High Speed Welding
Heath Suraba
How fast do I need to go?

.052" wire weaving 3Hz, 3mm Amplitude

Laser Hybrid 80ipm on Galvanized
What process?

- Single Wire
- Tandem
- Laser
- Laser Hybrid
- Seam Tracking / Vision
**Robotics Arc Welding Cell**
- One arm or multiple
- Single Axis or 2 Axis Positioner
- 2D Vision or 3D Vision
- Real time seam tracking
- Wire or Laser Touch Sense

**Lincoln Electric**
- Welding Equipment
  - Power Wave - R350, R500, i400
  - STT Module
  - Rapid X, Rapid Arc
  - Tandem
  - Laser, Laser Hybrid
- Welding Process Expertise
Wire Type
Diameter
Shielding Gas
Customer Engineering
Cleveland OH

Advantages
– Tooling, Systems

Pre-engineered Robotic Systems

Infinity Pak

TENNESSEE RAND
ENGINEERING • MACHINING • AUTOMATION • INTEGRATION

Wayne Trail
A Lincoln Electric Company
Advantages

- Simplicity
- Low cost
- Common
- Vision
- Seam Tracking
- Adaptive Fill

<= 2mm plate 120ipm travel
(very small gaps)

<= 3mm plate 70ipm
(up to 1.5mm gap)

<= 6mm plate 40ipm travel
(up to 1.5mm gap)
Less spatter and contact tip wear
<table>
<thead>
<tr>
<th>Project ID:</th>
<th>Application Engineer:</th>
<th>Quote Engineer:</th>
<th>Salesperson:</th>
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<tr>
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**Customer Information**
- **Company Name:** Cooper Power
- **Street Address:**
- **City, State, Zip:**
- **Phone:**
- **Email:**

**Application Category**
- **Application:** Automotive / Transportation
- **Category:** Heavy Industry
- **Part:** Pipe
- **Structural
- **Other:**

**Part Information**
- **Material:** 304 SS
- **Current Consumable:** 308LSi
- **Current Gas:** Trimix
- **Current Cycle Time:**

**Proposed Application**
- **Consumable:** 308LSi
- **Gas:** 95% Ar, 3% Co2, 2% N
- **Process:** STT
- **Trim/Voltage:** 300A PK, 145A BK
- **Wire Feed Speed:** 200 ipm
- **Travel Speed:** 600 pm
- **Cycle Time:** 50 sec
- **Power Source:** R50/STT

**Additional Information:**
Produced same weld surface appearance with 95% AR, 3% Co2, 2% N as High helium trimix did 90% He, 7.5% Ar, 2.5% Co2

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Customer Assistance Policy
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Material: 0.8mm Top Plate to 2.2mm Bottom Plate
Gap: 3.5mm – Demonstrating Gap Bridging Ability with STT Process
Benefits: Low Heat Input with Zero Spatter
Advantages

- Fast Travel Speeds
- Colder Than Pulse
- Fills Gaps
- Versatile
- Requires No STT Module

90 ipm travel
2mm Thick Material
90% Penetration
## Lower Arm - Rapid Arc

**177cm/min Travel (70ipm Travel)**

**40% Faster than current Process**
Rapid X™

Power Source Requirements

- S350
- R350
- S500
- R500
- Requires STT Module
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Pulse Ramp / Peak:
A sudden controlled increase in current increases arc energy and squeezes the molten droplet extending from the end of the electrode.

Tailout / Background:
The ramp down of current relaxes the plasma force, which was depressing the puddle in the Peak, therefore allowing it to rise up towards the droplet.

Puddle Repulsion:
Immediately following a short breaking into an arc, a gentle plasma boost pushes the puddle away establishing separation, and reducing further shorting, and creating a stable rhythm of the weld cycle.

Short:
As the arc collapses and the droplet contacts the weld puddle. Special hardware enables the current to be reduced quickly, and the weld current is lowered.

