



EN

welding torch

PHB 50 20 A

PHB 50 50 A

099-002025-EW501

Observe additional system documents!

29.11.2017

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General instructions

WARNING



Read the operating instructions!

The operating instructions provide an introduction to the safe use of the products.

- Read and observe the operating instructions for all system components, especially the safety instructions and warning notices!
- Observe the accident prevention regulations and any regional regulations!
- The operating instructions must be kept at the location where the machine is operated.
- Safety and warning labels on the machine indicate any possible risks. Keep these labels clean and legible at all times.
- The machine has been constructed to state-of-the-art standards in line with any applicable regulations and industrial standards. Only trained personnel may operate, service and repair the machine.
- Technical changes due to further development in machine technology may lead to a differing welding behaviour.



In the event of queries on installation, commissioning, operation or special conditions at the installation site, or on usage, please contact your sales partner or our customer service department on +49 2680 181-0.

A list of authorised sales partners can be found at www.ewm-group.com.

Liability relating to the operation of this equipment is restricted solely to the function of the equipment. No other form of liability, regardless of type, shall be accepted. This exclusion of liability shall be deemed accepted by the user on commissioning the equipment.

The manufacturer is unable to monitor whether or not these instructions or the conditions and methods are observed during installation, operation, usage and maintenance of the equipment.

An incorrectly performed installation can result in material damage and injure persons as a result. For this reason, we do not accept any responsibility or liability for losses, damages or costs arising from incorrect installation, improper operation or incorrect usage and maintenance or any actions connected to this in any way.

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The content of this document has been prepared and reviewed with all reasonable care. The information provided is subject to change; errors excepted.

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2 For your safety

2.1 Notes on the use of these operating instructions

DANGER

Working or operating procedures which must be closely observed to prevent imminent serious and even fatal injuries.

- Safety notes include the "DANGER" keyword in the heading with a general warning symbol.
- The hazard is also highlighted using a symbol on the edge of the page.

WARNING

Working or operating procedures which must be closely observed to prevent serious and even fatal injuries.

- Safety notes include the "WARNING" keyword in the heading with a general warning symbol.
- The hazard is also highlighted using a symbol in the page margin.

CAUTION

Working or operating procedures which must be closely observed to prevent possible minor personal injury.

- The safety information includes the "CAUTION" keyword in its heading with a general warning symbol.
- The risk is explained using a symbol on the edge of the page.



Special technical points which users must observe.


Instructions and lists detailing step-by-step actions for given situations can be recognised via bullet points, e.g.:

- Insert the welding current lead socket into the relevant socket and lock.

2.2 Explanation of icons

| Symbol | Description | Symbol | Description |
|--------|---|--------|---------------------------------|
| | Indicates technical aspects which the user must observe. | | Activate and release/tap/tip |
| | Switch off machine | | Release |
| | Switch on machine | | Press and keep pressed |
| | | | Switch |
| | Wrong | | Turn |
| | Correct | | Numerical value – adjustable |
| | Menu entry | | Signal light lights up in green |
| | Navigating the menu | | Signal light flashes green |
| | Exit menu | | Signal light lights up in red |
| | Time representation (e.g.: wait 4 s/activate) | | Signal light flashes red |
| | Interruption in the menu display (other setting options possible) | | |
| | Tool not required/do not use | | |
| | Tool required/use | | |

2.3 Part of the complete documentation

 **These operating instructions are part of the complete documentation and valid only in combination with all other parts of these instructions! Read and observe the operating instructions for all system components, especially the safety instructions!**

The illustration shows a general example of a welding system.

