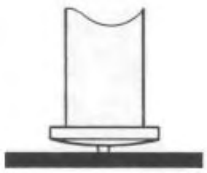
WHAT IS STUD WELDING?

Stud Welding is an arc welding process in which a stud or similar metal part can be end-joined to a workpiece instantaneously. This stud welding process involves the same basic principles and metallurgical aspects as any other arc welding procedure.

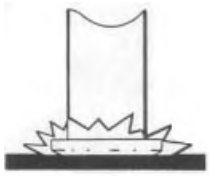
The Process is as follows. The stud is placed (with a hand tool called the Weld Gun) against the base metal, through the control of the stud welding equipment and the design of the stud; an arc is drawn which melts the base of the stud and a proportionate area of the base metal, the stud is then forced into the molten pool and held in place until the metals re-solidify. This high quality fusion weld is completed in milliseconds. There are two methods for accomplishing this stud welding process.

CD STUD WELDING



1. Stud against work

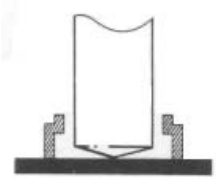
2. Stored energy discharged through weld tip & stud starts downward.



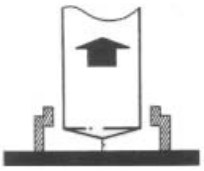
3. Stud forced into molten metal.

4. Metal solidifies & weld complete in milliseconds.

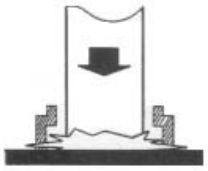
ARC STUD WELDING



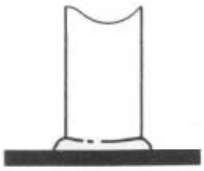
1. Stud and ceramic ferrule against work.



2. Stud lifts and arc is drawn.



3. Control times out & stud plunges into Molten material.



4. Metal solidifies & weld complete in milliseconds.

The two stud welding methods are called Capacitor discharge (CD) and ARC. The difference between these two methods involves the Power Source used to provide the welding current. Also, the design and application sequence of the stud varies slightly.

The equipment required to stud weld is composed of the following: a direct current Power Supply, a Controller, a Weld Gun, and Cables to tie the system components and base metal together. In most systems, the power supply and controller are combined as one component called the "Welder".

GENERAL SPECIFICATIONS

	CAPACITOR DISCHARGE	ARC
MATERIAL	Standard in low carbon steel, 302/304/305 stainless, and ll00, 6061, & 5000 series aluminum. Brass and other grades of stainless steel are also available	Standard in low carbon steel and 302/304/305 stainless. Aluminum, monel, inconel, and other grades of stainless steel are available.
PLATING	Copper plating is standard. Cadmium, Nickel, Zinc and other platings are available.	Cadmium to ASTM-A165 type TS, zinc to ASTM-B 633 (formerly A 164) and other platings are available. Non-weldable plating is removed from the weld end to avoid contamination of the weld.
ANNEALING	All low carbon steel and stainless steel studs are annealed where required.	Low carbon steel can be annealed to a maximum of 75 Rockwell B and stainless steel to a maximum of 90 Rockwell B.
THREADS	UNC-2A is standard for external threads prior to plating and UNC-2B for internal threads. Metric and other thread sizes are available.	UNC-2A is standard for external threads prior to plating and UNC-2B for internal threads. Metric and other thread sizes are available.
WELD BASE	Flanged, small flanged, and non-flanged are available.	1/4" dia. and over have solid flux. Diameters under 1/4" are standard pointed, and flux is optional.
STUD LENGTH	CD studs have no appreciable length reduction after welding.	SUNBELT arc stud length designations are BEFORE WELD. AFTER WELD lengths are shown in the table below.
FERRULES	Does not apply to CD.	All orders include ferrules when they are required.

STUD DIAMETER	APPROX. REDUCTION
3/16" thru 1/2"	1/8"
5/8" thru 7/8"	3/16"
7/8" and over	1/4"
1/8" wide rectangular	1/8"

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Sunbelt Stud Welding, Inc.
6381 Windfern Road
Houston, Texas 77040-4915

1-800-462-9353
713-939-8903
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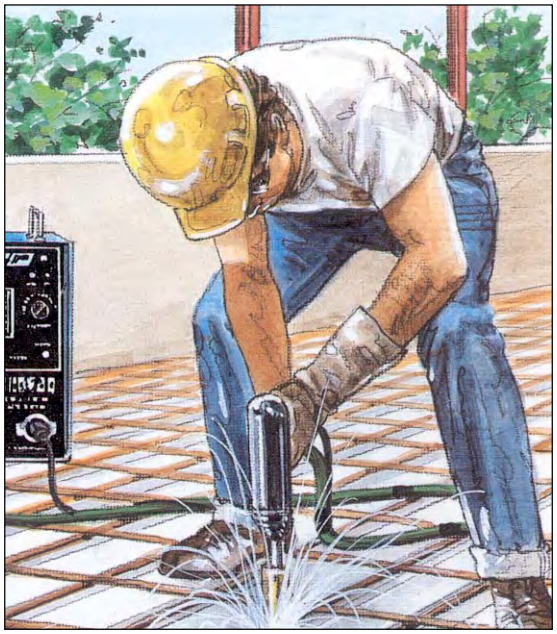
HOW CAN STUD WELDING REDUCE COST?



