Overview

Rapid X™ revolutionizes the productivity of welding.

- Increases Travel Speed by 40%
- Reduces Spatter by 30%
- Increases Penetration
- Reduces Heat Input
- Reduces Distortion

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*Based on a side by side comparison of Rapid X™ and Pulse.
Process Description

Traditional Pulse welding consists of a peak and background current to deposit a molten droplet after each pulse. Patented RapidArc®, a breakthrough in Pulse welding, provides excellent arc stability at shorter arc lengths, resulting in a significant increase in travel speed.

Patent Pending Rapid X™ revolutionizes Pulse Welding. Inspired by RapidArc®, Rapid X™ also uses an extremely short arc length, but now with a significant reduction in spatter generation. Low current wet-in technology momentarily drops the current producing spatter-free welds. UltimArc™ and synergic precision controls complete the Rapid X™ revolution. The resulting Rapid X™ process provides extremely fast travel speeds and clean welds to deliver increased productivity.

Waveform

Pulse Ramp/Peak
A rapid current increase creates a molten droplet.

Tailout
Reduced current relaxes the plasma force as the droplet approaches the puddle.

Wet-in
Proprietary hardware quickly reduces the current at the instant the droplet contacts the puddle, reducing spatter after the droplet detaches.

Puddle Repulsion
A plasma boost pushes the puddle away, creating separation and a stable rhythm of the weld pool.
Rapid X™ waveforms are synergic weld modes. Based on the wire feed speed 1, set by the operator, a pre-programmed voltage is automatically selected 2. Fine tune the arc length using Voltage adjustment 3.

**UltimArc™ Control**

The UltimArc™ control fine tunes the ramp and tailout rates with a single control. Increase (+) or decrease (-) this setting to minimize spatter levels.

**Adjust WFS to the desired setting.** Refer to the Application section for the recommended settings.

Based on WFS a preprogrammed nominal voltage is selected.

Adjusting voltage increases or decreases the arc length, allowing the user to fine tune arc characteristics.

**A note on Trim.**

Lincoln Electric® developed Trim as a means to simplify the complexities of Arc Length control in advanced welding application set-up, such as Pulse. Now, Lincoln Electric® Synergic Weld modes improve the ease of set-up by preselecting an ideal voltage based on the selected WFS. The user can then fine tune their Voltage setting based on their personal preference and can easily see whether they are above or below the nominal setting.
Wire Weld Joint Weld Bead
Torch Nozzle
Gas Cone
Acceptable Unacceptable
Weave
Control Knob
12:00
Weld Location
Tacking
Strike Arc
on side wall
Begin welding across root
Weld across root opening
Weld in root opening
Stop arc on side wall.
Torch perpendicular to weld surface
Torch at 45° to weld surface
Torch at 10° to weld surface
10°
10°
45°
45°

Pipe end angle
Heat
Note
Material
Electrode
Position
Gas
Root Opening Peak (A) Background (A) Tailout
Wire Feed Speed
1F / PA Lap
FRONT SIDE
SIDE
SIDE
\[\text{SuperArc } L-56 \ 0.035"\]
\[
\begin{array}{|c|c|c|c|}
\hline
& \text{1/4 in.} & \text{3/16 in.} & \text{12 ga} & \text{14 ga} \\
\hline
\text{90Ar / 10CO}_2 & 800 & 750 & 700 & 625 \\
\text{3/4 in.} & 30 & 50 & 60 & 65 \\
\hline
\text{V} & 25.0 & 24.0 & 24.0 & 22.0 \\
\text{A} & 260 & 245 & 235 & 220 \\
\hline
\end{array}
\]

\[\text{SuperArc } L-56 \ 0.045"\]
\[
\begin{array}{|c|c|c|c|}
\hline
& \text{1/4 in.} & \text{3/16 in.} & \text{12 ga} & \text{14 ga} \\
\hline
\text{90Ar / 10CO}_2 & 500 & 460 & 400 & 375 \\
\text{3/4 in.} & 35 & 45 & 55 & 60 \\
\hline
\text{V} & 24.0 & 23.5 & 21.0 & 20.0 \\
\text{A} & 300 & 280 & 240 & 235 \\
\hline
\end{array}
\]


**Rapid X™ Applications**

**1F / PA Lap**

- Use a 10-20° push angle.
- Use a 35° work angle.
- Position the electrode approximately one electrode diameter outside the joint favoring the bottom leg.
- For 14ga applications position the electrode directly in the joint or slightly favoring the top edge. May require decreased work angle.