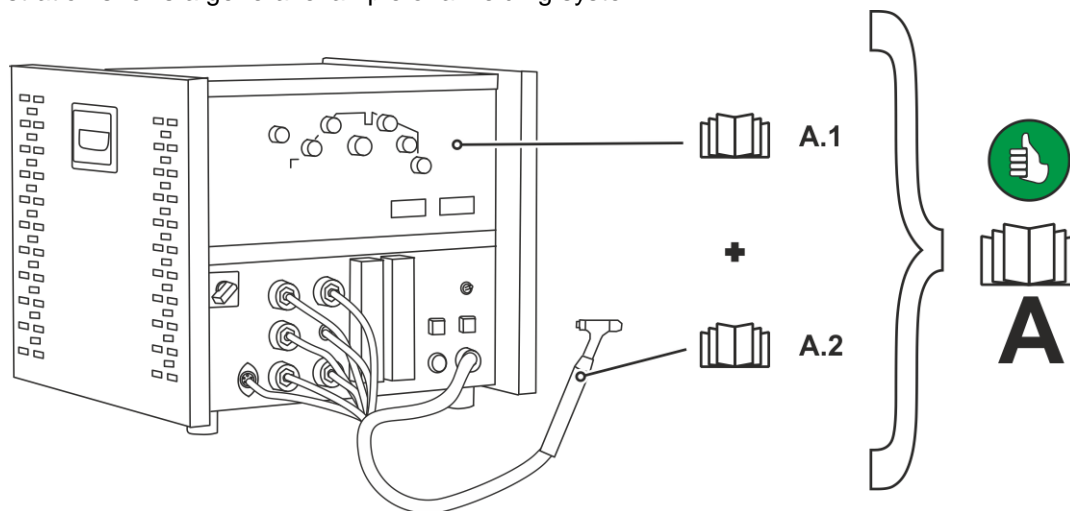


Figure 2-1

| Item | Documentation |
|------|------------------------|
| A.1 | Power source |
| A.2 | Welding torch |
| A | Complete documentation |

3 Intended use

WARNING



Hazards due to improper usage!

The machine has been constructed to the state of the art and any regulations and standards applicable for use in industry and trade. It may only be used for the welding procedures indicated at the rating plate. Hazards may arise for persons, animals and material objects if the equipment is not used correctly. No liability is accepted for any damages arising from improper usage!

- The equipment must only be used in line with its designated purpose and by trained or expert personnel!
- Do not improperly modify or convert the equipment!

3.1 Applications

Welding torches for arc welding systems for plasma welding.

3.2 Documents which also apply

3.2.1 Warranty



For more information refer to the "Warranty registration" brochure supplied and our information regarding warranty, maintenance and testing at www.ewm-group.com!

3.2.2 Declaration of Conformity



The labelled machine complies with the following EC directives in terms of its design and construction:

- Low Voltage Directive (LVD)
- Electromagnetic Compatibility Directive (EMC)
- Restriction of Hazardous Substance (RoHS)

In case of unauthorised changes, improper repairs, non-compliance with specified deadlines for "Arc Welding Equipment – Inspection and Testing during Operation," and/or prohibited modifications which have not been explicitly authorised by the manufacturer, this declaration shall be voided. An original document of the specific declaration of conformity is included with every product.

3.2.3 Service documents (spare parts)

WARNING



Do not carry out any unauthorised repairs or modifications!

To avoid injury and equipment damage, the unit must only be repaired or modified by specialist, skilled persons!

The warranty becomes null and void in the event of unauthorised interference.

- Appoint only skilled persons for repair work (trained service personnel)!

Spare parts can be obtained from the relevant authorised dealer.

4 Machine description – quick overview

4.1 PHB 50

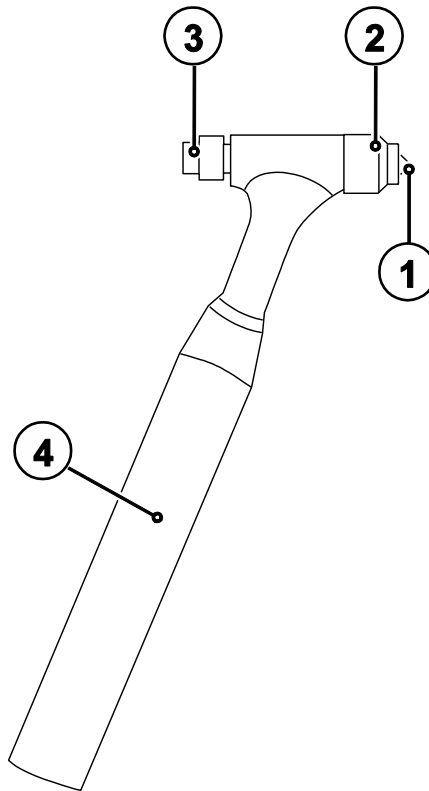


Figure 4-1

| Item | Symbol | Description |
|------|--------|--------------------|
| 1 | | Tungsten electrode |
| 2 | | Gas nozzle |
| 3 | | Back cap |
| 4 | | Grip plate |

4.2 Connection

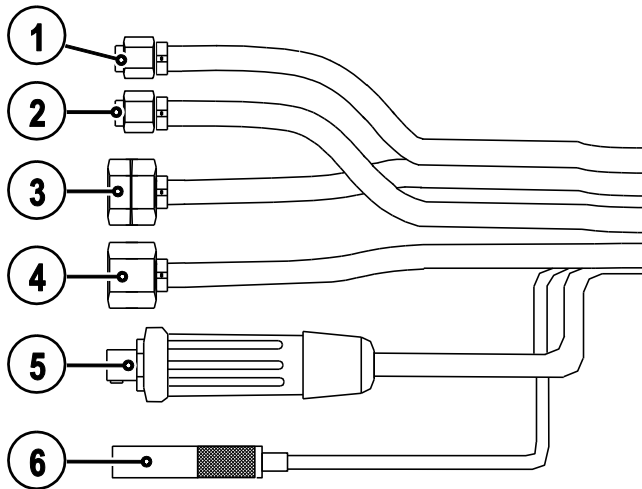


Figure 4-2

| Item | Symbol | Description |
|------|--------|--|
| 1 | | M12x1 coolant water nipple Water flow |
| 2 | | M12x1 coolant water nipple Water return |
| 3 | | G 1/4" connecting nipple Shielding gas |
| 4 | | G 1/4" connecting nipple Plasma gas |
| 5 | | Connector plug, welding current Welding current connection for torch |
| 6 | | Connector plug, pilot arc current Pilot arc power connection for torch |

5 Design and function

WARNING



Risk of injury from electrical voltage!

