



ESAB EMP 210

3-In-1 Multiprocess Welding System

ESAB EM 210

MIG/MAG Welding System



Instruction manual

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1 SAFETY

1.1 Meaning of symbols

As used throughout this manual: Means Attention! Be Alert!



DANGER!

Means immediate hazards which, if not avoided, will result in immediate, serious personal injury or loss of life.



WARNING!

Means potential hazards which could result in personal injury or loss of life.



CAUTION!

Means hazards which could result in minor personal injury.



WARNING!

Before use, read and understand the instruction manual and follow all labels, employer's safety practices and Safety Data Sheets (SDSs).



1.2 Safety precautions



WARNING!

These Safety Precautions are for your protection. They summarise precautionary information from the references listed in Additional Safety Information section. Before performing any installation or operating procedures, be sure to read and follow the safety precautions listed below as well as all other manuals, material safety data sheets, labels, etc. Failure to observe Safety Precautions can result in injury or death.



PROTECT YOURSELF AND OTHERS

Some welding, cutting and gouging processes are noisy and require ear protection. The arc, like the sun, emits ultraviolet (UV) and other radiation and can injure skin and eyes. Hot metal can cause burns. Training in the proper use of the processes and equipment is essential to prevent accidents. Therefore:

1. Wear a welding helmet fitted with a proper shade of filter to protect your face and eyes when welding or watching.
2. Always wear safety glasses with side shields in any work area, even if welding helmets face shields and goggles are also required.
3. Use a face shield fitted with the correct filter and cover plates to protect your eyes, face, neck and ears from sparks and rays of the arc when operating or observing operations. Warn bystanders not to watch the arc and not to expose themselves to the rays of the electric-arc or hot metal.
4. Wear flameproof gauntlet type gloves, heavy long-sleeve shirt, cuff less trousers, high-topped shoes and a welding helmet or cap for protection, to protect against arc rays and hot sparks or hot metal. A flameproof apron may also be desirable as protection against radiated heat and sparks.
5. Hot sparks or metal can lodge in rolled up sleeves, trouser cuffs, or pockets. Sleeves and collars should be kept buttoned and open pockets eliminated from the front of clothing.
6. Protect other personnel from arc rays and hot sparks with a suitable non-flammable partition or curtains.
7. Use goggles over safety glasses when chipping slag or grinding. Chipped slag maybe hot and can fly far. Bystanders should also wear goggles over safety glasses.



FIRES AND EXPLOSIONS

Heat from flames and arcs can start fires. Hot slag or sparks can also cause fires and explosions. Therefore:

1. Protect yourself and others from flying sparks and hot metal.
2. Remove all combustible materials well away from the work area or cover the materials with a protective non-flammable covering. Combustible materials include wood, cloth, sawdust, liquid and gas fuels, solvents, paints and coatings paper, etc.
3. Hot sparks or hot metal can fall through cracks or crevices in floors or wall openings and cause a hidden smoldering fire or fires on the floor below. Make certain that such openings are protected from hot sparks and metal.
4. Do not weld, cut or perform other hot work until the work piece has been completely cleaned so that there are no substances on the work piece which might produce flammable or toxic vapors. Do not do hot work on closed containers, they may explode.
5. Have fire extinguishing equipment handy for instant use, such as a garden hose, water pail, sand bucket, or portable fire extinguisher. Be sure you are trained in its use.
6. Do not use equipment beyond its ratings. For example, an overloaded welding cable can overheat and create a fire hazard.
7. After completing operations, inspect the work area to make certain there are no hot sparks or hot metal which could cause a later fire. Use fire watchers when necessary.



ELECTRICAL SHOCK

Contact with live electrical parts and ground can cause severe injury or death. DO NOT use AC welding current in damp areas, if movement is confined, or if there is danger of falling. Therefore:

1. Be sure the power source frame (chassis) is connected to the ground system of the input power.
2. Connect the workpiece to a good electrical ground.
3. Connect the work cable to the workpiece. A poor or missing connection can expose you or others to a fatal shock.
4. Use well-maintained equipment. Replace worn or damaged cables.
5. Keep everything dry, including clothing, work area, cables, torch/electrode holder and power source.
6. Make sure that all parts of your body are insulated from both the work piece and from the ground.
7. Do not stand directly on metal or the earth while working in tight quarters or a damp area; stand on dry boards or an insulating platform and wear rubber-soled shoes.
8. Put on dry, hole-free gloves before turning on the power.
9. Turn off the power before removing your gloves.
10. Refer to ANSI/ASC Standard Z49.1 for specific grounding recommendations. Do not mistake the work lead for a ground cable.



ELECTRIC AND MAGNETIC FIELDS

May be dangerous. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding and cutting current creates EMF around welding cables and welding machines. Therefore:

1. Welders having pacemakers should consult their physician before welding. EMF may interfere with some pacemakers.
2. Exposure to EMF may have other health effects which are unknown.
3. Welders should use the following procedures to minimise exposure to EMF:
 1. Route the electrode and work cables together. Secure them with tape when possible.
 2. Never coil the torch or work cable around your body.
 3. Do not place your body between the torch and work cables. Route cables on the same side of your body.
 4. Connect the work cable to the workpiece as close as possible to the area being welded.
 5. Keep welding power source and cables as far away from your body as possible.



FUMES AND GASES

Fumes and gases, can cause discomfort or harm, particularly in confined spaces. Shielding gases can cause asphyxiation. Therefore:

1. Keep your head out of the fumes. Do not breathe the fumes and gases.
2. Always provide adequate ventilation in the work area by natural or mechanical means. Do not weld, cut or gouge on materials such as galvanized steel, stainless steel, copper, zinc, lead beryllium or cadmium unless positive mechanical ventilation is provided. Do not breathe fumes from these materials.
3. Do not operate near degreasing and spraying operations. The heat or arc can react with chlorinated hydrocarbon vapors to form phosgene, a highly toxic gas and other irritant gases.
4. If you develop momentary eye, nose or throat irritation while operating, this is an indication that ventilation is not adequate. Stop work and take necessary steps to improve ventilation in the work area. Do not continue to operate if physical discomfort persists.
5. Refer to ANSI/ASC Standard Z49.1 for specific ventilation recommendations.
6. **WARNING:** This product when used for welding or cutting, produces fumes or gases which contain chemicals known to the State of California to cause birth defects and in some cases cancer (California Health & Safety Code §25249.5 et seq.)



CYLINDER HANDLING

Cylinders, if mishandled, can rupture and violently release gas. A sudden rupture of cylinder valve or relief device can injure or kill. Therefore:

1. Locate cylinders away from heat, sparks and flames. Never strike an arc on a cylinder.
2. Use the proper gas for the process and use the proper pressure reducing regulator designed to operate from the compressed gas cylinder. Do not use adaptors. Maintain hoses and fittings in good condition. Follow manufacturer's operating instructions for mounting regulator to a compressed gas cylinder.
3. Always secure cylinders in an upright position by chain or strap to suitable hand trucks, undercarriages, benches, wall, post or racks. Never secure cylinders to work tables or fixtures where they may become part of an electrical circuit.
4. When not in use, keep cylinder valves closed. Have valve protection cap in place if regulator is not connected. Secure and move cylinders by using suitable hand trucks.



MOVING PARTS

Moving parts, such as fans, rotors and belts can cause injury. Therefore:

1. Keep all doors, panels, guards and covers closed and securely in place.
2. Stop engine or drive systems before installing or connecting unit.
3. Have only qualified people remove covers for maintenance and troubleshooting as necessary
4. To prevent accidental starting of equipment during service, disconnect negative (-) battery cable from battery.
5. Keep hands, hair, loose clothing and tools away from moving parts.
6. Reinstall panels or covers and close doors when service is finished and before starting engine.



WARNING! FALLING EQUIPMENT CAN INJURE

- Only use lifting eye to lift unit. Do NOT use running gear, gas cylinders or any other accessories.
- Use equipment of adequate capacity to lift and support unit.
- If using lift forks to move unit, be sure forks are long enough to extend beyond opposite side of unit.
- Keep cables and cords away from moving vehicles when working from an aerial location.



WARNING! EQUIPMENT MAINTENANCE

Faulty or improperly maintained equipment can cause injury or death. Therefore:

1. Always have qualified personnel perform the installation, troubleshooting and maintenance work. Do not perform any electrical work unless you are qualified to perform such work.
2. Before performing any maintenance work inside a power source, disconnect the power source from the incoming electrical power.
3. Maintain cables, earthing wire, connections, power cord and power supply in safe working order. Do not operate any equipment in faulty condition.
4. Do not abuse any equipment or accessories. Keep equipment away from heat sources such as furnaces, wet conditions such as water puddles, oil or grease, corrosive atmospheres and inclement weather.
5. Keep all safety devices and cabinet covers in position and in good repair.
6. Use equipment only for its intended purpose. Do not modify it in any manner.



CAUTION!
ADDITIONAL SAFETY INFORMATION

For more information on safe practices for electric arc welding and cutting equipment, ask your supplier for a copy of “Precautions and Safe Practices for Arc Welding, Cutting and Gouging”, Form 52-529.

The following publications are recommended:

- ANSI/ASC Z49.1 - “Safety in Welding and Cutting”
- AWS C5.5 - “Recommended Practices for Gas Tungsten Arc Welding”
- AWS C5.6 - “Recommended Practices for Gas Metal Arc welding”
- AWS SP - “Safe practices” - Reprint, Welding Handbook
- ANSI/AWS F4.1 - “Recommended Safe Practices for Welding and Cutting of Containers That Have Held Hazardous Substances”
- OSHA 29 CFR 1910 - "Safety and health standards"
- CSA W117.2 - "Code for safety in welding and cutting"
- NFPA Standard 51B, “Fire Prevention During Welding, Cutting, and Other Hot Work”
- CGA Standard P-1, “Precautions for Safe Handling of Compressed Gases in Cylinders”
- ANSI Z87.1, "Occupational and Educational Personal Eye and Face Protection Devices"

1.3 User responsibility

Users of ESAB equipment have the ultimate responsibility for ensuring that anyone who works on or near the equipment observes all the relevant safety precautions. Safety precautions must meet the requirements that apply to this type of equipment. The following recommendations should be observed in addition to the standard regulations that apply to the workplace.

All work must be carried out by trained personnel well-acquainted with the operation of the equipment. Incorrect operation of the equipment may lead to hazardous situations which can result in injury to the operator and damage to the equipment.

1. Anyone who uses the equipment must be familiar with:
 - its operation
 - location of emergency stops
 - its function
 - relevant safety precautions
 - welding and cutting or other applicable operation of the equipment
2. The operator must ensure that:
 - no unauthorised person is stationed within the working area of the equipment when it is started up
 - no-one is unprotected when the arc is struck or work is started with the equipment
3. The workplace must:
 - be suitable for the purpose
 - be free from drafts
4. Personal safety equipment:
 - Always wear recommended personal safety equipment, such as safety glasses, flame-proof clothing, safety gloves
 - Do not wear loose-fitting items, such as scarves, bracelets, rings, etc., which could become trapped or cause burns
5. General precautions:
 - Make sure the return cable is connected securely
 - Work on high voltage equipment may only be carried out by a qualified electrician
 - Appropriate fire extinguishing equipment must be clearly marked and close at hand
 - Lubrication and maintenance must **not** be carried out on the equipment during operation

**WARNING!**

Wire feeders are intended to be used in GMAW (MIG/MAG) mode only.

If used in any other welding mode, such as SMAW (MMA), the welding cable between wire feeder and power source must be disconnected, or else the wire feeder becomes live or energized.

If equipped with ESAB cooler

Use ESAB approved coolant only. Non-approved coolant might damage the equipment and jeopardize product safety. In case of such damage, all warranty undertakings from ESAB cease to apply.

Recommended ESAB coolant ordering number: 0465 720 002.

For ordering information, see the "ACCESSORIES" chapter in the instruction manual.

**WARNING!**

Arc welding and cutting can be injurious to yourself and others. Take precautions when welding and cutting.



ELECTRIC SHOCK - Can kill

- Do not touch live electrical parts or electrodes with bare skin, wet gloves or wet clothing
- Insulate yourself from work and ground.
- Ensure your working position is safe



ELECTRIC AND MAGNETIC FIELDS - Can be dangerous to health

- Welders having pacemakers should consult their physician before welding. EMF may interfere with some pacemakers.
- Exposure to EMF may have other health effects which are unknown.
- Welders should use the following procedures to minimize exposure to EMF:
 - Route the electrode and work cables together on the same side of your body. Secure them with tape when possible. Do not place your body between the torch and work cables. Never coil the torch or work cable around your body. Keep welding power source and cables as far away from your body as possible.
 - Connect the work cable to the workpiece as close as possible to the area being welded.



FUMES AND GASES - Can be dangerous to health

- Keep your head out of the fumes
- Use ventilation, extraction at the arc, or both, to take fumes and gases away from your breathing zone and the general area



ARC RAYS - Can injure eyes and burn skin

- Protect your eyes and body. Use the correct welding screen and filter lens and wear protective clothing
- Protect bystanders with suitable screens or curtains



NOISE - Excessive noise can damage hearing

Protect your ears. Use earmuffs or other hearing protection.



MOVING PARTS - Can cause injuries

- Keep all doors, panels and covers closed and securely in place. Have only qualified people remove covers for maintenance and troubleshooting as necessary. Reinstall panels or covers and close doors when service is finished and before starting engine.
- Stop engine before installing or connecting unit.
- Keep hands, hair, loose clothing and tools away from moving parts.



FIRE HAZARD

- Sparks (spatter) can cause fire. Make sure therefore that there are no inflammable materials nearby
- Do not use on closed containers.



HOT SURFACE - Parts can burn

- Do not touch parts bare handed.
- Allow cooling period before working on equipment.
- To handle hot parts, use proper tools and/or insulated welding gloves to prevent burns.

MALFUNCTION - Call for expert assistance in the event of malfunction.

PROTECT YOURSELF AND OTHERS!



CAUTION!

This product is solely intended for arc welding.

ESAB has an assortment of welding accessories and personal protection equipment for purchase. For ordering information contact your local ESAB dealer or visit us on our website.

1.4 California proposition 65 warning



WARNING!

Welding or cutting equipment produces fumes or gases which contain chemicals known in the State of California to cause birth defects and, in some cases, cancer. (California Health & Safety Code Section 25249.5 et seq.)



WARNING!

This product can expose you to chemicals including lead, which are known to the state of California to cause cancer and birth defects or other reproductive harm. Wash hands after use.

For more information, go to www.P65Warnings.ca.gov.

2 INTRODUCTION

The **ESAB EMP 210** is a self-contained single phase multi process welding system that is capable of performing MIG (GMAW/FCAW), MMA (SMAW) and LIFT TIG (L-GTAW) welding.

The **ESAB EM 210** is a self-contained single phase welding system that is capable of performing MIG (GMAW/FCAW) welding.

The power sources are equipped with an integrated wire feed unit, digital voltage and amperage meters, and a host of other features.

2.1 Equipment

ESAB EMP 210 is supplied with:

- EMP 210 power source with 6 ft (1.8 m) gas hose fitted, NEMA 6-50P, the style of MIG Gun connector is TWECO connector
- Ground clamp with #6 AWG (16 mm²) lead and 50mm OKC cable connector, 9 ft (3m) long
- Electrode holder with #6 AWG (16 mm²) lead and 50mm OKC cable connector, 9 ft (3m) long
- Flowmeter regulator (0781-9411B)
- Instruction manual
- NEMA 6-50R to N5-15P power adapter
- 2 lb, Ø0.03 in. (1 kg, Ø0.8 mm) solid wire (1A5008201M)
- 0.024V / 0.030V feed roll fitted (7977036)
- 0.030K / 0.035K feed roll spare (7977731)

ESAB EM 210 is supplied with:

- EM 210 power source, 6 ft (1.8 m) gas hose, NEMA 6-50P, the style of MIG Gun connector is TWECO connector
- Ground clamp with #6 AWG (16 mm²) lead and 50mm OKC cable connector, 9 ft (3m) long
- Flowmeter regulator (0781-9411B)
- Instruction manual
- NEMA 6-50R to N5-15P power adaptor
- 2 lb, Ø0.03 in. (1 kg, Ø0.8 mm) solid wire (1A5008201M)
- 0.024 V / 0.030 V feed roll fitted (7977036)
- 0.030 K / 0.035 K feed roll spare (7977731)

3 TECHNICAL DATA

ESAB EMP 210		
Input voltage	120 V ±15% 1~ 50/60 Hz	230 V ±15% 1~ 50/60 Hz
Primary current		
I _{max} MIG (GMAW/FCAW)	26 A	38 A
I _{max} Lift TIG (L-GTAW)	22 A	29 A
I _{max} MMA (SMAW)	26 A	38 A
Open circuit voltage (OCV)	68 V	
Setting range		
MIG (GMAW/FCAW)	30 A / 15.5 V - 90 A / 18.5 V	30 A / 15.5 V - 200 A / 24 V
Lift TIG (L-GTAW)	10 A / 10.4 V - 90 A / 13.6 V	10 A / 10.4 V - 200 A / 18 V
MMA (SMAW)	20 A / 20.8 V - 70 A / 22.8 V	20 A / 20.8 V - 170 A / 26.8 V
Permissible load at MIG (GMAW)		
25% duty cycle	90 A / 18.5 V	
15% duty cycle		200 A / 24 V
60% duty cycle	58 A / 16.9 V	100 A / 19 V
100% duty cycle	45 A / 16.3 V	78 A / 17.9V
Permissible load at Lift TIG (L-GTAW)		
25% duty cycle	90 A / 13.6 V	
15% duty cycle		200 A / 18 V
60% duty cycle	58 A / 12.3 V	100 A / 14 V
100% duty cycle	45 A / 11.8 V	78 A / 13.2V
Permissible load at MMA (SMAW)		
25% duty cycle	70 A / 22.8 V	
15% duty cycle		170 A / 26.8 V
60% duty cycle	45 A / 21.8 V	85 A / 23.4 V
100% duty cycle	35 A / 21.4 V	69 A / 22.8 V
Apparent power I ₂ (At maximum current)	26 A	38 A
Active power I ₂ (At maximum current)	13 A	15 A
Maximum input current (I _{1max})		
MIG (GMAW)	26 A	38 A
Lift TIG (L-GTAW)	22 A	29 A
MMA (SMAW)	26 A	38 A

ESAB EMP 210		
Effective input current ($I_{1\text{eff}}$)		
MIG (GMAW)	13 A	14.7 A
Lift TIG (L-GTAW)	11 A	11.2 A
MMA (SMAW)	13 A	14.7 A
Max weld thickness	0.38 in. (9.52 mm)	
Operating temperature	+14 to 104 °F (-10 to +40 °C)	
Transportation temperature	-4 to 131 °F (-20 to +55 °C)	
Continual sound pressure at no-load	<70 dB	
Dimensions l x w x h	19.2 x 8.7 x 15 in. (488 x 220 x 381 mm)	
Weight	30.2 lb (13.7 kg)	
Insulation class transformer	F	
Enclosure class	IP21S	
Application class	S	

ESAB EM 210		
Input voltage	120 V ±15% 1~ 50/60 Hz	230 V ±15% 1~ 50/60 Hz
Primary current		
I _{max} MIG (GMAW/FCAW)	26 A	38 A
Open circuit voltage (OCV)	68 V	
Setting range		
MIG (GMAW/FCAW)	30 A / 15.5 V - 90 A / 18.5 V	30 A / 15.5 V - 200 A / 24 V
Permissible load at MIG (GMAW/FCAW)		
25% duty cycle	90 A / 18.5 V	
15% duty cycle		200 A / 24 V
60% duty cycle	58 A / 16.9 V	100 A / 19 V
100% duty cycle	45 A / 16.3 V	78 A / 17.9 V
Apparent power I ₂ (At maximum current)	26 A	38 A
Active power I ₂ (At maximum current)	13 A	15 A
Maximum input current (I _{1max})		
MIG (GMAW/FCAW)	26 A	38 A
Effective input current (I _{1eff})		
MIG (GMAW/FCAW)	13 A	15 A
Max weld thickness	0.38 in. (9.52 mm)	
Operating temperature	+14 to 104 °F (-10 to +40 °C)	

ESAB EM 210	
Transportation temperature	-4 to 131 °F (-20 to +55 °C)
Continual sound pressure at no-load	<70 dB
Dimensions l x w x h	19.2 x 8.7 x 15 in. (488 x 220 x 381 mm)
Weight	30.2 lb (13.7 kg)
Insulation class transformer	F
Enclosure class	IP21S
Application class	S

Supply from power generators

The power source can be supplied from different types of generators. However, some generators may not provide sufficient power for the welding power source to operate correctly. Generators with Automatic Voltage Regulation (AVR) or with equivalent or better type of regulation, with rated power 10 KW, are recommended.

