MIG/MAG-WELDING

COURSE BOOK

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DIFFERENT TYPES OF GAS-SHIELDED WELDING PROCESSES

Gas-shielded welding is the „umbrella term“ given to all weld processes in which the weld-pool, and the metal being transferred into it, are protected against the ingress of the atmosphere by a flow of shielding gas. The arc burns visibly between the electrode and the workpiece.

There are several different kinds of gas-shielded welding process, as distinguished by the type of **electrode**, **shielding gas** or **arc** that is used.

An initial rough categorisation may be made by the type of **electrode**. Thereafter, the various processes can be divided into those using a non-melting electrode and those using a melting electrode.

The non-melting - or „permanent“ - electrode is made of **tungsten**, meaning that this group of processes comes under the heading of gas tungsten-arc (GTA) welding.

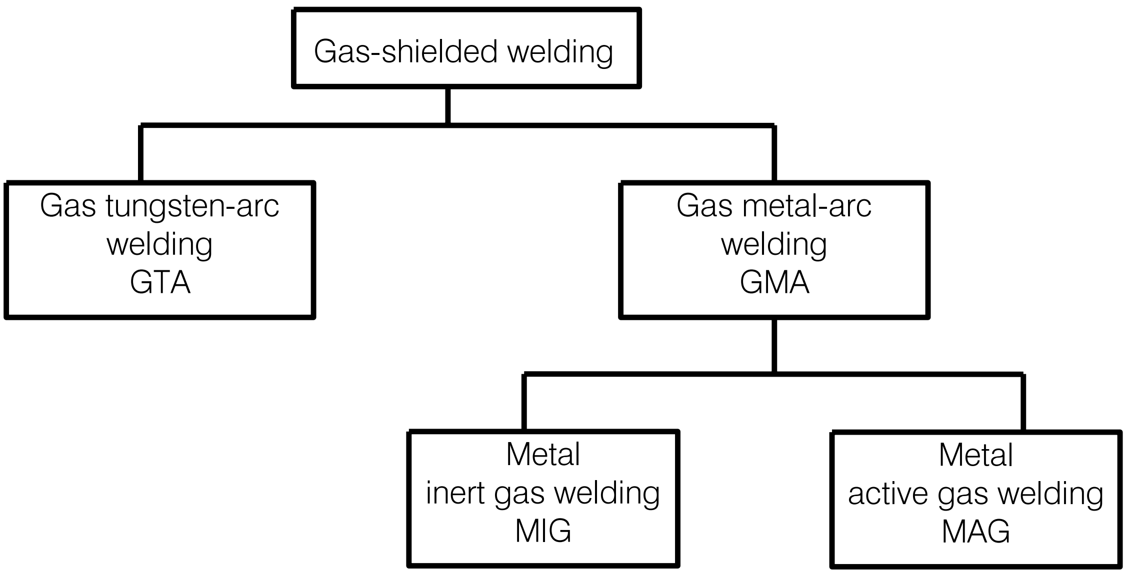
The **melting electrode,** on the other hand**,** is at once the **arc-carrier** and the **weld filler**. It is made of the same material as the metal to be welded, hence the term gas metal-arc (GMA) welding.

These rough categories can then be further differentiated with reference to the various shielding gases used.

In **gas tungsten-arc** (GTA) welding, **inert** gases are used. The term „**inert**“ comes from Greek and means „sluggish“ or „slow to react“. Of all the noble gases available, it is mainly **argon** or **helium,** or mixtures of these, that are used in tungsten inert gas (TIG) welding.

In gas **metal-arc welding**, both **inert** and **active** gases are used. This is why a distinction is made between metal inert gas welding **(MIG)** and metal active gas welding **(MAG)**.

A further distinction is made with reference to the type of shielding gas used - between MAGM welding where argon-based mixed gases are used with added active components such as CO_2 and O_2 (also known as GMMA = „gas-mixture metal-arc“ welding), and MAGC welding where welding-grade carbon dioxide CO_2 is used (also known as GMA-CO_2 welding).



HISTORY OF MIG/MAG WELDING

The development of the MIG/MAG process can be traced back to the year **1947**, when the first useable machines for this process came onto the market in the USA. The name given to it at this time was **S.I.G.M.A.** welding, standing for

„**S**hielded **I**nert **G**as **M**etal **A**rc“

(may be equated with MIG welding).

In 1952, Russian engineers were the first to use CO_2 (carbon dioxide) for welding, thereby giving birth to today's MAG welding. This process soon also gained widespread acceptance in Western Europe for the welding of unalloyed and low-alloyed steels.

However, with the drop in the price of argon in the 1960's, mixed gases started to be used, becoming increasingly widespread as time went on. The result of this is that with suitable power-source technology, high-grade MIG/MAG welding is now possible.

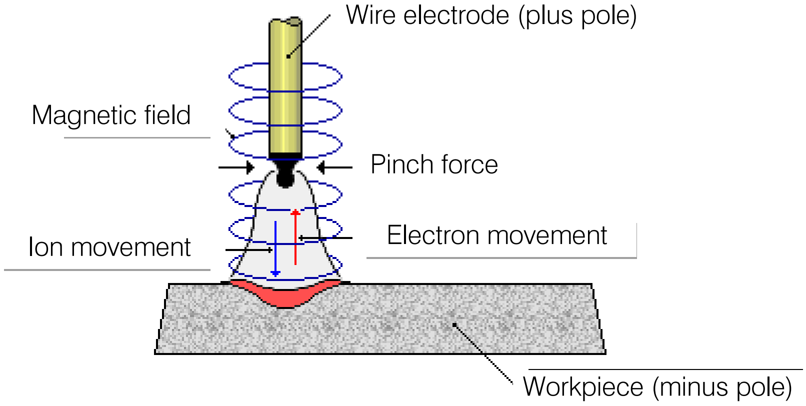
In recent years, MIG/MAG welding has become increasingly important, not only for welding unalloyed and low-alloy structural steels, but also - thanks to pulsed-arc technology - for welding aluminium and high-alloy steels.

Owing to its special features such as high **deposition rates**, deep penetration, great **economic efficiency**, ease of **handling,** complete **mechanisability** etc., the MIG/MAG process has tremendous advantages over other welding processes.

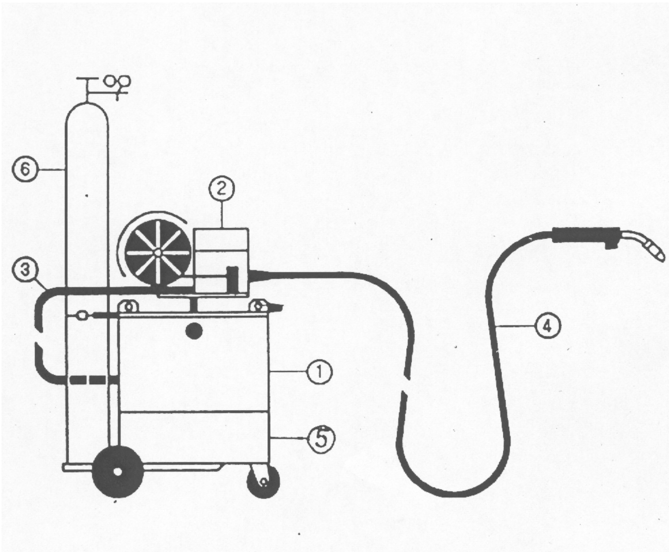
BASIC PRINCIPLE OF MIG/MAG WELDING

The arc burns between a melting electrode (which also acts as the weld filler) and the workpiece. The shielding gas is either **inert** (MIG - e.g. argon, helium and mixtures of these) or **active** (MAG).
Use is made here of 2, 3 or 4-component gas mixtures of e.g. carbon dioxide, argon, helium and oxygen. Pure carbon dioxide is also used.

The sketch illustrates the basic **principle of the process**. The „endless" wire electrode comes from the spool and is fed to the current contact tip by the drive rollers. The wire stick-out is relatively short, meaning that even though the electrodes are fairly thin, high amperages can still be used.
The shielding gas flows out of a gas nozzle that concentrically surrounds the electrode, protecting the arc against the ingress of the atmosphere.

