Smoothart

Multiprocess 175
Operating manual

BOC
A Member of The Linde Group

Welcome to a better way of welding.

This operating manual provides the basic knowledge required for MIG/MAG, TIG and MMA welding, as well as highlighting important areas of how to operate the Smootharc Multiprocess 175 machine.

With normal use and by following these recommended steps, your Smootharc Multiprocess 175 machine can provide you with years of trouble-free service. Smootharc equipment and technical support is available through the national BOC Customer Service Centre or contact your local Gas & Gear outlet.

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1.0 Recommended Safety Guidelines and Precautions

Diagram and safety explanation

	Electrical safety alert
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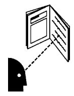
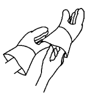
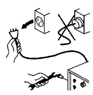
	Read instruction manual
	Become trained
	Wear dry, insulated gloves
	Insulate yourself from work and ground
	Disconnect input power before working on equipment
	Keep head out of fumes
	Use forced ventilation or local exhaust to remove fumes
	Use welding helmet with correct shade of filter

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.

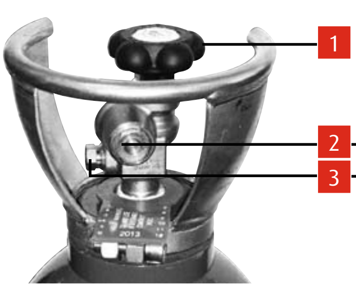
Recommended filter shades for arc welding

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.

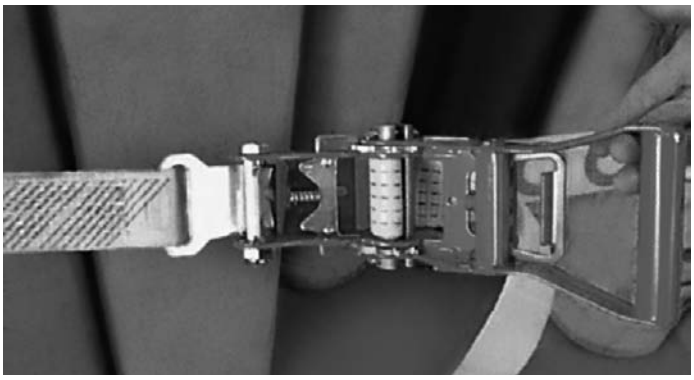
Clothing

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.
- Working on a dry insulated floor where possible.

1.4 User Responsibility

- Read the Operating Manual prior to installation of this machine.
- Unauthorised repairs 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
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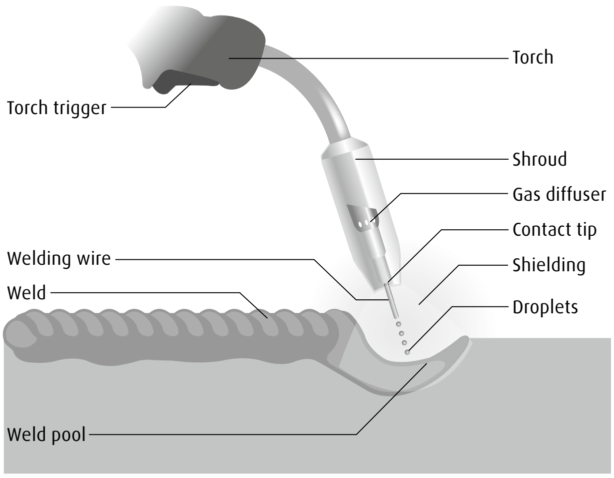
2.0 MIG/MAG Operating Manual

Typical MIG/MAG set up



2.1 Introduction to Metal Inert Gas (MIG) & Metal Active Gas (MAG)

MIG/MAG welding embraces a group of arc welding processes in which a continuous electrode (the wire) is fed by powered feed rolls (wire feeder) into the weld pool. An electric arc is created between the tip of the wire and the weld pool. The wire is progressively melted at the same speed at which it is being fed and forms part of the weld pool. Both the arc and the weld pool are protected from atmospheric contamination by a shield of inert (non-reactive) gas, which is delivered through a nozzle that is concentric with the welding wire guide tube.

Operation

MIG/MAG welding is usually carried out with a handheld torch as a semi-automatic process. The MIG/MAG process can be suited to a variety of job requirements by choosing the correct shielding gas, electrode (wire) size and welding parameters. Welding parameters include the voltage, travel speed, arc (stick-out) length and wire feed rate. The arc voltage and wire feed rate will determine the filler metal transfer method.

This application combines the advantages of continuity, speed, comparative freedom from distortion and the reliability of automatic welding with the versatility and control of manual welding. The process is also suitable for mechanised set-ups, and its use in this respect is increasing.

MIG/MAG welding can be carried out using solid wire, flux cored, or a copper-coated solid wire electrode. The shielding gas or gas mixture may consist of the following:

- Argon (MIG)
- Carbon dioxide (MAG)
- Argon and carbon dioxide mixtures (MAG)
- Argon with oxygen mixtures (MAG)
- Argon with helium mixtures (MIG)

Each gas or gas mixture has specific advantages and limitations. Other forms of MIG/MAG welding include using a flux-cored continuous electrode and carbon dioxide shielding gas, or using self-shielding flux-cored wire, requiring no shielding.

2.2 Introduction to Flux Cored Arc Welding (FCAW)

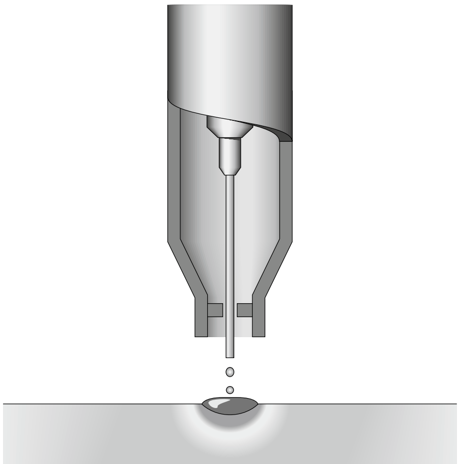
How it Works

Flux-cored arc welding (FCAW) uses the heat generated by a DC electric arc to fuse the metal in the joint area, the arc being struck between a continuously fed consumable filler wire and the workpiece, melting both the filler wire and the workpiece in the immediate vicinity. The entire arc area is covered by a shielding gas, which protects the molten weld pool from the atmosphere.

FCAW is a variant of the MIG/MAG process and while there are many common features between the two processes, there are also several fundamental differences.

As with MIG/MAG, direct current power sources with constant voltage output characteristics are normally employed to supply the welding current. With flux-cored wires the terminal that the filler wire is connected to depends on the specific product being used, some wires running electrode positive, others running electrode negative. The work return is then connected to the opposite terminal. It has also been found that the output characteristics of the power source can have an effect on the quality of the welds produced.

Extended self shielded flux cored wire nozzle



The wire feed unit takes the filler wire from a spool, and feeds it through the welding torch, to the arc at a predetermined and accurately controlled speed. Normally, special knurled feed rolls are used with flux-cored wires to assist feeding and to prevent crushing the consumable.

Unlike MIG/MAG, which uses a solid consumable filler wire, the consumable used in FCAW is of tubular construction, an outer metal sheath being filled with fluxing agents plus metal powder. The flux fill is also used to provide alloying, arc stability, slag cover, de-oxidation, and, with some wires, gas shielding.

In terms of gas shielding, there are two different ways in which this may be achieved with the FCAW process.

- Additional gas-shielding supplied from an external source, such as a gas cylinder
- Production of a shielding gas by decomposition of fluxing agents within the wire, self-shielding

Gas shielded wires are available with either a basic or rutile flux fill, while self-shielded wires have a broadly basic-type flux fill. The flux fill dictates the way the wire performs, the properties obtainable, and suitable applications.

Gas-shielded Operation

Many cored wire consumables require an auxiliary gas shield in the same way that solid wire MIG/MAG consumables do. These types of wire are generally referred to as 'gas-shielded'.

Using an auxiliary gas shield enables the wire designer to concentrate on the performance characteristics, process tolerance, positional capabilities, and mechanical properties of the products.

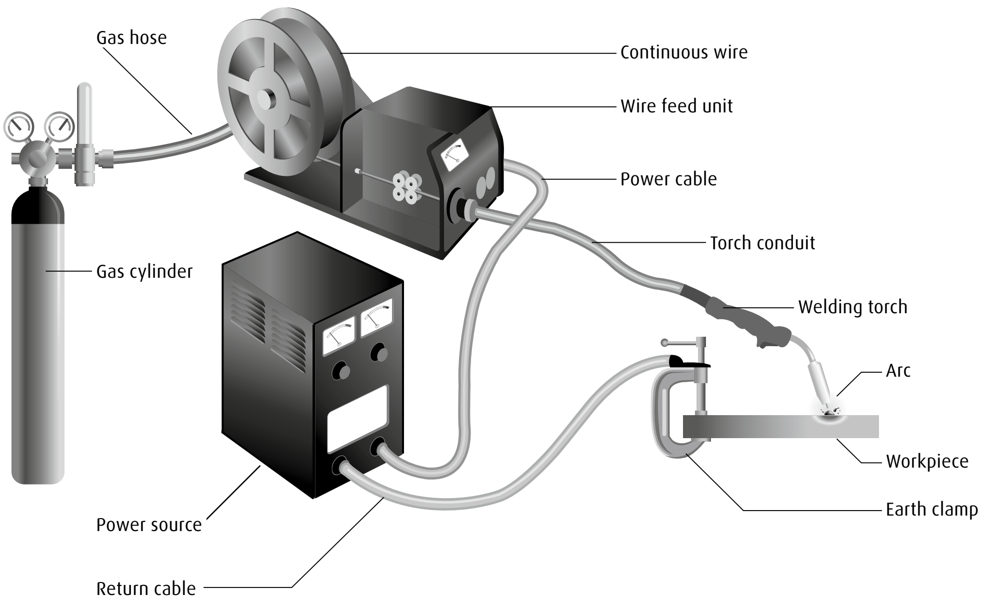
In a flux cored wire the metal sheath is generally thinner than that of a self-shielded wire. The area of this metal sheath surrounding the flux cored wire is much smaller than that of a solid MIG/MAG wire. This means that the electrical resistance within the flux cored wire is higher than with solid MIG/MAG wires and it is this higher electrical resistance that gives this type of wire some of its novel operating properties.

One often quoted property of fluxed cored wires are their higher deposition rates than solid MIG/MAG wires. What is often not explained is how they deliver these higher values and whether these can be utilised. For example, if a solid MIG/MAG wire is used at 250 amps, then exchanged for a flux cored wire of the same diameter, and welding power source controls are left unchanged, then the current reading would be much less than 250 amps, perhaps as low as 220 amps. This is because of Ohms Law that states that as the electrical resistance increases if the voltage remains stable then the current must fall.

To bring the welding current back to 250 amps it is necessary to increase the wire feed speed, effectively increasing the amount of wire being pushed into the weld pool to make the weld. It is this affect that produces the 'higher deposition rates' that the flux cored wire manufacturers claim for this type of product. Unfortunately in many instances the welder has difficulty in utilising this higher wire feed speed and must either increase the welding speed or increase the size of the weld. Often in manual applications neither of these changes can be implemented and the welder simply reduces the wire feed speed back to where it was and the advantages are lost. However, if the process is automated in some way then the process can show improvements in productivity.

It is also common to use longer contact tip to workplace distances with flux cored arc welding than with solid wire MIG/MAG welding and this also has the effect of increasing the resistive heating on the wire further accentuating the drop in welding current. Research has also shown that increasing this distance can lead to an increase in the ingress of

Process Schematic Diagram for MIG/MAG, FCAW and MCAW



nitrogen and hydrogen into the weld pool, which can affect the quality of the weld.

Flux cored arc welding has a lower efficiency than solid wire MIG/MAG welding because part of the wire fill contains slag forming agents. Although the efficiency varies differs by wire type and manufacturer it is typically between 75–85%.

Flux cored arc welding does, however, have the same drawback as solid wire MIG/MAG in terms of gas disruption by wind, and screening is always necessary for site work. It also incurs the extra cost of shielding gas, but this is often outweighed by gains in productivity.

Self-shielded Operation

There are also self-shielded consumables designed to operate without an additional gas shield. In this type of product, arc shielding is provided by gases generated by decomposition of some constituents within the flux fill. These types of wire are referred to as 'self-shielded'.

If no external gas shield is required, then the flux fill must provide sufficient gas to protect the molten pool and to provide de-oxidisers and nitride formers to cope with atmospheric contamination. This leaves less scope to address performance, arc stabilisation, and process tolerance, so these tend to suffer when compared with gas shielded types.

Wire efficiencies are also lower, at about 65%, in this mode of operation than with gas-shielded wires. However, the wires do have a distinct advantage when it comes to site work in terms of wind tolerance, as there is no external gas shield to be disrupted.

When using self-shielded wires, external gas supply is not required and, therefore, the gas shroud is not necessary. However, an extension nozzle is often used to support and direct the long electrode extensions that are needed to obtain high deposition rates.

2.3 Introduction to Metal Cored Arc Welding (MCAW)

How it Works

Metal-cored arc welding (MCAW) uses the heat generated by a DC electric arc to fuse metal in the joint area, the arc being struck between a continuously fed consumable filler wire and the workpiece, melting both the filler wire and the workpiece in the immediate vicinity. The entire arc area is covered by a shielding gas, which protects the molten weld pool from the atmosphere.

