WELDING
TOGETHER

MATRIX's TIG
Guideline

MATRIX 2200 AC/DC
MATRIX 3000 AC/DC
MATRIX 4100 AC/DC
MATRIX 5100 AC/DC

No 220321

Should you have any doubt or clarification not described in this guide, you can contact CEA S.p.A. at any time: we'll be pleased to assit you.

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TECHNICAL HINTS

MATRIX's AC/DC

2200, 3000, 4100, 5100

FITTED WITH 377244 PCB SERIES

Highly technologically advanced, robust, equipped with an innovative digital control panel, these power sources allow high quality TIG welding; they also offer excellent performance in MMA welding.

OVERVIEW

TIG welding is a clean process. The welder must maintain good welding conditions by properly cleaning material, using clean filler metal and clean welding gloves, and by keeping oil, dirt and other contaminants away from the weld area. Cleanliness cannot be underestimated, particularly on aluminium and magnesium. These metals are more susceptible to contaminants than are ferrous metals.

TIG process has some ***important advantages***:
- Narrow concentrated arc;
- Able to weld ferrous and no-ferrous metals;
- There is no slag to obscure the welder's vision of the molten weld pool;
- Uses a shielding gas to protect the weld pool and tungsten;
- A TIG weld should have no spatter;
- TIG produces no fumes but can produce ozone;
- The TIG process is a highly controllable process that leaves a clean weld which usually needs little or no finishing at all.

Just a ***few disadvantages***

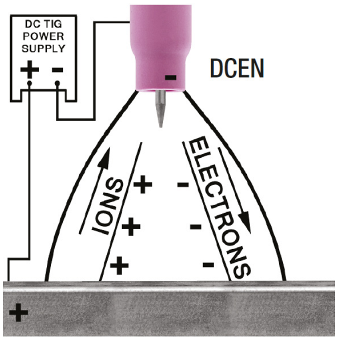
The main disadvantage of the TIG process is the low filler metal deposition rate in manual mode. Another disadvantage is that the hand-eye coordination necessary to accomplish the weld is difficult to learn, and requires a great deal of practice to become proficient.

The TIG welding process is so good that it is wisely used in the so-called high-tech industry applications such as:
- Nuclear Industry
- Aircraft
- Food industry
- Maintenance and repair work
- Some manufacturing areas

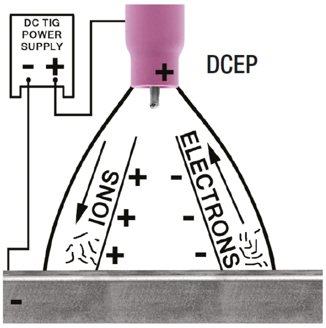
CURRENT TYPES

There're three choices of welding current type and polarity; they are:

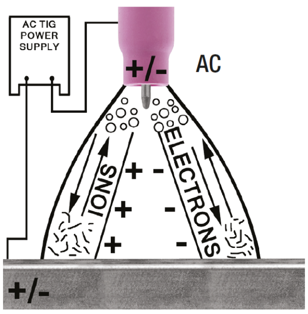
- Direct Current Electrode Negative - **DCEN**
- Direct Current Electrode Positive - **DCEP**
- Alternating Current - **AC**.



DCEN (DC-) is the most common mode of operation and is widely used for welding all carbon, alloy and stainless steels, as well as nickel and titanium alloys. Copper alloys, with the exception of those containing aluminium in significant amounts, can also be welded with this polarity. DCEN produces deep penetration because it concentrates the heat in the joint area. No cleaning action occurs with this polarity. The heat generated by the arc using this polarity occurs in the workpiece, thus a smaller electrode can be used as well as a smaller gas cup and reduced gas flow. The more concentrated arc allows for faster travel speeds.



DCEP (DC+) produces good cleaning action as the argon gas ions flowing toward the work strike with sufficient force to break up oxides on the surface. Since the electrons flowing toward the electrode cause a heating effect at the electrode, weld penetration is shallow. Because of the lack of penetration and the required use of very large tungsten, continuous use of this polarity is rarely used for TIG.

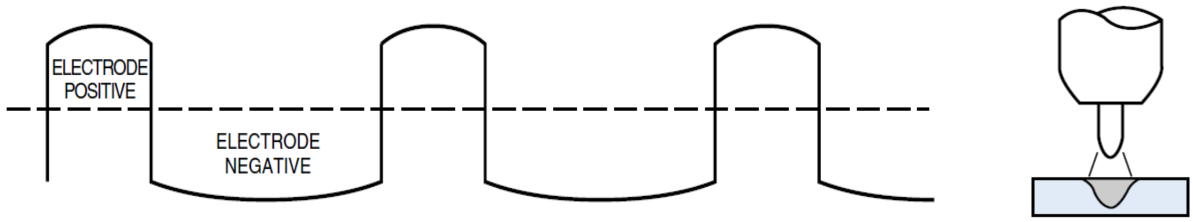


AC Alternating current is actually a combination of both electrode negative and electrode positive polarity.
It combines the good weld penetration of DCEN with the desired cleaning action of DCEP.
Medium size tungstens are generally used with this process.

Each of these current types has its applications, its advantages, and its disadvantages.
A look at each type and its uses will help the welder select the best current type for the job.

- **DCEN** (DC -) mainly used on: Stainless Steel, Mild Steel, Nickel, Copper, Titanium
- **DCEP** (DC+) mainly used on: Thin Material
- **AC** mainly used on: Aluminum, Magnesium and its alloy.

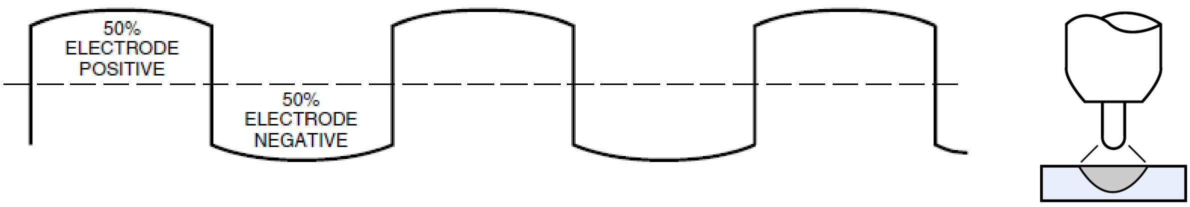
BALANCE WAVE CONTROL ADVANTAGES



MAX PENETRATION

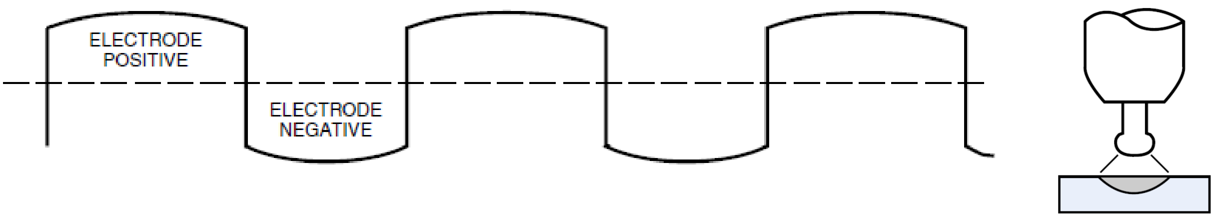
The waveform has been set to an unbalanced condition, this allows more time in the negative half cycle where current flow is from the electrode to the work. This produces more heat into the work and consequently deeper penetration.

- Can use higher currents with smaller electrodes
- Increased penetration at a given amperage and travel speed
- Use of smaller gas cup and reduced shielding gas flow rate.
- Reduced heat input with resultant smaller heat affected zone and less distortion.



BALANCED

It's when the balance control is set to produce equal amounts of time electrode negative and electrode positive. The waveform has been set to balanced. This allows equal time on each of the half cycles. Arc cleaning action is increased.



MAX CLEANING

It's when the balance control is set to produce the maximum time at electrode positive and minimum time at electrode negative. The wave Form has been set to an unbalanced condition. Only a certain amount of total cleaning action is available, and increasing the time in the electrode positive half cycle will not provide more cleaning and may melt the tungsten, and damage the torch.

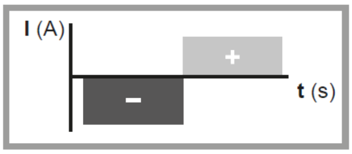
BALANCE PLUS

Possibility of independently adjust both ***current time (t)*** and ***its amplitude (A)*** while staying in either positive or negative polarity, by offering a perfect control of penetration and arc cleaning with a drastic reduction in lateral undercuts.

HOW-TO adjust the **current time**?

First you have to press AC Wave Balance and Frequency button once for adjusting the **time** of the Balance (-35 ÷ +10) as below shown:

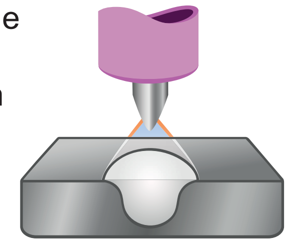
Display	-	+
0	50%	50%



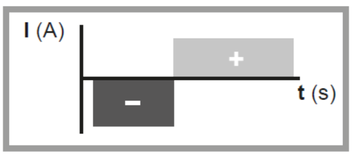
This setting (balanced) produces equal amounts of time electrode negative and electrode positive. Arc cleaning action is increased.

Display	-	+
-35	85%	15%

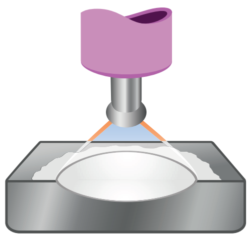
This adjustment reduces the balling action of the electrode and helps to maintain the point.
You get deep and narrow penetration, narrow bead with no visible cleaning.



Display	-	+
+10	40%	60%



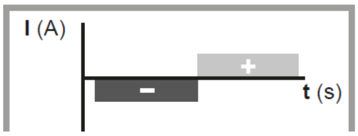
This adjustment increases the balling action of the electrode.
You get shallow penetration, wider bead and high cleaning action.



HOW-TO adjust the **amplitude**?

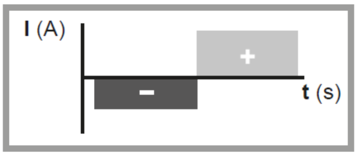
Press once again the key to adjust amplitude of the current (-50 ÷ +20)

Display	-	+
0	100%	100%

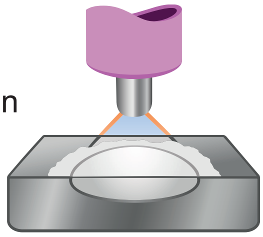


This setting (balanced) produces equal amplitude of electrode negative and electrode positive.
Arc cleaning action is increased.