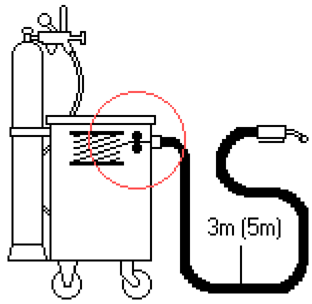


BASIC DESIGN OF A MIG/MAG WELDING MACHINE



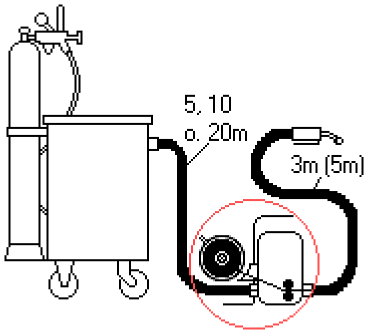
1. Welding power source
2. Wirefeed
3. Interconnecting cable
4. Manual welding torch
5. Cooling unit
6. Gas cylinder

Design variants



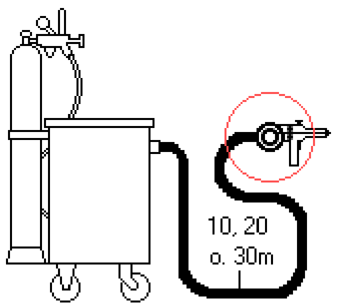
Cabin unit

- Wire is pushed
- Fixed workplace



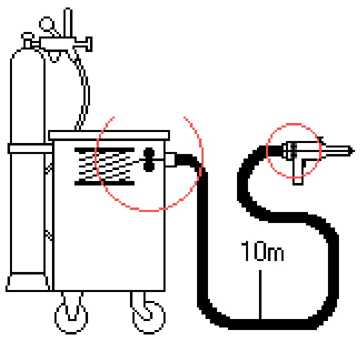
Universal unit

- Wire is pushed
- Mobile workplace



Small-spool unit

- Wire is pulled
- Wider operating range



Push-Pull unit

- Wire is pushed and pulled
- Wider operating range

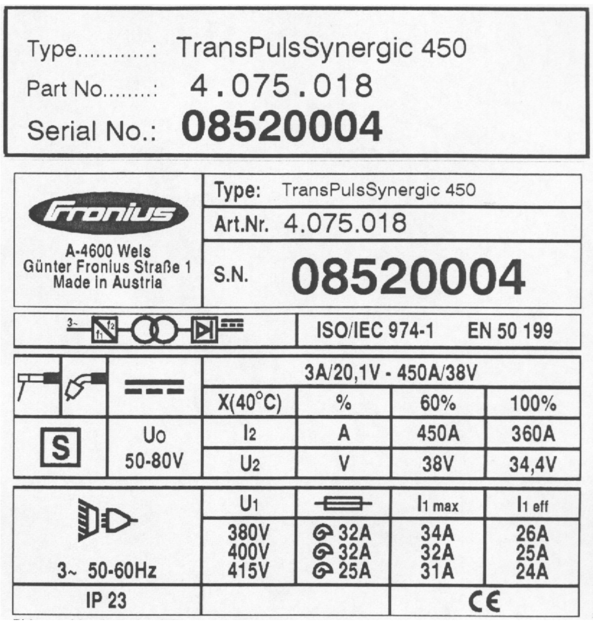
POWER SOURCES FOR MIG/MAG WELDING

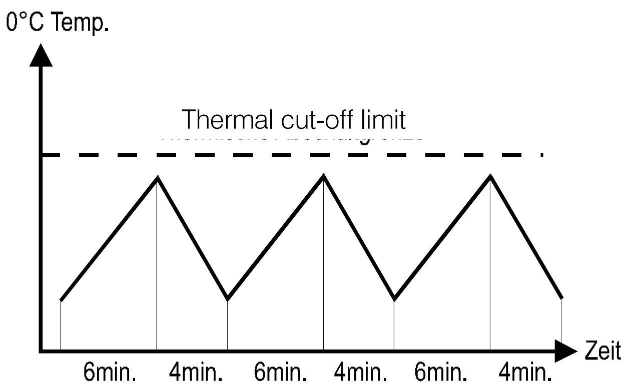
Only **DC power sources** are used for MIG/MAG welding, with the **plus pole** on the wire electrode (although there are exceptions to this when working with flux-cored wires).

The power source should be finely adjustable, in order to permit optimised settings over the entire power range. On **step-switched** machines, the gradations must be suitable for the current range of the machine (e.g. 18 - 36 steps on a 300A machine). On technically sophisticated power sources (such as **inverter power sources**), the power can be **continuously** (i.e. steplessly) adjusted with a potentiometer.

When choosing a gas-shielded welding machine, it is important to ensure that the power source has a sufficient powerful output. The power data of a machine will be found on its rating plate.

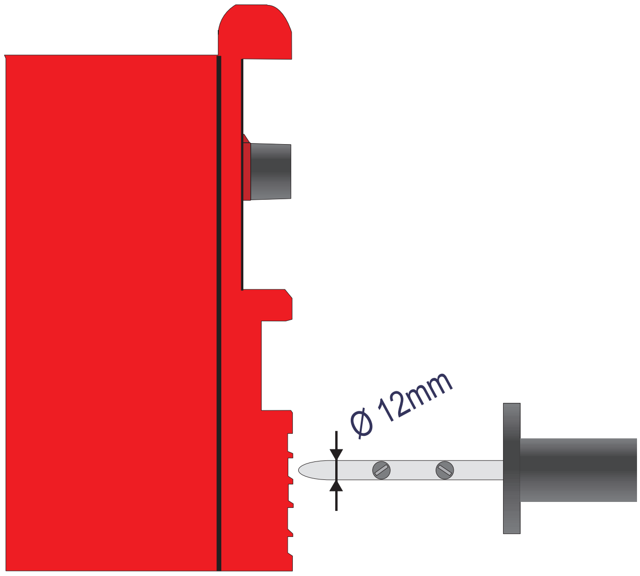
A power source's **duty cycle** is given in percent. The rating plate normally gives the permitted amperage and corresponding voltage for duty cycles of 100% and 60%. The information given is for a cycle time of 10 min at an ambient temperature of 40°.
The 450A power source whose rating plate is shown below can be 100% utilised at 360A.



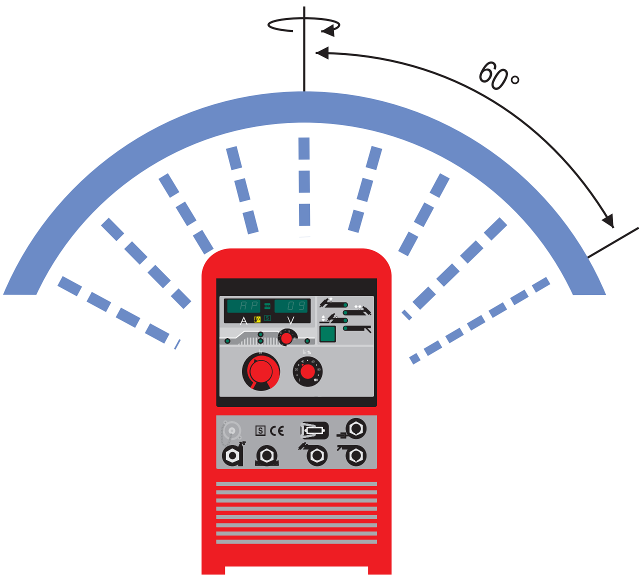


The degree of **protection** of the machine enclosure is given by a combination of letters and figures. e.g. **IP 23**.

The letters IP stand for „**I**nternational **P**rotection“ and indicate the degree of protection. The first figure is for protection against accidental contact and penetration by solid foreign bodies; the second figure is for protection against penetration by water.



Shock-hazard protection IP 2x'

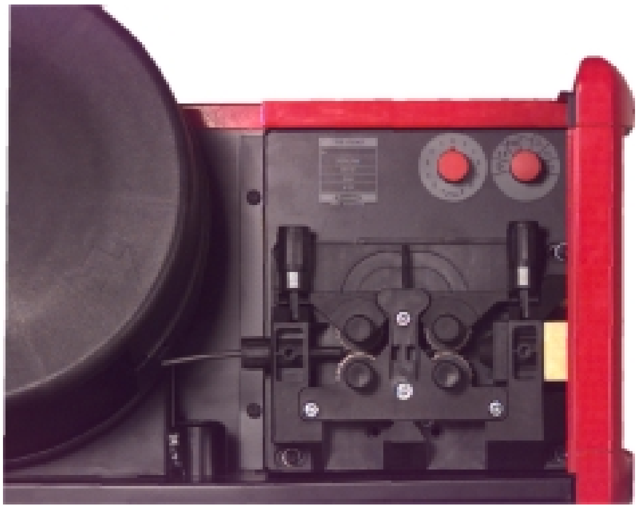


Splash-water test IP x3

WIREFEED

One of the main factors contributing to smooth, troublefree welding is constant, steady feed of the welding wire.
The wirefeed motors used are DC shunt-wound, permanent-magnet or high-class disc-rotor motors. These motors stand out for their high durability.

