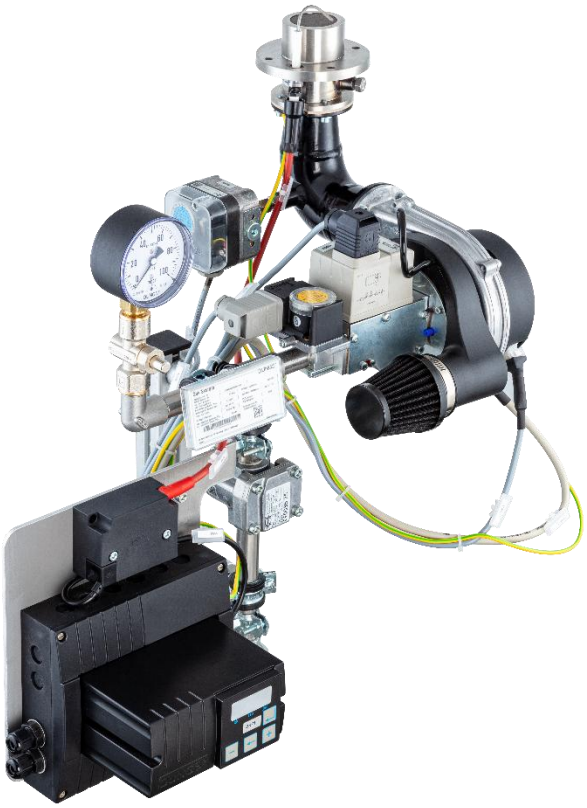
DUNGS®
Combustion Controls

Assembly instructions
for an incomplete machine

DUNGS HeatEngine®
for Hydrogen



Designation:	DUNGS HeatEngine® HEPM-Pxx/H2 (HeatEngine PreMix Point-style Hydrogen)
Date of issue:	2025-12-15
Publication version:	Version 2
Identification of the machine:	see drawing (appendix)

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1 Introduction and purpose of these instructions

The DUNGS HeatEngine burner system is an incomplete machine within the meaning of the Machinery Directive for installation in a thermoprocessing system as a higher-level machine. This document corresponds to assembly instructions in accordance with Annex VI of the Machinery Directive or Annex XI of the Machinery Regulation and contains a general description as well as the necessary information for installation and integration into the control system of the higher-level machine (thermoprocessing system). It also contains instructions for use and maintenance.

If the information contained in these instructions is not sufficient, please get in touch with your contact at Karl Dungs GmbH & Co. KG, the DUNGS Support Centre (+49 7181 804-804, supportcenter@dungs.com) or DUNGS Global Service (+49 7181 804-0, servicecenter@dungs.com). Contact our American colleagues for US-applications (+1-763-582-1700, info@karldungsusa.com).
You can also find more information about your product at www.dungs.com.

Name and address of the manufacturer:

Karl Dungs GmbH & Co

KG Karl-Dungs-Platz 1

73660 Urbach Germany

Current version of this document: https://www.dungs.com/en/product/dungsheatengine

You can find further information about the product on our website. As there are versions for both hydrogen and natural gas/propane, there are two separate documentations available. Please ensure that you always use the correct instructions for your version

2 General safety instructions

	The basic prerequisite for safe handling and trouble-free operation of the HeatEngine is the knowledge of the basic safety instructions and safety regulations. These instructions and the descriptions of the devices installed in the HeatEngine contain the most important instructions for operating the HeatEngine safely. These instructions, in particular the safety instructions, must be observed by all people who operate, run and maintain the HeatEngine. In addition, the rules and regulations for accident prevention applicable at the respective place of use must be observed.
	Note
	Before initial commissioning and before working on the HeatEngine, the instructions in this manual and the operating and installation instructions for the devices and components installed in the HeatEngine must be observed. Maintenance and operating personnel must be trained accordingly.
	Warning
	Before commissioning this DUNGS HeatEngine, the procedure must be agreed with the system operator and/or the installer. Improper adjustment, modification, operation and maintenance can lead to property damage and personal injury, possibly resulting in death.
	Danger
	All work on the HeatEngine (e.g. maintenance and repair work) may only be carried out by qualified, expert personnel. DUNGS service personnel and our authorized specialist dealers fulfil this requirement.
	Danger
	The HeatEngine is a burner system in which gas and air are mixed and burnt in a controlled manner as a combustible premix. Incorrect and/or improper use, installation, control and maintenance can lead to fire or explosion. Check all seals in the direction of flow for tightness using foam-forming agents.
	Note
	The system is intended for installation in a higher-level machine that provides the necessary protection against accidental contact and protection against foreign bodies and water. Operating the system without appropriate protection is considered improper use.

	Danger
	During ignition, a high-voltage spark of > 7kV is generated via the ignition electrode. The product and the associated electrical equipment must be de-energized before maintenance/repair. Before starting work, check that the system is de-energized. Work and troubleshooting on the electrical part of the HeatEngine may only be carried out by trained specialists. The accident prevention regulations and relevant standards must be observed.
	Warning
	The surfaces of the burner housing can become very hot during operation. Beware of unintentional contact with hot surfaces. The HeatEngine must be completely cooled down before maintenance/maintenance work can be carried out. To ensure sufficient cooling, the HeatEngine must be installed in a well-ventilated location.
	Warning
	Regular maintenance of the HeatEngine is necessary. Safety devices must be checked for proper functioning once a year or after 10,000 operating hours at the latest and repaired or replaced if necessary.
	Danger
	Sufficient pressure or cross ventilation must be provided at the installation site of the HeatEngine to prevent the formation of an explosive atmosphere in the event of a fault.
	Note
	If extraordinary noise exposure should occur during commissioning and maintenance work, it is advisable to wear personal protective equipment (hearing protection).
	Danger
	When working on the gas-carrying pipe system of the HeatEngine and the components installed in it, the gas supply must be safely shut off before starting work.
	Danger
	The system includes a combustion air fan with rotating parts. When working on the system/machine, wait until all parts have come to a standstill. Wear appropriate clothing or keep your distance during operation

3 System overview

3.1 Functional description

The HeatEngine is a premix surface burner system for generating heat in machines for thermal processes. The system has a modular design and fulfils the requirements of the relevant standards for thermal process plants (ISO 13577-2).
For NFPA 86:2023 some adaptions are needed, these will be carried out upon request.

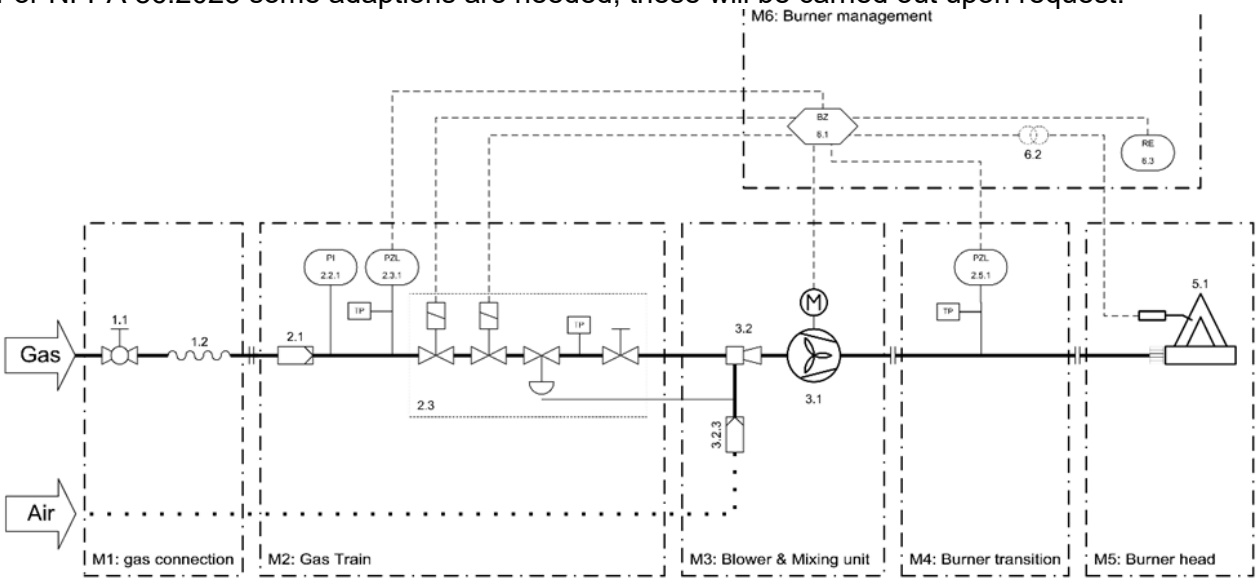

Figure 1: P&ID diagram of the HeatEngine

Figure 1 shows the P&ID diagram of the HeatEngine (see *Appendix 2*) and illustrates the individual modules of the HeatEngine and their functions. The main modules are:

- **M1** Gas connection with ball valve (1.1) as main shut-off valve and connection hose (1.2) if necessary
- **M2** Gas train with filter (2.1), pressure gauge (2.2.1), minimum gas pressure switch (2.3.1) and GasMultiBloc MBC (2.3) as a control and safety combination. The MBC combination control (2.3) combines the function of two automatic shut-off valves and a proportional/zero pressure regulator for mixture control.
  The Module 2 is different for NFPA 86:2023 versions. E.g. test ports, a maximum gas pressure switch and a second ball valve are added (see NFPA 86 P&ID diagram in *Appendix 2*). The following limitations and changes are required as well:
  - Above 44 kW / 150 kBTU/H visual indicators are needed. The use of a MBC is not possible, instead a DMV with FRNG (including visual indicator) is used.
- **M3** Combustion air fan (radial fan, 3.1) with intake housing and WhirlWind gas/air mixer (3.2) for zero pressure operation on the gas inlet. An air filter (3.2.3) is fitted to the intake opening and the negative pressure in the intake housing is connected to the MBC controller (2.3) as a pressure compensation for the power-dependent pressure losses
- **M4** Connector with pressure switch (2.5.1) for monitoring the air/gas mixture pressure
- **M5** Surface burner head (5.1) as point-style design - includes deflagration (flame arrestor) and connection point for on-site thermocouple for detecting flame flashback
- **M6** Burner control unit MPA with parameterization and ignition transformer
- **M7** Electrical wiring and assembly
- **UV sensor**

The burner system is supplied pre-assembled. Depending on the order, however, the M6 module (burner control unit and ignition transformer) can be supplied separately to support integration into the higher-level machine on site. The UV sensor for flame monitoring is always supplied separately. It must be installed on/in the parent machine in such a way that optical monitoring of the flame is possible, see *chapter 5.1*, information on sight glasses. The modular design enables customization to the individual higher-level machine without fundamentally changing the function. The burner head geometry and burner output must be selected according to the requirements.

Available hydrogen suitable standard versions of the DUNGS HeatEngine are:

Type	Designation	Item no.	Burner head geometry	Burner output[1)]	Gas connection
HEPM-P025/H2	HEPM-P025/H2-EU-S-IO-1W-E	308311	Point Ø 40 mm Point Ø 1.5”	5 - 25 kW 15 / 85 kBTU/H	Rp ½ ½” NPT
HEPM-P040/H2	HEPM-P040/H2-EU-S-IO-1W-E	308314	Point Ø 60 mm Point Ø 2.4”	7 - 40 kW 25 / 140 kBTU/H	Rp ½ ½” NPT
HEPM-P070/H2	HEPM-P070/H2-EU-S-IO-1W-E	308315	Point Ø 98 mm Point Ø 2.75”	10 - 70 kW 30 / 225 kBTU/H	Rp ¾ ¾” NPT

Table 1: Standard versions of the HeatEngine

Hydrogen as fuel has a higher reactivity than natural gas and LPG/propane. To reduce risk, the burner must be operated with an increased lambda of approx. 1.6 at high load and approx. 2.5 ... 3 at low load. In addition, a special flame arrestor is integrated in the burner head.

In accordance with the requirements of ISO 13577 2, additional monitoring must be provided so that the gas supply can be automatically shut off in the event of a flashback. For this purpose, the burner head has the option of installing a thermocouple as a sensor. By integrating this signal into the control system of the higher-level machine, the burner will be shut down. Details are to be determined on the basis of a machine-specific risk assessment.

Details of the equipment and burner head geometry as well as any technical data deviating from the standard can be found in the order-specific drawing and parts list (see appendix) for the system. The precise execution of the system varies depending on applicable standards and needs for the application. The detailed design can be read from the drawing using the type code. The type code is explained under *3.3 Technical data*.

We reserve the right to make modifications in the interest of technical development.

[1] Burner output in relation to lower calorific value and at neutral back pressure

3.2 Intended use and misuse

The HeatEngine is designed for installation in industrial thermoprocessing systems in accordance with ISO 13577-2. The product may only be operated in the enclosure intended for this purpose. For the installation and operation of the HeatEngine in a higher-level machine, the relevant application standards and guidelines must be observed, e.g. ISO 13577-2 or NFPA 86:2023. Outdoor operation in a production environment is only permitted with suitable protective measures. The product is intended for use in closed, dry rooms in an industrial environment.

The HeatEngine is a burner system that provides an adequate mixture of gas and air for the subsequent process. It is designed for hydrogen (H2).

Any use of the HeatEngine other than that described here is not

permitted. The following risks are possible in the event of misuse:

- The HeatEngine is only safe to operate if it is used as intended
- Failure to observe the instructions may result in personal injury or property damage, financial loss or environmental damage
- In the event of incorrect operation or misuse, there is a risk to life and limb of the operator as well as to the HeatEngine and other property

Warranty and liability

Warranty and liability claims for personal injury and damage to property are excluded if they are attributable to one or more of the following causes:

- improper use of the HeatEngine
- Improper transport, commissioning, operation and maintenance
- Failure to observe the instructions in the manual regarding transport, commissioning, operation, maintenance and repair
- Operating the HeatEngine with defective or non-functional safety and protective devices
- Unauthorized structural changes to the HeatEngine
- Unauthorized changes, e.g. to the control pressure
- Non-compliance with the required maintenance cycles
- Use of unauthorized spare and wear parts

Only use original spare and wear parts. In the case of externally sourced parts, there is no guarantee that they are designed and manufactured to withstand the stress and ensure safety. An exception to this is if no other spare parts are available and the alternative has been previously accepted by DUNGS.

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3.3 Technical data

Variants based on the type code

The exact design of the existing DUNGS HeatEngine can be defined through the type code (*Figure 2*). This indicates whether it is a point- or line-style burner head, the output of the burner system, the medium with which the system is operated and the region for which it was designed. It also includes the control unit, flame monitoring, wiring, voltage and, if required, a customized abbreviation with a sequential number.