Contact with live parts, e.g. power connections, can be fatal!

- Observe the safety information on the first pages of the operating instructions!
- Commissioning must be carried out by persons who are specifically trained in handling power sources!
- Connect connection or power cables while the machine is switched off!

CAUTION



Risk from electrical current!

If welding is carried out alternately using different methods and if a welding torch and an electrode holder remain connected to the machine, the open-circuit/welding voltage is applied simultaneously on all cables.

- The torch and the electrode holder should therefore always be placed on an insulated surface before starting work and during breaks.



Read and observe the documentation to all system and accessory components!

5.1 Welding torch cooling system



**Use of unsuitable coolants results in damage to the welding torch!
Unsuitable coolants can cause damage to the welding torch!**

- Use only KF 23E coolants (observe temperature range of - 10 °C bis + 40°C).



Coolant mixtures!

Mixtures with other liquids or the use of unsuitable coolants result in material damage and renders the manufacturer's warranty void!

- Only use the coolant described in this manual (overview of coolants).
- Do not mix different coolants.
- When changing the coolant, the entire volume of liquid must be changed.



Dispose of the coolant in accordance with local regulations and the material safety data sheets (German waste code number: 70104).

May not be disposed of in household waste.

Prevent entry into sewers.

Absorb with liquid-binding material (sand, gravel, acid-binding agents, universal binding agents, sawdust).

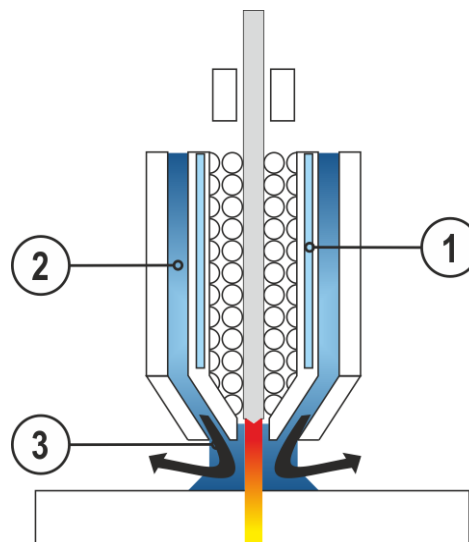


Figure 5-1

Part of the heat is transferred via the plasma nozzle and gas lens to the torch cooling system (1), another part is blown (3) from the torch by the shielding gas (2).

The large contact area of the electrode offers several advantages:

- Optimum cooling
- Optimum flow transfer
- Long electrode service life

5.2 Commissioning

5.2.1 Preparations

Let the plasma gas flow through the torch for several minutes so as to purge it from any air humidity and avoid ignition problems.

5.2.2 Start of welding

Before starting to weld, the arc has to briefly stabilise.

At this stage, the burning pilot arc is not centred.

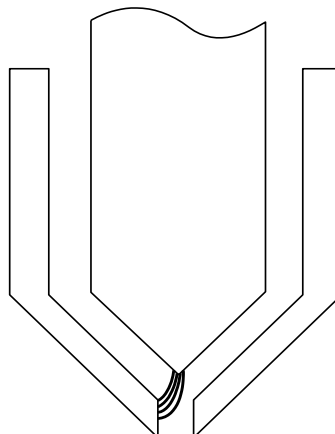


Figure 5-2

5.2.3 Setting the electrode

When starting a new welding task, the electrode has to be re-set.

Turn the collet casing adjusting ring to optimally set the arc.

You can transfer the electrode position to the electrode gauge to keep using it for the same task.

5.2.4 Selecting the nozzle

To ensure an optimum service life of the nozzles, don't operate the nozzle above the maximum current.

If necessary, switch to a nozzle of the next size.

The nozzle service life is also affected by the plasma gas quantity used.

The following applies: **The lower the plasma gas quantity, the shorter the service life.**

As a reference, take the nozzle diameter (same value or multiplied by factor 1.5) as distance between plasma nozzle and workpiece.

5.2.5 Double arc

When the current load is too high or the torch held at too steep an angle, a second arc will form between workpiece and plasma nozzle.



When the current load is too high or the torch held at too steep an angle, the nozzle service life will decrease significantly.