In practise, 2 and 4-roller drive systems are used. The advantage of the 4-roller systems is that they even ensure troublefree feeding of difficult-to-feed wires.
The wirefeed speed should be adjustable between 1 and approx. 22m/min. (On machines for high-performance **MAG welding,** feed speeds of up to **30 m/min** should be possible).

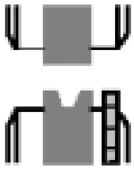


Smooth, uniform wirefeed depends on a number of different aspects of the welding machine:

- The **contact pressure** of the wirefeed rollers should be such that it does not deform the wire electrode, yet still ensures smooth wirefeed.
- Use feed rollers that are suitable for the diameter of wire.

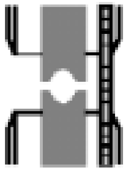
- Different **filler wires** require drive rollers with suitably shaped **grooves:**

Trapezoidal groove, smooth:



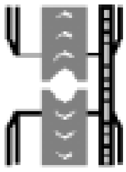
- Fe
- CrNi
- Unalloyed, low-alloy or high-alloy solid wires

Semi-circular groove, smooth:



- Aluminium
- CuSi 3
- Bronze wires

Semi-circular groove, ribbed



- Solid and flux-cored wires of various alloys

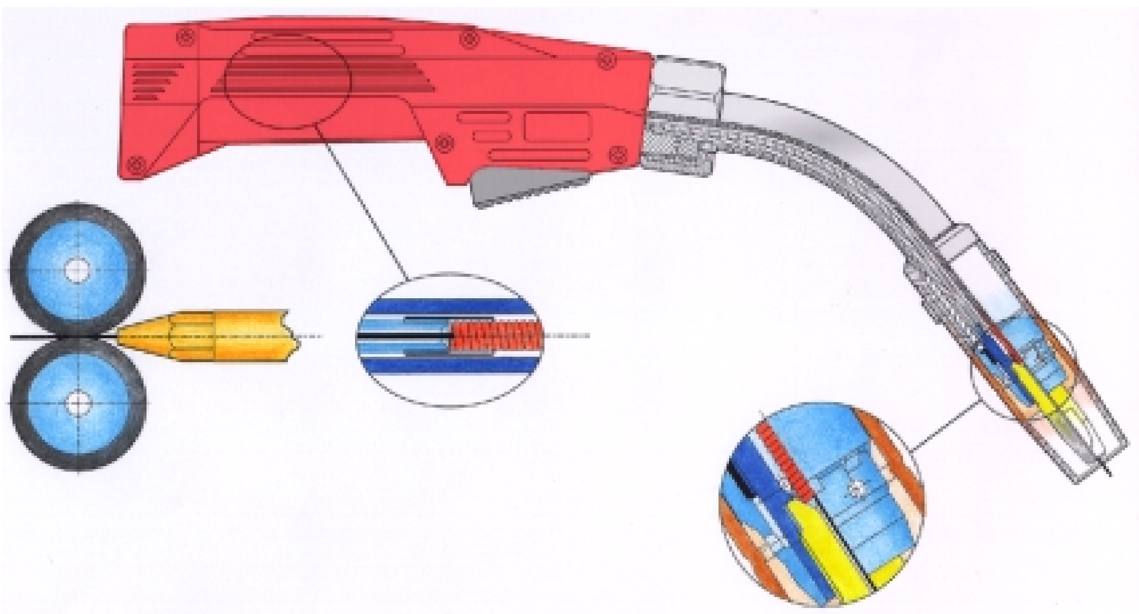
THE WELDING TORCH

As the welder's main implement, the welding torch is the „interface" to the welding machine. Many defects and malfunctions that occur during welding originate in the torch. Careful handling of the welding torch helps to ensure that the machine functions safely and dependably, as well as cutting costs.

A fundamental distinction is made between hand-held and machine-type welding torches. Up to torch lengths of approx. 4,5m, the wires are pushed, while for greater lengths than this, **push-pull** torches are used.

With the hand-held torches, a further distinction is made between gas-cooled and water-cooled designs of torch. The decision as to which type of cooling is needed - gas or water - will be taken mainly with reference to the power range in which welding is to take place, and to the **duty cycle**. Where amperages of over **300A** are encountered, it is advisable to use **water-cooled** welding torches (much longer torch life).

For **pulsed-arc welding**, only **water-cooled** torches may be used.

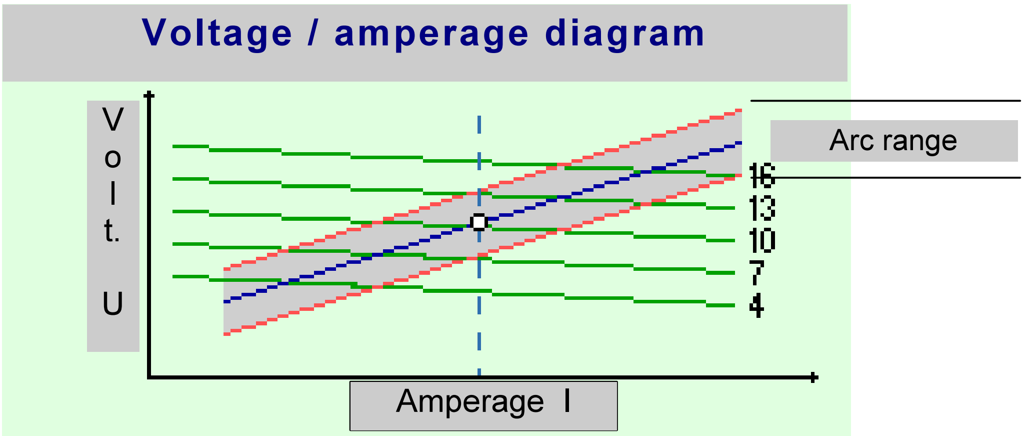


STATIC CHARACTERISTIC OF THE MIG/MAG POWER SOURCE

For MIG/MAG welding, power sources with **constant-voltage characteristics** (slightly drooping) are used.
On **step-switched** machines**,** the welding power-source **characteristic** is generally selected via **coarse and fine step switches**. On **steplessly** adjustable power sources, a **potentiometer** for the welding power also **automatically sets the characteristic**.

The static characteristic is the load characteristic of a welding machine (recorded point-by-point in the current-voltage diagram, in each case in the steady-state condition) which results when the machine settings are left unchanged, but the ohmic resistive load is changed.

The static characteristic is enclosed between the static minimum characteristic (lowest switching step) and maximum characteristic (highest switching step).



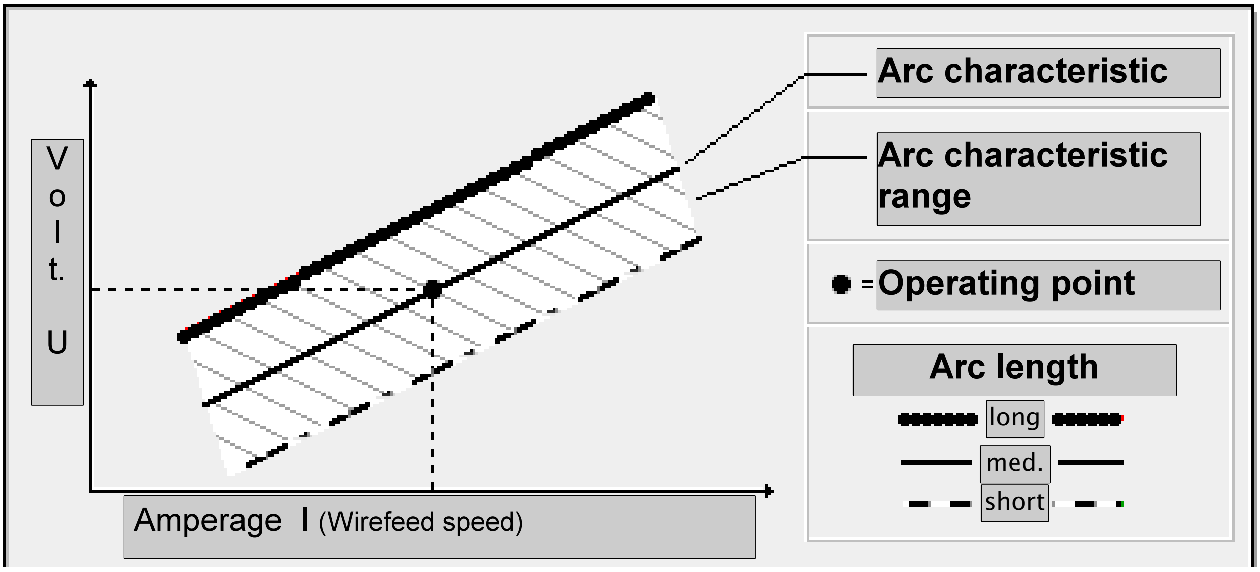
ARC CHARACTERISTIC

The term „arc characteristic“ refers to a polyline in the **voltage-current (U-I) diagram** that is made by joining together a large number of defined current values and their respective voltage values. Every single point in an arc characteristic is recorded at the same arc length, despite the different power levels obtaining. This means that an arc characteristic is determined experimentally.

