



BEGINNER'S GUIDE

TO

WELDING



Welding for Beginners:

A Step by Step Guide for the Hobby Welder

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1 - Welding Safety:

Your first welding project will be a fun and rewarding experience. Before you begin you must be prepared to work safely. Welding safety starts with proper PPE: "Personal Protective Equipment." Welding hazards include harmful UV rays, welding spatter, heat, and sharp objects. Follow these guidelines to ensure a safe and fun project.

Boots:

Wear a pair of leather work boots or other suitable footwear. It goes without saying that open toe shoes and sandals are out of the question. Be sure to tie up your boots to the very top and wear your pant legs on the outside of your boots. This will protect you from falling slag or weld spatter.

Clothing:

Wear a protective layer of clothing. The materials of choice are flame-retardant Nomex or 100% cotton work clothes. Never wear nylon clothing or tennis shoes when welding or cutting. Be sure to cover 100% of your skin including arms, legs, and neck. Any exposed area of your skin will be subject to UV rays and may develop a serious burn.

Fire Safety:

Keep the work area free from debris. Be sure to have a suitable fire extinguisher readily accessible.

Glasses:

While you may think your eyes are protected by the welding hood or shield, it is advisable to also wear protective safety glasses under your hood. This will accomplish two things. First, the glasses will provide protection against weld splatter entering your hood. Second, most welders tend to raise their helmet immediately upon completing a weld. As a weld cools, slag may pop off of the weld; safety glasses will provide protection. Use an appropriate pair of safety glasses with side shields.

Gloves:

When welding or cutting, you should always wear protective gloves. Leather is the material of choice. Your gloves are intended to shield your hands from UV rays, sharp objects, and welding spatter. Upon completing a weld, the material will be too hot to handle. Keep your gloves on until the components have cooled sufficiently.

Welding Hood:

The process of welding creates an arc which in turn creates harmful UV rays. The effects of the UV rays can cause permanent damage to your eyes if unprotected. To protect your eyes, use a shield with no less than a #10 rating. Bystanders should also wear protective safety glasses having no less than a #8 rating. Purchase an auto-darkening hood with an adjustable lens. Today, these are very affordable, and even the hobby welder should own one.

2 - Cutting Safety:

Chop Saw Safety:

A chop saw is a handy tool to have for cutting steel tubing and flat bar. Saws today are very affordable and will speed up the work on your project. Follow these tips for safe operation:

- Wear gloves when handling sharp or hot objects.
- Wear safety glasses and a face shield when operating the chop saw.
- Clamp the work securely and support both ends of the tubing.
- After cutting, de-bur your work with a small hand grinder to remove sharp edges.

Hand Saw Safety:

A hand saw can be used in place of a chop saw if your budget dictates. Follow these tips to keep your hands safe:

- Wear protective leather gloves when handling sharp objects.
- Use a vise or clamp to hold the work in place. Support both ends of the tubing or flat bar while cutting.

Cutting Torch Safety:

Chances are you will never pick up an OXY-Acetylene torch, but if at some point during the project you do, here are a few tips:

- Keep the torch tip clean at all times.
- Never use the torch head as a hammer.
- Remember this rule: "A before O, or up you go." Always turn on the acetylene only as you light the torch. To turn the torch off, close the acetylene valve on the torch first, followed by the oxygen.
- Inspect the acetylene tank for leaks prior to use.
- Open the acetylene valve on the tank just a ¼ turn, so it can be easily turned off in the event of an emergency.
- Keep the area clear of debris and ensure access to a suitable fire extinguisher.

3 – Types of Welding:

Below are some of the more common forms of welding. This manual is directed to the hobby welder who may be constructing a go-cart, ATV, stock car, or dune buggy. Therefore, the focus of the manual will be MIG welding (wire feed) and Stick Welding.

MIG welding, commonly known as “Wire Feed,” is one of the most common welding processes utilized today. A MIG welder is easy to use, very versatile, and provides excellent weld strength. A MIG welding machine pushes a small diameter wire through a welding lead to a torch head. The welding area is shielded by a curtain of inert gas, most commonly Argon. To adjust the heat range and penetration of a MIG weld, the voltage is adjusted.

A wire feed welder is the easiest form of welding to learn. Simply load a spool of wire on the arbor, connect the ground clamp to your work, and turn on the shielding gas. Just squeeze the trigger, and “voila,” you are welding. A wire feed welder has virtually an infinite range of adjustments. Therefore, you can change the settings to suit most any weld application or metal thickness including sheet metal from 10 GA all the way down to 28 GA.

