EVERLAST

POWER ® DIGITAL SERIES

DIGITAL TIG AC/DC

Operator ' s Manual

Includes DIGITAL AC/DC 210 EXT/ 320 EXT

Safety, Setup and General Use Guide

Rev. 1 0612-12

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Serial number: _______________________
Model number: _________________________
Date of Purchase: ________________________

EVERLAST

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Dear Customer,

THANKS! You had a choice, and you bought an Everlast. We appreciate you as a customer and hope that you will enjoy years of use from your welder.

Please go directly to the Everlast website to register your unit and receive your warranty information. Your unit registration is important should any information such as product updates or recalls be issued. It is also important so that we may track your satisfaction with Everlast products and services. If you are unable to register by website, contact Everlast directly through the sales department through the main customer service number in your country. Your unit will be registered and warranty will be issued and in full effect. Keep all information regarding your purchase. **In the event of a problem you must contact technical support before your welder can be a candidate for warranty service and returned.**

Please review the current online warranty statement and information found on the website of the Everlast division located in or nearest to your country. Print it for your records and become familiar of its terms and conditions.

Everlast offers full technical support, in several different forms. We have online support available through email, and a welding support forum designed for customers and noncustomer interaction. Technical advisors are active on the forum daily. We also divide our support into two divisions: technical and welding performance. Should you have an issue or question concerning your unit, please contact performance/technical support available through the main company headquarters available in your country. For best service call the appropriate support line and follow up with an email, particularly if off hours, or you cannot reach a live person. In the event you do not reach a live person, particularly during heavy call volume times, holidays, and off hours, leave a message and your call will normally be returned within 24 hours. Also for quick answers to your basic questions, join the company owned forum available through the website. You'll find knowledgeable, helpful people and staff available to answer your questions, and perhaps find a topic that already addresses your question at http://www.everlastgenerators.com/forums/.

Should you need to call or write, always know your model name, purchase date and welder manufacturing inspection date. This will assure the quick and accurate customer service. **REMEMBER: Be as specific and informed as possible. Technical and performance advisors rely upon you to carefully describe the conditions and circumstances of your problem or question. Take notes of any issues as best you can. You may be asked many questions by the advisors to clarify problems or issues that may seem very basic. However, diagnosis procedures MUST be followed to begin the warranty process. Advisors can't assume anything, even with experienced users, and must cover all aspects to properly diagnose the problem.**

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Let us know how we may be of service to you should you have any questions.

Sincerely,
Everlast Customer Service

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Everlast is dedicated to providing you with the best possible equipment and service to meet the demanding jobs that you have. We want to go beyond delivering a satisfactory product to you. That is the reason we offer technical support to assist you with your needs should an occasion occur. With proper use and care your product should deliver years of trouble free service.

Safe operation and proper maintenance is your responsibility.

We have compiled this operator's manual, to instruct you in basic safety, operation and maintenance of your Everlast product to give you the best possible experience. Much of welding and cutting is based upon experience and common sense. As thorough as this welding manual may be, it is no substitute for either. Exercise extreme caution and care in all activities related to welding or cutting. Your safety, health and even life depends upon it. While accidents are never planned, preventing an accident requires careful planning.
<u>Please carefully read this manual before you operate your Everlast unit.</u> This manual is not only for the use of the machine, but to assist in obtaining the best performance out of your unit. Do not operate the unit until you have read this manual and you are thoroughly familiar with the safe operation of the unit. If you feel you need more information please contact Everlast Support.

The warranty does not cover improper use, maintenance or consumables. <u>Do not attempt to alter or defeat any piece or part of your unit, particularly any safety device.</u> Keep all shields and covers in place during unit operation should an unlikely failure of internal components result in the possible presence of sparks and explosions. If a failure occurs, discontinue further use until malfunctioning parts or accessories have been repaired or replaced by qualified personnel.

Note on High Frequency electromagnetic disturbances:
Certain welding and cutting processes generate High Frequency (HF) waves. These waves may disturb sensitive electronic equipment such as televisions, radios, computers, cell phones, and related equipment. High Frequency may also interfere with fluorescent lights. Consult with an electrician if disturbance is noted. Sometimes, improper wire routing or poor shielding may be the cause.

HF can interfere with pacemakers. See EMF warnings in following safety section for further information. Always consult your physician before entering an area known to have welding or cutting equipment if you have a pacemaker.

SAFETY PRECAUTIONS

These safety precautions are for protection of safety and health. Failure to follow these guidelines may result in serious injury or death. Be careful to read and follow all cautions and warnings. Protect yourself and others.

Welding and cutting processes produce high levels of ultraviolet (UV) radiation that can cause severe skin burn and damage. There are other potential hazards involved with welding such as severe burns and respiratory related illnesses. Therefore observe the following to minimize potential accidents and injury:

Use appropriate safety glasses with wrap around shields while in the work area, even under welding helmets to protect your eyes from flying sparks and debris. When chipping slag or grinding, goggles and face shields may be required.

When welding or cutting, always use an approved shielding device, with the correct shade of filter installed. Always use a welding helmet in good condition. Discard any broken or cracked filters or helmets. Using broken or cracked filters or helmets can cause severe eye injury and burn. Filter shades of no less than shade 5 for cutting and no less than shade 9 for welding are highly recommended. Shades greater than 9 may be required for high amperage welds. Keep filter lenses clean and clear for maximum visibility. It is also advisable to consult with your eye doctor should you wear contacts for corrective vision before you wear them while welding.

Do not allow personnel to watch or observe the welding or cutting operation unless fully protected by a filter screen, protective curtains or equivalent protective equipment. If no protection is available, exclude them from the work area. Even brief exposure to the rays from the welding arc can damage unprotected eyes.

Always wear hearing protection because welding and cutting can be extremely noisy. Ear protection is necessary to prevent hearing loss. Even prolonged low levels of noise has been known to create long term hearing damage. Hearing protection also further protects against hot sparks and debris from entering the ear canal and doing harm.

Always wear personal protective clothing. Flame proof clothing is required at all times. Sparks and hot metal can lodge in pockets, hems and cuffs. Make sure loose clothing is tucked in neatly. Leather aprons and jackets are recommended. Suitable welding jackets and coats may be purchased made from fire proof material from welding supply stores. Discard any burned or frayed clothing. Keep clothing away from oil, grease and flammable liquids.

Leather boots or steel toed leather boots with rubber bottoms are required for adequate foot protection. Canvas, polyester and other man made materials often found in shoes will either burn or melt. Rubber or other non conductive soles are necessary to help protect from electrical shock.

Flame proof and insulated gauntlet gloves are required whether welding or cutting or handling metal. Simple work gloves for the garden or chore work are not sufficient. Gauntlet type welding gloves are available from your local welding supply companies. Never attempt to weld with out gloves. Welding with out gloves can result in serious burns and electrical shock. If your hand or body parts comes into contact with the arc of a plasma cutter or welder, instant and serious burns will occur. **Proper hand protection is required at all times when working with welding or cutting machines!**

continued

WARNING! **Persons with pacemakers should not weld, cut or be in the welding area until they consult with their physician. Some pacemakers are sensitive to EMF radiation and could severely malfunction while welding or while being in the vicinity of someone welding. *Serious injury or death may occur!***

Welding and plasma cutting processes generate electro-magnetic fields and radiation. While the effects of EMF radiation are not known, it is suspected that there may be some harm from long term exposure to electromagnetic fields. Therefore, certain precautions should be taken to minimize exposure:

- Lay welding leads and lines neatly away from the body.
- Never coil cables around the body.
- Secure cables with tape if necessary to keep from the body.
- Keep all cables and leads on the same side the body.
- Never stand between cables or leads.
- Keep as far away from the power source (welder) as possible while welding.
- Never stand between the ground clamp and the torch.
- Keep the ground clamp grounded as close to the weld or cut as possible.

Welding and cutting processes pose certain inhalation risks. Be sure to follow any guidelines from your chosen consumable and electrode suppliers regarding possible need for respiratory equipment while welding or cutting. Always weld with adequate ventilation. Never weld in closed rooms or confined spaces. Fumes and gases released while welding or cutting may be poisonous. Take precautions at all times. Any burning of the eyes, nose or throat are signs that you need to increase ventilation.