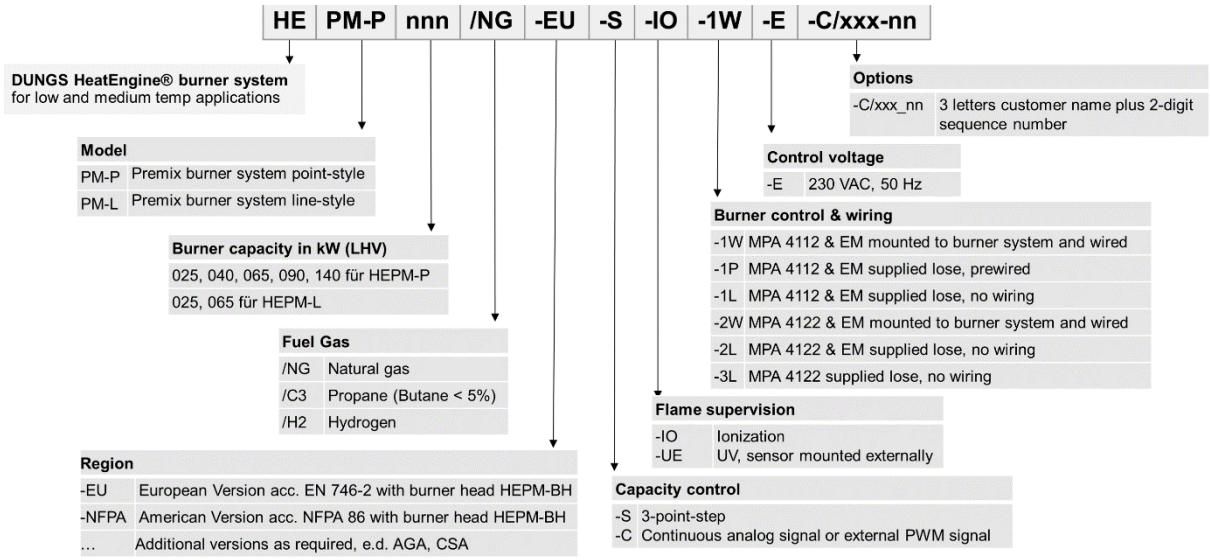


Figure 2: Type code of the HeatEngine

The type code applies to all HeatEngines regardless of the fuel. The hydrogen-compatible versions of the HeatEngine have minor restrictions on this type code. They are always equipped with a spot burner head and have a maximum output of 70 kW in the largest version.

Mechanical Data

	min.	**max.**
Pressure in the combustion chamber	-5 mbar -2“ WC	+3 mbar +1.5“ WC
Temperature in the combustion chamber	20 °C 68 °F	• 450 °C downstream of the burner • 300 °C upstream of the burner (incoming process air) • 842 °F downstream of the burner • 572 °F upstream of the burner (incoming process air)
Ambient temperature	-15 °C 5 °F	60 °C 140 °F

Gas pressure inlet	30 mbar	65 mbar (up to 65 kW variants) 100 mbar (from 90 kW variants)
	0.5 Psig	0.95 Psig (up to 225 kBTU/H variants) 1.45 Psig (from 315 kBTU/H variants)
Process air speed	2 m/s	5 m/s
	6.5 ft/s	15 ft/s
Medium	Hydrogen (H^2) Separate version available for natural gas/propane.	
Installation	Coordination of the installation with DUNGS is recommended (horizontal, vertical upwards, vertical downwards (increase low load if necessary))	
Dimensions	According to drawing (see appendix)	
Emissions at 17% O_2	• NO^x < 10 ppm over the entire modulation range	

Note: for order-specific deviations, see drawing (see appendix)

Execution	**Rated power [kW] / [kBTU/H]**	**Reaction zone[2] max. load [cm] / [“]**
HEPM-P025/H2	25 / 85	4 / 1.6
HEPM-P040/H2	40 / 140	6 / 2.4
HEPM-P070/H2	70 / 239	8 / 3.1

Table 2: Flame length of the standard versions

Control/ electrical engineering

Mains voltage	230 V AC 110 V AC (on request)
Mains frequency	50 Hz
Control	3-point step control Analog control on request
Protection class	IP 00 (like the air combustion fan)

3.4 Function of the control unit

The burner system is controlled via the MPA burner control unit as an interface to the control unit of the higher-level machine. Details can be found in the circuit diagram (see appendix). A 3-point step control is used as standard. Analog control with 0-10V or 4-20mA is also possible, but must be specifically requested.

[2] No visible flame, reaction zone when operating with hydrogen measured by OH camera

The following signal inputs and outputs are provided:

- Safety chain okay (emergency stop, overtemperature, machine-related safety limits)
- Heat request = switch on burner
- Increase performance.
- Reduce power.
- Interference suppression
- Operating message = Burner in operation
- Fault message

The combustion air fan and the automatic shut-off valves are controlled by the MPA burner control unit in accordance with the specified sequence. The speed of the fan for pre-purge and ignition as well as the maximum and minimum output are determined by the MPA parameters.

When heat is requested by the control system of the higher-level machine, the combustion air fan is started by the burner control system. The burner and the on-site combustion chamber are first pre-purged; the duration and fan output correspond to the MPA parameterization. Following the pre-purge, the blower output is reduced to the ignition output. To start the burner, the MPA opens the gas shut-off valves and activates the ignition transformer to ignite the gas-air mixture generated in the WhirlWind. The establishment of the flame is detected by the UV sensor and the MPA burner control unit sends the operating signal to the control unit of the higher-level machine, which then takes over the power control.

During operation, the power is determined by the fan speed. The blower output is specified via a PWM signal. The air flow generates a negative pressure in the WhirlWind gas/air mixer, which sucks in the fuel gas through the Venturi effect (zero pressure control).

The gas volume is set to the required flow on the MBC at the integrated main volume throttle D and via the offset B (see *Figure 6*). The procedure for setting the main volume throttle on the MBC is described in *5.4* Commissioning and *6 Manufacturer settings*. Further information can be found in the MBC documentation.

When the heat request signal is switched off, the burner is switched off. The burner control unit de-energizes the automatic shut-off valves of the MBC and the valves close. The burner is then purged to remove the ignitable gas-air mixture from the burner and the on-site combustion chamber. The duration and blower output correspond to the MPA parameterization.

The presetting of the MBC and the standard parameters of the MPA allow quick and easy commissioning after installation and integration into the control system of the higher-level machine.
A converter (order no. *301179*) is required for analog control.
This is necessary as the standard combustion air fan can only interpret signals in the form of pulse width modulation. The converter is fed by the MPA and modulates a PWM signal using the analog input signal.
Note that this converter is not required if a 0-10VDC / 4-20mA controlled blower is used.

The structure of a 3-point step control and the analog control are shown as block diagrams (see *Appendix 3*). However, this diagram is only a general representation. For effective analog control, this must be detailed on a project-specific basis.

Alternatively, temperature control can be handled directly via a bus connection with Profibus and a programmable logic controller (PLC). In this case, the modulation degree (in %) of the PWM signal can be entered via input byte EB 6 of the MPA.

4 Transport and storage

Take care when storing and transporting the HeatEngine to the site. Handle the components with care. This also includes vibration-free transport.
Do not throw or drop the product. Observe the relevant regulations, e.g. accident prevention regulations. Only store the product in a dry and clean working environment. Only store the product within the permitted temperature range. Correct operation of the HeatEngine is only guaranteed if it is transported and stored correctly.

5 Installation and commissioning

5.1 Scope of delivery

The scope of delivery of the HeatEngine depends on the selection regarding *Module 7 - Wiring*. Ideally, a pre-assembled version should be ordered. In this case, the HeatEngine is delivered assembled and wired. The associated automatic burner control unit is also preset. The HeatEngine can be regarded as a plug & play system.

Alternatively, however, the HeatEngine can also be supplied with pre-wired loose individual parts or completely without wiring. In principle, every HeatEngine system - regardless of the choice of cabling - is supplied with the corresponding plugs and seals. When ordering a non-wired HeatEngine, the following electrical components can be supplied:

- Connectors for combustion air fan, electrodes, MBC and pressure switches
- Ignition cable (length e.g. 550 mm, 1000 mm or 1500 mm)
- UV sensor (loose)
- Power supply cable for transformer
- Thermocouple not included. Connection point closed with plug

5.2 Integration into the machine

	Note
	Ensure a firm, stable substructure during installation. Reinforce if necessary!

	Note
	Pay attention to external EMC interference signals on site during installation! EMC interference signals can occur, for example, from motors with speed control via frequency converters.

The burner system is attached to the burner head via the mounting flange using six mounting screws. The mounting flange has two seals, see *Figure 3*. Information on the flange dimensions and the positions of the screw openings can be found in the drawing of the burner system.

