

# AC/DC Submerged Arc Welding



Processes

For over 50 years, Lincoln Electric has offered its submerged arc welding (SAW) customers high deposition rates, reliable penetration, and smooth bead appearance.

Now, Lincoln brings you an advance in SAW technology that provides the option of variable polarity. Changes in the balance of positive and negative polarity of the AC waveform enable the operator to change penetration and deposition, without changing the current or voltage settings.

Lincoln's AC/DC submerged arc process with the Power Wave® power source gives the operator real-time control. Instead of making a weld, stopping and re-programming the new parameters, and running a test weld to make sure they worked, changing the weld characteristics is as easy as turning a knob.



The Power Wave® AC/DC 1000® SD power source takes submerged arc welding to the next level. In addition to conventional benefits of SAW, such as high deposition rates and good penetration, heightened control and faster responses to the arc are unique to the design of the Power Wave AC/DC 1000 SD power source.

## »» MODULAR

The Power Wave AC/DC1000 SD power source is designed for easy paralleling, overcoming the problems typically associated with synchronization of AC waveforms for increased amperage applications.



## »» MULTI-ARC

AC/DC welding is designed for applications that require up to five independently controlled welding arcs.



## »» EASY INTEGRATION

Digital Communications provide a simple solution for the integration of the welding power source to the motion controlling Programmable Logic Controller (PLC).



## »» INCREASED PROCESS CONTROL

Digital Communications also enable the use of software tools to record the actual welding values for each weld as well as monitoring the status of the welding system.



## »» WAVEFORM CONTROL TECHNOLOGY®

The Power Wave AC/DC1000 SD power source is equipped with factory-programmed procedures for fast setup.

Patented. This product is protected by one or more of the following United States patents: 6,809,292; 6,795,778; 6,700,097; 6,697,701; 6,683,278; 6,660,966; 6,600,134; 6,683,278; 6,596,570; 6,570,130; 6,536,660; 6,489,952; 6,472,634; 6,636,776; 6,486,439; 6,441,342; 6,365,874; 6,291,798; 6,207,929; 6,111,216; 4,927,041; 4,861,965 and other pending U.S. patents. Similar patents are maintained in other countries.

## What Is AC/DC Submerged Arc?

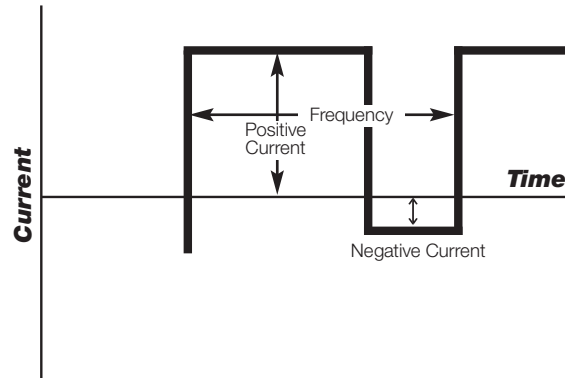
A submerged arc welding (SAW) solution that combined the advantages of AC and DC SAW welding was not possible until now.

The Power Wave AC/DC 1000 SD power source, coupled with Waveform Control Technology, provides control over the ratio of positive to negative amplitude, as well as the amount of time spent at each polarity.

One of the limiting factors for SAW AC welding has always been that it takes too long to cross from electrode positive (EP) to electrode negative (EN). This lag can cause arc instability, penetration, and deposition problems in certain applications.

The Lincoln Electric Power Wave AC/DC 1000 SD power source with Waveform Control was designed specifically to solve this problem, allowing the operator to take full advantage of the reduction in arc blow experienced with AC, while maintaining the penetration advantages of DC positive and the advantageous deposition rate of DC negative. Using these controls, the shape of the output waveform is changed, and in turn the welding characteristics are controlled.

With the Power Wave AC/DC 1000 SD power source, you get the best of both worlds: the speed, deposition rate, and penetration that DC SAW offers, and the resistance to arc blow that AC SAW offers. In single arc processes, the Power Wave AC/DC 1000 SD power source provides flexibility with Waveform Control Technology. In multiple arc processes, that same flexibility is achieved through control of phase shifting between arcs.