- Stop immediately and relocate work if necessary until adequate ventilation is obtained.
- Stop work completely and seek medical help if irritation and discomfort persists.

WARNING! Do not weld on galvanized steel, stainless steel, beryllium, titanium, copper, cadmium, lead or zinc without proper respiratory equipment and or ventilation.

WARNING! This product when used for welding or cutting produces fumes and gases which contains chemicals known to the State of California to cause birth defects and in some cases cancer. (California Safety and Health Code §25249.5 *et seq*.)

WARNING! Do not weld or cut around Chlorinated solvents or degreasing areas. Release of Phosgene gas can be deadly. Consider all chemicals to have potential deadly results if welded on or near metal containing residual amounts of chemicals.

Keep all cylinders upright and chained to a wall or appropriate holding pen. Certain regulations regarding high pressure cylinders can be obtained from OSHA or local regulatory agency. Consult also with your welding supply company in your area for further recommendations. The regulatory changes are frequent so keep informed.

All cylinders have a potential explosion hazard. When not in use, keep capped and closed. Store chained so that overturn is not likely. Transporting cylinders incorrectly can lead to an explosion. Do not attempt to adapt regulators to fit cylinders. Do not use faulty regulators. Do not allow cylinders to come into contact with work piece or work. Do not weld or strike arcs on cylinders. Keep cylinders away from direct heat, flame and sparks.

continued

WARNING! Electrical shock can kill. Make sure all electrical equipment is properly grounded. Do not use frayed, cut or otherwise damaged cables and leads. Do not stand, lean or rest on ground clamp. Do not stand in water or damp areas while welding or cutting. Keep work surface dry. Do not use welder or plasma cutter in the rain or in extremely humid conditions. Use dry rubber soled shoes and dry gloves when welding or cutting to insulate against electrical shock. Turn machine on or off only with gloved hand. Keep all parts of the body insulated from work, and work tables. Keep away from direct contact with skin against work. If tight or close quarters necessitates standing or resting on work piece, insulate with dry boards and rubber mats designed to insulate the body from direct contact.

All work cables, leads, and hoses pose trip hazards. Be aware of their location and make sure all personnel in area are advised of their location. Taping or securing cables with appropriate restraints can help reduce trips and falls.

WARNING! Fire and explosions are real risks while welding or cutting. Always keep fire extinguishers close by and additionally a water hose or bucket of sand. Periodically check work area for smoldering embers or smoke. It is a good idea to have someone help watch for possible fires while you are welding. Sparks and hot metal may travel a long distance. They may go into cracks in walls and floors and start a fire that would not be immediately visible. Here are some things you can do to reduce the possibility of fire or explosion:

- Keep all combustible materials including rags and spare clothing away from area.
- Keep all flammable fuels and liquids stored separately from work area.
- Visually inspect work area when job is completed for the slightest traces of smoke or embers.
- If welding or cutting outside, make sure you are in a cleared off area, free from dry tender and debris that might start a forest or grass fire.
- Do not weld on tanks, drums or barrels that are closed, pressurized or anything that held flammable liquid or material.

Metal is hot after welding or cutting! Always use gloves and or tongs when handling hot pieces of metal. Remember to place hot metal on fire-proof surfaces after handling. Serious burns and injury can result if material is improperly handled.

WARNING! Faulty or poorly maintained equipment can cause injury or death. Proper maintenance is your responsibility. Make sure all equipment is properly maintained and serviced by qualified personnel. Do not abuse or misuse equipment.
Keep all covers in place. A faulty machine may shoot sparks or may have exploding parts. Touching uncovered parts inside machine can cause discharge of high amounts of electricity. **Do not allow employees to operate poorly serviced equipment.** Always check condition of equipment thoroughly before start up. Disconnect unit from power source before any service attempt is made and for long term storage or electrical storms.

THINK Safety

Further information can be obtained from The American Welding Society (AWS) that relates directly to safe welding and plasma cutting. Additionally, your local welding supply company may have additional pamphlets available concerning their products. Do not operate machinery until your are comfortable with proper operation and are able to assume inherent risks of cutting or welding.

2.0 Connecting your Everlast TIG AC/DC machine

2.1.1 TIG 210EXT This machine is designed to operate on 240v +/- 15% input single phase AC outlet. Ensure there is adequate ventilation around the machine when it is connected to the main power supply.

2.1.2 TIG 320EXT This machine depending on your country is designed to work on a 220v, 380v or 460v (verify the voltage on your machine) +/- 15% input 3 phase supply. Ensure that there is adequate ventilation around the when it is connected to the main power supply.

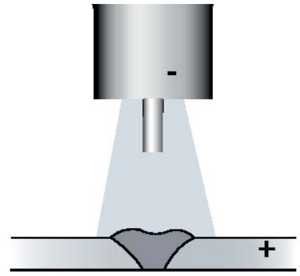
2.2 Shielding Gas When working the machine in the TIG mode of welding the process requires a shielding gas. The shielding gas can be supplied via a pressure regulator to the machine from either a fixed installation or single cylinder of gas. If a cylinder of gas is used, please ensure that the cylinder is securely fastened before starting any welding operation. Refer to the application section for the selection of the correct shielding gas.

2.3 TIG Torch Connection The TIG torch is fitted to the welding machine by means of the dinse connector. The TIG torch dinse connector is connected to the negative output port located on the front bottom panel of the machine. The gas hose is fitted to the gas fitting (GAS). The TIG torch switch or the foot pedal is connected using the 5 pin connection on the front bottom panel of the machine.

2.4 MMA Operation The Everlast AC/DC range can be used as a MMA welding machine by fitting an electrode holder and a work clamp to the respective dinse connectors (dependent on the type of electrodes being used. Please consult the electrode packaging for the correct polarities.)

2.5.1 For Direct Current (DC) Welding Select the correct size and type of non-consumable tungsten and shielding gas for the application (See selection chart at the end of section 3)

For (DC-) (most commonly used polarity) connect the TIG torch to the negative dinse plug connector and the work clamp to the positive dinse plug connector.



GTAW with DCEN produces deep penetration because it concentrates the heat in the joint area. No cleaning action occurs with this. The heat generated by the arc using this polarity occurs in the work thus a smaller electrode can be used as well as a smaller gas cup and gas flow. The more concentrated arc allows for faster travel speeds.

For (DC+) applications connect the TIG torch to the positive dinse plug connector and the work clamp to the negative dinse plug connector. In this mode most of the heat is generated within the non-consumable tungsten and the heat input into the plate is reduced resulting in lower penetration depths. (larger tungstens are normally selected for this application.

Ensure that the process selector switch (3) is switched TIG.

Ensure that the AC/DC selector switch (4) is set on DC.

Select 4T2T on the trigger selector switch (5).

