Synchronized Tandem MIG® Weld Process Guide

Overview

Synchronized Tandem MIG® gets it done faster.*

- **Increases Travel Speed up to 300%**
- **Increases Deposition Rates up to 80%**
- **Enhances Bead Appearance**
- **Reduces Spatter ****

Index

*Based on a side by side comparison of Synchronized Tandem MIG® and Pulse using Power Wave® i400's with 0.045" L56 wire. Synchronized Tandem MIG® parameters: WFS 500 in/min, Travel Speed 100 in/min, 23.3 Volts. Pulse parameters: WFS 350 in/min, Travel Speed 35 in/min, 22.5 Volts.

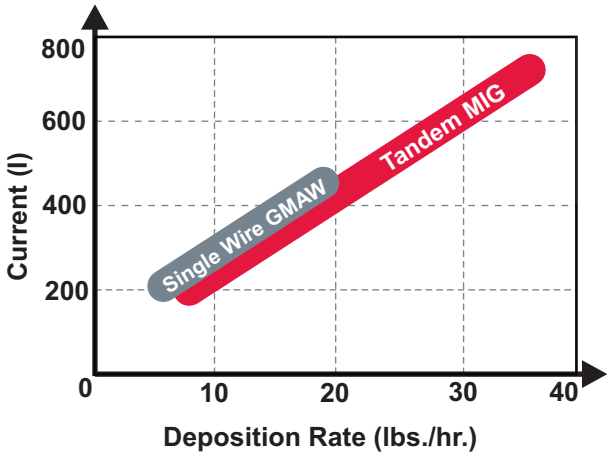
** Compared to non-synchronized tandem MIG.

Synchronized Tandem MIG® Details

Process Description

The maximum deposition rate in a traditional single wire GMAW (MIG) process is limited by the saturation current(I) for any specific wire diameter. To overcome this limitation, Tandem MIG combines two separate MIG welds into a single application. The outcome is a process capable of nearly double the deposition rate of single wire MIG.

Synchronized Tandem MIG® increases stability, reduces spatter and improves bead appearance compared to a standard tandem MIG process. **Synchronized Tandem MIG®** utilizes a pulse waveform and synergic precision controls allowing customization of both arcs to meet specific application needs. UltimArc™ controls fine tune the ramp, peak, background and tailout for each arc. The resulting **Synchronized Tandem MIG®** process provides exceptional deposition rates and fast travel speeds.



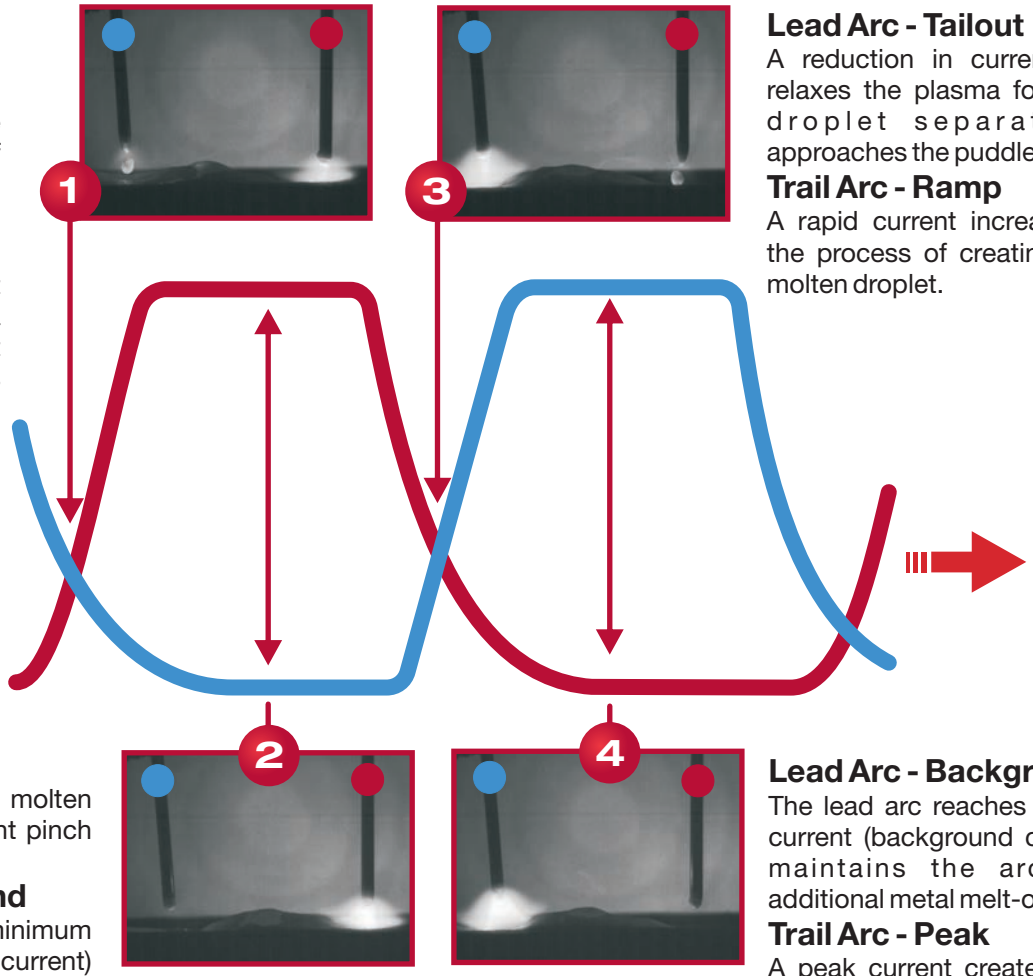
Waveform

Lead Arc - Ramp
A rapid current increase begins the process of creating a single molten droplet.

