

PROCESS

WAVEFORM CONTROL TECHNOLOGY™

RapidArc™ – High Speed GMAW Welding

- Faster travel speeds
- Lower spatter levels
- Out-of-position operation
- Lower heat input

What if there was a way to make welds up to 98 inches per minute (2.5 meters per minute) on steel, 16 – 8 gauge (1.5 – 4 mm) in thickness, without the risk of weld skips, undercut, or high spatter levels? Now there is, with RapidArc pulse welding from Lincoln Electric.

RapidArc is a pulsed GMAW process solution designed to increase productivity by reducing cycle time in semi-automatic, robotic, and hard automation applications. Unlike traditional pulse welding, RapidArc provides excellent arc stability at lower arc voltage (shorter arc length), with reduced spatter and washed out bead profile, allowing for significant increase in torch travel speed.

The unique combination of pulse and short arc metal transfer make RapidArc suitable for high-speed, low spatter carbon steel welding applications, with both solid wire and metal-cored electrodes.



Traditional Pulse Welding

As these photos demonstrate, RapidArc produces less spatter than traditional pulse welding. RapidArc performs at a 30% faster travel speed with similar bead appearance results.



RapidArc Pulse Welding

a d v a n t a g e s

FASTER TRAVEL SPEEDS

- Arc stability at low voltage allows for a significant increase in travel speed.

LOWER SPATTER

- Low spatter levels reduce post-weld cleanup time.

OUT-OF-POSITION OPERATION

- The combination of short arc and pulse metal transfer enables all-position welding and expands the range of applications.

LOWER HEAT INPUT

- Low voltage operation results in lower heat input, reducing the risk of burnthrough.

EXCELLENT BEAD PROFILE

- Tight arc length control enables the puddle to follow the arc, avoiding “humpy” (convex) bead shape and undercut.

EXCELLENT ARC STABILITY

- Robust and adaptive waveform avoids stubbing at low voltage operation.

GOOD CHOICE FOR CARBON STEEL WELDING APPLICATIONS

- The combination of lower heat input, fast follow, and tight arc length control makes RapidArc the ideal candidate for automated welding of steel components 16 - 8 gauge (1.5 – 4 mm) thick.
- RapidArc also has the capability to weld thicker materials, up to 1/2 in. (12.7 mm).

Patent pending for this process.

RapidArc™ — High Speed GMAW Welding

What

is RapidArc?

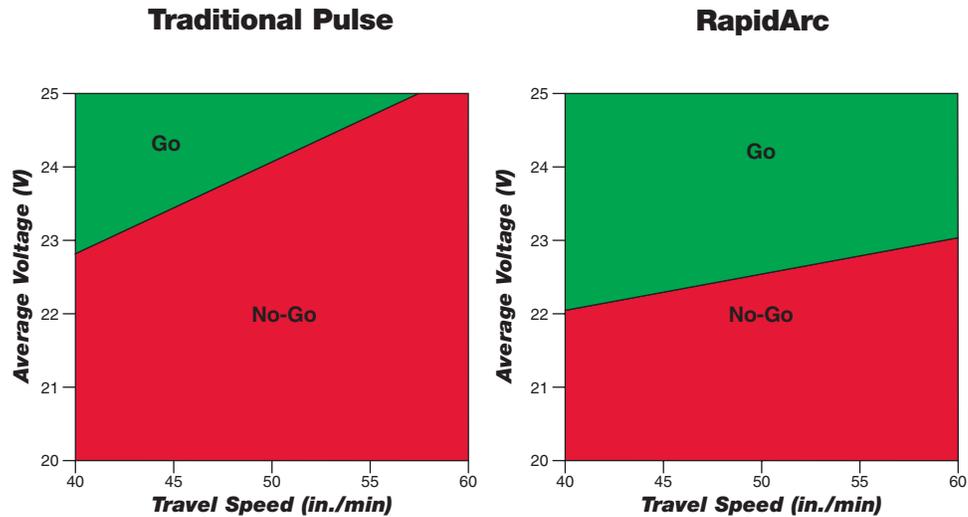
RapidArc is a refined pulse process, designed specifically for faster weld speeds than traditional pulse waveforms.

RapidArc improves low voltage welding at high speeds, as it stabilizes the process for shorter arc length. With traditional waveforms, the arc length is longer to avoid spatter, limiting the travel speed. With RapidArc, the arc length is kept short and tight, and spatter is avoided with precise control of the short circuit cycle. RapidArc stabilizes the shortened arc length with controlled short circuit cycles.

The short arc length and fast travel speeds were developed for robotic, hard automation, and semi-automatic applications.