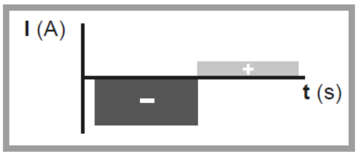
Display	-	+
+20	80%	120%



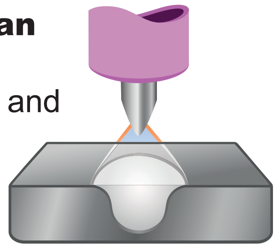
More curent in EP than EN
you get shallower penetration and minimized balling action of the electrode.



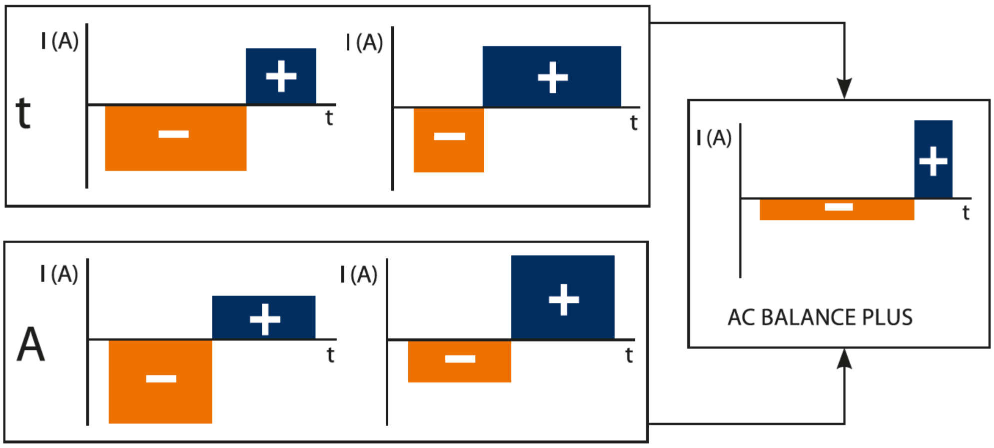
Display	-	+
-50	150%	50%



More current in EN than EP
you get deeper penetration and faster travel speed.



Below find an example of what you can do with **BALANCE PLUS,** as you can see the AC wave form is completely "customized" to your needs. This is a very powerful feature in your hands to achieve a total adjustment of the wave form for a very precise control of the heat input to the work piece and the electrode.



FREQUENCY CONTROL IN AC

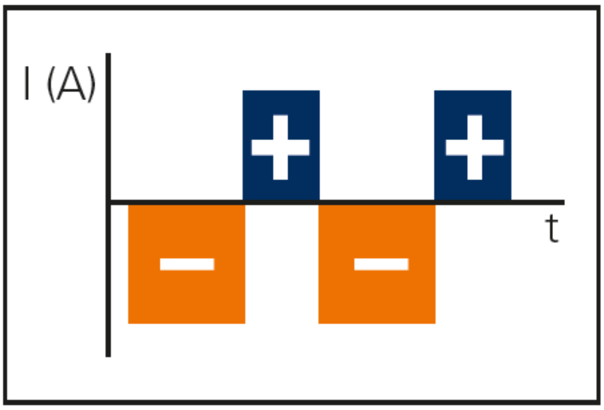
Frequency adjustment of the various AC wave shapes for better directional control, reduction of the thermally altered area, deeper penetration and electrode lower wearing out.

Advantages:

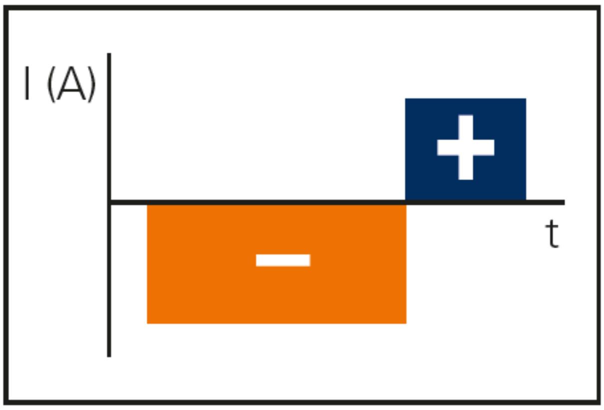
- Higher frequency yields narrower arc
- Higher frequency increases penetration
- Lower frequency widens arc
- Lower frequency produces a softer less forceful arc

In summary Mind that:

High level frequency enables to weld very thin material with excellent results. It gives you a narrower bead.
The frequncy can be adjusted up to 250Hz.

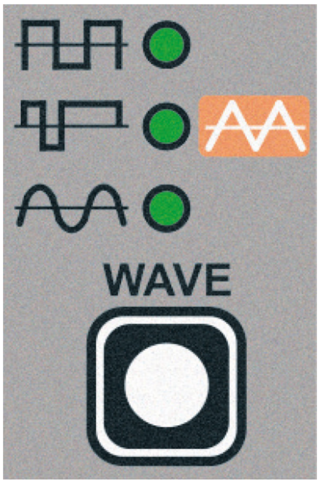


Low frequency (min 40 Hz) is ideal for medium thickness or whenever edge preparation is not accurate. It provides you a wider bead and good penetration.



WAVE SHAPES
SPECIAL TIG FUNCTIONS

WAVE SHAPE CONTROL IN AC

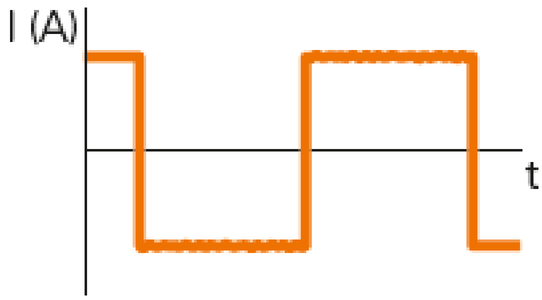


DYNAMIC TIG - Square wave: high arc dynamics for all applications.

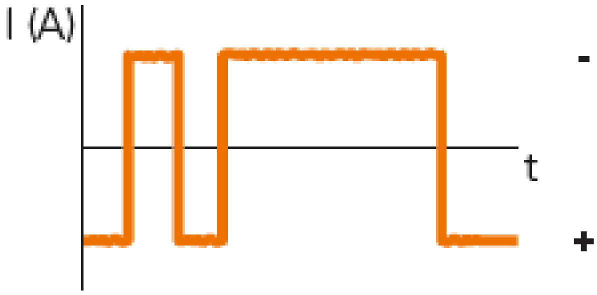
SPEED TIG - Mixed wave: optimal penetration at high welding speed and low consumption of the electrode.

COLD TIG - Triangular wave: low heat transfer with reduced deformation, ideal for small thickness.

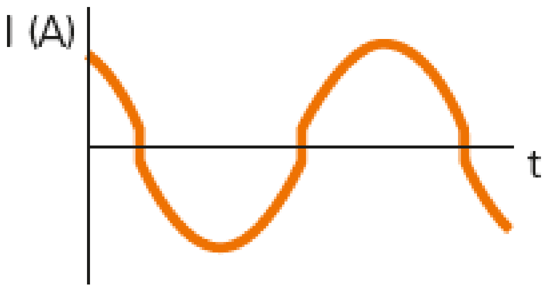
SOFT TIG - Sinusoidal wave: smoother and softer arc with a reduced noise, ideal for medium thickness; very useful for but welding too..



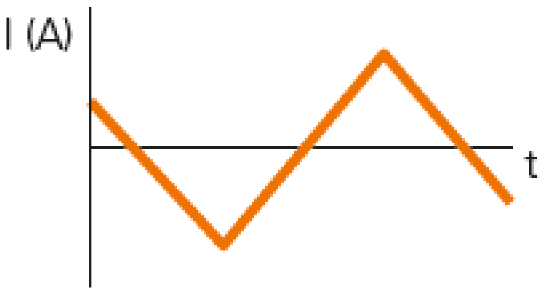
DYNAMIC TIG



SPEED TIG



SOFT TIG



COLD TIG

PULSE function

Some advantages of PULSE TIG:

- Good penetration with less heat input
- Less distortion
- Good control of the pool when welding out of position
- Ease of welding thin materials
- Ease of welding materials of dissimilar thickness

The main advantage of the Pulsed TIG welding arc is that the process produces the same weld as a standard arc, but with considerably less heat input. As peak amperage is reached, penetration is quickly achieved. Before the workpiece can become heat saturated, the amperage is reduced to the point where the pool is allowed to cool but current is sufficient to keep the arc established. The pulsed arc greatly reduces the need to adjust heat input as the weld progresses. This gives the welder much greater pool control when welding out of position and in situations where joints are of differing thicknesses.

The basic controls for setting pulse parameters are:

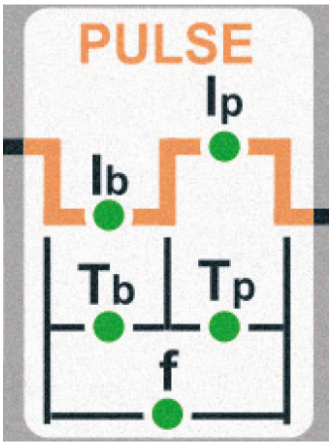
- **Ip** (Peak Current) - This value is usually set somewhat higher than it would be set for a non-pulsed TIG weld.

- **Ib** (Base Current) - This of course would be set lower than peak amperage.

- **f** (Pulses Per Second) - It's the number of times per second that the weld current achieves peak amperage.

- **Tp** (Time Peak Current) - Is the pulse peak duration. It controls how long the peak amperage level is maintained before it drops to the base value current.

- **Tb** (Time Base Current) - It's the pulse base duration. It controls how long the base current level is maintained before it goes up to the peak pulse value current.