Stud Welding can reduce costs by saving labor and material where end joined components are required by speeding up design time and application rates, and preventing many common secondary operations. Bosses and spotfacing, counterboring, undercutting and manual fillet welding, soldering, drilling and tapping, riveting, inserts and special retainers are often totally eliminated. Yet in most cases the welded joint is stronger than many of these traditional jointing methods.

A single operator, working with a single system, from just one side of the workpiece can attach many parts each minute.

Other advantages with **CD** stud welding include attachment to very thin metals, no reverse side marking such as in prelaminated, painted, or plated parts and no excessive part heating or warpage. **ARC** stud welding provides high fastener strength requiring less material for component system integrity, and is usually not affected by minor contamination situations presented in normal construction procedures.

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THE ARC STUD WELDING PROCESS

1. STUD AND CERAMIC FERRULE AGAINST THE WORK PLATE.

2. STUD LIFTS & ARC IS DRAWN.

3. CONTROL TIMES OUT & STUD PLUNGES INTO MOLTEN STEEL.

4. METAL SOLIDIFIES & WELD IS COMPLETED IN MILLI-SECONDS.

ARC Stud Welding involves the same basic principles and metallurgical aspects as any other arc welding procedure. The weld gun lifts the stud a short distance from the base metal and initiates a controlled electric arc from the power source which melts the end of the stud and a portion of the base metal. The ceramic ferrule contains the molten metal into which the stud is thrust automatically and a high quality fusion weld is accomplished. **ARC** Stud Welding is generally used to weld larger diameter studs to thick base metals. **ARC** studs may be almost any shape and there are literally hundreds, however, they must have one end of the stud designed for **ARC** welding and must be made of weldable materials. Mild steel, stainless steel, and aluminum are applicable materials for ARC stud welding.

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6381 Windfern Road
Houston, Texas 77040-4915

1-800-462-9353
713-939-8903
fax 713-939-9013

ARC STUD WELDING GENERAL INFORMATION

RECOMMENDED MINIMUM BASE METAL THICKNESS

STUD WELD BASE DIA. (in.)	STEEL		ALUMINUM	
	WITHOUT BACKUP (in.)	(gauge)	WITHOUT BACKUP (in.)	WITH BACKUP (in.)
0.187 0.250	0.0359 0.0478	20 18	0.125 0.125	0.125 0.125
0.312 0.375	0.0598 0.0747	16 14	0.187 .0187	0.125 0.187
0.437 0.500	0.0897 0.1196	13 11	0.250 0.250	0.187 0.250
0.625 0.750	0.148 0.187	9		
0.875 1.000	0.250 0.375			

ARC STUD WELDER SELECTION GUIDE

STUD WELDER		STUD WELD BASE DIAMETER IN INCHES				
PRO WELD	SUNBELT	UP TO 3/8"	UP TO 1/2"	UP TO 5/8"	UP TO 7/8"	UP TO 1" & WTD
ARC-656	ARC-500					
ARC-800	ARC-800					
ARC-1200	ARC-1550					
ARC-1850	ARC-2100M					
ARC-3000	N/A					

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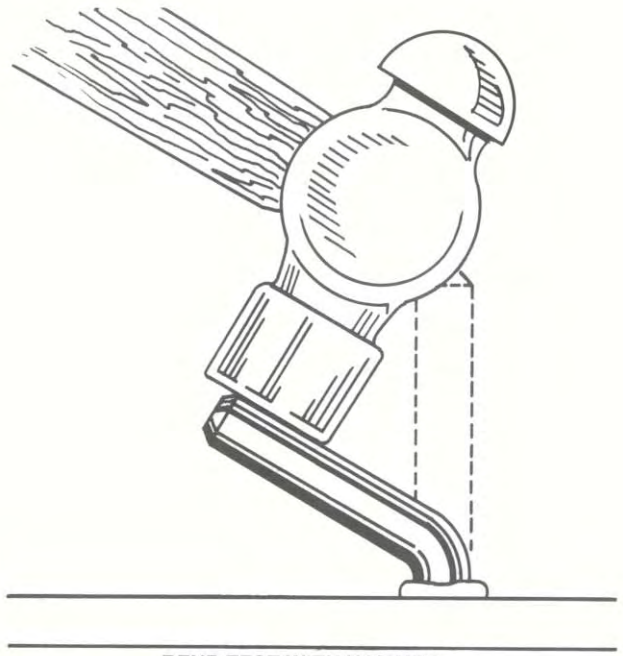
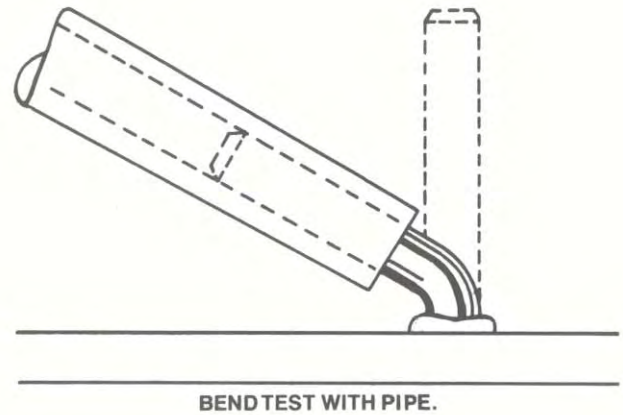
CD AND ARC STUD WELD TESTING (PHYSICAL)



BEND TEST WITH HAMMER.

BEND TEST: (See illustrations) By striking the stud with a hammer, or by sliding a length of pipe or tube over the stud, the stud can be bent a minimum of 30° away from its axis, or until failure occurs. Satisfactory welded studs should exhibit a complete 90° bend without failure.