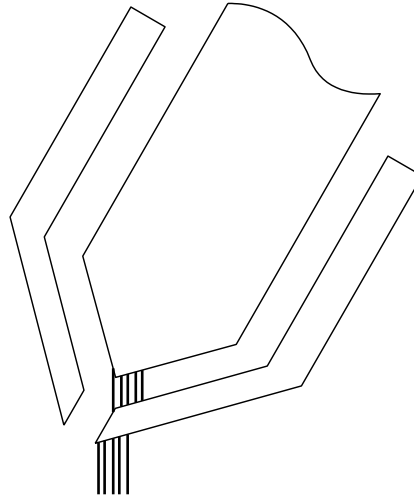


Figure 5-3

5.2.6 Grinding the electrode

The electrodes for plasma welding should be grinded mechanically. This will increase the electrode service life and the welding result will become reproducible.

The grinding angle for cathode welding is 30° (setting angle 15°).

The anode electrode, whose tip is balled or semispherical during operation, is pre-grinded with a bevel of about 1 mm and at a bevel angle of 45°. It will develop its final form for welding after brief loading in the higher current range (approx. 35 A)

The regrinding lengths depend on the maximum current load.

The following applies: The lower the actual current load during operation, the more frequently you can regrind an electrode.

5.3 Welding parameters

5.3.1 Main welding parameters

- Welding current
- Plasma quantity
- Shielding gas

5.3.2 Plasma gas

The plasma gas used is generally Argon.

5.3.3 Shielding gas supply (shielding gas cylinder for welding machine)

WARNING



Risk of injury due to improper handling of shielding gas cylinders! Improper handling and insufficient securing of shielding gas cylinders can cause serious injuries!

- Observe the instructions from the gas manufacturer and any relevant regulations concerning the use of compressed air!
- Do not attach any element to the shielding gas cylinder valve!
- Prevent the shielding gas cylinder from heating up.



An unhindered shielding gas supply from the shielding gas cylinder to the welding torch is a fundamental requirement for optimum welding results. In addition, a blocked shielding gas supply may result in the welding torch being destroyed.

- **Always re-fit the yellow protective cap when not using the shielding gas connection.**
- **All shielding gas connections must be gas tight.**

| | |
|-----------------------------------|---|
| For most welding tasks | Mixed argon/hydrogen gas: Ar + 4-6.5%H ₂ |
| For titan and aluminium materials | Pure argon |
| Aluminium | Helium and mixed argon/helium gases |

5.3.4 Operating instructions

The plasma nozzle has to be selected based on the welding current used.

To form a stable plasma jet, different plasma nozzle diameters are recommended for the individual currents:

| Wire diameter | Current | Plasma gas | Shielding gas |
|---------------|------------|------------|---------------|
| 0.6 mm | up to 6 A | 0.3 l/min. | 3.0 l/min. |
| 0.8 mm | up to 12 A | 0.3 l/min. | 3.0 l/min. |
| 1.0 mm | up to 18 A | 0.4 l/min. | 4.0 l/min. |
| –1.2 mm | up to 26 A | 0.4 l/min. | 4.0 l/min. |
| 1.4 mm | up to 32 A | 0.5 l/min. | 5.0 l/min. |
| 1.6 mm | up to 40 A | 0.5 l/min. | 5.0 l/min. |
| 1.8 mm | up to 50 A | 0.6 l/min. | 6.0 l/min. |



These data are reference values for welding operation at 60 duty cycle. Depending on the plasma gas quantity, overlapping is allowed.