RapidArc vs. Traditional Pulse

Obtain faster travel speeds at lower voltage



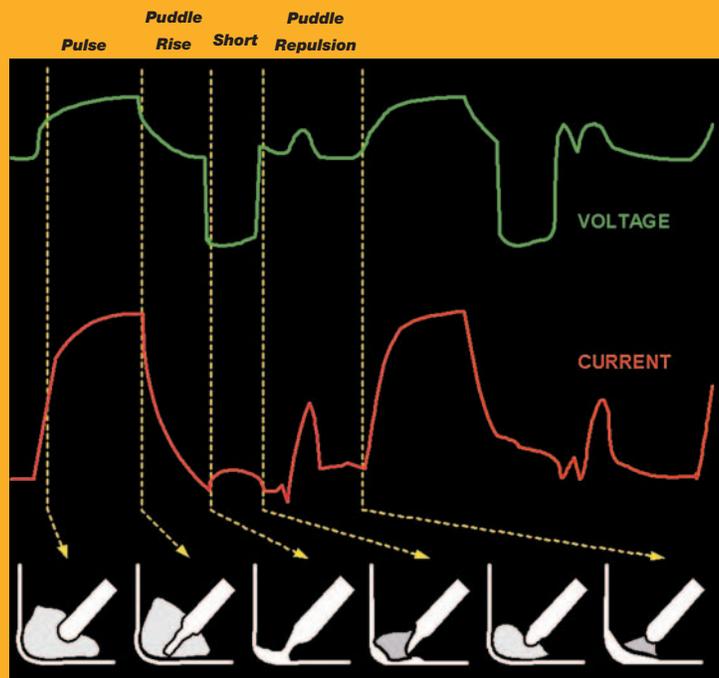
A study was performed resulting in the following data:
The green areas represent usable voltages and travel speeds, which produce acceptable arc stability and spatter level without stubbing, arc flare, or arc outage at a given wire-speed-to-travel-speed ratio.

How

RapidArc Works

To produce the travel speeds that RapidArc achieves, the arc length MUST be kept short. In other pulse welding waveforms, a short arc length results in stubbing and spatter. The RapidArc waveforms promote short circuiting at low current, which minimizes spatter. The RapidArc waveform can be broken into four segments:

- Pulse** — A sudden increase in current increases arc energy, and forms and squeezes a molten droplet extending from the end of the electrode.
- Puddle Rise** — The ramp down of current relaxes the plasma force, depressing the puddle, allowing it to rise up towards the droplet.
- Short** — The arc collapses, and the droplet contacts the weld puddle.
- Puddle Repulsion** — Immediately following a short breaking into an arc, a gentle plasma boost pushes the puddle away and conditions the electrode tip. This ensures reliable separation of the wire tip and the puddle resulting in a stable rhythm of the cycle.



RapidArc™ – High Speed GMAW Welding

Using RapidArc

for Steel Welding Applications

RapidArc was specifically designed to address the need for faster, all-position pulse welding of carbon steel, while maintaining superior bead appearance and acceptable spatter levels. It is a hybrid mode that combines the pulsed spray transfer and short circuiting transfer, which results in:

- Rhythmic puddle oscillation that avoids excessive current to clear the short circuit between the electrode and the weld puddle, so spatter is drastically reduced.
- An adaptive waveform that helps avoid stubbing at low voltages.

Using RapidArc with Solid Wire for Faster Travel Speeds

One aspect of the RapidArc procedure is the ability to optimize the process to achieve maximum possible travel speeds.

- RapidArc welds consistently produce flat, bead profiles, which indicate a smooth transition between the weld toe and the base metal.
- Arc length control can produce a shorter arc length that results in faster follow, and better bead profile at higher speeds. This helps eliminate the “humpy”, convex welds, weld skips, or inconsistent bead profile typically produced at higher travel speeds.

Using RapidArc with Metal-Cored Wire

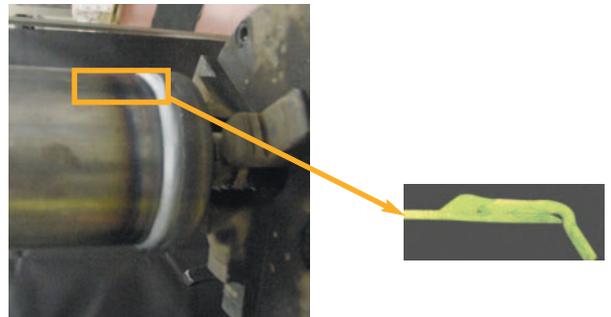
For the optimal RapidArc experience, pair the RapidArc waveform with Lincoln Electric’s metal-cored electrode, Metalshield® MC-6. This combination delivers minimal spatter. Lower voltage metal-cored welding increases the operating range of Metalshield MC-6. RapidArc with MC-6 provides the following advantages:

- The ability to weld materials 1/2 in. (12.7 mm) to 16 gauge (1.5 mm) in thickness.
- Enhanced bead profile on materials with mill scale.
- Higher deposition rate at same current as solid wire.
- Tolerant of poor fit-up joints.
- Reduced occurrence of undercut.
- The ability to advance one wire diameter size.
- Usable for semi-automatic, hard automation, and robotic applications.