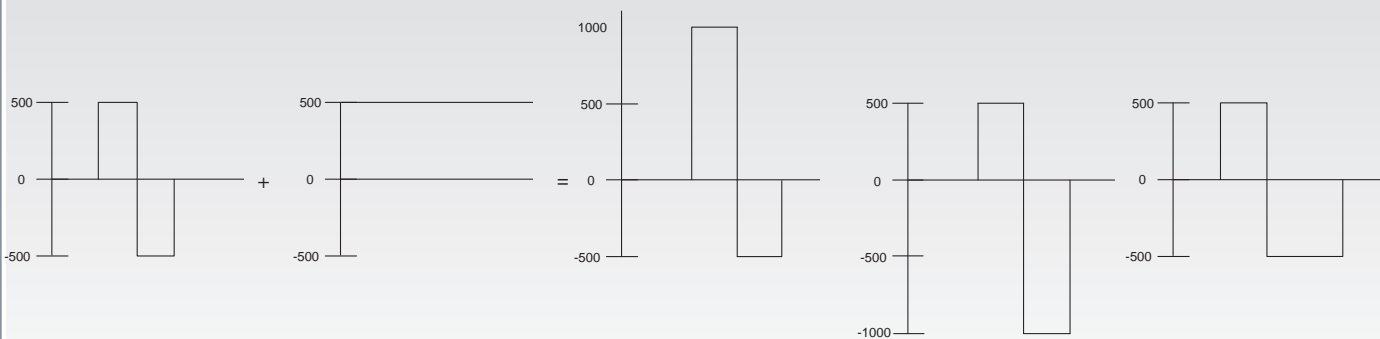


The above waveform represents the possible variations of an AC/DC waveform with Waveform Control Technology. Different parts of the waveform and wire feed speed may be modulated at varying rates to achieve a smooth, stable arc.

## How AC/DC Submerged Arc Works In A Single Arc Environment

Waveform Control Technology gives the operator the ability to change the positive and negative amplitude and time intervals independently of each other, to achieve the penetration and deposition rate that suits their application. In other words, if a weld requires greater penetration and reduced deposition, the

operator would add a positive DC offset, forcing an imbalance in the waveform. Adding negative current results in higher deposition rates. Changing the balance of the positive or negative time intervals provides additional penetration or deposition control.



A balanced AC process uses a combination of DC positive and DC negative amperage.

Adding positive or negative DC offsets change the deposition and penetration characteristics.

Increasing the positive amplitude of the waveform increases penetration.

Increasing the amplitude or time balance of the negative amplitude increases deposition and decreases penetration.

## Using AC/DC Submerged Arc Welding

The AC/DC SAW process is the ideal choice for high-deposition, high-speed welds that can be made in the 1G position. Whether your applications demands a single arc or up to five synchronized arcs, AC/DC SAW with the Power Wave power source will increase weld speeds and yield higher quality welds.

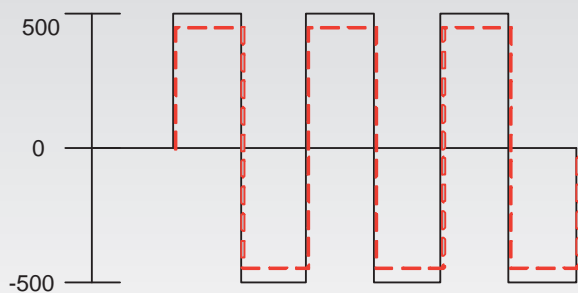
In multiple arc welding, as many as 5 arcs operate in a single weld puddle. The positive and negative polarity phases of the AC waveform can be independently adjusted, as well as the cycle balance. Changes to the combination of any of these values will change the deposition rate, penetration, and travel speed, without changing the voltage or current settings.

Typical DC/AC two-arc combinations can be replaced with Power Wave AC/DC 1000 SD power source models for either DC/AC or AC/AC welding applications.



