

Smootharc TIG 185 AC/DC Operating Manual



Welcome to a better way of welding.

This operating manual provides the basic knowledge required for TIG welding, as well as highlighting important areas of how to operate the Smootharc TIG 185 AC/DC machine.

With normal use and by following these recommended steps, your Smootharc TIG 185 AC/DC machine can provide you with years of trouble free service. BOC equipment and technical support is available through our national BOC Customer Service Centre or contact your local Gas & Gear outlet.

Important Notice

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1.0 Recommended safety guidelines and precautions

Diagram and safety explanation



Electrical safety alert



Welding electrode causing electric shock



Fumes and gases coming from welding process



Welding arc rays



Read instruction manual



Become trained



Wear dry, insulated gloves



Insulate yourself from work and ground



Disconnect input power before working on equipment



Keep head out of fumes



Use forced ventilation or local exhaust to remove fumes



Use welding helmet with correct shade of filter

Some safety precautions BOC recommends are as follows:

- Repair or replace defective cables immediately.
- Never watch the arc except through lenses of the correct shade.
- In confined spaces, adequate ventilation and constant observation are essential.
- Leads and cables should be kept clear of passageways.
- Keep fire extinguishing equipment at a handy location in the workshop.
- Keep primary terminals and live parts effectively covered.
- Never strike an arc on any gas cylinder.
- Never use oxygen for venting containers.

1.1 Health hazard information

The actual process of welding is one that can cause a variety of hazards. All appropriate safety equipment should be worn at all times, i.e. headwear, hand and body protection. Electrical equipment should be used in accordance with the manufacturer's recommendations.

Eyes

The process produces ultra violet rays that can injure and cause permanent damage. Fumes can cause irritation.

Skin

Arc rays are dangerous to uncovered skin.

Inhalation

Welding fumes and gases are dangerous to the health of the operator and to those in close proximity. The aggravation of pre-existing respiratory or allergic conditions may occur in some workers. Excessive exposure may cause conditions such as nausea, dizziness, dryness and irritation of eyes, nose and throat.

1.2 Personal protection

Respiratory

Confined space welding should be carried out with the aid of a fume respirator or air supplied respirator as per AS/NZS 1715 and AS/NZS 1716 Standards.

- You must always have enough ventilation in confined spaces. Be alert to this at all times.
- Keep your head out of the fumes rising from the arc.

- Fumes from the welding of some metals could have an adverse effect on your health. Don't breathe them in. If you are welding on material such as stainless steel, nickel, nickel alloys or galvanised steel, further precautions are necessary.
- Wear a respirator when natural or forced ventilation is insufficient.

Eye protection

A welding helmet with the appropriate welding filter lens for the operation must be worn at all times in the work environment. The welding arc and the reflecting arc flash gives out ultraviolet and infrared rays. Protective welding screen and goggles should be provided for others working in the same area.

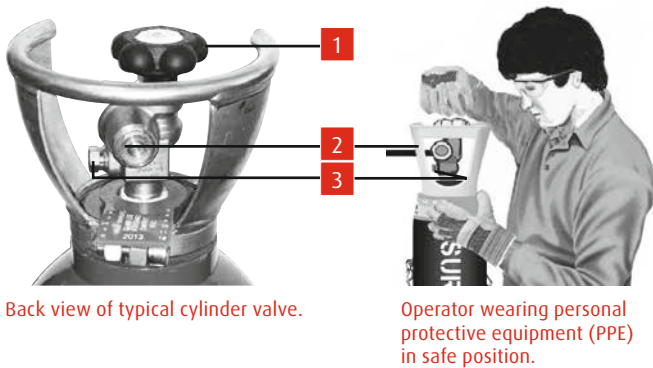
Recommended filter shades for arc welding

Less than 150 amps	Shade 10*
150 to 250 amps	Shade 11*
250 to 300 amps	Shade 12
300 to 350 amps	Shade 13
Over 350 amps	Shade 14

*Use one shade darker for aluminium.

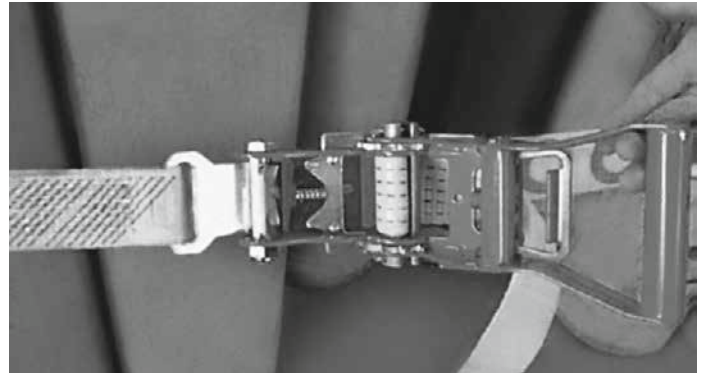
Clothing

Suitable clothing must be worn to prevent excessive exposure to UV radiation and sparks. An adjustable helmet, flameproof loose-fitting cotton clothing buttoned to the neck, protective leather gloves, spats, apron and steel capped safety boots are highly recommended.



Back view of typical cylinder valve.

Operator wearing personal protective equipment (PPE) in safe position.



Cylinder safety diagram

- | | |
|---|---------------------------|
| 1 | Cylinder valve hand-wheel |
| 2 | Back-plug |
| 3 | Bursting disc |

Ten points about cylinder safety

- | | |
|----|---|
| 1 | Read labels and Material Safety Data Sheet (MSDS) before use |
| 2 | Store upright and use in well ventilated, secure areas away from pedestrian or vehicle thoroughfare |
| 3 | Guard cylinders against being knocked violently or being allowed to fall |
| 4 | Wear safety shoes, glasses and gloves when handling and connecting cylinders |
| 5 | Always move cylinders securely with an appropriate trolley. Take care not to turn the valve on when moving a cylinder |
| 6 | Keep in a cool, well ventilated area, away from heat sources, sources of ignition and combustible materials, especially flammable gases |
| 7 | Keep full and empty cylinders separate |
| 8 | Keep ammonia-based leak detection solutions, oil and grease away from cylinders and valves |
| 9 | Never use force when opening or closing valves |
| 10 | Don't repaint or disguise markings and damage. If damaged, return cylinders to BOC immediately |

Cylinder valve safety

When working with cylinders or operating cylinder valves, ensure that you wear appropriate protective clothing – gloves, boots and safety glasses.

When moving cylinders, ensure that the valve is not accidentally opened in transit.

Before operating a cylinder valve

Ensure that the system you are connecting the cylinder into is suitable for the gas and pressure involved.

Ensure that any accessories (such as hoses attached to the cylinder valve, or the system being connected to) are securely connected. A hose, for example, can potentially flail around dangerously if it is accidentally pressurised when not restrained at both ends.

Stand to the side of the cylinder so that neither you nor anyone else is in line with the back of the cylinder valve. This is in case a back-plug is loose or a bursting disc vents. The correct stance is shown in the diagram above.

When operating the cylinder valve

Open it by hand by turning the valve hand-wheel anti-clockwise. Use only reasonable force.