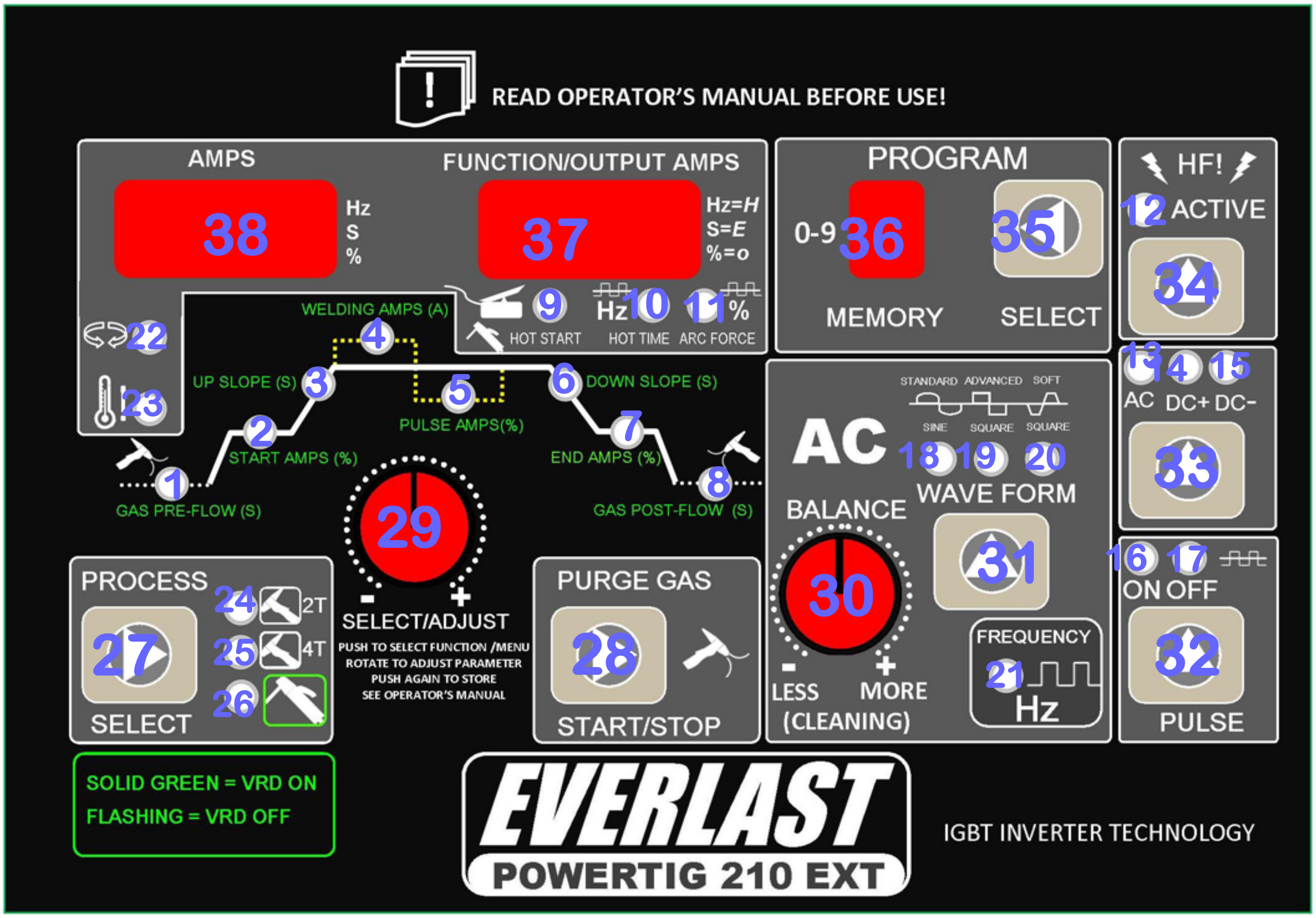
Depress the contactor switch on the torch and hold this down for the entire weld.

Selecting the 2T function will disable the Start current (9) and the process will immediately rise to the selected welding current.

For 4T operation, depress the contactor switch on the torch and release it when welding starts. Depress the contactor switch again at the end of the weld.

Selecting the 4T function will enable the start current (9) and the downslope cycle (12). Both start current and downslope cycle time must be manually selected.

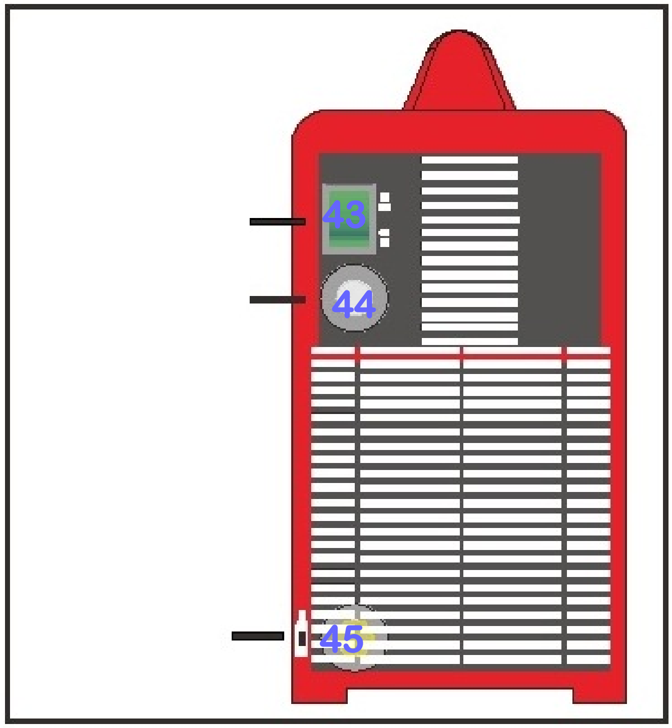
Using a remote control device (such as a foot control, or remote pendant). When using a remote device ensure that the device is properly fitted by connecting it to the remote control outlet connector (21). The remote operating control switch (7) must be set in the on position.



Description of the Control Panels

Number	Function	Description
1	Pre-Flow	
2	Start Amp Indicator	For TIG welding
3	Upslope Time Indicator	Period in TIG welding during which the start amps are increased to the specified main current.
4	Welding Amps Indicator	Main current
5	P.P Current Indicator	Pulse Peak Current (1-100%)
6	Downslope Time Indicator	Period in TIG welding during which the specified main amps are lowered to the final current
7	End Amps Indicator	For TIG welding
8	Post Flow	For TIG welding
9	Foot Switch Indicator	Lights up if foot switch connected
10	Hot Start	For MMA welding
11	Arc Force	For MMA welding
12	HF Contact Indicator	ON/OFF
13	TIG AC Indicator	
14	TIG DC+ Welding Indicator	
15	TIG DC- Welding Indicator	

Number	Function	Description
16	Pulse On Indicator	
17	Pulse Off Indicator	
18	Sine Indicator	Sinusoidal waveform indicator
19	OFF Indicator	100% rectangular waveform
20	REC Indicator	Rectangular waveform
21	AC Frequency Indicator	
22	Set-up Indicator	Lights up if under setting status
23	Over Heat Indicator Save the data	Lights up if the power source overheats (because the duty cycle has been exceeded) For more information on this see the trouble shooting section. It is recommended to save the data
24	2-Step Mode Indicator (2T)	Use with foot pedal control
25	4-Step Mode Indicator (4T)	Recommended for torch trigger auto on
26	MMA Mode Indicator	
27	Mode Button	Used to select 2-step mode or 4-step mode or MMA welding (2T / 4T)
28	Gas Test Button	Used to set the required amount of shielding gas at the pressure regulator. After you press this button, gas will flow out for 30 seconds. Press the button again to stop the test gas flow before the 30 seconds are up.
29	Parameter Adjusting Knob	Used to adjust welding parameter.
30	Balance	(-30%/+30%) Used to set the fusing power/cleaning action for TIG AC welding.
31	Wave Pattern	Used to select waveform (Sin, OFF or REC)
32	Pulse Selection Button	ON/OFF
33	Process Button	Used to select the process depending on the mode that has been chosen
34	HF Contact Button	ON/OFF
35	Store Button	Used to store 9 jobs
36	Memory Button	Memory display, 1 or 2 or 3 through 9
37	Actual Ouput Amp Display	
38	Pre-Set Amp Display	



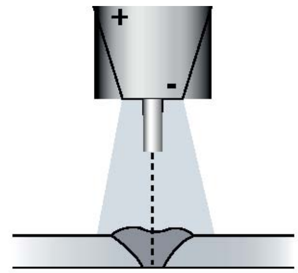
Number	Function	Description
39	Control Plug	5 pin connection socket for remote control TIG torch or foot pedal control
40	Output Nozzle	Shielding gas output
41	Negative Output	
42	Positive Output	
43	Power Switch	Switching the power source on and off
44	Power Input Cord	
45	Shielding Gas Connection	

2.5.2 For DC Pulse TIG Welding SDC welding of thin material can be enhanced by using the pulse mode.
When using the pulse mode for DC application the current will be varied between the welding current and the set background current. Additionally the pulse width and pulse frequency can be adjusted. By adjusting the pulse frequency and width the optimum heat input for a particular application can be obtained. As a general rule, increasing the frequency at a given set of welding and background current the heat input into the plate will increase.