Trail Arc - Tailout
A reduction in current (Tailout) relaxes the plasma force as the droplet separates and approaches the puddle.

180° Synchronization

Lead Current
Trail Current



Lead Arc - Tailout
A reduction in current (Tailout) relaxes the plasma force as the droplet separates and approaches the puddle.

Trail Arc - Ramp
A rapid current increase begins the process of creating a single molten droplet.

Lead Arc - Peak
A peak current creates a molten droplet providing sufficient pinch force to begin separation.

Trail Arc - Background
The trail arc reaches a minimum current level (background current) and maintains the arc without additional metal melt-off.

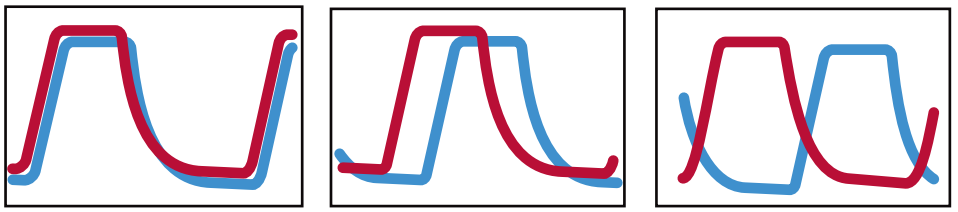
Lead Arc - Background
The lead arc reaches a minimum current (background current) and maintains the arc without additional metal melt-off.

Trail Arc - Peak
A peak current creates a molten droplet providing sufficient pinch force to begin separation.

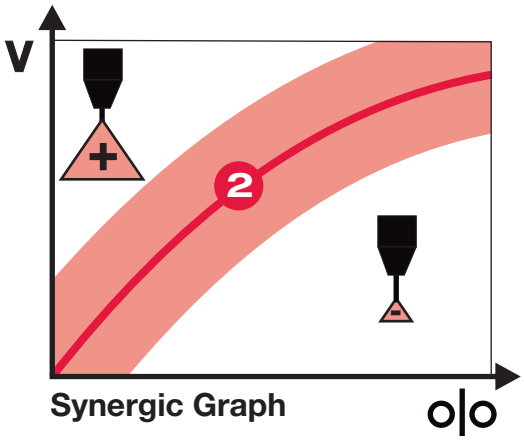
Synchronized Tandem MIG® Optimization 2

Phase Angle

Phase Angle is a wave control adjustment ranging from 0° to 360° which indicates the pulse relationship of the lead and trail arcs. 180° is the recommended starting point to minimize the electromagnetic forces between the two arcs resulting in increased stability, minimal arc blow and reduced spatter.

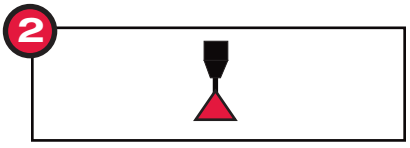


Synergic Welding

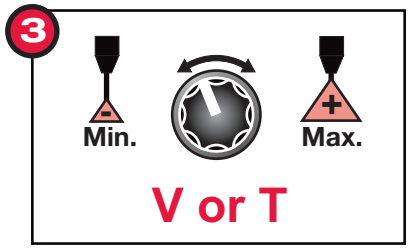


Synchronized Tandem MIG® waveforms are synergic weld modes. Based on the wire feed speed (WFS)❶, set by the operator, a pre-programmed voltage is automatically selected❷. Fine tune the arc length using Voltage / Trim adjustment❸.

Adjust WFS to the desired setting. Refer to the Application section for the recommended settings. Adjust the control on both the lead and trail machines.