**Metric**

80Ar / 20CO₂

\[
\begin{array}{|c|c|c|c|}
\hline
& \text{6.4} & \text{4.8} & \text{3.4} & \text{2.6} & \text{1.9} \\
\hline
\text{mm} & \text{18.4} & \text{17.1} & \text{15.2} & \text{14.0} & \text{12.0} \\
\text{m/min} & \text{90} & \text{100} & \text{115} & \text{125} & \text{140} \\
\text{cm/min} & \text{24.5} & \text{24.0} & \text{23.5} & \text{23.0} & \text{22.8} \\
\text{V} & \text{265} & \text{245} & \text{235} & \text{225} & \text{200} \\
\text{A} & \text{290} & \text{270} & \text{255} & \text{235} & \text{230} \\
\hline
\end{array}
\]

**1.2mm**

- \[\text{SupraMig } 1.2mm\]
- \[\text{SupraMig } 1.0mm\]
- \[\text{Lincoln Electric} \]
- \[\text{The Performance You Need. The Quality You Expect.} \]
### 2F / PB Lap

- **Use a 10° - 20° push angle.**
- **Use a 40° work angle.**
- Position the electrode approximately one electrode diameter outside the joint favoring the top leg.

<table>
<thead>
<tr>
<th>Wire</th>
<th>Weld Joint</th>
<th>Weld Bead</th>
<th>Torch Nozzle</th>
<th>Gas Cone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Weld Location

- **Tacking Strike Arc on side wall.**
- **Begin welding across root.**
- **Weld across root opening.**
- **Weld in root opening.**
- **Stop arc on side wall.**
- **Torch perpendicular to weld surface.**
- **Torch at 45° to weld surface.**
- **Torch at 10° to weld surface.**

### Acceptable / Unacceptable Weave

<table>
<thead>
<tr>
<th>Pipe end angle</th>
<th>Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Material

- **Electrode Position**
  - **Root Opening Peak (A)**
  - **Background (A)**
  - **Tailout**

### Wire Feed Speed

<table>
<thead>
<tr>
<th>2F / PB Lap</th>
<th>SIDEFRONT</th>
<th>SIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 in.</td>
<td>3/16 in.</td>
<td>10ga</td>
</tr>
<tr>
<td>800</td>
<td>700</td>
<td>660</td>
</tr>
<tr>
<td>500</td>
<td>475</td>
<td>600</td>
</tr>
<tr>
<td>400</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>375</td>
<td>375</td>
<td>600</td>
</tr>
</tbody>
</table>

### Electrode

- **SuperArc® L-56 0.035”**
  - **90Ar / 10CO₂**
  - **3/4 in.**
  - **Use a 10° - 20° push angle.**
  - **Use a 40° work angle.**
  - **Position the electrode approximately one electrode diameter outside the joint favoring the top leg.**

<table>
<thead>
<tr>
<th>Electrode</th>
<th>1/4 in.</th>
<th>3/16 in.</th>
<th>10ga</th>
<th>12ga</th>
<th>14ga</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperArc L-56 0.035”</td>
<td>800</td>
<td>700</td>
<td>700</td>
<td>660</td>
<td>615</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>40</td>
<td>60</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>23.5</td>
<td>22.5</td>
<td>22.5</td>
<td>22.0</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>230</td>
<td>220</td>
<td>215</td>
<td>210</td>
<td>200</td>
</tr>
</tbody>
</table>