TORQUE TEST: The stud may be torqued with conventional torque equipment by applying torque until a predetermined torque or proof load is reached or until failure occurs.



BEND TEST WITH PIPE.

TENSILE TEST: The stud may be tested with conventional tensile testing equipment until a predetermined load is reached or until failure occurs.

OTHER: The stud and weld can be submitted to other conventional forms of destructive or non-destructive testing as specifications may require.

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WEIGHTS AND PACKAGING CONCRETE ANCHORS

SHIPPING WEIGHT CHART						
DIAMETER	STUD LENGTH	POUNDS PER 1000	PIECES PER BOX	POUNDS PER BOX	PCS. PER PALLET	*LBS. PER PALLET
1/4	2-11/16	43	1000	47	27,000	1269
	3-1/8	50	1000	51	27,000	1377
	4-1/8	63	600	40	16,200	1,080
3/8	1-1/4	65	1000	67	27,000	1,809
	1-3/8	68	1000	70	27,000	1,890
	1-5/8	77	1000	79	27,000	2,133
	2-1/8	92	700	67	18,900	1,809
	2-5/8	111	600	68	16,200	1,836
	3-1/8	124	500	64	13,500	1,728
	4-1/8	154	350	55	9,450	1,485
	5-1/8	185	300	56	8,100	1,512
	6-1/8	212	200	44	5,400	1,188
	8-1/8	274	250	69	2,250	621
1/2	1-1/2	132	500	68	13,500	1,836
	1-5/8	138	450	64	12,150	1,728
	2-1/8	166	400	70	10,800	1,890
	2-5/8	198	350	71	9,450	1,917
	3-1/8	223	300	69	8,100	1,863
	4-1/8	277	200	56	5,400	1,512
	5-5/16	339	150	53	4,050	1,431
	6-1/8	388	125	50	3,375	1,350
	8-1/8	495	200	102	1,800	918
5/8	1-7/16	208	400	85	10,800	2,295
	1-11/16	227	325	77	8,775	2,079
	1-15/16	248	300	78	8,100	2,106
	2-3/16	270	250	71	6,750	1,917
	2-11/16	319	250	81	6,750	2,187
	3-3/16	363	200	75	5,400	2,025
	4-3/16	444	150	69	4,050	1,863
	4-11/16	487	125	63	3,375	1,701
	5-3/16	528	100	55	2,700	1,485
	6-3/16	604	100	62	2,700	1,674
	6-9/16	646	80	52	2,160	1,404
	8-3/16	781	150	117	1,350	1,053
	10-3/16	946	100	98	900	882

**Weight shown does not include the weight of a pallet (approx. 39 pounds)*

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Sunbelt Stud Welding, Inc.
6381 Windfern Road
Houston, Texas 77040-4915

1-800-462-9353
713-939-8903
fax 713-939-9013

WEIGHTS AND PACKAGING SHEAR CONNECTORS

SHIPPING WEIGHT CHART						
DIAMETER	STUD LENGTH	POUNDS PER 1000	PIECES PER BOX	POUNDS PER BOX	PCS. PER PALLET	*LBS. PER PALLET
3/4	3-3/16	478	125	60	6,000	2,880
	3-3/8	500	125	62	6,000	2,976
	3-11/16	548	100	55	4,800	2,640
	3-7/8	567	100	58	4,800	2,784
	4-3/16	600	100	62	4,800	2,976
	4-3/8	625	100	62	4,800	2,976
	4-11/16	672	75	51	3,600	2,448
	4-7/8	683	75	51	3,600	2,448
	5-3/16	735	60	44	2,880	2,112
	5-3/8	754	60	45	2,880	2,160
	5-11/16	797	60	48	2,880	2,304
	5-7/8	810	60	49	2,880	2,352
	6-3/16	852	60	50	2,880	2,400
	6-11/16	905	70	64	1,890	1,728
	7-3/16	968	60	59	1,620	1,593
	8-3/16	1,105	50	56	1,350	1,512
	9-3/16	1,222	100	126	900	1,134
	10-3/16	1,339	100	137	900	1,233
7/8	3-3/16	631	100	66	2700	1782
	3-11/16	709	100	74	2700	1998
	4-3/16	796	100	82	2700	2214
	4-11/16	878	80	72	2160	1944
	5-3/16	961	75	75	2025	2025
	5-11/16	1,067	60	65	1620	1755
	6-3/16	1,137	50	57	1350	1539
	6-11/16	1,236	50	63	1350	1701
	7-3/16	1,306	100	134	900	1206
	8-3/16	1,496	100	151	900	1359
	9-3/16	1,666	75	125	675	1125
	10-3/16	1,836	75	139	675	1251
1”	3-1/4	894	75	70	2025	1890
	4-1/4	1,079	50	57	1350	1539
	5-1/4	1,302	50	67	1350	1809
	6-1/4	1,514	45	81	1350	2187
	7-1/4	1,737	85	150	765	1350
	8-1/4	1,978	85	171	765	1539
	9-1/4	2,193	40	91	360	819

**Weight shown does not include the weight of a pallet (approx. 39 pounds)*

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WEIGHTS AND PACKAGING
DEFORMED BAR ANCHORS

SHIPPING WEIGHT CHART			
DIAMETER	BAR LENGTH	PCS. PER BOX	LBS. PER BOX
3/8	10-1/8	150	46
	12-1/8	150	55
	18-1/8	150	80
	24-1/8	150	108
1/2	10-1/8	100	54
	12-1/8	100	67
	18-1/8	100	98
	24-1/8	100	128
5/8	12-3/16	50	51
	18-3/16	50	76
	24-3/16	50	105
3/4	12-3/16	40	60
	18-3/16	40	87
	24-3/16	40	115
	30-3/16	40	142