2.5.3 For AC TIG Welding AC TIG welding is commonly used for the welding of Aluminum and Aluminum alloys. The positive half cycle of the AC current assist in the cleaning action required for successfully welding Aluminum.
Zirconiated tungstens are used for welding and the size of tungsten depends on the current employed.
In normal AC sine wave equal time is spent in the positive and negative cycle of the current. This delivers a balanced weld with good penetration and a good cleaning action (5).

AC Balance Control

In addition to increasing the welding current in AC applications, a change in the penetration or cleaning when welding can be achieved by adjusting the AC Balance.
The AC Balance (time spend in the positive (maximum cleaning) or negative (maximum penetration) can be adjusted by using the AC balance control knob (16)
By adjusting the AC balance control knob from –30 to +30 % (20-80%) progressively increases the time in the positive side of the AC curve (higher heat concentration in the non-consumable tungsten electrode.)
This has the result that the amount of penetration is decreased.
With the AC balance control set at 20%., higher currents can be used on thinner electrodes, resulting in the use of smaller gas cups, therefore increasing visibility and reducing gas flows.

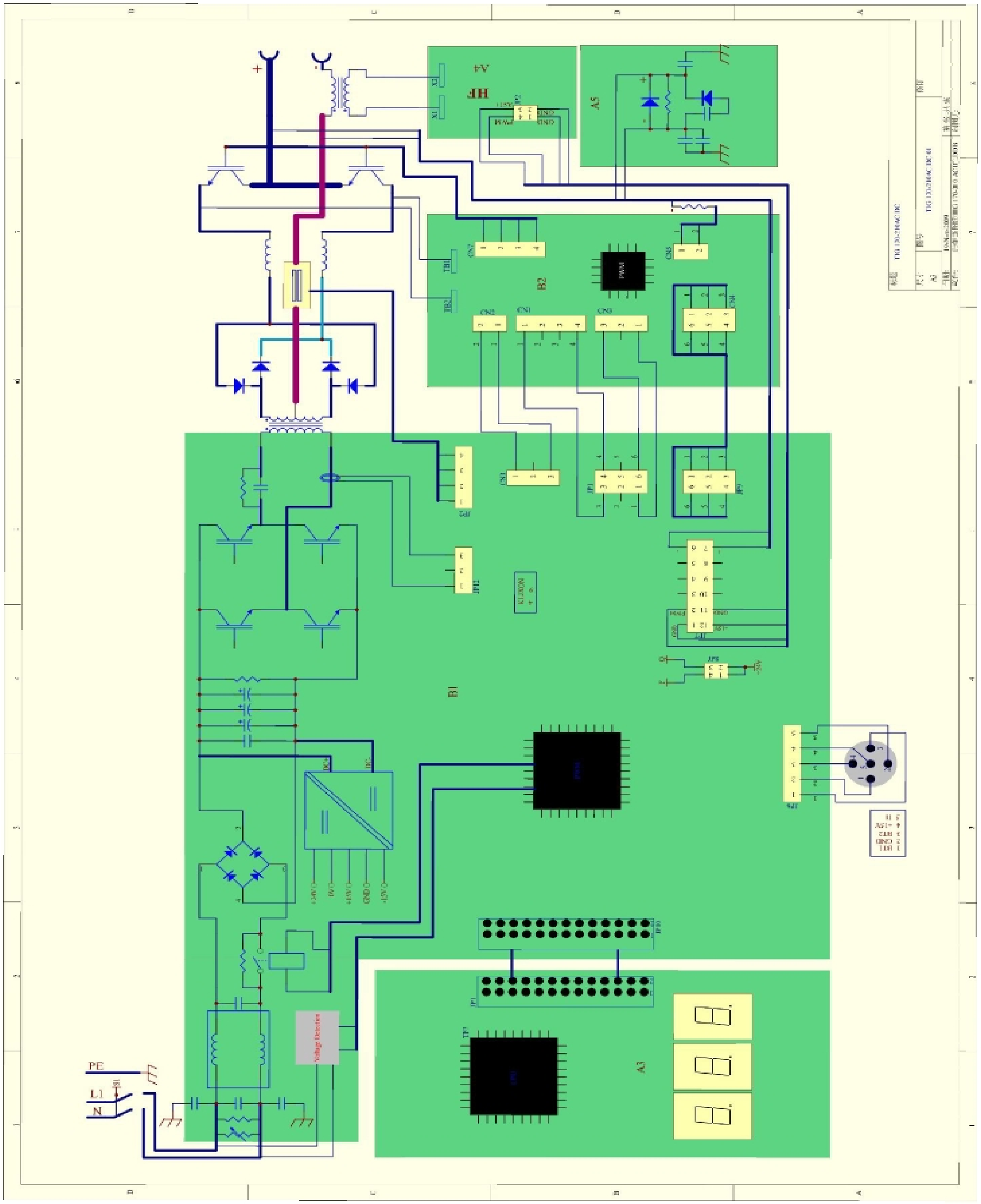


GTAW with AC combines the good weld penetration of DCEP with the desired cleaning action of DCEP. With certain types of AC waveforms high frequency helps re-establish the arc, which breaks each half cycle. Medium size tungstens are generally used with this process.