Arc characteristic range

Arc characteristics obtained at different arc lengths will always lie within an arc characteristic range that is delineated by the shortest and by the longest arc characteristic.

The hatched range is also only valid for one filler metal, one wire diameter and one type of shielding gas.

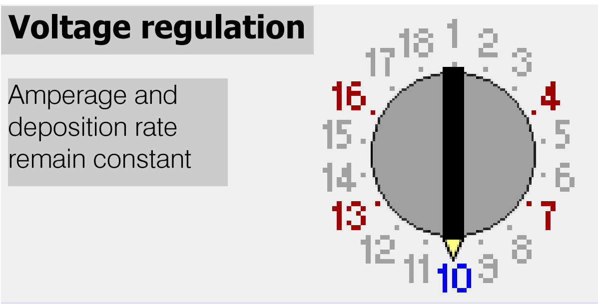


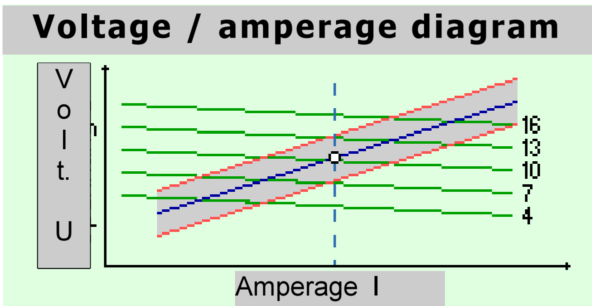
THE OPERATING POINT

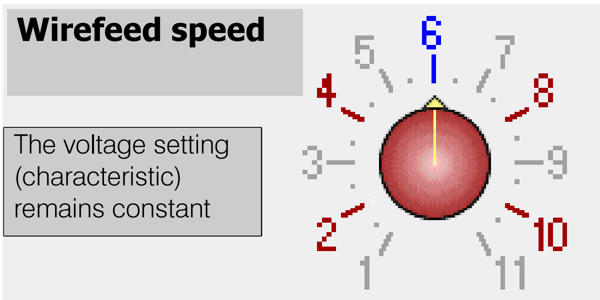
The operating point is the point at which the pre-set static characteristic (machine settings) intersects with the characteristic of the respective arc-characteristic range.
The question of which arc characteristic the pre-set static characteristic intersects with is decided by the wirefeed speed.

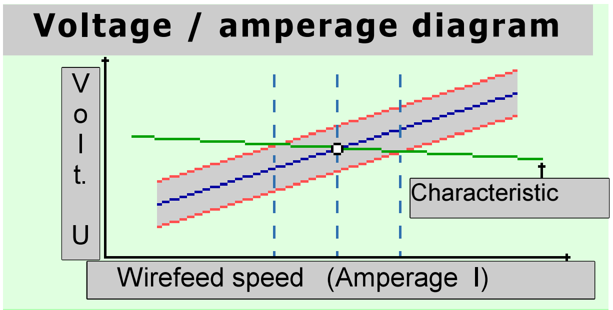
The operating point defines the arc length, the wirefeed speed, the deposition rate (in kg/h) and - to a large extent - even the penetration depth and the size of the weld pool.

The diagram shows how the operating point changes within the arc range when the voltage is changed (step switch on the machine) or when the wirefeed speed is changed.



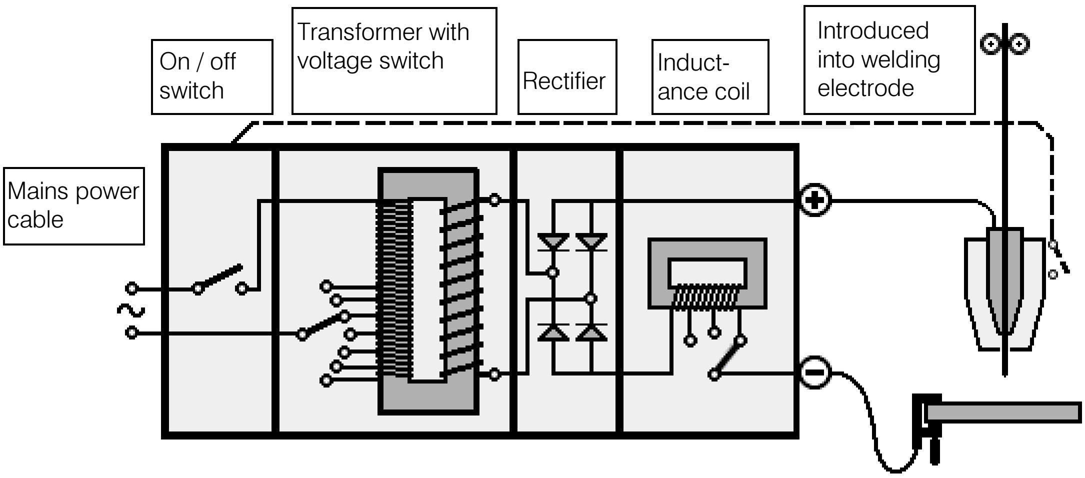






STEP-SWITCHED MIG/MAG MACHINES

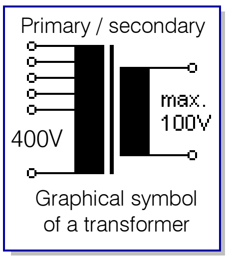
Basic principle of a step-switched GMA power source



Transformer with voltage switch

The transformer converts the high mains voltage in welding machines (400V) to a lower voltage (max. 100V). At the same time, the low mains amperage is transformed to a high welding amperage.

The **transformer** consists of an **iron core** and two coils **(primary and secondary coils).** The ratio of input voltage to output voltage is determined by the difference in the number of turns. With the voltage switch, the size of the output voltage can be regulated by means of different **tappings** on the primary coil.



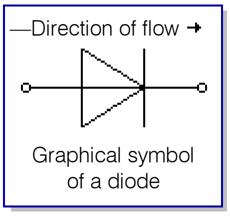
Graphical symbol of a transformer

Rectifier

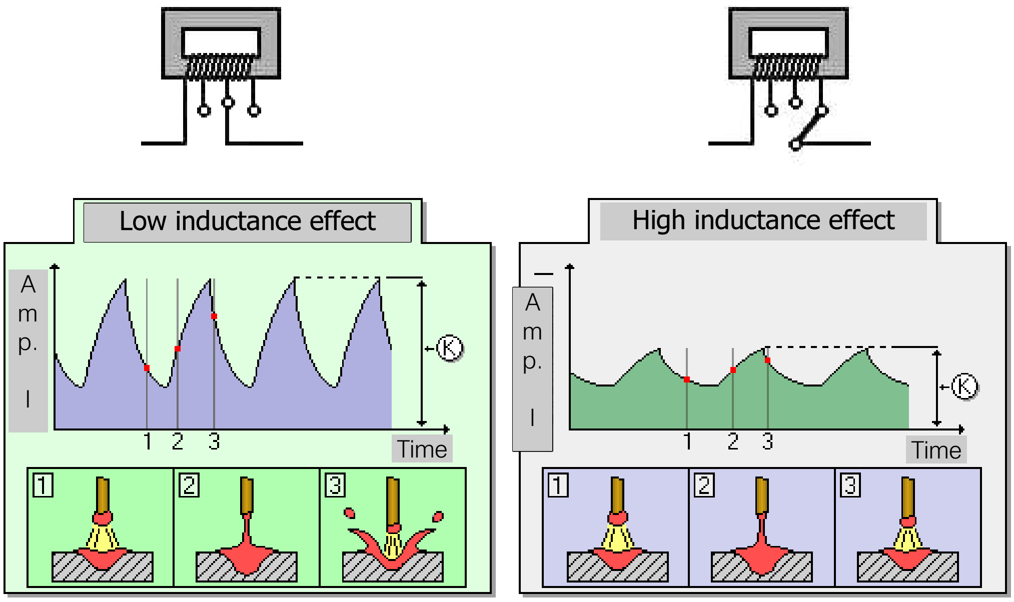
The rectifier has the job of converting **alternating or three-phase currents into the rectified direct current** that is needed for GMA welding.