Some 120 VAC, 15 A / 20 A electrical outlets fitted with GFCI (Ground Fault Circuit Interrupter) protection against a nuisance trip with this equipment due to worn or out of tolerance components in the GFCI. In such cases have the 120 VAC, 15 A / 20 A GFCI electrical outlet replaced by a qualified electrician.

**NOTE!**

The effective input current should be used for the determination of cable size and supply requirements.

**NOTE!**

Motor start fuses or thermal circuit breakers are recommended for this application. Check local requirements for your location.

**NOTE!**

The recommended time delay fuse or circuit breaker size for 120 V is 30 A. An individual branch circuit capable of carrying 30 A and protected by fuses or circuit breaker is recommended for this application. Fuse size is based on not more than 200% of the rated input amperage of the welding power source (based on article 630, National Electrical Code).

ESAB continuously strives to produce the best product possible and therefore reserves the right to change, improve or revise the specifications or design of this or any product without prior notice. Such updates or changes do not entitle the buyer of equipment previously sold or shipped to the corresponding changes, updates, improvements or replacement of such items.

The values specified in the table below are optimal values, your values may differ. Individual equipment may differ from the above specifications due to in part, but not exclusively, to any one or more of the following; variations or changes in manufactured components, installation and conditions and local power grid supply conditions.

Enclosure class

The **IP** code indicates the enclosure class, i.e. the degree of protection against penetration by solid objects or water.

Equipment marked **IP21S** is intended for indoor use.

Application class

The symbol S indicates that the power source is designed for use in areas with increased electrical hazard.

4 INSTALLATION

The installation must be carried out by a professional.



CAUTION!

This product is intended for industrial use. In a domestic environment this product may cause radio interference. It is the user's responsibility to take adequate precautions.

4.1 Installing 12.5 lb Spool (8 in. diameter)

In order to fit a 12.5 lb spool (8 in. diameter) assemble parts in the sequence shown in the figure below.

To install wire spool, refer to the steps below.

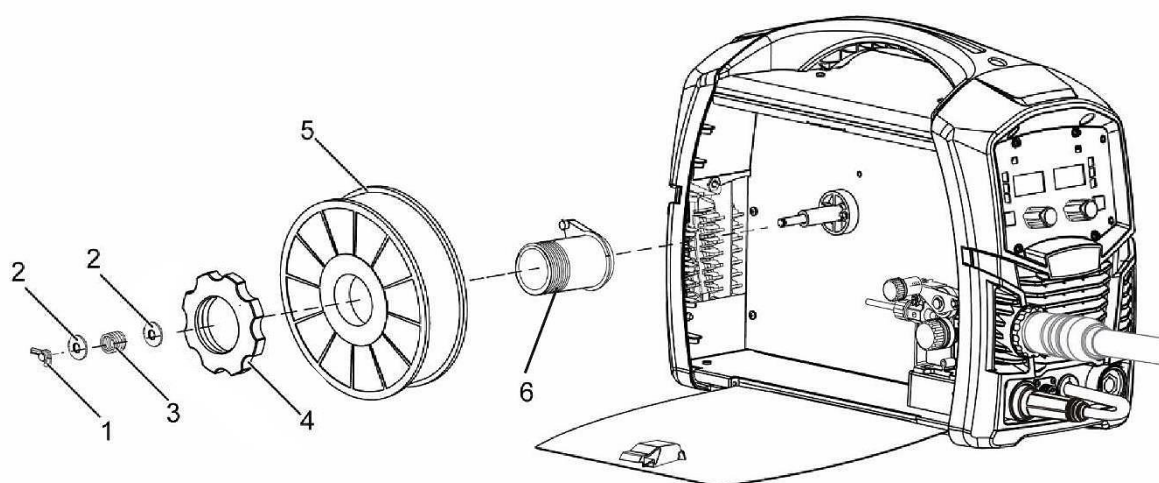


Figure 12: 12.5 lb (8 in.) spool installation

- | | |
|--------------------------|------------------------------|
| 1 Wire spool hub nut | 5 12.5 lb (8 in.) wire spool |
| 2 Flat washer small hole | 6 Spool hub |
| 3 Spring small hole | |
| 4 Plastic nut | |

- 1) Remove wire spool hub retaining clip. Grasp the loop and pull.
- 2) Place wire spool onto the hub, loading it so that the wire will feed off the bottom of the spool as the spool rotates counter clockwise. Make sure to align the spool alignment pin on the hub with the mating hole in the wire spool.
- 3) Replace the wire spool hub retaining clip in the set of holes closest to the spool.



NOTE!

The hub tension has been pre-adjusted at the factory. However if adjustment is required, see the "Wire reel brake" section.



CAUTION!

Use care in handling the spooled wire as it will tend to "unravel" when loosened from the spool. Grasp the end of the wire firmly and don't let go of it.

4.2 Installing 2 lb spool (4 in. diameter)

In order to fit a 2 lb spool (4 in. diameter) assemble parts in the sequence shown in the figure below.

To install wire spool, refer to the steps below.

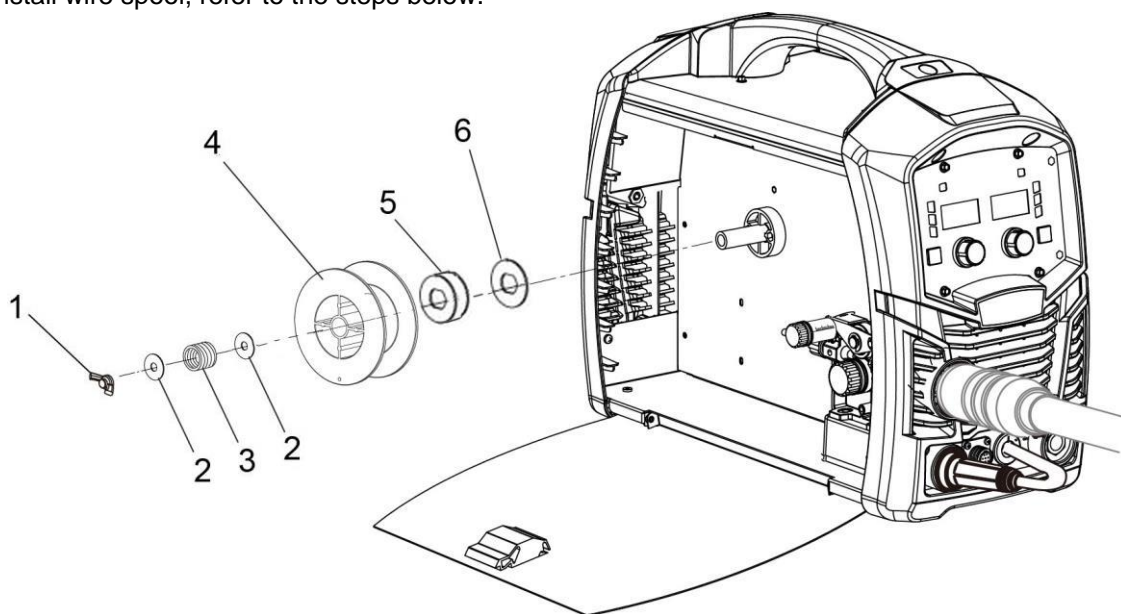


Figure 13: 2 lb (4 in.) spool installation

- | | |
|------------------------------------|--------------------------|
| 1 Wire spool hub nut | 5 10mm spacer large hole |
| 2 Flat washer small hole | 6 Fiber washer |
| 3 Spring small hole | |
| 4 2 lb (4 in.) diameter wire spool | |

- 1) Remove wire spool hub retaining clip. Grasp the loop and pull.
- 2) Place fiber washer and large spring onto the shaft, then load the wire spool on the shaft so that the wire will feed off the bottom of the spool as spool rotates counter clockwise.
- 3) Then place flat washer large hole, keyed washer, spring, flat washer small hole. Finally secure with wire spool hub nut.



NOTE!

The hub tension has been pre-adjusted at the factory. However if adjustment is required, see "Wire reel brake" section.



CAUTION!

Use care in handling the spooled wire as it will tend to "unravel" when loosened from the spool. Grasp the end of the wire firmly and don't let go of it.

4.3 Inserting wire into the wire feed mechanism

Release the tension from the pressure roller by turning the adjustable wire drive tension knob (1) in a counter clockwise direction. Then to release the pressure roller arm (2) push the tension screw toward the back of the machine which releases the pressure roller arm (2). With the MIG welding wire feeding from the bottom of the spool, see pass the electrode wire through the inlet guide (4), between the rollers, through the outlet guide (3) and into the MIG gun. Resecure the pressure roller arm (2) and wire drive tension screw and adjust the pressure accordingly. Remove the contact tip from the MIG gun. With the MIG gun lead reasonably straight, feed the wire through the MIG gun by pressing the trigger switch. Fit the appropriate velocity contact tip.



WARNING!

Before connecting the work clamp to the workpiece make sure the electricity supply is switched off. The electrode wire will be at welding voltage potential while it is being feed through the system. Keep the MIG gun away from eyes and face.

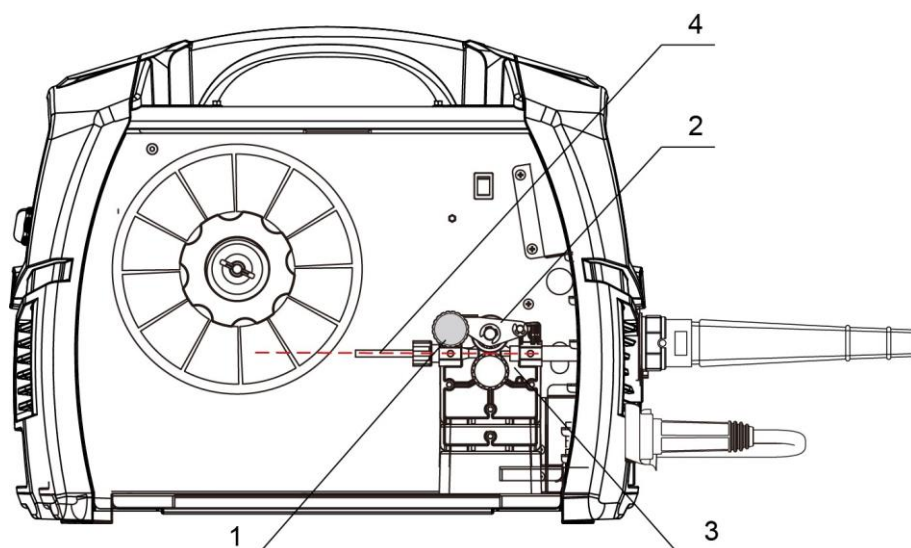


Figure 14: MIG welding wire - Installation

- 1 Wire drive tension knob
- 2 Pressure arm

- 3 Outlet wire guide
- 4 Inlet wire guide

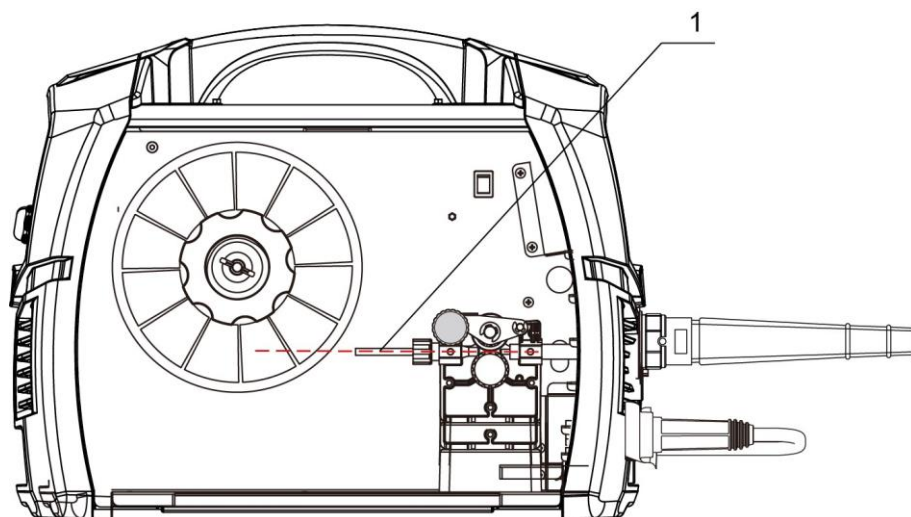


Figure 15: MIG welding wire - Installation

- 1 MIG welding wire

5 OPERATION

General safety regulations for handling the equipment can be found in the "SAFETY" chapter of this manual. Read it through before you start using the equipment!

5.1 Victor regulator

Pressure regulator attached to the cylinder valve reduce high cylinder pressures to suitable low working pressures for welding, cutting, and other applications.



Figure 16: Victor regulator

- | | |
|---------------------------------|----------------------------|
| 1 Low pressure gauge (delivery) | 4 Pressure adjusting screw |
| 2 High pressure gauge (supply) | 5 Inlet connection |
| 3 Outlet connection | |



WARNING!

Use the regulator for the gas and pressure for which it is designed. Never alter a regulator for use with any other gas.

Regulators purchased with open 1/8 in., 1/4 in., 3/8 in., or 1/2 in. NPT ports must be assembled to their intended system.

1. Note the maximum inlet pressure stamped on the regulator. DO NOT attach the regulator to a system that has a higher pressure than the maximum rated pressure stamped on the regulator.
2. The regulator body will be stamped "IN" or "HP" at the inlet port. Attach the inlet port to the system supply pressure connection.
3. If gauges are to be attached to the regulator and the regulator is stamped and listed by a third party (i.e. "UL" or "ETL"). The following requirements must be met:
 - Inlet gauges over 1000 PSIG (6.87 mPa) shall conform with the requirements of UL 404, "Indicating Pressure Gauges for Compressed Gas Service."
 - Low pressure gauges must be UL recognized for the class of regulator they are being used on according to UL252A.



WARNING!

Do not use a regulator that delivers pressure exceeding the pressure rating of the downstream equipment unless provisions are made to prevent over-pressurization (i.e. system relief valve). Make sure the pressure rating of the downstream equipment is compatible with the maximum delivery pressure of the regulator.

4. Be sure that the regulator has the correct pressure rating and gas service for the cylinder used.

**NOTE!**

For MIG application, the gas mixture used is 80% argon and 20% carbon dioxide.
For MAG application, 100% carbon dioxide is used.

5. Carefully inspect the regulator for damaged threads, dirt, dust, grease, oil, or other flammable substances. Remove dust and dirt with a clean cloth. Be sure the inlet swivel filter is clean and in place. Attach the regulator to the cylinder valve. Tighten securely with a wrench.

**WARNING!**

Do not attach or use the regulator if oil, grease, flammable substances or damage is present! Have a qualified repair technician clean the regulator or repair any damage.



Figure 17: Regulator to cylinder valve

6. Before opening the cylinder valve, turn the regulator adjusting screw counter-clockwise until there is no pressure on the adjusting spring and the screw turns freely.
7. Relief valve (where provided): The relief valve is designed to protect the low pressure side of the regulator from high pressures. Relief valves are not intended to protect downstream equipment from high pressures.

**WARNING!**

Do not tamper with the relief valve or remove it from the regulator.

**WARNING!**

Stand to the side of the cylinder opposite the regulator when opening the cylinder valve. Keep the cylinder valve between you and the regulator. For your safety, never stand in front of or behind a regulator when opening the cylinder valve!

8. Slowly and carefully open the cylinder valve until the maximum pressure shows on the high pressure gauge.

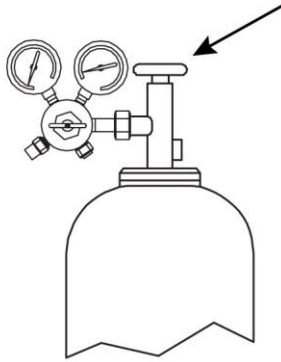


Figure 18: Open cylinder valve

9. On all cylinders, except acetylene, open the valve completely to seal the valve packing. On gauge less regulators, the indicator will register the cylinder contents open.



CAUTION!

Keep the cylinder valve wrench, if one is required, on the cylinder valve to turn OFF the cylinder quickly, if necessary.

10. Attach the desired downstream equipment.

5.2 Leak testing the system

Leak test the system before putting into operation.

- 1) Be sure that there is a valve in the downstream equipment to turn OFF the gas flow.
- 2) With the cylinder valve open, adjust the regulator to deliver the maximum required delivery pressure.
- 3) Close the cylinder valve.
- 4) Turn the adjusting screw/knob counter-clockwise one turn.
 - If the high-pressure gauge reading drops, there is a leak in the cylinder valve, inlet fitting, or high-pressure gauge.
 - If the low-pressure gauge drops, there is a leak in the downstream equipment, hose, hose fitting, outlet fitting or low-pressure gauge. Check for leaks using an approved leak detector solution.
 - If the high-pressure gauge drops and the low-pressure gauge increases at the same time, there is a leak in the regulator seat.
 - If the regulator requires service or repair, take it to a qualified repair technician.
- 5) Once leak testing has been performed and there are no leaks in the system, slowly open the cylinder valve and proceed.



WARNING!

If a leak has been detected anywhere in the system, discontinue use and have the system repaired. DO NOT use leaking equipment. Do not attempt to repair a leaking system while the system is under pressure.

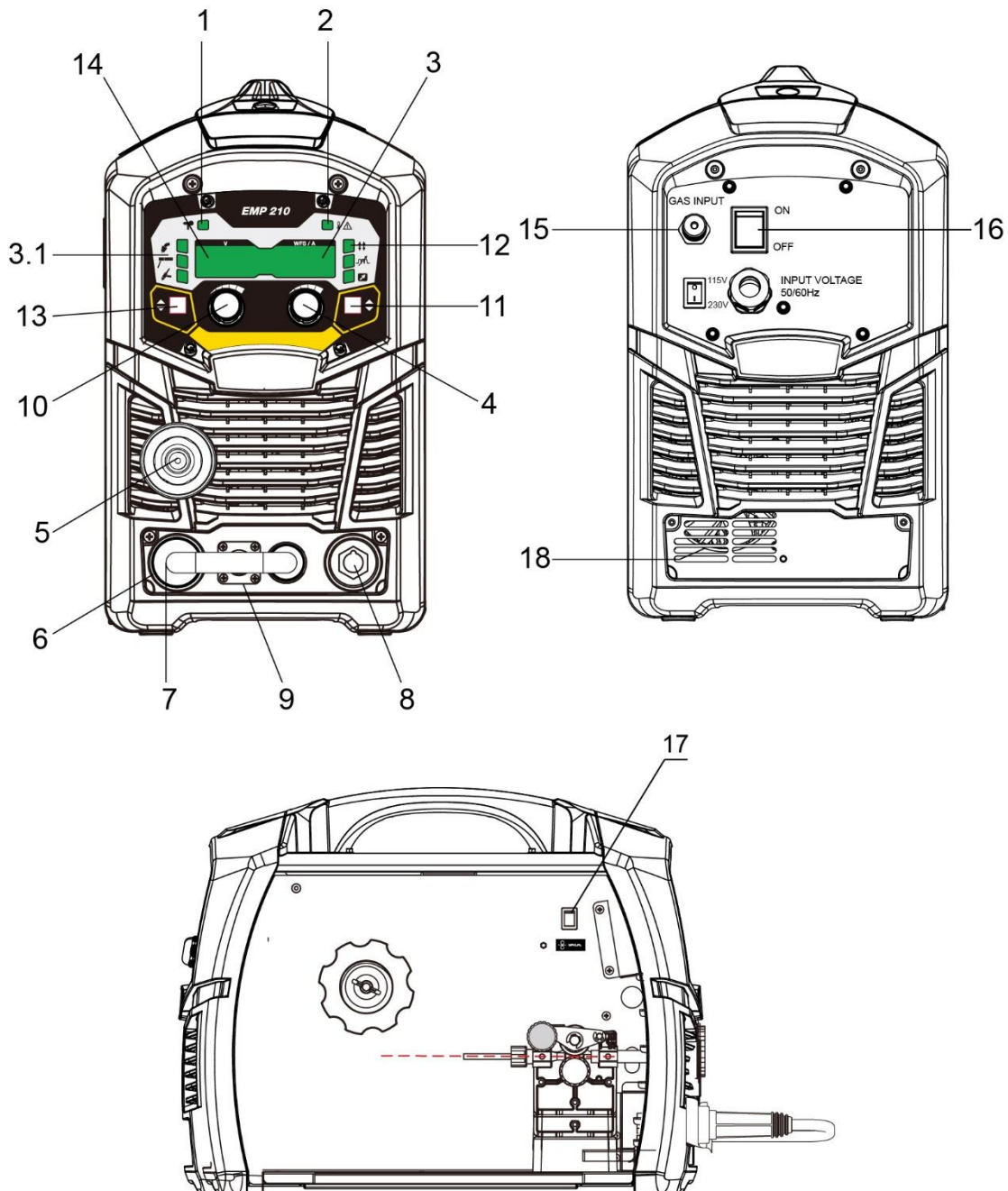
5.3 When you finish using the regulator

- 1) Close the cylinder valve.
- 2) Open the valve on the downstream equipment. This drains all pressure from the system.
- 3) Close the valve on the downstream equipment.
- 4) Turn the adjusting screw counter-clockwise to release the tension on the adjusting spring.
- 5) Check the gauges after a few minutes for verification that the cylinder valve is closed completely.