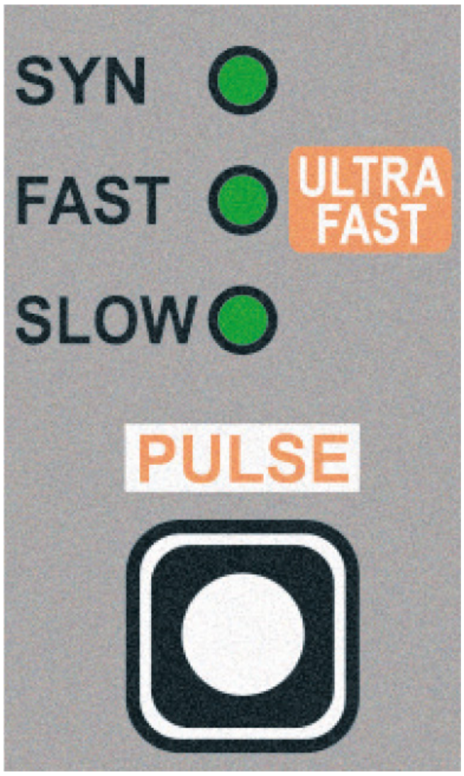
4 Pulse mode TIG

... are you a beginner? Choose **SYN**
To sinergically generate pulse parameters in function of chosen peak current! (DC)

… reduced arc cone? Choose **FAST**
Up to 500 Hz in TIG DC will give you a more concentrated arc cone!

…welding thin sheets? Choose **ULTRA FAST**
Up to 2000 Hz in TIG DC will allow you a greater reduction of the thermally altered area with contained deformation on very thin sheet!

…better finishing? Choose **SLOW**
To have both peak and base current time individual adjustments for an optimal filler deposition and good finishing! (AC & DC)



“SYN PULSE” facility, in function of the chosen peak current, in a simple and automatic way will synergically generate both an adequate pulse frequency and a base current, both readjustable in a synergic way. Pulse parameter values, preselected in the control, will save setting time, by ensuring the best possible pulse parameter combinations, ideal for less skilled welders.

ULTRA FAST - The advantage of high-frequency pulsing (from 500 up to 2000 pulses per second) is that the high-frequency pulse provides a much “stable” arc; the arc is less subject to wandering caused by magnetic fields (arc blow). Welding with higher frequencies has also proven beneficial by producing better agitation of the weld pool which helps to float impurities to the surface resulting in a weld with better metallurgical properties. High-frequency pulsing is used in precision mechanized and automated applications where an arc with exceptional directional properties and stability is required. It is also used where a stable arc is required at very low amperages.

P.S.: The pulsed waveform is often confused with the AC or Squarewave. The Squarewave or AC represents direction of current flow in the welding circuit, while the pulsed waveform represents the amount and duration of two different output levels of the current. The pulse waveform is not a AC wave at all. This is not to say that Squarewave cannot be pulsed between two different output levels, MATRIX machines have the possibility to choose SLOW Pulse mode even AC.

coldTACK

coldTACK is an innovative spot welding function to achieve precise and safe joining with a minimal thermal input. Each single coldTACK can be formed by one or more current peaks of current in a rapid sequence, this peak sequence allows a further reduction of the heat transfer and grants to realize o more precise and flatter spot on the welding join.

The machines mentioned in this quick guide are also fitted with normal Spot Welding, pls. refers to the User's Manual to get information about it.

However, in this chapter we'll talk about **coldTACK** function and **RTC** welding process.

Once "**coldTACK**" is activated, then the ignition of the arc can be obtained by means of HF or by "**Perfect-Point**" function, which allows you to obtain the most precise spot positioning.

How does **Perfect-Point** work?

It's simple, touch the workpiece with tungsten tip at the exact point at which you wish to do the tack, then press and keep it pressed the torch trigger, afterwards lift up the torch. **Perfect-Point** function it'll be automatically activated granting you a cold tack at the correct distance from the wished point.

Don't get confused with the "Lift-Arc" mode, **Perfect-Point** is faster, colder and allows you a perfect control of the heat input and no tungsten inclusion (no current during touching time) ...much more!

What's **coldTACK?**

The expression “**coldTack** ” refers to a temporary spot welding used to create the initial joint between two pieces of metal being welded together.
Let’s use a "basic" welding exercise to demonstrate how coldTack works.

Let's assume you’re going to weld two pieces of steel together; once you have your pieces in the required position (typically using a C-clamp), make two short welds at either ends. These two tack welds hold the pieces together, then you can complete the joint by a welding bead.
Even though these two tack welds are just the initial part of the process, the welds should be sound, considering they provide the foundation for the entire joint. Therefore, in case of not safe tacks, you may need to reposition your pieces causing a plenty of wasting time because of their repositioning.

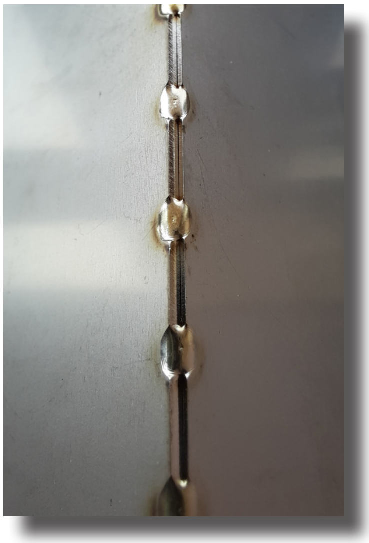
To avoid any inconvenience like that, you need to get a precise and safe joining, at this end **coldTACK** function grants all what you need whenever secure and fast tacking is your goal.... moreover, it also grants a strong welding joint with minimal thermal input.

As you know, being you a welder, during the joining of the pieces, you are not always in a comfortable position, it's therefore very important that the welding joint is carried out very quickly and in the required point. Thanks to **coldTACK**, this is much easier vs with traditional spot-welding methods.

In addition, the welding joint obtained from **coldTACK**, is very small and flat, therefore when making the welding pass there's won’t be any signs that the piece has been pre-spot welded.

coldTACK

CEA coldTACK



These pictures are self-explanatory,
coldTACK joints are much more:

- colder
- smaller
- flatter

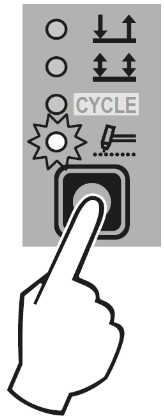
conventional tack

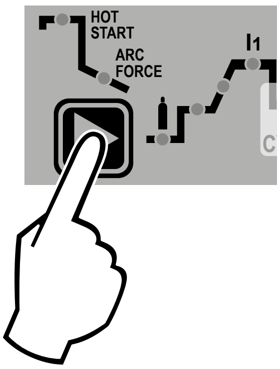
So, let’s see now HOW-TO set **coldTACK**”.

First keep in mind that this function is available just in <u>TIG DC HF</u> mode only, therefore you have to set the machine in this way.

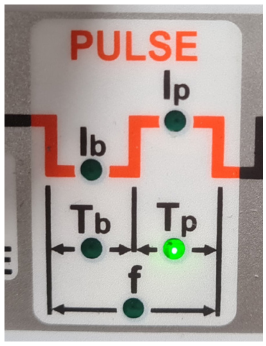
Then, press the key till the LED of Spot Welding / ColdTACK is flashing, as shown by the picture here beside;
HF DC LED mode will start flashing too.

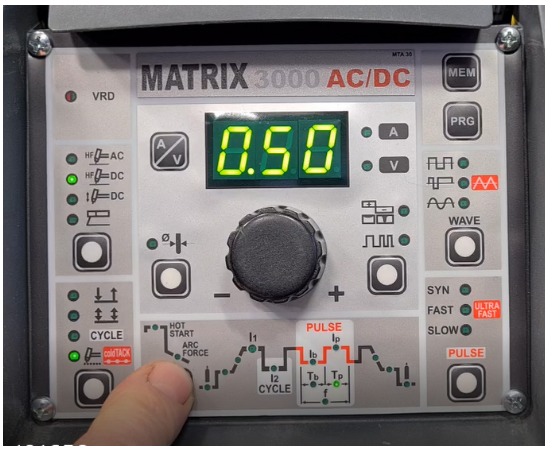
Flashing



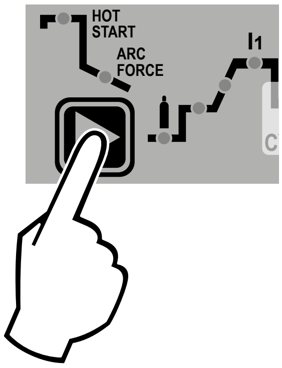


Press and release the welding parameter selection key,then "**Tp**" LED will start flashing and afterwards by the encoder you have to select the total time (0,01 ÷ 1,0 s) of ColdTack function.

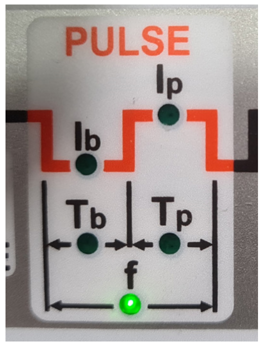




coldTACK



Press again the welding parameter selection key as shown by the picture, "**f**" LED will lit, afterwards by the encoder you have to select how many <u>Cold-TACK Pulsations</u> (from 1 to 10) will be repeated according to the previously chosen time.



For instance: if you set "**Tp**" as 1 s and you set "**f**" at n 5 ... that means the cold-TACK pulse will be repeated 5 times in the time of 1 s.
Below find a few example of SETTING for stainless steel by **coldTACK**

Thickness: **0.8 mm**
Current: 180 ÷ 190 A
Pulsation Total time: Tp 0.1 s
Time of the pulse: Tb (n 5)

Thickness: **1.0 mm**
Current: 190 ÷ 200 A
Pulsation Total time: Tp 0.1 s
Time of the pulse: Tb (n 5)

Thickness: **1.2 mm**
Current: 200 ÷ 210 A
Pulsation Total time: Tp 0.1 s
Time of the pulse: Tb (n 5)

Thickness: **1.5 mm**
Current: 210 ÷ 220 A
Pulsation Total time: Tp 0.15 s
Time of the pulse: Tb (n 8)

TIG RCT

TIG RCT allows to weld in TIG to realize very cold welding seams.

RCT is the acronyms of **RUNNING COLD TACK**; indeed, the TIG RCT process allows to benefit of all the coldTACK advantages, by repeating the single coldTACK point in a continuous way, in order to achieve a cold and perfect welding seam.

Using TIG RCT the welding seam is much colder in comparison to the one achievable with Pulse TIG and it represents the ideal solution to weld thin materials with a very low heat transfer.

