



Optimizing GMAW Welding Parameters

Welding Variables

Wire Feed Speed

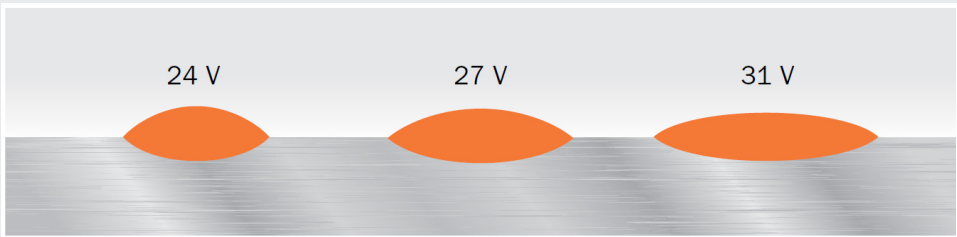
Primarily Controls	When Increased:	When Decreased:
Amperage (Penetration) Deposition Rate	Amperage increases Penetration increases Reinforcement increases Travel speed should increase	Amperage decreases Penetration decreases Reinforcement decreases Travel speed should decrease

As wire feed speed/deposition rate increases, it is possible to increase travel speed while maintaining a desired weld size. Increasing travel speed is required as wire feed speed increases to ensure that the arc is positioned at the leading edge of the weld pool so that maximum penetration into the base metal can be obtained.

Voltage

Primarily Controls	When Increased:	When Decreased:
Bead Width Heat Input	Arc cone becomes wider Weld bead width increases Weld becomes more concave Heat input increases	Arc cone becomes narrower Weld bead width decreases Weld becomes more convex Heat input decreases

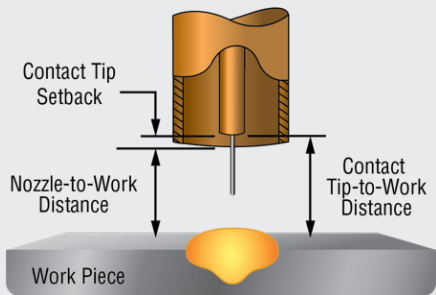
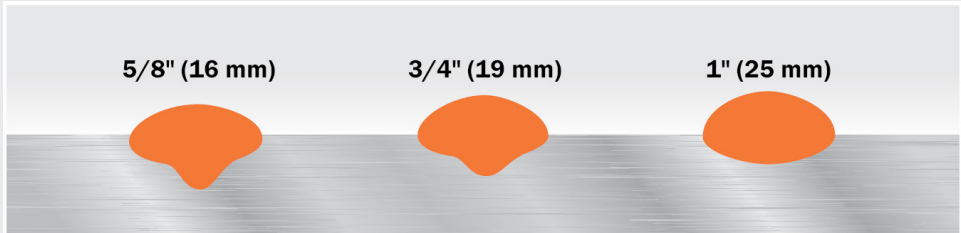
Using a voltage that is too low or too high with respect to the wire feed and travel speeds used can lead to weld discontinuities and defects. Excessive voltage may result in an arc that is difficult to control and a weld that suffers from undercut and/or a concave weld profile. Insufficient voltage usually results in an unstable arc that generates extra spatter. Welds made using insufficient voltage tend to be very convex, which can lead to issues achieving good weld metal fatigue life or fusion when making subsequent weld passes.



Contact Tip to Work Distance

Primarily Controls	When Increased:	When Decreased:
Amperage (Penetration)	Amperage decreases Penetration decreases	Amperage increases Penetration increases

Contact Tip to Work Distance (CTWD) is the distance between the contact tip and the base metal being welded. Some diffusers are configured so that the contact tip is recessed into the weld nozzle; the actual CTWD may be longer than is visible during welding. **Metal cored wires operate best when using a CTWD that is between 5/8" and 1"**