When the regulator is not in use and has been removed from the cylinder, it should be stored in an area where it will be protected from dust, oil, and grease. The inlet and outlet should be capped to protect against internal contamination and prevent insects from nesting.

5.4 Controls and indicators

5.4.1 ESAB EMP 210



1. Spool gun indicator

When the correct ESAB Spool-Gun* is connected, the LED will illuminate. (*Optional Accessory).

2. Thermal overload indicator (fault indicator)

This welding power source is protected by a self resetting thermostat. The LED indicator will illuminate if the duty cycle of the power source has been exceeded. Should the thermal overload indicator illuminate the output of the power source will be disabled. Once the power source cools down, the LED will turn OFF and the over temperature condition will automatically reset. Note that the mains power switch should remain in ON position such that the fan continues to operate thus allowing the unit to cool sufficiently. Do not switch the unit OFF during an overload condition.

3. Digital Wire Feed Speed (WFS) and Welding Amperage (A) (Right side LED display)

MIG mode

This digital meter is used to display the pre-set (preview) wire feed speed in IPM (inches per minute) in MIG mode and actual welding amperage of the power source when welding. During non-welding, the digital meter will display a pre-set (preview) value of wire feed speed. This value can be adjusted by varying the Wire feed speed control knob (4).

MMA and LIFT TIG modes

The digital meter is used to display the pre-set (preview) amperage in MMA / LIFT TIG modes and actual welding amperage of the power source when welding. At times of non-welding, the amperage meter will display a pre-set (preview) value in both MMA and LIFT TIG modes.

This value can be adjusted by varying the amperage control knob (4).

When welding, this digital meter will display actual welding amperage in all modes. At the completion of welding, the digital meter will hold the last recorded amperage value for a period of approximately 10 seconds in all modes. The amperage meter will hold the value until; (1) any of the front panel controls are adjusted in which case the unit will revert to preview mode, (2) welding is recommenced, in which case actual welding amperage will be displayed, or (3) a period of 10 seconds elapses following the completion of welding in which case the unit will return to preview mode.

**NOTE!**

The preview functionality provided on this power source is intended to act as a guide only. Some differences may be observed between preview values and actual welding values due to factors including the mode of welding, differences in consumables/gas mixtures, individual welding techniques and the transfer mode of the welding arc (dip versus spray transfer). Where exact settings are required (in the case of procedural work), it is recommended that alternate measurement methods be utilized to ensure output values are accurate.

3.1 Wire speed indicator

The wire speed indicator illuminates when MIG mode is selected to identify that the digital wire speed/amperage meter is previewing wire speed in IPM (inches per minute).

The wire speed indicator extinguishes when the user is MIG (GMAW/FCAW) welding or depressing the MIG gun trigger and the digital wire speed/amperage meter displays actual welding amperage of the power source.

4. Wire speed/amperage control

In MIG mode, the wire speed/amperage control knob adjusts the speed of the wire feed motor (which in turn adjusts the output current by varying the amount of MIG wire delivered to the welding arc). The optimum wire speed depends upon the material type and the welding application. The setup chart on the inside of the wire feed compartment door provides a brief summary of the required settings for a basic range of MIG (GMAW/ FCAW) welding applications.

In MMA and LIFT TIG modes, the wire speed/amperage control knob adjusts the amount of amperage (weld current) delivered to the welding arc by the power source. It directly adjusts the power source to deliver the desired level of weld current.

**NOTE!**

The preview functionality provided on this power source is intended to act as a guide only. Some differences may be observed between preview values and actual welding values due to factors including the mode of welding, differences in consumables/gas mixtures, individual welding techniques and the transfer mode of the welding arc (dip versus spray transfer). Where exact settings are required (in the case of procedural work), it is recommended that alternate measurement methods be utilized to ensure output values are accurate.

5. MIG gun adapter (TWECO style)

The MIG gun adapter is the connection point for the MIG gun. Refer section 5.6 Attaching the ESAB fusion 180 A MIG gun for installation of MIG gun to the power source.

6. Positive welding output terminal

The positive welding terminal is used to connect the welding output of the power source to the appropriate welding accessory such as the MIG gun (via the MIG polarity lead), electrode holder lead or work lead. Positive welding current flows from the power source via this dinse type terminal. Insert and turn the male plug securely to achieve a secure electrical connection.

**WARNING!**

Loose welding terminal connections can cause overheating and result in the male plug being fused in the dinse terminal.

7. MIG polarity lead

The polarity lead is used to connect the MIG gun to the appropriate positive or negative output terminal (allowing polarity reversal for different welding applications). In general, the polarity lead should be connected in to the positive welding terminal (+) when using steel, stainless steel or aluminum electrode wire. When using gasless wire, the polarity lead is generally connected to the negative welding terminal (-). If in doubt, consult the manufacturer of the electrode wire for the correct polarity. Insert and turn the male plug securely to achieve a secure electrical connection.

**WARNING!**

Loose welding terminal connections can cause overheating and result in the male plug being fused in the dinse terminal.

8. Negative welding output terminal

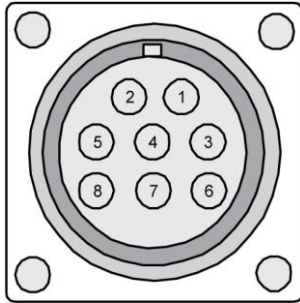
The negative welding terminal is used to connect the welding output of the power source to the appropriate welding accessory such as the MIG gun (via the MIG polarity lead), TIG torch or work lead. Negative welding current flows to the power source via this dinse type terminal. Insert and turn the male plug securely to achieve a secure electrical connection.

**WARNING!**

Loose welding terminal connections can cause overheating and result in the male plug being fused in the dinse terminal.

9. Remote control socket

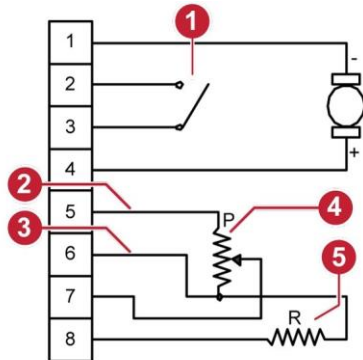
The 8 pin remote control socket is used to connect remote control devices to the welding power source. To make connections, align keyway, insert plug, and rotate threaded collar fully clockwise.



- 1 Spool gun motor negative
- 2 Spool gun trigger
- 3 Spool gun trigger
- 4 Spool gun motor positive, +24 V

- 5 Pot positive, Max CW
- 6 Pot negative, Min CCW
- 7 Pot wiper
- 8 Peripheral resistor, 10 K

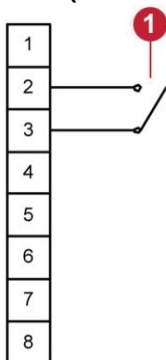
Spool gun



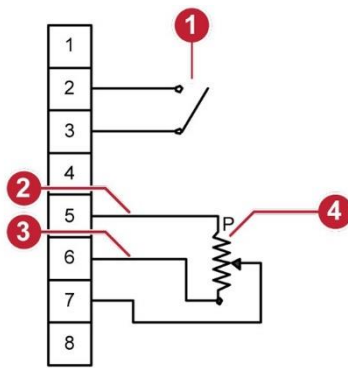
- 1 Trigger switch
- 2 Max (CW)
- 3 Min (CCW)

- 4 Pot V-A-WFS
- 5 Peripheral sense

MIG Gun (F180TH103035) / TIG Torch (W4013802)



- 1 Trigger switch

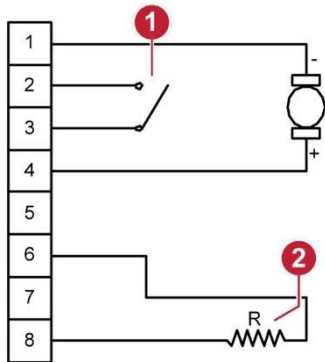
MIG Gun / TIG Torch

1 Trigger switch

2 Max (CW)

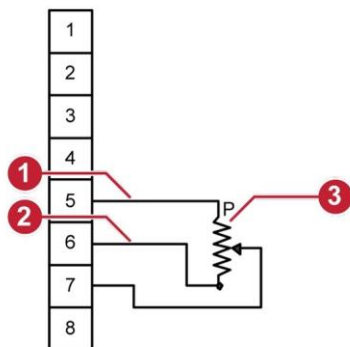
3 Min (CCW)

4 Pot Amps

Spool gun (1027-1397)

1 Trigger switch

2 10k Peripheral sense

SMAW

1 Max (CW)

3 Pot Amps

2 Min (CCW)

10. Multifunction control - Voltage, down slope and arc force

The multifunction control knob is used to adjust voltage (MIG mode), down slope (LIFT TIG mode) and arc force (MMA mode) depending on the welding mode selected.

**NOTE!**

The preview functionality provided on this power source is intended to act as a guide only. Some differences may be observed between preview values and actual welding values due to factors including the mode of welding, differences in consumables/gas mixtures, individual welding techniques and the transfer mode of the welding arc (dip versus spray transfer). Where exact settings are required (in the case of procedural work), it is recommended that alternate measurement methods be utilized to ensure output values are accurate.

When MIG mode is selected

Parameter Type	120V		230V	
	MIN	MAX	MIN	MAX
Voltage (V)	12	20	12	26
SPOOL GUN /WFS (in/min)	100	450	100	600
SPOOL GUN/WFS (m/min)	2.5	11.2	2.5	15
MIG GUN/WFS (in/min)	80	275	80	450
MIG GUN/WFS (m/min)	2	6.8	2	11.2

MIG/MAG welding process left side first LED is illuminated

Left-hand side LED display Indicates set welding voltage (V). Rotating Left-hand side encoder CW (Clockwise) will increase welding voltage value. Rotating Left-hand encoder CCW (Counter-Clockwise) will reduce Welding voltage value. (Min and Maximum range see table)

Right-hand side LED display Indicates set welding Wire Feed Speed (WFS) value. Rotating Right-hand side Encoder CW (Clockwise) will increase welding WFS value. Rotating Right-hand side Encoder CCW (Counter-Clockwise) will reduce WFS value. (Min and Maximum range see table)

Pressing and holding both Push Left-hand side Button and Push Left-hand side Button simultaneously for 2 seconds, the unit selection menu is activated. The MIG-LED flashes right now. Rotate the Left-hand side Encoder to switch the preset unit and the working unit adjustment. At preset unit adjustment, Left-hand side LED displays "UNT", Rotate Right-hand side Encoder Switch Metric and Imperial, namely IPM and MPM (Meters Per Minute); during working unit adjustment, Left-hand side LED displays "DIS", Rotate Right-hand side Encoder Switch current and wire delivery speed, namely WFS and AMP. Press Left-hand side Button short or trigger the welding gun switch to exit the unit selection menu

a) MIG/MAG Sub-Menu

Parameter Type	MIN	MAX
RIN (%)	10	100
PRG (S)	0	10
Bb (S)	0.01	0.1
POG (S)	0.5	10

Access to sub-menu functions is easily performed. Press and hold Left-hand side Button for 2 seconds will access the following functions, then the MIG-LED flashes right now.

- **Wire Run-In speed:** Indicated as "RIN" within Left-hand side LED display Value is adjusted by Right-hand side Encoder and is measured in either as IPM or MPM depending on user choice. The value is displayed within Right-hand side LED Display and is adjusted and as a percentage of chosen WFS
- **Pre-Gas Time:** Indicated as "PRG" within Left-hand side LED Display with a value shown in Right-hand side LED Display. Value is adjusted by Right-hand side Encoder and is measured in seconds.
- **Post-Gas Time:** Indicated as "POG" within Left-hand side LED Display with a value shown in Right-hand side LED Display. Value is adjusted by Right-hand side Encoder and is measured in seconds.
- **Wire Burn-Back Time:** Indicated as "Bb" within Left-hand side LED Display with a value shown in Right-hand side LED Display. Value is adjusted by Right-hand side Encoder and is measured in seconds.

Existing the sub-menu is easily completed. The operator can choose between pressing and holding Left-hand side Button for 2 seconds or alternatively, by pressing the torch trigger.

b) Inductance functions

Short pressing Right-hand side Button will access the Inductance functions, Inductance is used during the MIG/MAG welding process. Inductance setting is indicated as "IND" within Left-hand side LED Display with a value shown in Right-hand side LED Display. The inductance value is adjusted by Right-hand side Encoder. This is factory set to "5" adjustment is 1 to 9 (range is 1 to 9)

c) MIG Welding Process (2T/4T)

- i. Under this menu, the 2T/4T LED flashes. Left-hand side LED Display shows "TRG", Rotation Right-hand side Encoder switch 2T&4T mode.
- ii. Trigger Hold: Two modes of trigger are available for the operator to choose from. The default mode is 2T, effectively an "2T & 4T" for Arc start /stop
- iii. Additionally the operator can select 4T mode. This mode enable the operator to release the trigger and maintain the arc. By depressing the trigger once more and releasing, the arc will initiate end of weld sequence (Wire Burnback time, followed by Post Gas-Flow time if values have been set). When 4T is active 2T/4T LED remains illuminated.

When MMA mode is selected

Parameter Type	120V		230V	
	MIN	MAX	MIN	MAX
Current (A)	18	70	18	170

MMA welding process left side second LED is illuminated

Left-hand side LED Display Indicates Open Circuit (OCV) welding voltage (V) Right-hand side LED Display Indicates set welding amperage value (A). Rotating Right-hand side Encoder CW (Clockwise) will increase welding amperage value. Rotating Encoder CCW (Counter Clockwise) will reduce welding amperage value. (Min and Maximum range is table)

MMA Sub-Menu

Access to sub-menu functions is easily performed. Press and hold Left-hand side Button for 2 seconds will access the following functions. Then the MMA-LED flashes right now.

- Electrode Hot Start: Indicated as "HS" in the Left-hand side LED Display This is factory set to "5" adjustment is 0 to 10 (range is 0 to 10). Value is adjusted by Right-hand side Encoder.
- Arc Force: Indicated as "AF" in the Left-hand side LED Display with a value shown in Right-hand side LED Display. This is factory set to "5" adjustment is 0 to 10 (range is 0 to 10). Value is adjusted by Right-hand side Encoder

Pressing Left-hand side Button will select return to the first Sub-menu item.

When LIFT-TIG mode is selected

Parameter Type	120V		230V	
	MIN	MAX	MIN	MAX
Current (A)	8	90	8	200

TIG welding process left side third LED is illuminated

Left-hand side LED Display Indicates "---

Right-hand side LED Display Indicates set welding amperage value (A). Rotating Right-hand side Encoder CW (Clockwise) will increase welding amperage value. Rotating Right-hand side Encoder CCW (Counter-Clockwise) will reduce welding amperage value. (Min and Maximum range see table)

11. Arc control (inductance)

The arc control operates in MIG mode only and is used to adjust the intensity of the welding arc. Lower arc control settings make the arc softer with less weld spatter. Higher arc control settings give a stronger driving arc which can increase weld penetration. Soft means maximum inductance while Hard means minimum inductance.

12. Trigger mode control (MIG and LIFT TIG welding processes)

The trigger mode control is used to switch the functionality of the torch trigger between 2T (normal) and 4T (latch mode).

2T (Normal mode)

In this mode, the torch trigger must remain depressed for the welding output to be active. Press and hold the torch trigger to activate the power source (weld). Release the torch trigger switch to cease welding.

4T (Latch mode)

This mode of welding is mainly used for long welding runs to reduce operator fatigue. In this mode the operator can press and release the torch trigger and the output will remain active. To deactivate the power source, the trigger switch must again be depressed and released, thus eliminating the need for the operator to hold the torch trigger.

13. Process selection control

The process selection control is used to select the desired welding mode. Three modes are available, MIG (GMAW/FCAW), LIFT TIG (L-GTAW) and MMA (SMAW) modes. See the following sections: "Setup for MIG (GMAW) welding with gas shielded MIG wire", "Setup for MIG (FCAW) welding with flux core (gasless) wire", "Setup for LIFT TIG (L-GTAW) welding", "Setup for MMA (SMAW) welding".

Note that when the unit is powered OFF the mode selection control will automatically default to MIG mode. This is necessary so as to prevent inadvertent arcing should an electrode holder be connected to the unit and mistakenly be in contact with the work piece during power up.

14. Digital voltage meter (Left Side LED Display)

MIG Welding process

This digital meter is used to display the pre-set (preview) voltage in MIG mode and actual welding voltage of the power source when welding. At times of non-welding, the digital meter will display a pre-set (preview) value of voltage. This value can be adjusted by varying the multifunction control knob (10).

MMA and LIFT TIG Welding processes

This digital meter is used to display the welding output terminal voltage in MMA / LIFT TIG modes during non-welding or welding. This value cannot be adjusted by varying the multifunction control knob (10).

When welding, this digital meter will display actual welding voltage in all modes. At the completion of welding, the digital meter will hold the last recorded voltage value for a period of approximately 10 seconds in all modes. The voltage meter will hold the value until; (1) any of the front panel controls are adjusted in which case the unit will revert to preview mode, (2) welding is recommenced, in which case actual welding amperage will be displayed, or (3) a period of 10 seconds elapses following the completion of welding in which case the unit will return to preview mode.

**NOTE!**

The preview functionality provided on this power source is intended to act as a guide only. Some differences may be observed between preview values and actual welding values due to factors including the mode of welding, differences in consumables/gas mixtures, individual welding techniques and the transfer mode of the welding arc (dip versus spray transfer). Where exact settings are required (in the case of procedural work), it is recommended that alternate measurement methods be utilized to ensure output values are accurate.

15. Gas inlet (MIG mode only for MIG gun or spool gun operation)

The gas inlet connection, 5/8-18 UNF female thread is used to supply the appropriate MIG welding gas to the power source. See "Wire reel brake" and "Setup for MIG (GMAW) welding with gas shielded MIG wire" section.



WARNING!

Only inert shielding gases specifically designed for welding applications should be used.

16. ON / OFF switch

This single phase circuit breaker performs a dual function.

It is used to turn the unit ON/OFF and it will also trip in the event of a fault.



WARNING!



When the front digital displays are lit, the machine is connected to the electricity supply and the internal electrical components are at mains voltage potential.