Ensure that no gas is leaking from the cylinder valve connection or the system to which the cylinder is connected. DO NOT use ammonia-based leak detection fluid as this can damage the valve. Approved leak detection fluid, can be obtained from a BOC Gas & Gear centre.

When finished with the cylinder, close the cylinder valve by hand by turning the valve hand-wheel in a clockwise direction. Use only reasonable force.

Remember NEVER tamper with the valve.

If you suspect the valve is damaged, DO NOT use it. Report the issue to BOC and arrange for the cylinder to be returned to BOC.

1.3 Electrical shock

- Never touch 'live' electrical parts
- Always repair or replace worn or damaged parts
- Disconnect power source before performing any maintenance or service
- Earth all work materials
- Never work in moist or damp areas

Avoid electric shock by:

- Wearing dry insulated boots
- Wearing dry leather gloves
- Never changing electrodes with bare hands or wet gloves
- Never cooling electrode holders in water
- Working on a dry insulated floor where possible
- Never hold the electrode and holder under your arm

1.4 User responsibility

- Read the Operating Manual prior to installation of this machine
- Unauthorised repairs or modifications to this equipment may endanger the technician and operator and will void your warranty. Only qualified personnel approved by BOC should perform repairs
- Always disconnect mains power before investigating equipment malfunctions
- Parts that are broken, damaged, missing or worn should be replaced immediately
- Equipment should be cleaned periodically

BOC stock a huge range of personal protective equipment. This combined with BOC's extensive Gas and Gear network ensures fast, reliable service throughout the South Pacific.

STOP

PLEASE NOTE that under no circumstances should any equipment or parts be altered or changed in any way from the standard specification without written permission given by BOC. To do so, will void the Equipment Warranty.

Further information can be obtained from Welding Institute of Australia (WTIA) Technical Note No.7.

Health and Safety Welding

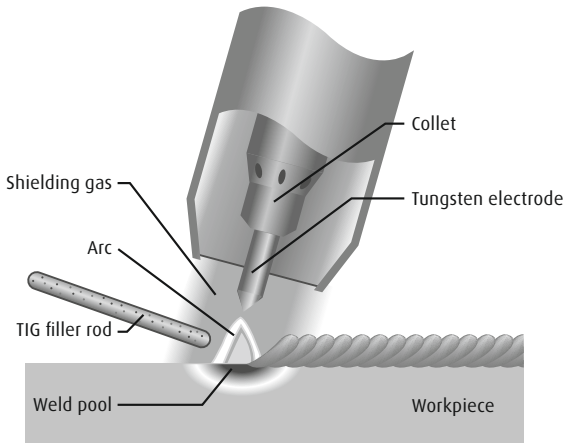
Published by WTIA,

PO Box 6165 Silverwater NSW 2128

Phone (02) 9748 4443

2.0 Gas tungsten arc welding (GTAW/TIG)

Schematic of the TIG welding process



2.1 Introduction

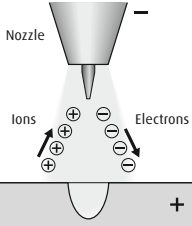
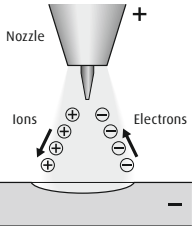
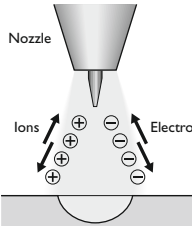
The Tungsten Inert Gas, or TIG process, uses the heat generated by an electric arc struck between a non-consumable tungsten electrode and the workpiece to fuse metal in the joint area and produce a molten weld pool. The arc area is shrouded in an inert or reducing gas shield to protect the weld pool 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.

2.2 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 one of several methods between the tungsten and the workpiece.

2.3 Process variables

Process variable	Explanation	Usage
<p>DCEN</p> <p>Narrow bead, deep penetration</p> 	<p>When direct-current electrode-negative (straight polarity) is used:</p> <ul style="list-style-type: none"> • 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 	<p>For a given diameter of tungsten electrode, higher amperage can be used with straight polarity. Straight polarity is used mainly for welding:</p> <ul style="list-style-type: none"> • Carbon steels • Stainless steels • Copper alloys <p>The increased amperage provides:</p> <ul style="list-style-type: none"> • Deeper penetration • Increased welding speed • A narrower, deeper, weld bead
<p>DCEP</p> <p>Wide bead, shallow penetration</p> 	<p>The DCEP (reverse polarity) are different from the DCEN in following ways:</p> <ul style="list-style-type: none"> • High heat is produced on the electrode rather on the base metal • The heat melts the tungsten electrode tip • The base metal remains relatively cool compared to using straight polarity • Relatively shallow penetration is obtained • An electrode whose diameter is too large will reduce visibility and increase arc instability 	<ul style="list-style-type: none"> • 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 with DCEN)
<p>Alternating Current with High-Frequency</p> <p>Average bead, Average penetration</p> 	<p>Welding with alternating current combines both direct-current characteristics:</p> <ul style="list-style-type: none"> • 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. 	

2.4 Shielding gas selection

Material	Shielding gas	Benefits
Aluminium Alloys	Argon	Used with high frequency AC good stable arc good cleaning action
	Argon/Helium	Used with high frequency AC good cleaning action higher welding speed increased penetration
Aluminium 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
Deoxidised copper	Helium	Increased heat input Stable arc Good penetration
	Helium(75%)/Argon(25%)	Stable arc 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

2.5 Welding wire selection

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

Base material	BOC Consumable
C-Mn and low carbon steels	BOC Mild steel TIG wire
Low Alloy steels	
1.25Cr/0.5Mo	Comweld CrMo1
2.5Cr/1Mo	Comweld CrMo2
Stainless Steel	
304/304L	Profill 308
316/316L	Profill 316
309/309-C-Mn	Profill 309
321/Stabilised grades	Profill 347
Aluminium	
1000 series	Comweld 1100
5000 series	Comweld 4043/4047/5356
6000 series	Comweld 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

