Capacitive Discharge, Fine-Spot Resistance Welder

Instruction Pamphlet

CD150DP / CD300DP / CD450DP / CD750DP

- Dual Pulse operation removes surface inconsistencies and contaminants
- Single or Dual Pulse operation
- Adjustable pulse width
- Available in 150ws, 300ws, 450ws and 750ws
- Adjustable from 1% to 100% energy discharge
- Up to 166 welds/min
- Simple, user-friendly interface

Fundamentals of Capacitive Discharge Resistance Welding

Capacitive discharge resistance welding uses capacitors to store energy for quick release. Figure 1 shows a typical capacitor discharge curve.

Capacitive resistance welders, also called capacitive discharge or CD welders, have many advantages over other welder types:

- Quick energy release for welding highly conductive metals such as copper
- Small heat effected weld zones
- Repeatable energy release independent of line voltage fluctuations
- Capable of extremely fine energy adjustment.

Weld nugget formation takes place during the first few milli-seconds of the welding process. A CD welder allows extremely fast energy release with large peak currents. More of the energy goes into weld formation and less into heating surrounding material. The heat affected zone, where the properties of the metal have been changed by rapid heating and cooling, is localized to a small area around the weld spot. The quick discharge rate of CD welders also allows electrically and thermally conductive materials, such as copper or aluminum, to be welded. Capacitive welders deliver repeatable welds even during line voltage fluctuations because weld energy is stored before use.

Weld Formation

Spot welding relies on metal resistivity (resistance) to heat and fuse metal. A large current is passed through the work piece metal. Energy is dissipated due to metal resistance in the form of heat which melts and fuses the weld materials. There are two

phases to the melting process. The welder must overcome both the material contact resistance and

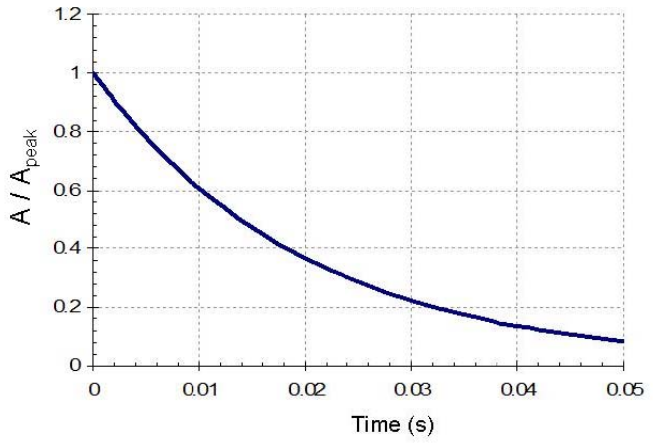

Figure 1: Sample capacitor discharge curve.

the bulk resistance of the material. Figure 2 shows an example of a micro-scale surface profile. On the micro-scale, material surfaces are rough and only contact in a limited number of locations. In the first few milli-seconds of weld formation the high-resistance metal bridges melt allowing other bridges to come into contact to continue the melting process. When all of the bridges have fused, the contact resistance is zero. The bulk resistance of the metal then plays the final role in the weld formation.

Weld Pressure

Several other factors play a part in the contact resistance. The larger the contact resistance the hotter the resultant weld. On the micro-scale, contact resistance is reduced when more metal bridges or contact points are formed (see Figure 2). Using more electrode pressure creates more metal bridges. This results in a lower contact resistance and a cooler weld. Conversely, light electrode pressure results in less metal contact, higher resistance, and a hotter weld. An appropriate amount of pressure should be used to insure good weld strength.

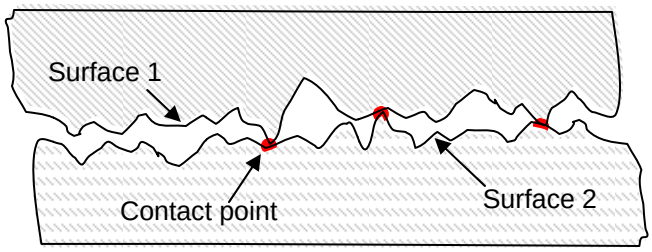

Figure 2: On the micro-scale, surface roughness limits surface-to-surface contact. More contact points result in a lower contact resistance.

Electrode Configurations

Figure 3 shows several electrode configurations used in resistance welding. Figure 3a is called a direct weld. Current is passed from one electrode through both work pieces and out an opposing electrode. Figure 3b shows a step electrode configuration. This configuration is used when there is access to only one side of the work piece and an electrode can be placed on both materials. Figure 3c is a series configuration. Electrodes can only be placed on one metal surface from one side. Current is divided between the two parts. This weld configuration requires more weld energy.