Stick Welding, otherwise known as arc-welding, is designated as SMAW or Shielded Metal Arc Welding. A stick welding machine simply uses a negative ground wire and a positive conductor wire to complete the electrical circuit. A welding rod or “stick” is placed in the torch handle. The weld takes place as current flows from the positive wire lead through the welding rod to the grounded parent steel. The weld area is shielded by a layer of flux on the outside of the welding rod. To adjust the heat range and penetration of an Arc-Welder, the amperage is adjusted. A downside to stick welding is the need to chip off the remaining flux upon completion of the weld.

TIG welding is used for more intricate work and exotic materials. TIG is suitable for welding stainless steel, magnesium, and aluminum.

Brazing will not be suitable for your go-cart project but may come in handy for automotive sheet metal repair work. In brazing, an oxy-acetylene torch is used to heat up the base metal and a filler rod. The filler rod is mixed into a molten weld puddle. When the puddle cools, the parts are bonded together.

4 – Materials:

Use this chart to determine the thickness of material required for your project. Refer to your plans and purchase the appropriate raw material.

Gauge	Steel Thickness	Galvanized Thickness	Aluminum Thickness
22 Gauge	0.029	0.033	0.025
20 Gauge	0.035	0.039	0.032
18 Gauge	0.047	0.051	0.040
16 Gauge	0.059	0.063	0.058
14 Gauge	0.074	0.078	0.064
13 Gauge	0.089	0.093	0.072
12 Gauge	0.104	0.108	0.101
11 Gauge	0.119	0.123	0.090
10 Gauge	0.134	0.138	0.101
7 Gauge	0.179	0.183	0.144

As a hobbyist, you will most likely be welding mild steel only. Here we will briefly discuss materials and associated effects on welding procedures.

1010 & 1020:

These are commonly known as mild steel or low carbon steel. This material is easy to work with and provides adequate strength for most hobby projects. This will be the material of choice for the hobbyist.

4130:

This high-alloy material is much stronger than mild steel but is also much more expensive.

4340:

This grade of Chrome-Molly steel is ultra strong; however, upon completion of your project, the work must be heat treated. This makes this material non-usable for the hobbyist.

5 – Surface Preparation:

To ensure a good weld, it is imperative to begin with a clean surface. Follow these guidelines:

- Remove any paint with a grinder or wire brush.
- Remove oil or grease with a solvent and a rag.
- Remove any loose rust with a grinder or wire brush.

Failure to clean the work area may result in a poor weak weld, spatter, and porosity.

SPIDERCARTS

6 - Step by Step Instructions for MIG Welding:

To master the art of welding, there are five basic principles to understand and conquer: current, arc length, torch angle, puddle manipulation, and travel speed. Master these, and you can begin to call yourself a welder.

Current determines the penetration of the weld. For thicker material, more current is required. Conversely, the current must be reduced for thinner material. On wire feed MIG welders the variable is voltage while on a stick welder the operator will adjust the amperage. Practice welding using various machine settings until you feel comfortable that you have achieved proper penetration and a proper weld.

Arc length is defined as the distance the arc must jump from the electrode to the base metal. Controlling the arc length is a function of wire speed, current settings, and torch position. If you set your wire feed speed correctly, the welding action creates a sound similar to frying bacon.

Torch angle can vary from position to position and welder to welder. A good rule of thumb is to hold the torch at an angle of 5 degrees to 15 degrees for flat welds and “pull” the weld. For vertical welds, it is best to “push” the weld uphill with the torch at an angle of 15 degrees.

Puddle manipulation is the key to ensuring a proper bond between the 2 objects that are being fused together. In order to adequately monitor the puddle, you must have a good view of the welding process. Be sure to place the torch and your helmet in a location that allows for a clear view of the puddle. Keep your electrode or wire in the leading 1/3 of the puddle at all times. Weaving your torch from side to side will push the puddle from side to side to ensure that both components are bonded. The weaving action can be a semicircle pattern, a “Z” pattern, or a figure 8 pattern. The weaving action should be no more than 3 times the diameter of the electrode.

Travel speed takes practice to master. If you move the torch too fast, your bead will be narrow and look like fish scales. If you move the torch too slow, your bead will be too wide. Refer to the illustrations in the “Perfect Weld” section to see the effects of travel speed.

