

# PROCESS

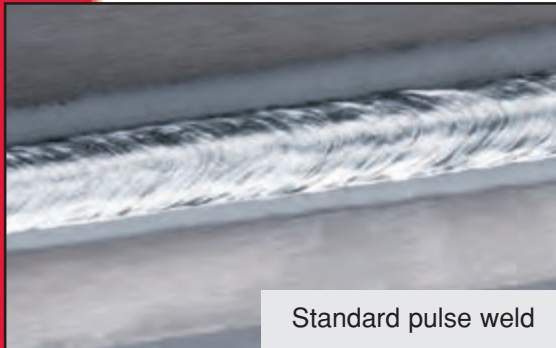
WAVEFORM CONTROL TECHNOLOGY<sup>®</sup>

## Pulse-On-Pulse<sup>™</sup> GMAW (MIG)

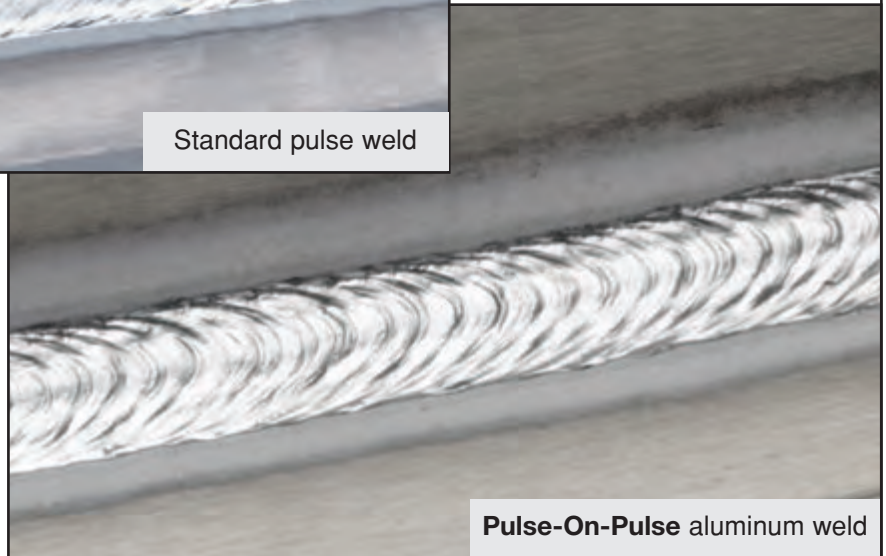
Pulse-On-Pulse was created by the Lincoln Electric Company to provide a GMAW solution for aluminum welding that made the welding process less difficult than standard pulse and thereby required less operator skill.

Unlike standard pulse welding, which uses a single pulse wave shape, Pulse-On-Pulse uses a sequence of varying pulse wave shapes to produce a GTAW-like bead appearance.

Lincoln's Pulse-On-Pulse process controls the arc length and the heat input together, making it easier for an operator to produce high-quality welds.



Standard pulse weld



Pulse-On-Pulse aluminum weld

Conditions for all weld samples:  
**Electrode** - 3/64" diameter 4043  
**SuperGlaze<sup>®</sup> Aluminum**  
**Shielding Gas** - 100% argon  
**Material** - 3mm thickness aluminum

### a d v a n t a g e s

#### **MORE FORGIVING OPERATION**

Minimal distortion, even when gap conditions and wire placement vary.

#### **LESS OPERATOR SKILL REQUIRED**

Outstanding control of arc characteristics, making it easier to produce excellent welds.

#### **UNIFORM BEAD APPEARANCE**

Rippled bead appearance requires no weaving to produce a uniform bead.

#### **EXCELLENT PENETRATION**

Controls the arc length and heat input together for excellent penetration profile.

#### **OUTSTANDING ARC HEAT CONTROL**

Controls the arc heat, making it ideal for welding thinner materials.

#### **BETTER SURFACE OXIDE CLEANING**

Provides a hotter arc, which improves cleaning action at the base material.



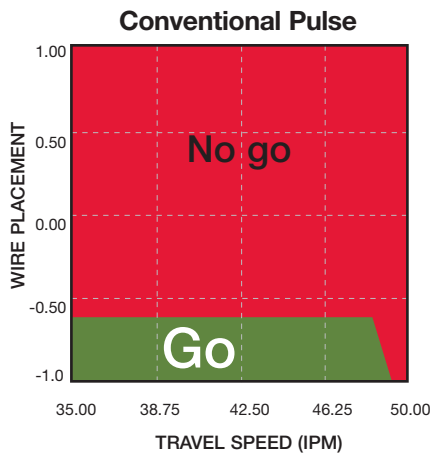
*This product is protected by one or more of the following United States patents: [6,515,259](#); [6,717,107](#); and other pending U.S. patents. Similar patents are maintained in other countries.*

# Pulse-On-Pulse GMAW (MIG)

## Comparing

### Pulse-On-Pulse to Conventional Pulse<sup>1</sup>

Wire placement influences weld shape and quality. In a series of design experiments over a range of travel speeds, the quality of Pulse-On-Pulse welds was less sensitive to variations in wire placement compared to welds made with conventional pulse.