- **RCT** is a direct current process, therefore it's not available in AC welding.
- **RCT** is very useful up to 1.5 mm material thickness, over this threshold we advise you to use Pulse mode instead.
- **RCT** Welding Mode is available both in 2 and 4 stroke, but it's not available in all PULSE modes.
- **RCT** allows you to stay at the initial and final current for an arbitrary length of time. During the initial and final current phases, the power supply is constant and not intermittent, making it possible to heat the workpiece up sufficiently before beginning to weld.
- **RTC** allows you to set slope-up and slope-down ramps (not possible in Spot welding), the current is as applied in the settings.

Once “**RTC**” has been activated, then the ignition of the arc can be obtained by means of "HF" or by “**Perfect-Point**” function, which allows you to obtain the most precise spot positioning.

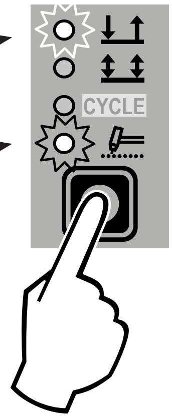
Thanks to the “Perfect-Point” mode, perfect centring of the welding point is guaranteed.

So, let’s see now HOW-TO set **RCT**

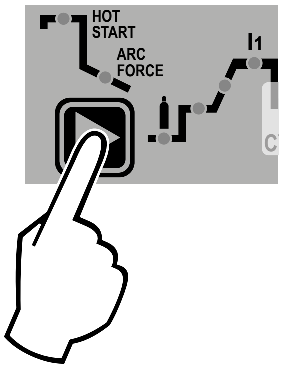
Press again the welding parameter selection key till you get the condition as shown by the picture on the right. In this way the machine is set in **2T** with **RCT** welding mode.
So, till you keep pressing the torch trigger, the machine will keep on welding by RTC mode till you release your finger from the trigger ... that's not all: you can set the pause working time too.

steady ON

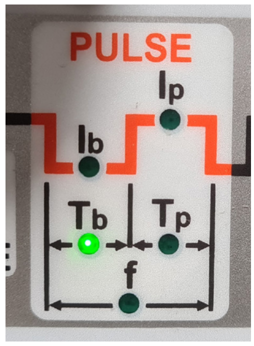
Flashing

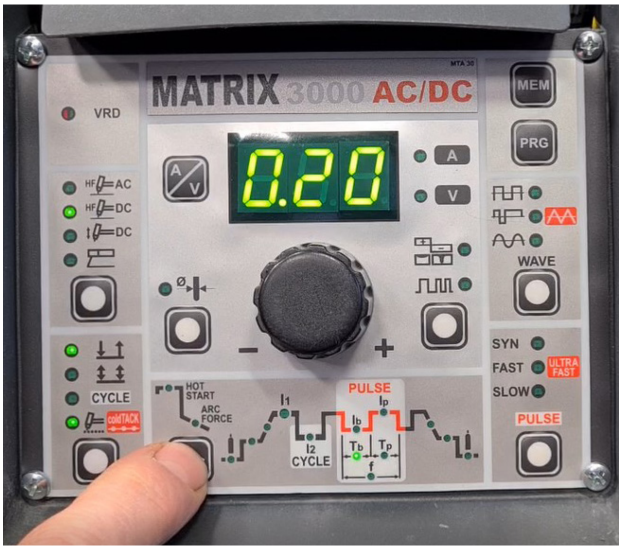


How to set **Pause Working time**?



Press again the welding parameter selection key as shown by the picture "**Tb**" LED will lit, afterwards by the encoder you have to select the Pause Time (from 0,1 to 2,0 s).
Then keep pressed to key to get out from programming mode and start welding.

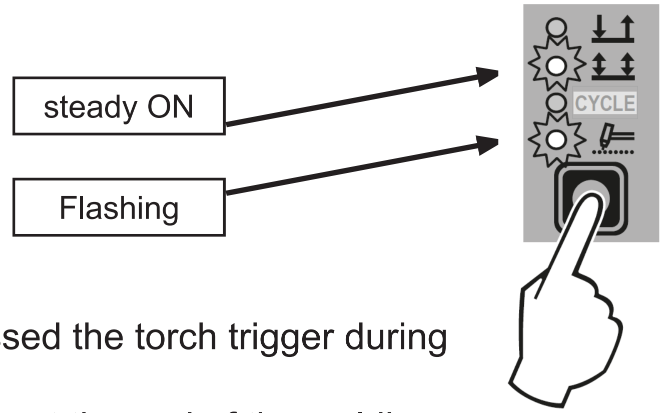




As you can understand, you don't have to keep on pressing/releasing the trigger to start and stop RCT welding mode, just press the trigger as long as you need.

If you feel uncomfortable keep on pressing the torch trigger during the welding, than you can set **4T.**

How to set it **RCT** - **4T**?



Press again the welding parameter selection key till you get the condition as shown by the picture. In this way the machine is set in **4T** with **RCT** fwelding mode.
By this selction, you don't have to keep pressed the torch trigger during the welding process.
If you hold the torch trigger at the begining or at the end of the welding cycle, then you can use **Initial** and **Final current** which can now be set from min (now 1A) to the max welding current of the machine being in use. Otherwise, if ypou simply press and release the trigger, then you start the welding cycle; afterwards to stop it, then quicky press and release it.

Pause Welding time can be set as per **RCT** - **2T**

TIPS: If you need <u>stronger welding tack</u>, then you have to modify one-by-one the below listed parameters (starting from the first, then if it’s not enough from the second and so on)

1) Increasing the Welding Current
2) Increasing Pulsation Total Time
3) Decrease the number of the pulsation ("n") by "Tp" parameter

RUNNING COLT TACK
settings

Below find just a few examples, as you can understand the aim of this table is just to provide you a preliminary setting, then after you have to set them according to your needs.

- Pre-gas: 0,3 - 0,5 s

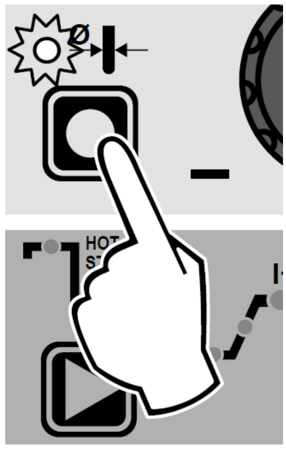
TIPS: you may need.....
- We advise you to use 2,4 tungsten diameter – WL2 Lanthanum 2%
- The electrode tip must be placed very close to the work piece: 1.0 ÷ 1.5 mm
- Electronic mask with a good “sensitivity”
- Don’t exceed with the current, otherwise you cannot maximize **RCT** advantages.
- When the machine is set in 4T, min. welding current acts like Pilot Current to help you during starting phase.

If you set 4T:
- Min current: 10 A
- Slope up/down: 0.0
- Final current: 10A

Frequency rate between Tp & Tb
- Tp 0,35 - Tb 0,65 = 1,0 HZ
- Tp 0,22 - Tb 0,32 = 1,5 HZ
- Tp 0,07 - Tb 0,08 = 2,0 HZ

Material	Thickness [mm]	butt weld [A]	Fillet Weld [A]	N	Tp	Tb
Stainless / Mild Steel	0,8	50 - 60	60 - 80	1	0,22	0,32
Stainless / Mild Steel	1,0	70 - 80	80 - 100	1	0,22	0,32
Stainless / Mild Steel	1,5	80 - 90	100 - 110	1	0,22	0,32
Stainless / Mild Steel	2,0	100 - 110	110 - 120	1	0,22	0,32
Stainless / Mild Steel	2,0	120 - 130	130 - 140	1	0,22 - 0,13	0,32 - 0,16
Stainless / Mild Steel	0,8	60 - 70	70 - 90	2	0,22	0,32
Stainless / Mild Steel	1,0	80 - 90	90 - 110	2	0,22	0,32
Stainless / Mild Steel	1,5	90 - 100	110 - 120	2	0,22	0,32
Stainless / Mild Steel	2,0	110 - 120	110 - 120	2	0,22	0,32
Stainless / Mild Steel	2,0	130 - 140	140 - 150	2	0,22 - 0,13	0,32 - 0,16
Stainless / Mild Steel	0,8	70 - 80	80 - 100	3	0,22	0,32
Stainless / Mild Steel	1,0	90 - 100	100 - 120	3	0,22	0,32
Stainless / Mild Steel	1,5	100 - 110	120 - 130	3	0,22	0,32
Stainless / Mild Steel	2,0	120 - 130	130 - 140	3	0,22	0,32
Stainless / Mild Steel	2,0	140 - 150	150 - 160	3	0,22 - 0,13	0,32 - 0,16

ELECTRODE DIAMETER SETTING
synergic mode



Set the diameter of the electrode to achieve the best control of ignition in a **synergic** manner. Mind that this parame- ter sets the arc striking energy, according to the below table.

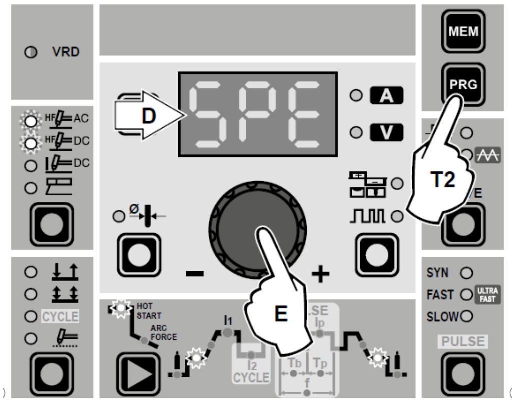
TIPS: you may need to get a low arc striking energy even if you are using not so low current, so you can set a small- er diameter than the one being used. i.e. For starting at the edge with low energy you can set it at 1.0 even if you're us- ing 2.0.
Mind that an excessive difference between the set electrode and the one used can make the arc striking difficult.

ELECTRODE DIAMETER [mm]	TIG HF AC welding process		TIG HF DC welding process	
	Arc Striking Current [A]	Arc Striking Time [ms]	Arc Striking Current [A]	Arc Striking Time [ms]
1.0	50	60	75	10
1.2	60	74	80	10
1.4	70	86	90	10
1.6	75	100	100	10
1.8	85	110	105	10
2.0	90	120	110	10
2.2	100	130	120	10
2.4	110	140	125	10
2.6	120	152	130	10
2.9	130	168	140	10
3.2	140	180	150	10
3.6	160	200	160	10
4.0	180	240	170	10

ADVANCED ARC STRIKING ENERGY SETTINGS
manual mode

The diameter of the electrode can be also MANUALLY set to achieve the best control of ignition in order to set the wished arc striking energy according to the application.