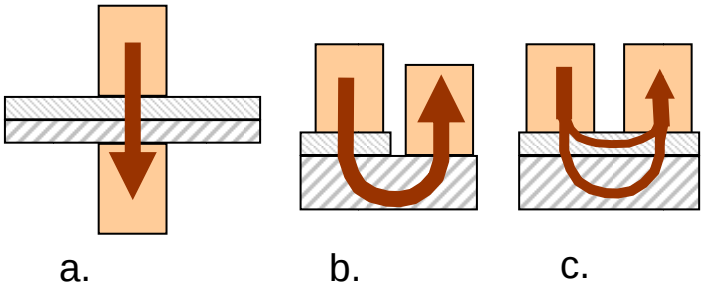

Figure 3: Examples of resistance welding electrode configurations: a. direct, b. step, c. series.

Determining Weld Energy

A capacitive discharge welder controls the voltage of the welding capacitors. However, the energy stored in the capacitor is a function of the voltage squared ($E = \frac{1}{2}*C*V^2$). This relation states that a small difference in voltage makes a large difference in weld energy. Sunstone CD150DP – CD750DP

welders have a voltage adjustment dial. The power stored in the welder can be found by referring to the equation above or by visiting Table 1.

Using Sunstone Dual Pulse Welders

Weld Energy Indication

Figure 4 shows the Sunstone Engineering Dual Pulse CD welder front panel. Weld voltage is indicated with a blue backlit LCD display. To convert this value to watts*seconds (joules) use Eqn. 1 or see Table 1 for a simplified list.

$$E = \frac{1}{2} C \cdot V^2$$

Eqn. 1.

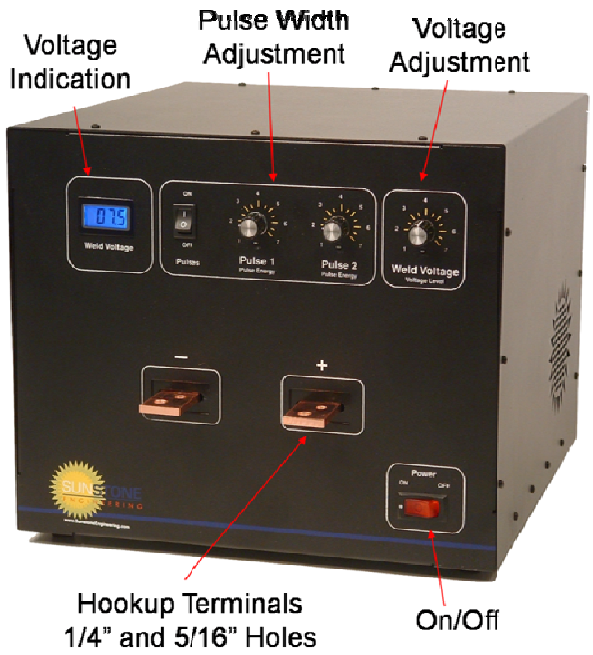

Figure 4: Welder front panel features: Blue LCD voltage indication display, easy to use pulse width and voltage control interface, each pulse can be turned off individually and both can be turned off at the same time for weld head setup, large weld head hook-up cables for 1/4" and 5/16" studs, red backlit on/off switch.

Pulse Control

Sunstone Dual Pulse welders have two pulse width energy controls. Each pulse can be adjusted separately or turned off if desired. Both pulses can be turned off without adjusting pulse values to facilitate weld head setup or electrode maintenance. Pulse 1 is adjustable between 1% and approximately 50% of the total stored energy. Pulse 2 is adjustable between 1% and 100% of the stored energy (see Table 2). Please note that when used in dual pulse mode the Pulse 2 energy level represents the percent of remaining power. For example if Pulse 1 was set to 25% the Pulse 2 setting would actually be taken from the remaining 75% of the set-point energy.

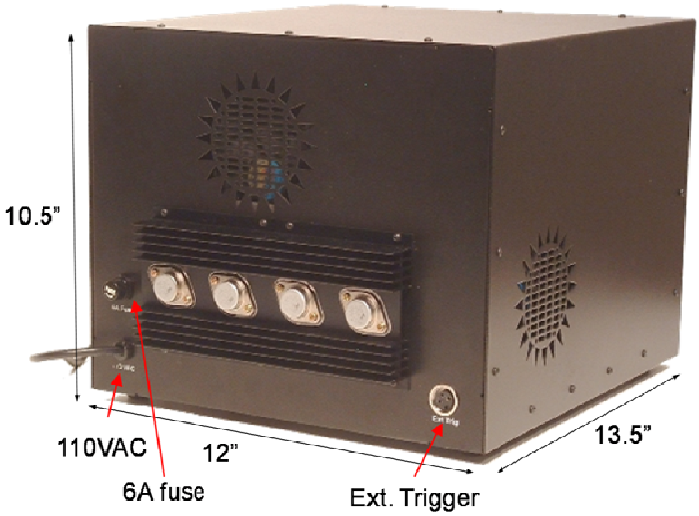

Figure 5: Welder back panel: External trigger port, 6A fuse, 110VAC voltage input.