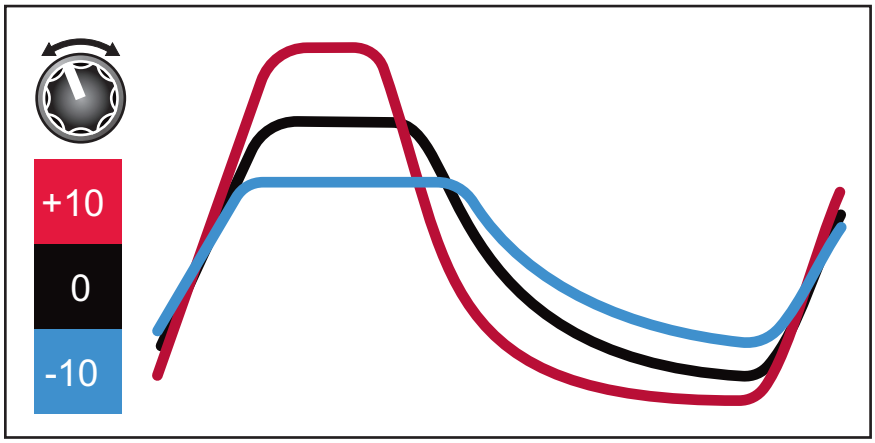
Based on WFS a preprogrammed nominal voltage is selected.



Adjusting Voltage / Trim increases or decreases the arc length, allowing the user to fine tune arc characteristics. Adjust the control on both the lead and trail machines.

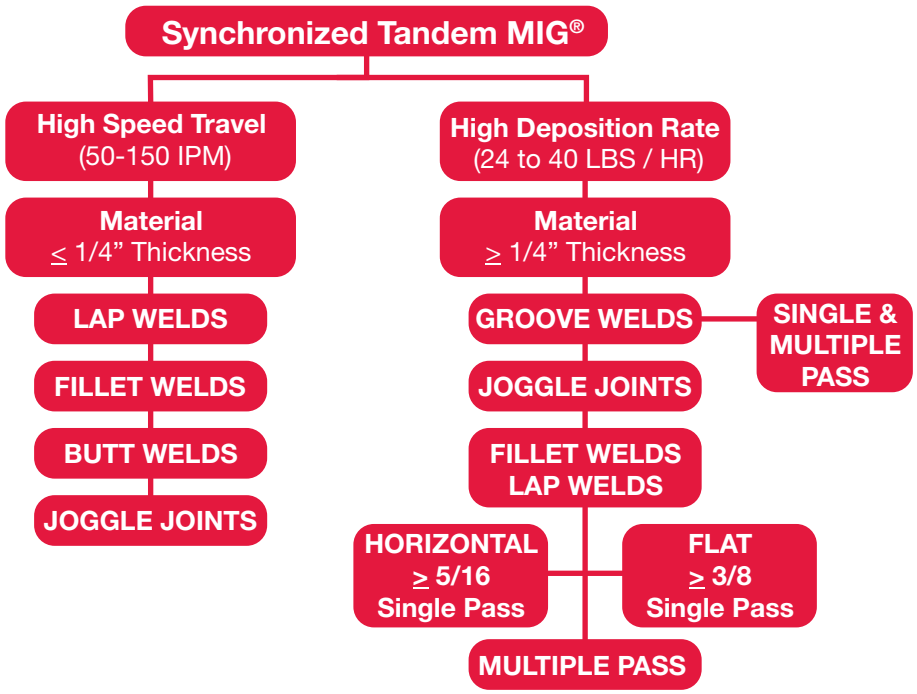
UltimArc™ Control

The **UltimArc**™ control fine tunes the ramp, peak, background and tailout with a single control. Increase(+) or decrease(-) this setting to adjust the arc focus. Follow recommended settings, adjust this control on both the lead and trail arc machines. Increase(+) for high speed applications. Use Nominal(0) or decrease(-) for high deposition applications.



Application Overview

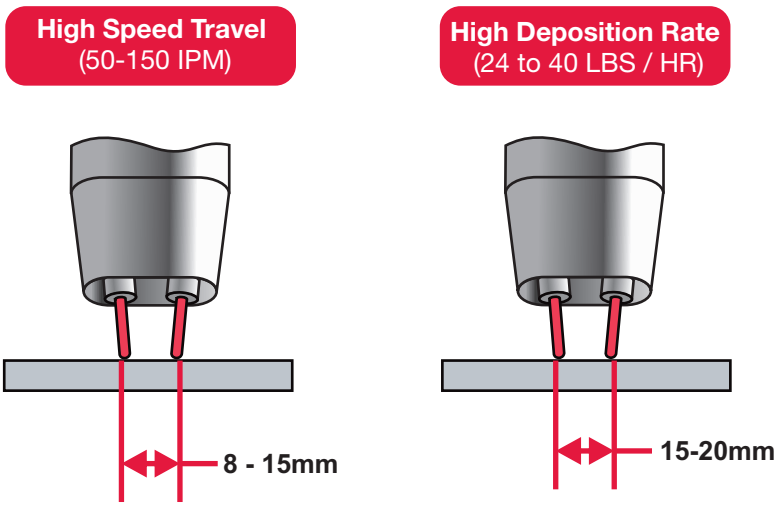
Synchronized Tandem MIG® is generally broken up into two main application categories, High Speed and High Deposition. This chart shows general guidelines on how the two different categories are defined. Understanding the specific Tandem MIG application is important so process variables can be set correctly.