17. Wire Feed Jog switch

When installing welding wire, press the jog switch to feed the wire through the drive rolls and gun

18. Cooling fan

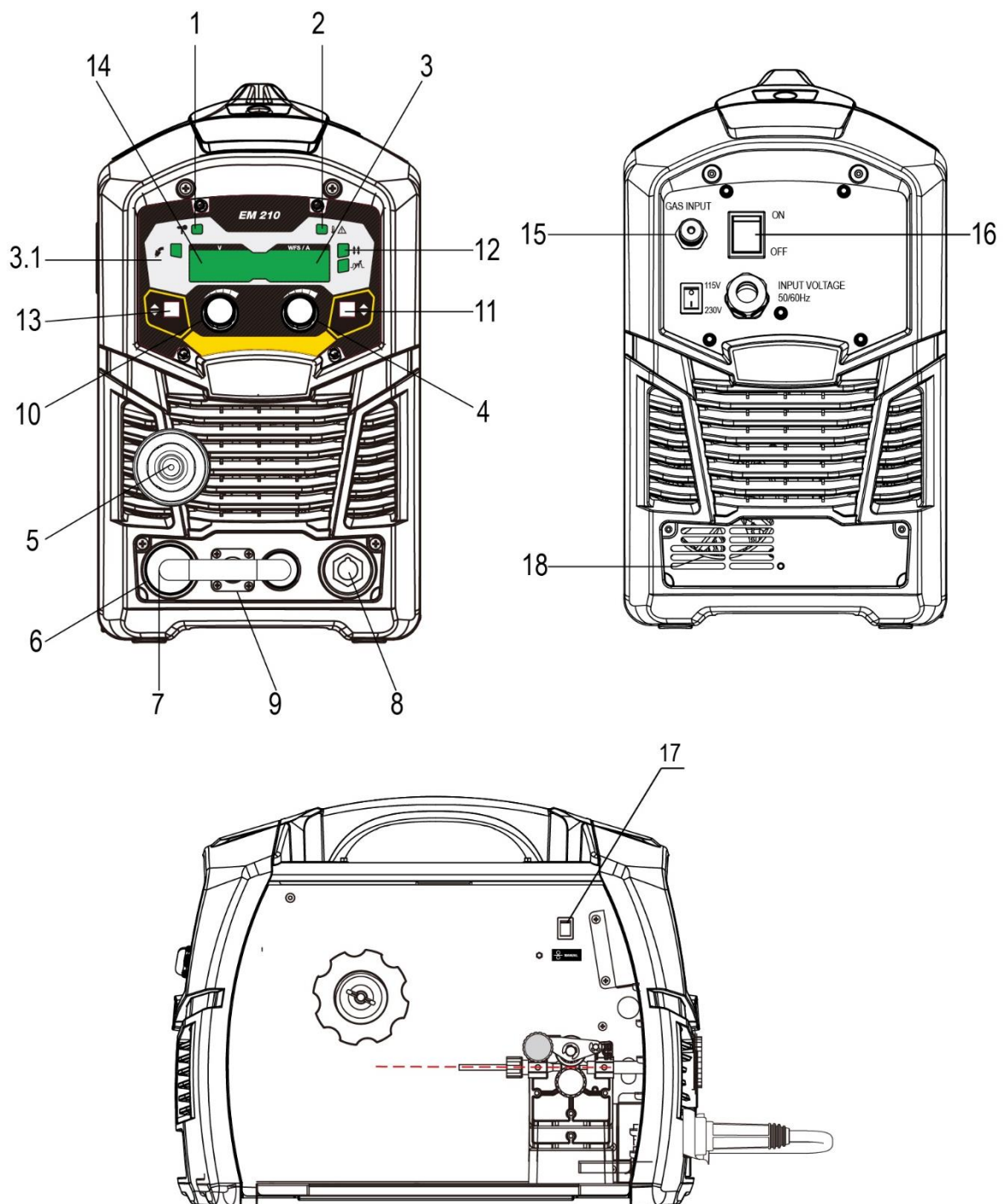
The fan and the power source work synchronously, when the power source is switched on, the fan switches on too, but if there is no load the fan switches off, unless the unit is in overtemp condition.



NOTE!

In MMA mode the fan operates continuously.

5.4.2 ESAB EM 210



1. Spool gun indicator

When the correct ESAB Spool-Gun* is connected, the LED will illuminate. (*Optional Accessory)

2. Thermal overload indicator (fault indicator)

This welding power source is protected by a self resetting thermostat. The LED indicator will illuminate if the duty cycle of the power source has been exceeded. Should the thermal overload indicator illuminate the output of the power source will be disabled. Once the power source cools down, the LED will turn OFF and the over temperature condition will automatically reset. Note that the mains power switch should remain in ON position such that the fan continues to operate thus allowing the unit to cool sufficiently. Do not switch the unit OFF during an overload condition.

3. Digital Wire Feed Speed (WFS) and Welding Amperage (A) (Right side LED display)**MIG mode**

This digital meter is used to display the pre-set (preview) wire feed speed in IPM (inches per minute) in MIG mode and actual welding amperage of the power source when welding. During non-welding, the digital meter will display a pre-set (preview) value of wire feed speed. This value can be adjusted by varying the Wire feed speed control knob (4).

**NOTE!**

The preview functionality provided on this power source is intended to act as a guide only. Some differences may be observed between preview values and actual welding values due to factors including the mode of welding, differences in consumables/gas mixtures, individual welding techniques and the transfer mode of the welding arc (dip versus spray transfer). Where exact settings are required (in the case of procedural work), it is recommended that alternate measurement methods be utilized to ensure output values are accurate.

3.1 Wire speed indicator

The wire speed indicator illuminates when MIG mode is selected to identify that the digital wire speed/amperage meter is previewing wire speed in IPM (inches per minute).

The wire speed indicator extinguishes when the user is MIG (GMAW/FCAW) welding or depressing the MIG gun trigger and the digital wire speed/amperage meter displays actual welding amperage of the power source.

4. Wire speed/amperage control

In MIG mode, the wire speed/amperage control knob adjusts the speed of the wire feed motor (which in turn adjusts the output current by varying the amount of MIG wire delivered to the welding arc). The optimum wire speed depends upon the material type and the welding application. The setup chart on the inside of the wire feed compartment door provides a brief summary of the required settings for a basic range of MIG (GMAW/ FCAW) welding applications.

**NOTE!**

The preview functionality provided on this power source is intended to act as a guide only. Some differences may be observed between preview values and actual welding values due to factors including the mode of welding, differences in consumables/gas mixtures, individual welding techniques and the transfer mode of the welding arc (dip versus spray transfer). Where exact settings are required (in the case of procedural work), it is recommended that alternate measurement methods be utilized to ensure output values are accurate.

5. MIG gun adapter (TWECO style)

The MIG gun adapter is the connection point for the MIG gun. Refer section 5.6 Attaching the ESAB fusion 180 A MIG gun for installation of MIG gun to the power source.

6. Positive welding output terminal

The positive welding terminal is used to connect the welding output of the power source to the appropriate welding accessory such as the MIG gun (via the MIG polarity lead), electrode holder lead or work lead. Positive welding current flows from the power source via this dinse type terminal. Insert and turn the male plug securely to achieve a secure electrical connection.

**WARNING!**

Loose welding terminal connections can cause overheating and result in the male plug being fused in the dinse terminal.

7. MIG polarity lead

The polarity lead is used to connect the MIG gun to the appropriate positive or negative output terminal (allowing polarity reversal for different welding applications). In general, the polarity lead should be connected in to the positive welding terminal (+) when using steel, stainless steel or aluminum electrode wire. When using gasless wire, the polarity lead is generally connected to the negative welding terminal (-). If in doubt, consult the manufacturer of the electrode wire for the correct polarity. Insert and turn the male plug securely to achieve a secure electrical connection.

**WARNING!**

Loose welding terminal connections can cause overheating and result in the male plug being fused in the dinse terminal.

8. Negative welding output terminal

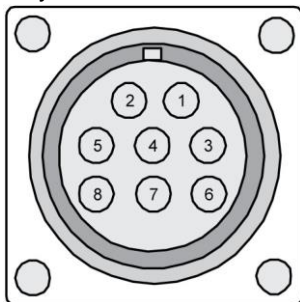
The negative welding terminal is used to connect the welding output of the power source to the appropriate welding accessory such as the MIG gun (via the MIG polarity lead), TIG torch or work lead. Negative welding current flows to the power source via this dinse type terminal. Insert and turn the male plug securely to achieve a secure electrical connection.

**WARNING!**

Loose welding terminal connections can cause overheating and result in the male plug being fused in the dinse terminal.

9. Remote control socket

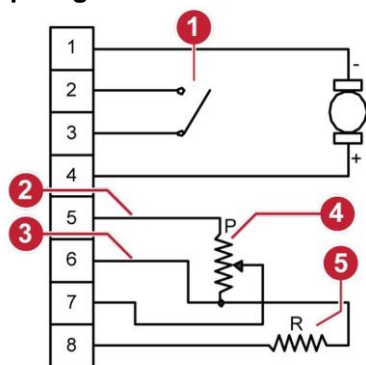
The 8 pin remote control socket is used to connect remote control devices to the welding power source. To make connections, align keyway, insert plug, and rotate threaded collar fully clockwise.



- 1 Spool gun motor negative
- 2 Spool gun trigger
- 3 Spool gun trigger
- 4 Spool gun motor positive, +24 V

- 5 Pot positive, Max CW
- 6 Pot negative, Min CCW
- 7 Pot wiper
- 8 Peripheral resistor, 10 K

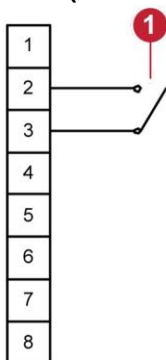
Spool gun



- 1 Trigger switch
- 2 Max (CW)
- 3 Min (CCW)

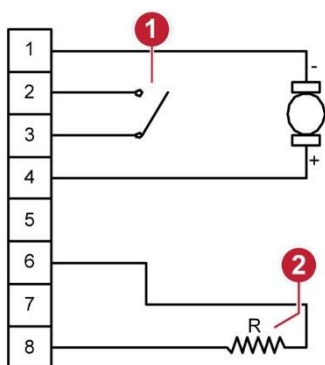
- 4 Pot V-A-WFS
- 5 Peripheral sense

MIG Gun (F180TH103035) / TIG Torch (W4013802)



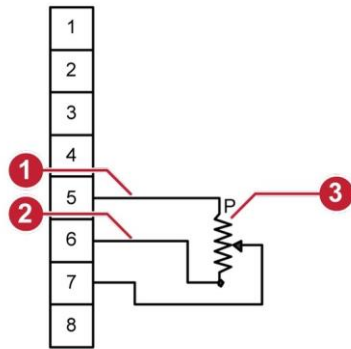
- 1 Trigger switch

MIG Gun / TIG Torch



- 1 Trigger switch

- 2 10k Peripheral sense

SMAW

1. Max (CW)
2. Min (CCW)

3 Pot Amps

10. Voltage control

The voltage control knob is used to adjust the voltage in MIG mode.

**NOTE!**

The preview functionality provided on this power source is intended to act as a guide only. Some differences may be observed between preview values and actual welding values due to factors including the mode of welding, differences in consumables/gas mixtures, individual welding techniques and the transfer mode of the welding arc (dip versus spray transfer). Where exact settings are required (in the case of procedural work), it is recommended that alternate measurement methods be utilized to ensure output values are accurate.

MIG mode

Parameter Type	120V		230V	
	MIN	MAX	MIN	MAX
Voltage (V)	12	20	12	26
SPOOL GUN /WFS (in/min)	100	450	100	600
SPOOL GUN/WFS (m/min)	2.5	11.2	2.5	15
MIG GUN/WFS (in/min)	80	275	80	450
MIG GUN/WFS (m/min)	2	6.8	2	11.2

MIG/MAG welding process left side first LED is illuminated

Left-hand side LED display Indicates set welding voltage (V). Rotating Left-hand side encoder CW (Clockwise) will increase welding voltage value. Rotating Left-hand encoder CCW (Counter-Clockwise) will reduce Welding voltage value. (Min and Maximum range see table)

Right-hand side LED display Indicates set welding Wire Feed Speed (WFS) value. Rotating Right-hand side Encoder CW (Clockwise) will increase welding WFS value. Rotating Right-hand side Encoder CCW (Counter-Clockwise) will reduce WFS value. (Min and Maximum range see table)

Pressing and holding both Push Left-hand side Button and Push Left-hand side Button simultaneously for 2 seconds, the unit selection menu is activated. The MIG-LED flashes right now. Rotate the Left-hand side Encoder to switch the preset unit and the working unit adjustment. At preset unit adjustment, Left-hand side LED displays "UNT", Rotate Right-hand side Encoder Switch Metric and Imperial, namely IPM and MPM (Meters Per Minute); during working unit adjustment, Left-hand side LED displays "DIS", Rotate Right-hand side Encoder Switch current and wire delivery speed, namely WFS and AMP. Press Left-hand side Button short or trigger the welding gun switch to exit the unit selection menu

a) MIG/MAG Sub-Menu

Parameter Type	MIN	MAX
RIN (%)	10	100
PRG (S)	0	10
Bb (S)	0.01	0.1
POG (S)	0.5	10

Access to sub-menu functions is easily performed. Press and hold Left-hand side Button for 2 seconds will access the following functions, then the MIG-LED flashes right now.

- **Wire Run-In speed:** Indicated as "RIN" within Left-hand side LED display Value is adjusted by Right-hand side Encoder and is measured in either as IPM or MPM depending on user choice. The value is displayed within Right-hand side LED Display and is adjusted and as a percentage of chosen WFS
- **Pre-Gas Time:** Indicated as "PRG" within Left-hand side LED Display with a value shown in Right-hand side LED Display. Value is adjusted by Right-hand side Encoder and is measured in seconds.
- **Post-Gas Time:** Indicated as "POG" within Left-hand side LED Display with a value shown in Right-hand side LED Display. Value is adjusted by Right-hand side Encoder and is measured in seconds.
- **Wire Burn-Back Time:** Indicated as "Bb" within Left-hand side LED Display with a value shown in Right-hand side LED Display. Value is adjusted by Right-hand side Encoder and is measured in seconds.

Existing the sub-menu is easily completed. The operator can choose between pressing and holding Left-hand side Button for 2 seconds or alternatively, by pressing the torch trigger.

b) Inductance functions

Short pressing Right-hand side Button will access the Inductance functions, Inductance is used during the MIG/MAG welding process. Inductance setting is indicated as "IND" within Left-hand side LED Display with a value shown in Right-hand side LED Display. The inductance value is adjusted by Right-hand side Encoder. This is factory set to "5" adjustment is 1 to 9 (range is 1 to 9)

c) MIG Welding Process (2T/4T)

- Under this menu, the 2T/4T LED flashes. Left-hand side LED Display shows "TRG", Rotation Right-hand side Encoder switch 2T&4T mode.
- Trigger Hold: Two modes of trigger are available for the operator to choose from. The default mode is 2T, effectively an "2T & 4T" for Arc start /stop.
- Additionally the operator can select 4T mode. This mode enable the operator to release the trigger and maintain the arc. By depressing the trigger once more and releasing, the arc will initiate end of weld sequence (Wire Burnback time, followed by Post Gas-Flow time if values have been set). When 4T is active 2T/4T LED remains illuminated.

11. Arc control (inductance)

The arc control operates in MIG mode only and is used to adjust the intensity of the welding arc. Lower arc control settings make the arc softer with less weld spatter. Higher arc control settings give a stronger driving arc which can increase weld penetration. Soft means maximum inductance while Hard means minimum inductance.

12. Trigger mode control

The trigger mode control is used to switch the functionality of the of the torch trigger between 2T (normal) and 4T (latch mode).

2T (Normal mode)

In this mode, the torch trigger must remain depressed for the welding output to be active.

Press and hold the torch trigger to activate the power source (weld). Release the torch trigger switch to cease welding.

4T (Latch mode)

This mode of welding is mainly used for long welding runs to reduce operator fatigue. In this mode the operator can press and release the torch trigger and the output will remain active. To deactivate the power source, the trigger switch must again be depressed and released, thus eliminating the need for the operator to hold the torch trigger.

13. Process selection control

The process selection control is used to select the MIG (GMAW/FCAW) welding mode. See the following sections: "Setup for MIG (GMAW) welding with gas shielded MIG wire" and "Setup for MIG (FCAW) welding with flux core (gasless) wire".

14. Digital voltage meter (Left Side LED Display)

MIG mode

This digital meter is used to display the pre-set (preview) voltage in MIG mode and actual welding voltage of the power source when welding. At times of non-welding, the digital meter will display a pre-set (preview) value of voltage. This value can be adjusted by varying the multifunction control knob (10).

**NOTE!**

The preview functionality provided on this power source is intended to act as a guide only. Some differences may be observed between preview values and actual welding values due to factors including the mode of welding, differences in consumables/gas mixtures, individual welding techniques and the transfer mode of the welding arc (dip versus spray transfer). Where exact settings are required (in the case of procedural work), it is recommended that alternate measurement methods be utilized to ensure output values are accurate.

15. Gas inlet

The gas inlet connection, 5/8-18 UNF female thread is used to supply the appropriate MIG welding gas to the power source. See "Wire reel brake" and "Setup for MIG (GMAW) welding with gas shielded MIG wire" section.

**WARNING!**

Only inert shielding gases specifically designed for welding applications should be used.

16. ON / OFF switch

This single phase circuit breaker performs a dual function.

It is used to turn the unit ON/OFF and it will also trip in the event of a fault.

**WARNING!**

When the front digital displays are lit, the machine is connected to the electricity supply and the internal electrical components are at mains voltage potential.

17. Manual switch

When the welding power source is empty, press the Manual switch to feed the wire.

18. Cooling fan

The fan and the power source work synchronously, when the power source is switched on, the fan switches on too, but if there is no load the fan switches off, unless the unit is in overtemp condition.

5.5 ESAB EMP 210 and ESAB EM 210 features

Wiredrive motor circuit breaker

The 4A circuit breaker protects the unit from electrical faults and will operate in the event of a motor overload.

**NOTE!**

If a circuit breaker trips, a short cooling period must be allowed before an attempt is made to reset the unit by pressing the circuit breaker reset button.

Local / remote switch (software control)

The local/ remote switch is used only when a remote control device (such as a TIG torch with remote current control) is fitted to the unit via the remote control socket (item 9). When the local/ remote switch is in the remote position, the unit will detect a remote device and work accordingly. When in the local mode, the unit will not detect the remote device and will operate from the power source controls only. Note that the trigger will operate at all times on the remote control socket irrespective of the position of the local/remote switch (in both local and remote modes).

Should a remote device be connected and the local/remote switch set to remote, the maximum setting of the power source will be determined by the respective front panel control, irrespective of the remote control device setting. As an example, if the output current on the power source front panel is set to 50% and the remote control device is set to 100%, the maximum achievable output from the unit will be 50%. Should 100% output be required, the respective front panel control must be set to 100%, in which case the remote device will then be able to control between 0-100% output.

Burnback control (software control)

The burnback control is used to prevent the MIG wire from stickling the weld pool and adjust the amount of MIG wire that protrudes from the MIG gun after the completion of MIG welding (commonly referred to as stick out). To decrease the burnback time (or lengthen the amount of wire protruding from the MIG gun at the completing of welding), turn the burnback control knob counter-clockwise. To increase the burnback time (or shorten the amount of wire protruding from the torch at the completing of welding), turn the burnback control knob clockwise.

**NOTE!**

For burnback to work as designed - The MIG GUN must remain in position at the end of the weld- Retracting the gun will prevent it from working as designed.

5.6 Attaching the ESAB fusion 180 A MIG gun

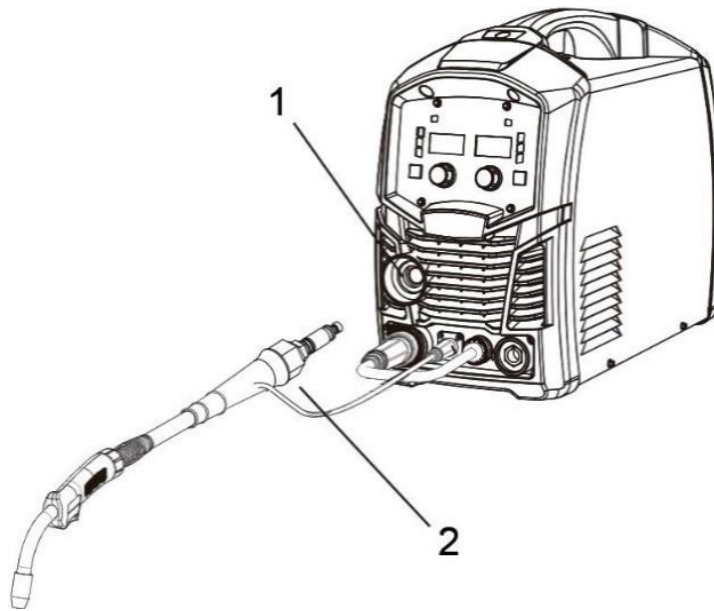


Figure 27: Attaching MIG gun

1 MIG gun adapter

2 MIG gun connector

- 1) Open side panel and loosen thumb screw.
- 2) Fit the MIG gun to the power source by pushing the MIG gun connector into the MIG gun adapter.
- 3) Tighten thumb screw and replace side panel.

5.7 Feed roller pressure adjustment

The pressure (top) roller applies pressure to the grooved feed roller via an adjustable pressure screw. These devices should be adjusted to a minimum pressure that will provide satisfactory wire feed without slippage. If slipping occurs, and inspection of the wire contact tip reveals no wear, distortion or burn back jam, the conduit liner should be checked for kinks and clogging by metal flakes and swarf. If it is not the cause of slipping, the feed roll pressure can be increased by rotating the pressure screw clockwise.



WARNING!

Before changing the feed roller ensure that the electricity supply to the power source is switched off.



CAUTION!

The use of excessive pressure may cause rapid wear of the feed rollers, shafts and bearing.

5.8 Changing the feed roll

To change the feed roll, remove the feed roll retaining screw by turning it in a counter clockwise direction. Once the feed roll is removed, to replace feed roll, simply reverse these directions.



NOTE!

Be sure not to lose key that is located on drive motor shaft. This key must align with drive roll groove for proper operation.