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Houston, Texas 77040-4915

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713-939-8903
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ARC STUDS WEIGHT CHARTS (STEEL)

ESTIMATED WEIGHTS OF THREADED STUDS IN POUNDS PER 1000 PIECES								
LENGTH	1/4-20	5/16-18	3/8-16	7/16-14	1/2-13	5/8-11	3/4-10	7/8-9
3/4	8.3	12.8	18.8	25.5	34.5			
1	11.0	17.0	25.0	34.0	46.0	70.0		
1-1/4	13.8	21.3	31.3	42.5	57.5	87.5	133.8	
1-1/2	16.5	25.5	37.5	51.0	69.0	105.0	160.5	243.8
1-3/4	19.3	29.8	43.8	59.5	80.5	122.5	187.3	284.4
2	22.0	34.0	50.0	68.0	92.0	140.0	214.0	325.0
2-1/4	24.8	38.3	56.3	76.5	103.5	157.5	240.8	165.6
2-1/2	27.5	42.5	62.5	85.0	115.0	175.0	267.5	406.3
2-3/4	30.3	46.8	68.8	93.5	126.5	192.5	294.3	446.9
3	33.0	51.0	75.0	102.0	138.0	210.0	321.0	487.5
3-1/4	35.8	55.3	81.3	110.5	149.5	227.5	347.8	528.1
3-1/2	38.5	59.5	87.5	119.0	161.0	245.0	374.5	568.8
3-3/4	41.3	63.8	93.8	127.5	172.5	262.5	401.3	609.4
4	44.0	68.	100.0	136.0	184.0	280.0	428.0	650.0
4-1/4	46.8	72.3	106.3	144.5	195.5	297.5	454.8	690.6
4-1/2	49.5	76.5	112.5	153.0	207.0	315.0	481.5	731.3
4-3/4	52.3	80.8	118.8	161.5	218.5	332.5	508.3	771.9
5	55.0	85.0	125.0	170.0	230.0	350.0	535.0	812.5
EACH ADD'L INCH	**11.0**	**17.0**	**25.0**	**34.0**	**46.0**	**70.0**	**107.0**	**162.5**
"P" FERRULE	**1.8**	**2.8**	**3.1**	**4.5**	**5.9**	**10.8**	**21.9**	**39.0**

ESTIMATED WEIGHTS OF NO-THREAD STUDS IN POUNDS PER 1000 PIECES									
LENGTH	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8
3/4	6.0	10.5	16.4	23.5	31.9	41.7			
1	8.0	14.0	21.8	31.3	42.5	55.6	86.6		
1-1/4	10.0	17.5	27.3	39.1	53.1	69.5	108.3	156.0	
1-1/2	12.0	21.0	32.7	47.0	63.8	83.4	129.9	187.2	225.0
1-3/4	14.0	24.5	38.2	54.8	74.4	97.3	151.6	218.4	297.5
2	16.0	28.0	43.6	62.6	85.0	111.2	173.2	249.6	340.0
2-1/4	18.0	31.5	49.1	70.4	95.6	125.1	194.9	280.8	382.5
2-1/2	20.0	35.0	54.5	78.3	106.3	139.0	216.5	312.0	425.0
2-3/4	22.0	38.5	60.0	86.1	116.9	152.9	238.2	343.2	467.5
3	24.0	42.0	65.4	93.9	127.5	166.8	259.8	374.4	510.0
3-1/4	26.0	45.5	70.9	101.7	138.1	180.7	281.5	405.6	552.5
3-1/2	28.0	49.0	76.3	117.4	148.8	194.6	303.1	436.8	595.0
3-3/4	30.0	52.5	81.8	125.2	159.4	208.5	324.8	468.0	637.5
4	32.0	56.0	87.2	125.2	170.0	222.4	346.4	499.2	680.0
4-1/4	34.0	59.5	92.7	133.0	180.6	236.3	368.1	530.4	722.5
4-1/2	36.0	63.0	98.1	140.9	191.3	250.2	389.7	561.6	765.0
4-3/4	38.0	66.5	103.6	148.7	201.9	264.1	411.4	592.8	807.5
5	40.0	70.0	109.0	156.5	212.5	278.0	433.0	624.0	850.0
EACH ADD'L INCH	**8.0**	**14.0**	**21.8**	**31.3**	**42.5**	**55.6**	**86.6**	**124.8**	**170.0**
"F" FERRULE	**2.0**	**2.9**	**4.3**	**5.0**	**5.2**	**7.4**	**15.5**	**30.1**	**49.0**

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ARC ENGINEERING SPECIFICATIONS AND LOAD STRENGTHS

These basic specifications are typical values of mechanical properties of Sunbelt studs. Also shown are the chemical properties of low carbon steel. For actual material analysis and physical properties, Sunbelt will provide, upon request, a detailed material certification.