5.4 Electrode replacement

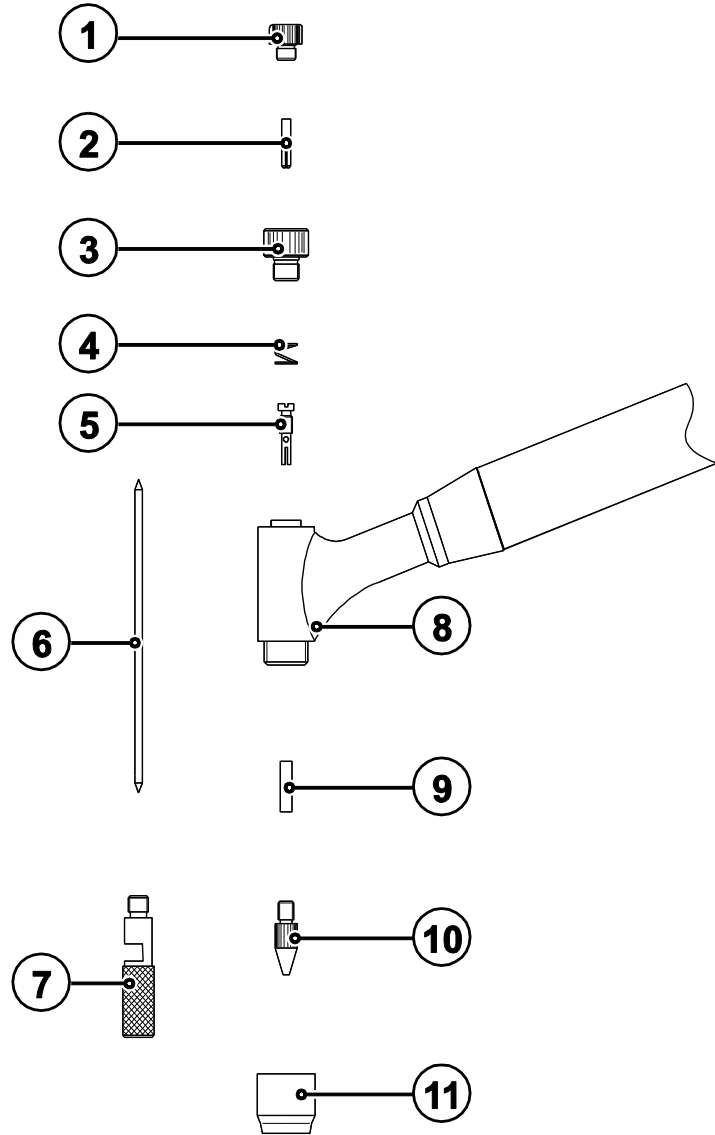


Figure 5-4

| Item | Symbol | Description |
|------|--------|------------------------|
| 1 | | Back cap |
| 2 | | Collet chuck |
| 3 | | Collet casing |
| 4 | | Compensating spring |
| 5 | | Electrode guide insert |
| 6 | | Tungsten electrode |
| 7 | | Setting gauge |
| 8 | | Torch body |
| 9 | | Insert tube, ceramic |
| 10 | | Plasma nozzle |
| 11 | | Gas nozzle |

Observe the following order:

- From the rear, screw the electrode guide insert into the torch body.
- Insert the compensating spring.
- Screw in the collet body as far as it goes.
- Insert the collet chuck with the tungsten electrode.
- From the front, screw the setting gauge into the plasma nozzle thread as far as it goes so as to place the tungsten electrode into the correct position.
- Screw the back cap into the threaded intermediate piece.
- Unscrew the setting gauge.
- From the front, insert the ceramic insert tube.
- Firmly screw in the plasma nozzle.
- Screw on the gas nozzle.



You can optimise the plasma jet at a later stage using the collet body. This way, you can slightly change the position of the tungsten electrode.

6 Maintenance, care and disposal

6.1 General

DANGER



Risk of injury due to electrical voltage after switching off!

Working on an open machine can lead to fatal injuries!

Capacitors are loaded with electrical voltage during operation. Voltage remains present for up to four minutes after the mains plug is removed.

1. Switch off machine.
2. Remove the mains plug.
3. Wait for at least 4 minutes until the capacitors have discharged!

WARNING



Incorrect maintenance, testing and repair!

Maintenance, testing and repair of the machine may only be carried out by skilled and qualified personnel. A qualified person is one who, because of his or her training, knowledge and experience, is able to recognise the dangers that can occur while testing welding power sources as well as possible subsequent damage, and who is able to implement the required safety procedures.

Observe the maintenance instructions.

- In the event that the provisions of one of the below-stated tests are not met, the machine must not be operated again until it has been repaired and a new test has been carried out!

Repair and maintenance work may only be performed by qualified authorised personnel; otherwise the right to claim under warranty is void. In all service matters, always consult the dealer who supplied the machine. Return deliveries of defective equipment subject to warranty may only be made through your dealer. When replacing parts, use only original spare parts. When ordering spare parts, please quote the machine type, serial number and item number of the machine, as well as the type designation and item number of the spare part.

Under the specified ambient conditions and normal working conditions this machine is essentially maintenance-free and requires just a minimum of care.

Contamination of the machine may impair service life and duty cycle. The cleaning intervals depend on the ambient conditions and the resulting contamination of the machine. The minimum interval is every six months.

6.2 Cleaning

- Clean the outer surfaces with a moist cloth (no aggressive cleaning agents).
- Purge the machine venting channel and cooling fins (if present) with oil- and water-free compressed air. Compressed air may overspeed and destroy the machine fans. Never direct the compressed air directly at the machine fans. Mechanically block the fans, if required.
- Check the coolant for contaminants and replace, if necessary.

6.2.1 Dirt filter

The duty cycle of the welding machine decreases as an effect of the reduced cooling air volume. Depending on the amount of dirt building up (at least every two months), the dirt filter has to be uninstalled and cleaned regularly (e.g. by purging with compressed air).