HOW-TO do it?
Activation will only take place after the machine configuration is changed from STANDARD (Std) to SPECIAL (***SPE***), which must be done as follows:



1) Set the machine OFF, push and hold the “PRG” key (T2).
2) Switch the ON the machine.
3) The display (D) shows the following message: Std , then release the “PRG” key
4) Turn the encoder (E) until the display (D) shows the following message: SPE (machine configured in SPECIAL mode).
5) Press the “PRG” key (T2) to confirm.

At this point the machine is set in SPE mode which allows you to modify a few welding parameters, however in this section you’ll focus on HOW-TO “manually” set the arc striking energy only, pls. refer to the user manual for further information about other features. Mind that the “electrode diameter selction key” doesn’t work anymore in SPE mode.

Press and release the welding parameter selection key as shown by the picture here beside.
The Hot Start LED starts flashing and the display will show the factory defualt value (150) of the ***CURRENT***, or the last one set, of the Arc Striking Energy. Afterwards, by turning the encoder, the current can be set from the minimum up to the maximum of the machine as shown below.

MATRIX 2200 AC/DC	MATRIX 3000 AC/DC	MATRIX 4100 AC/DC	MATRIX 5100 AC/DC
5 ÷ 220	5 ÷ 300	5 ÷ 400	5 ÷ 500

If you press again the key, it'll be possible to set the ***TIME*** and the display shows ***t.01*** or the last one set, then by the encoder you can set it from ***t.01*** (0,01 s) up to ***t.50*** (0,5 s). pls. note that the TIME can be adjusted just in TIG AC mode!

TIPS: Mind that “too low” arc striking energy settings can make the arc striking difficult; so, ***BE AWARE when adjusting Arc Striking Current and Time!***

TUNGSTEN ELECTRODES

Electrodes made of tungsten and tungsten alloys are secured within a TIG torch to carry current to the welding arc. Tungsten is preferred for this process because it has the highest melting point of all metals.

The tungsten electrode establishes and maintains the arc. It is said to be a "nonconsumable" in that the electrode is not melted and included in the weld pool. In fact, great care must be taken so that the tungsten does not contact the weld pool in any way, thereby causing a contaminated, faulty weld. This is generally referred to as a "tungsten inclusion".

Tungsten electrodes for TIG come in a variety of sizes and lengths. They may be composed of pure tungsten, or a combination of tungsten and other elements and oxides.

Chemical Composition				
	Weight Percent			
AWS Classification	CeO_2	La_2O_3	ThO_2	ZrO_2
EWP	—	—	—	—
EWCe-2	1.8 – 2.2	—	—	—
EWLa-1	—	0.8 – 1.2	—	—
EWLa-1.5	—	1.3 – 1.7	—	—
EWLa-2	—	1.8 – 2.2	—	—
EWTh-1	—	—	0.8 – 1.2	—
EWTh-2	—	—	1.7 – 2.2	—
EWZr-1	—	—	—	0.15 – 0.40
EWG[d]	NOT SPECIFIED			

The diameter of tungsten electrode needed is often determined by the thickness of base metal being welded and the required amperage to make the weld.

Types of tungsten and tungsten alloy electrodes for TIG (GTAW) are classified according to the chemical makeup of the particular electrode types. The above figure shows the 8 types of electrodes classified by the American Welding Society.

In the first column: the letter "E" is the designation for electrode. The "W" is the designation for the chemical element tungsten.

The next one or two letters designates the alloying element used in the particular electrode. The "P" designates a pure tungsten electrode with no intentionally added alloying elements. The "Ce", "La", "Th", and "Zr" designate tungsten electrodes alloyed with cerium, lanthanum, thorium, or zirconium, respectively.

The number "1", "1.5" or "2" behind this alloy element indicates the approximate percentage of the alloy addition.

Electrodes are color coded for ease of identification, infact each stick of tungsten has a color applied to one end which identifies the material type of the tungsten.

COLOR CODES AND TYPES OF ELECTRODES

Tungsten	Color Code	Characteristics
Pure	Green	Provides good arc stability for AC welding. Reasonably good resistance to contamination. Lowest current carrying capacity. Least expensive. Maintains a balled end. Used on transformer based machines only.
2% Ceriated	Gray	Similar performance to thoriated tungsten. Easy arc starting, good arc stability, long life. Possible replacement for thoriated.
2% Thoriated	Red	Easier arc starting. Higher current capacity. Greater arc stability. High resistance to weld pool contamination. Difficult to maintain balled end on AC.
1.5% Lanthanated	Gold	Similar performance to thoriated tungsten. Easy arc starting, good arc stability, long life, high current capacity. 1.5% possible replacement for thoriated. 2% possible replacement for Pure.
2% Lanthanated	Blue	
.8% Zirconiated	White	Excellent for AC welding due to favorable retention of balled end, high resistance to contamination, and good arc starting. Preferred when tungsten contamination of weld is intolerable. Possible replacement for Pure.
LaYZr™	Chartreuse*	Best for use on automated or robotic applications. Runs cooler than 2% Thoriated with longer life. Low to medium amperage range.

*Substitute for Purple (Same oxide blend).

- **EWP** (100% PURE Tungsten, Green)
  These electrodes are unalloyed, "pure" tungsten with a 99.5%tungsten minimum. They provide good arc stability when using AC current, Pure tungsten electrodes are preferred for AC sine wave welding of aluminum and magnesium because they provide good arc stability with both argon and helium shielding gas. Because of their inability to carry much heat, the pure tungsten electrode forms a balled end.

- **EWCe-2** (2% Cerium, Grey (formerly range)
  Alloyed with about 2% ceria, a non-radioactive material and the most abundant of the rare earth elements, which gives them a better starting characteristic and a higher current carrying capacity than pure tungsten. These are all-purpose electrodes that will operate successfully with AC or DC electrode negative. Compared with pure tungsten, the ceriated tungsten electrodes provide for greater arc stability. They have excellent arc starting properties at low current for use on orbital tube, pipe, thin sheet and small delicate part applications.

- **EWLa-1** (1% Lanthanum, Black)
- **EWLa-1.5** (1.5%Lanthanum, Gold)
- **EWLa-2** (2% Lanthanum, Blue)
  Alloyed with non-radioactive lanthanum oxide, often referred to as lanthana, another of the rare earth elements. These electrodes have excellent arc starting, low-burn-off rate, arc stability and excellent re-ignition characteristics. The addition of 1 – 2% lanthana increases the maximum current carrying capacity by approximately 50% for a given size electrode using alternating current compared to pure tungsten. Compared to cerium and thorium the lanthana electrodes had less tip wear at given current levels. Lanthanum electrodes generally have longer life and provide greater resistance to tungsten contamination of the weld. Thus the lanthana electrodes work well on AC or DC electrode negative with a pointed end or they can be balled for use with AC sine wave power sources.

- **EWTh-2** (2% Thorium, Red)
- **EWTh-1** (1% Thorium, Yellow)
  Commonly referred to as 1 or 2% thoriated tungstens, these are very commonly used electrodes since they were the first to show better arc performance over pure tungsten for DC welding. However, thoria is a low-level radioactive material, thus vapors, grinding dust and disposal of thorium raises health, safety and environmental concerns. It is advised not to use thoriated electrodes since radioactive dust that can be incorpo-rated is released during welding as well as during grinding.

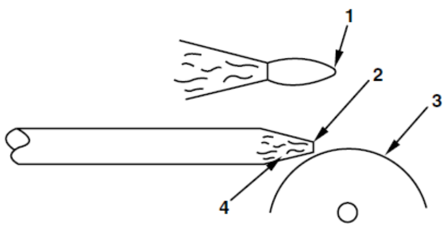
- **EWZr-1** (1% Zirconium, Brown)
  A zirconium oxide (zirconia) alloyed tungsten electrode is preferred for AC welding when the highest quality work is necessary and where even the smallest amounts of weld pool contamination cannot be tolerated. The current carrying capability is equal to or slightly greater than an equal sized cerium, lanthana or thorium alloyed electrode. Zirconium electrodes are typically used only for AC welding with a balled end.

- **EWG** (unspecified alloy, The manufacturer may select any color not already in usey)

TUNGSTEN ELECTRODE PREPARATION

Grinding Direction

We recommend to grind the electrode longitudinally. This kind of grinding causes an improved ignition and a more stable arc.
When electrodes are ground radially there is beside the inferior arc also a risk that small pieces of the electrode break off and get into the melt during welding.

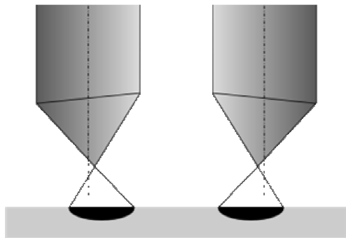


Ideal Tungsten Preparation – Stable Arc

1. Stable Arc
2. Flat
3. Grinding Wheel
4. Straight Ground

Centering

The tip should be ground centrically as far as possible. If this is not the case, however, the arc can be unstable and does not ignite on the correct point.



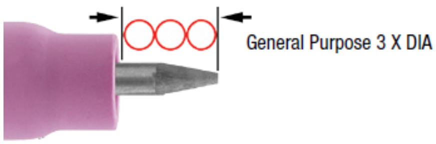
Angle

In conjunction with the diameter of the electrode the grinding angle has a decisive influence on the formation of weld and weld penetration.
The beside figure shows the relation between penetration profile and grinding angle at constant current and gas: If the electrode has a sharp tip, the entire energy is concentrated on a small area which causes a deep penetration. Whereas a blunt grinding angle causes that the same energy strikes a much larger area.
Thus, the arc and its penetration profile is a reflection of the grinding angle.

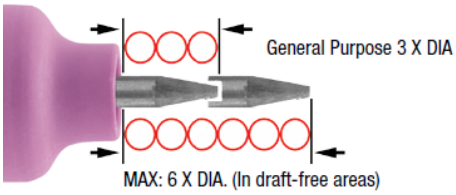
To improve the service life and to reduce the tip load it is rec-ommended to prepare a flat at the tip of the electrode after grinding. The tip resulting from it should have a diameter of about 10% of the electrode diameter; that means an electrode with diameter 2,4 mm should have a tip diameter of 0,24 mm.

