimate Tensile Load (Lbs.)	Yield Torque (inch lbs.)***	Ultimate Torque (inch lbs.)***	Shear Strength (75% of Tensile Load)
4-40	181	452	4	10	339
6-32	273	682	8	19	511
8-32	420	1,050	14	34	788
10-24	526	1,315	20	50	986
10-32	600	1,500	23	57	1,125
1/4-20	954	2,385	48	119	1,789
5/16-18	1,560	3,900	97	244	2,925
3/8-16	2,325	5,813	174	436	4,359
M3 - .50	230	576	5	14	432
M4 - .70	402	1,005	13	32	754
M5 - .80	650	1,626	26	64	1,220
M6 - 1.00	930	2,325	44	110	1,744
M8 - 1.25	1,680	4,200	106	265	3,150
M10 - 1.50	2,663	6,656	210	524	4,992

** & *** For footnote details see first page of CD Stud Weld Inspection - Mechanical

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CD STUD WELD INSPECTION – MECHANICAL – TENSILE / TORQUE STRENGTHS

Standard CD Weld Studs - Tensile / Torque Strengths					
Aluminum 5356 / 5154 - 40,000 PSI Min. Tensile, 29,000 PSI Min. Yield					
Thread Size	Yield Load (Lbs.)**	Ultimate Tensile Load (Lbs.)	Yield Torque (inch lbs.)***	Ultimate Torque (inch lbs.)***	Shear Strength (75% of Tensile Load)
4-40	175	241	4	5	181
6-32	264	363	7	10	273
8-32	406	560	13	18	420
10-24	508	701	19	27	526
10-32	580	800	22	30	600
1/4-20	928	1,280	46	64	960
5/16-18	1,508	2,080	94	130	1,560
3/8-16	2,233	3,080	167	231	2,310
M3 - .50	223	307	5	7	230
M4 - .70	389	536	12	17	402
M5 - .80	629	867	25	34	650
M6 - 1.00	899	1,240	42	59	930
M8 - 1.25	1,624	2,240	102	141	1,680
M10 - 1.50	2,574	3,550	203	280	2,663

Aluminum 1100 - 21,000 PSI Min. Tensile, 20,000 PSI Min. Yield					
Thread Size	Yield Load (Lbs.)**	Ultimate Tensile Load (Lbs.)	Yield Torque (inch lbs.)***	Ultimate Torque (inch lbs.)***	Shear Strength (75% of Tensile Load)
4-40	121	127	3	3	95
6-32	182	191	5	5	143
8-32	280	294	9	10	221
10-24	351	368	13	14	276
10-32	400	420	15	16	315
1/4-20	636	668	32	33	501
5/16-18	1,040	1,092	65	68	819
3/8-16	1,550	1,628	116	122	1,221
M3 - .50	154	161	4	4	121
M4 - .70	268	281	8	9	211
M5 - .80	434	455	17	18	341
M6 - 1.00	620	651	29	31	488
M8 - 1.25	1,120	1,176	71	74	882
M10 - 1.50	1,775	1,864	140	147	1,398

** & *** For footnote details see first page of CD Stud Weld Inspection - Mechanical

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CD STUD WELD INSPECTION – MECHANICAL – TENSILE / TORQUE STRENGTHS

Standard CD Weld Studs - Tensile / Torque Strengths					
Brass - 50,000 PSI Min. Tensile, 30,000 PSI Min. Yield					
Thread Size	Yield Load (Lbs.)**	Ultimate Tensile Load (Lbs.)	Yield Torque (inch lbs.)***	Ultimate Torque (inch lbs.)***	Shear Strength (75% of Tensile Load)
4-40	181	302	4	7	226
6-32	273	454	8	13	341
8-32	420	700	14	23	525
10-24	526	877	20	33	657
10-32	600	1,000	23	38	750
1/4-20	960	1,600	48	80	1,200
5/16-18	1,560	2,600	98	163	1,950
3/8-16	2,310	3,850	173	289	2,888
M3 - .50	230	384	5	9	288
M4 - .70	402	670	13	21	503
M5 - .80	650	1,084	26	43	813
M6 - 1.00	930	1,550	44	73	1,163
M8 - 1.25	1,680	2,800	106	176	2,100
M10 - 1.50	2,663	4,438	210	349	3,328