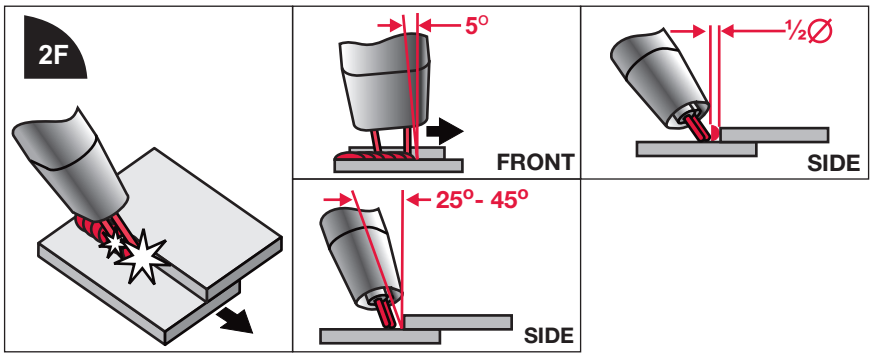
Tandem Torches

The electrode spacing affects the arc interaction. As the distance between the arcs increases, the arc interaction decreases. Excessive distance will cause the arcs to be in separate weld puddles. High deposition applications work best with an electrode spacing of 15-20 mm at the work. High travel speed applications work best with an electrode spacing of 8 to 15 mm at the work.

Lincoln Electric utilizes a torch with a 15 mm spacing for the majority of applications. However different applications may be optimized by a different torch spacing.



2F / PB Horizontal Lap



- Use a 5° push angle.
- Use a 25°- 45° work angle.
- Position the electrode approximately one half of an electrode diameter outside the joint favoring the bottom leg.

US

180°
90Ar / 10CO_2

Lead / Trail

	in / ga	Degrees	in	in / min	in / min	T	UltimArc™	V	A
SuperArc® L-56 0.035”	1/4	35	5/8	62	**900** / 600	**0.80** / 0.86	**+2.5** / 0.0	**25.6** / 24.1	**234** / 202
	3/16	35	5/8	80	**800** / 550	**0.80** / 0.85	**+5.0** / 0.0	**24.8** / 23.2	**234** / 197
	10ga	30	5/8	90	**800** / 500	**0.80** / 0.87	**+5.0** / 0.0	**24.8** / 23.1	**230** / 184
	12ga	30	5/8	110	**800** / 500	**0.80** / 0.95	**+10.0** / 0.0	**24.8** / 25.2	**218** / 180
SuperArc® L-56 0.045”	1/2	45	3/4	32	**475** / 425	**1.00** / 1.00	**0.0** / 0.0	**26.8** / 26.7	**234** / 202
	3/8	40	3/4	42	**475** / 425	**1.00** / 1.00	**0.0** / 0.0	**27.2** / 26.8	**234** / 197
	5/16	35	3/4	45	**450** / 400	**0.95** / 0.97	**+2.5** / 0.0	**25.0** / 26.0	**230** / 184
	1/4	35	3/4	60	**450** / 400	**0.95** / 0.97	**+2.5** / 0.0	**25.0** / 26.0	**218** / 180
	3/16	30	5/8	75	**500** / 325	**0.85** / 0.86	**+5.0** / 0.0	**23.7** / 21.4	**230** / 184
	10ga	30	5/8	100	**500** / 300	**0.82** / 0.86	**+10.0** / 0.0	**22.2** / 21.2	**218** / 180
SuperArc® L-56 0.052”	1/2	45	¾ - ⅞	20	**325** / 325	**0.90** / 1.02	**+5.0** / 0.0	**23.5** / 26.5	**260** / 280
	3/8	40	3/4	30	**325** / 325	**0.88** / 0.92	**+5.0** / 0.0	**23.0** / 24.0	**270** / 271
	5/16	35	3/4	40	**325** / 325	**0.85** / 0.92	**+5.0** / 0.0	**22.0** / 24.0	**272** / 280
	1/4	35	3/4	50	**325** / 325	**0.82** / 0.92	**+5.0** / 0.0	**21.2** / 24.0	**273** / 280
	3/16	30	5/8	80	**375** / 250	**0.76** / 0.86	**+7.5** / 0.0	**21.2** / 21.1	**323** / 242
	10ga	25	5/8	100	**375** / 245	**0.74** / 0.86	**+10.0** / +2.5	**20.0** / 21.0	**338** / 226
SuperArc® L-56 1/16”	1/2	45	3/4	20	**325** / 325	**0.95** / 1.00	0.0 / 0.0	**26.0** / 26.5	**260** / 280
	3/8	40	3/4	30	**325** / 325	**0.90** / 0.90	0.0 / 0.0	**24.0** / 24.0	**270** / 271

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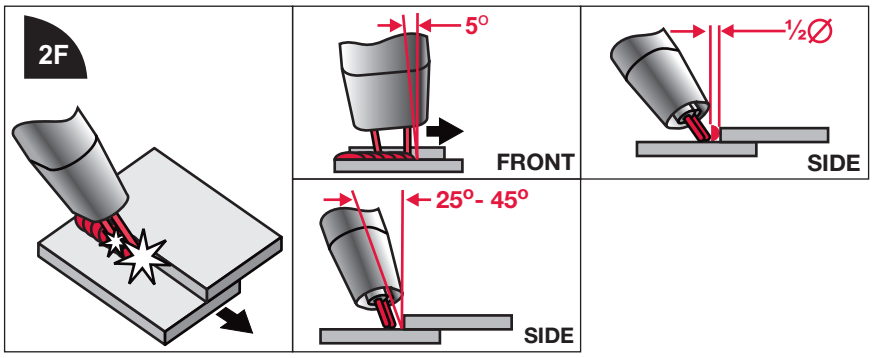
2F / PB Horizontal Lap cont.