USEFUL TABLES

STANDARD PARTS



GAS LENS PARTS



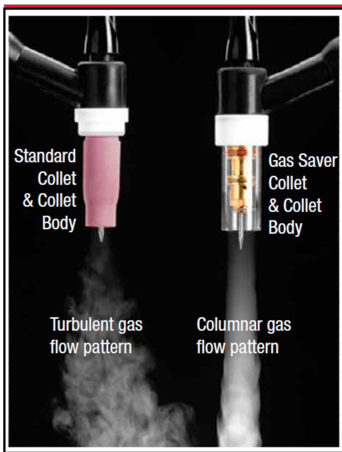
CUP CHART

ALUMINA
High impact resistance
Low thermal shock
(Aluminum Oxide)

CERAMIC
High thermal shock
Low impact resistance
(Lava)

SUPER CUP
High thermal shock
High impact resistance
(Silicon Nitride)

PYREX
High visibility
Low thermal shock
Low impact resistance
(Pyrex)



- 40% Argon savings
- Columnar flow gas pattern
- Longer electrode stick-out
- Lower gas flow rates
- Better visibility
- Longer parts life
- Cleaner welds

Recommendations for type of current and gas for different materials

Material	Direct Current		Alternating Current	Inert Gas	
	+	-		Argon	Helium
Unalloyed and alloyed steels		x		x	
Copper and copper alloys		x		x	x
Nickel and nickel alloys		x		x	
Aluminium and aluminium alloys	o			o	o
			x	x	x
		x			x
Magnesium and magnesium alloys	o			o	o
			x	x	x
Titanium, titanium alloys, zirconium, tantalum, molybdenum, tungsten		X		X	

x without restrictions; o only in case of thin walls; in case of direct current steels can also be welded with mixtures of argon/hydrogen, argon/helium and argon/nitrogen.

Recommendations for the choice of amperage for DC depending on tip angle and diameter

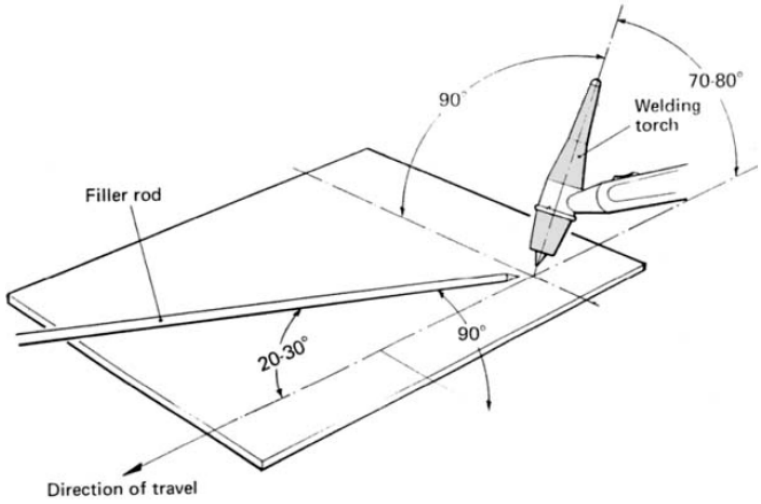
Diameter	15°	30°	45°	60°	75°
1,0 mm	5 – 20 A	10 – 30 A	20 – 80 A	–	–
1,6 mm	10 – 50 A	20 – 75 A	30 – 100 A	50 – 140 A	–
2,4 mm	30 – 50 A	20 – 90 A	30 – 140 A	50 – 180 A	80 – 230 A
3,2 mm	30 – 80 A	40 – 140 A	50 – 220 A	70 – 300 A	80 – 320 A
4,0 mm	50 – 100 A	50 – 150 A	60 – 250 A	70 – 350 A	90 – 450 A

Recommended amperage depending on the electrode diameter

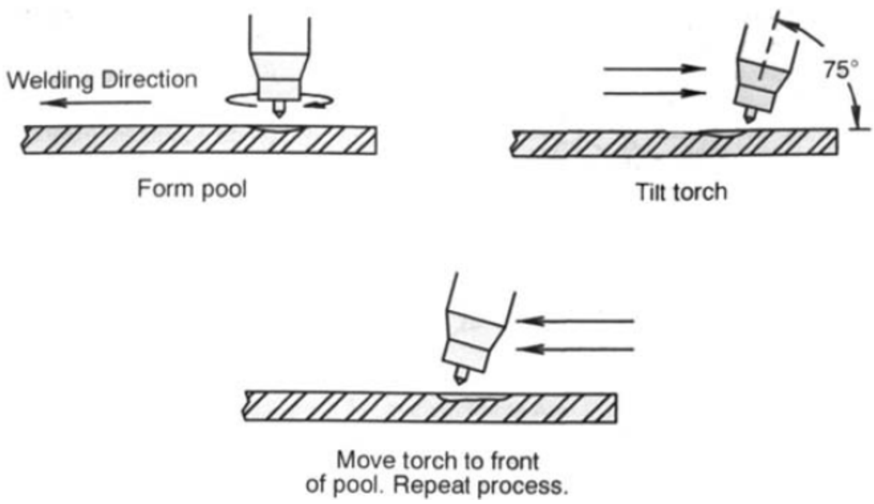
Diameter	Direct Current				Alternating Current	
	Electrode negative (-)		Electrode positive (+)			
	Pure tungsten	Tungsten with oxide additives	Pure tungsten	Tungsten with oxide additives	Pure tungsten	Tungsten with oxide additives
1,0 mm	10 – 75 A	10 – 75 A	no indication	no indication	15 – 55 A	15 – 70 A
1,6 mm	40 – 130 A	60 – 150 A	10 – 20 A	10 – 20 A	45 – 90 A	60 – 125 A
2,0 mm	75 – 180 A	100 – 200 A	15 – 25 A	15 – 25 A	65 – 125 A	85 – 160 A
2,4 mm	120 – 220 A	150 – 250 A	15 – 30 A	15 – 30 A	80 – 140 A	120 – 210 A
3,2 mm	160 – 310 A	225 – 330 A	20 – 35 A	20 – 35 A	150 – 190 A	150 – 250 A
4,0 mm	275 – 450 A	350 – 480 A	35 – 50 A	35 – 50 A	180 – 260 A	240 – 350 A
4,8 mm	380 – 600 A	480 – 650 A	50 – 70 A	50 – 70 A	240 – 350 A	330 – 450 A
5,0 mm	400 – 625 A	500 – 675 A	50 – 70 A	50 – 70 A	240 – 350 A	330 – 460 A
6,4 mm	575 – 900 A	750 – 1000 A	70 – 125 A	70 – 125 A	325 – 450 A	450 – 600 A

Electrode diameter	Cup size	ARGON FLOW FERROUS METALS		ARGON FLOW ALUMINIUM	
		Standard body l/min	Gas lens body l/min	Standard body l/min	Gas lens body l/min
1,0 mm	4 or 5	3÷5	3÷4	3÷6	3÷5
1,6 mm	4, 5, or 6	4÷6	3÷5	4÷7	4÷6
2,0 mm	5 or 6	5÷6	4÷5	5÷8	4÷6
2,4 mm	6, 7, or 8	5÷7	4÷5	5÷10	5÷7
3,2 mm	7, 8, or 10	5÷9	4÷6	6÷12	5÷10
4,0 mm	8 or 10	7÷12	5÷7	7÷14	6÷12
4,8 mm	8 or 10	10÷17	6÷12	12÷19	7÷14
5,0 mm	8 or 10	10÷17	6÷12	12÷19	7÷14
6,4 mm	10	12÷24	10÷17	14÷26	12÷21