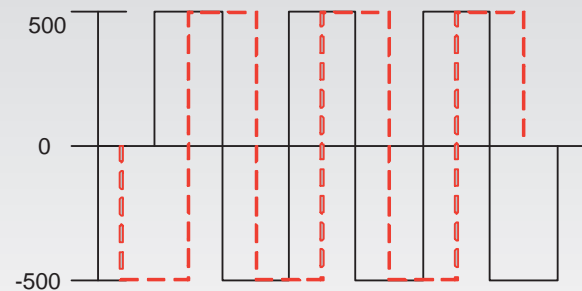
## How AC/DC Submerged Arc Works In A Multi-Arc Environment

When more than one arc is present, arc interaction plays an important role in the behavior of the weld. Two positive electrodes pull together because their magnetic fields attract each other. Two negative electrodes also pull together. One negative and one positive electrode repel or push against each



In this example, both electrodes are either always positive, or always negative, causing a constant “pull”. Constant “pulling” will lead to arc blow, penetration, and bead appearance problems.

other. By phase shifting the AC waveforms the amount of “push” and “pull” of the arc interaction can be balanced. This is the reason multi-arc processes use alternating current to minimize arc blow.



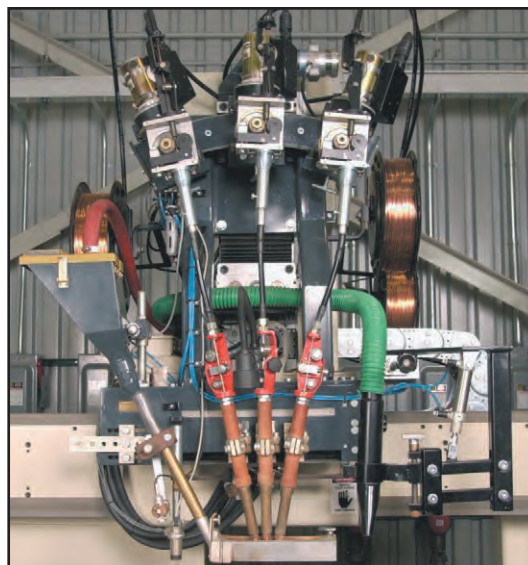
Similar to the way a single arc process allows operator flexibility through manipulation of the waveform, the dual arc process is controlled by shifting the phase of the waveform. In the above waveform, the amount of time that both electrodes are positive or negative is balanced with the amount of time that one is positive and one is negative.

## Where Is AC/DC Submerged Arc Welding Used?

The Lincoln Electric Power Wave AC/DC 1000 SD multi-arc welding power source is being used for:

- Logitudinal and spiral pipe mills
- Mold rebuilding
- Structural material for bridges, steel buildings and offshore platforms
- Pressure vessels
- Shipbuilding

The Power Wave AC/DC 1000 SD power source is designed to be easily paralleled for welding applications that require higher amperage. Each Power Wave AC/DC 1000 SD power source provides 1000 amps of AC or DC output at 100% duty cycle. Parallel up to 3 machines as needed for up to 6 independent arcs, resulting in greater output.

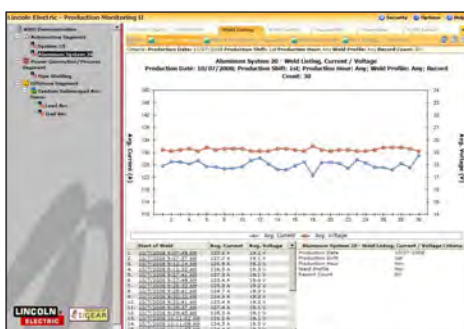


Three-arc Power Wave AC/DC 1000 SD power source submerged arc welding system controlled by a PLC.