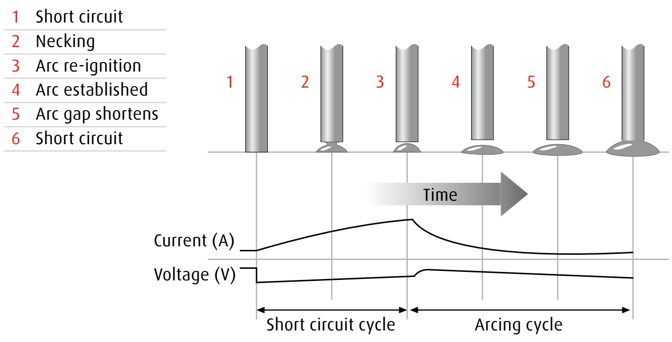
As MCAW is a variant of the MIG/MAG welding process there are many common features between the two processes, but there are also several fundamental differences.

As with MIG/MAG, direct current power sources with constant voltage output characteristics are normally employed to supply the welding current. With metal-cored wires the terminal the filler wire is connected to depends on the specific product being used, some wires designed to run on electrode positive, others preferring electrode negative, and some which will run on either. The work return lead is then connected to the opposite terminal. Electrode negative operation will usually give better positional welding characteristics. The output characteristics of the power source can have an effect on the quality of the welds produced.

The wire feed unit takes the filler wire from a spool or bulk pack, and feeds it through the welding torch, to the arc at a predetermined and accurately controlled speed. Normally, special knurled feed rolls are used with metal-cored wires to assist feeding and to prevent crushing the consumable.

Unlike MIG/MAG, which uses a solid consumable filler wire, the consumable used in MCAW is of tubular construction, an outer metal

Schematic of Dip Transfer



sheath being filled entirely with metal powder except for a small amount of non-metallic compounds. These are added to provide some arc stability and de-oxidation.

MCAW consumables always require an auxiliary gas shield in the same way that solid MIG/MAG wires do. Wires are normally designed to operate in argon-carbon dioxide or argon-carbon dioxide-oxygen mixtures or carbon dioxide. Argon rich mixtures tend to produce lower fume levels than carbon dioxide.

As with MIG/MAG, the consumable filler wire and the shielding gas are directed into the arc area by the welding torch. In the head of the torch, the welding current is transferred to the wire by means of a copper alloy contact tip, and a gas diffuser distributes the shielding gas evenly around a shroud which then allows the gas to flow over the weld area. The position of the contact tip relative to the gas shroud may be adjusted to limit the minimum electrode extension.

Modes of metal transfer with MCAW are very similar to those obtained in MIG/MAG welding, the process being operable in both 'dip transfer' and 'spray transfer' modes. Metal-cored wires may also be used in pulse transfer mode at low mean currents, but this has not been widely exploited.

2.4 Modes of metal transfer

The mode or type of metal transfer in MIG/MAG and MCAW welding depends upon the current, arc voltage, electrode diameter and type of shielding gas used. In general, there are four modes of metal transfer.

Modes of metal transfer with FCAW are similar to those obtained in MIG/MAG welding, but here the mode of transfer is heavily dependent on the composition of the flux fill, as well as on current and voltage.

The most common modes of transfer in FCAW are:

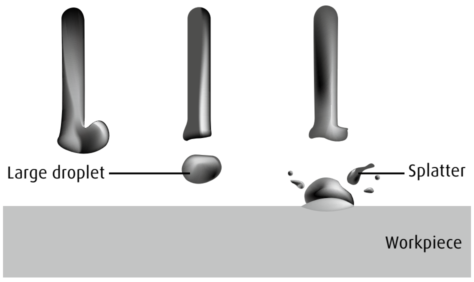
- Dip transfer
- Globular transfer
- Spray transfer
- Pulsed arc transfer operation has been applied to flux-cored wires but, as yet, is not widely used because the other transfer modes are giving users what they require, in most cases.

Dip Transfer

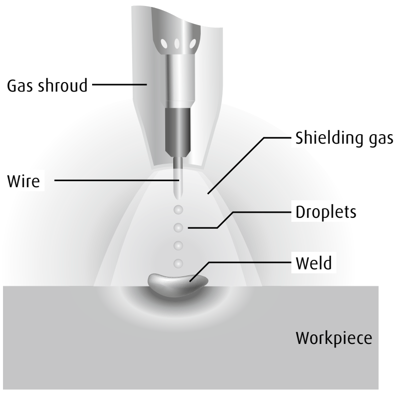
Also known as short-circuiting arc or short-arc, this is an all-positional process, using low heat input. The use of relatively low current and arc voltage settings cause the electrode to intermittently short-circuit with the weld pool at a controlled frequency. Metal is transferred by the wire tip actually dipping into the weld pool and the short-circuit current is sufficient to allow the arc to be re-established. This short-circuiting mode of metal transfer effectively extends the range of MIG/MAG welding to lower currents so thin sheet material can readily be welded. The low heat input makes this technique well-suited to the positional welding of root runs on thick plate, butt welds for bridging over large gaps and for certain difficult materials where heat input is critical. Each short-circuit causes the current to rise and the metal fuses off the end of the electrode. A high short-circuiting frequency gives low heat input. Dip transfer occurs between ±70-220A, 14–23 arc volts. It is achieved using shielding gases based on carbon dioxide and argon.

Metal-cored wires transfer metal in dip mode at low currents just like solid MIG/MAG wires. This transfer mode is used for all positional work with these types of wire.

Schematic of Globular Transfer



Schematic of Spray Transfer



Globular Transfer

Metal transfer is controlled by slow ejection resulting in large, irregularly-shaped 'globs' falling into the weld pool under the action of gravity. Carbon dioxide gas drops are dispersed haphazardly. With argon-based gases, the drops are not as large and are transferred in a more axial direction. There is a lot of spatter, especially in carbon dioxide, resulting in greater wire consumption, poor penetration and poor appearance. Globular transfer occurs between the dip and spray ranges. This mode of transfer is not recommended for normal welding applications and may be corrected when encountered by either decreasing the arc voltage or increasing the amperage. Globular transfer can take place with any electrode diameter.

Basic flux-cored wires tend to operate in a globular mode or in a globular-spray transfer mode where larger than normal spray droplets are propelled across the arc, but they never achieve a true spray transfer mode. This transfer mode is sometimes referred to as non-axial globular transfer.

Self-shielded flux-cored wires operate in a predominantly globular transfer mode although at high currents the wire often 'explodes' across the arc.

Spray Transfer

In spray transfer, metal is projected by an electromagnetic force from the wire tip in the form of a continuous stream of discrete droplets approximately the same size as the wire diameter. High deposition rates are possible and weld appearance and reliability are good. Most metals can be welded, but the technique is limited generally to plate thicknesses greater than 6mm. Spray transfer, due to the tendency of the large weld pool to spill over, cannot normally be used for positional welding. The main exception is aluminium and its alloys where, primarily because of its low density and high thermal conductivity, spray transfer in position can be carried out.

The current flows continuously because of the high voltage maintaining a long arc and short-circuiting cannot take place. It occurs best with argon-based gases.

In solid wire MIG/MAG, as the current is increased, dip transfer passes into spray transfer via a transitional globular transfer mode. With metal-cored wires there is virtually a direct transition from dip transfer to spray transfer as the current is increased.

For metal cored wire spray transfer occurs as the current density increases and an arc is formed at the end of the filler wire, producing a stream of small metal droplets. Often the outside sheath of the wire will melt first and the powder in the centre flows as a stream of smaller droplet into the weld pool. This effect seems to give much better transfer of alloying elements into the weld.

In spray transfer, as the current density increases, an arc is formed at the end of the filler wire, producing a stream of small metal droplets. In solid wire MIG/MAG this transfer mode occurs at higher currents. Flux-cored wires do not achieve a completely true spray transfer mode but a transfer mode that is almost true spray may occur at higher currents and can occur at relatively low currents depending on the composition of the flux.

Rutile flux-cored wires will operate in this almost-spray transfer mode, at all practicable current levels. They are also able to operate in this mode for positional welding too. Basic flux-cored and self-shielded flux-cored wires do not operate in anything approaching true spray transfer mode.

Typical Metal Transfer Mode

Process	Dip Transfer	Globular Transfer	Spray Transfer
Metal Inert Gas (MIG) Metal Active Gas (MAG)	✓	✗	✓
Flux Cored (Gas Shielded)	✓	✓	✓*
Flux Cored (Self Shielded)	✓	✓	✗
Metal Cored	✓	✗	✓

* Not True Spray

Pulsed Transfer

Pulsed arc welding is a controlled method of spray transfer, using currents lower than those possible with the spray transfer technique, thereby extending the applications of MIG/MAG welding into the range of material thickness where dip transfer is not entirely suitable. The pulsed arc equipment effectively combines two power sources into one integrated unit. One side of the power source supplies a background current which keeps the tip of the wire molten. The other side produces pulses of a higher current that detach and accelerate the droplets of metal into the weld pool. The transfer frequency of these droplets is regulated primarily by the relationship between the two currents. Pulsed arc welding occurs between ±50-220A, 23–35 arc volts and only with argon and argon-based gases. It enables welding to be carried out in all positions.

2.5 Fundamentals of MIG/MAG, FCAW and MCAW

Welding Technique

Successful welding depends on the following factors:

1 Selection of correct consumables

2 Selection of the correct power source

3 Selection of the correct polarity on the power source

4 Selection of the correct shielding gas

5 Selection of the correct application techniques
   a Correct angle of electrode to work
   b Correct electrical stickout
   c Correct travel speed

6 Selection of the welding preparation

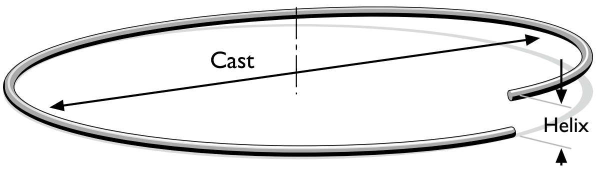
Selection of Correct Consumable

Chemical composition

As a general rule the selection of a wire is straightforward, in that it is only a matter of selecting an electrode of similar composition to the parent material. It will be found, however, that there are certain applications that electrodes will be selected on the basis of its mechanical properties or level of residual hydrogen in the weldmetal. Solid MIG/MAG wires are all considered to be of the 'low Hydrogen type' consumables.

The following table gives a general overview of the selection of some of the BOC range of MIG/MAG wires for the most common materials.

Cast and Helix



Cast – Diameter of the circle

Helix – Vertical height

Common Materials Welded with BOC MIG Wire

Material	BOC MIG Wire
AS2074 C1,C2,C3,C4-1,C4-2,C5,C6	BOC Mild Steel MIG Wire
AS/NZS1163 C250	BOC Mild Steel MIG Wire
AS/NZS3678 200,250,300	BOC Mild Steel MIG Wire
ASTM A36,A106	BOC Mild Steel MIG Wire
Stainless Steel	
Grade 304/L	BOC Stainless Steel 308LSi
Grade 309	BOC Stainless Steel 309LSi
Grade 316/L	BOC Stainless Steel 316LSi

Physical condition

Surface condition

The welding wire must be free from any surface contamination including mechanical damage such as scratch marks.

A simple test for checking the surface condition is to run the wire through a cloth that has been dampened with acetone for 20 secs. If a black residue is found on the cloth the surface of the wire is not properly cleaned.

Cast and Helix

The cast and helix of the wire has a major influence on the feedability of MIG/MAG wire.

If the cast is too large the wire will move in an upward direction from the tip when welding and if too small the wire will dip down from the tip. The result of this is excessive tip wear and increased wear in the liners.

If the helix is too large the wire will leave the tip with a corkscrew effect.

Selection of the Correct Power Source

Power sources for MIG/MAG welding is selected on a number of different criteria, including:

1 Maximum output of the machine

2 Duty cycle

3 Output control (voltage selection, wire feed speed control)

4 Portability

The following table gives an indication of the operating amperage for different size wires.

Wire Size	Amperage Range (A)
0.8 mm	60–180
0.9 mm	70–250
1.0 mm	90–280
1.2 mm	120–340

Selection of the Correct Polarity on the Power Source

Many power sources are fitted with an optional reverse polarity dinse connector.

To achieve the optimum welding it is important to adhere to the consumable manufacturer's instruction to select the polarity.

As a general rule all solid and metal cored wires are welded on electrode positive. (Work return lead fitted to the negative connector.)

Some grades of self shielded flux cored wires (i.e. E71T-11, E71T-GS etc) needs to be welded on electrode negative. (Work return lead fitted to the positive connector.)

Selection of the Correct Shielding Gas

The selection of the shielding gas has a direct influence on the appearance and quality of the weldbead.

The thickness of the material to be welded will determine the type of shielding gas that has to be selected. As a general rule the thicker the material (C-Mn and Alloy steels) are the higher the percentage of CO_2 in the shielding gas mixture.

Different grades of shielding are required for materials such as stainless steel, aluminium and copper.

The following table gives an indication of the most common shielding gases used for Carbon Manganese and alloy steel.

Material thickness	Recommended shielding gas
1–8 mm	Argoshield Light
5–12 mm	Argoshield Universal
>12 mm	Argoshield Heavy

More detailed selection charts, including recommendations for welding parameters (voltage, amperage, electrical stickout, travelspeed and gasflow rate) can be found in the following pages.