MIG Welding Tips:

Select the proper wire diameter for your project. Use the table below to determine the best choice based on the thickness of material you intend to weld. In general, use smaller diameter wire for thinner projects, and use larger wire for thicker work.

MIG Wire Selection Chart				
Thickness of Material	Wire Diameter			
	0.024	0.030	0.035	0.045
24 Gauge	X			
22 Gauge	X	X		
20 Gauge	X	X		
18 Gauge	X	X	X	
16 Gauge		X	X	
14 Gauge		X	X	X
12 Gauge		X	X	X
3/16"			X	X
1/4"			X	X
3/8"			X	X
1/2"			X	X
Common size for go-carts, ATV's etc.				
reference only; results may vary in certain conditions				

A good rule of thumb for MIG welding wire speed is a setting of 1 amp for every .001" of thickness. For example, if you are welding material that is 1/8" thick, set the wire speed at 125 amps. Refer to the chart below for typical wire speed settings when welding 1/8" thick mild steel.

Wire Speed for MIG Welding 1/8" Thick Steel		
Wire Diameter	Setting	Approximate Wire Speed
.030	2 inches per amp	2 x 125 amps = 250 IPM
.035	1.6 inches per amp	1.6 x 125 amps = 200 IPM
.045	1 inch per amp	1 x 125 amps = 125 IPM
reference only; results will vary for specific conditions		

For the hobby welder, the shielding gas of choice for mild steel welding is a mix of 75% argon and 25% CO2. If you will be welding aluminum, use 100% argon as a shielding gas. Refer to the chart below for shielding gas selection.

Shielding Gas Selection for MIG Welding		
Welding Wire	Gas	Usage
Solid Carbon Wire	CO2	Good for deep penetration.
Solid Carbon Wire	C25 - 75% Argon 25% CO2	Most common MIG gas, less spatter, better bead appearance.
Flux Core	no gas required	Outdoor welding, dirty conditions.
Aluminum	Argon	Welding Aluminum
Stainless	Helium or Argon/CO2 mix	Welding Stainless Steel
reference only; results will vary for specific conditions		

7– Step by Step Instructions for Stick Welding:

For the most part, the principles of MIG welding apply to stick welding. Refer to the previous section and review the 5 basic principles of welding.

One unique step that applies to stick welding is the art of striking an arc. For the novice welder, this can be a difficult challenge to overcome. Think of it as striking a match. Drag the electrode along the surface of the metal to strike an arc. You may also need to tap the electrode against the surface to break the flux at the tip of the electrode.

For the novice, you can practice this on scrap metal. While in practice mode, you can increase the current which will make it easier to strike an arc without the rod sticking to the metal. If the rod does stick to the metal, quickly move it back and forth to break the rod off.

One rod that is particularly susceptible to slag build up and is difficult to restart is 7018. To alleviate this problem, keep a file handy to scrape the tip of the rod when a restart is required.

Electrode Selection:

Beginner welders may find that a 6013 rod is easy to use. Once you master the art of welding, you should consider using 7018 rods for greater strength.

Common Stick Welding Electrodes		
AWS Class	Usage	Tensile Strength
A6011	Great for repair work on older, slightly rusty, painted, or galvanized surfaces.	60,000 psi
E6013	Great for filling gaps in poor fitting components. All purpose, easy to use.	60,000 psi
E7014	Commonly used when low or light penetration is acceptable but high filler deposit is required.	70,000 psi
E7018	A versatile, high strength, easy to use, all position welding rod.	70,000 psi
E7018AC	A specialty rod developed for the hobbyist using a low voltage 208/230 volt machine.	70,000 psi

Machine Settings:

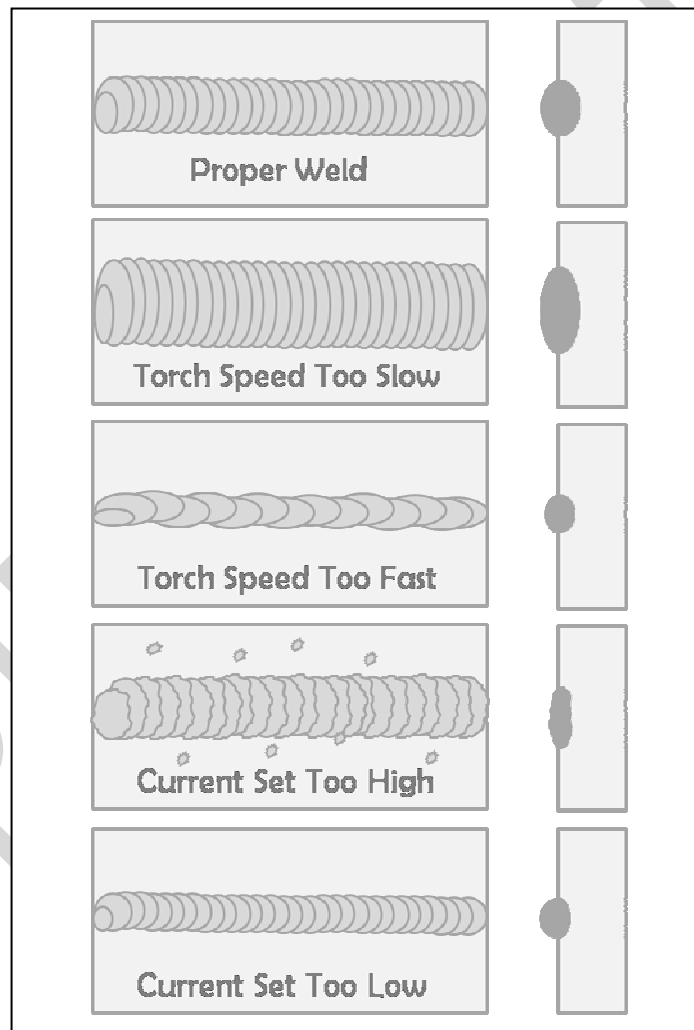
With experience, you will learn the proper settings and rod selection for your application. The table below is a quick guide to get you started:

Amperage Guide for Stick Welding		
Electrode Diameter	Thickness of Material	Amperage Range
1/16"	20 GA to 1/16"	40 to 80
3/32"	1/16" to 1/8"	60 to 100
1/8"	1/8" to 1/4"	80 to 140
5/32"	1/4" to 3/8"	120 to 180
3/16"	3/8" to 1/2"	160 to 220
1/4"	1/2" to 1"	200 to 300
reference only; results will vary for specific conditions		

8 – The Perfect Weld

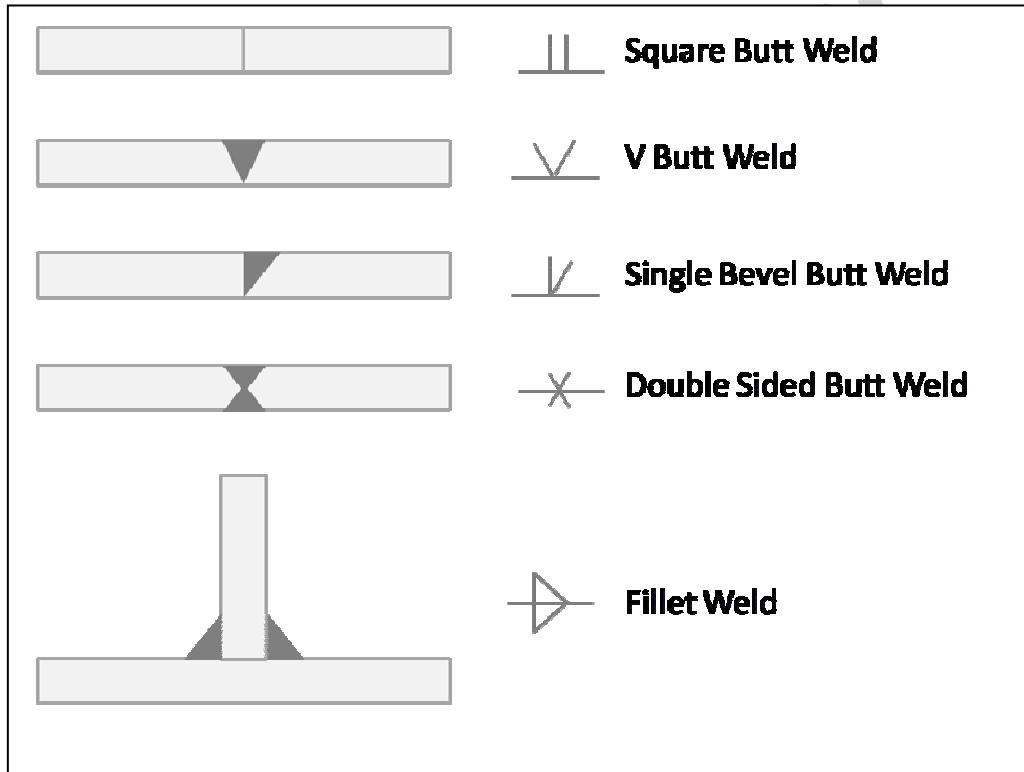
A perfect weld is a weld with good penetration, consistent pattern, no weld spatter, and has properly tied in the 2 components being welded together.