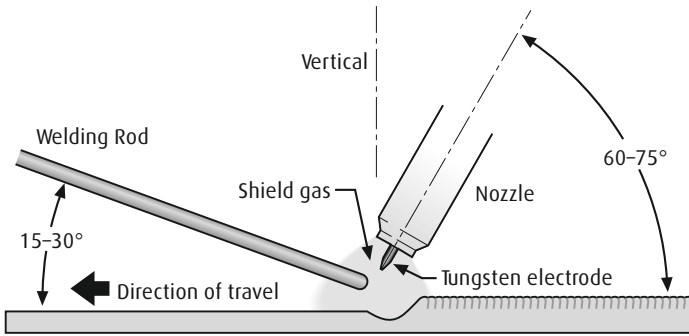
2.6 Non consumable tungstens

Tungsten Electrode Selector Chart

Thickness range	Desired results	Welding current	Electrode type	Shielding gas	Tungsten performance characteristics
Aluminium alloys and Magnesium alloys					
All	General purpose	ACHF	Pure (EW-P)	Argon	Balls easily. Low cost. Tends to spit at higher currents. Used for non-critical welds only.
			Zirconiated (EW-Zr)	Argon	Balls well. Takes higher current, with less spitting and with better arc starts and arc stability than pure tungsten.
			2% Thoriated (EW-Th2)	75% Argon/ 25% Helium	Higher current range and stability. Better arc starts, with lower tendency to spit. Medium erosion.
Only thin sections	Control penetration	DCRP	2% Ceriated (EW-Ce2)	Argon Helium	Lowest erosion rate. Widest current range. AC or DC. No spitting. Best arc starts and stability.
Only thick sections	Increase penetration or travel speed	DCSP	2% Thoriated (EW-Th2)	75% Argon/ 25% Helium	Best stability at medium currents. Good arc starts. Medium tendency to spit. Medium erosion rate.
			2% Ceriated (EW-Ce2)	Helium	Low erosion rate. Wide current range. AC or DC. No spitting. Consistent arc starts. Good stability.
Copper alloys, Cu-Ni alloys and Nickel alloys					
All	General purpose	DCSP	2% Thoriated (EW-Th2)	75% Argon/ 25% Helium	Best stability at medium currents. Good arc starts. Medium tendency to spit. Medium erosion rate.
			2% Ceriated (EW-Ce2)	75% Argon/ 25% Helium	Low erosion rate. Wide current range. AC or DC. No spitting. Consistent arc starts. Good stability.
Only thin sections	Control penetration	ACHF	Zirconiated (EW-Zr)	Argon	Use on lower currents only. Spitting on starts. Rapid erosion rates at higher currents.
Only thick sections	Increase penetration or travel speed	DCSP	2% Ceriated (EW-Ce2)	75% Argon/ 25% Helium	Low erosion rate. Wide current range. AC or DC. No spitting. Consistent arc starts. Good stability.
Mild Steels, Carbon Steels, Alloy Steels, Stainless Steels and Titanium alloys					
All	General purpose	DCSP	2% Thoriated (EW-Th2)	75% Argon/ 25% Helium	Best stability at medium currents. Good arc starts. Medium tendency to spit. Medium erosion rate.
			2% Ceriated (EW-Ce2)	75% Argon/ 25% Helium	Low erosion rate. Wide current range. AC or DC. No spitting. Consistent arc starts. Good stability.
			2% Lanthanated (EWG-La2)	75% Argon/ 25% Helium	Lowest erosion rate. Widest current range on DC. No spitting. Best DC arc starts and stability.
Only thin sections	Control penetration	ACHF	Zirconiated (EW-Zr)	Argon	Use on lower current only. Spitting on starts. Rapid erosion rates at higher currents.
Only thick sections	Increase penetration or travel speed	DCSP	2% Ceriated (EW-Ce2)	75% Argon/ 25% Helium	Low erosion rate. Wide current range. No spitting. Consistent arc starts. Good stability.
			2% Lanthanated (EWG-La2)	Helium	Lowest erosion rate. Highest current range. No spitting. Best DC arc starts and stability.

2.7 Welding techniques

TIG Welding techniques

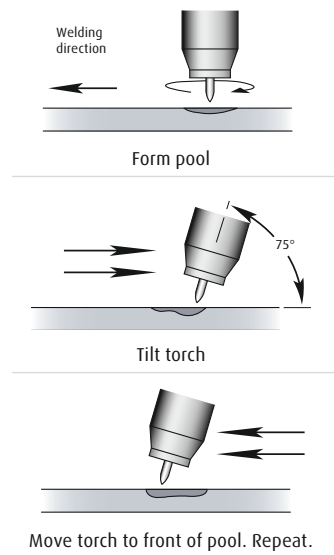


The suggested electrode and welding rod angles for welding a bead on plate are shown above. The same angles are used when making a butt weld. The torch is held 60-75° from the metal surface. This is the same as holding the torch 15-30° from the vertical.

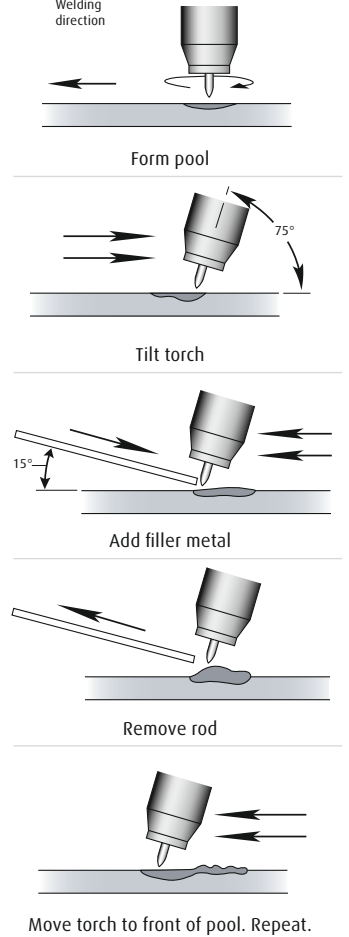
Take special note that the rod is in the shielding gas during the welding process.

2.8 Torch movement during welding

Tungsten Without Filler Rod

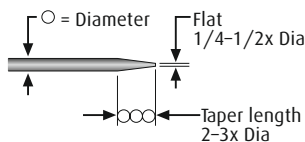


Tungsten With Filler Rod



Tungsten tip preparation

DCSP (EN) or DCRP (EP)



ACHP General Purpose



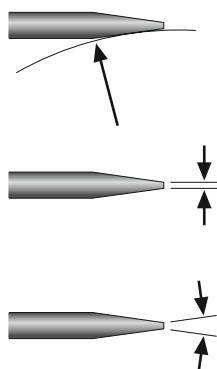
Ball tip by arcing on clean metal at low current DCRP (EP) then slowly increase current to form the desired ball diameter. Return setting to AC.

Tungsten grinding

Shape by grinding longitudinally (never radially). Remove the sharp point to leave a truncated point with a flat spot. Diameter of flat spot determines amperage capacity (See below).

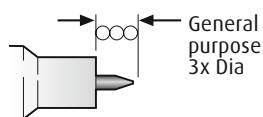
The included angle determines weld bead shape and size. Generally, as the included angle increases, penetration increases and bead width decreases.

Use a medium (60 grit or finer) aluminium oxide wheel.

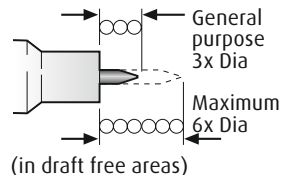


Tungsten extension

Standard Parts



Gas Lens Parts



Tungsten electrode tip shapes and current ranges

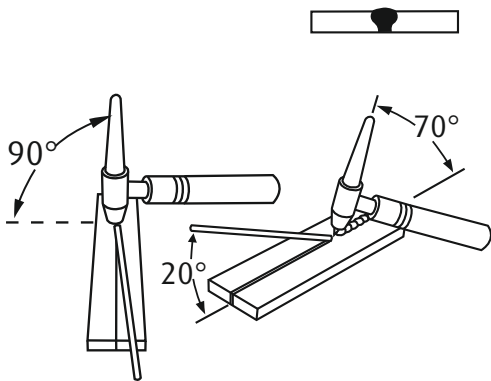
Thoriated, ceriated, and lanthanated tungsten electrodes do not ball as readily as pure or zirconiated tungsten electrodes, and as such are typically used for DCSP welding. These electrodes maintain a ground tip shape much better than the pure tungsten electrodes. If used on AC, thoriated and lanthanated electrodes often spit. Regardless of the electrode tip geometry selected, it is important that a consistent tip configuration be used once a welding procedure is established. Changes in electrode geometry can have a significant influence not only on the weld bead width, depth of penetration, and resultant quality, but also on the electrical characteristics of the arc. Below is a guide for electrode tip preparation for a range of sizes with recommended current ranges.