## Interfacing with the Power Wave® AC/DC 1000® SD

### Hard Automation

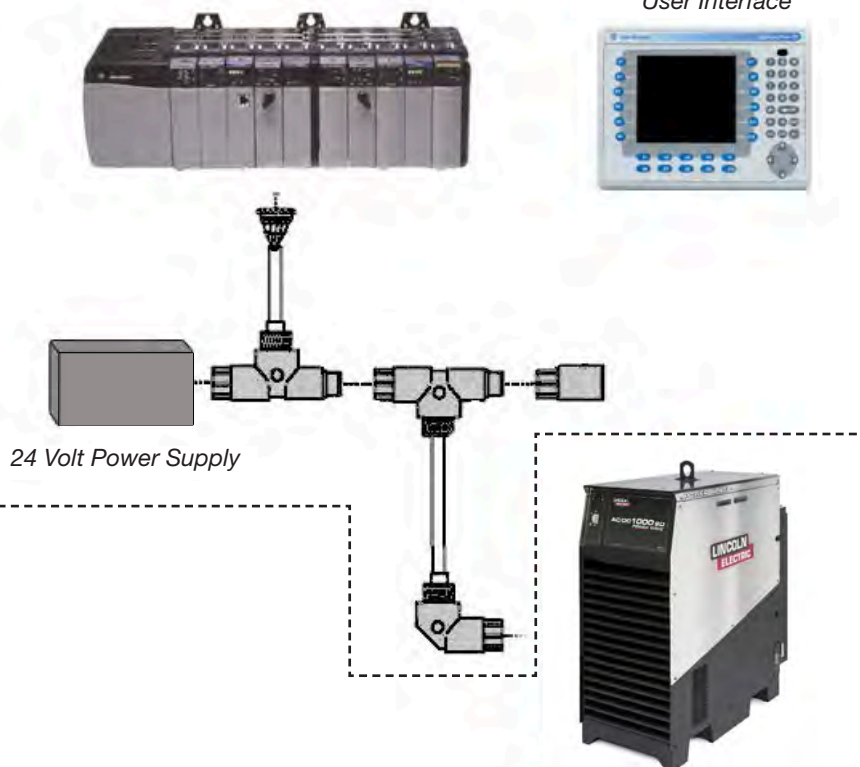
For repeatable, high-deposition, quality welds, the Power Wave® AC/DC 1000® SD coupled with a PLC provides a reliable hard automation welding solution. The Power Wave® AC/DC 1000® SD can be easily connected to a PLC with the standard Ethernet/DeviceNet™ connections. The Ethernet/DeviceNet™ functionality also allows the system to be tracked and monitored from a remote location, over a network.



Communications between ArcLink® and Ethernet enabled equipment can be tracked via Lincoln Electric's Production Monitoring™ software utility.

### Customer Supplied

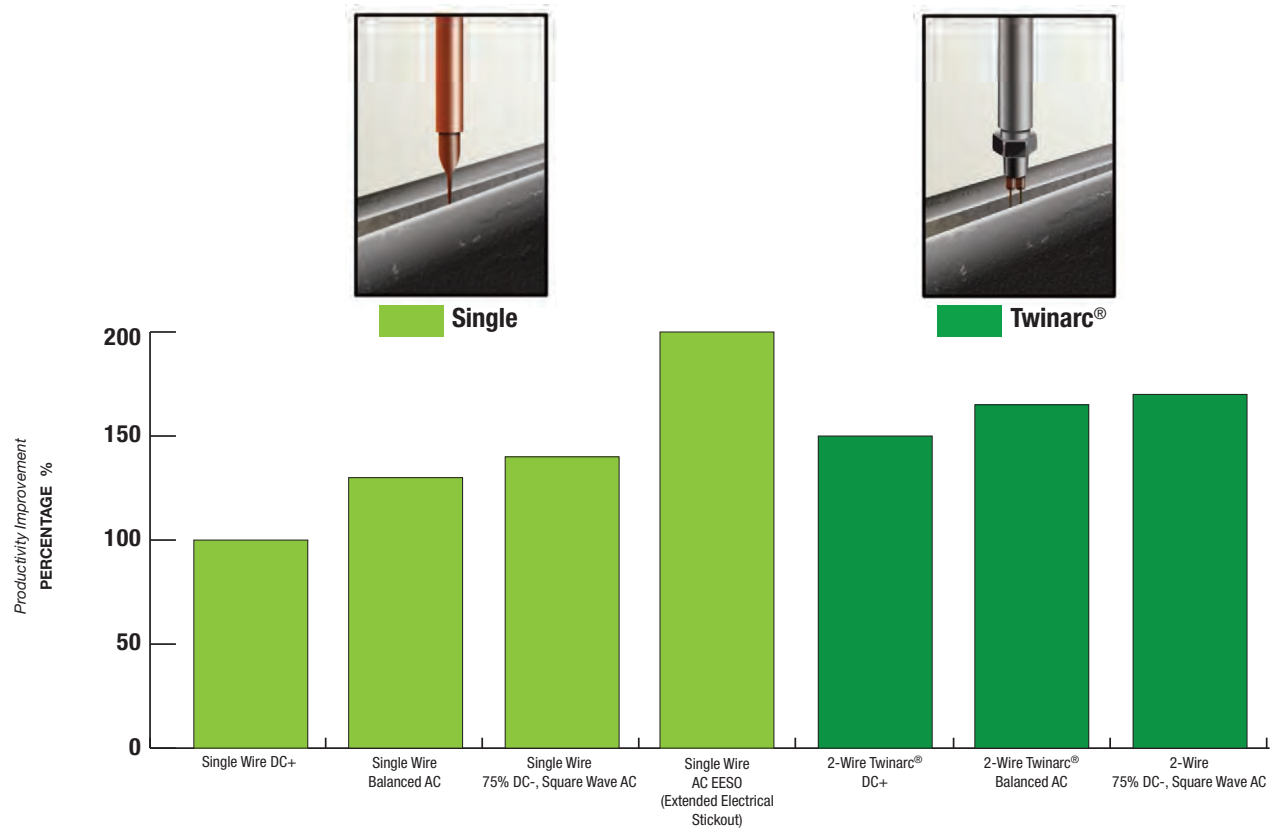
Programmable Logic Controller (PLC) – and – Allen-Bradley™ PanelView User Interface