- Use a 5° push angle.
- Use a 25°- 45° work angle.
- Position the electrode approximately one half of an electrode diameter outside the joint favoring the bottom leg.

Metric

180°
80Ar / 20CO_2

Lead / Trail

	mm	Degrees	mm	m / min	m / min	T	UltimArc™	V	A
SupraMIG® 1.0mm	6.4	35	16	1.78	**17.78** / 15.24	**0.95** / 1.00	**+2.5** / 0.0	**28.1** / 28.1	**308** / 300
	4.8	35	16	2.29	**17.78** / 12.70	**0.90** / 0.95	**+2.5** / 0.0	**27.0** / 26.2	**295** / 250
	3.4	30	16	2.54	**17.78** / 12.70	**0.90** / 0.95	**+5.0** / 0.0	**27.0** / 26.3	**311** / 258
	2.6	30	16	2.92	**17.78** / 12.70	**0.88** / 0.93	**+10.0** / 0.0	**26.3** / 26.1	**300** / 253
SupraMIG® 1.2mm	12	45	19	0.81	**12.07** / 12.80	**1.08** / 1.08	**0.0** / 0.0	**28.7** / 28.5	**313** / 295
	9.5	40	19	1.07	**12.07** / 12.80	**1.07** / 1.07	**0.0** / 0.0	**28.7** / 28.5	**290** / 295
	7.9	35	19	1.14	**11.43** / 10.16	**1.05** / 1.07	**+2.5** / 0.0	**27.8** / 28.3	**281** / 285
	6.4	35	19	1.52	**11.43** / 10.16	**1.05** / 1.07	**+2.5** / 0.0	**27.8** / 28.3	**290** / 280
	4.8	30	16	1.91	**12.70** / 8.26	**0.95** / 0.96	**+5.0** / 0.0	**25.8** / 24.5	**330** / 255
	3.4	30	16	2.54	**12.70** / 7.62	**0.92** / 0.96	**+10.0** / 0.0	**25.3** / 24.0	**326** / 248
SupraMIG® 1.4mm	12	45	19 - 21	0.51	**8.26** / 8.26	**1.00** / 1.09	**0.0** / 0.0	**26.0** / 27.3	**300** / 305
	9.5	40	19	0.76	**8.26** / 8.26	**0.98** / 1.02	**0.0** / 0.0	**25.7** / 26.2	**290** / 295
	7.9	35	19	1.02	**8.26** / 8.26	**0.95** / 1.02	**+2.5** / 0.0	**24.4** / 26.2	**281** / 285
	6.4	35	19	1.27	**8.26** / 8.26	**0.92** / 1.02	**+5.0** / 0.0	**24.0** / 26.2	**290** / 280
	4.8	30	16	2.06	**9.53** / 6.35	**0.86** / 0.96	**+7.5** / 0.0	**23.4** / 23.8	**330** / 255
	3.4	25	16	2.54	**9.53** / 6.22	**0.85** / 0.96	**+10.0** / +2.5	**23.0** / 23.4	**329** / 248
SupraMIG® 1.6mm	12	45	19 - 21	0.51	**8.26** / 8.26	**0.95** / 1.00	0.0 / 0.0	**26.0** / 26.5	**260** / 280
	9.5	40	19	0.76	**8.26** / 8.26	**0.90** / 0.90	0.0 / 0.0	**24.0** / 24.0	**270** / 271

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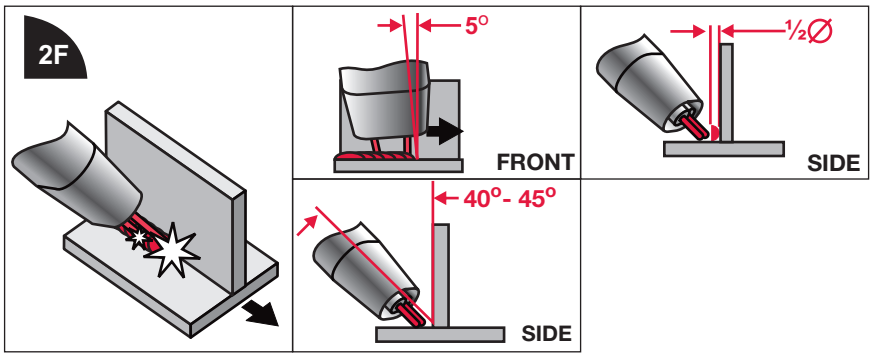
2F / PB



- Use a 5° push angle.
- Use a 40°- 45° work angle.
- Position the electrode approximately one half of an electrode diameter outside the joint favoring the bottom leg.