6.3 Maintenance work, intervals

6.3.1 Daily maintenance tasks

Visual inspection

- Mains supply lead and its strain relief
- Gas cylinder securing elements
- Check hose package and power connections for exterior damage and replace or have repaired by specialist staff as necessary!
- Gas tubes and their switching equipment (solenoid valve)
- Check that all connections and wearing parts are hand-tight and tighten if necessary.
- Check correct mounting of the wire spool.
- Wheels and their securing elements
- Transport elements (strap, lifting lugs, handle)
- Other, general condition

Functional test

- Operating, message, safety and adjustment devices (Functional test)
- Welding current cables (check that they are fitted correctly and secured)
- Gas tubes and their switching equipment (solenoid valve)
- Gas cylinder securing elements
- Check correct mounting of the wire spool.
- Check that all screw and plug connections and replaceable parts are secured correctly, tighten if necessary.
- Remove any spatter.
- Clean the wire feed rollers on a regular basis (depending on the degree of soiling).

6.3.2 Monthly maintenance tasks

Visual inspection

- Casing damage (front, rear and side walls)
- Wheels and their securing elements
- Transport elements (strap, lifting lugs, handle)
- Check coolant tubes and their connections for impurities

Functional test

- Selector switches, command devices, emergency stop devices, voltage reducing devices, message and control lamps
- Check that the wire guide elements (inlet nipple, wire guide tube) are fitted securely.
- Check coolant tubes and their connections for impurities
- Check and clean the welding torch. Deposits in the torch can cause short circuits and have a negative impact on the welding result, ultimately causing damage to the torch.

6.3.3 Annual test (inspection and testing during operation)

A periodic test according to IEC 60974-4 "Periodic inspection and test" has to be carried out. In addition to the regulations on testing given here, the relevant local laws and regulations must also be observed.



For more information refer to the "Warranty registration" brochure supplied and our information regarding warranty, maintenance and testing at www.ewm-group.com!

6.4 Disposing of equipment



Proper disposal!

The machine contains valuable raw materials, which should be recycled, and electronic components, which must be disposed of.

- ***Do not dispose of in household waste!***
- ***Observe the local regulations regarding disposal!***
- According to European provisions (Directive 2012/19/EU on Waste of Electrical and Electronic Equipment), used electric and electronic equipment may no longer be placed in unsorted municipal waste. It must be collected separately. The symbol depicting a waste container on wheels indicates that the equipment must be collected separately.
This machine has to be disposed of, or recycled, in accordance with the waste separation systems in use.
- According to German law (law governing the distribution, taking back and environmentally correct disposal of electric and electronic equipment (ElektroG)), used machines are to be placed in a collection system separate from unsorted municipal waste. The public waste management utilities (communities) have created collection points at which used equipment from private households can be disposed of free of charge.
- Information about returning used equipment or about collections can be obtained from the respective municipal administration office.
- In addition to this, returns are also possible throughout Europe via EWM sales partners.



7 Rectifying faults

All products are subject to rigorous production checks and final checks. If, despite this, something fails to work at any time, please check the product using the following flowchart. If none of the fault rectification procedures described leads to the correct functioning of the product, please inform your authorised dealer.

7.1 Checklist for rectifying faults



The correct machine equipment for the material and process gas in use is a fundamental requirement for perfect operation!

| Legend | Symbol | Description |
|--------|--------|-------------|
| | ↗ | Fault/Cause |
| | ✘ | Remedy |

Welding torch overheated

- ↗ Insufficient coolant flow
 - ✘ Check coolant level and refill if necessary
 - ✘ Eliminate kinks in conduit system (hose packages)
 - ✘ Vent coolant circuit
- ↗ Loose welding current connections
 - ✘ Tighten power connections on the torch and/or on the workpiece
 - ✘ Tighten contact tip correctly
- ↗ Overload
 - ✘ Check and correct welding current setting
 - ✘ Use a more powerful welding torch

No arc ignition

- ✓ Incorrect ignition type setting.
 - ✗ Setting the tungsten electrode
 - ✗ Regrind or replace the tungsten electrode
 - ✗ Ignition type: Select "HF start". Depending on the machine, the setting is defined by the changeover switch for ignition types or the hF parameter in one of the machine menus (see the "Control operating instructions", if applicable).

