Fundamentals of Metal Inert Gas (MIG) Welding

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 shielding gas
4. Selection of the correct application techniques:
   - **a** Correct angle of electrode to work
   - **b** Correct electrical stick-out
   - **c** Correct travel speed
5. Selection of the welding preparation.

Selection of correct consumables

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. However, there are certain applications for which electrodes will be selected on the basis of mechanical properties or the level of residual hydrogen in the weldmetal. Solid MIG wires are all considered to be of the 'low hydrogen type' consumables.

The following table gives a general overview of some of the BOC range of MIG wires for the most common materials. More detailed selection charts for specific materials can be found in the appropriate materials sections.

Material	Page No
Mild and Alloy steel	351
Quench and tempered steels	353
Ferritic materials	352
Stainless steel	406
Aluminium	425

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/NZS 3678-9 250, 300, 350, 400	BOC Mild Steel MIG Wire
AS1548-430, 460, 490	BOC Mild Steel MIG Wire
ASTM A36, A106	BOC Mild Steel MIG Wire
Stainless Steel	
Grade 304	BOC Stainless Steel 308LSi
Stainless to Carbon-Mn steels	
Grade 316	BOC Stainless Steel 316LSi
Aluminium	
1080	BOC Aluminium MIG 1080
6061, 3004	BOC Aluminium MIG 4043
5005	BOC Aluminium MIG 5356

Physical condition

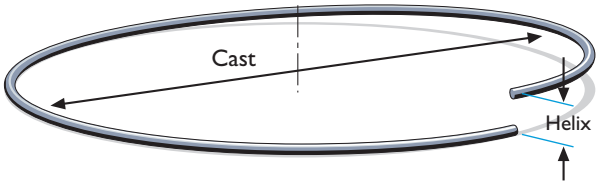
Surface condition.

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 20sec. 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 wire.



WARNING Welding can give rise to electric shock, excessive noise, eye and skin burns due to the arc rays, and a potential health hazard if you breathe in the emitted fumes and gases. Read all the manufacturer's instructions to achieve the correct welding conditions and ask your employer for the Materials Safety Data Sheets. Refer to www.boc.com.au or www.boc.co.nz

Cast – Diameter of the circle

Helix – Vertical height

If the cast is 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 and cause feeding problems.

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

A BOC power sources selection chart is contained in the arc equipment section of this manual (see pages 240–241).

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 type and thickness of the material to be welded will determine the type of shielding gas that is selected. As a general rule, the thicker the material (C-Mn and Alloy Steels), 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.

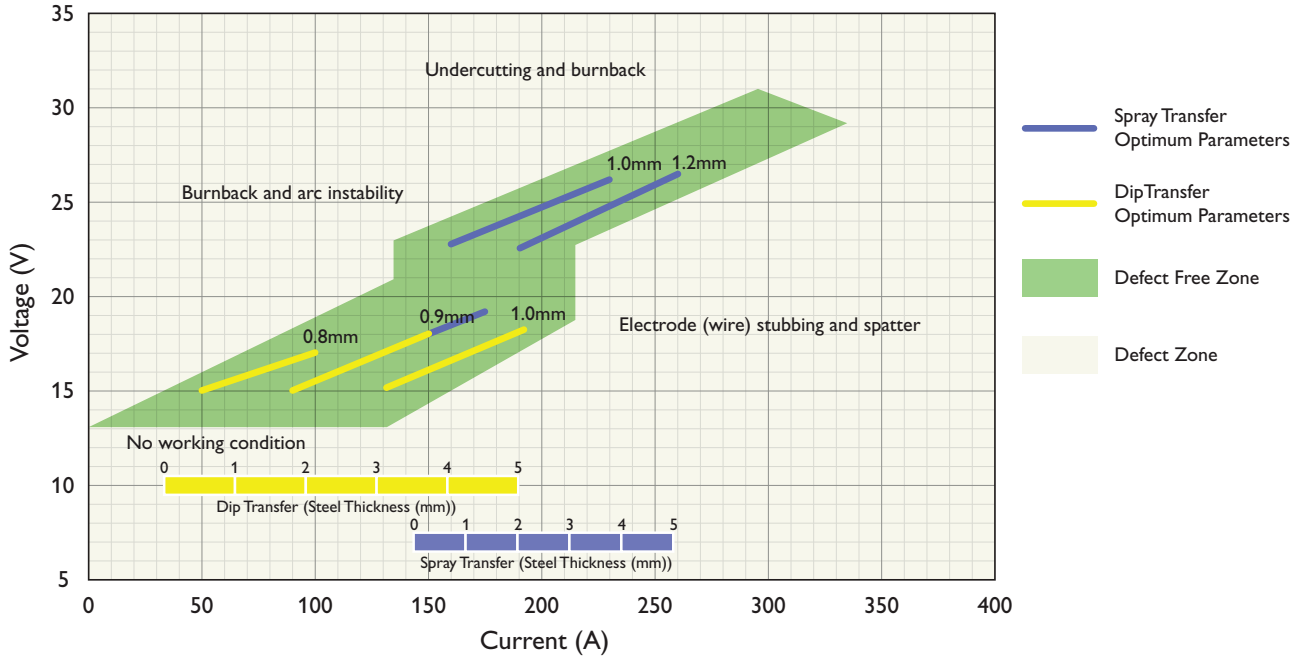
The following table gives an indication of the most common shielding gases used for carbon manganese and alloy steels:

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 stick-out, travel speed and gas flow rate) can be found in the following sections:

Material	Page
C-Mn and Alloy Steels	
Argoshield Light	60
Argoshield Universal	61
Argoshield Heavy	62
Argoshield 52	63
Stainless Steel	
Stainshield	65
Stainshield Heavy	65
Aluminium	
Argon	54
Alushield Light	67
Alushield Heavy	67
Copper	
Specshield Copper	80

Wire Operating Limits



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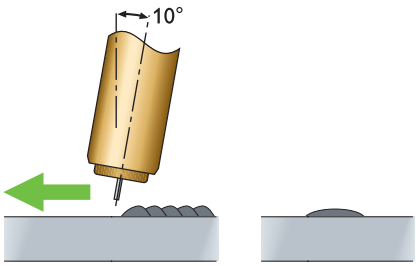
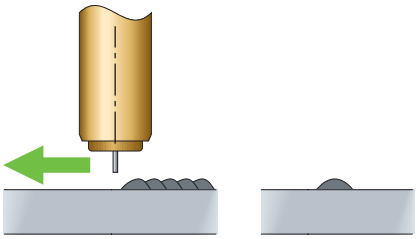
Correct Application Techniques

Direction of welding

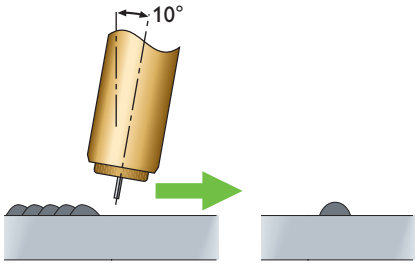
MIG welding with solid wires takes place normally with a push technique. The welding gun is tilted at an angle of 10° towards the direction of welding (push technique).



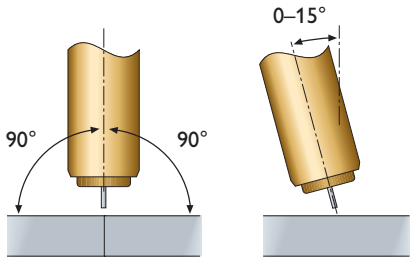
The influence of changing the torch angle and the welding direction on the weld bead profile can be seen below



Torch perpendicular to workpiece Narrow bead width with increased reinforcement

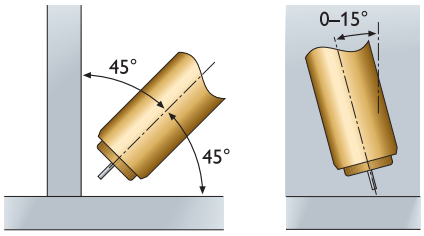


Torch positioned at a drag angle of 10° narrow bead with excessive reinforcement



Torch position for butt welds

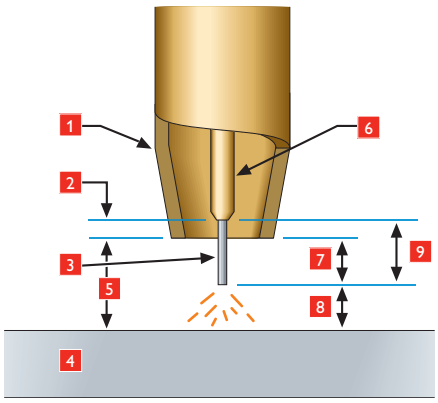
When welding butt welds, the torch should be positioned within the centre of the groove and tilted at an angle of ±15° from the vertical plane. Welding is still performed in the push technique



Torch position for fillet welds

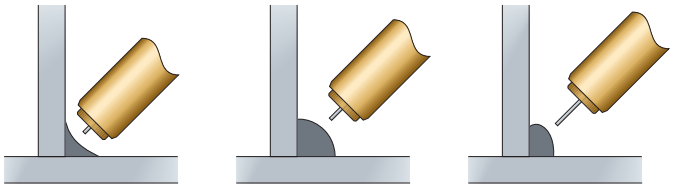
When welding fillet welds, the torch should be positioned at an angle of 45° from the bottom plate, with the wire pointing into the fillet corner. Welding is still performed in the push technique

Electrical stick-out



1	Gas Nozzle
2	Contact Tube Setback
3	Consumable Electrode
4	Workpiece
5	Standoff Distance
6	Contact Tube
7	Visible Stick-out
8	Arc length
9	Electrical Stick-out

The electrical stick-out is the distance between the end of the contact tip and the end of the wire. An increase in the electrical stick-out 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



Short Normal Long

Influence of the change in electrical stick-out length on the weldbead profile

Travel speed

Slow Normal Fast

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

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

Recommendations for travel speed are contained in the detailed gases datasheets found in pages 58–68 of this manual.

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