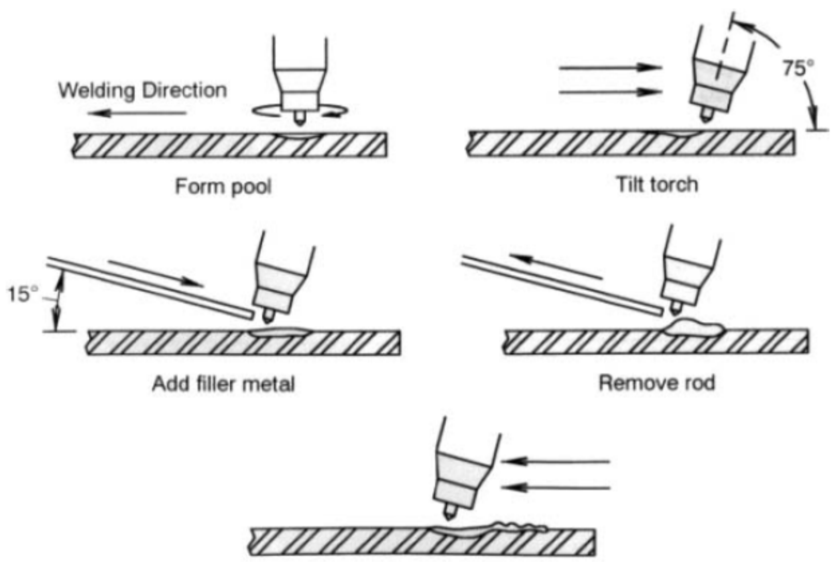
CORRECT TORCH AND ROD POSITIONG



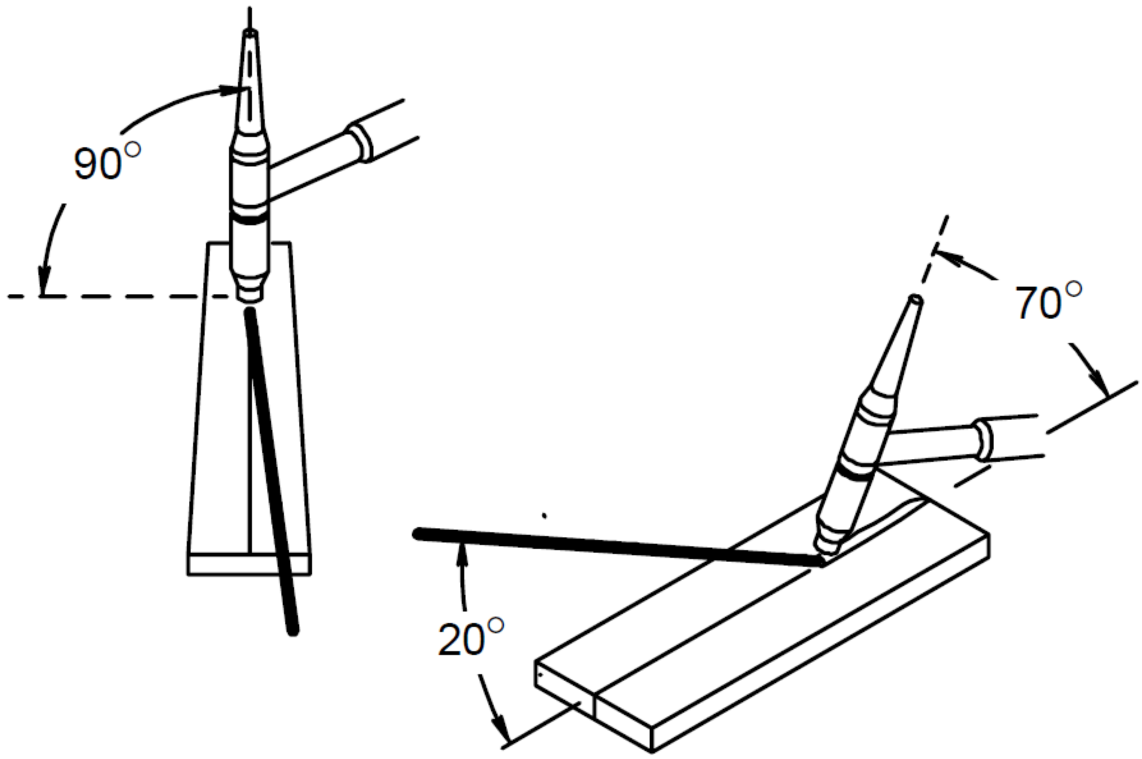
MOVING TORCH WITHOUT FILLER ROD



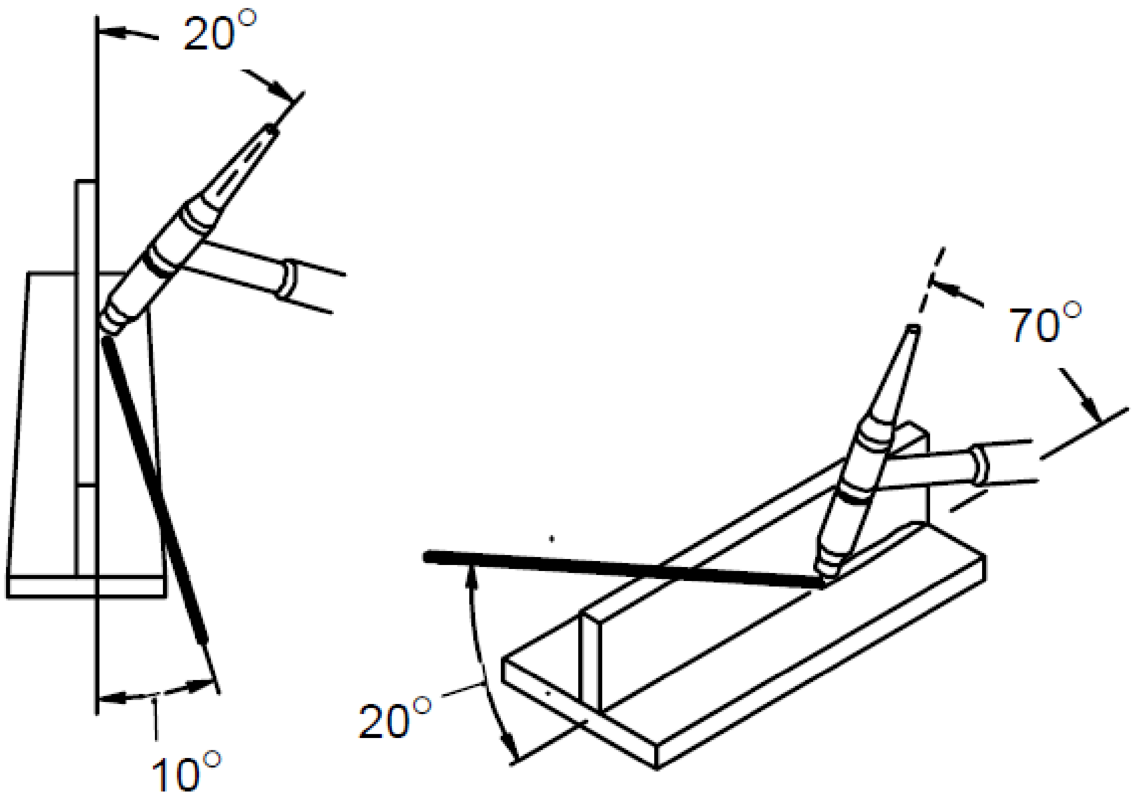
MOVING TORCH WITH FILLER ROD



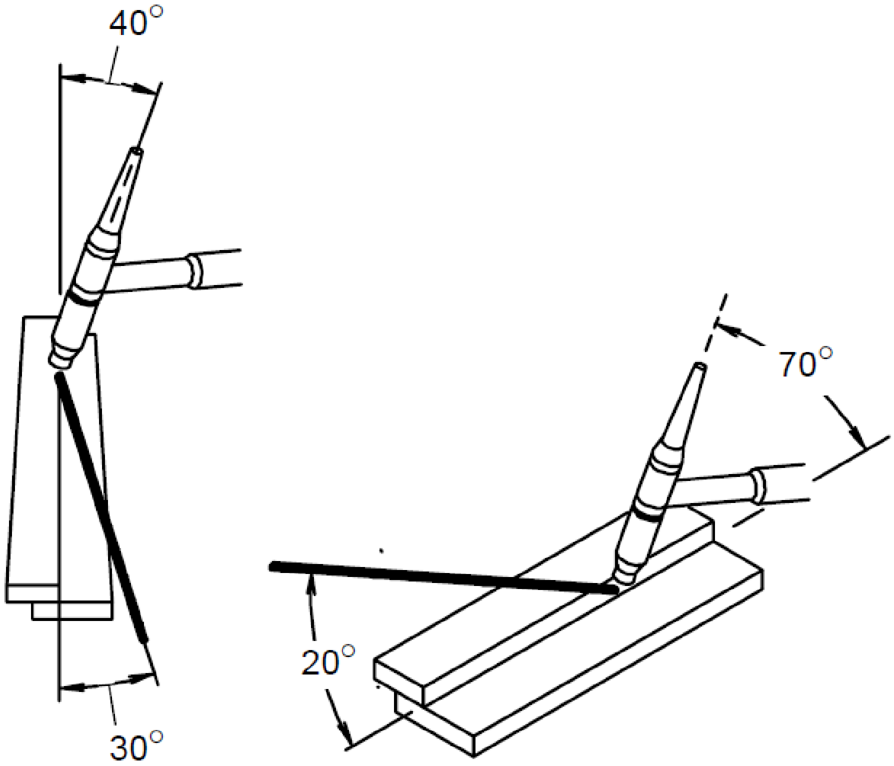
TORCH POSITION FOR MAKING BUTT JOINT



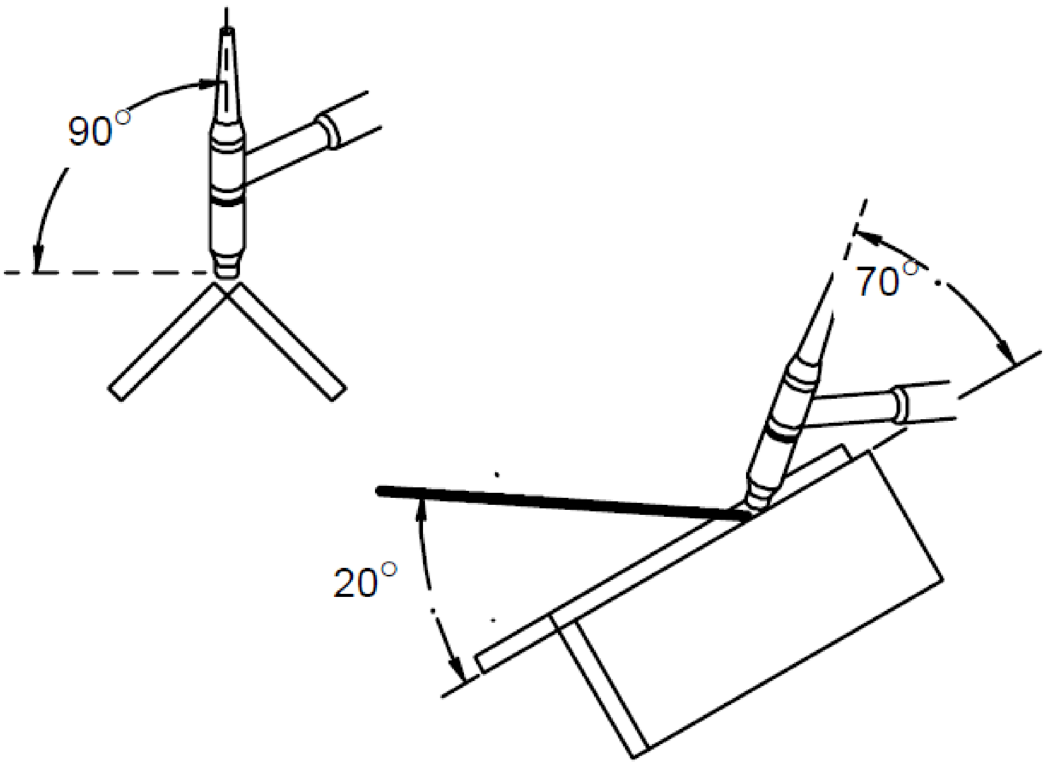
TORCH POSITION FOR MAKING T-JOINT



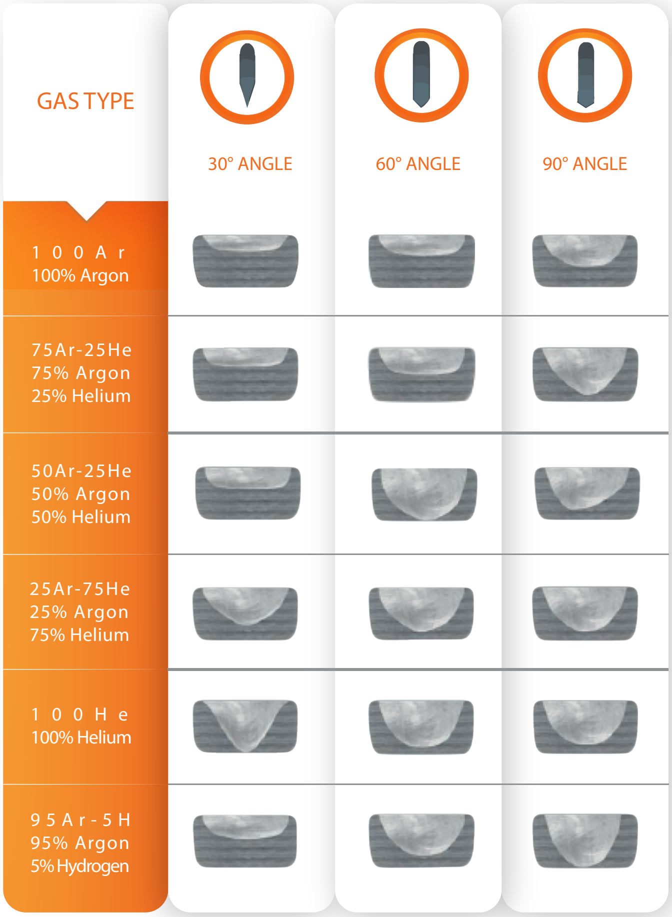
TORCH POSITION FOR MAKING BUTT JOINT



TORCH POSITION FOR MAKING CORNER JOINT



WELD PENETRATION PROFILE



PREPARING THE WELD JOINT

Many TIG (GTAW) problems, or supposed problems, are a direct result of using improper methods to prepare the joint. Chief among these is the improper use of grinding wheels to prepare joints. Soft materials such as aluminum become impregnated with microsized abrasive particles which, unless subsequently removed, will result in excessive porosity. Grinding wheels should be cleaned and dedicated exclusively to the material being welded.

Cleaning

Cleanliness of both the weld joint area and the filler metal is an important consideration when welding with the Gas Tungsten Arc Welding process. Oil, grease, shop dirt, paint, marking crayon, and rust or corrosion deposits all must be removed from the joint edges and metal surfaces to a distance beyond the heat affected zone. Their presence during welding may lead to arc instability and contaminated welds. If a weld is made with any of these contaminants present, the result could be a weld bead with pores, cracks, or inclusions. Cleaning may be accomplished by mechanical means, by the use of vapor or liquid cleaners, or by a combination of these.

Preparing Aluminum for Welding

The preparation of aluminum deserves more consideration than it is often times given. Aluminum is very susceptible to contaminants which can cause considerable problems when welding. First of all, aluminum has a surface oxide which must be removed. The important point is that the abrasive wheels and wire brushes should be used only on the material being cleaned. If a wire brush for example were used on rusty steel, and then on aluminum, the brush could carry contaminants from one piece to another.

STAINLESS STEEL MANUAL WELDING DC EN (Electrode Negative)					
Metal thickness	**Joint type**	**Electrode Diameter**	**Amperage**	**Gas Type**	**Flow l/min**
1.5 mm	Butt	1.6 mm	40A-60A	Argon	8,0
1.5 mm	Lap	1.6 mm	50A-70A	Argon	8,0
1.5 mm	Corner	1.6 mm	40A-60A	Argon	8,0
1.5 mm	Fillet	1.6 mm	50A-70A	Argon	8,0
3.0 mm	Butt	2.4 mm	65A-85A	Argon	8,0
3.0 mm	Lap	2.4 mm	90A-110A	Argon	8,0
3.0 mm	Corner	2.4 mm	65A-85A	Argon	8,0
3.0 mm	Fillet	2.4 mm	90A-110A	Argon	8,0
5.0 mm	Butt	2.4 mm	100A-125A	Argon	10,0
5.0 mm	Lap	2.4 mm	125A-150A	Argon	10,0
5.0 mm	Corner	2.4 mm	100A-125A	Argon	10,0
5.0 mm	Fillet	2.4 mm	125A-150A	Argon	10,0
6.0 mm	Butt	3.2 mm	135A-160A	Argon	10,0
6.0 mm	Lap	3.2 mm	160A-180A	Argon	10,0
6.0 mm	Corner	3.2 mm	135A-160A	Argon	10,0
6.0 mm	Fillet	3.2 mm	160A-180A	Argon	10,0

In TIG welding of stainless steel, welding rods having the AWS-ASTM prefixes of E or ER can be used as filler rods. However, only bare uncoated rods should be used. Light gauge metals less then 1/16” (1.6mm) thick should always be welded with DCEN (electrode on negative pole) using argon gas. Follow the normal pecautions for welding stainless such as: clean surfaces, dry electrodes; use only stainless steel tools and brushes, keep stainless from coming in contact with other metals.

MILD STEEL MANUAL WELDING DC EN (Electrode Negative)					
Metal thickness	**Joint type**	**Electrode Diameter**	**Amperage**	**Gas Type**	**Flow l/min**
1.5 mm	Butt	1.6 mm	60A-70A	Argon	8,0
1.5 mm	Lap	1.6 mm	70A-90A	Argon	8,0
1.5 mm	Corner	1.6 mm	60A-70A	Argon	8,0
1.5 mm	Fillet	1.6 mm	70A-90A	Argon	8,0
3.0 mm	Butt	2.4 mm	80A-100A	Argon	8,0
3.0 mm	Lap	2.4 mm	90A-115A	Argon	8,0
3.0 mm	Corner	2.4 mm	80A-100A	Argon	8,0