Customer targeted examples of applications:



Automotive engine cradle welding – 2 mm to 2 mm (0.08 in. to 0.08 in.) lap weld and 3 mm to 4 mm (0.12 in. to 0.16 in.) lap weld at 70 ipm (1.78 mpm)



Air compressor end cap hard automation – 1 mm to 1.5 mm (0.04 in. to 0.06 in.) lap weld at 80 ipm (2.03 mpm)

Table 1

Power Source Waveform Mode	Wire Diameter	Waveform
13	0.035	GMAW RapidArc Solid Wire
18	0.045	GMAW RapidArc Solid Wire
27	0.052	GMAW RapidArc Solid Wire
87	0.045	GMAW-C RapidArc Metal-Cored
88	0.052	GMAW-C RapidArc Metal-Cored
89	1/16 in.	GMAW-C RapidArc Metal-Cored

Choose solid wire or metal-cored wire weld modes from the list in Table 1. Select the mode number for your application in the Power Wave® 355M, 455M, 455M/STT, or F355i.

RapidArc™ – High Speed GMAW Welding

Using RapidArc

for Steel Welding Applications (cont.)

Controlling the Waveform

RapidArc is a member of the Waveform Control Technology™ family, which allows for advanced control over the power supply output.

Wire Feed Speed

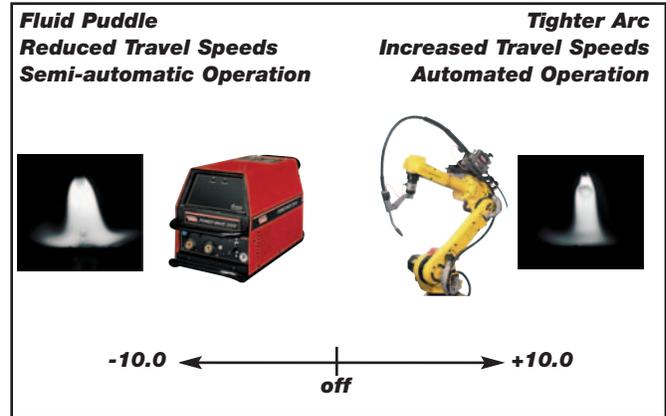
Select the wire feed speed to produce a weld size suitable for the joint fit-up and the base metal gauge.

Trim

Adjustments made to the trim value control the arc length. Shorter arc lengths increase puddle follow and travel speeds, but at a cost of increasing spatter.

Wave Control

Increased waveform control (available as a function of the user interface or teach pendant). It fine-tunes the waveform to control plasma arc width and stiffness, puddle fluidity, and penetration.



The effect of Wave Control on RapidArc

Comparing

RapidArc to Traditional Pulse

Lower Voltage/Higher Travel Speeds

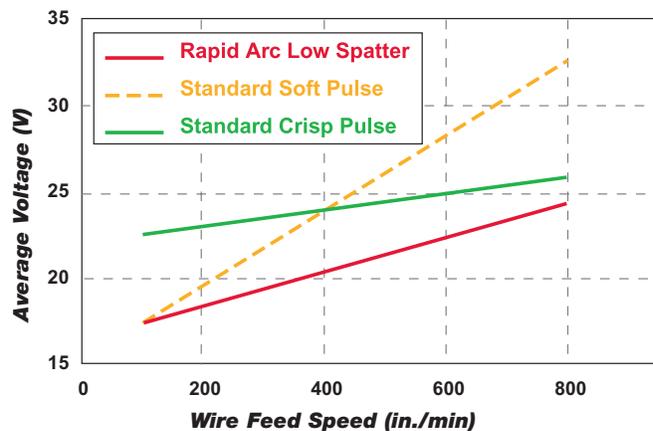
As the graph illustrates, RapidArc performs at the same wire feed speed as either soft or crisp pulse programs at a much lower arc voltage. Voltage reduction allows faster travel speed and/or lower spatter levels.