Figure 3: Mounting flange and seals of the HeatEngine

The burner head is mounted on the housing of the process chamber using the mounting flange, position 1 in *Figure 3*. One seal, position 2 in *Figure 3*, is located on the transition piece between the burner head and combustion air fan and on the mounting flange. The second seal, position 3 in *Figure 3,* is placed between the mounting flange of the HeatEngine and the outer wall of the process chamber during installation. The external components such as cables and gas line must be protected from the heat. An outer lining, as shown in *Figure 4* on the left, only minimally increases the temperature resistance. With this variant, it is important that the mounting flange and screws are not insulated. With an inner lining, as shown in *Figure 4* on the right,it achieves a temperature resistance of maximum up to 450°C / 840°F.

The outer wall of the process chamber is represented by position 2 in *Figure 4* .Position 3 shows the outer insulation and position 4 the inner insulation. A sight glass must be provided to enable visual inspection of the flame matrix in accordance with ISO 13577-2 and NFPA 86:2023. This is

used for visual inspection of the flame pattern and for burner adjustment. In *Figure 4,* position 1 corresponds to the sight glass.

The viewing glass required for visual inspection of the flame matrix must always be aligned so that it is in line of sight with the matrix.

With point-style burner heads a wall adjacent to the mounting wall must be used for this purpose. A sight glass placed perpendicular to the focal surface of a point-style burner head is shown in *Figure 44*. The UV sensor must be installed at the same angle to ensure a clear view of the flame.

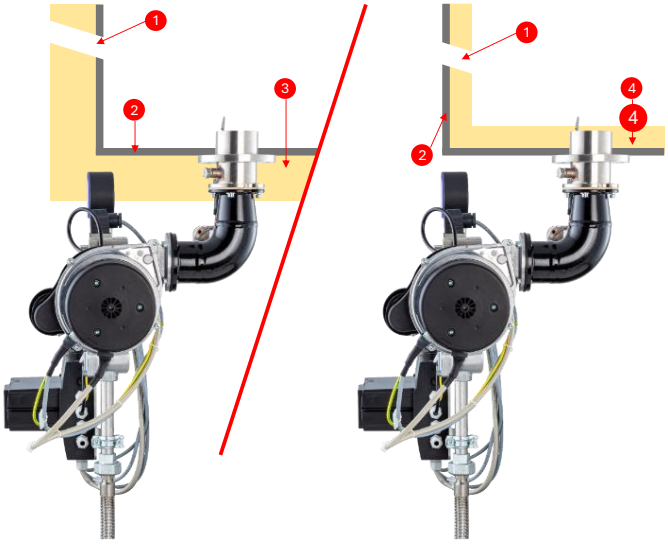


Figure 4: HeatEngine in process chamber with outer and inner lining/insulation

In addition to installation of the burner head flange, the gas control line must be supported! This must be realized on site according to the possibilities of the higher-level machine.

When determining the installation position, ensure that the burner system is accessible for inspection and maintenance work. In accordance with ISO 13577-2 and NFPA 86:2023 it must be possible to visually inspect the flame and flame matrix.

When determining the installation location, it must be ensured that the combustion air fan can draw in sufficient clean, dust-free air and that the emissions produced during combustion are safely discharged. Sufficient openings must be provided in the higher-level machine for the air supply, through which clean ambient air can be drawn in.

	Warning
⚠	Insufficient air supply represents a safety risk and must be ruled out.

After installing the burner system, establish a gas connection and check that the gas supply line is adequately dimensioned. The ball valve must be installed as a manually operated main shut-off valve in accordance with ISO 13577-2 or NFPA 86:2023 and must be easily accessible. The connection hose, if present, must be installed so that it is protected from damage.

	Warning
⚠	Ensure that the gas pressure is secured on site. Excessive gas pressure (greater than the specified maximum inlet pressure) can lead to damage.

After the mechanical installation of the burner system in the higher-level machine, establish electrical connections and, if necessary, intermediate wiring in accordance with the circuit diagram (see appendix). Check the on-site electrical fuse protection.

After installation and before commissioning the DUNGS HeatEngine

a) Check power supply.
b) Carry out an electrical function test.
c) Check the gas system for tightness.
d) Check the ventilation of the installation room.

Depending on the installation location of the higher-level machine, obtain the necessary authorizations in accordance with regional regulations before commissioning.

	Warning
⚠	Premix burner systems that run with hydrogen have a higher risk of flashback. To minimize this risk, the burner is operated with an increased lambda value (see 3.1 Functional description). The additional thermocouple that's installed has to be integrated into the burner's safety chain.

5.3 Checking the Installation

The installation and commissioning of the HeatEngine must be carried out by qualified, expert personnel. The relevant standards and regulations must be observed during installation and commissioning. Commissioning must be prepared as follows:

1. Check whether the higher-level machine is ready to start the burner system, e.g.
   a) Burner not blocked
   b) No flammable objects in front of the burner head (e.g. packaging waste, loose insulation, sticker, etc.)
   c) Heat dissipation managed
   d) Exhaust gas removal ensured
   e) All required interlocks in order and integrated into the safety chain
2. Check the position of the electrodes in the burner head, see *9.1 Maintenance and servicing of the burner head HEPM-BH*
3. Establish/check voltage and gas supply
4. Check the parameterization of the burner control unit MPA and adjust if necessary
   a) Parameter 30 *Duration of pre-ventilation is* preset to a maximum value of approx. 1 hour as standard and can be shortened according to the machine configuration.
      Note: In accordance with ISO 13577-2, 5 complete air changes are required.
      In accordance with NFPA 86:2023, 4 complete air changes are required.
   b) Parameter 51 *Post-purge time* is preset to 6 seconds as standard to purge the burner itself and may need to be extended according to the machine configuration in order to also purge the combustion chamber and exhaust gas system.
   c) Parameters 240 to 248 control the combustion air fan. They are preset with default values and can be adjusted to optimize the process.

	Note
	The current fan speed can be displayed in the manual mode of the MPA. To switch to manual mode, press the “-” and “ENTER” buttons simultaneously. The fan speed is displayed in %.

5. Checking the compensation hose:
   In the standard version of the HeatEngine, the MBC acts as a constant pressure regulator. To compensate for influences such as a dirty air filter in the combustion air blower, a connection must be established between the MBC and the supply air collector. To do this, the MBC's vent (see *Figure 6*, vent E) must be connected to the blower pressure via a compensation hose. The attached hose can be seen in *Figure 5*. The maximum gas volume is adjusted to the air volume.

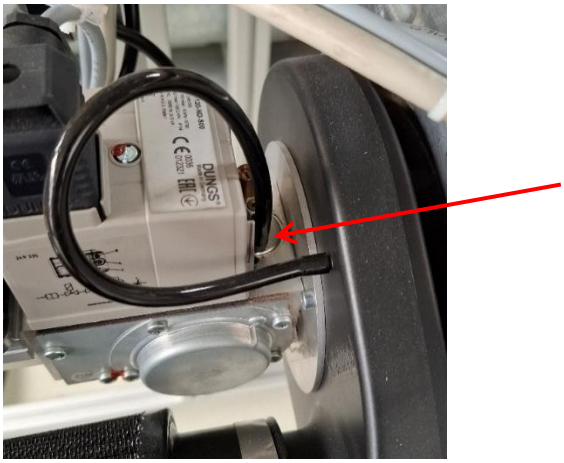


Figure 5: Compensation hose on the MBC

5.4 Commissioning

During commissioning, pay attention to the following:

- Unusual noise
- The shape and color of the burner flame (directly on the pad without oscillation or pulsation)
- Measure the power at the specified load levels (low, medium, and full load) using suitable measuring devices (e.g., gas meters)
- Document the settings of the burner system

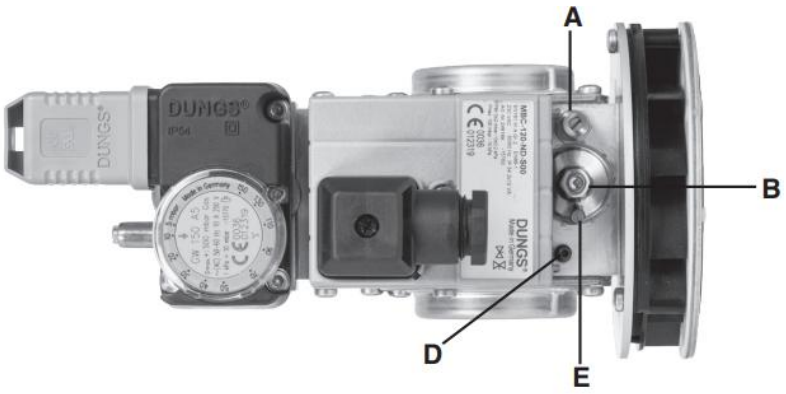
	Warning
	The system must be properly purged during initial commissioning or after work on the gas system.