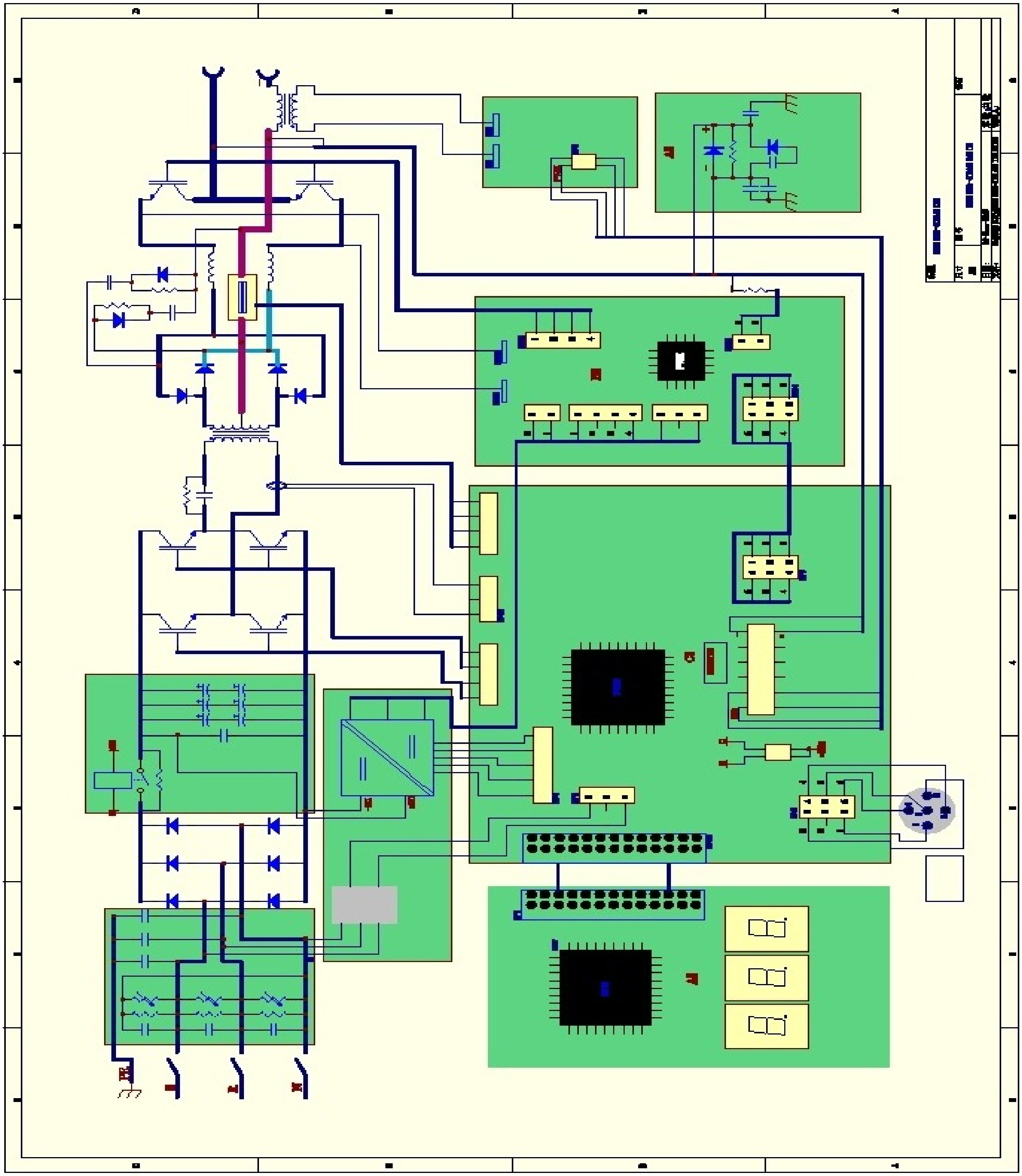
2.6 Technical Specifications

Model	PowerTig 210EXT	PowerTig 320EXT
Power Voltage (V)	240V 1 phase	220V, 380V & 460V 3 phase (depending on Country)
Frequency (Hz)	50/60	50/60
Fuse Rating (A)	32	32
OutPut Current (A)	Stick 10-160	Stick 10-320
	DC TIG 5-210	DC TIG 5-210
	AC TIG 10-210	AC TIG 10-320
No-Load Voltage (V)	62	62
Duty Cycle 40% @	210A	320A
Power Factor	0.95	0.95
Protection Grading	1P23	1P23
Weight (lbs)	37.4	59.4
Dimensions (in)	17x8.5x16.5	19x10x19

2.7 .1 Schematics PowerTig 210EXT



2.7.2 Schematics PowerTig 320EXT



3.1 INTRODUCTION

The Tungsten Inert Gas, or TIG process uses the heat generated by an electric arc struck between a non-consumable tungsten electrode and the workpiece to fuse metal in the joint area and produce a molten weld pool. The arc area is shrouded in an inert or reducing gas shield to protect the weld pool and the non-consumable electrode. The process may be operated autogenously, that is, without filler, or filler may be added by feeding a consumable wire or rod into the established weld pool.

3.2 PROCESS

Direct or alternating current power sources with constant current output characteristics are normally employed to supply the welding current. For DC operation the tungsten may be connected to either output terminal, but is most often connected to the negative pole. The output characteristics of the power source can have an effect on the quality of the welds produced. Shielding gas is directed into the arc area by the welding torch and a gas lens within the torch distributes the shielding gas evenly over the weld area. In the torch the welding current is transferred to the tungsten electrode from the copper conductor. The arc is then initiated by on of several methods between the tungsten and the workpiece.

3.3 PROCESS VARIABLES

DCEN

When direct-current electrode –negative (straight polarity) is used:

- Electrons strike the part being welded at a high speed.
- Intense heat on the base metal is produced.
- The base metal melts very quickly.
- Ions from the inert gas are directed towards the negative electrode at a relatively slow rate.
- Direct current with straight polarity does not require post-weld cleaning to remove metal oxides.

Use of DCEN

For a given diameter of tungsten electrode, higher amperage can be used with straight polarity.

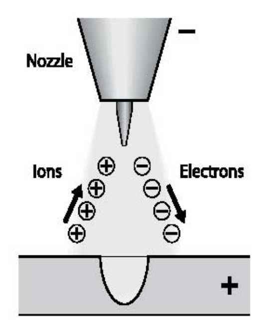
Straight polarity is used mainly for welding

- Carbon steels
- Stainless steels
- Copper alloys

The increased amperage provides

- Deeper penetration
- Increased welding speed
- A narrower, deeper weld bead

DCEN - Narrow bead - Deep penetration



DCEP

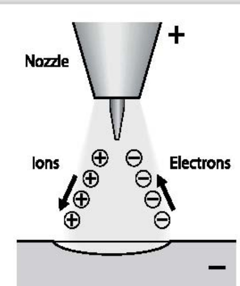
The DCEP (reverse polarity) are different from the DCEN in the following ways:

- High heat is produced on the electrode rather then on the base metal.
- The heat melts the tungsten electrode tip.
- The base metal remains relatively cool compared to the sing straight polarity.
- Relatively shallow penetration is obtained.
- An electrode whose diameter is too large will reduce visibility and increase instability.

Use of DCEP

- Intense heat means a larger diameter of electrode must be used with DCEP.
- Maximum welding amperage should be relatively low (approximately six times lower than DCEN)

DCEP -Wide bead - Shallow penetration



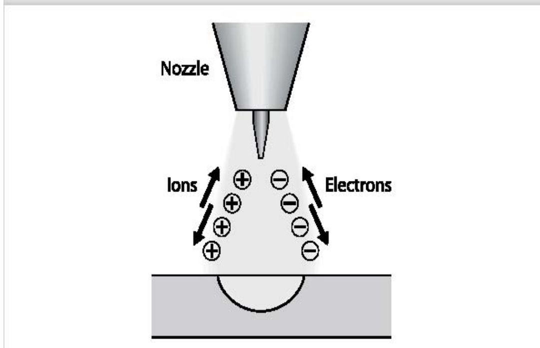
(continued)
Alternating Current with High Frequency

Welding with alternating current

Welding with alternating current combines both direct-current characteristics:

- In the positive phase, cleaning action occurs in the weld puddle.
- During the negative phase, heat is concentrated in the weld puddle.
- The above causes increased penetration.

AC - Average bead - Average penetration



3.4 SHIELDING GAS SELECTION

Material	Sheilding Gas	Benefits
Aluminum Alloys	Argon	1) Used with high frequency AC: good stable arc; good cleaning action
	Argon/Helium	1) Used with high fequency AC: good cleaning action; higher welding speed; increased penetration
Aluminum Bronze	Argon	Reduces penetration during surfacing minimising dilution
Brass	Argon	Stable arc; low fume
Cobalt-based Alloys	Argon	Stable and easy to control arc
Copper-nickel (Monel)	Argon	Stable and easy to control arc; can be used for copper-nickel to steel
Deoxised Copper	Helium	Increased heat imput; Stable arc; Good penetration
	Helium(75%)	Stable arc
	Argon(25%)	Lower penetration
Nickel Alloys (Inconel)	Argon	Stable arc; Manual operation
	Helium	High speed automated welding
Steel	Argon	Stable arc; Good penetration
	Helium	High speed automatic welding; Deeper penetration; Small concentrated HAZ
Magnesium Alloys	Argon	Used with continuous high frequency AC; Good arc stability; Good cleaning action
Stainless Steel	Argon	Good penetration; Good arc stability
	Helium	Deeper penetration
Titanium	Argon	Stable arc
	Helium	High speed welding

3.5 CONSUMABLE SELECTION

a) Welding Wire

The following table includes the recommended welding consumable for the most commonly welded materials.

Base Material	Consumable
C-Mn and low Carbon Steels	Mild steel TIG wire
Low Alloy Steels	
1.25 Cr/0.5Mo	CrMo1
2.5Cr/1Mo	CrMo2
Stainless Steel	
304/304L	308L
316/316L	316L
309/309-C-Mn	347L
Aluminum	
1000 series	1100
5000 series	4043/4047/5356
6000 series	4043/4047/5356
Filler rod diameter (mm)	Thickness of metal (mm)
2	0.5-2
3	2-5
4	5-8
4 or 5	8-12
5 or 6	12 or more

b) Non Consumable Tungsten

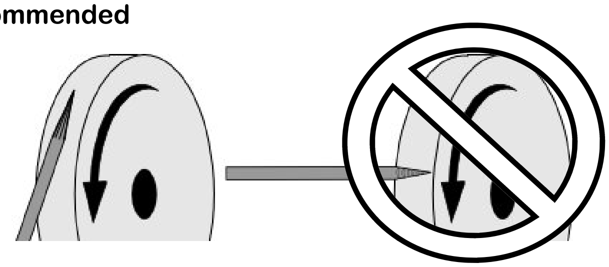
Tungsten Electrode Selector Chart				
Base Metal Type	Thickness Range	Desired Results	Welding Current	Electrode Type
Aluminum Alloys & Magnesium Alloys	All	General purpose	ACHF	Pure (EW-P)
				Zirconiated (EW-Zr)
				2% Thoriated (EW-Th2)
	Only thin sections	Control penetration	DCRP	2% Ceriated (EW-Ce2)
	Only thick sections	Increase penetration or travel speed	DCSP	2% Thoriated (EW-Th2)
				2% Ceriated (EW-Ce2)
Copper Alloys, Cu-NI Alloys & Nickel Alloys	All	General purpose	DCSP	2% Thoriated (EW-Th2)
				2% Ceriated (EW-Ce2)
	Only thin sections	Control penetration	ACHF	Zirconiated (EW-Zr)
	Only thick sections	Increase penetration or travel speed	DCSP	2% Ceriated (EW-Ce2)
Mild Steels, Carbon Steels, Alloy Steels, Stainless Steels & Titanium Aloys	All	General purpose	DCSP	2% Thoriated (EW-Th2)
				2% Ceriated (EW-Ce2)
				2% Lanthanated (EWG-La2)
	Only thin sections	Control penetration	ACHF	Zirconiated (EW-Zr)
	Only thick sections	Increase penetration or travel speed	DCSP	2% Ceriated (EW-Ce2)
				2% Lanthanated (EWG-La2)

b) Non Consumable Tungsten (continued)