Synergic Waveform:
Rapid X™ waveforms are Synergic weld modes automatically changing the nominal voltage, as WFS is varied. Once the desired WFS is selected, the voltage can be varied.
## Automation Division Application Engineering

<table>
<thead>
<tr>
<th>Date</th>
<th>2/11/2013</th>
<th>Application Engineer</th>
<th>Heath Suraba</th>
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<tr>
<td></td>
<td></td>
<td>Salesperson</td>
<td>Tony Noah</td>
<td>Phone: 859-421-7746</td>
<td>Email</td>
<td><a href="mailto:Tony_Noah@lincolnelectric.com">Tony_Noah@lincolnelectric.com</a></td>
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<tr>
<th>Company Name:</th>
<th>Street Address:</th>
<th>City, State, Zip:</th>
<th>Contact Name:</th>
<th>Phone:</th>
<th>Email:</th>
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### Application Category

<table>
<thead>
<tr>
<th>Automotive / Transportation</th>
<th>Heavy industry</th>
<th>Offshore</th>
<th>Pipe</th>
<th>Power Generation</th>
<th>Structural</th>
<th>Other</th>
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### Part Information

<table>
<thead>
<tr>
<th>Material:</th>
<th>Gal Steel</th>
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<tr>
<td>Current Consumable:</td>
<td>S-6</td>
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<tr>
<td>Current Gas:</td>
<td>80% Ar 20% CO2</td>
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<tr>
<td>Current Cycle Time:</td>
<td>N/A</td>
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### Proposed Application

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<tr>
<th>Consumable:</th>
<th>L-59 .035&quot;</th>
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<tr>
<td>Gas:</td>
<td>80% Ar 20% CO2</td>
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<tr>
<td>Process:</td>
<td>Rapid X</td>
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<tr>
<td>Trim/Voltage:</td>
<td>20.5</td>
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<tr>
<td>Wire Feed Speed:</td>
<td>320 ipm</td>
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<tr>
<td>Travel Speed:</td>
<td>25 ipm</td>
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<td>Cycle Time:</td>
<td></td>
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<tr>
<td>Power Source:</td>
<td>PA350 with STT module</td>
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</tbody>
</table>

### Additional Information:

- Rapid X .035" L59
- 220 ipm WFS
- 25 ipm Travel
- 80% Ar 20% CO2
- R350 with STT module

**Rapid X**

- 2x faster, No Spatter
- 25 ipm Travel

**Class A Penetration**

**Spatter**
# Automation Division

**Application Engineering**

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<th>Application Category</th>
<th>Part Information</th>
<th>Proposed Application</th>
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<tbody>
<tr>
<td>Company Name:</td>
<td>X Automotive / Transportation</td>
<td>Material: Galv Steel</td>
<td>Consumable: L-50 .045&quot;</td>
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<td>Street Address:</td>
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<td>Current Consumable: 5-6</td>
<td>Gas: 80%Ar 20%CO2</td>
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<tr>
<td>City, State, Zip:</td>
<td>Heavy Industry</td>
<td>Current Gas: 0% Ar 20%CO2</td>
<td>Process: Rapid X</td>
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<td>Contact Name:</td>
<td>Offshore</td>
<td>Current Cycle Time: N/A</td>
<td>Trim/Voltage:</td>
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<tr>
<td>Phone:</td>
<td>Pipe</td>
<td>Wire Feed Speed:</td>
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<td>Email:</td>
<td>Power Generation</td>
<td>Travel Speed: 45 IPM</td>
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<td></td>
<td>Structural</td>
<td>Cycle Time:</td>
<td>Power Source: PW350 or PW560</td>
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<tr>
<td></td>
<td>Other</td>
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**Additional Information:**

## Cross Member

### Current

### Rapid X

### Comparison
Production Weld

Demo Weld Cell

50% Faster, No Spatter
(Vision to locate Joint)
## Automation Division
### Application Engineering