STUD SIZE	SUGGESTED FASTENING TORQUE (INCH LBS)				ULTIMATE TENSILE STRENGTH (LBS)				ULTIMATE SHEAR LOAD (LBS)			
	LCS	HSS	304SS	5000 SA	LCS	HSS	304SS	5000 SA	LCS	HSS	304SS	5000 SA
8-32	17.8	-	19.8	-	1010	-	1260	-	750	-	940	-
10-24	20.8	-	22.8	10	1230	-	1530	770	920	-	1150	460
1/4-20	65	130	75.2	40	2300	3800	2880	1360	1720	2400	2160	850
5/16-18	129	260	132	70	3740	6200	4680	2300	2800	4000	3500	1400
3/8-16	212	400	236	81	5550	9300	6920	3250	4160	6000	5190	2100
7/16-14	338	-	376	140	7630	-	9600	4400	5710	-	7200	2400
1/2-13	465	900	517	-	10200	16900	12800	5950	7650	11000	9600	3000
5/8-11	1000	-	1110	-	16300	-	20200	-	12200	-	15150	-
3/4-10	1259	-	1530	-	24000	-	30000	-	18000	-	22500	-
7/8-9	1919	-	2328	-	33300	-	41600	-	24900	-	31200	-
1”-8	2832	-	3440	-	43600	-	54500	-	32700	-	40900	-

LCS (Low Carbon Steel):

- ***Chemical Properties*: C**-.23% Max.; **P**-.040% Max.; **Mn**-.90% Max.; **S**-.050% Max
- ***Mechanical Properties*:** Tensile Strength: 60,000 PSI Min.; Yield Strength: 50,000 PSI Min.; Elongation in two inches: 20% Min.
- ***Mechanical Properties (Annealed):*** Tensile Strength: 50,000 PSI, Yield Strength: 35,000 PSI; Elongation in two inches: 25%.

HSS (High Strength Steel):

- ***Mechanical Properties:*** Tensile Strength: 120,000 PSI Min.

304SS (Stainless Steel Type 302/304/305/316):

- ***Mechanical Properties:*** Tensile Strength: 85,000 PSI Min.; Yield strength: 40,000 PSI Min.; Elongation in two inches: 45%.
- ***Mechanical Properties (Annealed):*** Tensile Strength: 80,000; Yield strength: 30,000 PSI Min.; Elongation in two inches: 50%.

5000SA (Aluminum Alloy – 5000 Series):

- ***Mechanical Properties:*** Tensile Strength: 42,000 PSI Min.; Yield Strength: 30,000 PSI Min.

Disclaimer: *The provided performance data is intended as guideline specifications & strengths only and is based on assumptions of general and reasonable use. Performance suitability for any specific application should be determined by the user.*

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6381 Windfern Road
Houston, Texas 77040-4915

1-800-462-9353
713-939-8903
fax 713-939-9013

MANUFACTURING DATA

THREADS

Standard threads are UNC-2A for male threads, UNC-2B for female. Some sizes are also stocked in UNF-2A and 2B sizes. Other thread classifications are available on special order. Whenever possible, all studs are thread rolled.

PLATING

Zinc plating is available according to ASTM-A 164-55-RS. Other plating materials are available on request. Plating is removed from the weld base to prevent contamination on all studs except 10 Gauge pins.

ANNEALING

Sunbelt arc welding studs can be annealed to a maximum of 75 Rockwell B for low carbon steel; 90 Rockwell B for stainless steel.

FLUX

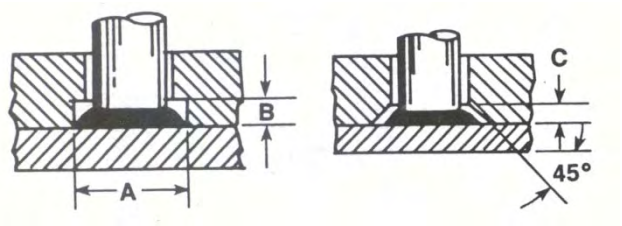
Except for some studs less than 5/16" diameter, all studs are solid fluxed at the center of the weld base.

FERRULES

All orders include ferrules when required. Ferrules are supplied with the studs and are not sold individually.

ARC STUD WELD FILLET ACCOMMODATION

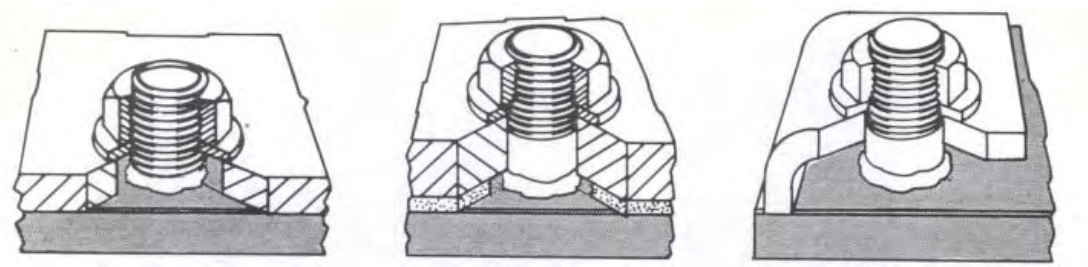
STUD SIZE (in.)	COUNTERBORE (in.)		90° COUNTER-SINK (in.)
	A	B	C
1/4	0.437	0.125	0.125
5/16	0.500	0.125	0.125
3/8	0.593	0.125	0.125
7/16	0.656	0.187	0.125
1/2	0.750	0.187	0.187
5/8	0.875	0.218	0.187
3/4	1.125	0.312	0.187



COUNTERBORE OR COUNTERSINK METHODS

When an arc stud is welded, a fillet forms around its base with the fillet dimensions being closely controlled by the design of the ferrule used. Since the diameter of the fillet is generally larger than the diameter of the stud, some consideration is required in the design of mating parts. Counter bore and counter sink methods are commonly used. Dimensions will vary with studs and ferrules. Additional methods of accommodating fillet include oversized clearance holes, use of a gasket material around the fillet or use of a dog type construction.