Energy Adjustment

Each Sunstone welder is infinitely adjustable between its minimum and maximum energy. The CD150DP - CD750DP welders have weld repetition rates of up to 166 welds/min (the hardware defined limit). See Table 5 for additional details on weld repetition rates. The weld voltage knob is used to set the total welder energy storage (see Table 1 and Eqn. 1) and is also used to set the peak weld current (see Table 2). The pulse widths are then adjusted to provide the appropriate weld energy released during each weld.

Weld Actuation

The welders are actuated by means of an external trigger port located on the back of the welder (see Figure 5). The trigger uses a DIN 3 connector and requires shielded wire. Figure 6 shows the proper pin placement for custom external trigger cables (shown for welder back panel connector). The standard external trigger cable connector is an SD-30LP made by CUI Inc.

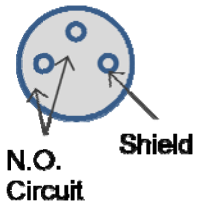

Figure 6: External trigger wiring diagram for the welder back panel connector. N.O. stands for Normally Open.

Weld Attachments

Sunstone Engineering produces a variety of welding hand pieces and weld heads to accommodate a diverse range of welding applications. Hand piece welding attachments allow ease of use and versatility, while fixed weld heads provide control and precision. Cabling between welder and weld head is important in determining peak weld current and adjusting weld pulse timing. Table 2 indicates the Pulse 1 and 2 settings to be used with different cabling. Table 3 indicates peak currents that can be expected with 3 to 4 foot sections of these cables. Typically, hand pieces will use 4 or 8 AWG gauge wire while weld heads will be hooked up with 0 or 4 AWG gauge wire.

Voltage and Power Requirements

The CD150DP – CD750DP welders use 110VAC wall power. If using the welder in a country where 220VAC etc. wall power is used, a voltage transformer can be purchased from Sunstone Engineering. The welder uses a 6mm x 30mm 6A fuse. A 750W wall circuit should be used to run the welder.

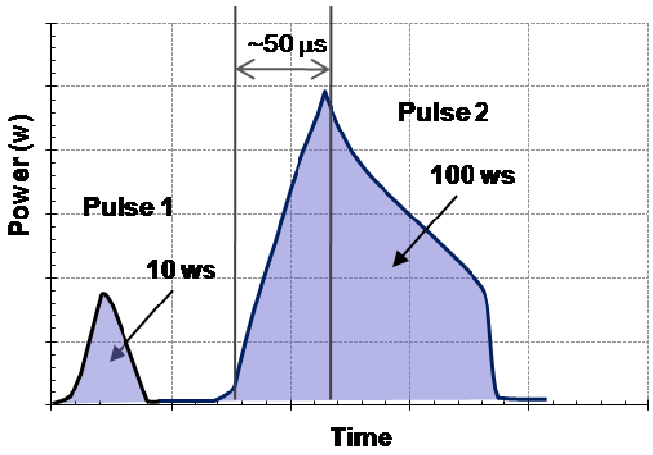

Figure 7: Capacitor discharge using the dual pulse setting.

Using the Dual Pulse Weld Function

Using multiple current pulses increases weld quality. In dual pulse mode Sunstone welders will fire twice from a single actuation. The first pulse is used to remove surface inconsistencies and contaminants. This initial burst of energy displaces oils and breaks through oxide layers. The pulse also seats the welding electrodes. The second pulse is done at a much higher energy level (watt*seconds) and performs the actual weld. Figure 7 shows what the welder discharge curve would look like using the dual pulse setting as outlined above.

Setting Pulse 1 and 2

The Pulse 1 energy setting should be chosen such that the parts adhere weakly. To determine Pulse 1, turn off Pulse 2 and do a series of test welds starting at a low pulse energy setting. Increase the pulse energy 3-5% every test until the parts just stick together. Pulse 1 energy should then be decreased by 3-5%. Pulse 2 should then be set at a level 4 – 5 times that of Pulse 1. A test weld should be performed and pulled apart to determine

weld strength. A nickel strip to nickel plated steel weld, typically seen in battery pack manufacturing, should pull apart leaving holes in the thin nickel metal and leaving the weld nuggets on the battery terminal. Thicker materials should be pulled with a specific pull force requirement in mind.

Tables

Quick-reference Tables 1 – 7 provide useful information for using Sunstone Dual Pulse welders.