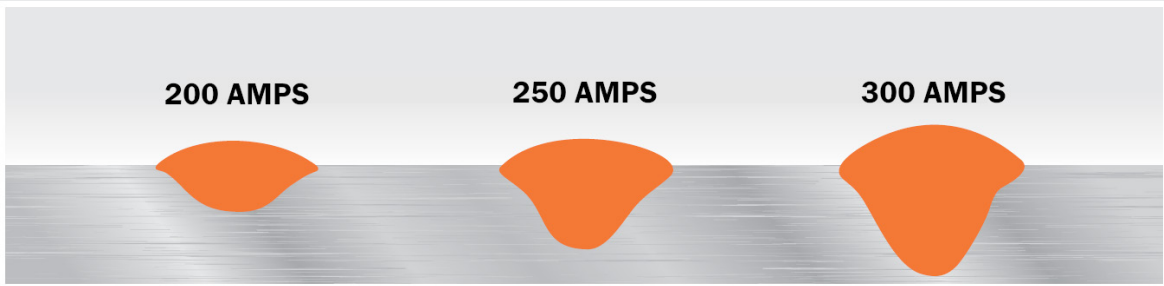


Welding Variables

Amperage

Controlled By	Primarily Controls	When Increased:	When Decreased:
Wire Feed Speed CTWD	Penetration Heat Input	Penetration increases Heat input increases	Penetration decreases Heat input decreases

Unlike voltage, amperage is not adjusted at the power source. Instead, it is the result of the wire feed speed (which is adjusted at the power source) and contact tip to work distance used. As amperage increases, penetration into the base metal also tends to increase assuming travel speed is not excessively low.



Metal Cored Wire Welding Parameters

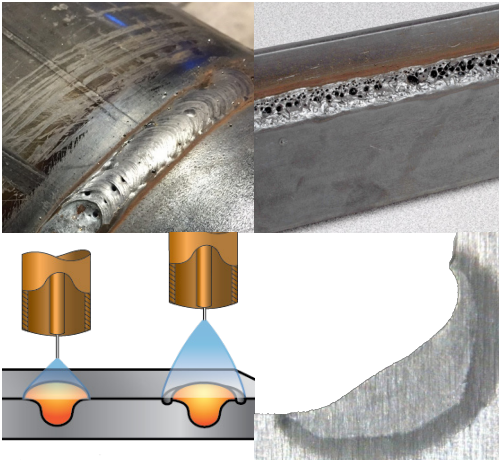
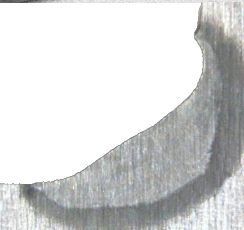
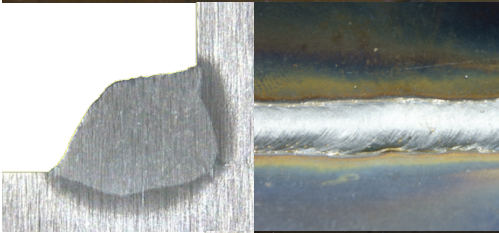
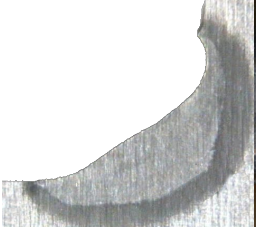
Diameter		Wire Feed Speed		Amps	Volts	Deposition Rate		3/16"	1/4"	5/16"
in.	mm	ipm	m/min			lbs/hr	kg/hr	4.8 mm Fillet @ ipm	6.4 mm Fillet @ ipm	7.9 mm Fillet @ ipm
0.045"	1.2	200	5.1	205	25	5.0	2.3	16.8	9.5	6.1
		300	7.6	240	26.5	7.8	3.6	26.3	14.8	9.5
		400	10.2	270	28	10.7	4.8	35.7	20.1	12.9
		500	12.7	305	29.5	13.5	6.1	45.1	25.4	16.3
		600	15.2	340	30.5	16.3	7.4	54.6	30.7	19.7
		700	17.8	375	32	19.1	8.7	64.0	36.0	23.1
		750	19.1	390	33	20.5	9.3	68.8	38.7	24.8
0.052"	1.4	200	5.1	230	25	6.9	3.1	23.1	13.0	8.3
		300	7.6	280	27	10.5	4.8	35.2	19.8	12.7
		400	10.2	325	28.5	14.1	6.4	47.2	26.6	17.0
		500	12.7	375	30.5	17.7	8.0	59.3	33.4	21.3
		550	14.0	400	31.5	19.6	8.9	65.7	36.9	23.6
1/16"	1.6	150	3.8	255	25.5	6.8	3.1	22.8	12.8	8.2
		200	5.1	290	27	9.4	4.3	31.5	17.7	11.3
		250	6.4	330	28	11.9	5.4	39.9	22.4	14.4
		300	7.6	370	29	14.4	6.5	48.2	27.1	17.4
		350	8.9	405	30.5	16.9	7.7	56.6	31.8	20.4
		400	10.2	445	31.5	19.5	8.8	65.3	36.7	23.5