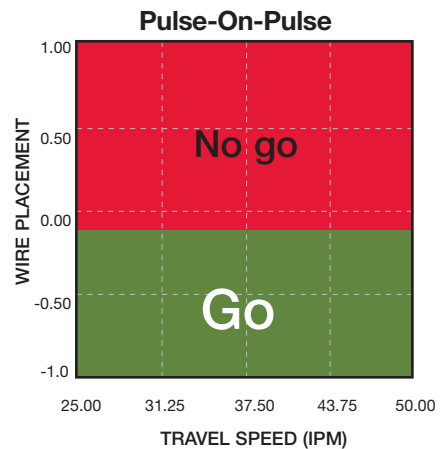


The green area represents wire placement and travel speeds at which acceptable welds are made. The red area represents unacceptable welds.

torch angle > 130  
convexity < 0.75 mm  
lack of fill = < 2.5 mm

#### WIRE PLACEMENT

wire-to-joint offset in wire diameter -1 0 +1



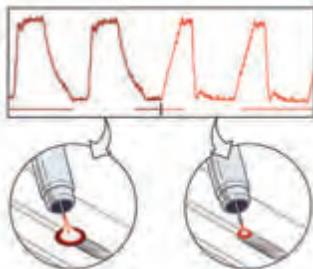
Pulse-On-Pulse made good welds at faster travel speeds over a wider range of wire placement.

<sup>1</sup> The Lincoln Electric Company, R & D engineering report comparison of robustness with respect to electrode placement in CV pulsed arc and Pulse-On-Pulse GMAW of aluminum, April 30, 2002

## How

### Pulse-On-Pulse works

Using Waveform Control Technology, the welding machine alternates between high and low energy pulses. This combination of high and low pulses produces the "rippled" bead appearance.



The high energy pulses provide a hotter arc (longer arc duration), which improves cleaning action at the base material. The low energy pulses allow the weld puddle to cool, which controls the heat input for good penetration.



# Pulse-On-Pulse GMAW (MIG)

## When

to use **Pulse-On-Pulse**

Pulse-On-Pulse was specifically designed to address conditions that commonly arise when welding lap and fillet welds, especially when working with poor "fit-up" conditions.

### Pulse-On-Pulse is also ideal for:

- Excellent control of heat input on thinner materials.
- Optimum productivity in robotic and semiautomatic applications.
- Uniform, consistent beads on welds in which appearance is critical.



## Utilizing

### Pulse-On-Pulse on Lincoln Welding Systems

#### Adjust WIRE FEED SPEED to:

- Control the weld deposition rate.
- Control heat input.

#### Adjust TRIM to:

- Control the arc length for a more stable process.

#### Adjust ARC CONTROL to:

- Increase or decrease the space between the "ripples".



Decrease the parameter from 0 to -10 to increase the space between the "ripples".



Increase the parameter from 0 to +10 to reduce the space between the "ripples".



### Choosing Aluminum Wire for Pulse-On-Pulse



**SuperGlaze®** wires control problems usually associated with aluminum wire feeding such as birdnesting, tangling, and burnback to provide a stable arc, great feedability and exceptional control – every time you weld.

Lincoln's aluminum wire coupled with our advanced GMAW welding equipment makes aluminum as easy to weld as any other material...and makes Lincoln the one source for all your aluminum needs.

## LINCOLN WELDING SYSTEM FEATURING PULSE-ON-PULSE

### Power MIG® 350MP

This single phase wire feeder welding package is unbeatable when it comes to multi-process welding.

Synergic design gives you ultimate control over the arc by automatically aligning wire feed speed and voltage. Three ways to feed aluminum: push, push-pull, and spool gun.



# Pulse-On-Pulse GMAW (MIG)

## Lincoln Welding Systems with Pulse-On-Pulse (cont.)

### Power Wave® 355M/Power Feed® 10M

The Power Wave 355M is factory programmed with over 60 standard welding programs to optimize the arc for a variety of applications, including steel, stainless steel, aluminum, nickel alloys and others.



### Power Wave® 455M/Power Feed® 10M

The Power Wave 455M is a high efficiency inverter designed for ease of use and performance. Sophisticated software controls the welding waveform for reduced arc spatter and fumes and for an exceptionally smooth arc.

### Power Wave® F355i

This inverter power source is ideal for robotics, automotive, transportation, fabrication and agriculture applications. Fully integrated with the FANUC Arc Mate R-J3iB controller with 350 amps @ 60% duty cycle.



#### 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 customer and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for advice or information about their use of our products. We respond to our customers based on the best information in our possession at that time. Lincoln Electric is not in a position to warrant or guarantee such advice, and assumes no liability, with respect to such information or advice. We expressly disclaim any warranty of any kind, including any warranty of fitness for any customer's particular purpose, with respect to such information or advice. As a matter of practical consideration, we also cannot assume any responsibility for updating or correcting any such information or advice once it has been given, nor does the provision of information or advice create, expand or alter any warranty with respect to the sale of our products.

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 requirement.

*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.

#### WHAT IS NEXTWELD?

The challenges facing industrial fabricators today are increasingly difficult. Rising labor, material, and energy costs, intense domestic and global competition, a dwindling pool of skilled workers, more stringent and specific quality demands.

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 like this one. 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?

NEXTWELD is the future of welding but its benefits are available to you today. Ask your Lincoln Electric representative how to improve the flexibility, efficiency and quality of your welding operations to reduce your cost of fabrication.

**LINCOLN®  
ELECTRIC**

THE WELDING EXPERTS<sup>SM</sup>

THE LINCOLN ELECTRIC COMPANY  
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