2.6 4T/2T Trigger Latch Selection

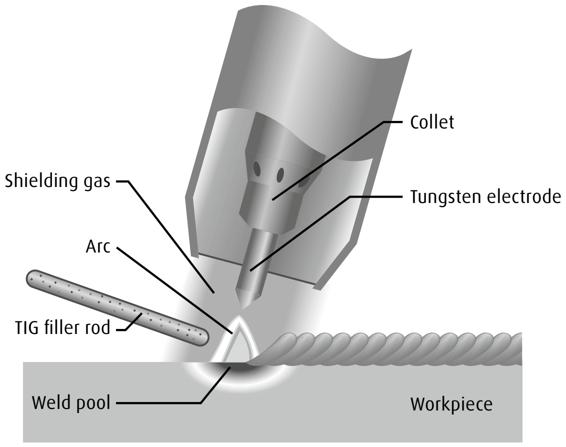
On all MIG machines there is no current or wire feed until the trigger on the torch is depressed. If a welder is doing a lot of welding then he has to hold the trigger down for long periods of time and may cause discomfort. This is can be similar to repetitive strain injury (RSI) that has become a very popular topic for compensation by office workers.

On all machines a special function called 2T and 4T is available. Also referred to as 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 oxidisation (contaminants) causing a defective weld. (Remember, a defective weld may not be detected by a visual inspection.)

The 2T/4T function also allows for the shielding gas to continue after the weld has finished and cooled. This eliminates the risk of oxidation while the weld is still in its molten state. This is particularly important when welding stainless steel materials.

3.0 Gas tungsten arc welding (GTAW/TIG)

Schematic of the TIG welding process



3.1 Introduction

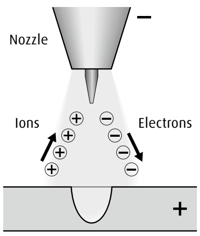
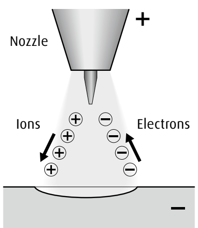
The Tungsten Inert Gas, or TIG process, uses the heat generated by an electric arc struck between a non-consumable tungsten electrode and the workpiece to fuse metal in the joint area and produce a molten weld pool. The arc area is shrouded in an inert or reducing gas shield to protect the weld pool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

3.3 Process variables

Process variable	Explanation	Usage
DCEN Narrow bead, deep penetration 	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	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
DCEP Wide bead, shallow penetration 	The DCEP (reverse polarity) are different from the DCEN in following ways: · 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 sing straight polarity · Relatively shallow penetration is obtained · An electrode whose diameter is too large will reduce visibility and increase arc instability	· 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)

3.4 Shielding gas selection

Material	Shielding gas	Benefits
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 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

3.5 Welding wire selection

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

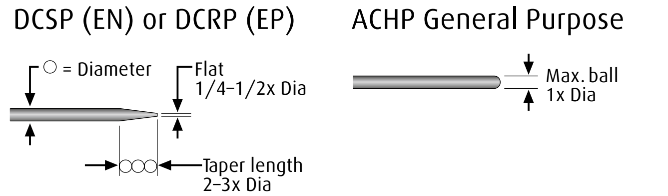
Base material	BOC Consumable
C-Mn and low carbon steels	BOC Mild steel TIG wire
Low Alloy steels	
1.25Cr/0.5Mo	Comweld CrMo1
2.5Cr/1Mo	Comweld CrMo2
Stainless Steel	
304/304L	Profill 308
316/316L	Profill 316
309/309-C-Mn	Profill 309
321/Stabilised grades	Profill 347

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

3.6 Tungsten electrode selection

Base metal type	Thickness range	Desired results	Welding current	Electrode type	Shielding gas	Tungsten performance characteristics
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 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 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

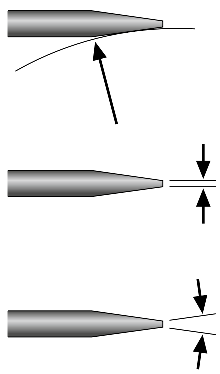
Tungsten tip preparation



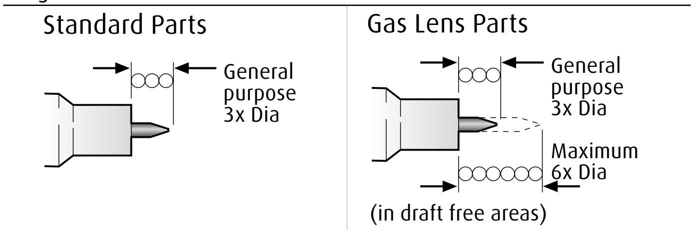
Ball tip by arcing on clean metal at low current DCRP (EP) then slowly increase current to form the desired ball diameter. Return setting to AC.

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



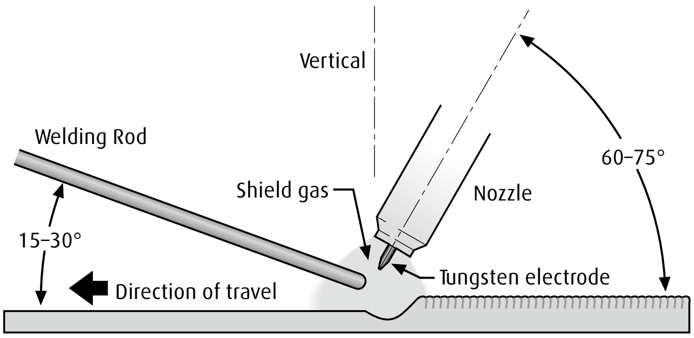
Tungsten electrode tip shapes and current ranges

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.

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

3.7 Welding techniques

TIG Welding techniques

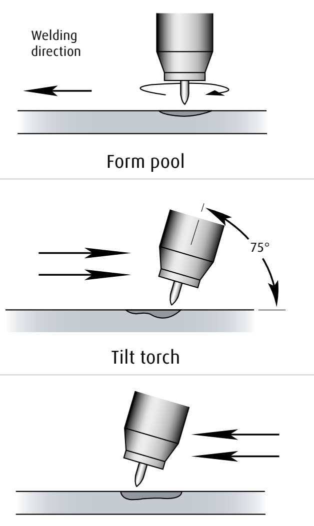


The suggested electrode and welding rod angles for welding a bead on plate are shown above. The same angles are used when making a butt weld. The torch is held 60–75° from the metal surface. This is the same as holding the torch 15–30° from the vertical.

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

3.8 Torch movement during welding

Tungsten Without Filler Rod

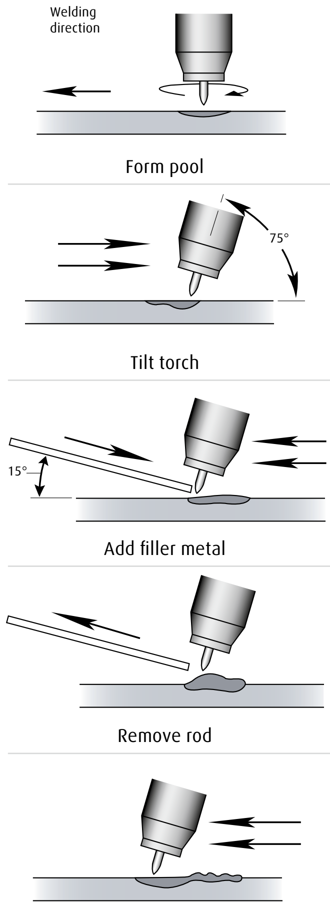


Form pool

Tilt torch

Move torch to front of pool. Repeat.

Tungsten With Filler Rod



Form pool

Tilt torch

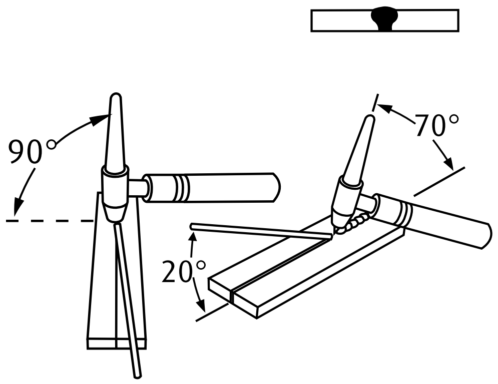
Add filler metal

Remove rod

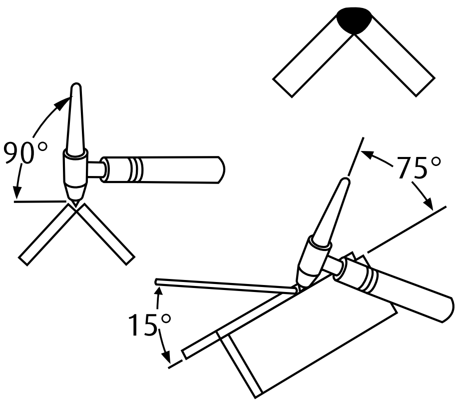
Move torch to front of pool. Repeat.