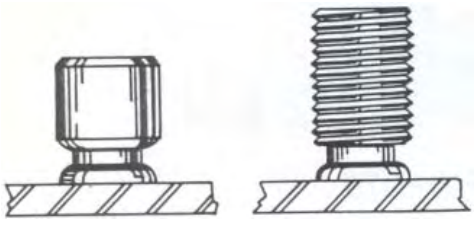
SEVERAL OPTIONAL METHODS OF FILLET ACCOMMODATION



(A) OVERSIZE CLEARANCE HOLE **(B) GASKET MATERIAL** **(C) DOG CLAMP**

IF AN OVERSIZE FILLET DOES NOT MEET THE APPLICATION:

Welded studs designed with a reduced weld base are available so that the weld fillet does not exceed the maximum diameter of the fastener. This design is not recommended if full fastener strength is important.



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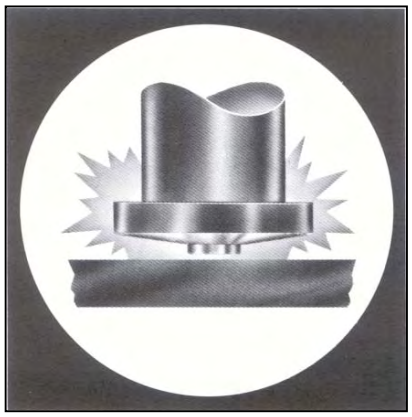
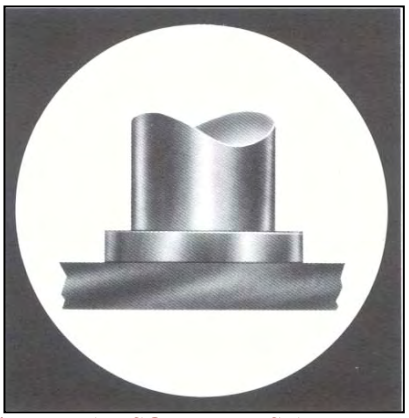
THE CAPACITOR DISCHARGE STUD WELDING PROCESS

1. STUD AGAINST WORK.

2. STORED ENERGY DISCHARGED THROUGH SPECIAL WELD "TIMING" TIP & STUD STARTS DOWNWARD.



3. STUD FORCED INTO MOLTEN METAL.



4. METAL SOLIDIFIES AND WELD COMPLETED IN MILLISECONDS.

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. 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. As long as one end of the stud is designed for CD welding, CD studs can be manufactured in almost any shape. CD Stud Welding is compatible with just about any weldable material and permits the welding of dissimilar metals.

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CD STUD/BASE METAL COMBINATION WELDING CAPABILITIES

BASE WELD SURFACE MATERIAL	STUD MATERIAL			
	Mild Steel	Stainless	Aluminum	Brass
	1008, 1010	304, 305	1100, 6061	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, & 300 Series except 303	Excellent	Excellent	-	Excellent
LEAD FREE BRASS; ELECTROLYTIC COPPER; LEAD FREE ROLLED COPPER	Excellent	Excellent	-	Excellent
MOST ALUMINUM ALLOYS OF THE 1100, 3000, 5000, 6000SERIES* *	-	-	Excellent	-
DIE CAST ZINC ALLOYS	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.*

CD STUD REVERSE-SIDE MARKING LIMITATIONS

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

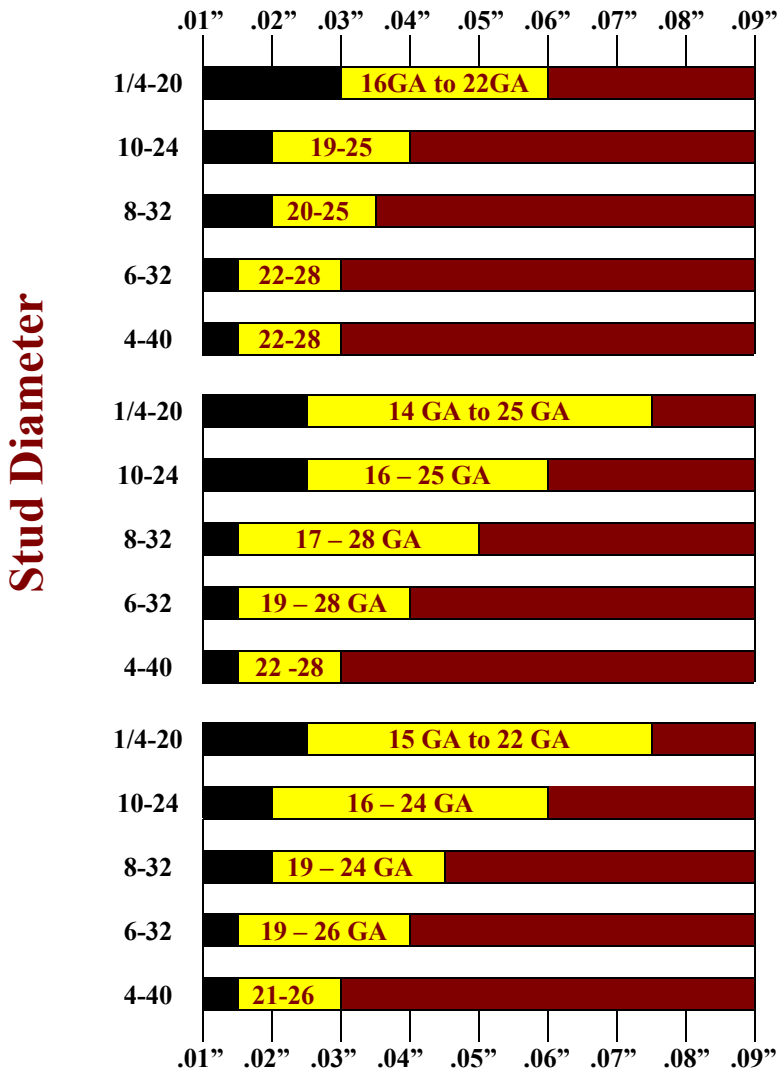
EXCELLENT – No marking, excellent weld.
ACCEPTABLE – Visible markings, excellent weld.
UNACCEPTABLE – Unacceptable marking, base metal failure.