Tungsten electrode tip shapes and current ranges

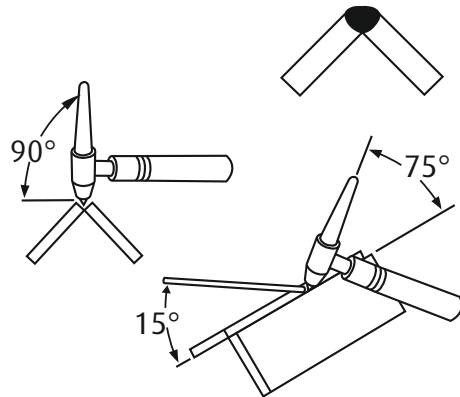
Electrode diameter (mm)	Diameter arc tip (mm)	Constant included angle, (degrees)	Current range (A)
1.0	0.125	12	2-15
1.0	0.250	20	5-30
1.6	0.500	25	8-50
1.6	0.800	30	10-70
2.3	0.800	35	12-90
2.3	1.100	45	15-150
3.2	1.100	60	20-200
3.2	1.500	90	25-250

2.9 Positioning torch tungsten for various weld joints

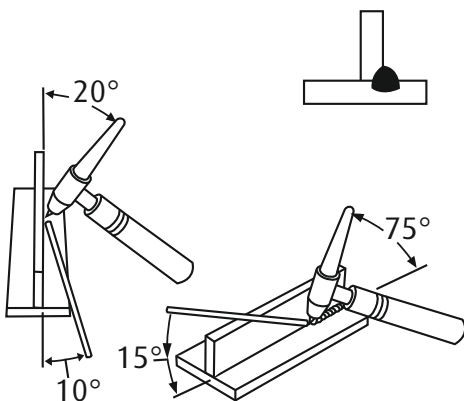
Butt Weld and Stringer bead



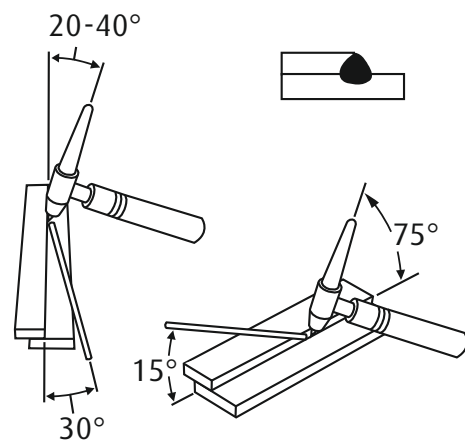
Corner Joint



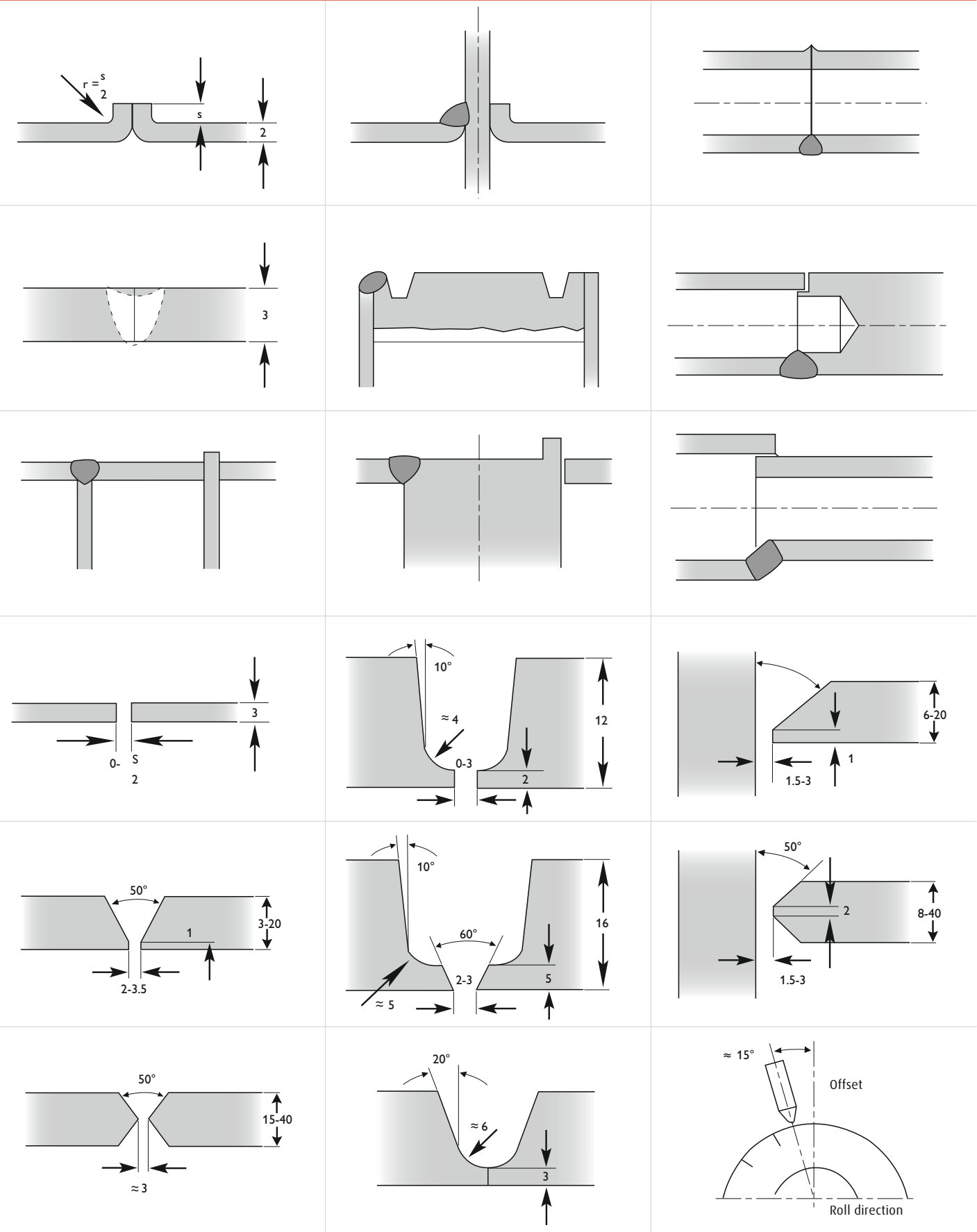
'T' Joint



Lap Joint



2.10 Joint preparation

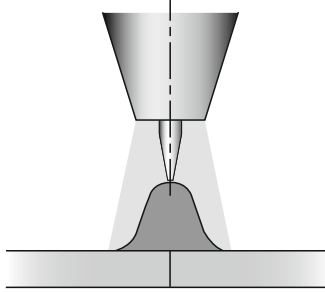


All measurements in mm

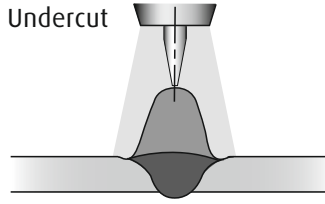
Condition

Result

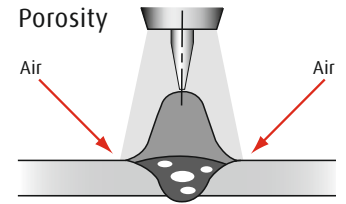
Long arc length



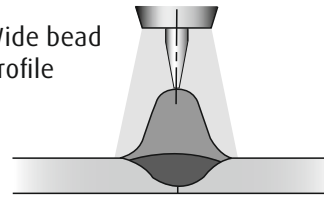
Undercut



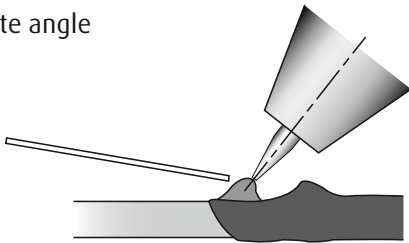
Porosity



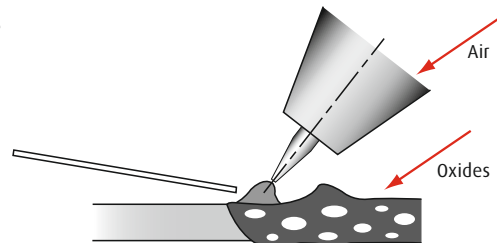
Wide bead profile



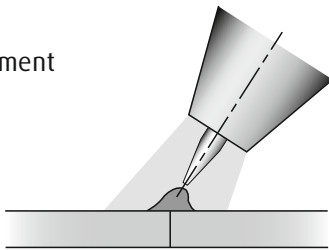
Acute angle



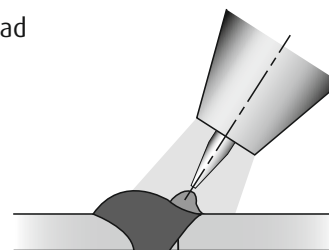
Loss of gas coverage



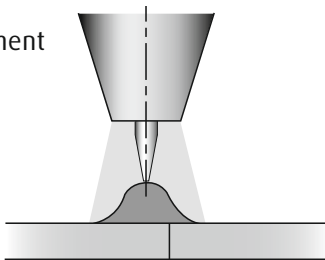
Angular mis-alignment



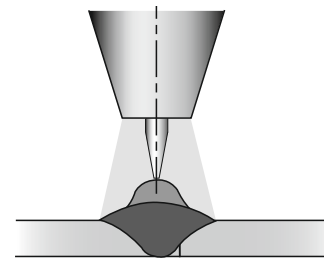
Unsymmetrical bead profile



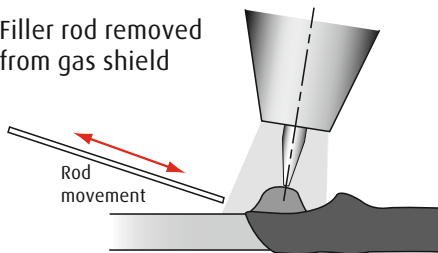
Mis-alignment



Incomplete penetration

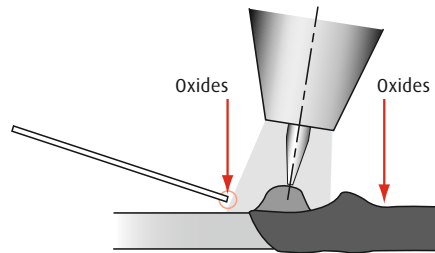


Filler rod removed from gas shield



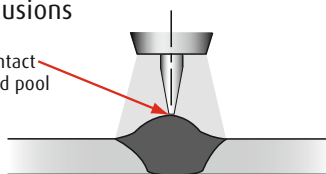
Oxides

Oxides

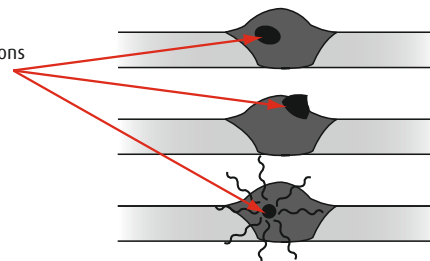


Tungsten inclusions

Electrode contact with the weld pool



Tungsten inclusions



3.0 TIG welding of materials

3.1 Application summary

Material	Type of current	Polarity
C-Mn 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
Magesium and Mg alloys	Alternating current (~)	

3.2 C-Mn 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 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.

C-Mn steel welding parameters

Plate thickness (mm)	0.8	1	1.5	2	1	1.5	2
Joint type	Fillet	Fillet	Fillet	Fillet	Butt	Butt	Butt