3.9 Positioning torch tungsten for various weld joints

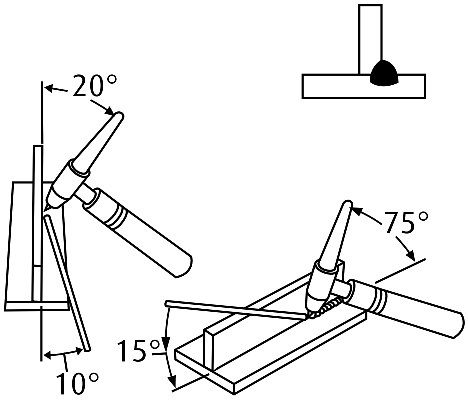
Butt Weld and Stringer bead



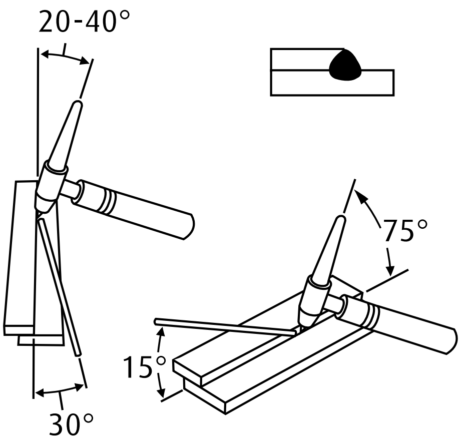
Corner Joint



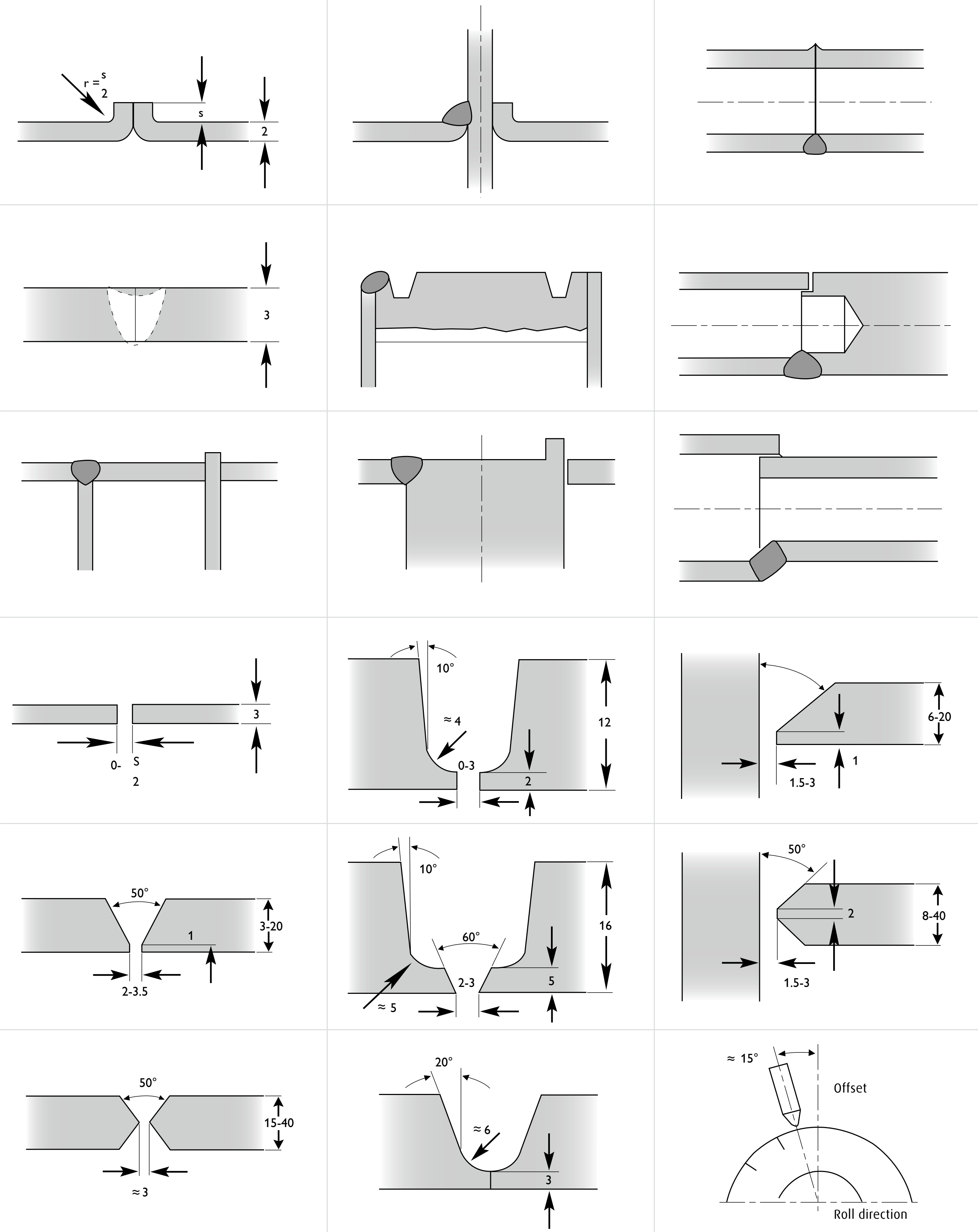
'T' Joint



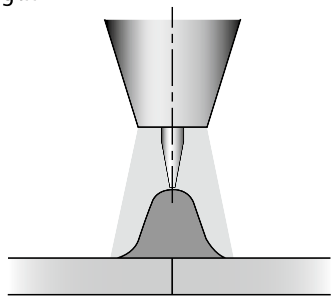
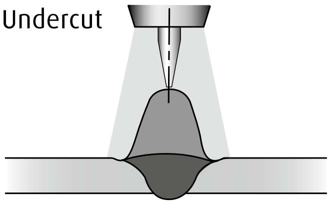
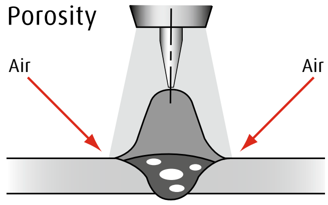
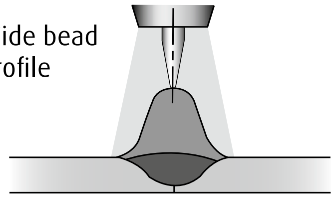
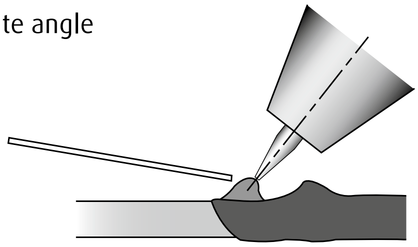
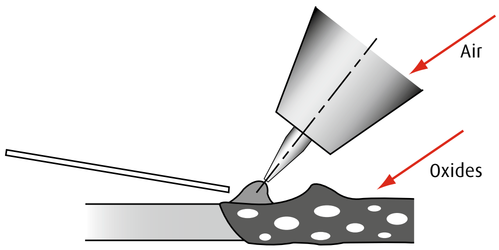
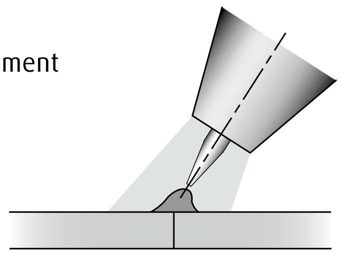
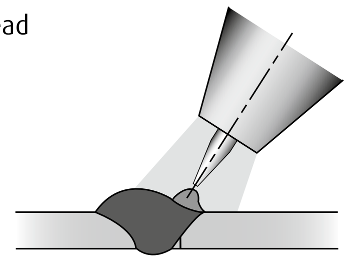
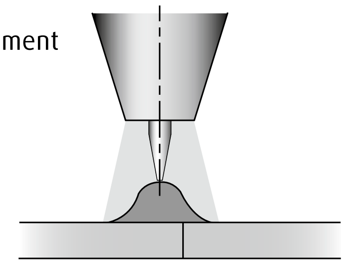
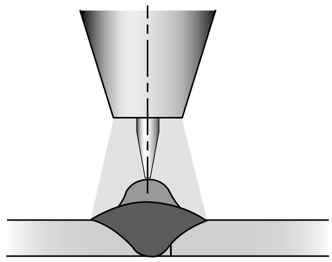
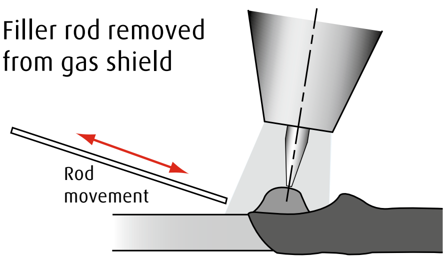
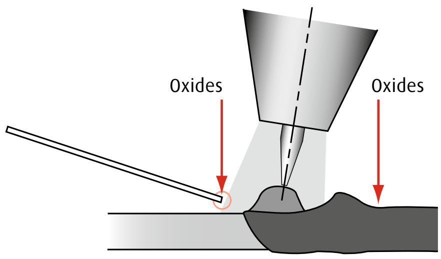
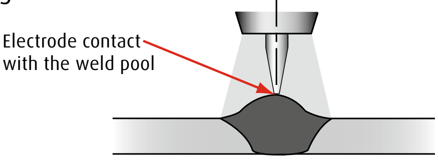
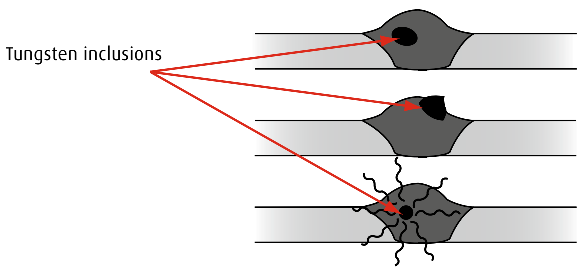
Lap Joint



3.10 Joint preparation

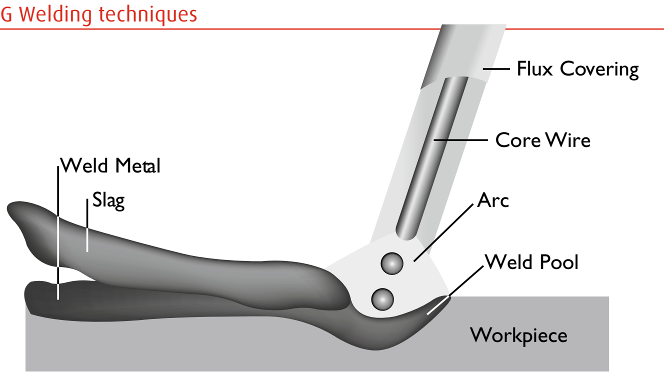


All measurements in mm

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 	
Tungsten inclusions 	

4.0 Manual Metal Arc Welding Process (MMAW)

TIG Welding techniques



4.1 Introduction

Arc welding, although in the past principally the tool of tradesmen and fabricators, has in recent years found increasing usage with small workshops, farmers, handyman-hobbyists amongst others. This has been brought about by the introduction of low-cost portable arc welding machines and the ready availability of small diameter electrodes and thinner section construction materials. Provided the operator is familiar with the basic principles and techniques, arc welding can be a fast, efficient and safe method of joining metals.

The main purpose of this manual is to help the welder with limited experience to obtain a better understanding of the process, and to acquire a reasonable degree of proficiency in the least possible time. Even welders with some experience will benefit from the information in this manual.

4.2 Process

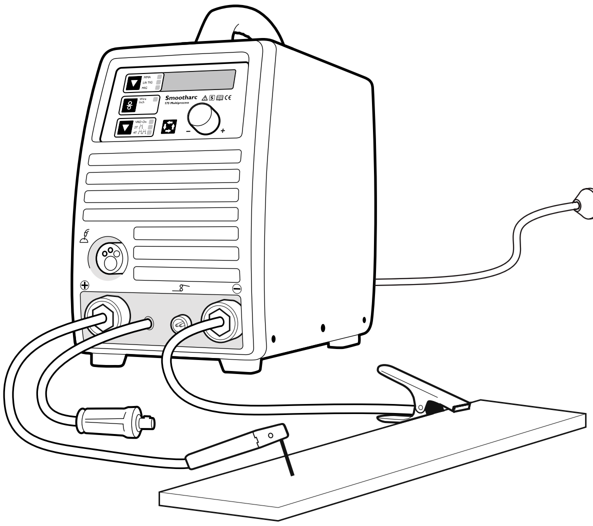
Manual Metal Arc welding is the process of joining metals where an electric arc is struck between the metal to be welded (parent metal) and a flux-coated filler wire (the electrode). The heat of the arc melts the parent metal and the electrode which mix together to form, on cooling, a continuous solid mass.

Before arc welding can be carried out, a suitable power source is required. Two types of power sources may be used for arc welding, direct current (DC) or alternating current (AC).

The essential difference between these two power sources is that, in the case of DC, the current remains constant in magnitude and flows in the same direction. Similarly, the voltage in the circuit remains constant in magnitude and polarity (i.e. positive or negative).

In the case of AC however, the current flows first in one direction and then the other. Similarly, the voltage in the circuit changes from positive to negative with changes in direction of current flow. This complete reversal is called a ‘half cycle’ and repeats as long as the current flows. The rate of change of direction of current flow is known as the ‘frequency’ of the supply and is measured by the number of cycles completed per second. The standard frequency of the AC supply in Australia is 50 Hz (Hertz).

Installation for MMA process



4.3 Welding Machine

The most important consideration when contemplating the use of arc welding for the first time is the purchase of a suitable welding machine.

BOC supplies a popular range of arc welding machines. Machines range from small portable welders that operate from standard 240 Volt household power to heavy-duty welders used by the largest steel fabricators.

Basic Welding Machine and Cables

The choice of welding machine is based mostly on the following factors:

- primary voltage, e.g. 240 Volt or 380 Volt
- output amperage required, e.g. 140 amps
- output required, e.g. AC or DC +/-
- duty cycle required, e.g. 35% @ 140 amps
- method of cooling, e.g. air-cooled or oil-cooled method of output amperage control, e.g. tapped secondary lugs
- or infinitely variable control.

For example, the Smootharc Multiprocess 175 connects to 240 Volt supply (15 amps Input), has an output of 175 amps DC @ 35% duty cycle.

Having decided on a welding machine, appropriate accessories are required. These are items such as welding cables, clamps, electrode holder, chipping hammer, helmet, shaded and clear lenses, scull cap, gloves and other personal protective equipment.

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

4.4 Welding Technique

Successful welding depends on the following factors:

- selection of the correct electrode
- selection of the correct size of the electrode for the job
- correct welding current
- correct arc length
- correct angle of electrode to work
- correct travel speed
- correct preparation of work to be welded.

4.5 Electrode Selection

As a general rule the selection of an electrode is straight forward, in that it is only a matter of selecting an electrode of similar composition to the parent metal. It will be found, however, that for some metals there is a choice of several electrodes, each of which has particular properties to suit specific classes of work. Often, one electrode in the group will be more suitable for general applications due to its all round qualities.

The table (page 27) shows just a few of the wide range of electrodes available from BOC with their typical areas of application.

For example, the average welder will carry out most fabrication using mild steel and for this material has a choice of various standard BOC electrodes, each of which will have qualities suited to particular tasks. For general mild steel work, however, BOC Smootharc 13 electrodes will handle virtually all applications. BOC Smootharc 13 is suitable for welding mild steel in all positions using AC or DC power sources. Its easy-striking characteristics and the tolerance it has for work where fit-up and plate surfaces are not considered good, make it the most attractive electrode of its class. Continuous development and improvement of BOC Smootharc 13 has provided in-built operating qualities which appeals to the beginner and experienced operator alike. For further recommendations on the selection of electrodes for specific applications, see table page 27.

Electrodes and Typical Applications

Name	AWS Class.	Application
BOC Smootharc 13	E6013	A premium quality electrode for general structural and sheet metal work in all positions including vertical down using low carbon steels
BOC Smootharc 24	E7024	An iron powder electrode for high speed welding for H-V fillets and flat butt joints. Medium to heavy structural applications in low carbon steels
BOC Smootharc 18	E7018-1	A premium quality all positional hydrogen controlled electrode for carbon steels in pressure vessel applications and where high integrity welding is required and for free-machining steels containing sulphur
BOC Smootharc S 308L	E308L	Rutile basic coated low carbon electrodes for welding austenitic stainless steel and difficult to weld material
BOC Smootharc S 316L	E316L	
BOC Smootharc S 309L	E309L	Rutile basic coated low carbon electrode for welding mild steel to stainless steel and difficult to weld material

Electrode Size

The size of the electrode is generally dependent on the thickness of the section being welded, and the larger the section the larger the electrode required. In the case of light sheet the electrode size used is generally slightly larger than the work being welded. This means that if 1.5 mm sheet is being welded, 2.0 mm diameter electrode is the recommended size. The following table gives the recommended maximum size of electrodes that may be used for various thicknesses of section.

Recommended Electrode Sizes

Average Thickness of Plate or Section	Max. Recommended Electrode Dia.
≤1.5 mm	2.0 mm
1.5–2.0 mm	2.5 mm
2.0–5.0 mm	3.15 mm
5.0–8.0 mm	4.0 mm
≤8.0 mm	5.0 mm

Welding Current

Correct current selection for a particular job is an important factor in arc welding. With the current set too low, difficulty is experienced in striking and maintaining a stable arc. The electrode tends to stick to the work, penetration is poor and beads with a distinct rounded profile will be deposited.

Excessive current is accompanied by overheating of the electrode. It will cause undercut, burning through of the material, and give excessive spatter. Normal current for a particular job may be considered as the maximum which can be used without burning through the work, over-heating the electrode or producing a rough spattered surface, i.e. the current in the middle of the range specified on the electrode package is considered to be the optimum.