US

180°
90Ar / 10CO_2

					Lead / Trail				
					o|o	T	UltimArc™	V	A
	in / ga	Degrees	in	in / min	in / min				
SuperArc® L-56 0.035”	1/4	45	5/8	40	**800** / 550	**0.85** / 0.87	**+2.5** / 0.0	**26.4** / 23.7	**234** / 202
	3/16	45	5/8	50	**800** / 550	**0.80** / 0.85	**+2.5** / 0.0	**24.8** / 23.2	**234** / 197
	10ga	45	5/8	65	**800** / 500	**0.75** / 0.85	**+5.0** / 0.0	**23.2** / 22.5	**230** / 184
	12ga	45	5/8	80	**800** / 500	**0.80** / 0.88	**+10.0** / 0.0	**23.0** / 23.4	**218** / 180
SuperArc® L-56 0.045”	1/2	45	3/4	22	**475** / 425	**1.00** / 1.00	**0.0** / 0.0	**26.7** / 27.0	**234** / 202
	3/8	45	3/4	22	**450** / 400	**0.95** / 0.97	**0.0** / 0.0	**25.4** / 25.7	**234** / 197
	5/16	45	3/4	32	**450** / 400	**0.95** / 0.97	**+2.5** / 0.0	**25.0** / 25.7	**230** / 184
	1/4	45	3/4	40	**450** / 400	**0.94** / 0.96	**+2.5** / 0.0	**24.7** / 25.5	**218** / 180
	3/16	45	3/4	50	**475** / 375	**0.93** / 0.95	**+5.0** / 0.0	**25.3** / 24.2	**230** / 184
	10ga	45	5/8	65	**500** / 325	**0.85** / 0.87	**+7.0** / 0.0	**23.1** / 22.0	**218** / 180
SuperArc® L-56 0.052”	1/2	45	¾ - ⅞	16	**325** / 325	**0.90** / 0.96	**+5.0** / 0.0	**23.5** / 25.0	**260** / 280
	3/8	45	3/4	22	**325** / 325	**0.88** / 0.91	**+5.0** / 0.0	**23.0** / 23.7	**270** / 271
	5/16	45	3/4	32	**325** / 325	**0.85** / 0.95	**+5.0** / 0.0	**22.2** / 24.7	**272** / 280
	1/4	45	3/4	40	**325** / 325	**0.85** / 0.92	**+5.0** / 0.0	**21.8** / 24.0	**273** / 280
	3/16	45	5/8	50	**375** / 250	**0.85** / 0.90	**+7.5** / 0.0	**21.5** / 21.1	**323** / 242
	10ga	45	5/8	65	**375** / 225	**0.80** / 0.90	**+10.0** / 0.0	**19.0** / 21.0	**338** / 226
SuperArc® L-56 1/16”	1/2	45	3/4	20	**325** / 325	**0.95** / 1.00	0.0 / 0.0	**26.0** / 26.5	**260** / 280
	3/8	45	3/4	30	**325** / 325	**0.90** / 0.90	0.0 / 0.0	**24.0** / 24.0	**270** / 271

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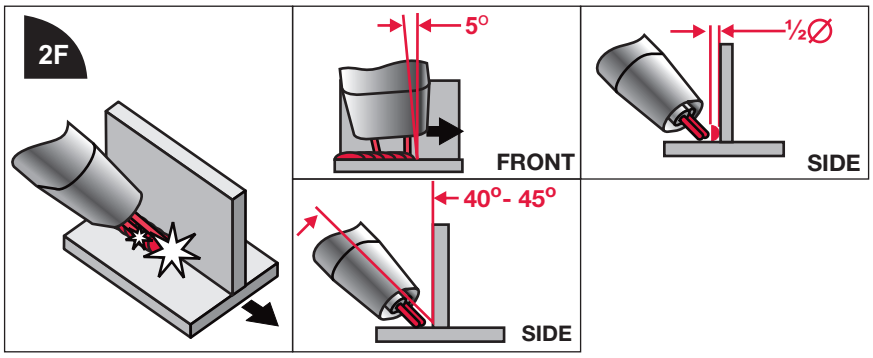
2F / PB



- Use a 5° push angle.
- Use a 40°- 45° work angle.
- Position the electrode approximately one half of an electrode diameter outside the joint favoring the bottom leg.