It should be noted that these charts are based on optimum laboratory conditions. Even under optimum conditions, it is difficult to determine the precise point at which reverse-side marking will appear. Therefore, these charts should be used only as a guide.

OPTIMUM COMB. STUD SIZE/BASE METAL THICKNESS TO PREVENT REVERSE-SIDE MARKING

***Note:** Stud tip size can influence degree of reverse side marking!*

Base Metal Thickness



Base Metal Thickness

MILD STEEL
BASE METAL: Mild Steel **STUD**: Mild Steel, Flanged or Small Flanged

STAINLESS STEEL
BASE METAL: Stainless Steel **STUD:** Stainless Steel, Flanged or Small Flanged

ALUMINUM
BASE METAL: Aluminum **STUD**: Aluminum, Flanged or Small Flanged

K E Y	
	UNACCEPTABLE
	ACCEPTABLE
	EXCELLENT

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CD STUD LOAD STRENGTHS

STUD MATERIAL	STUD SIZE	MAXIMUM FASTENING TORQUE (Inch Lbs.)*	ULTIMATE TENSILE LOAD (Lbs.)	MAXIMUM SHEAR LOAD (Lbs.)
LOW-CARBON, COPPER FLASHED STEEL	6-32	6	500	375
	8-32	12	765	575
	10-24	14	960	720
	1/4-20	43	1750	1300
	5/16-18	72	2900	2200
	3/8-16	106	4300	3250
STAINLESS STEEL: 304	6-32	10	790	590
	8-32	20	1260	940
	10-24	23	1530	1150
	1/4-20	75	2880	2160
	5/16-18	126	3750	5350
	3/8-16	186	4850	7150
ALUMINUM ALLOY: 1100	6-32	2.5	200	125
	8-32	5	295	185
	10-24	6.5	380	235
	1/4-20	21.5	670	415
	5/16-18	36	1125	695
	3/8-16	53	1660	1000
ALUMINUM ALLOY: 6061	6-32	6.5	350	160
	8-32	13	560	229
	10-24	19	670	310
	1/4-20	40	1240	679
	5/16-18	70.5	2025	1210
	3/8-16	100	2985	1750
BRASS: 70-30 (260) 65-35 (268)	6-32	8	600	390
	8-32	16	860	560
	10-24	18.5	1040	680
	1/4-20	61	1950	1275
	5/16-18	102	3280	2140
	3/8-16	150	4800	3160

These values should develop fastener tension to slightly less than yield point.

Disclaimer: *The provided performance date is intended as guideline specifications & strengths only and is based on assumptions of general and reasonable use. Performance suitability for any specific application should be determined by the user.*

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STUD WELDING PROCESS SELECTION

LEGEND: A – APPLICABLE S – SPECIAL APPLICATION		L – LIMITED APPLICATION N – NOT APPLICABLE	
FACTORS TO BE CONSIDERED	**CD STUD WELDING**		**ARC STUD WELDING**
	Contact/Gap	**Drawn Arc**	
STUD SHAPE:			
Round	A	A	A
Square	A	A	A
Rectangular	A	A	A
Other	A	A	A
STUD DIAMETER /AREA:			
1/16” – 1/8” Diameter	A	A	N
1/8’ – 1/4” Diameter	A	A	L
1/4” – 1/2” Diameter	S	S	A
1/2” – 1” Diameter	N	N	A
Area up to 0.05 in.	A	A	L
Area over 0.05 in.	N	N	A
STUD METAL:			
Mild Steel	A	A	A
Stainless Steel	A	A	A
Aluminum	A	S	S
Brass	A	A	L
BASE METAL:			
Mild Steel	A	A	A
Stainless Steel	A	A	A
Aluminum	A	S	S
Brass	A	A	L
BASE METAL THICKNESS:			
Under 0.025”	S	S	N
0.025” – 0.062”	A	A	L
0.063” – 0.125”	A	A	S
0.126” & over	A	A	A
DESIGN CRITERIA:			
Heat effect on materials	A	A	S
Reverse side marking	A	A	L
Weld fillet clearance	A	A	S
Strength of stud	A	A	A
Strength of base metal	A	A	A

May be applicable with special techniques if deemed necessary.