In the case of welding machines with separate terminals for different size electrodes, ensure that the welding lead is connected to the correct terminal for the size electrode being used. When using machines with adjustable current, set on the current range specified.
The limits of this range should not normally be exceeded.

The following table shows the current ranges generally recommended for BOC Smootharc 13.

Generally Recommended Current Range for BOC Smootharc 13

Size of Electrode (mm)	Current Range (Amp)
2.5	60–95
3.2	110–130
4.0	140–165
5.0	170–260

Arc Length

To start the arc, the electrode should be gently scraped on the work until the arc is established. There is a simple rule for the proper arc length; it should be the shortest arc that gives a good surface to the weld. An arc too long reduces penetration, produces spatter and gives a rough surface finish to the weld. An excessively short arc will cause sticking of the electrode and rough deposits that are associated with slag inclusions.

For downhand welding, it will be found that an arc length not greater than the diameter of the core wire will be most satisfactory. Overhead welding requires a very short arc, so that a minimum of metal will be lost. Certain BOC electrodes have been specially designed for 'touch' welding. These electrodes may be dragged along the work and a perfectly sound weld is produced.

Electrode Angle

The angle which the electrode makes with the work is important to ensure a smooth, even transfer of metal. The recommended angles for use in the various welding positions are covered later.

Correct Travel Speed

The electrode should be moved along in the direction of the joint being welded at a speed that will give the size of run required. At the same time the electrode is fed downwards to keep the correct arc length at all times. As a guide for general applications the table below gives recommended run lengths for the downhand position.

Correct travel speed for normal welding applications varies between approximately 125–375 mm per minute, depending on electrode size, size of run required and the amperage used.

Excessive travel speeds lead to poor fusion, lack of penetration, etc. Whilst too slow a rate of travel will frequently lead to arc instability, slag inclusions and poor mechanical properties.

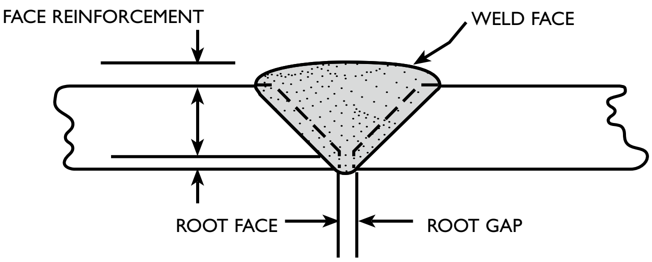
Run Length per Electrode – BOC Smootharc 13

Electrode Size (mm)	Electrode Length (mm)	Run Length (mm) Min. to Max.
4.0	350	175 to 300
3.2	350	125 to 225
2.5	350	100 to 225

Correct Work Preparation

The method of preparation of components to be welded will depend on equipment available and relative costs. Methods may include sawing, punching, shearing, lathe cut-offs, flame cutting and others. In all cases edges should be prepared for the joints that suit the application. The following section describes the various joint types and areas of application.

Butt Welding



4.6 Types of Joints

Butt Welds

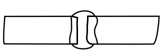
A butt weld is a weld made between two plates so as to give continuity of section. Close attention must be paid to detail in a butt weld to ensure that the maximum strength of the weld is developed. Failure to properly prepare the edges may lead to the production of faulty welds, as correct manipulation of the electrode is impeded.

Two terms relating to the preparation of butt welds require explanation at this stage. They are:

- Root Face: the proportion of the prepared edge that has not been bevelled.
- Root Gap: the separation between root faces of the parts to be joined.

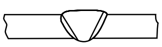
Various types of butt welds are in common use and their suitability for different thickness of steel are described as follows:

Square Butt Weld



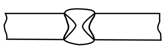
The edges are not prepared but are separated slightly to allow fusion through the full thickness of the steel. Suitable for plate up to 6 mm in thickness.

Single 'V' Butt Weld



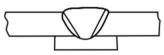
This is commonly used for plate up to 16 mm in thickness and on metal of greater thickness where access is available from only one side.

Double 'V' Butt Weld



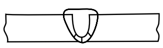
Used on plate of 12 mm and over in thickness when welding can be applied from both sides. It allows faster welding and greater economy of electrodes than a single 'V' preparation on the same thickness of steel and also has less of a tendency to distortion as weld contraction can be equalised.

Butt Weld with Backing Material



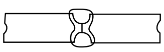
When square butt welds or single 'V' welds cannot be welded from both sides it is desirable to use a backing bar to ensure complete fusion.

Single 'U' Butt Weld



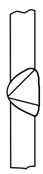
Used on thick plates an alternative to a single 'V' preparation. It has advantages as regards speed of welding. It takes less weld metal than a single 'V', there is less contraction and therefore a lessened tendency to distortion. Preparation is more expensive than in the case of a 'V', as machining is required. The type of joint is most suitable for material over 40 mm in thickness.

Double 'U' Butt Weld



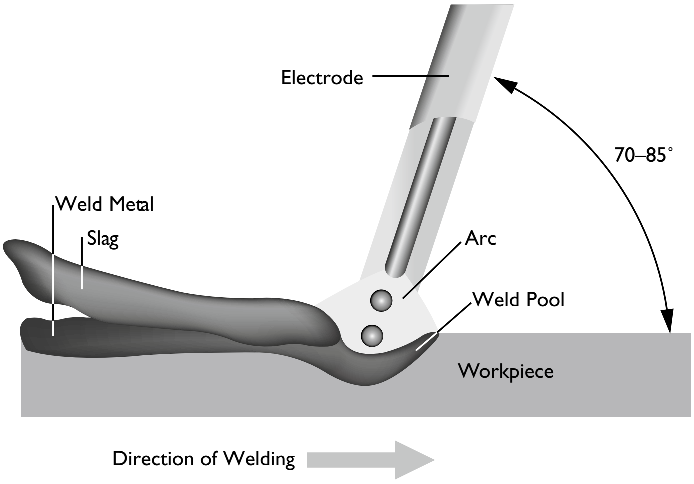
For use on thick plate that is accessible for welding from both sides. For a given thickness it is faster, needs less weld metal and causes less distortion than a single 'U' preparation.

Horizontal Butt Weld



The lower member in this case is bevelled to approximately 15° and the upper member 45°, making an included angle of 60°. This preparation provides a ledge on the lower member, which tends to retain the molten metal.

Welding Progression Angle



General notes on Butt Welds

The first run in a prepared butt weld should be deposited with an electrode not larger than 4.0 mm. The angle of the electrode for the various runs in a butt weld is shown.

It is necessary to maintain the root gap by tacking at intervals or by other means, as it will tend to close during welding.

All single ‘V’, single ‘U’ and square butt welds should have a backing run deposited on the underside of the joint; otherwise 50% may be deducted from the permissible working stress of the joint.

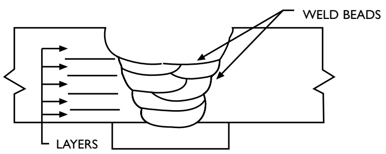
Before proceeding with a run on the underside of a weld it is necessary to remove any surplus metal or under penetration that is evident on that side of the joint.

Butt welds should be overfilled to a certain extent by building up the weld until it is above the surface of the plate. Excessive build-up, however, should be avoided.

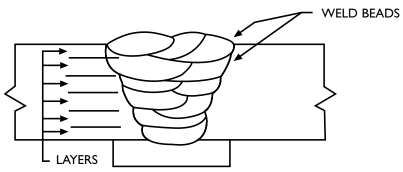
In multi-run butt welds it is necessary to remove all slag, and surplus weld metal before a start is made on additional runs; this is particularly important with the first run, which tends to form sharp corners that cannot be penetrated with subsequent runs. Electrodes larger than 4.0 mm are not generally used for vertical or overhead butt welds.

The diagrams following indicate the correct procedure for welding thick plate when using multiple runs.

Electrode Angle for 1st and 2nd Layers



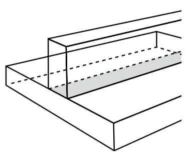
Electrode Angle for Subsequent Layers



4.7 Fillet Welds

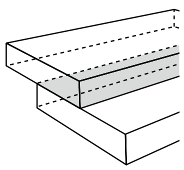
A fillet weld is approximately triangular in section, joining two surfaces not in the same plane and forming a lap joint, tee joint or corner joint. Joints made with fillet welds do not require extensive edge preparation, as is the case with butt welded joints, since the weld does not necessarily penetrate the full thickness of either member. It is important that the parts to be joined be clean, close fitting, and that all the edges on which welding is to be carried out are square. On sheared plate it is advisable to entirely remove any ‘false cut’ on the edges prior to welding. Fillet welds are used in the following types of joints:

‘T’ Joints



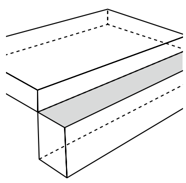
A fillet weld may be placed either on one or both sides, depending on the requirements of the work. The weld metal should fuse into or penetrate the corner formed between the two members. Where possible the joint should be placed in such a position as to form a “Natural ‘V’ fillet” since this is the easiest and fastest method of fillet welding.

Lap Joints



In this case, a fillet weld may be placed either on one or both sides of the joint, depending on accessibility and the requirements of the joint. However, lap joints, where only one weld is accessible, should be avoided where possible and must never constitute the joints of tanks or other fabrications where corrosion is likely to occur behind the lapped plates. In applying fillet welds to lapped joints it is important that the amount of overlap of the plates be not less than five times the thickness of the thinner part. Where it is required to preserve the outside face or contour of a structure, one plate may be joggled.

Corner Joints



The members are fitted as shown, leaving a ‘V’-shaped groove in which a fillet weld is deposited. Fusion should be complete for the full thickness of the metal. In practice it is generally necessary to have a gap or a slight overlap on the corner. The use of a 1.0–2.5 mm gap has the advantage of assisting penetration at the root, although setting up is a problem. The provision of an overlap largely overcomes the problem of setting up, but prevents complete penetration at the root and should therefore be kept to a minimum, i.e. 1.0–2.5 mm.

The following terms and definitions are important in specifying and describing fillet welds.

Leg Length

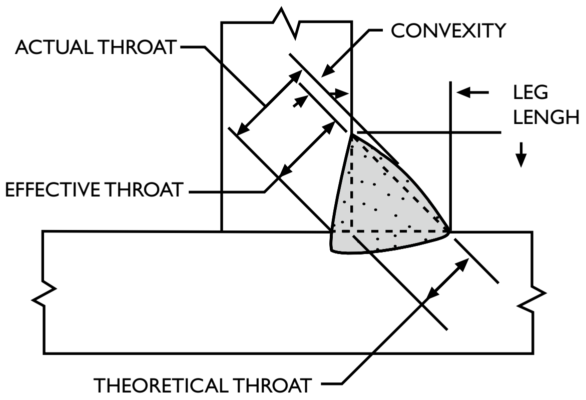
A fusion face of a fillet weld, as shown below. All specifications for fillet weld sizes are based on leg length.

Throat Thickness

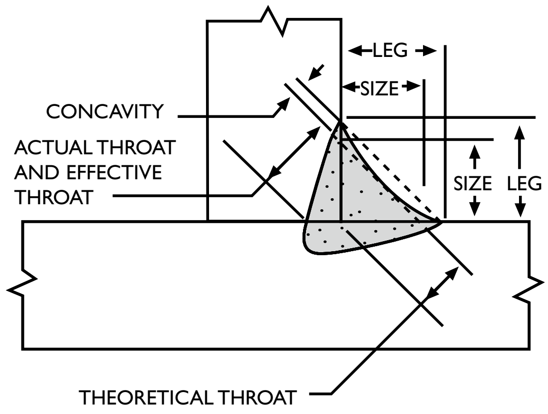
A measurement taken through the centre of a weld from the root to the face, along the line that bisects the angle formed by the members to be joined.

Effective throat thickness is a measurement on which the strength of a weld is calculated. The effective throat thickness is based on a mitre fillet (concave Fillet Weld), which has a throat thickness equal to 70% of the leg length. For example, in the case of a 20 mm fillet, the effective throat thickness will be 14 mm.

Convex Fillet Weld



Concave Fillet Weld



Convex Fillet Weld

A fillet weld in which the contour of the weld metal lies outside a straight line joining the toes of the weld. A convex fillet weld of specified leg length has a throat thickness in excess of the effective measurement.

Concave Fillet Weld

A fillet in which the contour of the weld is below a straight line joining the toes of the weld. It should be noted that a concave fillet weld of a specified leg length has a throat thickness less than the effective throat thickness for that size fillet. This means that when a concave fillet weld is used, the throat thickness must not be less than the effective measurement. This entails an increase in leg length beyond the specified measurement.

The size of a fillet weld is affected by the electrode size, welding speed or run length, welding current and electrode angle. Welding speed and run length have an important effect on the size and shape of the fillet, and on the tendency to undercut.

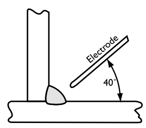
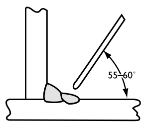
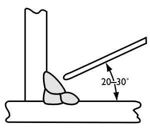
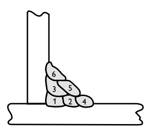
Insufficient speed causes the molten metal to pile up behind the arc and eventually to collapse. Conversely, excessive speed will produce a narrow irregular run having poor penetration, and where larger electrodes and high currents are used, undercut is likely to occur.