Metric

180°
80Ar / 20CO_2

	mm	Degrees	mm	m / min	m / min	T	UltimArc™	V	A
							Lead / Trail		
SupraMIG® 1.0mm	6.4	45	16	1.02	**16.51** / 11.43	**0.95** / 1.00	**+2.5** / 0.0	**27.4** / 27.0	**278** / 234
	4.8	45	16	1.27	**17.78** / 10.16	**0.95** / 1.00	**+2.5** / 0.0	**28.1** / 26.8	**300** / 214
	3.4	45	16	1.65	**17.78** / 10.16	**0.95** / 0.97	**+5.0** / 0.0	**28.1** / 26.4	**288** / 203
	2.6	45	16	2.03	**17.78** / 10.16	**0.93** / 0.95	**+10.0** / 0.0	**27.9** / 25.6	**277** / 200
SupraMIG® 1.2mm	12	45	19	0.51	**12.70** / 10.80	**1.06** / 1.06	**0.0** / 0.0	**28.8** / 28.5	**290** / 275
	9.5	45	19	0.56	**11.43** / 10.16	**1.05** / 1.07	**0.0** / 0.0	**27.7** / 28.1	**275** / 268
	7.9	45	19	0.81	**11.43** / 10.16	**1.05** / 1.07	**+2.5** / 0.0	**27.7** / 28.0	**270** / 266
	6.4	45	19	1.01	**11.43** / 10.16	**1.04** / 1.06	**+2.5** / 0.0	**27.2** / 27.7	**275** / 270
	4.8	45	19	1.27	**12.70** / 9.53	**1.03** / 1.05	**+5.0** / 0.0	**27.8** / 27.3	**285** / 250
	3.4	45	16	1.65	**12.70** / 8.26	**0.95** / 0.97	**+7.0** / 0.0	**25.7** / 24.2	**308** / 240
SupraMIG® 1.4mm	12	45	19 - 21	0.41	**8.26** / 8.26	**1.00** / 1.06	**0.0** / 0.0	**26.0** / 27.3	**280** / 295
	9.5	45	19	0.56	**8.26** / 8.26	**0.98** / 1.05	**0.0** / 0.0	**25.6** / 27.2	**280** / 295
	7.9	45	19	0.81	**8.26** / 8.26	**0.95** / 1.04	**+2.5** / 0.0	**25.0** / 27.0	**276** / 286
	6.4	45	19	1.01	**8.26** / 8.26	**0.93** / 1.02	**+5.0** / 0.0	**24.3** / 26.5	**264** / 281
	4.8	45	16	1.27	**9.53** / 6.35	**0.90** / 0.95	**+7.5** / 0.0	**24.6** / 23.5	**310** / 249
	3.4	45	16	1.65	**9.53** / 5.72	**0.87** / 0.94	**+10.0** / 0.0	**23.3** / 22.3	**310** / 230
SupraMIG® 1.6mm	12	45	19	0.51	**8.26** / 8.26	**0.95** / 1.00	0.0 / 0.0	**26.0** / 26.5	**260** / 280
	9.5	45	19	0.76	**8.26** / 8.26	**0.90** / 0.90	0.0 / 0.0	**24.0** / 24.0	**270** / 271

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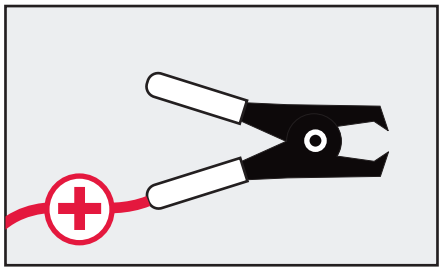
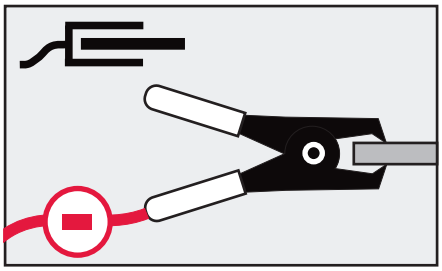
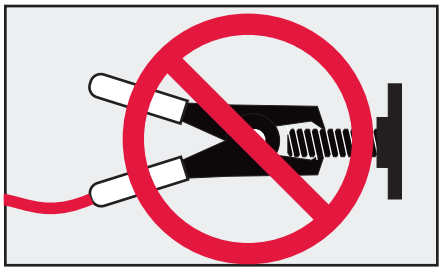
Sense Leads



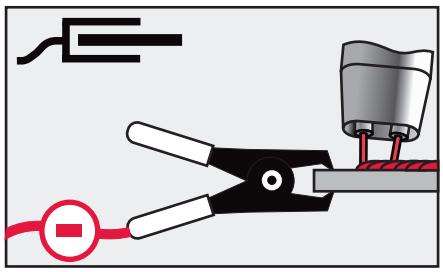
A positive (+) sense lead is required and is contained in Lincoln Electric® wire feed control cables.



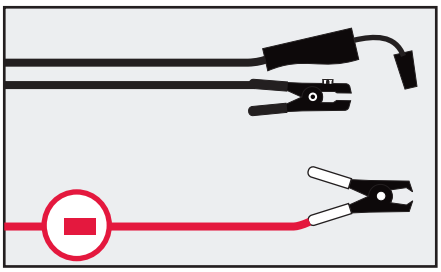
A negative sense lead (optional) is highly recommended and should be connected directly to the workpiece.