Number of passes	1	1	1	1	1	1	1
Tungsten electrode (mm)	1.6	1.6	1.6	2.4	1.6	1.6	2.4
Consumable size (mm)	1.5	1.5	2	2.5	1.5	2	2.5
Current (A)	70	90	110	130	80	120	140
Welding speed (cm/min)	30	30	30	25	20	20	20
Gasflow (l/min)	5	5	6	6	6	7	7

Shielding gas: Argon, Consumable ER70S-6, Position: Downhand, Polarity: DC-

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 restrictions 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.

3.4 Stainless steel

TIG is a high quality process ideally suited for welding of stainless steels, particularly thin sheet up to about 5 mm 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 good 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.

General welding parameters

Plate thickness (mm)	1	1.5	2	3	5	6	8	12
Tungsten electrode (mm)	1	1.6	1.6	1.6-2.4	2.4-3.2	3.2-4.0	4	4.8-6.4
Gas flow (l/min)	3-4	3-4	4	4-5	4-6	5-6	5-6	5-7
Current (A)	30-60	70-100	90-110	120-150	190-250	220-340	300-360	350-450
Consumable size (mm)	1	1.5	1.5-2.0	2.0-3.0	3.0-4.0	4.0-6.0	4.0-6.0	4.0-6.0

Polarity: DC-

3.5 Aluminium

TIG is a high quality process widely used for welding aluminium, particularly in section size up to about 6mm. The process may be operated with or without filler.

TIG welding of aluminium 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 aluminium 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.

Aluminium welding parameters

Plate Thickness (mm)	1	2	3	4	5	5	6	6
Joint type	Square butt	Square butt	Square butt	Square butt	Square butt	V-butt (70)	Square butt	V-butt (70)
Tungsten size (mm)	1.6	1.6	2.4	2.4	2.4	3.2	3.2	3.2
Consumable Size (mm)	1.6	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Current (A)	75	110	125	160	185	165	210	185
Welding speed (mm/min)	26	21	17	15	14	14	8	10
Gas flow (l/min)	5	6	6	8	10	12	12	12

Alternating current, Welding position: Downhand: Pure Aluminium

3.6 Balanced squarewave

The balance on squarewave machines can be adjusted to achieve the desired 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.