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<th>Part Information</th>
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</tr>
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<tbody>
<tr>
<td>Company Name: Toyota</td>
<td>X Automotive / Transportation</td>
<td>Material: Mid Steel</td>
<td>Consumables: L-50.045&quot;</td>
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<tr>
<td>Street Address: 1001 Cherry Blossom Way</td>
<td>Heavy Industry</td>
<td>Current Consumable: S-3</td>
<td>Gas: 80%Ar 20%CO2</td>
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<tr>
<td>City, State, Zip: Georgetown, Ky 40324</td>
<td>Offshore</td>
<td>Current Gas: 80% Ar 20%CO2</td>
<td>Process: Rapid Arc, Rapid X, Pulse</td>
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<tr>
<td>Contact Name: Manson Nyles</td>
<td>Pipe</td>
<td>Current Cycle Time: N/A</td>
<td>Trim/Voltage:</td>
</tr>
<tr>
<td>Phone: 502-570-6727</td>
<td>Power Generation</td>
<td>Wire Feed Speed:</td>
<td>Travel Speed: 70 ipm</td>
</tr>
<tr>
<td>Email: <a href="mailto:Manson_Nyles@temn.toyota">Manson_Nyles@temn.toyota</a></td>
<td>Structural</td>
<td>Cycle Time:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>Power Source: PW350 or PW500</td>
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**Additional Information:**

**Lower Arm**

Rapid X Bridged 1.5mm Gap at 152 cm/min
On the Fly Parameter Change with 50% Increase in Travel Speed

- Rapid Arc
- Rapid X
- Pulse
- Weld Travel Direction
Advantages

- Fast Travel Speeds
- Colder Than Pulse
- Fills Gaps
- Versatile
- Requires No STT Module

- <= 2mm plate 150ipm travel
  (very small gaps)

- <= 3mm plate 120ipm
  (up to 1.5mm gap)

- <= 6mm plate 100ipm travel
  (up to 1.5mm gap)
Tandem MIG:

Two independent arcs welding simultaneously in one puddle.
• The 2 Big Categories
  – High Travel Speed Tandem MIG
  – High Deposition Tandem MIG
• Two Independent Power Sources
• Two Electrically Isolated Wires – One Puddle
• Spacing Varies Depending on Process (8-20 mm)
  – Lead Arc – Penetration & Majority Deposition
  – Trail Arc – Bead Appearance & Remainder Deposition
Tandem MIG

- Phase Angle Control
  - Control is on the lead arc only
  - Varies between 0° & 360°
  - 180° is the nominal setting
Tandem MIG

180° Syncronization

Lead Current

Trail Current
Tandem MIG
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Advantages

- Fast Travel Speeds
- Low Heat Input
- Very Low Distortion

- <= 2mm plate 400ipm travel (very small gaps)
- <= 3mm plate 200ipm (very small gaps)
- <= 6mm plate 200+iipm travel (very small gaps)
Disadvantages

- High Cost
- Complexity or Unfamiliarity
- Need High Volume to Justify
Advantages

• Uses filler metal to bridge gaps
• Metallurgy of Filler wire
• Control dilution
Vision

iRVision to locate part

Variable Part Gaps

iRVision on Teach Pendant

Laser Identifies Gap Heights

FIND IT

MEASURE IT

ADAPT TO IT

WELD IT
Vision, Calculated Adaptive Fill

- FIND IT
- MEASURE IT
- ADAPT TO IT
- WELD IT
Real Time Seam Tracking

SmartLaserSensorRemote

Welding With Vision

- Side: 2.30 mm
- Height: -3.73 mm
- Gap: mm
- Mismatch: 3.09 mm
- Quality: 100%
- Welding Speed: 44710.0 cm/min
- Seam No: 4
  Seam Name: LeftLapDown

Measuring
Laser is ON
65mm stand off
72mm Look Ahead
The Path Forward

How fast do I need to go?

What process should I use?

What equipment do I need?