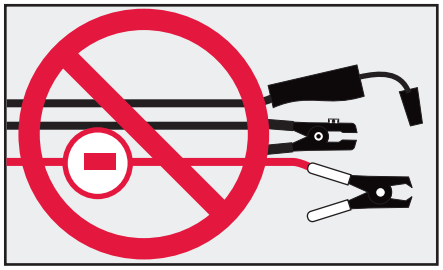
DO NOT connect either sense lead to a welding stud as this may result in erratic arc or increased spatter.



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

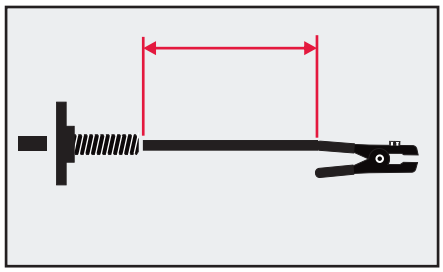


The negative sense lead should be separated away from welding cables to minimize interference.

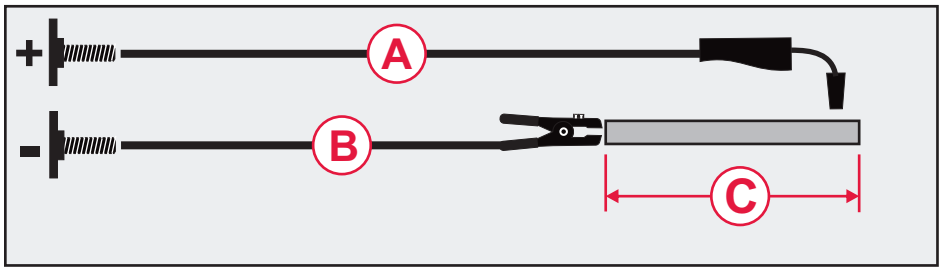


DO NOT route sense lead cable close to high current welding cables as this may distort the sense lead signal.

Work Leads

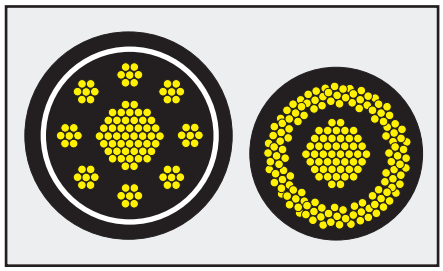


Connect the work lead to the negative stud on the power source and directly to the work piece. Maintain the shortest connection length possible.

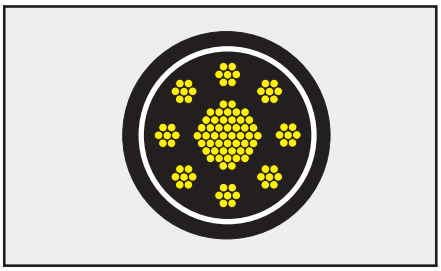


The total length of the welding current loop (A+B+C) should be minimized to reduce inductance.

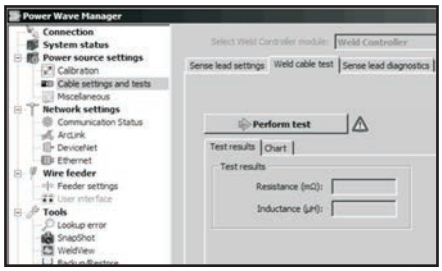
Route cables (A,B) close together to further reduce cable inductance.



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



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®.

Troubleshooting

Problem

Solution	Spatter	Erratic arc	Arc Blow	Porosity	Under cut	Convex Bead	Concave Bead	Burn Through	Poor Penetration
Trim	↑ !	↑	↓ !		↓ !	↑	↓ !	↓	
Travel Speed	↓ !	↓ !			↓ !	↓ !		↑ !	↓ !
Wire Feed Speed	↓	↓	↕		↓	↓ !	↑ !	↓ !	↑ !
Contact Tip to Work Distance	↓			↓		↓	↑	↑	↓
Push Angle	↓	↓			↑	↑	↓	↑	↓
Tip		🔧							
Gas Coverage	🔧			↑ !					
Surface Contaminates	🔧	🔧	🔧	🔧 !					
Proper Feeding		🔧 !							
Leads	🔧	🔧	🔧						
Phase Angle	↕	↕ !	↕	↕ !					

KEY

- ↑ Increase
- ↓ Decrease
- ↕ Adjust
- ! Important
- 🔧 Inspect & Replace

Synchronized Tandem MIG® Glossary

Icons

 Wire Type	 Gas	 Material Thickness	 Wire Feed Speed	 Travel Speed	 Work Angle	T Trim	V Volts	A Amps	 Contact Tip to Work Distance	 Phase Angle
 Arc Length	 Control Knob	 Weld Stud	 Torch	 Positive Sense Lead	 Negative Sense Lead	 Work Clamp	 Tandem Nozzle	 Stop / Avoid		

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 preprogrammed 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.

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.

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 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 stubbing 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.

Refer to the included trouble-shooting guide for assistance in overcoming welding issues.

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.