Fillet Weld Data

Nominal Fillet Size (mm)	Minimum Throat Thickness (mm)	Plate Thickness (mm)	Electrode Size (mm)
5.0	3.5	5.0–6.3	3.2
6.3	4.5	6.3–12	4.0
8.0	5.5	8.0–12 & over	4.0
10.0	7.0	10 & over	4.0

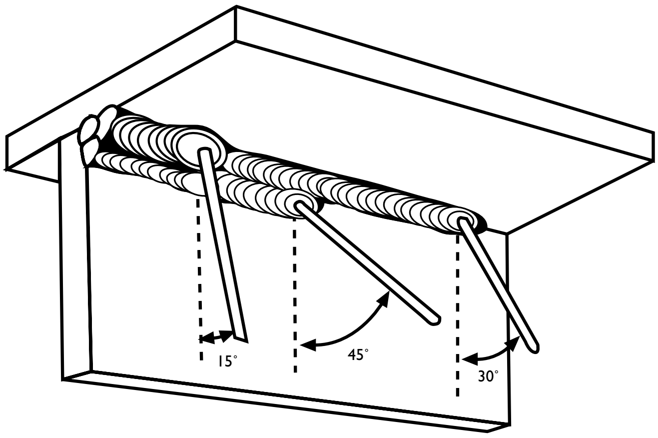
Selection of welding current is important. If it is too high the weld surface will be flattened, and undercut accompanied by excessive spatter is likely to occur. Alternatively, a current which is too low will produce a rounded narrow bead with poor penetration at the root. The first run in the corner of a joint requires a suitably high current to achieve maximum penetration at the root. A short arc length is recommended for fillet welding. The maximum size fillet which should be attempted with one pass of a large electrode is 8.0 mm. Efforts to obtain larger leg lengths usually result in collapse of the metal at the vertical plate and serious undercutting. For large leg lengths multiple run fillets are necessary. These are built up as shown below. The angle of the electrode for various runs in a downhand fillet weld is shown below.

Recommended Electrode Angles for Fillet Welds

1st Run	2nd Run
	
3rd Run	Multi-run Fillet
	

Multi-run horizontal fillets have each run made using the same run lengths (run length per electrode table). Each run is made in the same direction, and care should be taken with the shape of each, so that it has equal leg lengths and the contour of the completed fillet weld is slightly convex with no hollows in the face.

Recommended Angles for Overhead Fillet Welds



Vertical fillet welds can be carried out using the upwards or downwards technique. The characteristics of each are: upwards – current used is low, penetration is good, surface is slightly convex and irregular. For multiple run fillets large single pass weaving runs can be used. Downwards – current used is medium, penetration is poor, each run is small, concave and smooth (only BOC Smootharc 13 is suitable for this position).

The downwards method should be used for making welds on thin material only. Electrodes larger than 4.0 mm are not recommended for vertical down welding. All strength joints in vertical plates 10.0 mm thick or more should be welded using the upward technique. This method is used because of its good penetration and weld metal quality. The first run of a vertical up fillet weld should be a straight sealing run made with 3.15 mm or 4.0 mm diameter electrode. Subsequent runs for large fillets may be either numerous straight runs or several wide weaving runs.

Correct selection of electrodes is important for vertical welding.

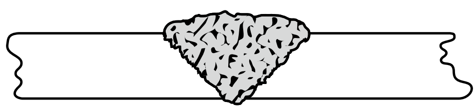
In overhead fillet welds, careful attention to technique is necessary to obtain a sound weld of good profile. Medium current is required for best results. High current will cause undercutting and bad shape of the weld, while low current will cause slag inclusions. To produce a weld having good penetration and of good profile, a short arc length is necessary. Angle of electrode for overhead fillets is illustrated above.

4.8 Typical Defects Due to Faulty Technique

Manual metal arc welding, like other welding processes, has welding procedure problems that may develop which can cause defects in the weld. Some defects are caused by problems with the materials. Other welding problems may not be foreseeable and may require immediate corrective action. A poor welding technique and improper choice of welding parameters can cause weld defects. Defects that can occur when using the shielded metal arc welding process are slag inclusions, wagon tracks, porosity, wormhole porosity, undercutting, lack of fusion, overlapping, burn through, arc strikes, craters, and excessive weld spatter. Many of these welding technique problems weaken the weld and can cause cracking. Other problems that can occur which can reduce the quality of the weld are arc blow, finger nailing, and improper electrode coating moisture contents.

Defects caused by welding technique

Slag Inclusions



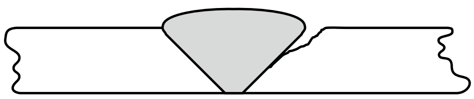
Slag inclusions occur when slag particles are trapped inside the weld metal which produces a weaker weld. These can be caused by:

- erratic travel speed
- too wide a weaving motion
- slag left on the previous weld pass
- too large an electrode being used
- letting slag run ahead of the arc.

This defect can be prevented by:

- a uniform travel speed
- a tighter weaving motion
- complete slag removal before welding
- using a smaller electrode
- keeping the slag behind the arc which is done by shortening the arc, increasing the travel speed, or changing the electrode angle.

Undercutting



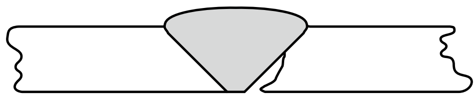
Undercutting is a groove melted in the base metal next to the toe or root of a weld that is not filled by the weld metal. Undercutting causes a weaker joint and it can cause cracking. This defect is caused by:

- excessive welding current
- too long an arc length
- excessive weaving speed
- excessive travel speed.

On vertical and horizontal welds, it can also be caused by too large an electrode size and incorrect electrode angles. This defect can be prevented by:

- choosing the proper welding current for the type and size of electrode and the welding position
- holding the arc as short as possible
- pausing at each side of the weld bead when a weaving technique is used
- using a travel speed slow enough so that the weld metal can completely fill all of the melted out areas of the base metal.

Lack of Fusion



Lack of fusion is when the weld metal is not fused to the base metal. This can occur between the weld metal and the base metal or between passes in a multiple pass weld. Causes of this defect can be:

- excessive travel speed
- electrode size too large
- welding current too low
- poor joint preparation
- letting the weld metal get ahead of the arc.

Lack of fusion can usually be prevented by:

- reducing the travel speed
- using a smaller diameter electrode
- increasing the welding current
- better joint preparation
- using a proper electrode angle.

5.0 General Welding Information

5.1 Recommended Welding Parameters for MIG/MAG

Argoshield Light

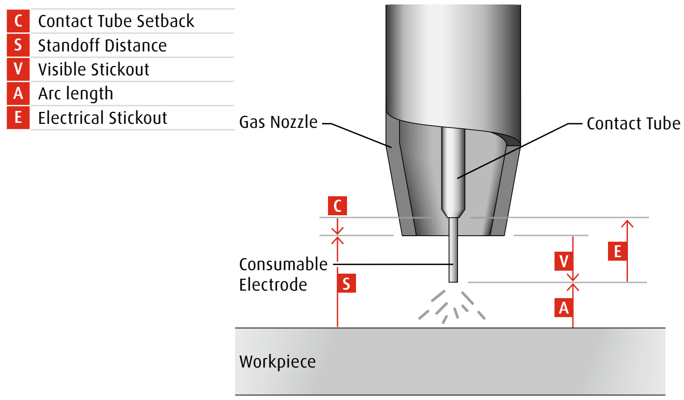
Indicative Welding Parameters	Dip Transfer				Spray Transfer
Material thickness (mm)	1–1.6	2	3	4	3
Welding position	Horizontal / Vertical	Horizontal / Vertical	Horizontal / Vertical	Horizontal / Vertical	Horizontal
Wire diameter (mm)	0.8–0.9	0.8–0.9	0.8–0.9	0.9–1.0	0.8
Current (amps)	45–80	60–100	80–120	80–150	160–180
Voltage (volts)	14–16	16–17	16–18	16–18	23–25
Wire feed speed (m/min)	3.5–5.0	4.0–7.0	4.0–7.0	4.0–7.0	7.5–9.0
Gas rate flow (L/min)	15	15	15	15	15
Travel speed (mm/min)	350–500	350–500	320–500	280–450	800–1000

Stainshield (Aus) or Stainshield Light (NZ)

Indicative Welding Parameters	Dip Transfer		
Material thickness (mm)	4	6	8
Welding position	Horizontal / Vertical	Horizontal / Vertical	Horizontal / Vertical
Wire diameter (mm)	0.9–1.0	0.9–1.0	0.9–1.0
Current (amps)	100–125	120–150	120–150
Voltage (volts)	17–19	18–20	18–20
Wire feed speed (m/min)	5.0–6.5	6.0–7.5	6.0–8.0
Gas rate flow (L/min)	15	15	18
Travel speed (mm/min)	400–600	280–500	280–450

6.0 Correct Application Techniques

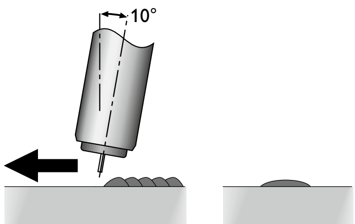
Electrical stickout



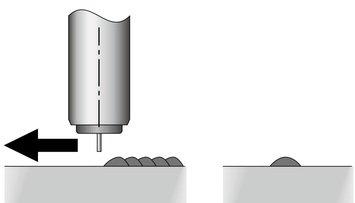
Correct Application Techniques

Direction of welding.

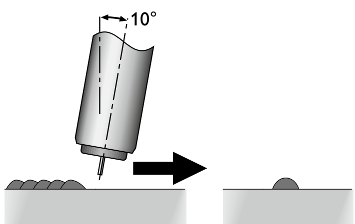
MIG/MAG welding with solid wires takes place normally with a push technique. The welding torch is tilted at an angle of 10° towards the direction of welding. (Push technique)



The influence of changing the torch angle and the welding direction on the weld bead profile can be seen below.

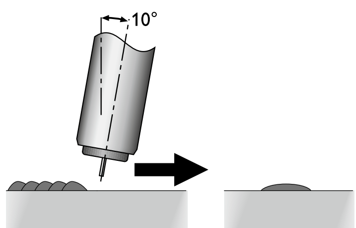


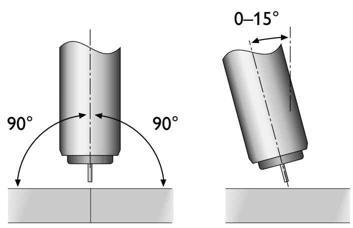
Torch perpendicular to workpiece narrow bead width with increased reinforcement.



Torch positioned at a drag angle of 10° narrow bead with excessive reinforcement.

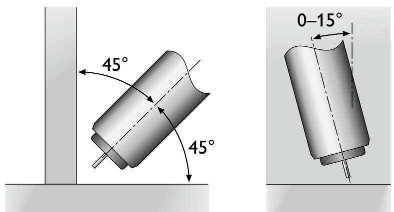
Flux cored welding with cored wires takes place normally with the drag technique. The welding torch is tilted at an angle of 10° away from the direction of welding. For all other applications the torch angle remains the same.



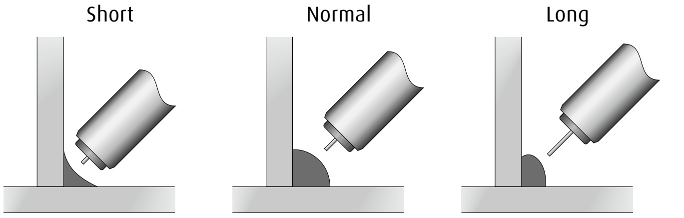


Torch position for butt welds

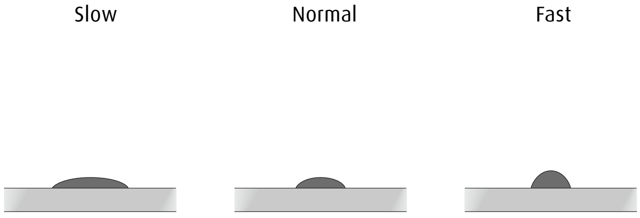
When welding butt welds the torch should be positioned within the centre of the groove and tilted at an angle of ±15° from the vertical plane. Welding is still performed in the push technique.



Electrical stickout



Travel speed



Torch position for fillet welds

When welding fillet welds the torch should be positioned at an angle of 45° from the bottom plate with the wire pointing into the fillet corner. Welding is still performed in the push technique.

Electrical stickout

The electrical stickout is the distance between the end of the contact tip and the end of the wire. An increase in the electrical stickout results in an increase in the electrical resistance. The resultant increase in temperature has a positive influence in the melt-off rate of the wire that will have an influence on the weldbead profile.

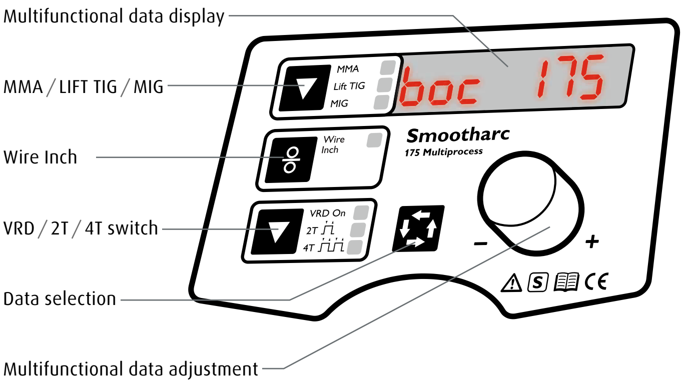
Influence of the change in electrical stickout length on the weldbead profile.