The current is converted by means of a suitable array of **diodes**.

Diodes are semiconductor devices whose electrical resistance depends on the direction of the current. In the direction of flow, the electric current is allowed through - whereas in the opposite (i.e. reverse) direction, it is blocked.



Inductor



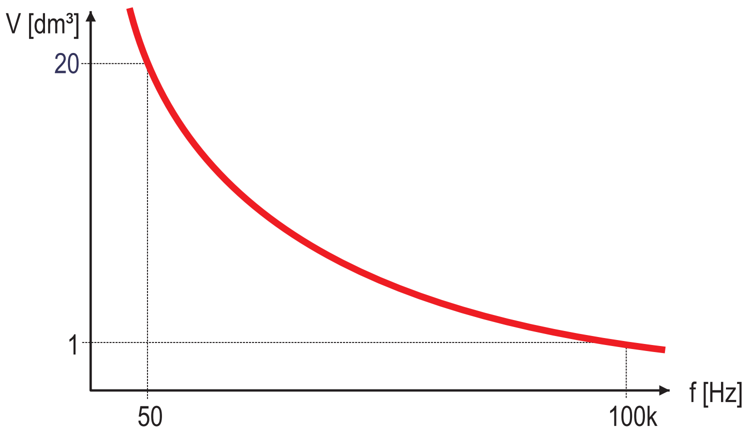
The inductor has the job of attenuating transient **amperage peaks**. This reduces spattering and improves the stability of the arc.

The inductance coil consists of insulated turns of wire placed around an iron core. The magnet field generated here is a counteracting force against strong fluctuations, and has an attenuating effect.

BASIC PRINCIPLE OF PULSED-ARC WELDING

Primary transistor-switched power source (inverter)

The characteristic feature of inverter power sources is that the welding transformer's location in the energy path is not until after the switching transistor. The reason for this is that the weight and volume of a transformer - as dictated by an electrotechnical law - depend upon the frequency at which this transformer is operated. The higher the frequency, the smaller the volume.



Relationship between the volume and frequency of a transformer at a given output power.

It is this relationship between volume and frequency that is exploited by inverter power sources. This is why inverter power sources have low weight and compact dimensions, yet with no loss in power. This makes them easier to carry and transport - a particularly valuable feature for use out in the field. Also, the low volume of inverter power sources means that they take up less space in the often very cramped conditions found in workshops.

Another advantage is their high electrical efficiency (up to 90%).

To make it possible to exploit the high switching frequency, it is necessary to rectify the mains AC voltage first. This is the reason for the term „inverter power source“ (to invert = to convert). The DC voltage found after the primary rectifier is converted to a high frequency with the aid of a transistor switch. The output voltage of the transformer is then rectified once again.

Pulsed-arc welding has an increasingly wide spectrum of use for a large number of other materials (unalloyed and low-alloy materials, high-alloy steels and nickel-based alloys).

Advantages:

- Spatter-free or low-spatter welding over the entire power range
- No intermediate arc range
- Extension of the working range (materials up to 0,8mm can be welded)
- Control of penetration in overlay welding
- Thicker wire electrode diameters can be used in light-gauge sheet welding

Disadvantages:

- Higher purchase costs than step-switched machines
- Lower welding speeds than in standard welding

Pulsed-arc welding is characterised by a stable, low-spatter, controlled metal transfer. The current curve in pulsed-arc welding is marked by two characteristic phases:

- **Background-current phase** with a background current I_G. In this phase, the welding process only receives just enough energy to keep the arc burning stably and to pre-heat both the end of the electrode and the surface of the material.

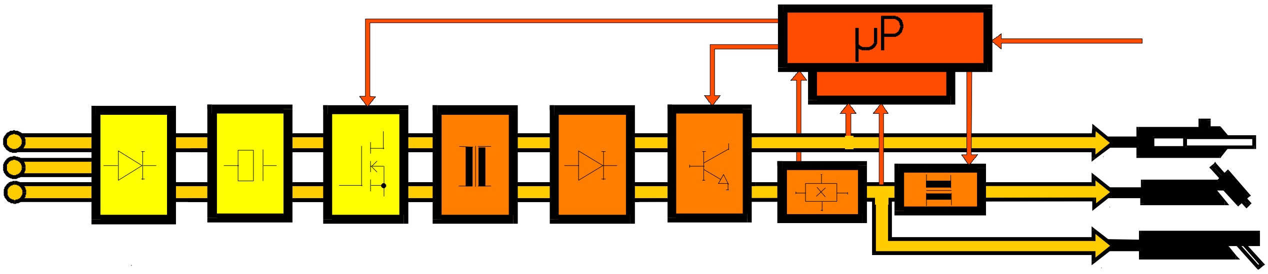
- **Pulse phase of le**ngth t_P with a **pulsed current** I_P. With I_P the critical boundary of the spray arc must be exceeded in order for the molten filler metal to be shed from the wire electrode and transferred - without short-circuiting - to the workpiece. This behaviour is only possible if the shielding gas being used is one with an inert-gas component of approx. 80% (e.g. 82/18 Argon/CO_2).

POWER SOURCES FOR PULSED-ARC WELDING

Systems with closed-loop control

The increasing use being made of electronics in power source technology has led to the development of „closed-loop-controlled“ systems that keep the welding current or welding voltage constant, regardless of the length of the mains cable and/or of any fluctuations in the mains voltage.

The central element in this system is the closed-loop control with sensors for the welding current and welding voltage.



Block diagram of an inverter power source

The actual values from the welding process are constantly compared with the pre-selected command values (welding parameters) by the microprocessor, and any deviations are immediately corrected via the actuator. This ensures the basic precondition for reproducibility of the welding results.

Another advantage is that on transistor power sources, the welding properties are not dependent upon the design of the transformer or the output inductance.

This opens up hitherto unheard-of possibilities for influencing the quality of the weld and of the welding process, with the aid of electronics.

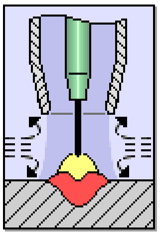
Functional principle of an inverter power source

The voltage of the 400V three-phase mains is first **rectified**.

A high-speed **transistor switch „chops“** (i.e. switches on and off) this direct voltage at a frequency of e.g. 60kHz (60,000 times per seconds). The transformer then delivers the required working voltage, which is rectified and supplied to the output sockets. An **electronic controller** adapts the **characteristic** of the power source to the weld-process that has been selected.

SHIELDING GASES

The shielding gas must be selected to suit the material and the welding task. The shielding gas has an influence upon the arc behaviour, weld-metal transfer, deposition rate, bead-profile, penetration depth and the mechanical properties, as well as on the chemical composition of the weld pool.



The shielding gas protects the weld pool from air. It influences the processes taking place in the arc, the droplet detachment and the weld shape.

Shielding gases are odourless, colourless and tasteless. Although not in themselves toxic, they can displace breathing-air.