Cost Savings

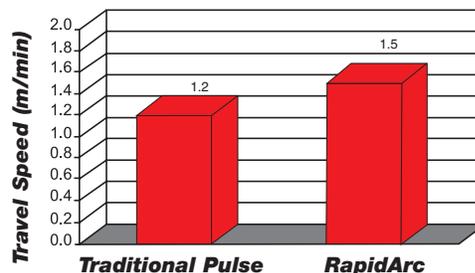
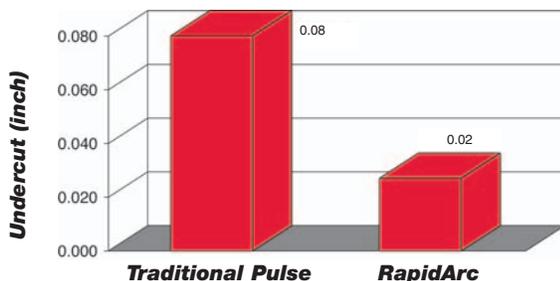
Higher travel speeds than traditional pulse welding reduce cycle times 10 – 30%. Faster weld speeds equal more parts per day, and lower spatter decreases labor cost for post-weld part and fixture cleanup.

Improved Bead Profile

RapidArc welds displayed only one-fourth the incidence of undercut when compared to traditional pulse welds.



Rapid arc consistently requires lower voltage than traditional pulse programs. Note that both standard pulse waveforms weld at 4V higher than RapidArc at 400 ipm.



Evidence from specific customer applications indicates that RapidArc can perform at a 28% increase in travel speed, reducing cycle time and exhibiting only one-fourth as much undercut as traditional pulse.

RapidArc™ – High Speed GMAW Welding

5/6

Lincoln Consumables used for RapidArc Welding

SuperArc® /SuperGlide®

Lincoln's SuperArc, our premium copper-coated MIG wire, and SuperGlide, our premium bare wire, are the choice of welders and welding decision-makers everywhere because of their exceptional consistency, feedability, and arc action.

A better arc means less spatter, less clean-up, and improved productivity – and premium SuperArc and SuperGlide deliver the best arc in MIG welding. Our MicroGuard™ Ultra surface treatment, with proprietary arc enhancement agents, facilitates excellent weld puddle control, very good wetting action, straight bead edges, and a wider operating range.

Studies have shown that SuperArc with MicroGuard Ultra pushes the performance of RapidArc by an additional 10 – 15% when compared to unstabilized competitive wires.



The exceptional feeding characteristics of SuperGlide, made possible by MicroGuard Ultra surface treatment, translate to reduced down-time and high operator appeal.

Metalshield™ MC-6

For high quality welds that require a great bead shape, appearance and low spatter levels, you can't beat MC-6. Combining the arc characteristics of MIG with the performance benefits of flux-cored welding, MC-6 is capable of fast travel speeds and high deposition rates with low smoke and spatter under high Argon gas blends.

- Tolerates gaps and inconsistent fit-up.
- Forging arc helps less skilled operators make great looking welds and keeps rework to a minimum.



Lincoln Welding Systems Featuring RapidArc

Power Wave® 455M

Power Wave® 455M/STT

For welding thicker materials in robotics, hard automation, PLC and semiautomatic applications, choose the Power Wave 455M. For those applications where heat input control, minimal distortion, and reduced spatter are essential, opt for the PowerWave 455M/STT. Both models feature Waveform Control Technology for superior arc performance on a variety of materials, including steel, stainless steel, aluminum and nickel alloys. Custom control of the arc for each wire type and size provide consistent welds time after time. These Power Waves are designed to be part of a modular, multi-process welding system.



RapidArc™ — High Speed GMAW Welding

6/6

Lincoln Welding Systems Featuring RapidArc

Power Wave 355M/Power Feed™ 10M

The Power Wave 355M features some of Lincoln's best arc performance technologies and processes all rolled into one highly efficient inverter power source designed for high-end semiautomatic welding. Lincoln's Waveform Control Technology is at the heart of the Power Wave 355M's performance, enabling processes like RapidArc™, Pulse-on-Pulse™, and Power Mode™ for thinner materials. Precise control over process parameters allows you to weld on a variety of materials, including steel, stainless steel, aluminum, and nickel alloys in virtually any application. Optimize the arc for each wire type and size for a consistent weld time after time. Versatility combined with control, speed combined with accuracy... that's what Lincoln Nextweld innovations deliver in the Power Wave 355M.



Power Wave® F355i

The Power Wave F355i is fully integrated with the FANUC ArcMate™ R-J3iB controller and designed for the most demanding robotic applications.

- This compact unit delivers 350 Amps at 60% duty cycle for MIG, Pulsed MIG or Flux-Cored welding applications.
- The Power Wave F355i/ARCMate R-J3iB communicates via ArcLink™, allowing all welding procedures and process controls to be managed through the ARCMate robot teach pendant – one central control for setup, process control and diagnostics.

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 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.

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