The travel speed will have an influence on the weldbead profile and the reinforcement height.

If the travel speed is too slow a wide weldbead with excessive rollover will result. Contrary if the travel speed is too high a narrow weldbead with excessive reinforcement will result.

7.0 Package Contents

Front Panel of Multiprocess 175

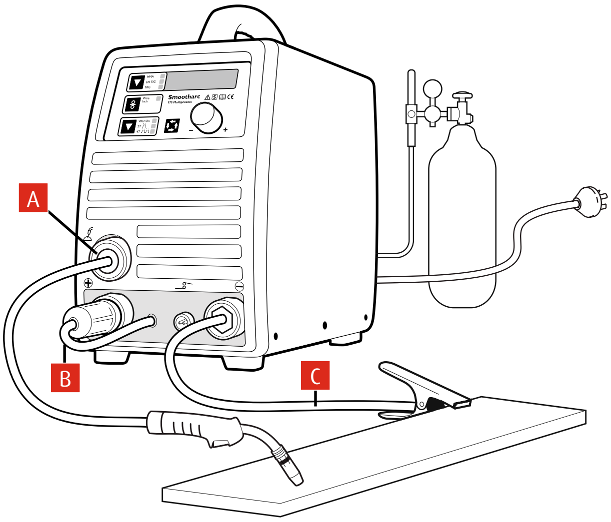


Package consists of the following:

- Power source
- Work return lead
- MMA electrode holder and cable
- BOC 17 series TIG torch
- Binzel MB15AK MIG/MAG torch
- Regulator
- Gas hose
- Spare feed rolls
- Operating manual

8.0 Smootharc Multiprocess 175 Installation

Installation for MIG/MAG process



8.1 Installation for MIG/MAG process

1 Connect the gas cylinder to the regulator. Select correct shielding gas for the application.

2 Insert the earth return lead connection into the front panel.

3 Fit the wire spool to the machine. Select correct welding wire for application.

4 Select the appropriate feed roller to suit the wire being used
- This machine comes complete with two types of wire feed rollers
- V groove for use with solid carbon manganese and stainless steels
- U groove for use with soft wires such as aluminium

5 Loosen the wire feed tension screws and insert the wire. Re fit and tension rollers ensuring the wire is gripped sufficiently so as not to slip but avoid over tightening as this can affect feed quality and cause wire feed components to wear rapidly.

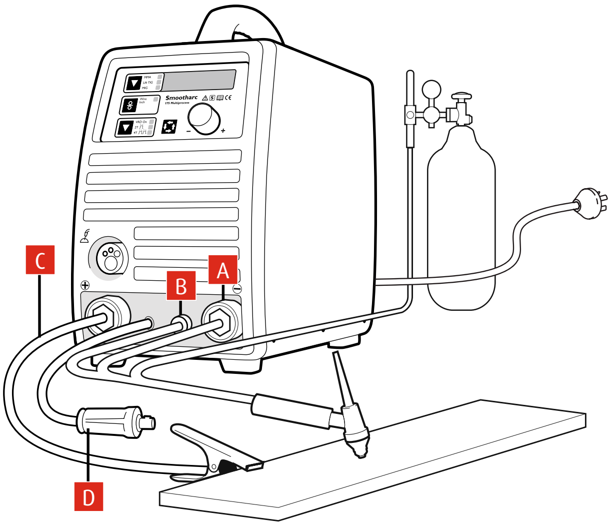
6 Fit and tighten the torch on the output connection [A]. Ensure correct torch liner and contact tip are selected.

7 Select the correct polarity for the type of wire used as indicated on the consumable packaging. This is achieved by swapping the polarity terminal wires. For most solid wires the terminal should be set as torch positive.

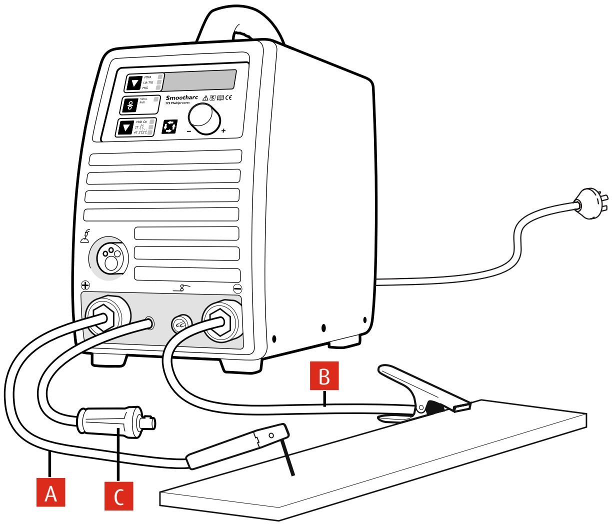
8 For torch positive, plug the short mechanical connector (link plug) [B] on the front panel into the positive (+) terminal and the work return lead [C] into the negative (-) terminal.

9 For torch negative, couple the short mechanical connector [B] into the terminal marked negative (-), and the work return lead [C] into the positive (+) terminal.

Installation for TIG setup



Installation for MMA process



8.2 Installation for TIG setup

1 Connect the gas cylinder to the regulator. Select correct shielding gas for the application.

2 Connect the dinse plug [A] of the TIG torch to negative (-) of the front panel, and fasten it clockwise.

3 Connect the electrical lead of the TIG torch to the relative interfaces of panel and fasten the screw [B].

4 Connect one end of the work return lead [C] to positive (+) of the front panel, and fasten it clockwise. Connect the other end of the clamp to the work piece.

5 The short mechanical connector (link plug) [D] should remain hanging free.

8.3 Installation for MMA process

1 Connect the electrode holder [A] to the positive (+) of the machine and fasten it clockwise tightly.

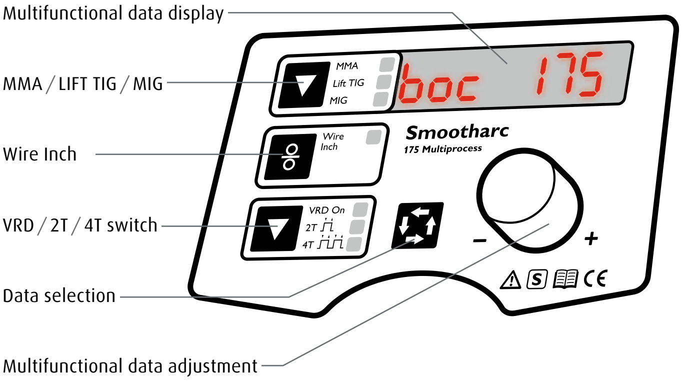
2 Connect the work return lead [B] into the negative (-) of the machine and fasten it clockwise.

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.

4 The short mechanical connector (link plug) [C] should remain hanging free.

9.0 Control panels

Front Panel of Multiprocess 175



Data selection (effective under MIG mode)

Multifunctional data adjustment
Coarse adjustments made by pressing and turning the knob. Big regulating rate and high speed

Fine adjustments made by only turning the knob. Small regulating rate and low speed.

9.1 Polarity selection

Polarity selection can be reversed when welding in MIG/MAG mode. This is important for certain types of self-shielded flux cored wires. This can be achieved by switching the work return lead to the positive (+) terminal and the short mechanical connector (link plug) to the negative (-) terminal for a DC electrode negative polarity setting.

10.0 Smootharc Multiprocess 175 Operation

Illustration 1. Start-up display

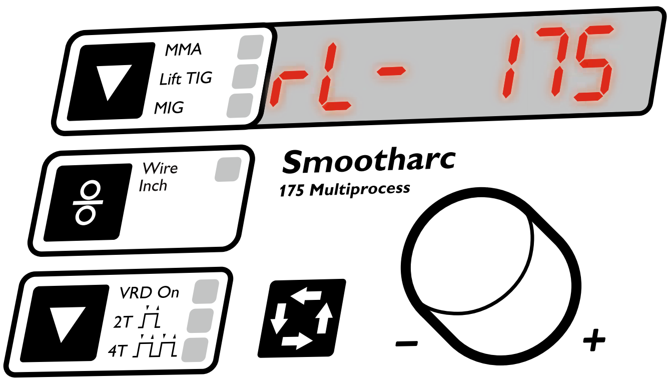


Illustration 2. MMA mode – VRD enabled

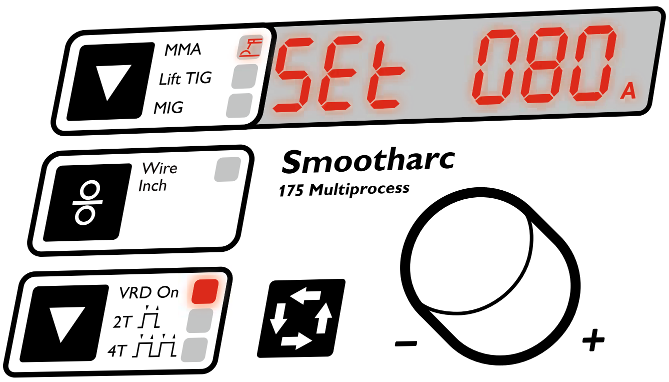
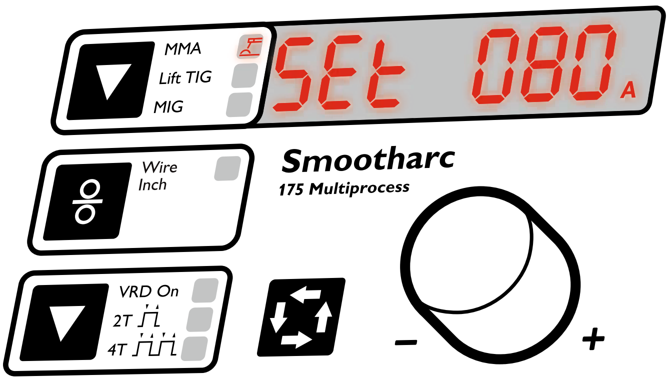


Illustration 3. MMA mode – VRD disabled



10.1 Starting up

Switch on the welding power source. The front panel display will light up as shown in Illustration 1. After the *Multifunctional Data display* (or any key or knob on front panel) flashes for 5 seconds, the machine enters into the welding mode that was saved in the last shutdown.

10.2 Operation for MMA mode

Press the *MMA/LIFT TIG/MIG* switch to MMA. The MMA indicator light will illuminate.

In the MMA mode, press the *VRD/2T/4T* switch. The VRD function is enabled when the indicator light is on.

Multifunctional Data display shows the preset current (A) 80A shown in Illustration 2.

Adjusting the *Multifunctional Data adjustment* will change the welding current during the welding process. The welding current range is 10-175A.

Three seconds after changing the welding parameters, the *Multifunctional Data display* will flash once to indicate that the setting has been saved. If the parameters are unchanged this setting will remain as such even after restarting the machine.

The machine has the ability to display the arc voltage during MMA welding (23.2V at 80A as shown in Illustration 4). The arc voltage will only be displayed during welding and for five seconds after completion of welding when the display will revert back to the preset display amperage.

Illustration 4. MMA mode – Display status when welding

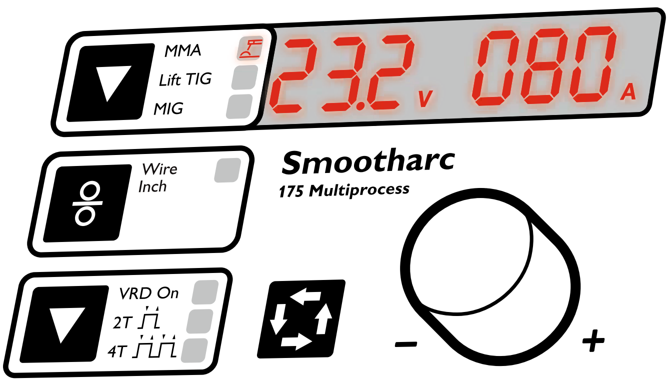


Illustration 5. Lift TIG mode – Current preset

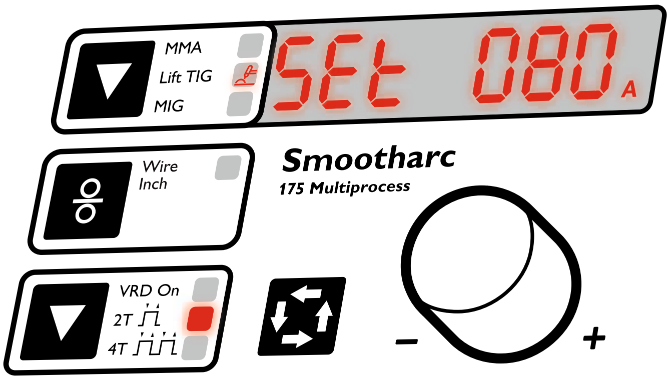


Illustration 6. Lift TIG mode – Status when welding is performed

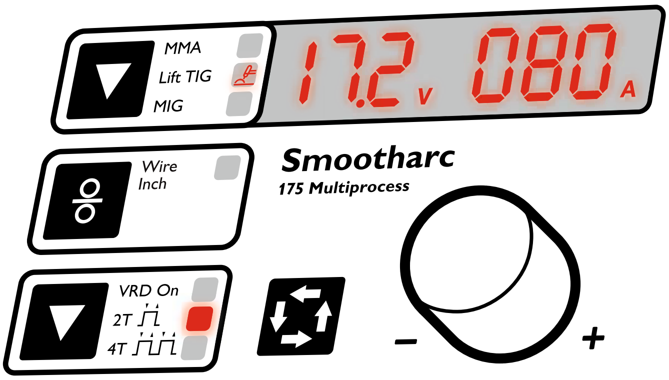
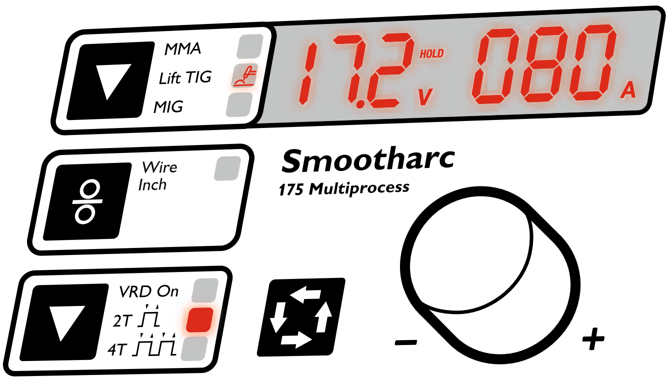


Illustration 7. Lift TIG mode – Status after welding is stopped



10.3 Operation instruction under LIFT TIG mode

Press the *MMA/LIFT TIG/MIG* switch to LIFT TIG. The LIFT TIG indicator light will illuminate.