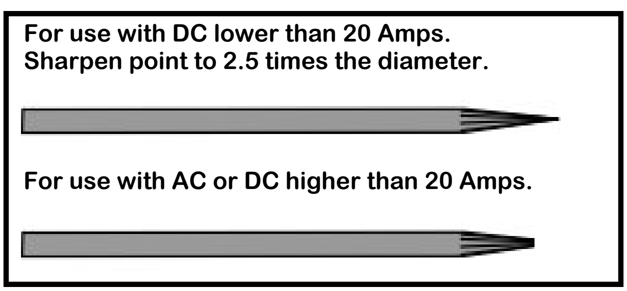
Shielding Gas	Tungsten Performance Characteristics
Argon	Ball easily; low cost; tends to spit at higher currents; used for non-critical welds only
Argon	Balls well; takes higher current; with less spitting and with better arc starts and arc stability than pure tungsten
75% Argon / 25% Helium	Higher current range and stability; better arc starts with lower tendency to spit; medium erosion
Argon Helium	Lowest erosion rate; widest current range; AC or DC no spitting; best arc starts and stability
75% Argon / 25% Helium	Best stability at medium currents; good arc starts; medium tendency to spit; medium erosion rate
Helium	Low erosion rate; wide current range; AC or DC no spitting; consistent arc start; good stability
75% Argon / 25% Helium	Best stability at medium currents; good arc starts; medium tendency to spit; medium erosion rate
75% Argon / 25% Helium	Low erosion rate; wide current range; AC or DC no spitting; consistent arc start; good stability
Argon	Use on lower currents only; spitting on starts; rapid erosion rates at higher currents
75% Argon / 25% Helium	Low erosion rate; wide current range; AC or DC no spitting; consistent arc start; good stability
75% Argon / 25% Helium	Best stability at medium currents; good arc starts; medium tendency to spit; medium erosion rate
75% Argon / 25% Helium	Low erosion rate; wide current range; AC or DC no spitting; consistent arc start; good stability
75% Argon / 25% Helium	Lowest erosion rate; widest current range; AC or DC no spitting; best arc starts and stability
Argon	Use on lower currents only; spitting on starts; rapid erosion rates at higher currents
75% Argon / 25% Helium	Low erosion rate; wide current range; AC or DC no spitting; consistent arc start; good stability
Helium	Lowest erosion rate; highest current range; no spitting; best DC arc starts and stability

b) Non Consumable Tungsten (continued)

The tungsten must be shaped prior to initiating an arc. With inverter based TIG welders, tungsten sharpness is important. Refer to the following diagram to correctly sharpen a Tungsten electrode. Notice the incorrect way of sharpening an electrode. Radially sharpening an electrode will cause an unstable, wandering arc, making it difficult to control the weld puddle. Carefully rotate the tungsten as it is being ground to prevent a flat spot or a hollow ground point. Also note that tapering the tungsten to 2.5 X's of its diameter is generally recommended



for most DC welding applications. For higher amperage DC welding, do not over sharpen the point, but leave a slight truncation on the end of the electrode. This prevents the tungsten tip from breaking away and falling into the weld. When AC welding, a small ball may form. This is normal. However



if a large globular ball begins to form, resharpen the tungsten and adjust the AC balance. It is also normal for a slight dome to form on the tungsten in DC mode. However, if the arc becomes erratic or the arc is difficult to start, regrinding will be necessary. If the tungsten is accidentally dipped into the weld puddle, re-grind the tungsten, particularly on aluminum. Grind tungsten electrodes only on a dedicated stone, free of contamination from other metals. Hand held tungsten grinders usually grind perfect points. Chemical sharpeners may be used.

Once the tungsten has been sharpened, install it into the torch, with approximately 1/8 of an inch of the tungsten sticking out.

continued

The following table supplies basic information about Tungsten selection and suitability.

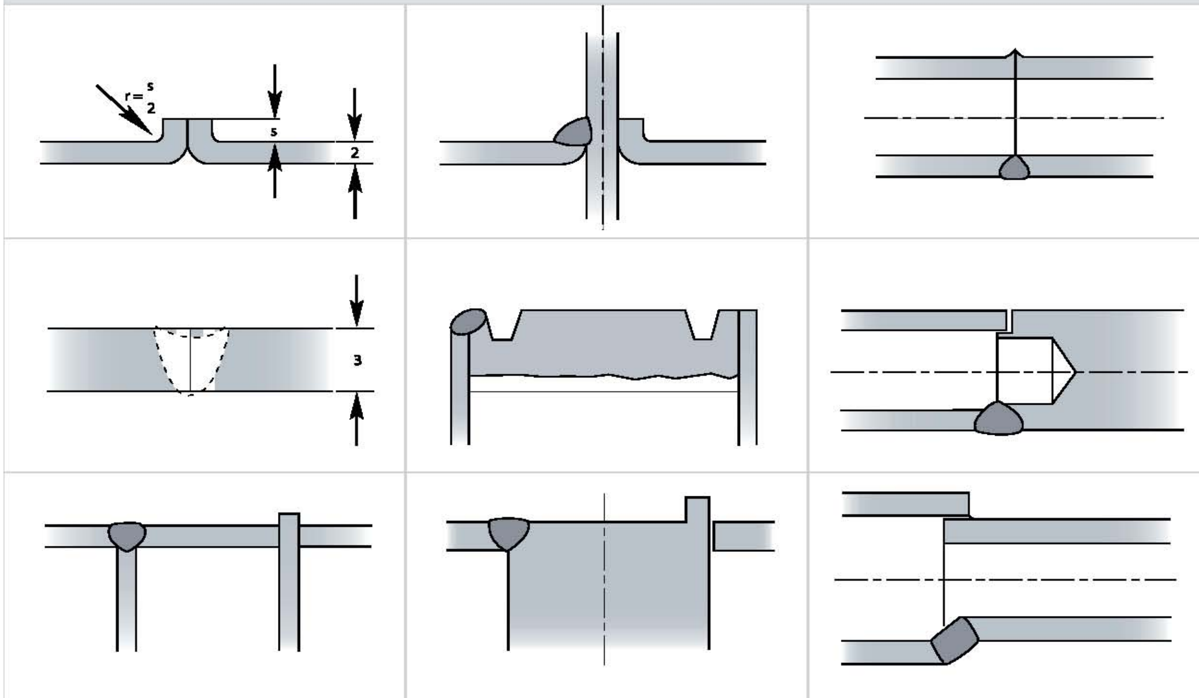
Electrode Diameter			DIRECT CURRENT, A		ALTERNATING CURRENT, A	
			Straight Polarity DCEN	Reverse Polarity DCEP	Unbalanced Wave	Balanced Wave
NR	.020"	.050mm	5–20	Not Recommended	5–15	10–20
	.040"	1.0mm	15–80		10–60	20–30
OK	□□□"	1.6mm	70–150	10–20	50–100	30–80
	³/□□"	2.4mm	150–250	15–30	100–160	60–130
	⅛"	3.2mm	250–400	25–40	150–210	100–180
	□/□□"	4.0mm	400–500	40–55	200–275	160–240
NR	³/□□"	4.8mm	500–750	55–80	250–300	190–300
	¼"	6.4mm	750–1100	80–125	325–450	325–450

	Material	USA & Australia	Europe	Japan
	4% Thoriated	(*)	Orange	(*)
	2% Thoriated	Red	Red	Red
OK	2% Lanthanated	Blue (+)	(*)	Yellow–Green
	1.5% Lanthanated	Gold (+)	(*)	(*)
	1% Lanthanated	Black	Black	Black
	2% Ceriated	Orange	Grey	Grey
	1% Zirconiated	Brown	White	(*)
NR	Pure Tungsten	Green	Green	Green
(*) not standardized; (+) Pending 1997 revision to the ANSI/AWS A5.12 will add standardization.				