** & *** For footnote details see first page of CD Stud Weld Inspection - Mechanical

CD Weld Studs

General Information & Technical Details

WEIGHT CHARTS – CD FLANGED MILD STEEL STUDS

THREADED STUDS IN POUNDS PER 1,000 PIECES							
Length	4-40	6-32	8-32	10-24	1/4-20	5/16-18	3/8-16
1/4	0.7	1.0	1.4	1.8	3.1	—	—
3/8	0.9	1.4	1.9	2.5	4.4	7.0	9.5
1/2	1.2	1.8	2.5	3.2	5.7	9.1	12.6
5/8	1.4	2.1	3.0	3.9	7.0	11.1	15.7
3/4	1.7	2.5	3.6	4.6	8.2	13.2	18.8
7/8	1.9	2.9	4.2	5.4	9.5	15.3	21.9
1	2.2	3.3	4.7	6.1	10.8	17.4	25.8
1-1/4	2.7	4.0	5.8	7.5	13.4	21.5	31.3
1-1/2	3.2	4.8	6.9	8.9	16.0	25.7	37.5
1-3/4	3.6	5.5	8.0	10.4	18.5	29.8	43.8
2	4.1	6.3	9.2	11.8	21.1	34.0	50.0
2-1/4	4.6	7.0	10.3	13.2	23.7	38.1	56.3
2-1/2	5.1	7.8	11.4	14.6	26.3	42.3	62.5
Ea.Add. Inch	2.0	3.0	4.4	5.7	10.3	16.6	25.0

NON-THREADED STUDS IN POUNDS PER 1,000 PIECES							
Length	3/32	1/8	5/32	3/16	1/4	5/16	3/8
1/4	0.7	1.1	1.6	2.2	3.9	—	—
3/8	0.9	1.5	2.3	3.2	5.6	8.7	11.8
1/2	1.2	1.9	2.9	4.2	7.4	11.4	15.7
5/8	1.4	2.4	3.6	5.2	9.1	14.1	19.6
3/4	1.6	2.8	4.3	6.1	10.8	16.8	23.5
7/8	1.9	3.2	5.0	7.1	12.6	19.5	27.4
1	2.1	3.7	5.7	8.1	14.3	22.3	31.3
1-1/4	2.6	4.5	7.0	10.0	17.8	27.7	39.1
1-1/2	3.1	5.4	8.4	12.0	21.3	33.1	47.0
1-3/4	3.6	6.3	9.7	14.0	24.8	38.5	54.8
2	4.0	7.2	11.1	15.9	28.3	44.0	62.6
2-1/4	4.5	8.0	12.4	17.9	31.8	49.4	70.4
2-1/2	5.0	8.9	13.8	19.8	35.2	54.8	78.3
Ea.Add. Inch	1.9	3.5	5.4	7.8	13.9	21.7	30.5

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CD WELD STUDS- STANDARD STOCK SIZES

The attached information indicates the THREADED CD Weld Studs that are considered to be "Standard Stock Sizes." This means that 99% of the time these studs will be in stock.

The attached information does not cover the vast inventory of CD Weld Studs that are:
"Threaded CD Weld Studs NOT Considered to be "Standard Stock Sizes" that are in stock.
Non Threaded CD Weld Studs that are in stock.
Other Styles of CD Weld Studs that are in stock.

Contact your [Complete Stud Welding](#) Sales Representatives for assistance.

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CD WELD STUDS- STANDARD STOCK SIZES

Thread Size	Stud Length	MILD STEEL		STAINLESS STEEL		ALUMINUM	
		Flanged	Non-Flanged	Flanged	Non-Flanged	Flanged	Non-Flanged
4 - 40	X 1/4	Y	Y	Y	Y	Y	
	X 5/16			Y			
	X 3/8	Y	Y	Y	Y	Y	
	X 1/2	Y	Y	Y	Y	Y	
	X 5/8	Y	Y	Y	Y		
	X 3/4	Y	Y	Y	Y		
	X 7/8			Y			
	X 1	Y	Y	Y			
	X 1-1/4			Y			
6 - 32	X 1/4	Y	Y	Y	Y	Y	
	X 5/16			Y	Y		
	X 3/8	Y	Y	Y	Y	Y	
	X 1/2	Y	Y	Y	Y	Y	
	X 5/8	Y	Y	Y	Y	Y	
	X 3/4	Y	Y	Y	Y	Y	
	X 7/8	Y	Y	Y	Y		
	X 1	Y	Y	Y	Y	Y	
	X 1-1/4	Y	Y	Y	Y	Y	
	X 1-1/2	Y	Y	Y	Y		
	X 2			Y			
8 - 32	X 1/4	Y	Y	Y	Y		
	X 5/16	Y	Y	Y	Y		
	X 3/8	Y	Y	Y	Y	Y	
	X 1/2	Y	Y	Y	Y	Y	
	X 5/8	Y	Y	Y	Y	Y	
	X 3/4	Y	Y	Y	Y	Y	
	X 7/8		Y	Y	Y		
	X 1	Y	Y	Y	Y	Y	
	X 1-1/4	Y	Y	Y	Y	Y	
	X 1-1/2	Y	Y	Y	Y		
	X 1-3/4			Y			
	X 2		Y	Y	Y		
10 - 24	X 1/4	Y	Y	Y	Y		
	X 5/16			Y	Y		
	X 3/8	Y	Y	Y	Y	Y	
	X 1/2	Y	Y	Y	Y	Y	
	X 5/8	Y	Y	Y	Y	Y	
	X 3/4	Y	Y	Y	Y	Y	
	X 7/8	Y	Y	Y			
	X 1	Y	Y	Y	Y	Y	
	X 1-1/4	Y	Y	Y	Y	Y	
	X 1-1/2	Y	Y	Y	Y	Y	
	X 1-3/4	Y	Y	Y			
	X 2	Y	Y	Y	Y	Y	
	X 3					Y	