The welding mode (2T/4T)* can be selected by depressing the *VRD/2T/4T*. The selected mode will illuminate.

The illustrations above indicate that the LIFT TIG mode and 2T NORMAL has been selected.

The welding amperage can be adjusted by turning the *Multifunctional Data adjustment*. In the illustrations above it is selected at 80A.

Welding amperage can be adjusted whilst welding and the welding current range is 10-175A.

If settings are unchanged for three seconds the *Multifunctional Data display* will flash once to indicate that the setting has been saved and these will be retained, and displayed when the machine restarts.

* 2T is non-latched trigger operation (press and hold to keep welding and let go to stop). 4T is latched trigger operation (click trigger to start welding and click again to stop).

Illustration 8. MIG mode – Preset voltage

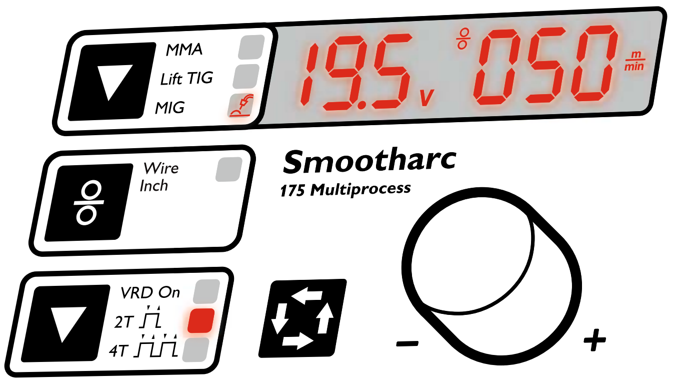
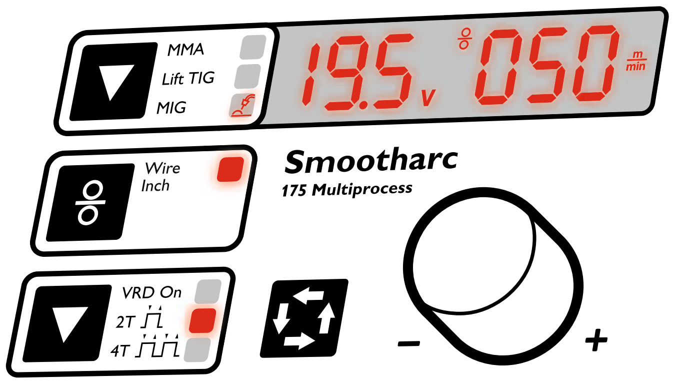


Illustration 9. MIG mode – Wire Check



10.4 Operation instruction under MIG mode

Press the *MMA/LIFT TIG/MIG* switch to MIG. The MIG indicator light will illuminate.

In MIG mode, the wire can be fed through the system by pressing the *Wire Inch* button.

To feed the wire through the torch the *Wire Inch* button has to be pressed to feed the wire. To stop feeding the wire release the button.

In both illustrations shown above the *Multifunctional Data display* shows a preset voltage of 19.5V and a wire feed speed of 05.0m per minute.

The welding mode (2T/4T)* can be selected by depressing the *VRD/2T/4T*. The selected mode will illuminate. (Refer to the section on MIG Fundaments in this manual for an explanation for 2T and 4T operation).

The welding parameters can be adjusted during welding by turning the *Multifunctional Data adjustment*. This action will synergically change both parameters (volts and wire feed speed).

The synergic welding parameter range is 17.5V 2.0 m/min to 25.8V 12 m/min.

* 2T is non-latched trigger operation (press and hold to keep welding and let go to stop). 4T is latched trigger operation (click trigger to start welding and click again to stop).

Illustration 10. MIG mode – Fine adjustment of voltage range

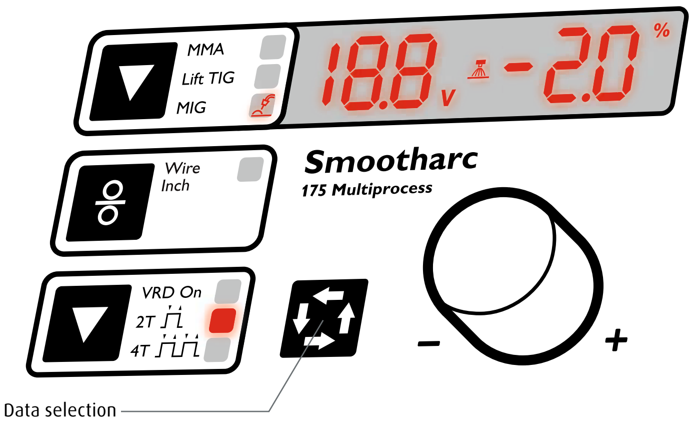
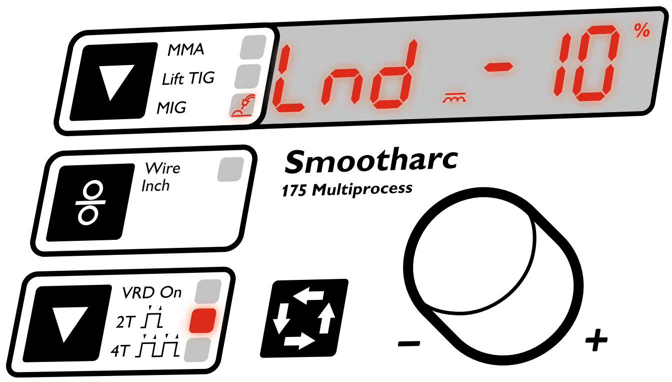


Illustration 11. MIG mode – Fine adjustment of Inductance presetting range



Use of the *Data Selection* button (MIG mode only)

Pressing the *Data Selection* button will enable you to switch between:

1 Arc welding adjustment mode
2 Inductance
3 Preset voltage and wire speed

By pressing the *Data Selection* button the *Multifunctional Data display* will change according to the welding parameter function mode that can be changed. In Illustration 10, it displays the arc voltage and the adjustment that can be done. In this mode the arc voltage is adjustable and the adjustment range of the preset value is ±20%.

When the *Data Selection* button is pressed again the *Multifunctional Data Display* will change to display the inductance as shown in Illustration 11. In this mode the inductance is adjustable and its adjustment range is ±10%.

When the Data Selection key is pressed again the *Multifunctional Data Display* will return to the preset voltage and wire feed speed.

If settings are unchanged for three seconds the *Multifunctional Data Display* will flash once to indicate that the setting has been saved and these will be retained, and displayed when the machine restarts.

11.0 Troubleshooting and Fault Finding

11.1 TIG/MMA functions

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 post flow time before turning off valve
Shield gas incorrect	Change to proper gas (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
Improper lift arc starting technique	Follow directions as set out on page 43
Poor scratch starting technique	Many codes do not allow scratch starts. Use copper strike plate. Use high frequency arc starter.
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 use gas lens
Wrong gas	Do not use ArO_2 or $ArCO_2$ GMAW (MIG) gases for TIG welding
Heavy surface oxides not being removed	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. Remove condensation from line with adequate gas pre-flow time
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
Excessive turbulence in gas stream	Change to gas safer 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 rigid torches

The phenomenon listed below may happen due to relevant accessories used, welding material, surroundings and power supply.
Please improve surroundings and avoid these problems.

Phenomenon

Cause	Solution
Arc starting difficulty. Arc interruption happens easily	Examine whether grounding wire clamp contacts with the work pieces well. Examine whether each joint has improper contact.
The output current fails to reach the set current	Check connects are tight and cables are not damaged. Ensure correct electrode size has been selected.
The current is unstable during operation: This situation may relate to the following factors	The voltage of electric power network changes; Serious interference from electric power network or other electric facilities.
Gas vent in welds	Examine whether the gas supply circuit has leakage. Examine whether there is sundries such as oil, dirt, rust, paint etc. on the surface.

11.2 MIG/MAG functions

Power source

Component	Fault symptom	Cause
Primary cable	No or low welding output	Poor or incorrect primary connection, lost phase
Earth cable and clamp	Arc will not initiate	Damaged, loose or undersized cables and clamps
Connectors and lugs	Overheating of connectors and lugs	Loose or poorly crimped connectors
Switches	Erratic or no output control	Switches damaged or incorrectly set for the application

Wire feeder

Component	Fault symptom	Cause
Gas solenoid valve	No gas flow or gas flows continuously	Gas valve faulty or sticking in open position
Wire feed rolls	Wire slippage, wire deformation	Incorrect feed roll size, incorrect tension adjustment, misalignment
Inlet, outlet guides	Wire shaving or snarling	Incorrect wire guide sizes, misalignment
Torch connector	Wire restriction, gas leaks, no trigger control	Torch connector not correctly mounted or secured, incorrect size of internal guide, bent contact pins
Wire feed speed control	No control over wire feed speed, no amperage control	Faulty wire speed feed potentiometer, machine in overload or trip condition
Wire inch switch	Wire live when feeding through cable and torch before welding	Faulty wire inch switch, activitation of torch trigger switch
Spindle	Wire spool drags or overruns	Spindle brake set too tight or too loose, spool not properly located on spindle

Welding torch

Component	Fault symptom	Cause
Type	Welding torch overheats	Welding torch underrated for welding application
Liners	Erratic wire feed, wire snarls up at outlet guide	Liner of incorrect type and size for wire in use, worn or dirty liner, liner too long or too short
Gas distributor	Inadequate gas flow, contaminated or porous weld	Damaged or blocked distributor
Nozzle	Inadequate gas cover, restricted joint accessibility	Nozzle too large or too small, incorrect length or shape
Contact tip	Erratic feeding, wire shudder, wire burnback, unstable arc, spatter	Incorrect size of contact tip, incorrect contact tip to nozzle distance for metal transfer mode, tip has worn out
Nozzle insulator	Arcing between contact tip and nozzle and between nozzle and workpiece	No nozzle insulator fitted, spatter build up has caused parts to short out

Regulator / flowmeter

Component	Fault symptom	Cause
Inlet stem	No gas flow, gas leaks at regulator body or cylinder valve	Blocked inlet stem, leaking inlet stem to body thread, bullnose not properly seated in cylinder valve
Gas hose and fitting	Leaks at connections or in the hose, porosity in the weld	Poorly fitted loose connections, damaged hose, air drawn into gas stream

Welding wire

Component	Fault symptom	Cause
Wire basket and spool	Erratic wire feeding or wire stoppages	Damaged wire basket, loose spooling, random-wound wire
Wire	Wire sticks in contact tip, erratic feeding	Varying wire diameter, copper flaking, surface damage
Wire	Weld has excessive amount of spatter	Wrong polarity has been selected

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 travel speed
Contaminated shield gas	Replace the shielding gas

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 without 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 nozzle
Excessive turbulence in gas stream	Change to gas saver parts or gas lens, lower flow rate if possible

12.0 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.

12.1 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.

13.0 Technical Specifications

Specifications	MULTIPROCESS 175
Part No.	BOC175MULTI
Power voltage	Single phase 240 V ±15 %
Frequency	50/60 Hz
Rated input current	28 A
Output current	
MMA	20 to 175 A
TIG	10 to 175 A
MIG	50 to 175 A
Rated working voltage	16.5 to 22.8 V
No-load voltage	56 V
Duty cycle	35 %
Wire feeder	Internal
Wire feeder speed	2 to 12 m/min
Post flow time (S)	3
Welding wire diameter	0.6/0.8/1.0 mm
Remote control	No
Efficiency	80 %
Power factor	0.73
Insulation grade	F
Housing protection grade	IP23S
Welding thickness (mm)	>0.8 mm
Dimensions L × W × H	420 × 220 × 439 mm
Weight	12.8 kg
Standards	IEC 60974.1

14.0 Warranty Information

14.1 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.

14.2 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.

14.3 Warranty Period

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

14.4 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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