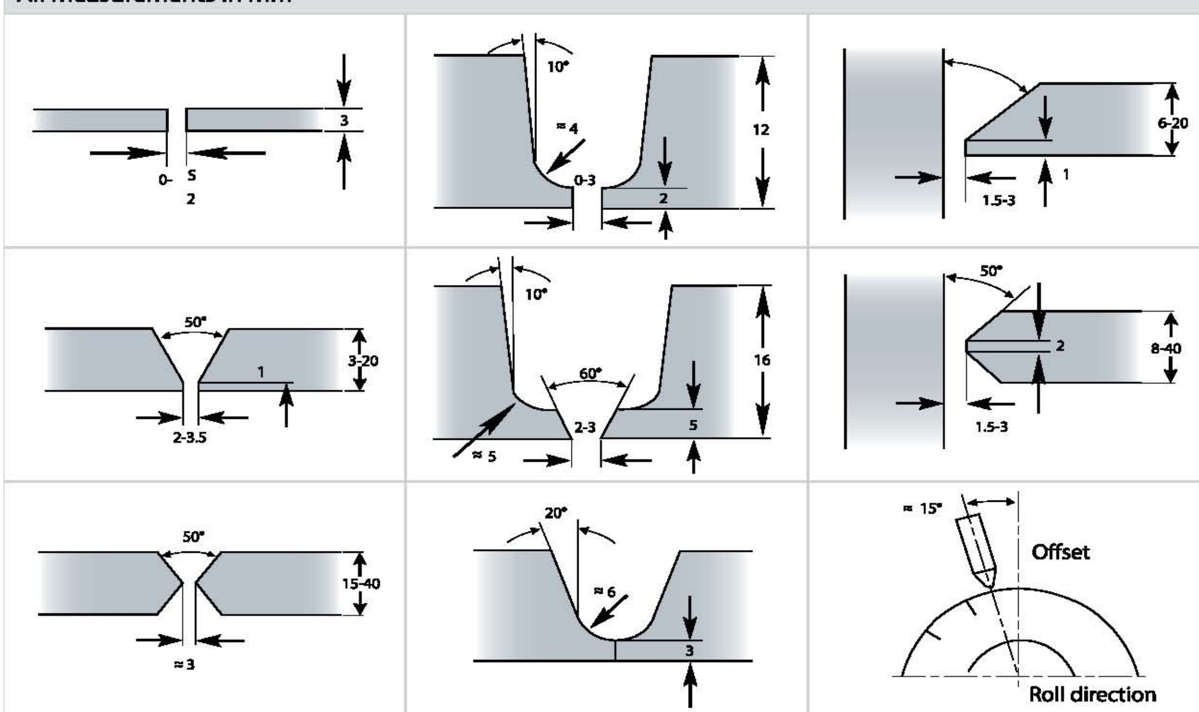
Note: Use only recommended sizes in Tig torches unless you purchase additional collets to fit the electrodes snugly. Loose fitting electrodes quickly ruin TIG torch parts.

3.6 Joint Preparation

All measurements in mm



All measurements in mm



3.0 TIG Welding of Materials

3.1 Application Summary

Material	Type of Current	Polarity
C-Min Steel	Direct Current (-)	DC Negative
Alloyed Steel	Direct Current (-)	DC Negative
Copper and Cu Alloys	Direct Current (-)	DC Negative
Nickel and Ni Alloys	Direct Current (-)	DC Negative
Titanium and Ti Alloys	Direct Current (-)	DC Negative
Aluminum and Al Alloys	Alternating Current (-)	
	Direct Current (-) with Helium	DC Negative
Magnesium and Mg Alloys	Alternating Current (-)	

3.2 C-Min Steel

TIG welding may be used for welding carbon steel but because deposition rates are low, it is usually only used for welding sheet and thin sections for high quality applications, small components, and root passes of multipass butt joints in plate and pipe.

Standard DC TIG equipment is normally suitable and DCEN polarity is usually chosen to provide good workpiece heating.

Only inert or reducing gases should be used for TIG welding and pure argon is normally recommended as the shielding gas for steel.

Filler rods are usually selected to match the chemical composition and the mechanical properties of the parent plate. The weldability of the steel may impose restrictions on the choice of filler rod.

Steels with carbon contents above about 0.3% are hardenable, and fast cooling will produce a has HAZ and this is liable to result in hydrogen cracking. This form of cracking can be prevented by use of preheat and suitable welding procedures.

Plate Thickness (mm)	Joint Type	Number of passes	Tungsten Electrode Size (mm)	Consumable Size (mm)	Current (A)	Welding Travel Speed (cm/min)	Gasflow (l/min)
0.8	Fillet	1	1.6	1.5	70	30	5
1.0	Fillet	1	1.6	1.5	90	30	5
1.5	Fillet	1	1.6	2.0	110	30	6
2.0	Fillet	1	2.4	2.5	130	25	6
1.0	Butt	1	1.6	1.5	80	20	6
1.5	Butt	1	1.6	2.0	120	20	7
2.0	Butt	1	2.4	2.5	140	20	7

3.3 Alloyed Steel

TIG welding may be used for welding alloy steels but because deposition rates are low, it is usually only used for welding sheet and thin sections for high quality applications, small components, and root passes of multipass butt joints in plate and pipe.

Standard DC TIG equipment is normally suitable and DCEN polarity is usually chosen to provide good workpiece heating. Tungsten electrodes with additions of thorium oxide, cerium oxide or lanthanum oxide are used for welding steel and they give good arc stability. Only inert or reducing gases should be used for TIG welding and pure argon is normally recommended as the shielding gas for welding alloy steel.

Filler rods are usually selected to match the chemical composition and the mechanical properties of the parent plate. The weldability of the steel may impose restriction on the choice of filler rod.

Alloy steels with high carbon equivalents are hardenable, and fast cooling will produce a hard HAZ and this is liable to result in hydrogen cracking. This form of cracking can be prevented by use of preheat and suitable welding procedures.

Plate Thickness (mm)	Tungsten Electrode Size (mm)	Consumable Size (mm)	Current (A)	Gasflow (l/min)
1.0	1.0	1.0	30-60	3-4
1.5	1.6	1.5	70-100	3-4
2.0	1.6	1.5-2.0	9-110	4
3.0	16.-2.4	2.0-3.0	120150	4-5
5.0	2.4-3.2	3.0-4.0	190-250	4-
6.0	3.2-4.0	4.0-6.0	220-340	5-6
8.0	4.0	4.0-6.0	300-360	5-6
12.0	4.8-6.4	4.0-6.0	350-450	5-7

3.4 Stainless Steel

Is a high quality process ideally suited for welding of stainless steels, particularly thin sheet up to about 5mm thick where weld integrity and good surface finish are critical. The process has a high degree of controllability resulting in clean, smooth, high quality welds with god penetration and strength with very low defect rates.

Standard TIG equipment is suitable and stainless steels are TIG welded using DCEN polarity. A thoriated tungsten electrode is normally used but health concerns have promoted use of ceriated or lanthanated instead. The filler rod used depends on the type of stainless being welded but, in general, is matching for austenitic grades, enriched in nickel for duplex grades, and may be matching or an austenitic type for ferritic and martensitic grades.