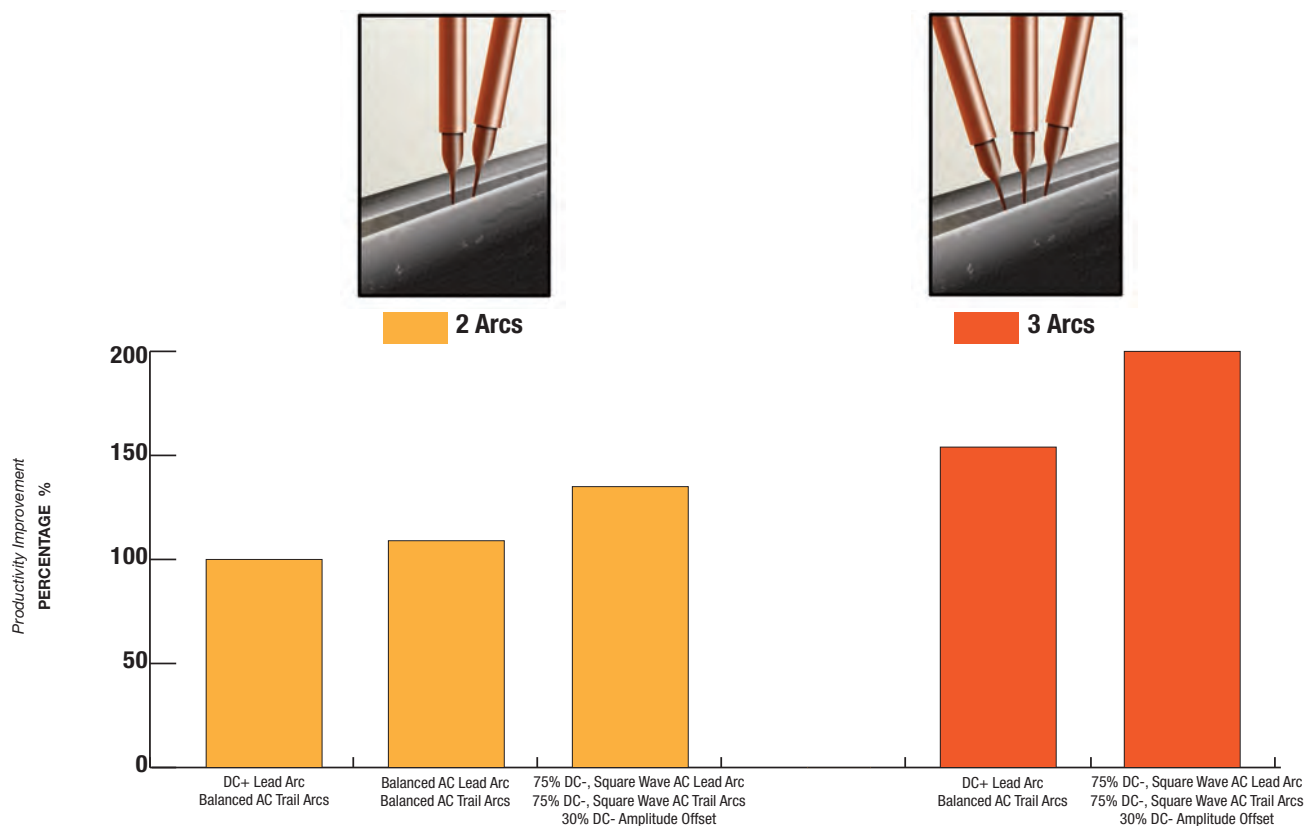
Power Wave AC/DC 1000 SD power source with Ethernet/DeviceNet™ Gateway