1. Open the gas ball valve and check the gas pressure on the pressure gauge
2. Check the setting of the gas pressure switch (item 2.3.1, Fig. 1) or set to
   - 25 mbar / 10”WC (approx. 80% of the minimum required inlet pressure of 30 mbar / 0.5 Psig)
3. Check setting of mixture pressure switch (item 2.5.1, Fig. 1) or set to 0.5 mbar / 0.2”WC
4. Switch on burner system (*heat request* signal)
   The burner starts with a regular starting process with pre-purge, approaching the ignition

position, ignition spark and flame formation. The fan output during pre-purge and ignition as well as the flame stabilization time is determined by MPA parameters 240 to 242.

	Note
	Before the system was delivered, the MBC is preset so that the burner ignites. During initial commissioning or after work on the gas system, several start attempts may be necessary to fill the system with fuel. After three attempts to start without ignition, check the fuel supply, burner control settings, and spark position again.

5. Run the burner to MAX (high load) and check the flame matrix. If the flame matrix is glowing/incandescent, immediately increase the gas flow rate at the main throttle valve **D** of the MBC (see *Figure 6*). The blower output is set by the MPA parameter 246 *Maximum speed* determined. The gas quantity can be determined by a gas meter, a gas counter or a measuring orifice in the gas supply line



A	Measuring connection
B	Pressure regulator / Offset screw
D	Main volume throttle
E	Breathing hole

Figure 6: MBC Connections

6. Set the burner to MIN (low load) and visually check the flame matrix. If necessary, adjust the gas quantity at offset screw **B** of the MBC. The blower output is determined by the MPA parameter 245 *Minimum speed.* The gas quantity can be determined by a gas meter, a gas counter or a measuring orifice in the gas supply line.

	Note
	Only change the offset in very small steps of e.g. ¼ turn and make a note of this. The set offset can be determined by measuring the MBC outlet pressure at measuring port A. The gas pressure p_D corresponds to the offset when the black compensation hose is removed from the breathing port E. A slightly negative offset of approx. -0.05 to 0.0 mbar is recommended for a slightly increased lambda at low load.

7. Switch back and forth several times between high load and low load, repeating steps 5 and 6. Finally, document the settings of the pressure switches, MPA parameters, position (length) of the main volume throttle, any changes made to the offset, controller outlet pressure (**measuring point 3**) at MAX and MIN and, if possible, gas volume flows MAX and MIN

	Warning
	The flame matrix must not glow/light up under any circumstances or in any operating state. If the matrix glows, the burner must be switched off immediately and the combustion air volume (lambda) increased.

	Warning
	A glowing flame matrix can cause flame flashbacks, which can permanently damage the matrix.

At the end of commissioning, check the connections and closures for tightness using a foaming agent and retighten if necessary

6 Manufacturer settings

The HeatEngine must be adjusted to the correct air-hydrogen mixture using a lambda analyzer.

The setting values of the MBC and the pressure monitor can be used as an aid. The min. pressure monitor on the MBC is set to 25 mbar / 10”WC as standard and the mixture pressure monitor on the burner connection piece is set to 0.5 mbar / 0.2”WC. The setting values for the main volume throttle, on the other hand, are not generally valid values, but merely reference points for the setting. This is because each system is different due to various tolerances.

As already described under *5.4 Commissioning*, there are two possible setting values for the MBC. Offset B should not be adjusted if possible, or only minimally if absolutely necessary and with documentation of the changes made.

The main volume throttle A, on the other hand, can and should be used to adjust the gas volume at the MBC. This changes the ratio of the air/gas mixture. The position and direction of rotation of the main volume throttle is shown in Figure 77.

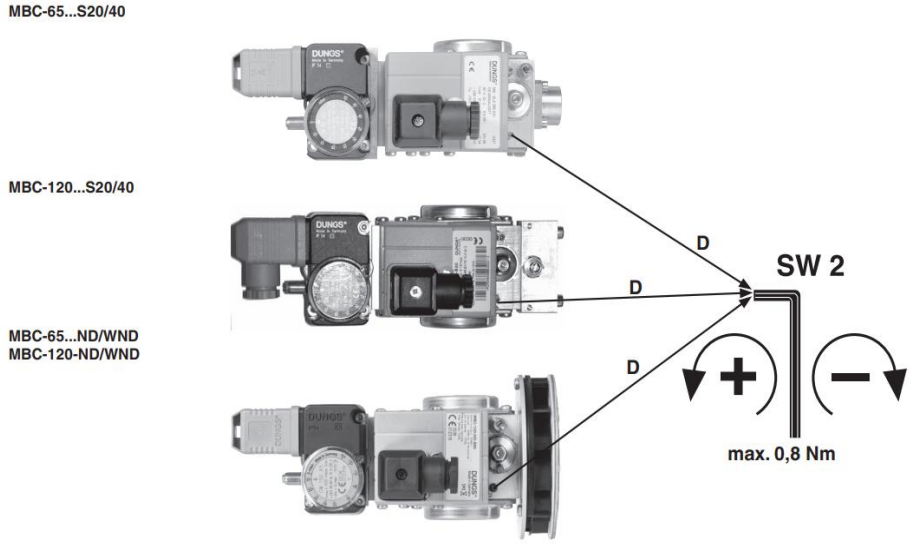


Figure 7: Diagram for setting the main volume throttle

Guidance values for the setting of the main volume throttle have been identified from various laboratory tests. It should be emphasized once again that these are not absolute values. In addition to the product's own tolerances, the setting values depend on the capacity, fuel quality and gas pressure, among other parameters. Therefore, these values are given in the following table (*Table 3*) in addition to the design of the HeatEngine and the setting value of the main volume throttle.

Execution	Rated power [kW] / [kBTU/H][3]	Fuel	Throttle position [mm]	Offset [mbar]
HEPM-P025/H2	25 / 85	Hydrogen (H^2)	15	-0,1
HEPM-P040/H2	40 / 140	Hydrogen (H^2)	17,3	-0,4
HEPM-P070/H2	70 / 238	Hydrogen (H^2)	18,8	-0,65

Table 3: Standard values for setting the main volume throttle

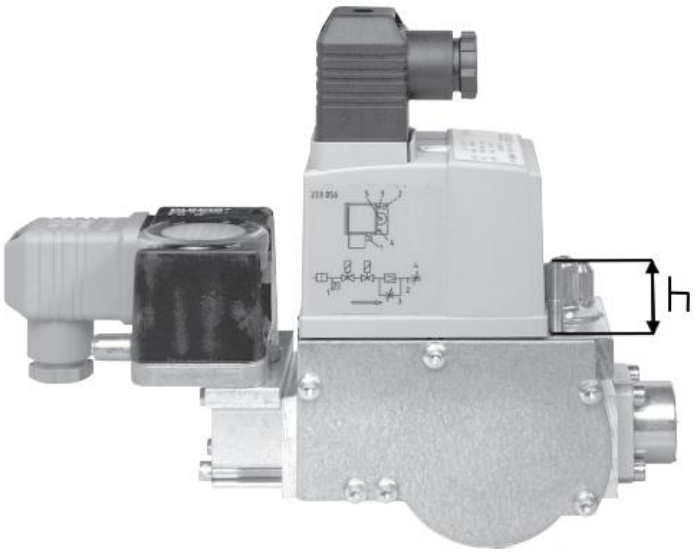


Figure 8: Height measuring of main volume throttle

7 Operation

The burner system is designed for fully automatic operation without supervision. The higher-level machine monitors the safety-related interlocks, switches the burner on and off according to the process requirements and controls the output by activating the corresponding inputs on the MPA burner control unit (see documentation). The MPA burner control unit monitors the gas and mixture pressure, controls the automatic shut-off valves and monitors the formation of the flame.