Shielding gas is conventionally pure argon, but other gases are available to provide specific properties and these include argon-hydrogen, argon-helium mixtures, argon-helium-hydrogen, and argon-nitrogen mixtures.

When welding pipes an inert gas purge is required inside the pipe to prevent oxidation on the underside of the weld. Gas purging may also be used to protect the root side of butt welds in plate or sheet materials too.

3.5 Aluminum

Is a high quality process widely used for welding aluminum, particularly in section size up to about 6mm. The process may be operated with or without filler.
TIG welding of aluminum can be carried out using any of the three standard operating modes, alternating current (AC), direct current electrode negative (DCEN) and direct current electrode positive (DCEP).
AC is the most frequently used since with AC cleaning of the oxide film occurs on the electrode positive cycle and heating occurs on the electrode negative cycle. With aluminum the surface oxide film must be removed to allow full fusion to take place and AC TIG does this efficiently, allowing high quality joints to be made. High purity argon and argon-helium shielding gas mixtures can be used.
The AC output may be conventional sine wave or square wave and many electronic power sources allow the AC waveform to be adjusted, and also provide facilities for pre and post gas flow and current slope in and slope out.

3.6 Balanced Squarewave

The balance on squarewave machines can be adjusted to achieve the desire results. Greater amounts of EN create a deeper, narrower weldbead and better joint penetration. This helps when welding thick material and promote faster welding speeds. Greater amounts of EP removes more oxides from the surface but also have a shallower penetration.

Plate Thickness (mm)	Joint Type	Tungsten Electrode Size (mm)	Consumable Size (mm)	Current (A)	Welding Speed (mm/min)	Gasflow (l/min)
1.0	Square Butt	1.6	1.6	75	26	5
2.0	Square Butt	1.6	3.2	110	21	6
3.0	Square Butt	2.4	3.2	125	17	6
4.0	Square Butt	2.4	3.2	160	15	8
5.0	Square Butt	2.4	3.2	185	14	10
5.0	V-butt (70)	3.2	3.2	165	14	12
6.0	Square Butt	3.2	3.2	210	8	12
6.0	V-butt (70)	32	3.2	185	10	12

Alternatin current, Welding position, Downhand, Pure Aluminum

3.7 Copper and Copper Alloys

Cleanliness is important when welding copper, and all dirt, grease and other contaminants must be removed before welding. Copper alloys containing aluminum will from a surface oxide film and this must also be removed before welding. Preheat will be required for unalloyed copper but some copper alloys can be TIG welded without preheat except on thick sections.

Standard DC TIG welding equipment is suitable for most copper and copper alloys, but aluminum bronze is normally TIG welded using AC current to break down the tenacious oxide film on the surface.

Pure argon, helium or argon-helium mixtures are standard shielding gases for DC TIG welding copper and copper alloys. Alushield Heavy is ideal for TIG welding copper and some copper alloys, particularly in thicker sections. Pure argon is the shielding gas used fro AC TIG welding.

TIG consumables are solid filler rods based on pure copper and several copper alloy compositions, including aluminum bronzes, silicon bronzes, and cupro-nickels. It is normal to try to use a filler material with similar composition to that of the parent material but this is not always possible, and sometimes not desirable.

Porosity is the main welding problem encountered when TIG welding unalloyed copper and some copper alloys are prone to solidification cracking and porosity. Certain alloys are difficult to weld (brass will lose zinc if welding is attempted) and those containing lead are virtually unweldable.

Problem	Cause	Solution
Excessive electrode consumption	1.Inadequate gas flow	1. Increase gas flow
	2. Improper size electrode for current required	2. Use larger electrode
	3. Operating reverse polarity	3. Use larger electrode or change polarity
	4. Electrode contamination	4. Remove contaminated portion, then prepare again
	5. Excessive heating inside torch	5. Replace collet. Try wedge collet or reverse collet.
	6. Electrod oxidising during cooling	6. Increase gas flow post time to 1 sec per 10 amps
	7. Sheild gas incorrect	7. Change to proper gas (no oxygen or CO2)
Erratic Arc	1. Incorrect voltage (arc too long)	1. Maintain short arc length
	2. Current too low for electrode size	2. Use smaller electrod or increase current
	3. Electrode contaminated	3. Remove contaminated portion, then prepare again
	4. Joint too narrow	4. Open joint groove
	5. Contaminated shield gas, Dark stains on the electrode or weld bead indicte contamination	5. The most common cause is moisture or aspirated air in gas stream. Use welding grad gas only. Find the source of the contamination and eliminate it properly.
	6. Base metal is oxidised, dirty or oily	6. Use appropriate chemical cleaners, wire brush or abrasives prior to welding.
Inclusion of tungsten or oxides in weld	1. Poor scratch starting technique	1. Many codes do not allow scratch starts. Use copper strike plate. Use high frequency arc starter.
	2. Excessive current for tungsten size used	2. Reduce the current or use larger electrode
	3. Accidental contact of electrode with puddle	3. Maintain proper arc length
	4. Accidental contact of electrode to filler rod	4. Maintain a distance between electrode and filler metal
	5. Using excessive electro extension	5. Reduce the electrode extension to recommended limits
	6. Inadequate sheilding or excessive drafts	6. Increase gas flow, shield arc from wind, or use gas lens
	7. Wrong gas	7. Do not use ArO2, or ArCO2, GMAW (MIG) gases for TIG welding

Problem	Cause	Solution
Porosity in Weld Deposit	1. Entrapped impurities, hydrogen, air, nitrogen, water vapour	1. Don not weld on wet material. Remove condensation from line with adequate gas pre-flow time
	2. Defect gas hose or loose connection	Check hoses and connections for leaks
	3. Filler material is damp (particularly aluminum)	Dry filler metal in oven prior to welding
	4. Filler material is oily or dusty	4. Replace filler material
	5. Alloy impurities in the base metal such as sulfur, phosphorous, lead and zinc	5. Change to a different alloy composition which is weldable. These impurities can cause a tendency to crack when hot.
	6. Excessive travel speed with rapid freezing of weld trapping gases before they escape.	6. Lower the travel speed.
	7. Contaminated shield gas	7. Replace the shielding gas.
Cracking in Welds	1. Hot cracking in heavy section or with metals which are hot shorts	1. Pre-heat. Increase weld bead cross-section size. Change weld bead contour. Use metal with fewer alloy impurities.
	2. Crater cracks due to improperly breaking the arc or terminating the weld at the joint edge.	2. Reverse direction and weld back into previous weld at edge. Use Amprak or foot control to manually down slope current.
	3. Post weld cold cracking due to excessive joint restraint, rapid cooling or hydrogen embrittlement.	3. Pre-heat prior to welding. Use pure or non-contaminated gas. Increase bead size. Prevent craters or notches. Change the weld joint design.
	4. Centerline cracks in single pass weld.	4. Increase bead size. Decrease root opening. Use pre-heat. Prevent craters
	5. Underbead cracking from brittle microstructure	5. Eliminate sources of hydogen, joint restraint and use pre-heat
Inadequate Sheilding	1. Gas flow blockage or leak in hoses or torch	1. Locate and eliminate blockage or leak.
	2. Excessive travel speed exposes molten weld to atmospheric contamination	2. Use slower travel speed or carefully increase the flow rate to a safe level below creating excessive turbulence. Use a trailing sheild cup.
	3. Wind or drafts	3. Set up screens around weld area.
	4. Excessive electrode stick out.	4. Reduce electrode stick out. Use a larger size cup.
	5. Excessive turbulence in gas stream.	5. Change to gas safer parts or gas lens parts.

Problem	Cause	Solution
Arc Blow	1. Induced magnetic field from DC weld current.	1. Change to ACHF current. Rearrange the split ground connection.
	2. Arc is unstable due to magnetic influence.	2. Reduce weld current and use arc length as short as possible
Short Parts Life	1. Short water cooled leads life	1. Verify coolant flow direction. Return flow must be on the power cable lead.
	2. Cup shattering or cracking during use	2. Change cup size or type. Change tungsten position.
	3. Short collet life	3. Ordinary style is split and twists or jams. Change to wedge style.
	4. Short torch head life	4. Do not operate beyond rated capacity. Use water cooled model. Do not bend rigid torches