Typical Hard Automation Welding System Configuration

## SINGLE ARC AND TWINARC® SUBMERGED ARC WELDING



## MULTI-ARC SUBMERGED ARC WELDING





## Submerged Arc Equipment System

Increase your productivity by up to 100% over traditional systems.

- **Power Wave® Process Control** – Gain complete control over the welding process, including polarity switching at the touch of a button.
- **Complete Configuration Flexibility** – Parallel up to 3 machines as needed for up to 5 independent arcs, resulting in greater output.
- **Connect Anywhere in the World** – One model for all of your global operations. (380-575 VAC, 50/60 Hz voltage input).
- **Outstanding Efficiency and Power Factor Correction (Up to 95%)** – Inverter-based design saves energy and reduces phase imbalance.
- **Severe-Duty Design** – For shop or field applications. IP23 Rated.
- **Production Monitoring™ 2** – Track equipment usage, store weld data and configure limits to assist in welding efficiency analysis.
- **True Energy™** – Measures, calculates and displays instantaneous energy in the weld for critical heat input calculations.
- **Applications** – Documented operational procedures for hundreds of applications.



Power Wave AC/DC 1000 SD  
power source



MAXsa® 10 Controller



NEXTWELD®

### WHAT IS NEXTWELD®?

*Through our commitment to extensive research and investments in product development, Lincoln Electric has established an industry benchmark for applying technology to improve the quality, lower the cost and enhance the performance of arc welding processes. Advancements in power electronics, digital communications and Waveform Control Technology® are the foundation for many of the improvements.*

*NEXTWELD® brings you a series of Process, Technology, Application and Success Story documents. NEXTWELD® explains how technologies, products, processes and applications are linked together to answer the important questions that all businesses face:*

- *How can we work faster, smarter, more efficiently?*
- *How can we get equipment and people to perform in ways they've never had to before?*
- *How do we stay competitive?*

*Ask your Lincoln Electric representative how to improve the flexibility, efficiency and quality of your welding operations to reduce your cost of fabrication.*

### CUSTOMER ASSISTANCE POLICY

The business of The Lincoln Electric Company is manufacturing and selling high quality welding equipment, consumables, and cutting equipment. Our challenge is to meet the needs of our customers and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for information or advice about their use of our products. Our employees respond to inquiries to the best of their ability based on information provided to them by the customers and the knowledge they may have concerning the application. Our employees, however, are not in a position to verify the information provided or to evaluate the engineering requirements for the particular weldment. Accordingly, Lincoln Electric does not warrant or guarantee or assume any liability with respect to such information or advice. Moreover, the provision of such information or advice does not create, expand, or alter any warranty on our products. Any express or implied warranty that might arise from the information or advice, including any implied warranty of merchantability or any warranty of fitness for any customers' particular purpose is specifically disclaimed.

Lincoln Electric is a responsive manufacturer, but the selection and use of specific products sold by Lincoln Electric is solely within the control of, and remains the sole responsibility of the customer. Many variables beyond the control of Lincoln Electric affect the results obtained in applying these types of fabrication methods and service requirements.

Subject to Change – This information is accurate to the best of our knowledge at the time of printing. Please refer to [www.lincolnelectric.com](http://www.lincolnelectric.com) for any updated information.

**LINCOLN®  
ELECTRIC**  
THE WELDING EXPERTS®

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