3.0 mm	Fillet	2.4 mm	90A-115A	Argon	8,0
5.0 mm	Butt	2.4 mm	115A-135A	Argon	10,0
5.0 mm	Lap	2.4 mm	140A-165A	Argon	10,0
5.0 mm	Corner	2.4 mm	115A-135A	Argon	10,0
5.0 mm	Fillet	2.4 mm	140A-170A	Argon	10,0
6.0 mm	Butt	3.2 mm	160A-175A	Argon	10,0
6.0 mm	Lap	3.2 mm	170A-200A	Argon	10,0
6.0 mm	Corner	3.2 mm	160A-175A	Argon	10,0
6.0 mm	Fillet	3.2 mm	175A-200A	Argon	10,0

Mild and low carbon steels with less then 0.30% carbon and less than 2.5 cm (1”) thick, generally do not require preheat. An exception to this allowance is welding on highly restrained joints. These joints should be preheated 10 to 38°C (50 to 100°F) to minimize shrinkage cracks in the base metal. Low alloy steels such as the chromium-molybdenum steels will have hard heat affected zones after welding, if the preheat temperature is too low. This is caused by rapid cooling of the base material and the formation of martensitic grain structures. A 93 to 204°C (200 to 400°F) preheat temperature will slow the cooling rate and prevent the martensitic structure.

ALUMINUM MANUAL WELDING AC							
Metal thickness	Joint type	Electrode Diameter	Amperage	AC Frequency Hz setting	Balance Setting	Gas Type	Flow l/min
1.5 mm	Butt	1.6 mm	60A-80A	110	-15%	Argon	8,0
1.5 mm	Lap	1.6 mm	70A-90A	110	-20%	Argon	8,0
1.5 mm	Corner	1.6 mm	60A-80A	110	-15%	Argon	8,0
1.5 mm	Fillet	1.6 mm	75A-100A	110	-20%	Argon	8,0
3.0 mm	Butt	2.4 mm	120A-140A	120	-15%	Argon	10,0
3.0 mm	Lap	2.4 mm	130A-150A	120	-20%	Argon	10,0
3.0 mm	Corner	2.4 mm	120A-140A	120	-15%	Argon	10,0
3.0 mm	Fillet	2.4 mm	130A-160A	120	-20%	Argon	10,0
5.0 mm	Butt	2.4/3.2 mm	180A-210A	140	-20%	Argon	12,0
5.0 mm	Lap	2.4/3.2 mm	190A-220A	140	-20%	Argon	12,0
5.0 mm	Corner	2.4/3.2 mm	180A-210A	140	-20%	Argon	12,0
5.0 mm	Fillet	2.4/3.2 mm	190A-220A	140	-20%	Argon	12,0
6.0 mm	Butt	3.2 mm	210A-240A	140	-20%	Argon	12,0
6.0 mm	Lap	3.2 mm	220A-250A	140	-20%	Argon	12,0
6.0 mm	Corner	3.2 mm	210A-240A	140	-20%	Argon	12,0
6.0 mm	Fillet	3.2 mm	220A-250A	140	-20%	Argon	12,0

WELDING ALUMINUM
The use of TIG welding for aluminum has many advantages for both manual and automatic processes. Filler metal can be either wire or rod and should be compatible with the base alloy. Filler metal must be dry, free of oxides, grease, or other foreign matter. If filler metal becomes damp, heat for 2 hours at 121°C (250°F) before using. AC or Squarewave are the recommended welding methodes.

SQUARE WAVE CONTROLS

FEATURE	WAVEFORM	EFFECT ON BEAD	EFFECT ON APPEARANCE
AC Balance Control: Controls arc cleaning action. Adjusting the % EN of the AC wave controls the width of the etching zone surrounding the weld.	51 – 99% EN Amperage, 0, % EP, % EN, Time (1 AC Cycle)	Reduces balling action and helps Deep, narrow penetration	Narrow bead, with no visible cleaning Bead No Visible Cleaning
	30 – 50% EN Amperage, 0, % EP, % EN, Time (1 AC Cycle)	Increases balling action of the electrode Shallow penetration	Wider bead and cleaning action Bead Cleaning
AC Frequency Control: Controls the width of the arc cone. Increasing the AC Frequency provides a more focused arc with increased directional control.	60 Cycles per Second Amperage, 0, % EP, % EN, Time (1 AC Cycle)	Wider bead, good penetration — ideal for buildup work	Wider bead and cleaning action Bead Cleaning
	120 Cycles per Second Amperage, 0, % EP, % EP, % EN, % EN, Time (1 AC Cycle)	Narrower bead for fillet welds and automated applications	Narrower bead and cleaning action Bead Cleaning
Independent AC Amperage Control : Allows the EN and EP amperage values to be Set independently. Adjusts the ratio of EN to EP to precisely control heat input to the work and the electrode.	Current, 0, EP+, EN –, Time	More current in EN than EP: Deeper penetration and faster travel speeds	Narrow bead, with no visible cleaning Bead No Visible Cleaning
	Current, 0, EP+, EN –, Time	More current in EP than EN: Shallower penetration	Wider bead and cleaning action Bead Cleaning