A dual groove feed roller is supplied as standard. It can accommodate 0.02-0.03 in. (0.6-0.8 mm) diameter hard wires. Select the roller required with the chosen wire size marking facing outward.

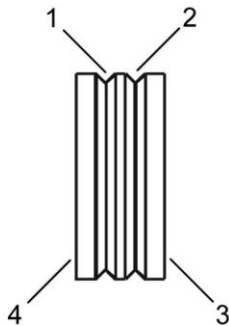


Figure 28: Dual groove feed roller

1 Groove A
2 Groove B

3 Groove A size
4 Groove B size

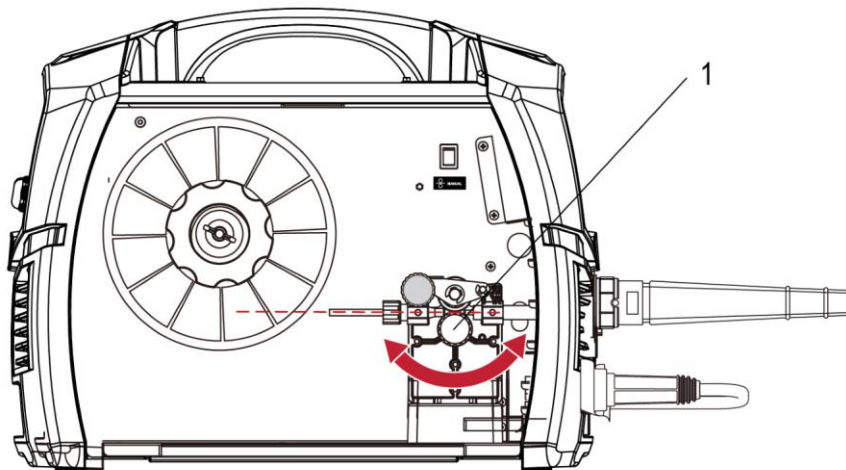


Figure 29: Changing the feed roll

1 Feed roll retaining knob

5.9 Wire reel brake

The wire reel hub incorporates a friction brake which is adjusted during manufacture for optimum braking. If it is considered necessary, adjustment can be made by turning the thumb screw inside the open end of the hub clockwise to tighten the brake. Correct adjustment will result in the wire reel circumference continuing no further than 1/8 in.-3/16 in. (3-5 mm) after release of the trigger. The electrode wire should be slack without becoming dislodged from wire spool.

**CAUTION!**

Overtension of the brake will cause rapid wear of mechanical wire feeder parts, overheating of electrical components and possibly more incidences of contact tip burnback.

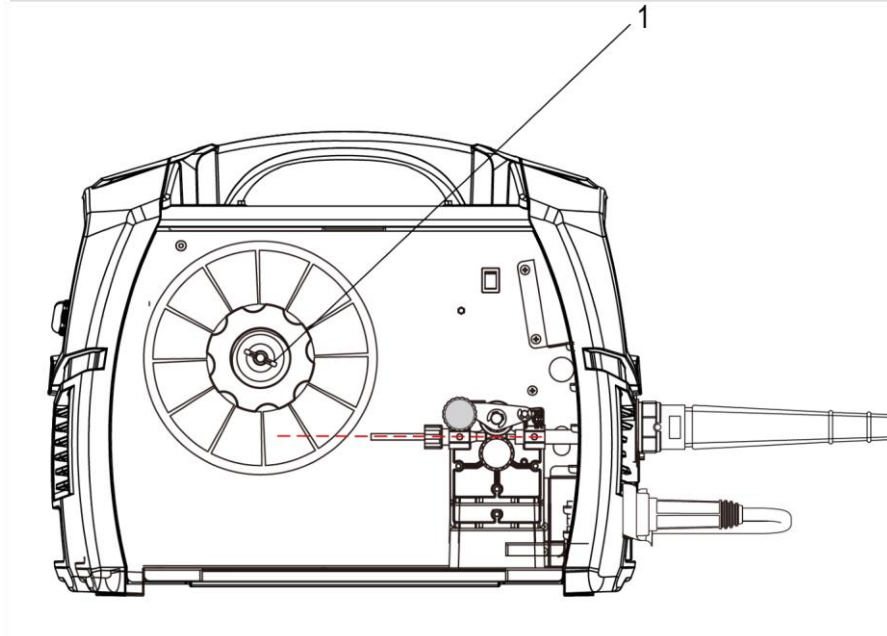


Figure 30: Wire reel brake

1 Spool hub tension thumb screw

5.10 Setup for MIG (GMAW) welding with gas shielded MIG wire

- 1) Select MIG mode with the process selection control, see "ESAB EMP 210, ESAB EM 210 controls, indicators and features".
- 2) Connect the MIG polarity lead to the negative welding terminal (-). If in doubt, consult the electrode wire manufacturer. Welding current flows from the power source via dinse type terminals. It is essential, however, that the male plug is inserted and turned securely to achieve a sound electrical connection.
- 3) Fit the MIG gun to the power source, see "Attaching the ESAB fusion 180 A MIG gun" section.
- 4) Connect the work lead to the positive welding terminal (+). If in doubt, consult the electrode wire manufacturer. Welding current flows from the power source via dinse type terminals. It is essential, however, that the male plug is inserted and turned securely to achieve a sound electrical connection.
- 5) Switch the LOCAL/REMOTE switch inside the wire feed compartment to LOCAL to use the wire speed and voltage controls of the power source.
- 6) Switch the MIG gun/spool gun switch inside the wire feed compartment to MIG gun.



WARNING!

Before connecting the work clamp to the workpiece make sure the electricity supply is switched off.



CAUTION!

Loose welding terminal connections can cause overheating and result in the male plug being fused in the terminal. Remove any packaging material prior to use. Do not block the air vents at the front or rear of the welding power source.

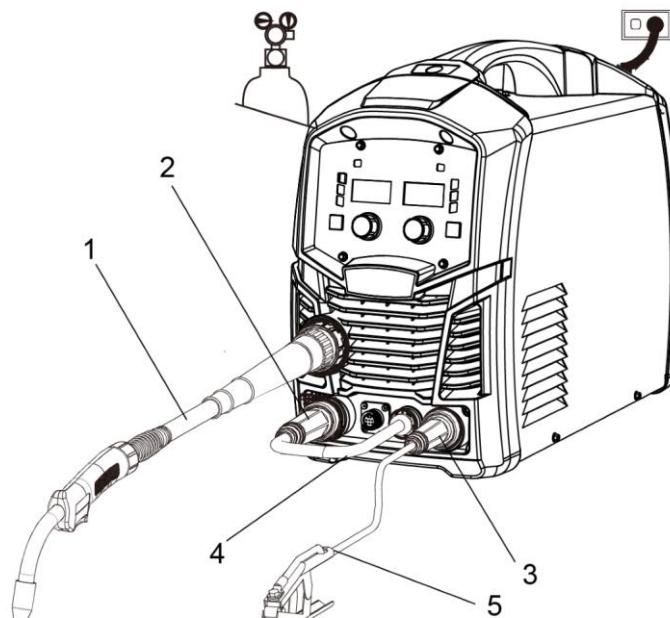


Figure 32: Setup for MIG welding with gas shielded MIG wire

- | | |
|---------------------------------|---------------------|
| 1 MIG gun | 4 MIG polarity lead |
| 2 Positive welding terminal (+) | 5 Work lead |
| 3 Negative welding terminal (-) | |

5.11 Setup for MIG (FCAW) welding with flux core (gasless) wire

- 1) Select MIG mode with the process selection control see "ESAB EMP 210, ESAB EM 210 controls, indicators and features" section.
- 2) Connect the MIG polarity lead to the negative welding terminal (-). If in doubt, consult the electrode wire manufacturer. Welding current flows from the power source via dinse type terminals. It is essential, however, that the male plug is inserted and turned securely to achieve a sound electrical connection.
- 3) Connect the work lead to the positive welding terminal (+). If in doubt, consult the electrode wire manufacturer. Welding current flows from the power source via dinse type terminals. It is essential, however, that the male plug is inserted and turned securely to achieve a sound electrical connection.
- 4) Refer to the weld guide located on the inside of the wire feed compartment door for further information.
- 5) Switch the LOCAL/REMOTE switch inside the wire feed compartment to LOCAL to use the wire speed and voltage controls of the power source. If there is no switch, it is software controlled.
- 6) Switch the MIG gun/spool gun switch inside the wire feed compartment to MIG gun. If there is no switch, it is software controlled.



WARNING!

Before connecting the work clamp to the workpiece make sure the electricity supply is switched off.



CAUTION!

Remove any packaging material prior to use. Do not block the air vents at the front or rear of the welding power source.

Loose welding terminal connections can cause overheating and result in the male plug being fused in the terminal.

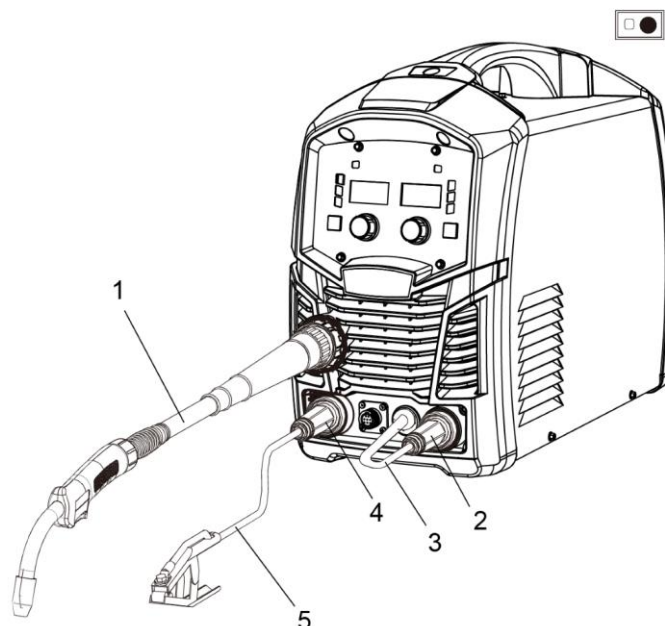


Figure 34: Setup for MIG welding with gasless MIG wire

- | | |
|---------------------------------|---------------------------------|
| 1 MIG gun | 4 Positive welding terminal (+) |
| 2 Negative welding terminal (-) | 5 Work lead |
| 3 MIG polarity lead | |

5.12 Setup for spool gun MIG (GMAW) welding with gas shielded MIG wire

Select the process selection control to MIG for spool gun welding.

For setup and operation of the spool gun, please refer to the spool gun instruction manual.

Switch the MIG gun/spool gun switch inside the wire feed compartment to spool gun.

Connect the shielding gas for the to the shielding gas inlet on the rear panel of the power source.

1. Make sure the welding power source is turned off before connecting the welding torch.

**NOTE!**

If the power source has already been setup for MIG welding you will have to remove the MIG gun and retract the welding wire out of the wirefeeder before beginning the next step.



2. Insert the back end of the spool gun into the MIG gun connector and tighten the locking nut to secure the spool gun in the MIG gun adapter.
3. Connect gas supply fitting and tighten with a wrench.



4. Align control plug to panel fitting and tighten securely.



5.13 Setup for LIFT TIG (L-GTAW) welding (only for ESAB EMP 210)

- 1) Select LIFT TIG mode with the process selection control, see section 5.4.1 "ESAB EMP 210"
- 2) Connect the TIG torch to the negative welding terminal (-). Welding current flows from the power source via dinse type terminals. It is essential, however, that the male plug is inserted and turned securely to achieve a sound electrical connection.
- 3) Connect the work lead to the positive welding terminal (+). Welding current flows from the power source via dinse type terminals. It is essential, however, that the male plug is inserted and turned securely to achieve a sound electrical connection.
- 4) Connect the TIG torch trigger switch/ remote foot control (RFC) via the 8 pin socket located on the front of the power source. The TIG torch will require a trigger switch/foot control to operate in LIFT TIG mode.

**NOTE!**

A 26 V TIG torch with an 8 pin plug must be used to turn the weld current ON/OFF via the TIG torch trigger switch to TIG weld or a foot control with an 8 pin plug must be used to turn the weld current ON/OFF as well as providing remote control of the weld current.

- 5) Fit the welding grade shielding gas regulator/flowmeter to the shielding gas cylinder (see "Victor regulator" section) then connect the shielding gas hose from the TIG torch to the regulator/ flowmeter outlet. Note that the TIG torch shielding gas hose is connected directly to the regulator/ flowmeter. The power source is not fitted with a shielding gas solenoid to control the gas flow in LIFT TIG mode therefore the TIG torch will require a gas valve.

**WARNING!**

Before connecting the work clamp to the workpiece and inserting the electrode in the TIG torch make sure the electricity supply is switched off.

Secure the welding grade shielding gas cylinder in an upright position by chaining it to a stationary support to prevent falling or tipping.

**CAUTION!**

Remove any packaging material prior to use. Do not block the air vents at the front or rear of the welding power source.

Loose welding terminal connections can cause overheating and result in the male plug being fused in the terminal.

5.14 Setup for MMA (SMAW) welding (only for ESAB EMP 210)

- 1) Connect the electrode holder lead to the positive welding terminal (+). If in doubt, consult the electrode manufacturer. Welding current flows from the power source via dinse type terminals. It is essential, however, that the male plug is inserted and turned securely to achieve a sound electrical connection.
- 2) Connect the work lead to the negative welding terminal (-). If in doubt, consult the electrode manufacturer. Welding current flows from the power source via dinse type terminals. It is essential, however, that the male plug is inserted and turned securely to achieve a sound electrical connection.
- 3) Select MMA mode with the process selection control, see section 5.4.1 "ESAB EMP 210".



WARNING!

Before connecting the work clamp to the workpiece make sure the electricity supply is switched off.



CAUTION!

Remove any packaging material prior to use. Do not block the air vents at the front or rear of the welding power source.

Loose welding terminal connections can cause overheating and result in the male plug being fused in the terminal.

6 BASIC WELDING GUIDE

6.1 MIG (GMAW/FCAW) basic welding

Two different welding processes are covered in this section GMAW and FCAW, to provide the very basic concepts in using the MIG mode of welding, where a MIG gun is handheld and the electrode (welding wire) is fed into a weld puddle, and the arc is shielded by an inert welding grade shielding gas or inert welding grade shielding gas mixture.

Gas metal arc welding (GMAW)

This process, also known as MIG welding, CO₂ welding, micro wire welding, short-arc welding, dip transfer welding, wire welding etc. is an electric arc welding process which fuses the parts to be welded by heating them with an arc between a solid continuous, consumable electrode and the work. Shielding is obtained from an externally supplied welding grade shielding gas or welding grade shielding gas mixture. The process is normally applied semi-automatically, however, the process may be operated automatically and can be machine operated. The process can be used to weld thin and fairly thick steels, and some non-ferrous metals in all positions.

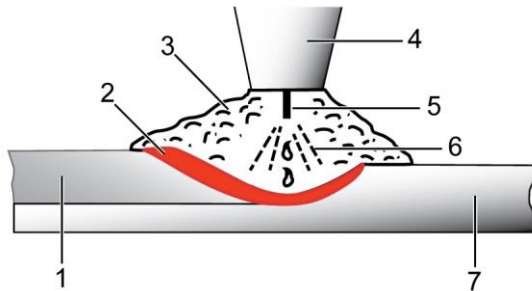
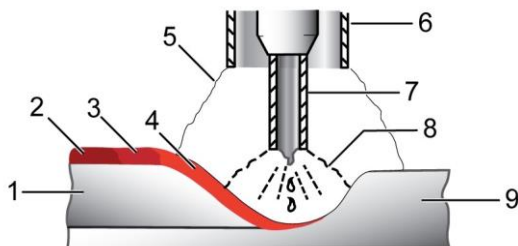


Figure 38: GMAW process

- | | |
|-------------------------|--------------|
| 1 Solidified weld metal | 5 Electrode |
| 2 Molten weld metal | 6 Arc |
| 3 Shielding gas | 7 Base metal |
| 4 Nozzle | |

Flux cored arc welding (FCAW):

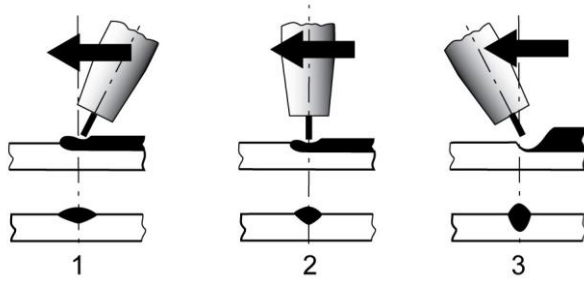
This is an electric arc welding process which fuses the parts to be welded by heating them with an arc between a continuous flux filled electrode wire and the work. Shielding is obtained through the decomposition of the flux within the tubular wire. Additional shielding may or may not be obtained from an externally supplied gas or gas mixture. The process is normally applied semi-automatically; however, the process may be applied automatically or by machine. It is commonly used to weld large diameter electrodes in the flat and horizontal position and small electrode diameters in all positions. The process is used to a lesser degree for welding stainless steel and for overlay work.



- | | |
|----------------------------|------------------------|
| 1 Solidified weld metal | 6 Nozzle (optional) |
| 2 Slag | 7 Flux cored electrode |
| 3 Molten slag | 8 Arc |
| 4 Molten metal | 9 Base metal |
| 5 Shielding gas (optional) | |

6.2 Position of MIG gun

The angle of the MIG gun to the weld affects on the width of the weld.



1 Push

2 Vertical

3 Drag / Pull

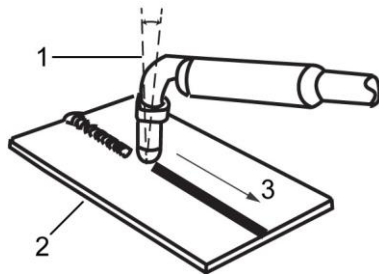
The MIG gun should be held at an angle to the weld joint. (See Secondary adjustment variables below)



CAUTION!

Do NOT pull the MIG gun back when the arc is established. This will create excessive wire extension (stick-out) and make a very poor weld.

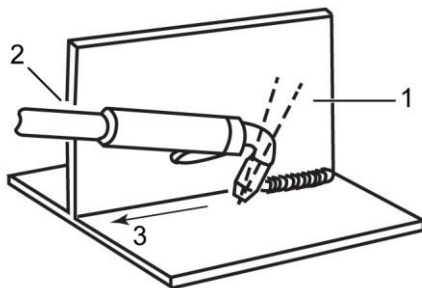
The electrode wire is not energized until the MIG gun trigger switch is depressed. The wire may therefore be placed on the seam or joint prior to lowering the helmet.



1 5° to 15° Longitudinal angle

2 90° Transverse angle

3 Direction of travel



1 30° to 60° Transverse angle

2 5° to 15° Longitudinal angle

3 Direction of travel

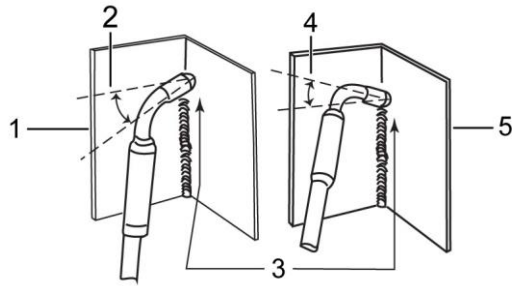
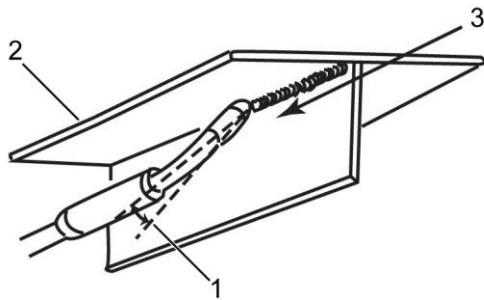


Figure 43: Vertical fillet welds

- 1 30° to 60° Transverse angle
- 2 10° Longitudinal angle
- 3 Direction of travel

- 4 10° to 20° Longitudinal angle
- 5 30° to 60° Transverse angle



- 1 5° to 15° Longitudinal angle
- 2 30° to 60° Transverse angle

- 3 Direction of travel

6.3 Distance from the MIG gun nozzle to the workpiece

The electrode wire stick out from the MIG gun nozzle should be between 3/8 in. to 3/4 in. (10 to 20 mm). This distance may vary depending on the type of joint that is being welded.

Travel speed

The speed at which the molten pool travels influences the width of the weld and penetration of the welding run.

MIG welding (GMAW) variables

Most of the welding done by all processes is on carbon steel. The items below describe the welding variables in short-arc welding of .023 to 1/4 in. (0.6 mm to 6.4 mm) mild sheet or plate. The applied techniques and end results in the GMAW process are controlled by these variables.