The following different kinds of shielding gases are found:

	Inert shielding gases (noble gases)	**Active shielding gases**
Shielding gases	Argon (Ar)	Carbon dioxide (CO_2)
Gas mixtures	Argon + helium (He)	Argon + carbon dioxide Argon + oxygen (O_2) Argon + carbon dioxide + oxygen
Materials	Welding of non-ferrous metals	Welding of steels
GMA processes	MIG (metal inert gas) welding	MAG (metal active gas) welding

Process DIN 1910 Part 4	Chem. behaviour	Classification fig. DIN EN 439	Materials
MIG (131)	Inert	I 1 I 2 I 3	All metals apart from steels Aluminium, copper Aluminium, copper
MAGM (135)	Less strongly oxidising	M 11 M 12 M 13	Stainless and high-alloy steels Stainless and high-alloy steels Low-alloy steels
		M 21 M 22 M 23	Unalloyed and low-alloy steels, flux-core wires Unalloyed and low-alloy steels Unalloyed, low-alloy and stainless steels
	More strongly oxidising	M 31 M 32 M33	Unalloyed and low-alloy steels Unalloyed and low-alloy steels Unalloyed steels
MAGC (135)		C	Unalloyed steels, low-alloy steels (with limitations), flux-core wires

Classification of shielding gases to EN 439

Designation		Components in vol.-%						Process	Remarks
Gr'p	Classif. fig.	Oxidising		Inert		Reducing	In-active		
		CO_2	O_2	Ar	He	H_2	N_2		
R	1			Rest[1)2)]		1 to 15		TIG Tungsten plasma arc (TPA) Root-shield. Plasma-cut.	Reduced
	2					15 to 35			
I	1			100				MIG, TIG	Inert
	2			Rest[1)2)]	100			TPA	
	3			Rest[1)2)]	20 to 80			Root-shielding	
M1	1	>0 to 5		Rest[1)2)]		>0 to 5		MAG	Slightly oxidising
	2	>0 to 5		Rest[1)2)]					
	3		>0 to 3	Rest[1)2)]					
	4	>0 to 5	>0 to 3	Rest[1)2)]					
M2	1	>5 to 25		Rest[1)2)]					
	2		>3 to 10	Rest[1)2)]					
	3	>5 to 25	>0 to 8	Rest[1)2)]					
M3	1	>25 to 50		Rest[1)2)]					
	2		>10 to 15	Rest[1)2)]					
	3	>5 to 50	>8 to 15	Rest[1)2)]					
C	1	100							Strongly oxidising
	2	Rest	>0 to 30						
F	1					1 to 30	Rest	Root-shielding	Reduced

1) Only applies to mixed gases with equal or higher helium contents.
2) Argon may be up to 95% replaced by helium.

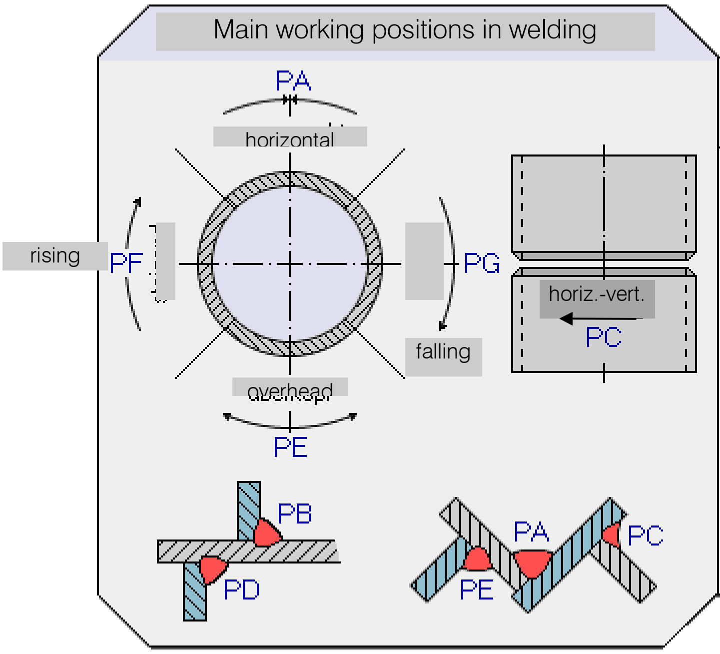
Setting the shielding gas flow rate

The gas is withdrawn from the cylinder via a pressure-reduction valve and a gas flow-meter with a fine-regulation valve. From here, the gas flows through an interconnecting hose to the solenoid valve in the wirefeeder, and from there through the hosepack to the torch.

The required gas flow-rate can be adjusted on the fine-regulation valve and read off from the flow-meter. As a rule-of-thumb, the flow of shielding gas (in l/min) should be between **10 and 12 times** the **diameter of the wire**

e.g. 1,2mm wire = flow-rate of approx. 12 - 14 l/min.

WELDING POSITIONS

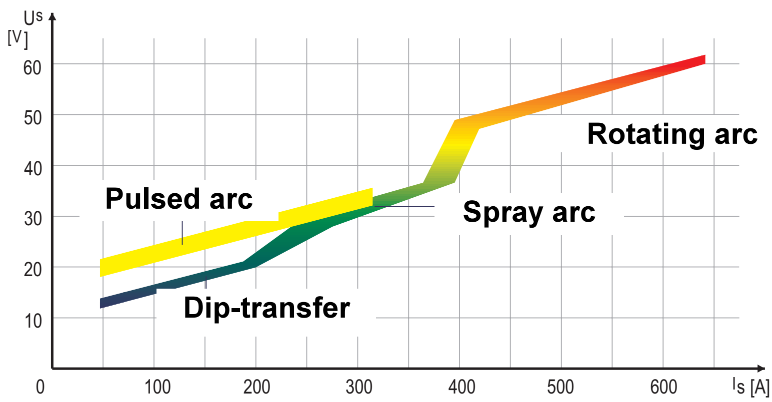


Position	neu DIN EN 287	alt DIN 1912
Gravity position	PA	w
Horizontal position	PB	h
Horiz.-vert. Position	PC	q
Horiz.-overhead pos.	PD	hü
Overhead position	PE	ü
Rising position	PF	s
Falling position	PG	f

TYPES OF ARC

Metal transfer

Depending on the current density, the arc power and the shielding gases being used, very different types of metal transfer may take place, each of which is characterised by a particular type of arc.



Arc ranges in GMA welding

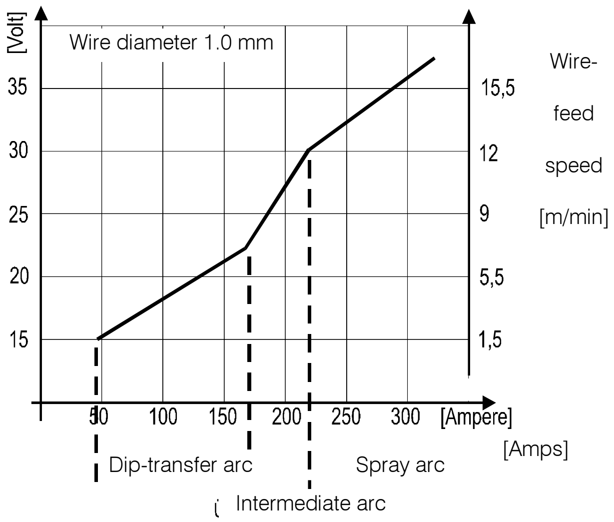
Types of arc	DIN symbol	Droplet size	Metal transfer
Dip-transfer arc	k	Fine	Only in short circuit, regular
Intermediate arc	ü	Fine to coarse	Partly in short circuit, partly short-circuit-free, irregular
Spray arc	s	Fine to super-fine	Short-circuit-free, regular
Globular-transfer arc	l	Coarse	Irregular in short circuit, partly short-circuit-free
Pulsed arc	P	Adjustable	Short-circuit-free, regular

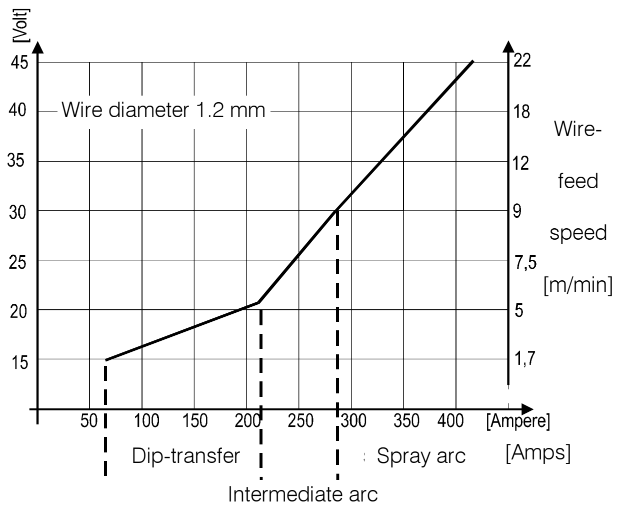
(Classification to DIN 1910, Part 4)

The choice of which of these types of arc to use will depend on the thickness of the sheet, and the type of welding task to be accomplished.

Transistor power sources permit a very considerable improvement in the metal transfer, especially when working with dip-transfer and pulsed arcs.

The reason for this may be found in the high response speeds of the inverter power source, and in the very great scope for influencing the metal transfer that results from this fast responsiveness.