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CD STUDS WEIGHT CHARTS (FLANGED – STEEL)

ESTIMATED WEIGHTS OF THREADED STUDS IN POUNDS PER 1000 PIECES						
LENGTH	**4-40**	**6-32**	**8-32**	**10-24**	**1/4-20**	**5/16-18**
1/4	0.69	1.00	1.39	1.79	3.08	4.90
3/8	0.94	1.38	1.93	2.50	4.37	6.98
1/2	1.18	1.76	2.49	3.21	5.66	9.06
5/8	1.43	2.13	3.04	3.93	6.95	11.13
3/4	1.67	2.51	3.60	4.64	8.24	13.21
7/8	1.92	2.89	4.15	5.35	9.52	15.29
1	2.16	3.26	4.71	6.07	10.81	17.36
1-1/4	2.65	4.02	5.82	7.50	13.39	21.52
1-1/2	3.15	4.77	6.93	8.92	15.96	25.67
1-3/4	3.64	5.52	8.04	10.35	18.54	29.83
2	4.13	6.27	9.15	11.78	21.12	33.98
2-1/4	4.62	7.03	10.26	13.21	23.69	38.14
2-1/2	5.11	7.78	11.37	14.63	26.27	42.29
EACH ADD'L INCH	**1.96**	**3.01**	**4.44**	**5.71**	**10.31**	**16.62**

ESTIMATED WEIGHTS OF NON-THREADED STUDS IN POUNDS PER 1000 PIECES						
LENGTH	**3-32**	**1/8**	**5-32**	**3/16**	**1/4**	**5/16**
1/4	0.68	1.06	1.59	2.24	3.87	5.97
3/8	0.92	1.50	2.27	3.21	5.61	8.68
1/2	1.16	1.93	2.94	4.19	7.35	11.39
5/8	1.40	2.37	3.62	5.16	9.09	14.11
3/4	1.64	2.80	4.30	6.14	10.84	16.82
7/8	1.88	3.24	4.98	7.12	12.56	19.53
1	2.12	3.67	5.65	8.09	14.32	22.25
1-1/4	2.60	4.54	7.01	10.04	17.81	27.67
1-1/2	3.08	5.41	8.36	11.99	21.29	33.10
1-3/4	3.56	6.28	9.72	13.95	24.78	38.52
2	4.04	7.15	11.07	15.90	28.26	43.95
2-1/4	4.52	8.02	12.43	17.85	31.75	49.37
2-1/2	5.00	8.89	13.78	19.80	35.23	54.80
EACH ADD'L INCH	**1.92**	**3.48**	**5.42**	**7.81**	**13.94**	**21.70**

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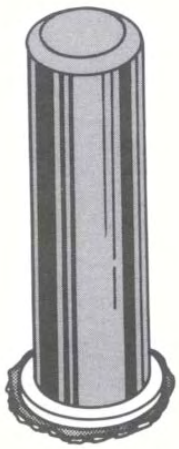
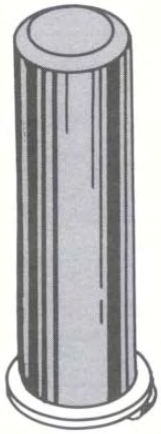
VISUAL INSPECTION OF A CD STUD WELD

The **CD stud weld** can be visually inspected by observing the **fillet** at the base of the stud. The illustrations and comments below will assist you in visually judging the quality of the weld.



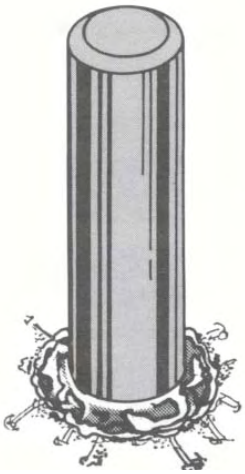
GOOD

Full, even fillet all around stud.



COLD

No fillet or uneven fillet.



HOT

Large crater-excessive metal expulsion, very shiny appearance.

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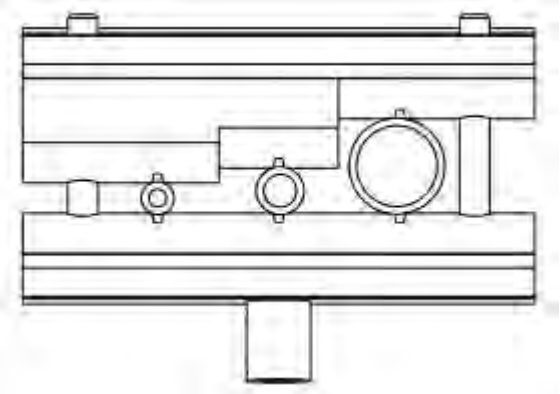
I-ROD™ STANDARD



I-ROD™ STANDARD			
Property Value	**ASTM Test**	**Metric**	**Imperial**
Density, 73°F (23° C)	D792	1.41 g/cm	0.0509lb/in3
Tensile Strength, 73°F (23° C)	D638	64.8 MPa	9,400 psi
Tensile Modulus of Elasticity, 73° F (23° C)	D638	2.62 GPa	380 ksi
Elongation (at break), 73°F (23°C)	D638	30-60%	30-60%
Flexural Modules of Elasticity, 73°F (23°C)	D790	2.76 GPa	400 ksi
Flexural Strength, 73°F (23°C)	D790	82.7 MPa	13 ksi
Compressive Strength, 10% def, 73°F (23°C)	D695	103 MPa	15 ksi
Coefficient of Frication (dry vs. steel)	N/A QTM 55007	.25	0.25
IZOD Impact (notched), 73°F (23°C)	D256	.534 J/cm	1 ft-lb/in notch
Hardness, Rockwell, 73°F (23°C) M/R	D785	88/120	88/120
Maximum Service Temperature	(Long Term)	83°C	181°F
Deformation Under Load	D621	1.0%	1.0%
Melting Point	D3418	168° C	329°F
Coefficient of Linear Expansion	E831	97.2 µm/m/°C	54µin/in/°F
Heat Deflection Temperature, 265 psi	D648	220°F	220°F
Flammability Rating	VL94	HB	HB
Dielectric Strength, Short Term	D149	420 V/mil	420 V/mil

See Section 15-Marine Products for further details

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