[3] The Output is specified in relation to the lower heating value (LHV)

8 Product and capacity changes

It is necessary to replace safety-relevant components once they have reached the end of their service life. DUNGS recommends replacement in accordance with *Table* *4Table 4: Service life of the components*

9 Maintenance and servicing

All maintenance and servicing work on the HeatEngine may only be carried out by qualified, expert personnel. DUNGS service personnel and our authorized specialist dealers fulfil this requirement.

Carry out regular annual inspections to maintain and ensure functional safety. Observe the instructions for the components used. Replace defective components from the DUNGS delivery program (pressure switch, MBC, etc. see details on the order-specific drawing). If a spare part is required, please contact your responsible sales engineer.

The minimum requirements for maintenance are as follows:

1. General condition check
2. Check condition of gas filter, air filter and wearing parts
3. Visual and functional inspection including the safety and control devices (pressure switch and GasMultiBloc MBC)
4. Check the safety-relevant components to ensure that they have reached their nominal service life.
    a) Replace UV sensor after 8,000 hours in accordance with the relevant instructions.
5. Check fuel-carrying system components for tightness, corrosion, and signs of ageing.
6. Check the burner head with ignition and monitoring device, see chapter 9.1
7. Check the combustion chamber and heating surface for soiling
8. Check the supply of the necessary combustion air network
9. Check the exhaust gas routing for function and safety
10. Final inspection check by measuring and documenting the measurement and test results.

9.1 Maintenance and servicing of the burner head HEPM-BH

The intended service life of the flame matrix is 20,000 hours of flame operation or five years. This is expressly not a guaranteed service life, but rather the intended period of use as determined by careful engineering rules. Furthermore, use beyond this period is possible if the burner head is in proper working order and no changes in the combustion properties of the burner head are detected during maintenance or operation.

DUNGS recommends maintenance every 4000 hours with flame or at least once a year.

The minimum maintenance requirements are as follows:

6. Check the ignition and ionization electrodes for wear and replace them if necessary according to the replacement instructions in section 9.3.
7. Check the positioning and mounting (firmness and clamping effect) of the ignition electrode: Distance to the flame tube approx. 2 mm (see *Figure 9*)
   This ensures ignition against the flame tube (with secure grounding/earth connection). Ignition against the flame matrix is not permitted.

Figure 9: Positioning of the ignition electrode

7. Check the functionality of the UV sensor (see *9.3.3 Replacement of the UV*)
8. Visual inspection of the flame matrix (corrosion, damaged areas, and highly permeable areas) when the burner is not in operation
9. Visual inspection of the flame pattern (even distribution across the entire pad, no lifting of the flame) during operation
10. Check the burner setting at low, medium, and high load (compare with settings during initial and recommissioning)

Note: Contamination and improper operation

Contamination or improper operation can increase the pressure loss of the burner pad during its service life. This results in reduced burner output for the machine, especially at the upper load points. As part of maintenance, the service technician checks whether the maximum firing capacity is still within an acceptable range for the machine. If this is not the case, the flame matrix can be cleaned with a vacuum cleaner or vacuum device (or compressed air), or replaced.

9.2 Replacement parts for burner heads HEPM-BH

The quantities of all spare parts kits are designed so that five burner heads can be repaired with the contents. Depending on the burner head size, there are minor differences in the spare parts kits and not every spare parts kit is available for every variant. Detailed information on this can be found in the subchapters. The following spare parts kits are generally available:

- Ignition electrode (including screw ring)
- Electrode plug
- Seals

In addition to the spare parts kits, the complete burner heads (scope as per *Module 5*) and the flame tube – with integrated flame matrix and deflagration (flame arrestor) – are available as individual spare parts. These are fully assembled and tested.

The exact spare parts and spare parts kits available for each burner head size are described in the following subchapters. To ensure a clear understanding of which spare parts are required, the nomenclature of the burner heads is relevant:

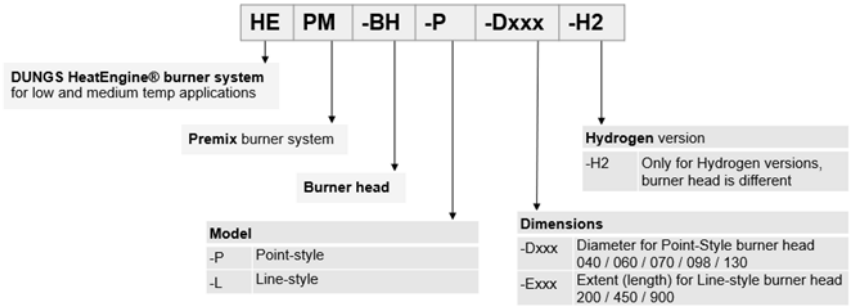


Figure 10: Nomenclature of the burner heads HEPM-BH

There is less variation in hydrogen-compatible burner heads than in standard burner heads. Contrary to the nomenclature, there are no linear burner heads available as hydrogen variants. The following burner heads are installed in the standard HeatEngines for hydrogen:

Order no. HeatEngine	**Designation HeatEngine**	**Built-in burner head**
308311	HEPM-P025/H2	HEPM-BH-P-D040-H2
308314	HEPM-P040/H2	HEPM-BH-P-D060-H2
308315	HEPM-P070/H2	HEPM-BH-P-D098-H2

Table 5: Mapping between standard HeatEngine and burner head

When purchasing a complete burner head, it is not ready to start. The UV sensor is not included. It must be ordered as a separate spare part.

9.2.1 Point style burner heads up to 40 kW

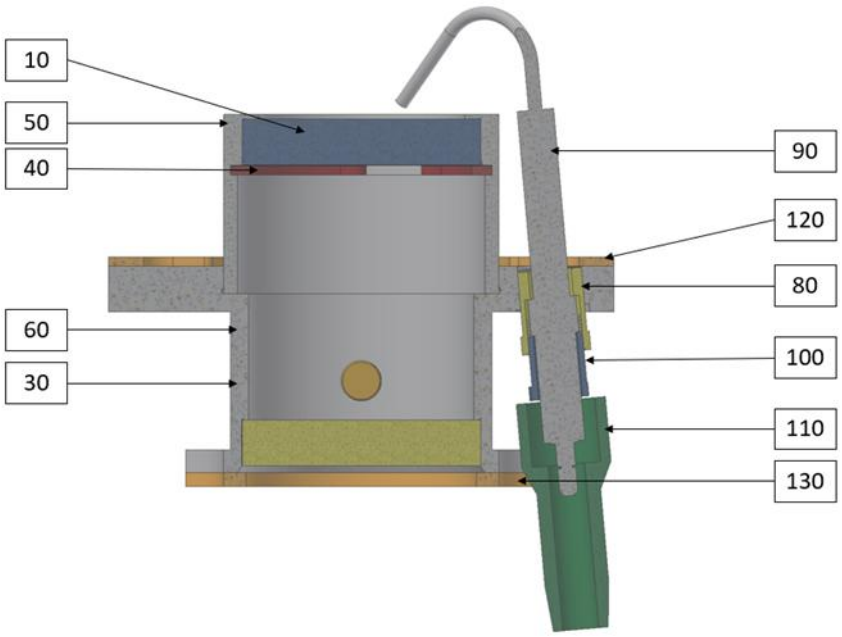


Figure 11: Structure burner head HEPM-BH-P-D040-H2

Pos	Designation	Repl. Set Electr. + Ring	Repl. Set Electr.plug	Repl. Set Gaskets	Repl. Set Flame tube	Repl. Set ... cpl.	UV sensor
10	Flame matrix						
30	Flame arrestor						
40	Retaining ring						
50	Flame tube						
60	Burner housing						
80	Threaded bush						
90	Ignition electrode	5					
100	Screw ring	5					
110	Electrode plug		10	10			
120	Gasket between burner flange and process chamber			5	5		
130	**Gasket** between burner flange and burner adapter			5	5		
140	Gasket between burner adapter and combustion air fan (not shown, Module 4)			5	5		
	UV sensor (not shown, loose)						1
	Order no. HEPM-BH-P-D040-H2	308328	302916	308330	308325	308322	256692
	Order no. HEPM-BH-P-D060-H2	308328	302916	308330	308326	308323	256692