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 aluminium will form 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 aluminium 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 for AC TIG welding.

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

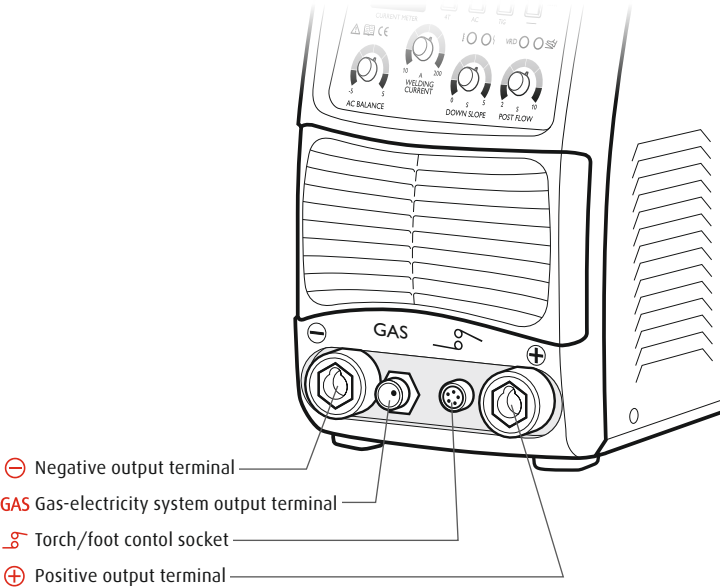
Porosity is the main welding problem encountered when TIG welding unalloyed copper and some copper alloys are prone to solidification cracking and porosity. Certain alloys are difficult to weld (brass will lose zinc if welding is attempted), and welding is not recommended for those containing lead.

Copper and copper alloy welding parameters

Plate thickness (mm)	1.5	3	5
Joint type	Square butt	Square butt	Square butt
Root gap (mm)	1.0	2.0	3.0
Layers	1	1	2
Tungsten size (mm)	1.6	3.2	4.0
Consumable size (mm)	2.0	3.0	4.0
Current (A)	120	185	270
Welding speed (cm/min)	0.29	0.25	0.15
Gasflow (l/min)	7	8	8

4.0 Package contents

Front Connections of TIG 185 AC/DC



Package Contents

- Power source

- Work return lead

- TIG torch

- MMA electrode holder and cable

- Regulator

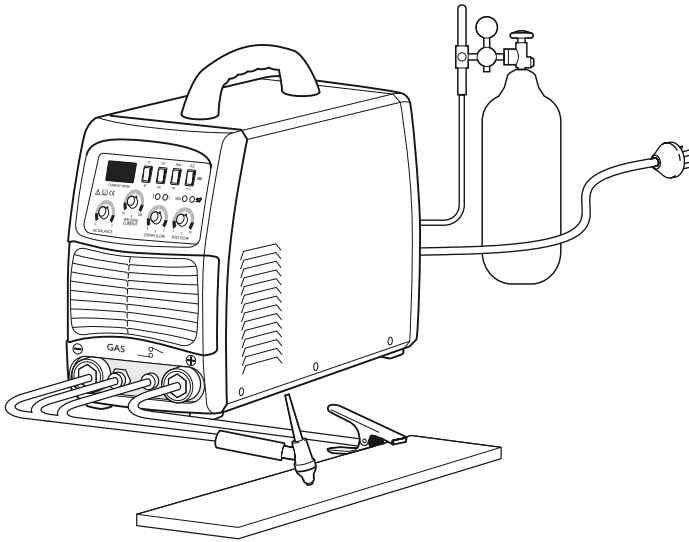
- Gas hose

- Operator's manual

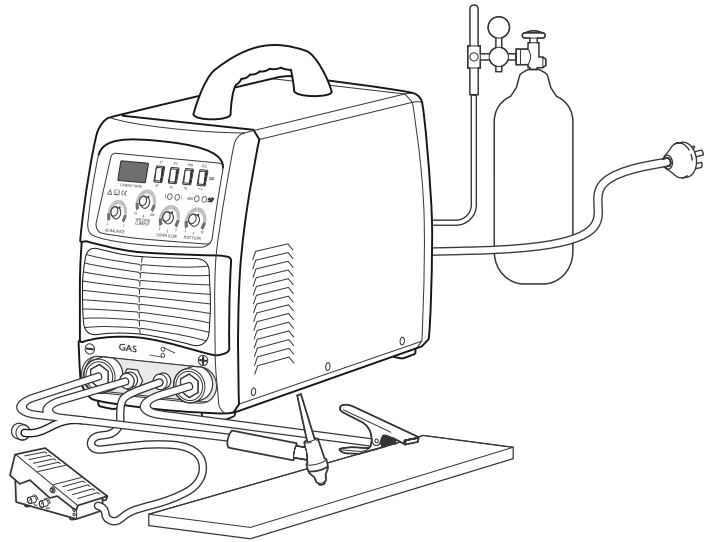
- Foot control (optional extra)

5.0 Smootharc TIG 185 AC/DC installation

Installation for TIG setup



Installation for TIG setup using foot control



WARNING

Before installing please ensure that all the power is turned off. Connect the work return lead to the machine. Ensure that the work return lead is firmly connected before connecting the power plug in to the electrical output socket. Ensure free flow of air around machine to avoid overheating.

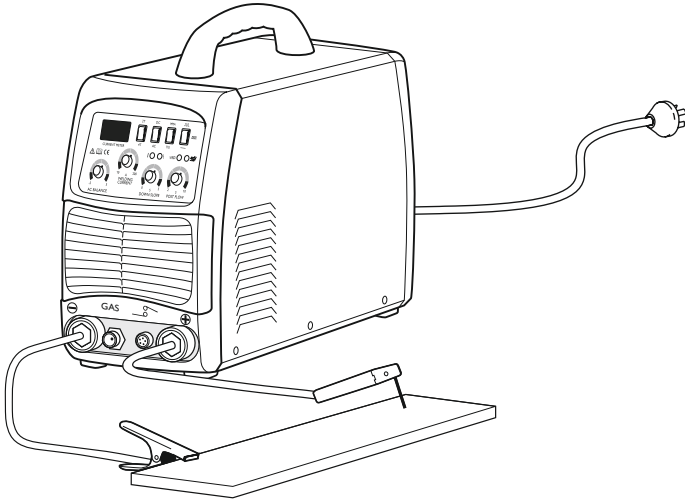
5.1 Installation for TIG setup

- 1 Connect one end of the work return lead to positive \oplus of the front panel, and fasten it clockwise. Connect the other end of the clamp to the work piece.
- 2 Connect the gas cylinder to the regulator. Select correct shielding gas for the application.
- 3 Connect the dinse plug of the TIG torch to negative \ominus of the front panel, and fasten it clockwise.
- 4 Connect securely the gas lead of the TIG torch to the gas output terminal **GAS**.
- 5 Connect the 5-pin plug of the TIG torch to the Torch/foot control socket ⏏ and fasten the screw.