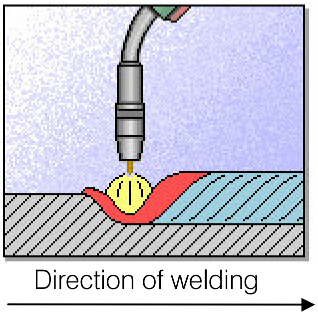


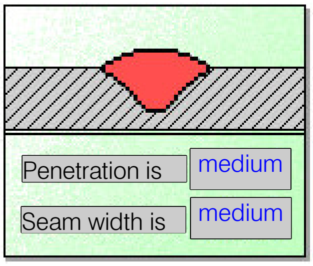
The data given here is for a gas mixture of 82% argon and 18% CO_2.

TORCH MANIPULATION

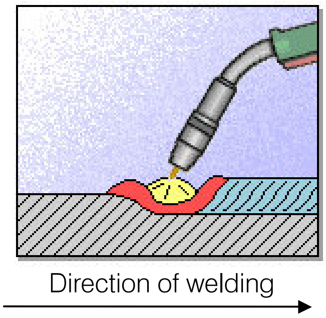
Even where no changes are made to the machine settings (voltage and wirefeed speed), the welding process and weld profile are still influenced by the way in which the torch is manipulated. Three different torch-tilts are differentiated here:

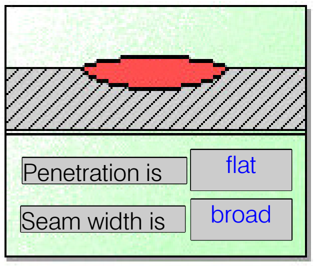
- Vertical — Torch is held upright



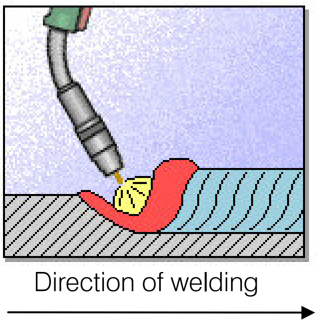


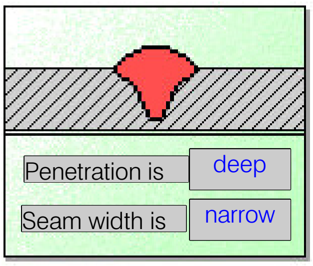
- Leading — Torch is pushed





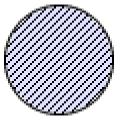
- Trailing — Torch is pulled



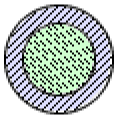


WIRE ELECTRODES

There are two main types of electrode:



Solid-wire electrodes:



Flux-cored wire electrodes:

Wire-electrode diameter:

Rated diameter in mm	0,8	0,9	1,0	1,2	1,4	1,6	2,0	2,4
Solid-wire electrode	X	X	X	X		X	X	X
Flux-cored wire electrode			X	X	X	X	X	X

A suitable diameter of wire-electrode must be selected for the welding job in question. Example:

Thickness of workpiece	0,8	0,9	1,0	1,2	1,4	1,6	2,0	2,4
1mm	X	X	X	X				
7 mm			X	X				
15 mm				X	X	X		

The customary term „SG 2“ has been **changed** in **Euronorm Standard EN 440**, and is now referred to as **G3 Si 1.**

Flux-cored wire electrodes

To a certain (limited) extent, the filling of a flux-cored electrode has the same functions as the coating on a rod electrode:

- forming a slag
- introducing alloying elements into the weld-pool
- decreasing the harmful influence of the ambient air

Field of use:

- for high-alloy steels
- outdoor (field) use
- for position weldability

DEPOSITION RATE

The smaller the wire diameter, the higher the deposition rate (at constant amperage), owing to the lower resistance.

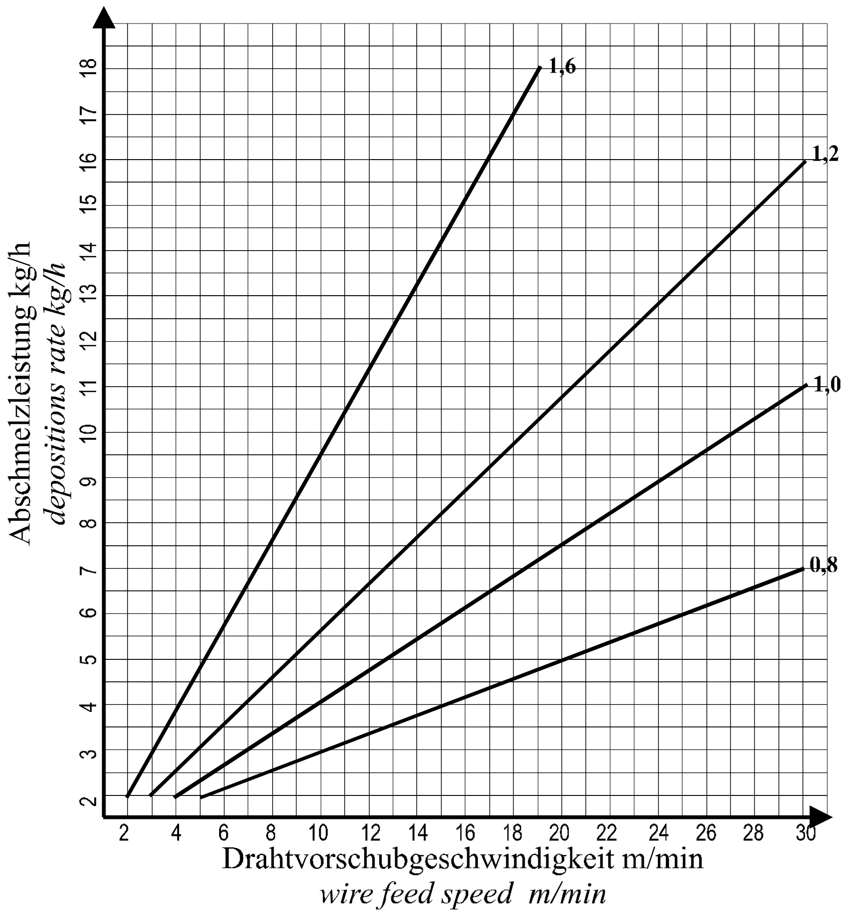
The crucial factor for the **deposition rate** is the **wirefeed speed.** The deposition rate is quoted in **kg/h** or g/min.

Formula:

$$\frac{\text{Wirefeed speed m/min} \times \text{Wire weight g/m} \times 60}{1000} = \text{kg/h}$$

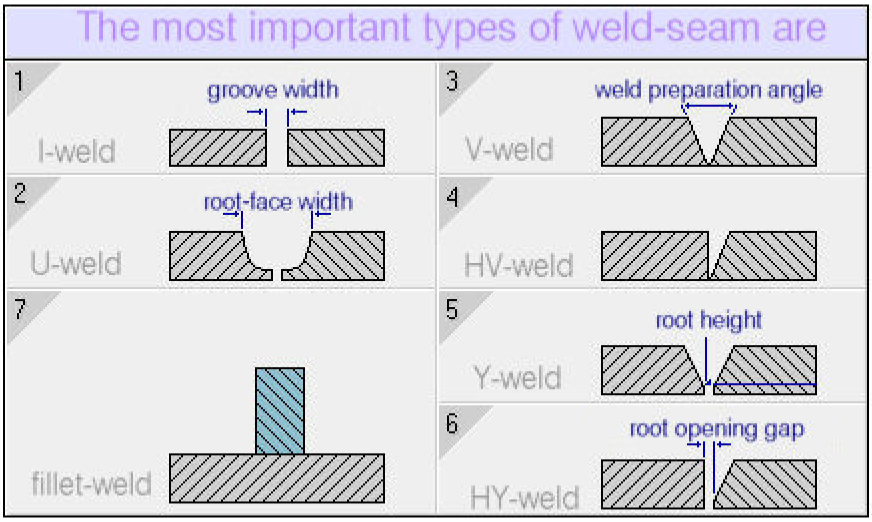
e.g.:

$$\frac{12\text{m/min} \times 8{,}9\text{g/ m (1,2mm diam.)} \times 60}{1000} = 6{,}4\text{kg/h}$$



TYPES OF WELD-SEAM

When choosing what type of arc to weld with, you should consider which types of weld-seam the welding task will involve. The joint type (i.e. the relative positions of the weldments) and the shape of the groove between them determine the type of weld-seam.