Table 6: Replacement sets for burner heads D040-H2 and D060-H2

9.2.2 Point style burner head for 70 kW

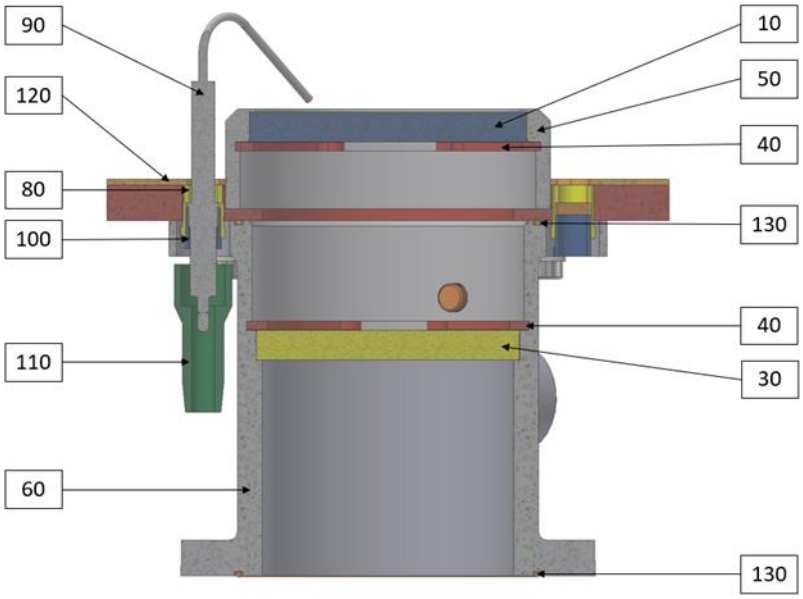


Figure 12: Structure of burner head HEPM-BH-P-D098-H2

Pos	Designation	Repl. Set Electr. + Ring	Repl. Set Electr.plug	Repl. Set Gaskets	Repl. Set Flame tube	Repl. Set … cpl.	UV sensor
10	Flame matrix						
30	Flame arrestor						
40	Retaining ring						
50	Flame tube						
60	Burner housing						
80	Threaded bush						
90	Ignition electrode	5					
100	Screw ring	5					
110	Electrode plug		10	10			
120	Gasket between burner flange and process chamber			5	5		
130	**O-Ring** between burner flange and burner adapter			10	5		
140	Gasket between burner adapter and combustion air fan (not shown, Module 4)			5	5		
	UV sensor (not shown, loose)						1
	Order no. HEPM-BH-P-D070-H2	308329	302916	308331	308327	308324	256692

Table 7: Replacement sets for burner heads D098-H2

9.3 Replacement instructions

When replacing and installing the complete burner head, ensure that only the mounting flanges provided for this purpose are used for fastening. Ensure that the burner head is installed without tension.

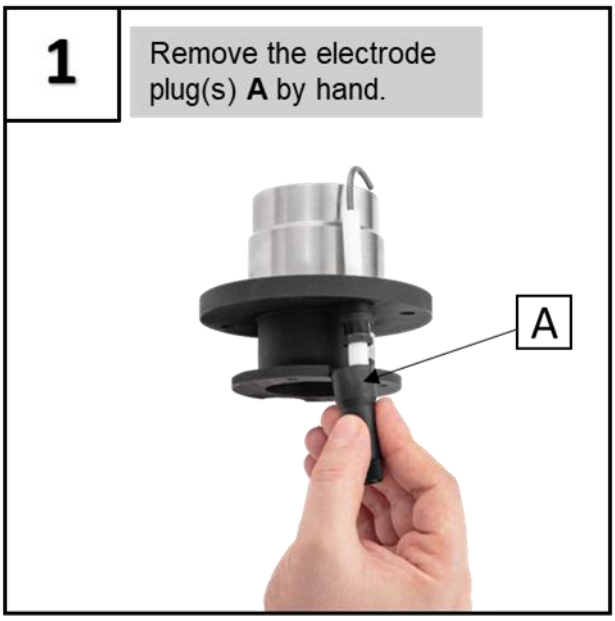
It is assumed that the HEPM-BH burner head is supplied with a DUNGS MBC-WND WhirlWind system and an MPA as burner control. The fuel/air mixture supply from the DUNGS MBC-WND WhirlWind system must be mounted without tension at the interface of the HEPM-BH burner head. For the US versions, the HEPM-BH units might be installed with a DMV / FRG combination depending on the power consumption.

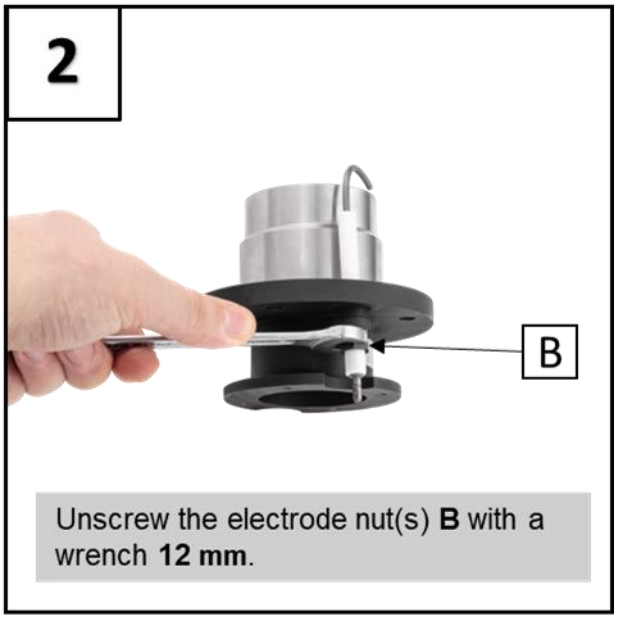
	Note
	Depending on the burner design and size, the dead weight can range from 0.5 to 100 kg. Use suitable lifting equipment and do not stand under suspended loads. When installing and removing HEPM-BH burner heads, there is a considerable risk of crushing and trapping, depending on the installation location and position. Use suitable tools and the necessary protective equipment.

After successful installation, a tightness test is necessary. The tightness test can be carried out during operation using foam-forming agents, provided there is sufficient access. If a tightness test cannot be carried out after installation due to the design of the machine, it should be carried out prior to installation. In this case, the tightness test of the connection points should be carried out at 1.5 times the operating pressure using air as the medium (no fuel/air mixture!).

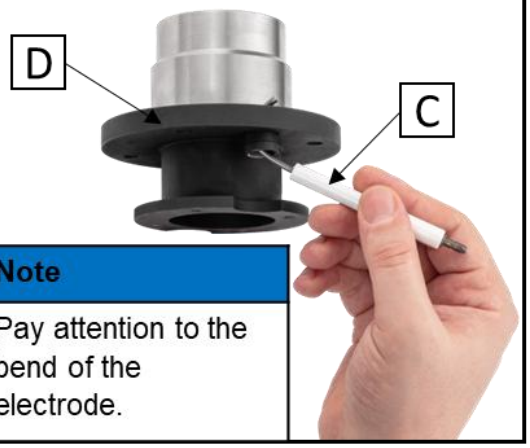
9.3.1 Replacement of the electrode(s)

	Warning
	Make sure the burner head is cold!