Bad arc ignition

- ✓ Material inclusions in the tungsten electrode due to contact with filler material or workpiece
 - ✗ Regrind or replace the tungsten electrode
 - ✗ Clean and change gas nozzle
 - ✗ Insufficient plasma gas quantity
 - ✗ Pilot arc current too low

Pilot arc ignites but no main arc forms

- ✓ Distance between workpiece and torch too high
 - ✗ Decrease distance to workpiece
- ✓ Contaminated workpiece surface
- ✓ Bad current transfer on ignition
 - ✗ Check the setting on the "Tungsten electrode diameter/Ignition optimisation" rotary dial and increase if necessary (higher ignition energy).
 - ✗ Setting the tungsten electrode
- ✓ Incompatible parameter settings
 - ✗ Check settings and correct if necessary

Pore formation

- ✓ Inadequate or missing gas shielding
 - ✗ Check shielding gas setting and replace shielding gas cylinder if necessary
 - ✗ Shield welding site with protective screens (draughts affect the welding result)
- ✓ Unsuitable or worn welding torch equipment
 - ✗ Check size of gas nozzle and replace if necessary
- ✓ Condensation (hydrogen) in the gas tube
 - ✗ Purge hose package with gas or replace

Increased wear

- ✓ Increased electrode wear
 - ✗ Plasma gas purity too low
 - ✗ Electrode distance too high
 - ✗ Insufficient water cooling
 - ✗ Gas supply leak
 - ✗ Shielding gas (argon) pre-/post-flow period too low
- ✓ Increased nozzle wear
 - ✗ Electrode distance too high
 - ✗ Insufficient water cooling
 - ✗ Insufficient plasma gas quantity
 - ✗ Current limit exceeded

7.2 Vent coolant circuit

- If there is less coolant in the coolant tank than the minimum required you may need to vent the coolant circuit. In this case the welding machine will automatically shut down the coolant pump and signal an error,.**
- To vent the cooling system always use the blue coolant connection, which is located as deep as possible inside the system (close to the coolant tank)!**

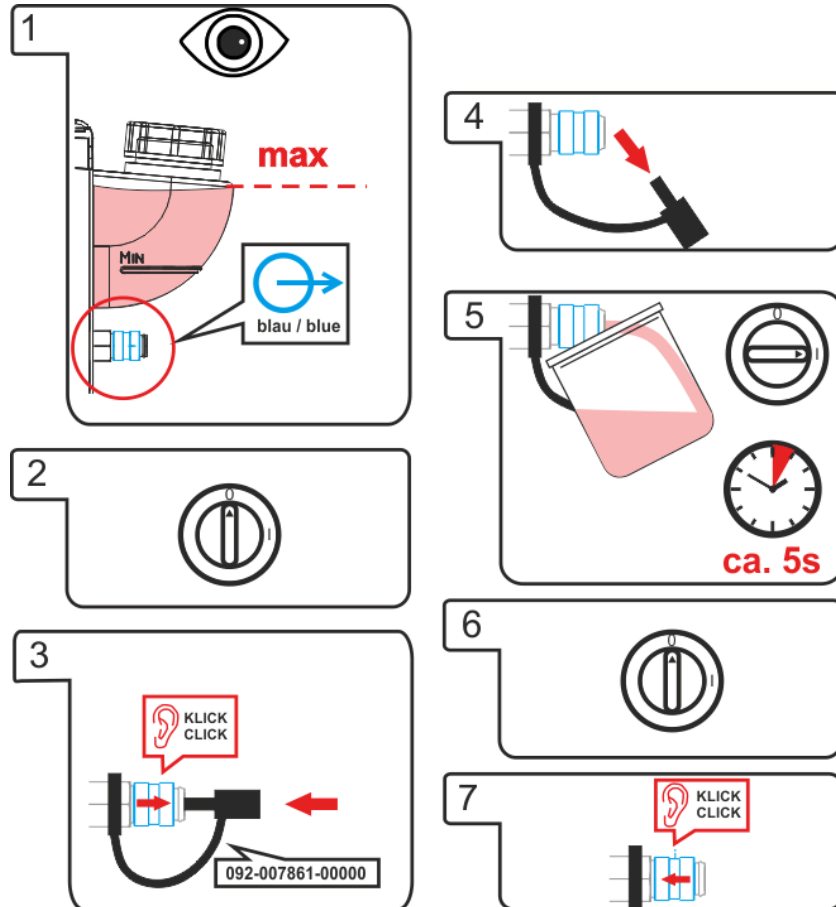


Figure 7-1

8 Technical data

8.1 PHB 50

 **Performance specifications and guarantee only in connection with original spare and replacement parts!**

| Type | PHB 50 20 A | PHB 50 50 A |
|--|--|-------------|
| Power range, maximum value at 60% duty cycle | 20 A | 50 A |
| Plasma gas | Argon | |
| Shielding gas | Argon, argon/hydrogen (approx. 6–7 vol.%), | |
| Plasma gas quantity | 0.3–0.5 l/min | |
| Shielding gas quantity | 3.0–6.0 l/min | |
| Cooling system | Liquid cooling unit | |
| Torch cooling | Coolant mixture | |
| Coolant pressure | 2 bar | |
| Min. coolant flow rate | 3 l/min. | |
| Coolant conductivity | <40 µS | |
| Hose package length | 3m | |
| Constructed to standard | EN 50078 | |

9 Replaceable parts

9.1 PHB 50



The manufacturer's warranty becomes void if non-genuine parts are used!