Preselected variables

Preselected variables depend upon the type of material being welded, the thickness of the material, the welding position, the deposition rate and the mechanical properties. These variables are:

- Type of electrode wire
- Size of electrode wire
- Type of gas (not applicable for FCAW self shielding wires)
- Gas flow rate (not applicable for FCAW self shielding wires)

Primary adjustable variables

These control the process after preselected variables have been found. They control the penetration, bead width, bead height, arc stability, deposition rate and weld soundness. They are:

- Arc voltage
- Welding current (wire feed speed)
- Travel speed

Secondary adjustable variables

These variables cause changes in primary adjustable variables which in turn cause the desired change in the bead formation. They are:

- Sick-out (distance between the end of the contact tube (tip) and the end of the electrode wire). Maintain at about 3/8 in. (10 mm) stick-out
- Wire Feed Speed. Increase in wire feed speed increases weld current, Decrease in wire feed speed decreases weld current.

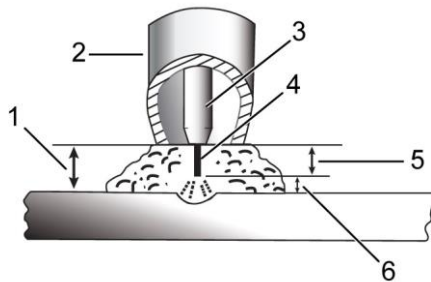


Figure 45: Electrode stick-out

- | | |
|------------------------|----------------------|
| 1 Tip to work distance | 4 Electrode wire |
| 2 Gas nozzle | 5 Actual stick-out |
| 3 Contact tip (tube) | 6 Average arc length |
- Nozzle Angle. This refers to the position of the MIG gun in relation to the joint. The transverse angle is usually one half the included angle between plates forming the joint. The longitudinal angle is the angle between the centre line of the MIG gun and a line perpendicular to the axis of the weld. The longitudinal angle is generally called the nozzle angle and can be either trailing (pulling) or leading (pushing). Whether the operator is left handed or right handed has to be considered to realize the effects of each angle in relation to the direction of travel.

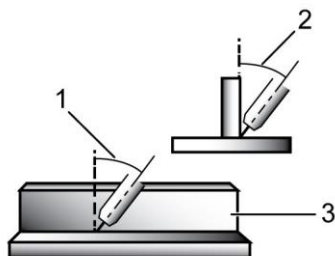


Figure 46: Transverse and longitudinal nozzle axes

- | | |
|----------------------|----------------|
| 1 Longitudinal angle | 3 Axis of weld |
| 2 Transverse angle | |

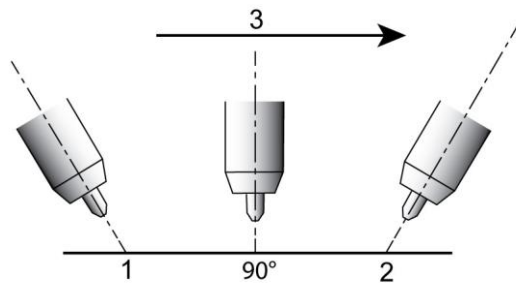


Figure 47: Nozzle angle, right handed operator

- 1 Leading or "pushing" angle (forward pointing) 3 Direction of torch travel
 2 Trailing or "pulling" angle (backward pointing)

Establishing the arc and making weld beads

Before attempting to weld on a finished piece of work, it is recommended that practice welds be made on a sample metal of the same material as that of the finished piece.

The easiest welding procedure for the beginner to experiment with MIG welding is the flat position. The equipment is capable of flat, vertical and overhead positions.

For practicing MIG welding, secure some pieces of 1/16 in. or 3/16 in. (1.6 mm or 5.0 mm) mild steel plate 6 in. x 6 in. (150 mm x 150 mm). Use .035 in. (0.9 mm) flux cored gasless wire or a solid wire with shielding gas.

Power source setting

Power source setting requires some practice by the operator, as the welding plant has two control settings that have to balance. These are the wire speed control (see "Victor regulator" section) and the welding voltage control, see "ESAB EMP 210, ESAB EM 210 controls, indicators and features" section. The welding current is determined by the wire speed control, the current will increase with increased wire speed, resulting in a shorter arc. Less wire speed will reduce the current and lengthen the arc. Increasing the welding voltage hardly alters the current level, but lengthens the arc. By decreasing the voltage, a shorter arc is obtained with a little change in current level.

When changing to a different electrode wire diameter, different control settings are required. A thinner electrode wire needs more wire speed to achieve the same current level.

A satisfactory weld cannot be obtained if the wire speed and voltage settings are not adjusted to suit the electrode wire diameter and the dimensions of the workpiece.

If the wire speed is too high for the welding voltage, "stubby" will occur as the wire dips into the molten pool and does not melt. Welding in these conditions normally produces a poor weld due to lack of fusion. If, however, the welding voltage is too high, large drops will form on the end of the wire, causing spatter. The correct setting of voltage and wire speed can be seen in the shape of the weld deposit and heard by a smooth regular arc sound. Refer to the Weld Guide located on the inside of the wirefeed compartment door for setup information.

Electrode wire size selection

The choice of Electrode wire size and shielding gas used depends on the following:

- Thickness of the metal to be welded
- Capacity of the wire feed unit and power source
- The amount of penetration required
- The deposition rate required
- The bead profile desired
- The position of welding
- Cost of the wire

6.4 MMA (SMAW) Basic Welding Technique

Size of electrode

The electrode size is determined by the thickness of metals being joined and by the type of welding machine available. Small welding machines will only provide sufficient current to run the smaller size electrodes.

For thin sections, it is necessary to use smaller electrodes otherwise the arc may burn holes through the workpiece. Practice will soon establish the most suitable electrode for a given application.

Storage of electrodes

Always store electrodes in a dry place and in their original containers.

Electrode polarity

Electrodes are generally connected to the electrode holder. The electrode holder is connected to the positive polarity. The work lead is connected to the negative polarity and it is connected to the workpiece. If in doubt consult the electrode data sheet or your nearest accredited ESAB distributor.

6.5 Effects of arc welding on various materials

High tensile and alloy steels

The two most prominent effects of welding these steels are the formation of a hardened zone in the weld area, and, if suitable precautions are not taken, the occurrence in this zone of under-bead cracks may result. Hardened zone and under-bead cracks in the weld area may be reduced by using the correct electrodes, preheating, using higher current settings, using larger electrode sizes, short runs for larger electrode deposits or tempering in a furnace. Hydrogen controlled electrodes must be used for this application.

Austenitic manganese steels

The effect on manganese steel of slow cooling from high temperatures is to embrittle it. For this reason it is absolutely essential to keep manganese steel cool during welding by quenching after each weld or skip welding to distribute the heat.

Cast iron

Most types of cast iron, except white iron, are weldable. White iron, because of its extreme brittleness, generally cracks when attempts are made to weld it. Welding whiteheart malleable iron can be problematic, due to the porosity caused by gas held in this type of iron.

Copper and alloys

The most important factor is the high rate of heat conductivity of copper, making preheating of heavy sections necessary to give proper fusion of the weld and the base metal.

Arc welding practice

The techniques used for arc welding are almost identical regardless of what types of metals are being joined. Naturally enough, different types of electrodes would be used for different metals as described in the following section.

Welding position

The electrodes dealt with in this publication can be used in most positions, i.e. they are suitable for welding in flat, horizontal, vertical and overhead positions. Numerous applications call for welds to be made in positions intermediate between these. See some of the common types of welds below.

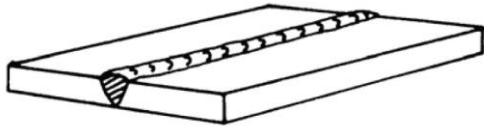


Figure 48: Flat position, Downhand butt weld

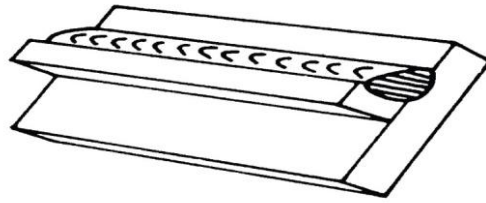


Figure 49: Flat position, Gravity fillet weld

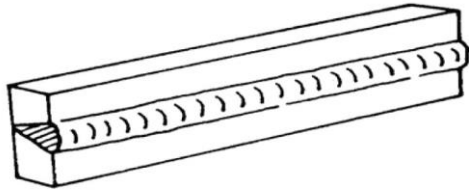


Figure 50: Horizontal position, Butt weld

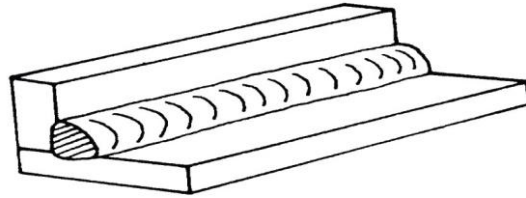


Figure 51: Horizontal-Vertical (HV) position

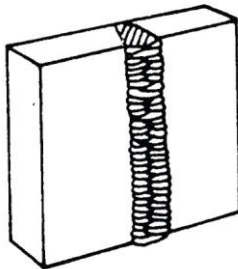


Figure 52: Vertical position, Butt weld

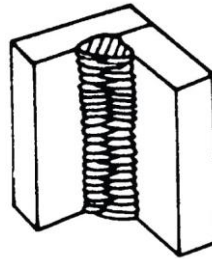


Figure 53: Vertical position, Fillet weld

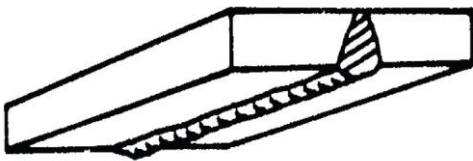


Figure 54: Overhead position, Butt weld

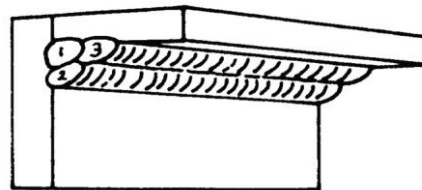


Figure 55: Overhead position, Fillet weld

Joint preparations

In many cases, it will be possible to weld steel sections without any special preparation. For heavier sections and for repair work on castings, etc., it will be necessary to cut or grind an angle between the pieces being joined to ensure proper penetration of the weld metal and to produce sound joints.

In general, surfaces being welded should be clean and free of rust, scale, dirt and grease. Slag should be removed from oxy-fuel cut surfaces. Typical joint designs are shown below.

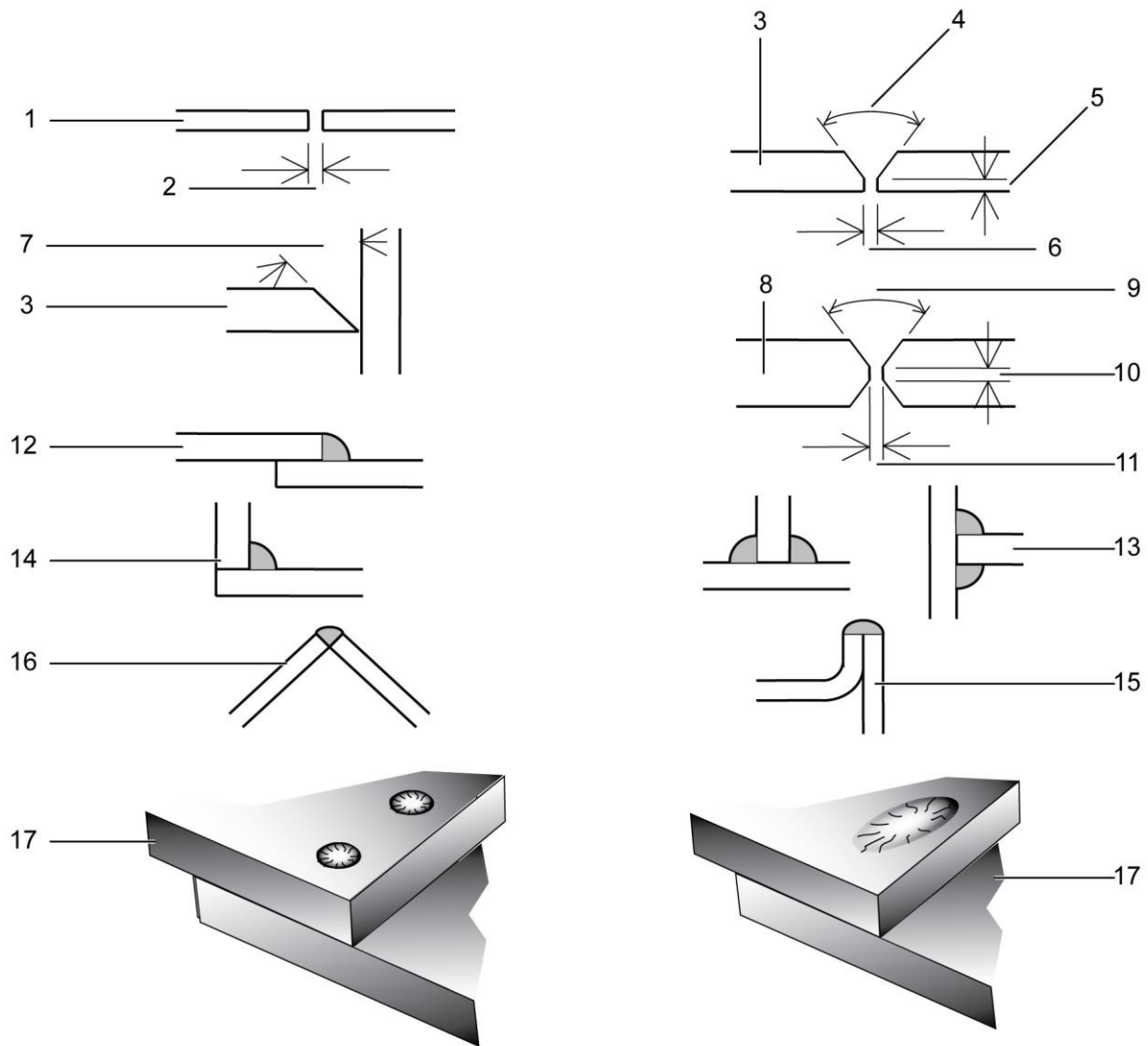


Figure 56: Typical joint designs for arc welding

- 1 Open square butt joint
- 2 Gap varies from 1/16 in. (1.6 mm) to 3/16 in. (4.8 mm) depending on plate thickness
- 3 Single vee butt joint
- 4 Not less than 70°
- 5 Maximum 1/16 in. (1.6 mm)
- 6 1/16 in. (1.6 mm)
- 7 Not less than 45°
- 8 Double vee butt joint
- 9 Not less than 70°

A: Gap varies from 1/16 in. (1.6 mm) to 3/16 in. (4.8 mm) depending on plate thickness

B: Not less than 70°

C: Maximum 1/16 in. (1.6 mm)

D: 1/16 in. (1.6 mm) **E:** Not less than 45°

F: Not less than 70°

G: Maximum 1/16 in. (1.6 mm)

H: Maximum 1/16 in. (1.6 mm)

10 Maximum 1/16 in. (1.6 mm)

11 1/16 in. (1.6 mm)

12 Lap joint

13 Tee joint (Fillet both sides of the joint)

14 Fillet joint

15 Edge joint

16 Corner weld

17 Plug weld

Arc welding technique

For those who have not yet done any welding, the simplest way to commence is to run beads on a piece of scrap plate. Use mild steel plate about 1/4 in. (6.4 mm) thick and a 1/8 in. (3.2 mm) electrode. Clean any paint, loose scale or grease off the plate and set it firmly on the workbench so that welding can be carried out in the downhand position. Make sure that the work clamp is making good electrical contact with the work, either directly or through the work table. For light gauge material, always clamp the work lead directly to the workpiece, otherwise the circuit will not be satisfactory.

The Welder

Place yourself in a comfortable position before beginning welding. Get a seat of suitable height and do as much work as possible sitting down. Do not hold your body tense. A taut attitude of mind and a tensed body will soon make you feel tired. Relax and you will find that it becomes much easier. Wear a leather apron and gauntlets to prevent being burnt or sparks setting your clothes on fire.

Place the work so that the direction of welding is across, rather than to or from, your body. The electrode holder lead should be clear of any obstruction so that you can move your arm freely along as the electrode burns down.

If the lead is slung over your shoulder, it allows greater freedom of movement and takes a lot of weight off your hand. Be sure the insulation on your cable and electrode holder is not faulty, otherwise you are risking an electric shock.

Striking an arc

Practice this on a piece of scrap plate before going on to more exacting work. You may at first experience difficulty due to the tip of the electrode "sticking" to the work piece. This is caused by making too heavy a contact with the work and failing to withdraw the electrode quickly enough. A low amperage will accentuate it. This sticking of the tip may be overcome by scratching the electrode along the plate surface in the same way as a match is struck. As soon as the arc is established, maintain a 1/16 in. - 1/8 in. (1.6 mm - 3.2 mm) gap between the burning electrode end and the parent metal. Draw the electrode slowly along as it melts down.

Another difficulty is the tendency, after the arc is struck, to withdraw the electrode so far that the arc is broken again. A little practice will soon remedy both of these faults.

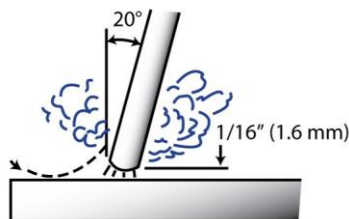


Figure 57: Striking the arc

Arc length

The securing of an arc length necessary to produce a good weld soon becomes almost automatic. You will find that a long arc produces more heat. A very long arc produces a crackling or spluttering noise and the weld metal comes across in large, irregular blobs. The weld bead is flattened and spatter increases. A short arc is essential if a high quality weld is to be obtained although if it is too short there is the danger of it being blanketed by slag and the electrode tip being solidified in. If this should happen, give the electrode a quick twist back over the weld to detach it. Contact or "touch-weld" electrodes such as E7014 do not stick in this way, and make welding much easier.

Rate of travel

After the arc is struck, your next concern is to maintain it, and this requires moving the electrode tip towards the molten pool at the same rate as it is melting away. At the same time, the electrode has to move along the plate to form a bead. The electrode is directed at the weld pool at about 20° from the vertical. The rate of travel has to be adjusted so that a well-formed bead is produced.

If the travel is too fast, the bead will be narrow, strung out and may even be broken up into individual globules. If the travel is too slow, the weld metal piles up and the bead will be too large.

Making welded joints

Having attained some skill in the handling of an electrode, you will be ready to make welded joints.

Butt welds

Set up two plates with their edges parallel, as shown below, allowing 1/16 in. - 3/32 in. (1.6 mm - 2.4 mm) gap between them and tack weld at both ends. This is to prevent contraction stresses from the cooling weld metal pulling the plates out of alignment. Plates thicker than 1/4 in. (6.4 mm) should have their mating edges beveled to form a 70° to 90° included angle. This allows full penetration of the weld metal to the root. Using a 1/8 in. (3.2 mm) E7014 electrode at 100 A, deposit a run of weld metal on the bottom of the joint.

Do not weave the electrode, but maintain a steady rate of travel along the joint sufficient to produce a well-formed bead. At first you may notice a tendency for undercut to form, but keeping the arc length short, the angle of the electrode at about 20° from vertical, and the rate of travel not too fast, will help eliminate this. The electrode needs to be moved along fast enough to prevent the slag pool from getting ahead of the arc. To complete the joint in thin plate, turn the workpiece over, clean the slag out of the back and deposit a similar weld.

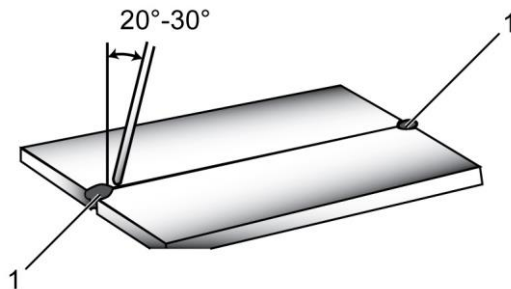


Figure 58: Butt weld

1 Tack weld

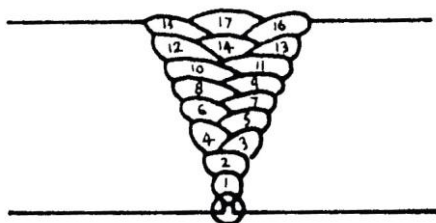


Figure 59: Weld build up sequence

Heavy plate will require several runs to complete the joint. After completing the first run, chip the slag off and clean the weld with a wire brush. It is important to do this to prevent the slag being trapped by the second run. Subsequent runs are then deposited using either a weave technique or single beads laid down in the sequence shown above. The width of the weave should not be more than three times the core wire diameter of the electrode. When the joint is completely filled, the back is either machined, ground or gouged out to remove slag which may be trapped in the root, and to prepare a suitable joint for depositing the backing weld. If a backing bar is used, it is

not usually necessary to remove this, since it serves a similar purpose to the backing weld in securing proper fusion at the root of the weld.