The parameters shown above are generalized and not specific to a particular metal cored wire; consult product data sheets for product-specific information. Travel speeds provided are theoretical, provided for reference only, and are calculated using deposition rate; certain listed travel speeds may be unattainable considering the nature of the welding process and the specific conditions under which welding will occur.

Troubleshooting Common GMAW (MIG) Issues

Use this document to identify and resolve common issues, discontinuities, and defects encountered when welding using GMAW.

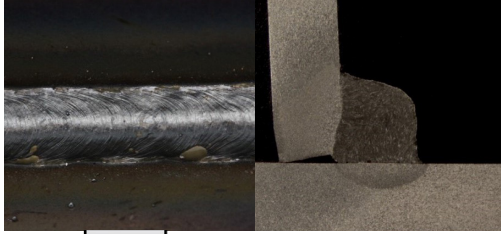
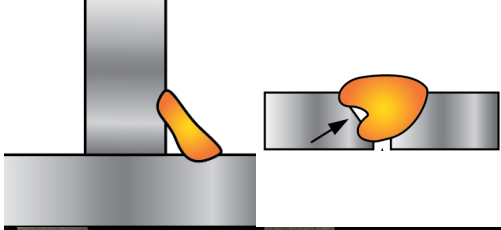
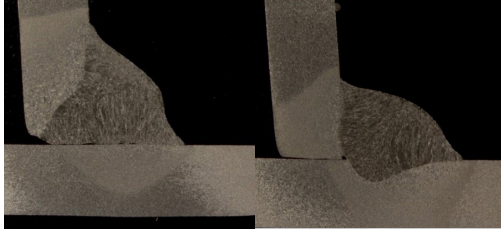
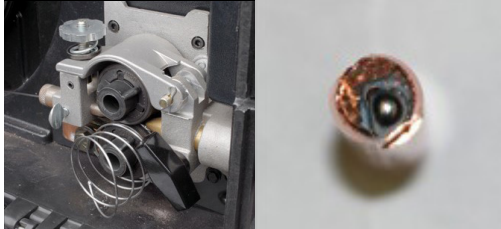
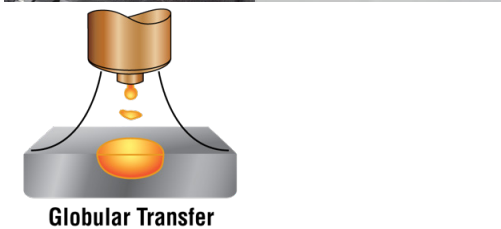