- Only use system components and options (power sources, welding torches, electrode holders, remote controls, spare parts and replacement parts, etc.) from our range of products!
- Only insert and lock accessory components into the relevant connection socket when the machine is switched off.

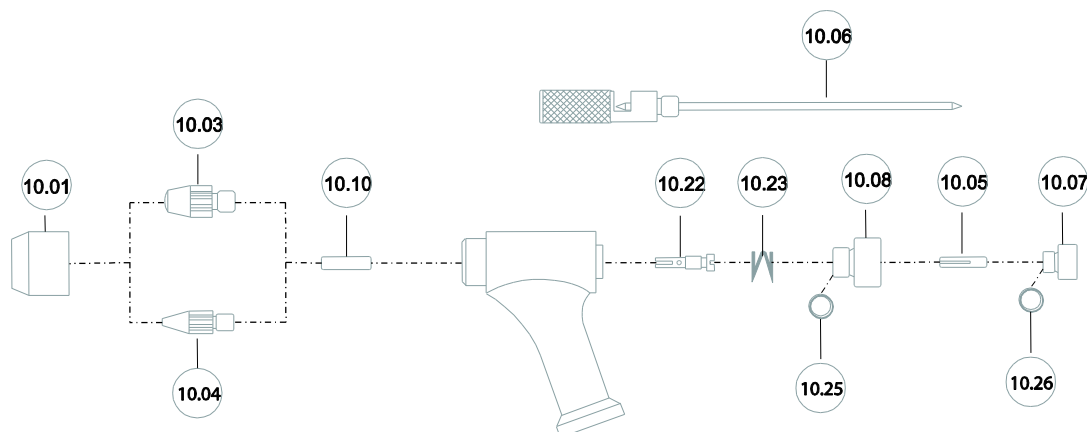


Figure 9-1

| Item | Order number | Type | Designation |
|-------|------------------|----------------------------|-----------------------------|
| 10.01 | 094-002027-00000 | GASNOZZ SPEC CERAM | Special gas nozzle |
| 10.01 | 094-002028-00000 | d = 9.5 mm / l = 17 mm | Special gas nozzle |
| 10.03 | 094-002029-00000 | PNOZZ 0.6mm | Plasma nozzle |
| 10.03 | 094-002030-00000 | PNOZZ 0.8mm | Plasma nozzle |
| 10.03 | 094-002031-00000 | PNOZZ 1.0mm | Plasma nozzle |
| 10.03 | 094-002032-00000 | PNOZZ 1.2mm | Plasma nozzle |
| 10.03 | 094-002033-00000 | PNOZZ 1.4mm | Plasma nozzle |
| 10.03 | 094-002034-00000 | PNOZZ 1.6mm | Plasma nozzle |
| 10.03 | 094-002035-00000 | PNOZZ 1.8mm | Plasma nozzle |
| 10.04 | 094-002036-00000 | PNOZZ S 0.6mm | Plasma nozzle, pointed |
| 10.04 | 094-002037-00000 | PNOZZ S 0.8mm | Plasma nozzle, pointed |
| 10.04 | 094-002038-00000 | PNOZZ S 1.0mm | Plasma nozzle, pointed |
| 10.04 | 094-002039-00000 | PNOZZ S 1.2mm | Plasma nozzle, pointed |
| 10.05 | 094-002043-00000 | COLLET 1.0mm | Collet chuck |
| 10.05 | 094-002044-00000 | COLLET 1.5mm | Collet chuck |
| 10.06 | 094-002047-00000 | TE SPEC 1.0x62 | Tungsten electrode, special |
| 10.06 | 094-002048-00000 | TE SPEC 1.5x63 | Tungsten electrode, special |
| 10.07 | 094-002046-00000 | BACK CAP WITH O-RING | Back cap |
| 10.08 | 094-002042-00000 | RETAINER | Collet body |
| 10.1 | 094-002051-00000 | CERAMIC TUBE 1.0 | Insert tube |
| 10.1 | 094-002052-00000 | CERAMIC TUBE 1.5 | Insert tube |
| 10.22 | 094-002049-00000 | ELECENBUSH 1.0 | Electrode guide insert |
| 10.22 | 094-002050-00000 | ELECENBUSH 1.5 | Electrode guide insert |
| 10.23 | 094-002040-00000 | CENT SPRING | Compensating spring |
| 10.25 | 094-002041-00000 | O-Ring 5x1.5 | O-ring |
| 10.26 | 094-002045-00000 | O-Ring g 4x1.2 | O-ring |
| - | 094-002053-00000 | ELECTRODE ADJUSTMENT GAUGE | Electrode setting gauge |

10 Appendix A

10.1 Overview of EWM branches

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