5.2 Installation for TIG setup with optional foot control

- 1 Connect one end of the work return lead to positive \oplus of the front panel, and fasten it clockwise. Connect the other end of the clamp to the work piece.
- 2 Connect the gas cylinder to the regulator. Select correct shielding gas for the application.
- 3 Connect the dinse plug of the TIG torch to negative \ominus of the front panel, and fasten it clockwise.
- 4 Connect securely the gas lead of the TIG torch to the gas output terminal **GAS**.
- 5 Connect the electrical lead of the foot control to the 5-pin Torch/foot control socket ⏏ and fasten the screw.
- 6 The 5-pin plug of the TIG torch should now hang free.

Installation for MMA process

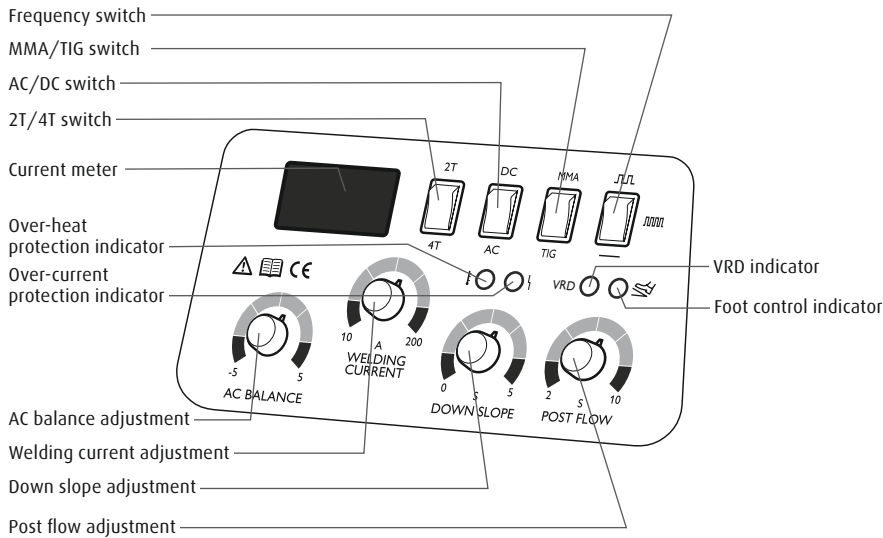


5.3 Installation for MMA process

- 1 Connect the work return lead into the negative \ominus of the machine and fasten it clockwise.
- 2 Connect the electrode holder to the positive \oplus of the machine and fasten it clockwise tightly.
- 3 Please note that for manual metal arc (MMA) welding the electrode holder can be switched to the negative pole of the welding machine if so required by the specification of the electrode.

6.0 Control panel

Control Panel of TIG 185 AC/DC



6.1 Function switches

- 1 *AC/DC switch.* AC switch intended for aluminium. DC position is for all other materials.
- 2 *2T/4T switch (trigger latching).* This special feature allows the operator to relax the trigger after first depressing it, the gas shielding to start before the welding commences. This feature is of particular importance as it ensures that the weld will have adequate gas shielding to eliminate the risk of oxidation (contaminants) causing a defective weld. (Remember, a defective weld may not be detected by a visual inspection.)
- 3 *MMA/TIG switch.* Allows you to switch between TIG and MMA welding.
- 4 *Frequency switch.* Changes the pulse frequency.

6.2 Adjustment knobs

- 1 *Welding current adjustment.* Adjusts welding current.
- 2 *AC balance adjustment.* 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.
- 3 The AC balance (time spend in the positive (maximum cleaning) or negative (maximum penetration) can be adjusted by using the *AC balance adjustment*. By adjusting the *AC balance adjustment* from 20-100% 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.
- 4 With the *AC balance adjustment* 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.

- 5 *Down slope adjustment.* Down-slope adjustment allows a gradual decrease in amperage at the end of the weld to improve crater control.
- 6 *Post flow adjustment.* Allows a variable flow of shielding gas after current has been switched off to ensure that no oxidation of both the tungsten and the weld pool happens.
- 7 *Welding current adjustment.* When switched to MMA function only the current control knob is active.

6.3 Indicator function

- 1 *Over-heat protection indicator.* This indicator will illuminate when the duty cycle of the machine has been exceeded. The machine will normally reset itself after 2-3 minutes.
- 2 *Over-current protection indicator.* This indicator will illuminate when an accidental over-current has occurred.
- 3 *VRD indicator.* This indicator will illuminate when using MMA mode.
- 4 *Foot control indicator.* This indicator will illuminate when foot control is in use.

7.0 Smootharc TIG 185 AC/DC operation

WARNING

Do not connect or disconnect the machine cables whilst welding as this may cause serious harm to yourself and/or the machine.

7.1 Operation for AC welding

- 1 Refer to section 5.1 for how to connect torch
- 2 Switch *MMA/TIG switch* to **TIG**
- 3 Set the *AC/DC switch* to **AC**
- 4 Turn on power switch on the rear of machine (fan will operate continuously)
- 5 Turn on shielding gas and regulate gas flow to specified flow rate
- 6 Select the *AC balance* control based on the degree of cleaning of the base material that is required
- 7 The post flow can be regulated by adjusting the *post flow adjustment*
- 8 Press the contactor switch on the welding torch to start up the electromagnetic valve. The sound of the high frequency spark discharge in the welding machine will be audible and the shielding gas will flow

7.2 Operation for DC welding

- 1 Switch *MMA/TIG switch* to **TIG**
- 2 Set the *AC/DC switch* to **DC**
- 3 Turn on power switch on the rear of machine (fan will operate continuously)
- 4 Turn on shielding gas and regulate gas flow to specified flow rate
- 5 The post flow can be regulated by adjusting the *post flow adjustment*
- 6 Press the contactor switch on the welding torch to start up the electromagnetic valve. The sound of the high frequency spark

discharge in the welding machine will be audible and the shielding gas will flow

7.3 Operation for foot control (TIG welding only)

- 1 Ensure the foot pedal is correctly installed as described in 5.2. The foot control indicator light will illuminate when the foot pedal is in use.
- 2 Switch *MMA/TIG switch* to **TIG**
- 3 Turn on power switch on the rear of machine (fan will operate continuously)
- 4 Turn on shielding gas and regulate gas flow to specified flow rate
- 5 The post flow can be regulated by adjusting the *post flow adjustment*
- 6 Press the foot control pedal to start up the electromagnetic valve. The sound of the high frequency spark discharge in the welding machine will be audible and the shielding gas will flow
- 7 Step on the foot switch for remote control. The minimum and maximum current can be set by the two dials on the side. These dials control the percentage of the welding current that has been selected on the machine. e.g. if you set the current on the machine to 100 and you turn the 'max' dial half way then the current will not exceed 50.