Fillet welds

These are welds of approximately triangular cross section made by depositing metal in the corner of two faces meeting at right angles, see figure "Multi-runs in HV fillet weld".

A piece of angle iron is a suitable to start or two strips of steel may be tacked together at right angles.

Using a 1/8 in. (3.2 mm) E7014 electrode at 100 A, position the angle iron with one leg horizontal and the other vertical. This is known as a horizontal-vertical (HV) fillet. Strike the arc and immediately bring the electrode to a position perpendicular to the line of the fillet and about 45° from the vertical. Some electrodes require to be sloped about 20° away from the perpendicular position to prevent slag from running ahead of the weld, see the figures below. Do not attempt to build up much larger than 1/4 in. (6.4 mm) width with a 1/8 in. (3.2 mm) electrode, otherwise the weld metal tends to sag towards the base, and undercut forms on the vertical leg. Multi-runs can be made as shown below. Weaving in HV fillet welds is undesirable.

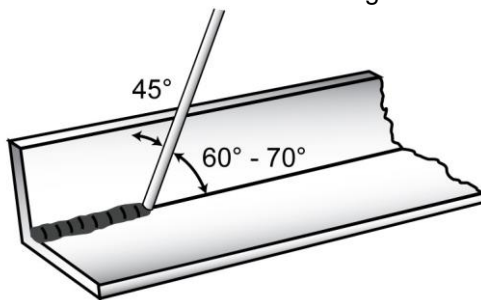


Figure 60: Electrode position for the HV fillet weld

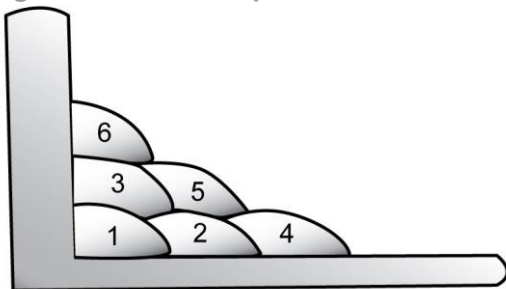


Figure 61: Multi-runs in HV fillet weld

Vertical welds

- Vertical up
Tack weld a three feet long angle iron to your workbench in an upright position. Use a 1/8 in. (3.2 mm) E7014 electrode and set the current at 100 A. Make yourself comfortable in a seat in front of the workpiece and strike the arc in the corner of the fillet. The electrode needs to be about 10° from the horizontal to enable a good bead to be deposited, see the figures below. Use a short arc, and do not attempt to weave on the first run. When the first run has been completed remove the slag and begin the second run at the bottom. This time a slight weaving motion is necessary to cover the first run and obtain good fusion at the edges. At the completion of each side motion, pause for a moment to allow weld metal to build up at the edges, otherwise undercut will form and too much metal will accumulate in the centre of the weld. Figure "Multi run vertical fillet weld" illustrates multi run technique and figure "Examples of vertical fillet welds" shows the effects of pausing at the edge of weave and of weaving too rapidly.

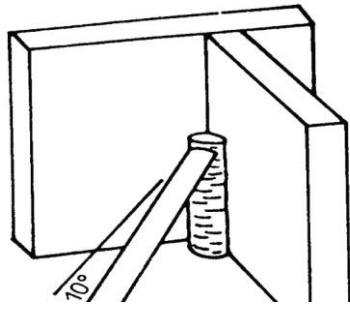


Figure 62: Single run vertical fillet weld

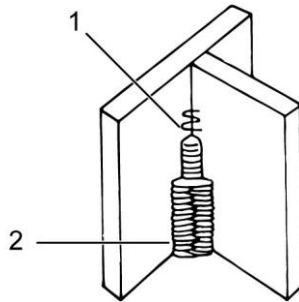


Figure 63: Multi run vertical fillet weld

1 Weaving motion for second and subsequent runs

2 Pause at the edge of the weave

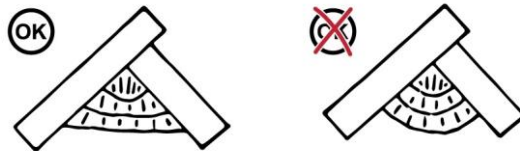


Figure 64: Examples of vertical fillet welds

- **Correct**
Pause at the edge of the weave to allow the metal to build up and eliminate undercut.
- **Incorrect**
Note weld contour when insufficient pause at the edge of weave, see the figure above.
- **Vertical down**
The E7014 electrode makes welding in this position particularly easy. Use a 1/8 in. (3.2 mm) electrode at 100 A. The tip of the electrode is held in light contact with the work and the speed of downward travel is regulated so that the tip of the electrode just keeps ahead of the slag. The electrode should point upwards at an angle of about 45°.
- **Overhead welds**
Apart from the rather awkward position necessary, overhead welding is not much more difficult than downhand welding. Set up a workpiece for overhead welding by first tacking an angle iron at the right angles to another piece of an angle iron or a pipe. Then tack this to the workbench or hold in a vice so that the workpiece is positioned in the overhead position as shown in the sketch. The electrode is held at 45° to the horizontal and tilted 10° in the line of travel, see the figure below. The tip of the electrode may be touched lightly on the metal, which helps to give a steady run. A weave technique is not advisable for overhead fillet welds. Use a 1/8 in. (3.2 mm) E6013 electrode at 100 A, and deposit the first run by simply drawing the electrode along at a steady rate. You will notice that the weld deposit is rather convex, due to the effect of gravity before the metal freezes.

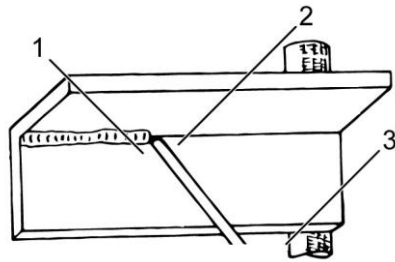


Figure 65: Overhead fillet weld

- | | |
|--------------------------------|--------------------------|
| 1 45° to plate | 3 Angle tacked to a pipe |
| 2 Tilted 10° in line of travel | |

Distortion

Distortion in some degree is present in all forms of welding. In many cases it is so small that it is barely perceptible, but in other cases allowance has to be made before welding commences for the distortion that will subsequently occur. The study of distortion is so complex that only a brief outline can be attempted here.

The cause of distortion

Distortion is caused by:

- Contraction of weld metal:**
 Molten steel shrinks approximately 11% in volume on cooling to room temperature. This means that a cube of molten metal would contract approximately 2.2% in each of its three dimensions. In a welded joint, the metal becomes attached to the side of the joint and cannot contract freely. Therefore, cooling causes the weld metal to flow plastically, that is, the weld itself has to stretch if it is to overcome the effect of shrinking volume and still be attached to the edge of the joint. If the restraint is too strong, for example in a heavy section of a plate, the weld metal may crack. Even in cases where the weld metal does not crack, stresses will remain "Locked up" in the structure. If the joint material is relatively weak, for example, a butt joint in 5/64 in. (2.0 mm) sheet, the contracting weld metal may cause the sheet to become distorted.
- Expansion and contraction of parent metal in the fusion zone:**
 While welding is proceeding, a relatively small volume of the adjacent plate material is heated to a very high temperature and attempts to expand in all directions. It is able to do this freely at right angles to the surface of the plate (that is "through the weld", but when it attempts to expand "across the weld" or "along the weld", it meets considerable resistance. To enable expansion, it has to deform plastically, that is, the metal adjacent to the weld is at a high temperature and rather soft, and by expanding, pushes the cooler, harder metal further and tends to bulge (or it is "upset"). When the weld area begins to cool, the "upset" metal attempts to contract as much as it expanded, but, because it has been "upset" it does not resume its former shape, and the contraction of the new shape exerts a strong pull on adjacent metal.
 The metal in the weld area is stretched (plastic deformation), the workpiece may be pulled out of shape by the powerful contraction stresses (distortion), or the weld may crack, in any case "locked up" stresses will remain in the workpiece. Figures below illustrate how distortion is created.

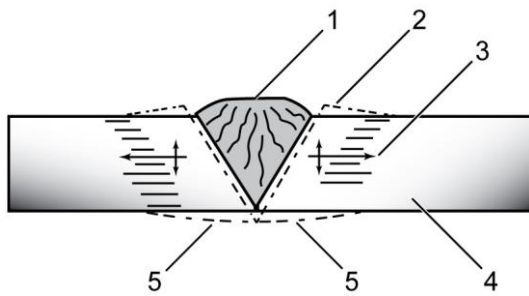


Figure 66: Parent metal expansion

- | | |
|------------------------------|--------|
| 1 Weld | 4 Cool |
| 2 Upsetting | 5 Hot |
| 3 Expansion with compression | |

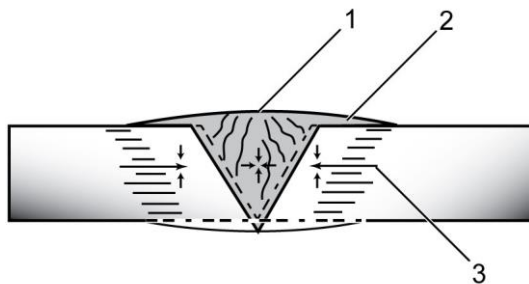


Figure 67: Parent metal contraction

- | | |
|-------------------|----------------------------|
| 1 Weld | 3 Contraction with tension |
| 2 Permanent upset | |

Overcoming distortion effects

There are several methods of minimizing distortion effects.

- **Peening**
This is done by hammering the weld while it is still hot. The weld metal is flattened slightly and because of this the tensile stresses are reduced. The effects of peening is relatively shallow, and it is not advisable on the last layer.
- **Distribution of stresses**
Distortion may be reduced by selecting a welding sequence which will distribute the stresses suitably so that they tend to cancel each other. see the figures below for various weld sequences. Choice of a suitable weld sequence is probably the most effective method of overcoming distortion, although an unsuitable sequence may exaggerate it. Simultaneous welding of both sides of a joint by two welders is often successful in eliminating distortion.
- **Restraint of parts**
Forcible restraint of the welded components is often used to prevent distortion. Jigs, positions, and tack welds are used.
- **Presetting**
It is possible in some cases to tell from past experience or to find by trial and error (or less frequently, to calculate) how much distortion will take place in a given welded structure. By correct presetting of the components to be welded, constructional stresses can be made to pull the parts into correct alignment. A simple example is shown in the figure below.

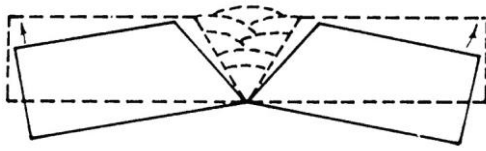


Figure 68: Principle of presetting

- **Preheating**

Suitable preheating of parts of the structure other than the area to be welded can be sometimes used to reduce distortion. Figure "Reduction of distortion by preheating" shows a simple application. By removing the heating source from B and C as soon as welding is completed, the sections B and C will contract at a similar rate, thus reducing distortion.

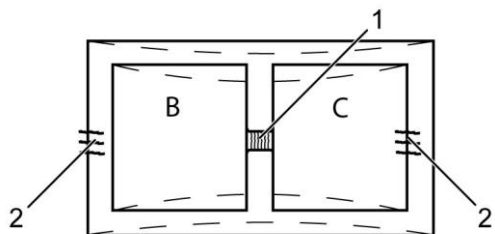


Figure 69: Reduction of distortion by preheating

1Weld

2Preheat

Dotted lines show the effect if no preheat is used.

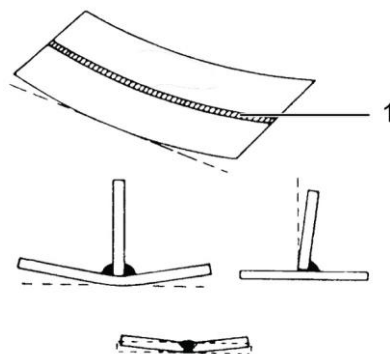


Figure 70: Examples of distortion

1Weld

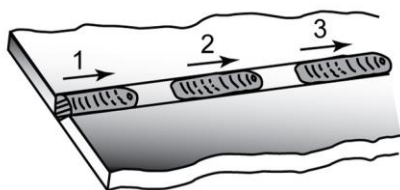


Figure 71: Welding sequence

Block sequence. The spaces between the welds are filled in when the welds are cool.

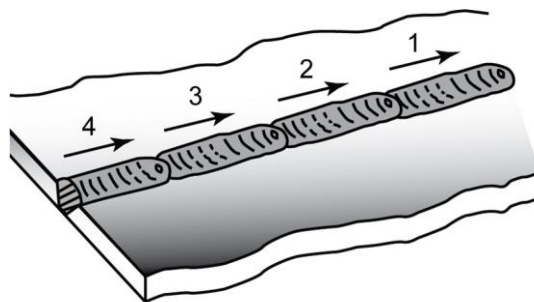


Figure 72: Step back sequence

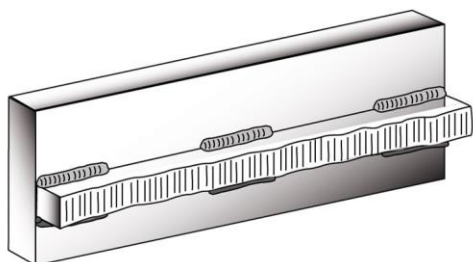


Figure 73: Chain intermittent welding

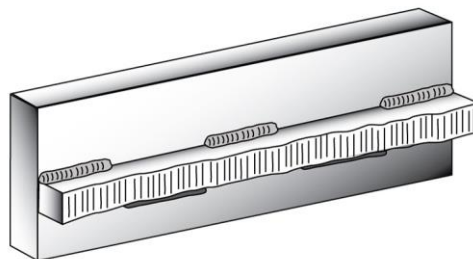


Figure 74: Staggered intermittent welding

6.6 TIG (L-GTAW) basic welding technique

Gas Tungsten Arc Welding (L-GTAW) or TIG (Tungsten Inert Gas) is a welding process in which fusion is produced by an electric arc that is established between a single tungsten (non-consumable) electrode and the workpiece. Shielding is obtained from a welding grade shielding gas or welding grade shielding gas mixture which is generally Argon based. A filler metal may also be added manually in some circumstances depending on the welding application.

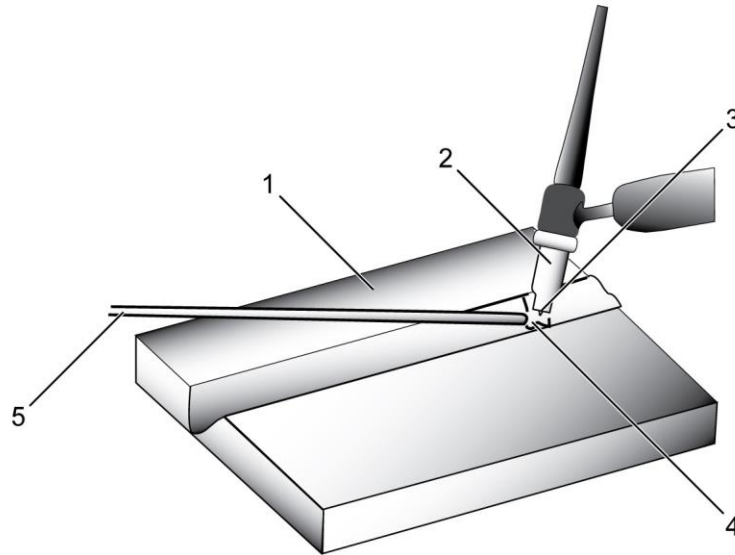


Figure 75: TIG (L-GTAW) welding application

- | | |
|----------------------|----------------|
| 1 Workpiece | 4 Inert gas |
| 2 Gas cup | 5 Filler metal |
| 3 Tungsten electrode | |
- **Workpiece**
Can be any commercial metal
 - **Gas cup**
Either ceramic, high-impact or water cooled metal
 - **Tungsten electrode** Non-consumable • **Inert gas**
Shields electrode and weld puddle
 - **Filler metal**
Welds are made with or without addition of filler metal

Tungsten electrode current ranges

Table 15: Current ranges for various tungsten electrode sizes

Electrode diameter	DC current
0.040 in. (1.0 mm)	30-60 A
1/16 in. (1.6 mm)	60-115 A
3/32 in. (2.4 mm)	100-165 A
1/8 in. (3.2 mm)	135-200 A
5/32 in. (4.0 mm)	190-280 A
3/16 in. (5 mm)	250-340 A

Guide for selecting filler wire diameter**Table 16: Filler wire selection guide**

Electrode diameter	DC current range
1/16 in. (1.6 mm)	20-90 A
3/32 in. (2.4 mm)	65-115 A
1/8 in. (3.2 mm)	100-165 A
3/16 in. (5 mm)	200-350 A

Tungsten electrode types Table 17:

Electrode type (ground finish)	Welding application	Features	Color code
Thoriated 2%	DC welding of mild steel, stainless steel and copper.	Excellent arc starting, Long life, High current carrying capacity.	Red
Zirconated 1%	High quality AC welding of aluminum, magnesium and their alloys.	Self cleaning, Long life, Maintains balled end, High current carrying capacity.	White
Ceriated 2%	AC and DC welding of mild steel, stainless steel, copper, aluminum, magnesium and their alloys.	Longer life, More stable arc, Easier starting, Wider current range, Narrower more concentrated arc.	Grey

**NOTE!**

The ESAB EMP 210 inverter is not suited for AC TIG welding.

TIG Welding filler rods

Base metal thickness	DC current for mild steel	DC current for stainless steel	Tungsten electrode diameter	Filler rod diameter (if required)	Argon gas flow rate CFH	Joint type
0.040 in. 1.0 mm	35-45 40-50	20-30 25-35	0.040 in. 1.0 mm	1/16 in. 1.6 mm	10-15	Butt/Corner Lap/Fillet
0.045 in. 1.2 mm	45-55 50-60	30-45 35-50	0.040 in. 1.0 mm	1/16 in. 1.6 mm	10-15	Butt/Corner Lap/Fillet
1/16 in. 1.6 mm	60-70 70-90	40-60 50-70	0.040 in. 1.0 mm	1/16 in. 1.6 mm	15	Butt/Corner Lap/Fillet
1/8 in. 3.2 mm	80-100 90-115	65-85 90-110	0.040 in. 1.0 mm	3/32 in. 2.4 mm	15	Butt/Corner Lap/Fillet
3/16 in. 4.8 mm	115-135 140-165	100-125 125-150	0.040 in. 1.0 mm	1/8 in. 3.2 mm	20	Butt/Corner Lap/Fillet
1/4 in. 6.4 mm	160-175 170-200	135-160 160-180	0.040 in. 1.0 mm	5/32 in. 4.0 mm	20	Butt/Corner Lap/Fillet

TIG welding is generally regarded as a specialized process that requires operator competency. While many of the principles outlined in the previous arc welding section are applicable a comprehensive outline of the TIG welding process is outside the scope of this Instruction Manual.

6 BASIC WELDING GUIDE

6.7 Electrode wire size selection

The choice of electrode wire size and shielding gas used depends on the following:

- Thickness of the metal to be welded
- Type of joint
- Capacity of the wire feed unit and power source
- The amount of penetration required
- The deposition rate required
- The bead profile desired
- The position of welding
- Cost of the wire

7 MAINTENANCE

7.1 Routine service and calibration requirements

Maintain more often if used in unfavorable conditions.



WARNING!

Maintenance and repair work should be performed by an experienced person, and electrical work only by a trained electrician.



WARNING!

The mains supply must be disconnected during cleaning and maintenance.

Routine inspection, Testing & Maintenance

The inspection and testing of the power source and associated accessories shall be carried out by a licensed electrician. This includes an insulation resistance test and an earthing test to ensure the integrity of the unit is compliant with ESAB's original specifications.

Testing Schedule

1. For transportable equipment, at least once every 3 months; and
2. For fixed equipment, at least once every 12 months.

The owners of the equipment shall keep a suitable record of the periodic tests and a system of tagging, including the date of the most recent inspection.

A transportable power source is deemed to be any equipment that is not permanently connected and fixed in the position in which it is operated.

Insulation resistance

Minimum insulation resistance for in-service ESAB inverter power sources shall be measured at a voltage of 500 V between the parts, see "Minimum insulation resistance requirements: ESAB inverter power sources" section. Power sources that do not meet the insulation resistance requirements set out below shall be withdrawn from service and not returned until repairs have been performed such that the requirements outlined below are met.