### Metric

- **80Ar / 20CO₂**
  - **19 mm**

<table>
<thead>
<tr>
<th>Electrode</th>
<th>6.4</th>
<th>4.8</th>
<th>3.4</th>
<th>2.6</th>
<th>1.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>SupraMig 1.0mm</td>
<td>17.8</td>
<td>16.5</td>
<td>14.6</td>
<td>14.0</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>100</td>
<td>125</td>
<td>140</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>24.0</td>
<td>23.5</td>
<td>22.5</td>
<td>22.0</td>
<td>21.0</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>245</td>
<td>235</td>
<td>220</td>
<td>200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrode</th>
<th>6.4</th>
<th>4.8</th>
<th>3.4</th>
<th>2.6</th>
<th>1.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>SupraMig 1.2mm</td>
<td>12.0</td>
<td>11.3</td>
<td>10.5</td>
<td>9.9</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>76</td>
<td>101</td>
<td>127</td>
<td>140</td>
<td>152</td>
</tr>
<tr>
<td></td>
<td>24.5</td>
<td>22.5</td>
<td>21.5</td>
<td>20.5</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>280</td>
<td>265</td>
<td>250</td>
<td>240</td>
<td>230</td>
</tr>
</tbody>
</table>

**See Customer Assistance Policy and Disclaimer Notice on page 9.**
3F / PG Lap

- Use a 10° drag angle.
- Use a 30° work angle.
- Position the electrode approximately one electrode diameter outside the joint favoring the bottom leg.
- For 14ga applications position the electrode directly in the joint or slightly favoring the edge.

<table>
<thead>
<tr>
<th>90Ar / 10CO₂</th>
<th>3/4 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperArc® L-56 0.035&quot;</td>
<td></td>
</tr>
<tr>
<td>3/16 in.</td>
<td>780</td>
</tr>
<tr>
<td>10ga</td>
<td>650</td>
</tr>
<tr>
<td>12ga</td>
<td>650</td>
</tr>
<tr>
<td>14ga</td>
<td>600</td>
</tr>
</tbody>
</table>

| SuperArc® L-56 0.045" | |
| 3/16 in. | 475 | 50 | 22.0 | 295 |
| 10ga | 400 | 50 | 21.0 | 260 |
| 12ga | 400 | 60 | 21.0 | 260 |
| 14ga | 360 | 70 | 19.5 | 240 |

**Metric**

80Ar / 20CO₂

| SupraMig® 1.0mm | |
| 4.8 | 15.9 | 125 | 24.0 | 240 |
| 3.4 | 15.2 | 140 | 24.0 | 225 |
| 2.6 | 14.0 | 152 | 23.3 | 220 |
| 1.9 | 12.1 | 165 | 22.5 | 210 |

| SupraMig® 1.2mm | |
| 4.8 | 11.4 | 127 | 23.0 | 280 |
| 3.4 | 9.7 | 127 | 21.5 | 250 |
| 2.6 | 9.7 | 152 | 21.5 | 250 |
| 1.9 | 8.9 | 178 | 20.5 | 230 |

**Rapid X™ Set-Up**

### Sense Leads

- **A positive (+) sense lead is required.** This is a standard connection in an Arclink® cable.

- **A negative sense lead (optional) is highly recommended for total welding cable lengths >50 ft.** and should be connected directly to the workpiece.

- **DO NOT** connect either sense lead to a welding stud as this may result in erratic arc or increased spatter.

- **For best performance, connect the work sense lead close to the welding arc.**

- **The negative sense lead should be separated away from welding cables to minimize interference.**

- **DO NOT** route sense lead cable close to high current welding cables as this may distort the sense lead signal.

### Work Leads

- **Connect the work lead to the negative stud on the power source and directly to the work piece.** Maintain the shortest connection length possible.

- **The total length of the welding current loop (A+B+C) should be minimized to reduce inductance.**

- **Route cables (A,B) close together to further reduce cable inductance.**

- **Lincoln Electric® coaxial cables combine the positive and negative welding leads into one cable to minimize cable inductance.**

- **Test cable inductance levels using the Power Wave® Manager software exclusively from Lincoln Electric®.**

**For configurations with excessive inductance, use Lincoln Electric® patented coaxial welding cables.**

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**LINCOLN ELECTRIC**

The Performance You Need.
The Quality You Expect.
Connection Diagram

1. Tack weld the root opening.
2. Strike an arc on the side wall.
4. Weld across the root opening.
5. Stop arc on the side wall.
6. Torch perpendicular to the weld surface.
7. Torch at 45° to the weld surface.
8. Torch at 10° to the weld surface.