SAFETY

Please follow these points to help insure your comfort and safety.

1. Always wear safety glasses when working with spot welders and weld heads.
2. Remove hand jewelry before welding.
3. Avoid touching weld spots immediately after the weld has been performed as they will be hot.
4. Be careful not to pinch fingers in moving weld head parts or between welding electrodes.
5. All welds are performed at low voltage for increased safety of operation.

Additional Information

For additional information and instructional videos please visit our web pages.

www.SunstoneEngineering.com

Table 1: Energy storage with weld voltage.

Model	Voltage (Volts)																			
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
CD150DP	14	19	24	31	38	46	55	64	74	86	97	110	123	137	152	N/A	N/A	N/A	N/A	N/A
CD300DP	27	37	49	62	76	92	109	128	149	171	195	220	246	274	304	N/A	N/A	N/A	N/A	N/A
CD450DP	41	56	73	92	114	138	164	193	223	257	292	329	369	412	456	N/A	N/A	N/A	N/A	N/A
CD750DP	43	59	77	97	120	145	173	203	235	270	307	347	389	433	480	529	581	635	691	750

Table 2: Energy release by hook-up cable gauge number (AWG) and Pulse dial setting. Four and eight AWG cabling is typically seen when using hand held attachments.

	Pulse 1			Pulse 2		
Dial Marker	0 gauge	4 gauge	8 gauge	0 gauge	4 gauge	8 gauge
1	2%	1%	0%	7%	5%	1%
2	6%	5%	1%	25%	20%	4%
3	14%	10%	2%	52%	42%	10%
4	19%	15%	3%	69%	58%	16%
5	46%	37%	9%	91%	83%	30%
6	66%	55%	15%	100%	99%	63%
7	67%	57%	15%	100%	100%	70%

Table 3: Peak weld current shown by model number and external cabling gauge number (AWG). Four and eight AWG cabling is typically seen when using hand held attachments.

Model	0 AWG	4 AWG	8 AWG
150	4000	3000	600
300	4000	3000	600
450	4000	3000	600
750	5300	4000	800

Table 4: Sunstone Dual Pulse general technical specifications.

Feature	CD150DP / CD300DP / CD450DP / CD750DP
Dual Pulse	Yes
Pulse 1 Energy Adjustment (% of set-point energy)	1% - 50%
Pulse 2 Energy Adjustment (% of set-point energy)	1%-100%
Peak Current	4000-5000 Amps

Table 5: Weld speed in welds per minute by Dual Pulse model number at maximum energy set-point.

Pulse width (max energy set-point)	Rep Rate **CD150DP** welds/min (pulse energy)	Rep Rate **CD300DP** welds/min (pulse energy)	Rep Rate **CD450DP** welds/min (pulse energy)	Rep Rate **CD750DP** welds/min (pulse energy)
5%	166 (7.5ws)	166 (15ws)	166 (23ws)	166 (38ws)
25%	166 (38ws)	166 (75ws)	166 (113ws)	166 (188ws)
50%	166 (75ws)	166 (150ws)	150 (225ws)	120 (375ws)
100%	166 (150ws)	89 (300ws)	59 (450ws)	36 (750ws)

Table 6: Weld pulse characteristics.

Model	Min and Max Output	Capacitor Bank	Pulse Width		Rise Time (to max voltage)	Min Pulse Height
CD150DP	0.2 ws - 150 ws	800,000 µF	Min	0.1 ms	0.4 ms	0.5 V
			Max	10 ms	0.4 ms	0.5 V
CD300DP	0.4 ws - 300 ws	1,600,000 µF	Min	0.1 ms	0.4 ms	0.5 V
			Max	20 ms	0.4 ms	0.5 V
CD450DP	0.6 ws - 450 ws	2,400,000 µF	Min	0.1 ms	0.4 ms	0.5 V
			Max	30 ms	0.4 ms	0.5 V
CD750DP	0.6 ws - 750 ws	2,400,000 µF	Min	0.1 ms	0.6 ms	0.5 V
			Max	30 ms	0.6 ms	0.5 V

Table 7: Sunstone Dual Pulse welder physical characteristics.

	CD150DP		CD300DP		CD450DP		CD750DP	
	Inches	cm	Inches	cm	Inches	cm	Inches	cm
Height	10.5	26.7	10.5	26.7	10.5	26.7	10.5	26.7
Width	12.0	30.5	12.0	30.5	12.0	30.5	12.0	30.5
Depth	13.5	34.3	13.5	34.3	13.5	34.3	13.5	34.3
Weight	35 lbs	(16 kg)	38 lbs	(17 kg)	40 lbs	(18 kg)	45 lbs	(21 kg)

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