The hobby welder will not have access to a lab with fancy testing equipment to x-ray your welds and perform destructive testing. Refer to this visual guide to determine the quality of your weld.



9 – Typical Weld Joint and Welding Symbols:

The plans you purchase may include weld symbols. Use this guide to determine the type of weld required. For thicker material $\frac{1}{4}$ " and up, be sure to bevel the edges of the plate to ensure adequate penetration of the weld.



10 – Practice, Practice, Practice:

While this section of the guide is short, it is an area you should spent the most time in initially. As a novice welder, your welding will improve with practice, both ascetically and structurally.

Find scrap metal and practice, practice, practice. Take 2 pieces of scrap metal, weld them together and perform a simple destruction test. Place the metal in a vise and fold it back and forth or strike it with a hammer until the two parts are separated. If the weld is proper, the metal will tear yet the bead of weld will still be intact.

It the weld breaks before the parent metal tears, its back to the drawing board. Practice, practice, practice until you master the art of fusion.

Testing your practice work is probably the most import step to complete prior to working on your final welding project. The last thing you want to do is to run 50 MPH in your new go-cart or ATV and have a poor weld break.

It is important to note that a pretty weld is not necessarily a structurally sound weld. You as the welder must view the weld puddle to ensure that you are properly tying in the two components. You must learn to set the heat high enough for adequate penetration of the parent metal.

11 – Quick Tips, Tricks, and Solutions:

Aluminum Welding – Use 100% argon as a shielding gas. Push the weld puddle when welding aluminum.

Bead too Narrow with Fish Scale Appearance – Torch speed too fast.

Bead too wide – Torch speed too slow.

Can't Strike an Arc – Check for proper ground. Remove slag at the end of welding rod.

Erratic Stick Welding – Welding rods may be wet. Store your welding rods in a sealed plastic bag. Another option is to store the rods in a warm oven at low temperature.

Filling Large Gaps – For stick welding, lay another rod in the gap to use as filler material. Be sure to remove the flux first. Or you can feed the second rod with your other hand. Be sure to wear well-insulated, dry gloves or use a spare torch head to hold the rod. For MIG welding, you can pulse the trigger to fill the gap, then make another pass over the weld to tie it all together.

Overhead Welding – Reduce the current by 10% to 20%. Reduce the torch angle to near zero or up to a maximum of 5 degrees.

Porosity – Reduce voltage, increase shielding gas pressure or replace empty shielding gas bottle. Remove grease, dirt, paint, or other debris prior to welding.

Spatter – Current set too high, reduce voltage. Wire speed too high, reduce wire speed.

Undercut – Reduce the current, use a smaller wire or electrode.

13 - Glossary of Terms:

Argon – The common shielding gas utilized in wire feed MIG welding applications.

Acetylene – The common fuel used in a cutting torch application.

AC – Alternating Current

Chrome-Molly Steel – High strength 4130 or 4340 steel alloy with a high content of chromium and molybdenum.

DC – Direct Current.

IPM – Inches per minute.

MIG – Metal inert gas welding, commonly known as wire feed welding.

Mild Steel – Grade 1010 and 1020 steel, commonly used for fabrication. Mild steel has carbon content in the range of .15 percent to .25 percent.

Porosity – Small holes or pockets in the surface of the finished bead of weld.

Splatter – Molten metal that is blown out of the weld puddle and forms tiny balls or marbles that stick to your finished product.

Tensile Strength – The amount of pressure required to break a weld that has an area of one square inch.

TIG – Tungsten inert gas welding.

Undercut – The area adjacent to the bead of weld is cut below the surface of the parent structure.

Credits

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Cover & eBook Graphics by Digital4u2

I hope this guide has helped any beginner welders out there. Though I know it won't be much use to those of you that might be more advanced, we wanted to provide a "quick-start" guide to our customers that have never welded before. We here at Spidercarts have a passion for Go Kart projects and hope you will enjoy your project as well. But as always be careful and be informed!

Thanks,

Robert Dicken