Note:
- Material
- Electrode
- Position
- Gas
- Root Opening Peak (A) Background (A) Tailout
- Wire Feed Speed
- Rapid X™ Set-Up

The Performance You Need.
The Quality You Expect.
## Troubleshooting

### Problem

<table>
<thead>
<tr>
<th>Spatter</th>
<th>Erratic Arc</th>
<th>Porosity</th>
<th>Under Cut</th>
<th>Convex Bead</th>
<th>Concave Bead</th>
<th>Burn Through</th>
<th>Poor Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Spatter Icon] +</td>
<td>![Erratic Arc Icon] +</td>
<td>![Porosity Icon] +</td>
<td>![Under Cut Icon] -</td>
<td>![Convex Bead Icon] +</td>
<td>![Concave Bead Icon] +</td>
<td>![Burn Through Icon] +</td>
<td>![Poor Penetration Icon] +</td>
</tr>
</tbody>
</table>

### Solution

<table>
<thead>
<tr>
<th>Tip</th>
<th>Gas Coverage</th>
<th>Surface Contaminates</th>
<th>Proper Feeding</th>
<th>Sense Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Tip Icon] +</td>
<td>![Gas Coverage Icon] +</td>
<td>![Surface Contaminates Icon] +</td>
<td>![Proper Feeding Icon] +</td>
<td>![Sense Lead Icon] +</td>
</tr>
</tbody>
</table>

### Increase
- Increase

### Decrease
- Decrease

### Inspect & Replace
- Inspect & Replace

### Important
- Important
**Rapid X™ Glossary**

**Icons**

- Wire Type
- Gas
- Material Thickness
- Wire Feed Speed
- Travel Speed
- Volts
- Amps
- Contact Tip to Work Distance
- Arc Length
- Control Knob
- Stop / Avoid

<table>
<thead>
<tr>
<th>Weld Stud</th>
<th>Torch</th>
<th>Positive Sense Lead</th>
<th>Negative Sense Lead</th>
<th>Work Clamp</th>
<th>Torch Nozzle</th>
<th>Travel Speed (Slow)</th>
<th>Travel Speed (Fast)</th>
<th>Spatter (Minimal)</th>
<th>Spatter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Technical Terms**

- **Cable Inductance** — Resistance to change in current.
- **GMAW** — Gas metal arc welding including metal inert gas (MIG) and metal active gas (MAG) welding.
- **Porosity** — Gas entrapped in solidifying metal forms spherical or elongated pores in the weld.
- **Push Angle** — The angle at which the electrode leads the weld pool relative to the direction of travel.
- **Synergic** — A mode of control which automatically selects a programmed nominal voltage based on the wire feed speed (WFS) set by the operator.
- **Work Angle** — The angle of the electrode, off perpendicular, relative to the work piece surface.

**Procedure Notes**

All listed procedures are starting points and may require some adjustment depending on the specific application.

<table>
<thead>
<tr>
<th>Torch angle, electrode placement, contamination, mill scale, joint fit up, and joint consistency are factors that may require special consideration depending on the specific application.</th>
</tr>
</thead>
</table>

At higher travel speeds, joint fit up, wire placement, and contamination all become factors that are more significant.

The result of welding at higher travel speeds is a tendency to produce more spatter, less penetration, more undercut, and a less desirable bead shape. Depending on the limitations / requirements of the actual application, slower travel speeds and higher arc voltages may be required.

As the travel speed increases in fast follow applications (1/4” to 14 Gauge), a tighter and arc length must be maintained so that the puddle properly follows the arc. Operators typically reduce the arc length control (Trim) to achieve this.

At faster travel speeds, the bead shape can become very convex (or ropy), and the weld will not "wet" well. There is a point at which the arc is set so short that the arc will become unstable and spatter will occur. This forms a limitation of just how fast the travel speed can be raised.

It is ultimately the responsibility of the end user to ensure the proper weld deposition rate, bead profile, and structural integrity of a given weld application.

**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.

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