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CD WELD STUDS – STANDARD STOCK SIZES . . . CONTINUED

Thread Size	Stud Length	MILD STEEL		STAINLESS STEEL		ALUMINUM	
		Flanged	Non-Flanged	Flanged	Non-Flanged	Flanged	Non-Flanged
10 - 32	X 1/4	Y	Y	Y	Y	Y	
	X 5/16			Y	Y		
	X 3/8	Y	Y	Y	Y	Y	
	X 7/16			Y			
	X 1/2	Y	Y	Y	Y	Y	
	X 5/8	Y	Y	Y	Y	Y	
	X 3/4	Y	Y	Y	Y	Y	
	X 7/8	Y	Y				
	X 1	Y	Y	Y	Y	Y	
	X 1-1/4	Y	Y	Y	Y	Y	
	X 1-1/2	Y	Y	Y	Y	Y	
	X 1-3/4	Y	Y	Y			
	X 2	Y	Y	Y	Y	Y	
1/4 - 20	X 1/4	Y		Y			
	X 3/8	Y	Y	Y	Y	Y	
	X 1/2	Y	Y	Y	Y	Y	
	X 5/8	Y	Y	Y	Y	Y	
	X 3/4	Y	Y	Y	Y	Y	
	X 7/8	Y	Y	Y	Y		
	X 1	Y	Y	Y	Y	Y	
	X 1-1/4	Y	Y	Y	Y	Y	
	X 1-3/8			Y			
	X 1-1/2	Y	Y	Y	Y	Y	
	X 1-3/4		Y	Y	Y		
	X 2	Y	Y	Y	Y	Y	
	X 2-1/4			Y			
	X 2-1/2	Y	Y	Y	Y	Y	
	X 3			Y		Y	
5/16 - 18	X 1/2	Y	Y	Y	Y		
	X 5/8			Y	Y		
	X 3/4	Y	Y	Y	Y		
	X 7/8			Y			
	X 1	Y	Y	Y	Y		
	X 1-1/4	Y	Y	Y	Y		
	X 1-1/2	Y	Y	Y	Y		
	X 1-3/4			Y			
3/8 - 16	X 2			Y			
	X 1/2	Y	Y	Y	Y		
	X 3/4	Y		Y	Y		
	X 1	Y	Y	Y	Y		
	X 1-1/4	Y	Y	Y	Y		
	X 1-1/2	Y	Y	Y	Y		
X 2		Y		Y			

CD Weld Studs

General Information & Technical Details

CD WELD STUDS – STANDARD STOCK SIZES . . . CONTINUED

Thread Size	Stud Length	MILD STEEL		STAINLESS STEEL		ALUMINUM	
		Flanged	Non-Flanged	Flanged	Non-Flanged	Flanged	Non-Flanged
M3	X 6	Y	Y	Y	Y		
	X 8	Y	Y	Y	Y		
	X 10	Y	Y	Y	Y		
	X 12	Y	Y	Y	Y		
	X 16	Y		Y	Y		
	X 20	Y		Y			
	X 25	Y		Y			
M4	X 6	Y	Y	Y			
	X 8	Y	Y	Y	Y		
	X 10	Y	Y	Y	Y		
	X 12	Y	Y	Y	Y		
	X 15	Y	Y				
	X 16	Y		Y	Y		
	X 20	Y	Y	Y	Y		
	X 25	Y	Y	Y			
	X 30	Y		Y			
	X 35	Y					
	X 40			Y			
M5	X 6						
	X 8	Y		Y			
	X 10	Y	Y	Y	Y		
	X 12	Y	Y	Y	Y		
	X 15			Y			
	X 16	Y	Y	Y	Y		
	X 20	Y	Y	Y	Y		
	X 25	Y	Y	Y	Y		
	X 30	Y		Y	Y		
	X 35	Y		Y			
	X 40	Y		Y			
	X 50	Y					
M6	X 10	Y	Y	Y	Y		
	X 12	Y		Y	Y		
	X 15	Y					
	X 16	Y	Y	Y	Y		
	X 20	Y	Y	Y	Y		
	X 25	Y	Y	Y	Y		
	X 30	Y		Y			
	X 35	Y		Y			
	X 40	Y		Y			
	X 50	Y		Y			
M8	X 12	Y		Y	Y		
	X 15	Y					
	X 16	Y	Y	Y	Y		
	X 20	Y	Y	Y	Y		
	X 25	Y	Y	Y	Y		
	X 30	Y		Y	Y		
	X 35			Y			