	Porosity: Causes	Porosity: Cures	Notes
	Restricted/obstructed shielding gas flow	Clean welding nozzle; Clean welding diffuser ports; Consider using a larger nozzle size	Check the nozzle and diffuser cleanliness periodically during the shift. Nozzle size should increase with amperage and bead width
	Insufficient shielding gas flow	Ensure flow rate is between 40-50 cfh measured at the nozzle orifice	Higher travel speeds require higher shielding gas flow rates
	Turbulent shielding gas flow	Reduce wind speed in welding environment; Reduce contact tip to work distance; Reduce shielding gas flow to suggested rate	Contact tip to work distance should not exceed 1" (25 mm) in typical welding applications
	Undercut: Causes	Undercut: Cures	Notes
	Excessive voltage (arc length when using GMAW-P)	Reduce voltage (arc length) in 0.5 volt increments until undercut is eliminated	Increasing voltage increases arc length and arc force.
	Insufficient work angle: work angle places too much emphasis on bottom plate	Increase work angle so that the arc energy is more evenly distributed between the top and bottom plates.	The ideal work angle for most 2F applications is 40-50 degrees.
	Insufficient wire feed speed and/or excessive travel speed	Increase wire feed speed in small increments and/or decrease travel speed	Undercut results from arc force creating a gouge that is not filled in. Increasing WFS and reduce travel speed allows this gouge to fill
	Excessive Spatter: Causes	Excessive Spatter: Cures	Notes
	Insufficient voltage (arc length when using GMAW-P)	Increase voltage (arc length) in 0.5 volt increments until arc stability improves	The product data sheet includes a starting point for setting voltage for a particular wire feed speed
	Insufficient amperage and/or excessive contact tip to work distance	Increase wire feed speed in small increments and/or reduce contact tip to work distance (<1")	Both wire feed and contact tip to work distance influence welding amperage. Stay within the recommended operating amp range
	Excessive "whipping" technique.	Eliminate whipping technique or reduce whipping distance	Excessive whipping can also negatively affect the weld penetration profile
	Arc blow	Relocate the welding work clamp so that the direction of welding is toward the work clamp	For large weldments, multiple work clamps may be required along the length of the weld
	Excessive Convexity: Causes	Excessive Convexity: Cures	Notes
	Insufficient voltage (arc length when using GMAW-P)	Increase voltage (arc length) in 0.5 volt increments until bead contour flattens	Increasing voltage increases arc cone width. As a result, voltage tends to increase bead width and improve bead "wetting"
	Insufficient travel speed	Increase travel speed until bead contour flattens	The shape of the back edge of the weld pool during welding can help indicate if the appropriate travel speed is being maintained
	Excessive wire feed speed	Reduce wire feed speed in 25-50 ipm increments until bead contour flattens	Increasing travel speed is preferable to reducing wire feed speed in many applications
	Insufficient travel angle	Utilize a "push" travel angle of 10-15 degrees	When a drag travel angle is used, the bead will tend to be more convex than when a push travel angle is used
	Excessive Concavity: Causes	Excessive Concavity: Cures	Notes
	Excessive voltage (arc length when using GMAW-P)	Reduce voltage (arc length) in 0.5 volt increments until bead contour flattens	Voltage and welding technique are the key contributors to weld bead concavity, but the problem can be enhanced by other factors
	Insufficient wire feed speed	Increase wire feed speed in 25-50 ipm increments until bead contour flattens	
	Excessive travel speed (with excessive voltage)	Reduce travel speed until bead contour flattens	
	Improper welding technique	Minimize oscillation (weaving) or oscillate slower through the weld center.	Oscillating too slow through the weld center can create issues with bead convexity; striking a balance is critical.