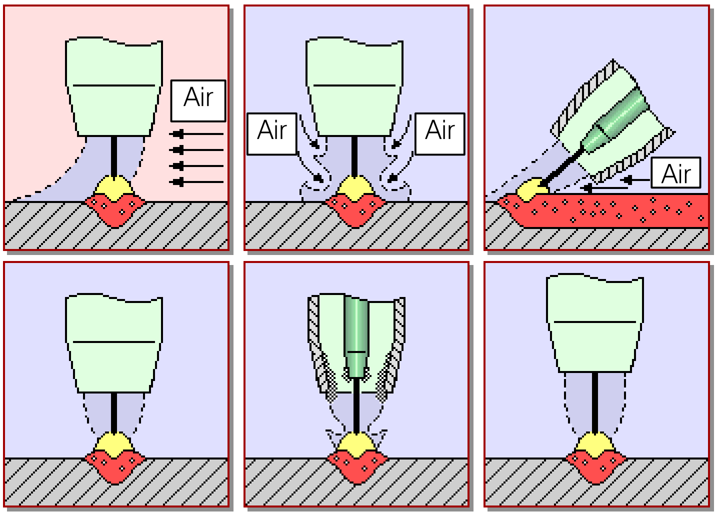
Fillet welds (7) are welded joints in which the weldments are perpendicular to one another in two planes.

„Butt weld“ (1 - 6) is the name given to welded joints where the parts to be joined are in the same plane.

WELD DEFECTS

Consequences of inadequate gas shielding

Insufficient gas shielding of the weld pool leads to reactions between the air and the weld pool, and to porous welds with inadequate stability.



Fault:

Draughts (e.g. out on construction sites) interfere with

the shielding gas coverage

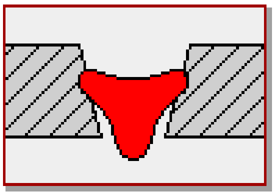
Consequence:

Insufficient gas shielding, pore-formation in the weld-seam

Fusion defects:

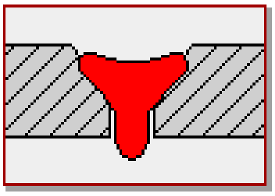
Only the arc (not the weld-pool) has sufficient energy to fuse the groove face and create a stable join. If fusion defects are to be prevented, then, the seam to be welded must be expertly prepared and worked.

<u>The following mistakes are sometimes made here:</u>



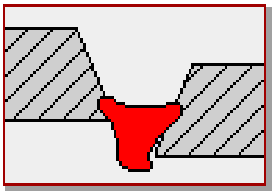
Weld preparation angle is too small

Correct: 40° to 60°

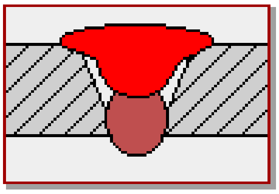


Root height is too great

Root opening gap is too large

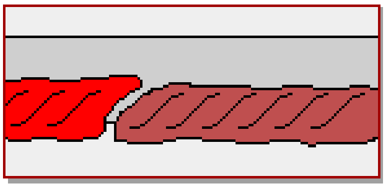


Edge misalignment is too great



Overwelding of strongly reinforced beads

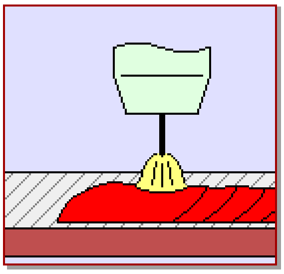
Correct: Before overwelding, weld the bottom bead so that this is trough-shaped



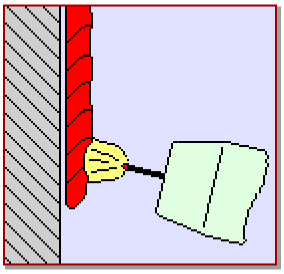
Attachment fusion defect when welding at low low arc power; attachment point not ground; not welded with sufficient overlap.

Correct: Grind end of seam, ignite before the end of the seam and continue welding.

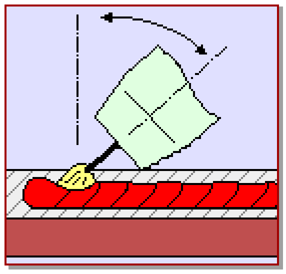
Fusion defects may occur when the arc is prevented from reaching the weld edges or the already-welded pass, because of the weld pool running ahead.



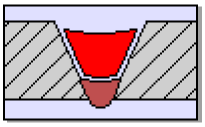
Welding speed is too low or deposition rate is too high. Do not weld excessively thick beads!

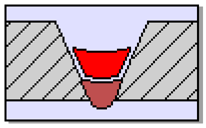


Welding in the PG position (vertical-down). The deposition rate must be limited. Do not weld too slowly!

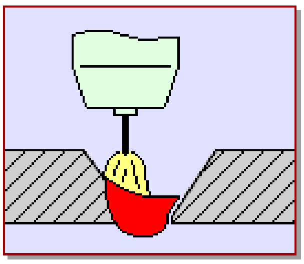


Excessively „pushing“ torch angle.

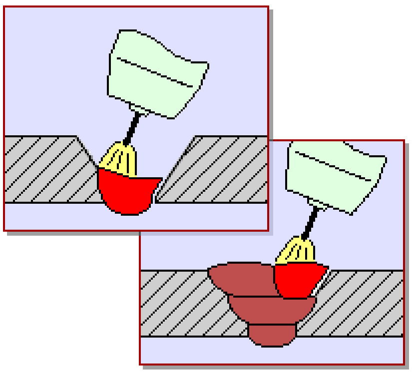




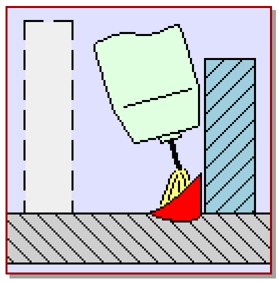
If the torch position is incorrect, the arc fuses the weld-edges on one side only. This results in fusion defects and thus unstable joins.



The torch is not being held over the middle.



The torch is being inclined too much towards one weld edge.



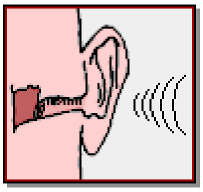
Faulty torch position caused by restricted accessibility

WORKPLACE SAFETY

In welding engineering, the following are major hazards:

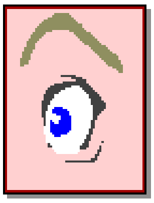
- Fires started by flying sparks
- Pollutants
- Noise
- Optical radiation
- Electrical hazard
- Handling faults

Danger from noise and optical radiation



Certain welding processes and machines cause high levels of noise.

Acoustic pressure over 85dB(A) can lead to hearing damage. Noise also damages the human nervous system.



Optical radiatin hazards emanate from the arc and the weld pool.

	Heat	Light	UV rays
Eyes:	Opacity	Dazzling	Flash-burning
Skin:	**Burns**		Burns

Precautions

- Wherever possible, choose low-noise processes
- Acoustic insulation of the source of the noise
- Above 85dB(A), wear hearing-protectors

Precautions

- Standard safety glass (to DIN EN 169)
- Safety shield
- Protective screen / helmet

Example of shade numbers (DIN EN 169)

	Assistants			Gas				E		TIG/MAG						
Light	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Dark

Cause and effects of optical radiation - ultraviolet rays

Both the arc and the weld-pool emit visible and invisible radiation. The intensity of this radiation will depend upon:

- the energy input
- the size of the arc
- the arc temperature
- the temperature distribution

Effects:

Ultra-violet rays are the most dangerous of all for the eyes.

Welder’s „flash-burning" causes eye pain, lacrimation (weeping), heliophobia (painful aversion to light) and swollen eyelids. Damage is done to the conjunctiva, and in serious cases to the cornea as well.

The skin can be burned by ultraviolet rays (sunburn-like effect).

Hazards from electrical circuits

1. Defective mains connection (e.g. loose / pulled-out sockets)
2. Defective welding power source (switches or covers missing)
3. Defective welding-current leads / hosepacks
4. Wire electrode
5. Faulty workpiece clamps
6. Defective welding-current return leads

All maintenance work must be carried out with the power source switched off and in an electrically „dead“ state, by skilled personnel!

Precautions:

- Repairs on defective mains connections or defective welding power sources may only be carried out by trained, skilled electricians!
- Maintenance work and simple repairs may only be carried out by a suitably trained welder.

Protective equipment and first-aid:

For all welding work, clothing must be worn that covers the body properly and that is not contaminated with flammable or easily combustible substances.

N.B.: No clothing made of easily melting synthetic fibres such as nylon or perlon!

Even when you follow the accident-prevention rules very carefully, minor accidents can never be ruled out entirely. For this reason, everybody should be informed on the immediate action that has to be taken to give first-aid at the site of an accident!

Bibliography:

DVS (German Welding Society) course on gas-metal arc welding