Table 19: Minimum insulation resistance requirements: ESAB inverter power sources

Components to be tested	Minimum insulation resistance (Mohm)
Input circuit (including any connected control circuits) to welding circuit (including any connected control circuits)	5
All circuits to exposed conductive parts	2.5
Welding circuit (including any connected control circuits) to any auxiliary circuit which operates at a voltage exceeding extra low voltage	10
Welding circuit (including any connected control circuits) to any auxiliary circuit which operates at a voltage not exceeding extra low voltage	1
Separate welding circuit to separate welding circuit	1

Earthing

The resistance shall not exceed 1 ohm between any metal of a power source where such metal is required to be earthed, and

1. The earth terminal of a fixed power source; or
2. The earth terminal of the associated plug of a transportable power source

Due to the dangers of stray output currents damaging fixed wiring, the integrity of fixed wiring supplying ESAB welding power sources should be inspected by a licensed electrical worker in accordance with the requirements below.

Due to the dangers of stray output currents damaging fixed wiring, the integrity of fixed wiring supplying ESAB welding power sources should be inspected by a licensed electrical worker in accordance with the requirements below.

1. For outlets/wiring and associated accessories supplying transportable equipment – at least once every 3 months; and
2. For outlets/wiring and associated accessories supplying fixed equipment - at least once every 12 months.

General maintenance checks

Welding equipment should be regularly checked by an accredited ESAB service provider to ensure that:

1. Flexible cord is of the multi-core tough rubber or plastic sheathed type of adequate rating, correctly connected and in good condition.
2. Welding terminals are in suitable condition and are shrouded to prevent inadvertent contact or short circuit.
3. The welding system is clean internally, especially from metal filing, slag, and loose material.

Accessories

Accessory equipment, including output leads, electrode holders, torches, wire feeders and the like shall be inspected at least monthly by a competent person to ensure that the equipment is in a safe and serviceable condition. All unsafe accessories shall not be used.

Repairs

If any parts are damaged for any reason, it is recommended that replacement be performed by an accredited ESAB service provider.

Power source calibration Schedule

Output testing of all ESAB inverter power sources and applicable accessories shall be conducted at regular intervals to ensure they fall within specified levels. Calibration intervals shall be as outlined below -

1. For transportable equipment, at least once every 3 months; and
2. For fixed equipment, at least once every 12 months.

Calibration requirements

Where applicable, the tests outlined in "Calibration parameters" section, shall be conducted by an accredited ESAB service agent.

Table 20: Calibration parameters

Testing requirements
Output current (A) to be checked to ensure it falls within applicable ESAB power source specifications
Output voltage (V) to be checked to ensure it falls within applicable ESAB power source specifications
Motor speed (RPM) of wire drive motors to be checked to ensure it falls within required ESAB power source / wire feeder specifications
Accuracy of digital meters to be checked to ensure it falls within applicable ESAB power source specifications

Periodic calibration of other parameters such as timing functions are not required unless a specific fault has been identified.

Calibration equipment

All equipment used for power source calibration shall be in proper working condition and be suitable for conducting the measurement in question. Only test equipment with valid calibration certificates (NATA certified laboratories) shall be utilized.

7.2 Cleaning the welding power source



WARNING!


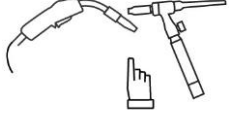
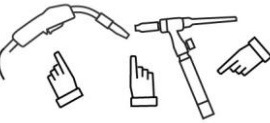


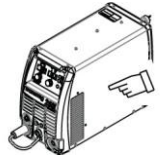

Maintenance and repair work should be performed by an experienced person, and electrical work only by a trained electrician.



WARNING!

The mains supply must be disconnected during cleaning and maintenance.

To clean the welding power source, open the enclosure and use a vacuum cleaner to remove any accumulated dirt, metal filings, slag and loose material. Keep the shunt and lead screw surfaces clean as accumulated foreign material may reduce the welders output welding current.

Interval	Area to maintain	
Each use	 <p>Visual check of regulator and pressure</p>	 <p>Visual check of torch consumable parts</p>
Weekly	 <p>Visually inspect the torch body and consumables</p>	 <p>Visually inspect the cables and leads. Replace if necessary</p>
3 months	 <p>Replace all broken parts</p>	 <p>Clean exterior of power supply</p>
6 months	 <p>Bring the unit to an authorized Tweco service provider to remove any accumulated dirt and dust from the interior. This may need to be done more frequently under exceptionally dirty conditions.</p>	

8 TROUBLESHOOTING

8.1 Power source problems

Table 22: Power source problems

Type of fault	Cause	Corrective action
Electricity supply is ON, the power indicator is illuminated, however, the power source will not start welding when the torch trigger switch is pressed.	The power source is not in the correct mode of operation.	Set the power source to the correct mode of operation with the process selection switch.
	Faulty torch trigger.	Repair or replace torch trigger switch/lead.
Fault indicator is illuminated and the power source will not start welding when the torch trigger switch is pressed.	Duty cycle of the power source has been exceeded.	Leave the power source switched ON and allow it to cool down. Do not start welding until the fault indicator is turned off.
The power source will not feed wire in MIG mode.	Electrode wire stuck in conduit liner or contact tip (burnback jam).	Check for clogged / kinked MIG gun conduit liner or worn contact tip. Replace faulty components.
	Internal fault in the power source	Contact an authorised ESAB service technician.
Welding wire continues to feed when the torch trigger is released.	The trigger mode selection switch is in 4T latch mode.	Change the trigger mode selection switch from 4T latch mode to 2T normal mode.
	The torch trigger leads shorted.	Repair or replace the torch trigger switch/lead.
Welding arc cannot be established in MIG mode.	MIG gun polarity lead is not connected into a welding output terminal.	Connect the MIG gun polarity lead to either the positive welding output terminal or the negative welding output terminal as required.
	Poor or no work lead contact.	Clean work clamp area and ensure good electrical contact.
Inconsistent wire feed.	Worn or dirty contact tip.	Replace if necessary.
	Worn feed roll.	Replace.
	Excessive brake tension on wire reel hub.	Reduce brake tension on spool hub.
	Worn, kinked or dirty conduit liner.	Clean or replace the conduit liner.

Type of fault	Cause	Corrective action
No gas flow in MIG mode.	The gas hose is damaged	Replace or repair.
	Gas passage contains impurities.	Disconnect the gas hose from the rear of the power source and blow out dirt.
	Gas regulator turned OFF.	Turn ON regulator.
	Empty gas cylinder.	Replace gas cylinder.
Gas flow continues after the trigger switch has been released (MIG mode).	Gas valve has jammed open due to dirt in the gas or the gas line.	Contact an authorised ESAB service technician.
Power indicator will not illuminate and welding arc cannot be established.	The electricity supply has exceeded voltage limits of the power source.	Ensure that the electricity supply is within 120 V $\pm 10\%$ or 230 VAC $\pm 10\%$.
TIG electrode melts when arc is struck.	The TIG torch is connected to the (+) VE terminal.	Connect the TIG torch to the (-) VE terminal.
Arc flutters during TIG welding.	Tungsten electrode is too large for the welding current.	Select the correct size of tungsten electrode. See "TIG (L-GTAW) basic welding technique" section.

8.2 MIG (GMAW/FCAW) welding troubleshooting

Solving problems beyond the welding terminals

The general approach to fix MIG (GMAW/FCAW) welding problems is to start at the wire spool then work through to the MIG gun. There are two main areas where problems occur with GMAW, porosity and inconsistent wire feed.

Porosity

When there is a gas problem, the result is usually porosity within the weld metal. Porosity always stems from some contaminant within the molten weld pool which is in the process of escaping during solidification of the molten metal. Contaminants range from no gas around the welding arc to dirt on the work piece surface. Porosity can be reduced by checking the following points.

Table 23: Porosity

Type of fault	Corrective action
No shielding gas or wrong flow meter settings.	Ensure that the shielding gas cylinder is not empty and the flow meter is correctly adjusted to 31.75 CFH.
No shielding gas or wrong flow gauge.	Ensure that the shielding gas cylinder is not empty and the flow meter is correctly adjusted to workshop welding: 28-35 CFH or outdoors welding: 35-46 CFH.
Gas leaks.	Check for gas leaks between the regulator/cylinder connection and in the gas hose to the power source.
Internal gas hose in the power source.	Ensure the hose from the solenoid valve to the MIG gun adapter has not fractured and that it is connected to the MIG gun adapter.
Welding in a windy environment.	Shield the weld area from the wind or increase the gas flow.
Dirty from welding, oily, painted, oxidized or greasy plate.	Clean contaminates off the workpiece.
Distance between the MIG gun nozzle and the workpiece.	Keep the distance between the MIG gun nozzle and the workpiece to a minimum.

**NOTE!**

To maintain the MIG gun is in good working order do the following:

- Ensure that the gas holes are not blocked and gas is exiting out of the MIG gun nozzle.
- Do not restrict gas flow by allowing spatter to build up inside the MIG gun nozzle.
- Check that the MIG gun O-rings are not damaged.

**WARNING!**

Disengage the feed roll when testing for gas flow by ear.

Inconsistent wire feed

Wire feeding problems can be reduced by checking the following points.

Table 24: Wire feeding problems

Type of fault	Corrective action
Feed roller driven by motor in the cabinet slipped.	Wire spool brake is too tight.
Wire spool unwound and tangled.	Wire spool brake is too loose.
Worn or incorrect feed roller size.	Use a feed roller matched to the size you are welding.
	Replace feed roller if worn.
Wire is rubbed against the misaligned guides and reduced wire feed ability.	Misalignment of inlet/outlet guides
The liner is blocked with swarf	Increased amounts of swarf are produced by the wire passing through the feed roller when excessive pressure is applied to the pressure roller adjuster.
	Swarf can also be produced by the wire passing through an incorrect feed roller groove shape or size.
	Swarf is fed into the conduit liner where it accumulates thus reducing wire feed ability.
Incorrect or worn contact tip	The velocity contact tip transfers the weld current to the electrode wire. If the hole in the contact tip is too large then arcing may occur inside the contact tip resulting in the wire jamming in the contact tip.
	When using soft wire such as aluminum it may become jammed in the contact tip due to expansion of the wire when heated. A velocity contact tip designed for soft wires should be used.
Poor work lead contact to workpiece	If the work lead has a poor electrical contact to the work piece then the connection point will heat up and result in a reduction of power at the arc.
Bent liner	This will cause friction between the wire and the liner thus reducing wire feed ability

Basic MIG (GMAW/FCAW) welding troubleshooting**Table 25: MIG (GMAW /FCAW) welding problems**

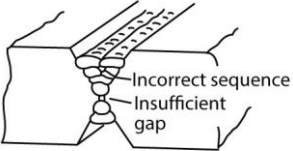
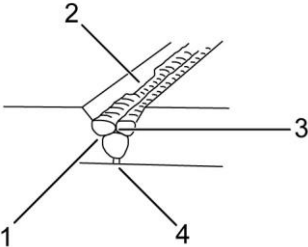
Type of fault	Cause	Corrective action
Undercut	Welding arc voltage is too high.	Decrease voltage or increase the wire feed speed.
	Incorrect MIG gun angle.	Adjust angle.
	Excessive heat input.	Increase the MIG gun travel speed and/or decrease welding current by decreasing the voltage or decreasing the wire feed speed.
Lack of penetration	Welding current is too low	Increase welding current by increasing wire feed speed and increasing voltage.
	Joint preparation is too narrow or gap is too tight.	Increase joint angle or gap.
	Shielding gas is incorrect.	Change to a gas which gives higher penetration.
Lack of fusion	Voltage is too low.	Increase voltage.
Excessive spatter	Voltage is too high.	Decrease voltage or increase the wire speed control.
	Voltage is too low.	Increase the voltage or decrease wire speed.
Irregular weld shape	Incorrect voltage and current settings. Convex, voltage is too low. Concave, voltage is too high.	Adjust voltage and current by adjusting the voltage control and the wire speed control.
	Wire is wandering.	Replace velocity contact tip.
	Incorrect shielding gas.	Check shielding gas.
	Insufficient or excessive heat input.	Adjust the wire speed control or the voltage control.
Weld cracking	Weld beads are too small.	Decrease travel speed.
	Weld penetration is narrow and deep.	Reduce current and voltage and increase MIG gun travel speed or select a lower penetration shielding gas.
	Excessive weld stresses.	Increase weld metal strength or revise design.
	Excessive voltage.	Decrease voltage.
	Cooling rate is too fast.	Slow the cooling rate by preheating part to be welded or cool slowly.

Type of fault	Cause	Corrective action
Cold weld puddle	Loose welding cable connection.	Check all welding cable connections.
	Low primary voltage.	Contact supply authority.
	Fault in power source.	Have an accredited ESAB service provider test then replace the faulty component.
The arc does not have a crisp sound that short arc exhibits when the wirefeed speed and voltage are adjusted correctly	The MIG gun has been connected to the wrong voltage polarity on the front panel.	Connect the MIG polarity cable to the positive (+) welding terminal for solid wires and gas shielded flux cored wires. Refer to the electrode wire manufacturer for the correct polarity.
Poor weld result from setup chart parameters	Contact tip has arc marks in the bore causing excessive drag on the wire.	Replace the contact tip with only a genuine ESAB velocity contact tip.

8.3 MMA (SMAW) welding troubleshooting (only for ESAB EMP 210)

Table 26: MMA (SMAW) metal welding troubleshooting

Type of fault	Cause	Corrective action
Welding current is varying	ARC FORCE is set at a value that causes the welding current to vary excessively with the arc length.	Reduce the ARC FORCE until welding current is reasonably constant while prohibiting the electrode from sticking to the work piece when you “dig” the electrode into the workpiece.
A gap is left by the failure of the weld metal to fill the root of the weld.	The welding current is too low.	Increase the welding current.
	The electrode is too large for joint.	Use a smaller diameter electrode.
	Insufficient gap.	Allow a wider gap.
Non-metallic particles are trapped in the weld metal.	Non-metallic particles may be trapped in undercut from previous run.	If a bad undercut is present clean slag out and cover with a run from a smaller gauge electrode.
	Joint preparation is too restricted.	Allow for adequate penetration and room for cleaning out the slag.
	Irregular deposits allow slag to be trapped.	If very bad, chip or grind out irregularities.
	Lack of penetration with slag trapped beneath weld bead.	Use a smaller electrode with sufficient current to give adequate penetration. Use suitable tools to remove all slag from comers.
	Rust or mill scale is preventing full fusion.	Clean the joint before welding.
	Wrong electrode for the position in which welding is done.	Use electrodes designed for position in which welding is done, otherwise proper control of slag is difficult.

Type of fault	Cause	Corrective action
 <p>Figure 83: Example of insufficient gap or incorrect sequence</p>		
A groove has been formed in the base metal adjacent to the toe of a weld and has not been filled by the weld metal (undercut).	The welding current is too high.	Reduce the welding current.
	The welding arc is too long.	Reduce the length of the welding arc.
	The angle of the electrode is incorrect.	Electrode should not be inclined less than 45° to the vertical face.
	Joint preparation does not allow correct electrode angle.	Allow more room in the joint for manipulation of the electrode.
	The electrode is too large for the joint.	Use smaller gauge electrode.
	Insufficient deposit time at the edge of weave.	Pause for a moment at the edge of the weave to allow weld metal build-up.
	The power source is set for MIG (GMAW) welding.	Set the power source to MMA (SMAW) mode.
Portions of the weld run do not fuse to the surface of the metal or edge of the joint.	Small electrodes used on a heavy cold plate.	Use larger electrodes and preheat the plate.
	The welding current is too low.	Increase the welding current.
	Wrong electrode angle.	Adjust the angle so the welding arc is directed more into the base metal.
	Travel speed of the electrode is too high.	Reduce the travel speed of the electrode.
	Scale or dirt on joint surface.	Clean the surface before welding.
 <p>Figure 84: Example of lack of fusion</p> <p>1 Lack of side fusion, scale dirt, small electrode, 3 Lack of inter-run fusion amperage too low 2 Lack of fusion caused by dirt, electrode angle, 4 Lack of root fusion incorrect, rate of travel too high</p>		

8.4 TIG (L-GTAW) welding problems (only for ESAB EMP 210)

Table 27: TIG (L-GTAW) welding problems

Type of fault	Cause	Corrective action
Excessive bead build up or poor penetration or poor fusion at edges of weld.	The welding current is too low.	Increase the weld current and/or faulty joint preparation.
Weld bead is too wide and flat or undercut at edges of weld or excessive burn through.	The welding current is too high.	Decrease the weld current.
Weld bead is too small or insufficient penetration or ripples in bead are widely spaced apart.	The travel speed is too fast.	Reduce the travel speed.
Weld bead is too small or insufficient penetration or ripples in bead are widely spaced apart.	The travel speed is too slow.	Increase the travel speed.
Uneven leg length in fillet joint	Wrong placement of filler the rod.	Re-position filler rod.
Electrode melts or oxidizes when an arc is struck.	The TIG torch lead connected to positive welding terminal.	Connect the TIG torch lead to negative welding terminal.
	No gas flowing to welding region.	Check the gas lines for kinks or breaks and gas cylinder contents.
	The TIG torch is clogged with dust or dirt.	Clean the TIG torch.
	The gas hose is cut.	Replace the gas hose.
	Gas passage contains dirt.	Disconnect the gas hose from the rear of power source then raise the gas pressure and blow out dirt.
	Gas regulator turned OFF.	Turn ON.
	TIG torch valve is turned OFF.	Turn ON.
	The electrode is too small for the welding current.	Increase the electrode diameter or reduce the welding current.
	The power source is set for MIG welding.	Set the power source to LIFT TIG mode.
Dirty weld pool	Electrode contaminated by contact with workpiece or filler rod material.	Clean the electrode by grinding off the contaminates.
	Work piece surface has foreign material on it.	Clean the surface.
	Gas contaminated with air.	Check the gas lines for cuts and loose fitting or change gas cylinder.
Poor weld finish	Inadequate shielding gas.	Increase the gas flow or check the gas line for gas flow problems.

Type of fault	Cause	Corrective action
Arc start is not smooth	The tungsten electrode is too large for the welding current.	Select the right size electrode.
	A wrong electrode is being used.	Select the right size electrode.
	Gas flow rate is too high.	Select the right rate for the welding task. See "TIG (L-GTAW) Basic welding technique" section.
	Incorrect shielding gas is being used.	Select the right shielding gas.
	Poor work clamp connection to workpiece.	Improve connection to the workpiece.
Arc flutters during TIG welding	The tungsten electrode is too large for the welding current.	Select the right size electrode.
Tungsten blackens due to lack of shielding gas	Gas valve on the TIG torch has not been turned ON.	Turn ON TIG torch gas valve before you commence welding.
	Gas cylinder valve OFF or TIG torch hose not connected to regulator.	Turn ON gas cylinder valve or connect TIG torch hose to regulator.

8.5 Error Codes

Error codes

The error code is used to indicate that a fault has occurred in the equipment. Errors are indicated by the text "Err" and the error code number flashing alternately in the power source display.

Suggested service technician actions for error codes are described in the sub-sections below.

Thermal error

If the protection light is on, the power source might be overheated.

- 1) Wait until the temperature drops and the protection light turns off, the power source will work and you can return to welding.
- 2) If the light does not turn off, follow troubleshooting procedure.

Exception display description

Display	Description
Err Vol	Input voltage is inconsistent with selected voltage.
Ovr Cur	Over current has happened and over current protection is active.
Err Sht	Output short circuit has happened and output short circuit protection is active.

9 ORDERING SPARE PARTS



CAUTION!

Repair and electrical work should be performed by an authorised ESAB service technician.

Use only ESAB original spare and wear parts.

ESAB EMP 210 and ESAB EM 210 are designed and tested in accordance with the Canadian standards **CAN/CSA-E60974-1**. On completion of service or repair work, it is the responsibility of the person(s) performing the work to ensure that the product still complies with the requirements of the above standards.

Spare parts and wear parts can be ordered through your nearest ESAB dealer, see [esab.com](https://www.esab.com). When ordering, please state product type, serial number, designation and spare part number in accordance with the spare parts list. This facilitates dispatch and ensures correct delivery

APPENDIX

ORDERING NUMBERS



Ordering number	Denomination	Type
0700503200	ESAB	EMP 210
0700501200	ESAB	EM 210
0463 815 *	Instruction manual	

The three last digits in the document number of the manual show the version of the manual. Therefore they are replaced with * here. Make sure to use a manual with a serial number or software version that corresponds with the product, see the front page of the manual.

Technical documentation is available on the Internet at: www.esab.com



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