7.4 Operation for MMA welding

- 1 Switch *MMA/TIG switch* to **MMA**. When using MMA function the VRD light will illuminate.
- 2 Turn on power switch (fan will operate continuously)
- 3 Select proper *welding current* according to the electrode manufacturer's specification

8.0 Troubleshooting and fault finding

Excessive electrode consumption

Cause	Solution
Inadequate gas flow	Increase gas flow
Inadequate post gas flow	Increase post flow time to 1 sec per 10 amps
Improper size electrode for current required	Use larger electrode
Operating of reverse polarity	User larger electrode or change polarity
Electrode contamination	Remove contaminated portion, then prepare again
Excessive heating inside torch	Replace collet. Try wedge collet or reverse collet
Electrode oxidising during cooling	Increase gas flow post time to 1 sec per 10 amps
Shielding gas incorrect	Change to Argon (no oxygen or CO ₂)

Erratic Arc

Cause	Solution
Incorrect voltage (arc too long)	Maintain short arc length
Current too low for electrode size	Use smaller electrode or increase current
Electrode contaminated	Remove contaminated portion, then prepare again
Joint too narrow	Open joint groove
Contaminated shield gas. Dark stains on the electrode or weld bead indicate contamination	The most common cause is moisture or aspirated air in gas stream. Use welding grade gas only. Find the source of the contamination and eliminate it promptly
Base metal is oxidised, dirty or oily	Use appropriate chemical cleaners, wire brush, or abrasives prior to welding

Inclusion of tungsten or oxides in weld

Cause	Solution
Excessive current for tungsten size used	Reduce the current or use larger electrode
Accidental contact of electrode with puddle	Maintain proper arc length
Accidental contact of electrode to filler rod	Maintain a distance between electrode and filler metal
Using excessive electrode extension	Reduce the electrode extension to recommended limits
Inadequate shielding or excessive drafts	Increase gas flow, shield arc from wind, or change to gas saver or gas lens
Wrong gas	Do not use ArO ₂ or ArCO ₂ GMAW (MIG) gases for TIG welding
Heavy surface oxides not being removed	Use ACHF. Adjust balance control for maximum cleaning, or wire brush and clean the weld joint prior to welding

Porosity in Weld Deposit

Cause	Solution
Entrapped impurities, hydrogen, air, nitrogen, water vapour	Do not weld on wet material.
Defective gas hose or loose connection	Check hoses and connections for leaks
Filler material is damp (particularly aluminium)	Dry filler metal in oven prior to welding
Filler material is oily or dusty	Replace filler metal
Alloy impurities in the base metal such as sulphur, phosphorous, lead and zinc	Change to a different alloy composition which is weldable. These impurities can cause a tendency to crack when hot
Excessive travel speed with rapid freezing of weld trapping gases before they escape	Lower the travel speed
Contaminated shield gas	Replace the shielding gas

Cracking in Welds

Cause	Solution
Hot cracking in heavy sections or welding on metals prone to hot cracking	Increase weld bead cross-section size. Change weld bead contour for e.g. concave to flat or convex, check fit-up gap, reduce welding speed
Post weld cold cracking due to excessive joint restraint, rapid cooling or hydrogen embrittlement	Preheat prior to welding. Use pure or non-contaminated gas. Increase the bead size. Prevent craters or notches. Change the weld joint design
Centreline cracks in single pass weld	Increase bead size. Decrease root opening. Use preheat. Prevent craters
Underbead cracking from brittle microstructure	Eliminate sources of hydrogen, joint restraint, and use preheat

Inadequate shielding

Cause	Solution
Gas flow blockage or leak in hoses or torch	Locate and eliminate the blockage or leak
Excessive travel speed exposes molten weld to atmospheric contamination	Use slower travel speed or carefully increase the flow rate to a safe level below creating excessive turbulence. Use a trailing shield cup
Wind or drafts	Set up screens around the weld area
Excessive electrode stickout	Reduce electrode stickout. Use a larger size cup, or switch to gas saver or gas lens
Excessive turbulence in gas stream	Change to gas saver parts or gas lens parts

Short parts Life

Cause	Solution
Cup shattering or cracking in use	Change cup size or type. Change tungsten position
Short collet life	Ordinary style is split and twists or jams. Change to wedge style
Short torch head life	Do not operate beyond rated capacity. Do not bend torch heads

9.0 Periodic maintenance

WARNING

Only authorised electricians should carry out repairs and internal servicing

Modification of the 15A primary input plug or fitment of a lower rated primary input plug will render the warranty null and void.

The working environment or amount of use the machine receives should be taken into consideration when planning maintenance frequency of your Smootharc welder.

Preventative maintenance will ensure trouble-free welding and increase the life of the machine and its consumables.

9.1 Power source

- Check electrical connections of unit at least twice a year.
- Clean oxidised connections and tighten.
- Inner parts of machine should be cleaned with a vacuum cleaner and soft brush.
- Do not use any pressure-washing devices.
- Do not use compressed air as pressure may pack dirt even more tightly into components.

10.0 Technical specifications

Specifications	TIG	MMA
Part No.	BOC185ACDC/FC	
Power voltage AC	Single phase 240 V ±15 %	
Frequency	50/60 Hz	
Rated input current (I _{max})	22.0 A	24.5 A
Output current range	10 to 180 A	10 to 135 A
Rated working voltage	17.2 V	25.4 V
No-load voltage	64 V	
Duty cycle	35%	180 A
	100%	106 A
Arc initiation	HF	
Remote control	Yes (for foot control connection)	
Efficiency	80 %	
Power factor	0.73	
Insulation grade	F	
Housing protection grade	IP21	
Dimensions L × W × H	450 × 204 × 368 mm	
Weight	14.7 kg	
Standards	IEC 60974.1; 10	

11.0 Warranty information

11.1 Terms of warranty

The Smootharc machine has a limited warranty that covers manufacturing and material defects only. The warranty is affected on the day of purchase and does not cover any freight, packaging and insurance costs. Verbal promises that do not comply with terms of warranty are not binding on warrantor.

11.2 Limitations on warranty

The following conditions are not covered under terms of warranty: loss or damage due to or resulting from natural wear and tear, non-compliance with operating and maintenance instructions, connection to incorrect or faulty voltage supply (including voltage surges outside equipment specs), incorrect gas pressure overloading, transport or storage damage or fire or damage due to natural causes (e.g. lightning or flood). This warranty does not cover direct or indirect expenses, loss, damage of costs including, but not limited to, daily allowances or accommodation and travelling costs.

Modification of the 15A primary input plug or fitment of a lower rated primary input plug will render the warranty null and void.

NOTE

Under the terms of warranty, welding torches and their consumables are not covered. Direct or indirect damage due to a defective product is not covered under the warranty. The warranty is void if changes are made to the product without approval of the manufacturer, or if repairs are carried out using non-approved spare parts. The warranty is void if a non-authorised agent carries out repairs.

11.3 Warranty period

The warranty is valid for 18 months from date of purchase provided the machine is used within the published specification limits.

11.4 Warranty repairs

A BOC approved service provider must be informed within the warranty period of any warranty defect. The customer must provide proof of purchase and serial number of the equipment when making a warranty claim. Warranty repairs may only be carried out by approved BOC service providers. Please contact your local BOC Gas & Gear for a directory of BOC approved service providers in your area.

For more information contact the BOC Customer Service Centre.

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