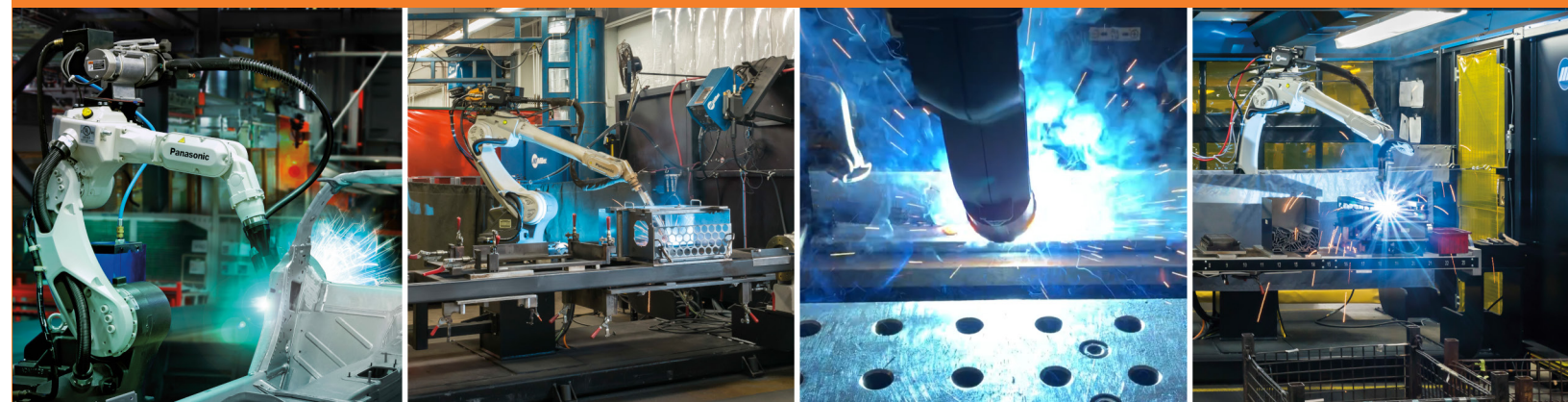


Troubleshooting Common GMAW (MIG) Issues

Use this document to identify and resolve common issues, discontinuities, and defects encountered when welding using GMAW.

	Bead Roll & Cold Lap: Causes	Bead Roll & Cold Lap: Cures	Notes
	Incorrect work angle	Decrease work angle so that the arc cone is distributed slightly more onto the bottom plate	The typical ideal work angle is 40-50 degrees from vertical. When bead roll occurs, decrease work angle to 40 degrees.
	Insufficient joint offset	Focus the center of the arc on the bottom plate, approximately one wire diameter out from the weld joint.	Joint offset is suggested when performing large single-pass welds and/or when welding over mill scale
	Insufficient amperage and/or "riding the puddle"	Increase amperage by increasing wire feed speed and decreasing contact tip to work distance. Increase travel speed.	"Riding the puddle" occurs when the arc is far behind the leading edge of the weld pool. Always ensure the arc is at the lead edge.
	Lack of Fusion: Causes	Lack of Fusion: Cures	Notes
	Insufficient amperage	Increase amperage by increasing wire feed speed and/or reducing contact tip to work distance	Increased welding amperage results in increased base metal penetration
	"Riding the puddle"	Increase welding travel speed so that the welding arc is on the leading edge of the weld pool	"Riding the puddle" occurs when the arc is far behind the leading edge of the weld pool. Always ensure the arc is at the lead edge.
	Incorrect work angle	Change work angle so that arc energy is focused toward the area where lack of fusion is occurring	
	Unequal Leg Sizes: Causes	Unequal Leg Sizes: Cures	Notes
	Incorrect work angle	For larger top legs, focus arc energy more into the bottom plate For larger bottom legs, focus arc energy more into the top plate	A 5-degree change to work angle may be all that is required for correction of minor leg size inequality.
	Excessive joint offset	Reduce the distance the wire is placed outside of the weld joint	Joint offset typically does not exceed one wire diameter
	Improper welding technique	Avoid excessive changes to work angle during oscillation. Alternatively, eliminate oscillation altogether.	
	Poor Wire Feeding: Causes	Excessive Weld Size: Cures	Notes
	Complicated wire feed path	Eliminate unnecessary loops and sharp bends between the wire feeder and gun	A "chattering" feeling in the welding gun can often indicate feeding problems before they become severe enough to affect the weld
	Worn contact tip; dirty/worn liner	Inspect contact tip for excessive "keyholing." Replace liner if necessary.	A good preventative maintenance schedule is critical to maximize welding uptime
	Wire deformed by drive rolls	Reduce drive roll tension. Ideally tension should be set to allow the drive rolls to slip when severe resistance is encountered.	Metal cored wires are more sensitive to wire deformation than solid wire, meaning more care is required during wire setup
	Poor Arc Stability: Causes	Poor Arc Stability: Cures	Notes
	Globular transfer	Increase wire feed speed and voltage. Ensure that contact tip to work distance is within the recommended range	Metal cored wires are designed to operate in a spray transfer, which requires relatively high amperages and voltages
	Arc blow	Relocate the welding work clamp so that the direction of welding is toward the work clamp	Arc blow problems are often indicated by reduced arc stability toward one end of a weldment
	Excessive "whipping" technique.	Eliminate whipping technique or reduce whipping distance	Excessive whipping can also negatively affect the weld penetration profile

Globular Transfer



For technical support of Hobart Filler Metals products, contact Hobart's Applications Engineers by phone at 1-800-532-2618 or by e-mail at Applications.Engineering@HobartBrothers.com

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