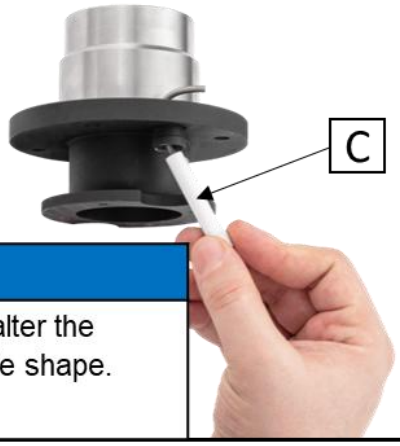
3 Remove the electrode(s) **C** through the hole in the threaded bush **D**.



Note

Pay attention to the bend of the electrode.

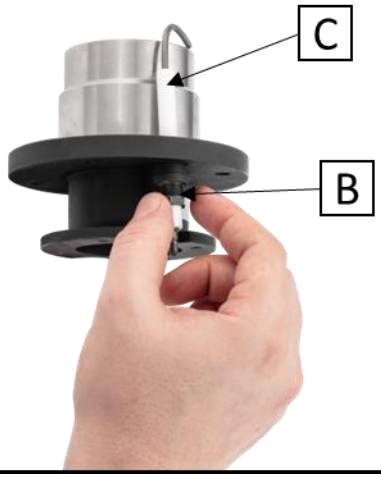
4 Insert new electrode **C**.



Note

Do not alter the electrode shape.

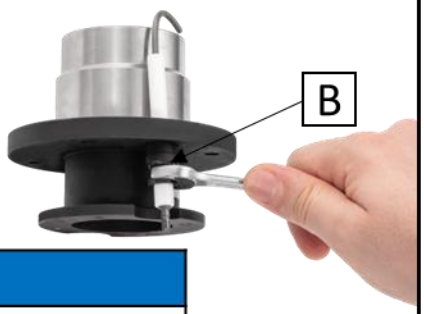
5 Tighten the electrode **C** with the electrode nut **B** by hand.



6 Align the electrode **C**:

The ignition electrode should be positioned as close as possible to the edge of the flame tube, approx. 3-4 mm.

7 Tighten the electrode nut(s) **B** with a wrench **12 mm**.



Note

Ensure electrode(s) remain aligned.

8 Reattach the electrode plug(s) **A** by hand.

9.3.2 Replacement of the flame tube

The flame tube, burner pad and flashback protection can only be replaced on point-style burner heads. If the burner pad needs to be replaced on line-style burner heads, the entire burner head must be replaced. Before the flame tube can be removed, the electrodes must be removed in accordance with the previous instructions 9.3.1(*up to step 4*) and reattached after replacing the flame tube (*from step 5*).

Warning

Make sure the burner head is cold!

1 Manually unscrew the flame tube **A** from the threaded bush **B**. If necessary, use a clamping device and pipe wrench.

Warning

The use of a pipe wrench can result in marks!

2 Screw the new flame tube **A** into the threaded bush **B** by hand.

Note

If available, use a strap wrench.

9.3.3 Replacement of the UV sensor

The UV sensor has a plug connection under the connection cover, which makes replacement very easy. (see DUNGS MPA41xx documentation).

1. Switch off the power supply to the HeatEngine.
   Ensure that it cannot be switched on during the work.
2. Loosen the bayonet lock with a screwdriver.
3. Remove the UV sensor from the connector by turning it.

Figure 13: UV sensor with connector

4. Loosen the bayonet lock on the UV sensor connector using a screwdriver.
5. Disconnect the power supply plug and the ground plug.
6. Install the new UV sensor in reverse order of the steps.
7. Check the new UV sensor for functionality.

Function test of the UV sensor

The UV sensor checks its own function during every burner start in state 7. In addition, a manual check of the UV sensor must be carried out by a technician at least once a year.

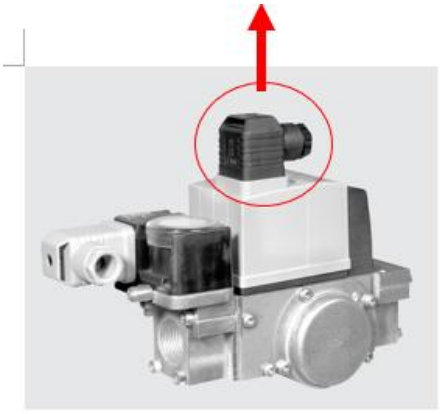


Figure 14: Plug on the Multibloc

1. Loosen the locking screw on the electrical connection of the Multibloc.
2. Remove the plug from the Multibloc and start the HeatEngine.
   Depending on the operating status of the burner, a fault occurs which can be traced back to the UV sensor:

FA7 □ No flame during safety time
FA9 □ Flame failure during stabilization time
FA8 □ Flame failure during operation

   The UV sensor test was successful if one of the faults occurs.
   If none of the faults occur and the burner continues to operate, the UV sensor must be replaced.
3. Reattach the power supply plug to the Multibloc and secure it with the locking screw.

10 Cleaning

If necessary, the burner components, combustion chamber and heating surfaces must be cleaned. Ensure that the burner system is properly switched off before cleaning. The steps to be taken can be found in the maintenance instructions. The relevant cleaning instructions can also be found in the documentation for the individual components.

Regular cleaning is particularly important for the air filter on the combustion air blower. Over time, many particles from the ambient air can accumulate here, clogging the filter and thus severely impairing maximum performance. Ensuring that the cleanest possible ambient air is drawn in guarantees a longer service life for the air filter.

Furthermore, it must be ensured that the UV sensor has an unobstructed view of the burner's flame position. If the UV sensor or any quartz glass pane in the UV adapter is dirty, it must be cleaned. This includes cleaning the UV tube and, if present, the quartz glass pane in the connector. To clean, remove the UV sensor and the connecting piece (see *9.3.3 Replacing the UV sensor*). Use a soft, slightly damp, clean cloth for cleaning.

	Warning
	Avoid skin contact with the UV sensor.

11 Malfunctions

Various faults and error patterns can occur during operation. Known malfunctions and possible causes are listed below. Furthermore, starting difficulties can be remedied under certain circumstances by increasing the starting power.

Failure effect	**Possible failuresr**	**Proposed solution**
No ignition spark during ignition phase	Ignition transformator defective	Replace ignition transformator
	Ignition cable damaged or not properly connected	Establish proper connection with new ignition cable
	Ignition electrode dirty, worn or incorrectly positioned	Control postion of the electrode (according documentation) or replace it
No flame formation during ignition phase	No or too little gas	Ensure a constant, adequate gas supply
	Incorrect gas-air-mixture	Adjust the mixing ratio according to the documentation.
Flame termination during ignition phase	Missing flame signal	Replace ionization electrode / UV sensor
	Ionization line damaged or not properly connected	Establish proper connection with new ionization cable
	Ionization electrode dirty, worn or incorrectly positioned possible	Control postion of the electrode (according documentation) or replace it

Flame failure during operation	Unstable flame signal	Replace ionization electrode / UV sensor
	Burner low load too low	Increase low load, clean air filter if necessary
	Flame lifts off	Reduce high loads
	Fault in gas supply to the burner	Ensure sufficient, sustainable gas supply

12 Decommissioning and disposal

To decommission, switch off the gas supply and power supply and close the gas ball valve.

Once the intended service life has been reached or when the higher-level machine is decommissioned, the DUNGS HeatEngine® can also be disposed of separately according to the components.

Local guidelines for the disposal of these materials must be observed.

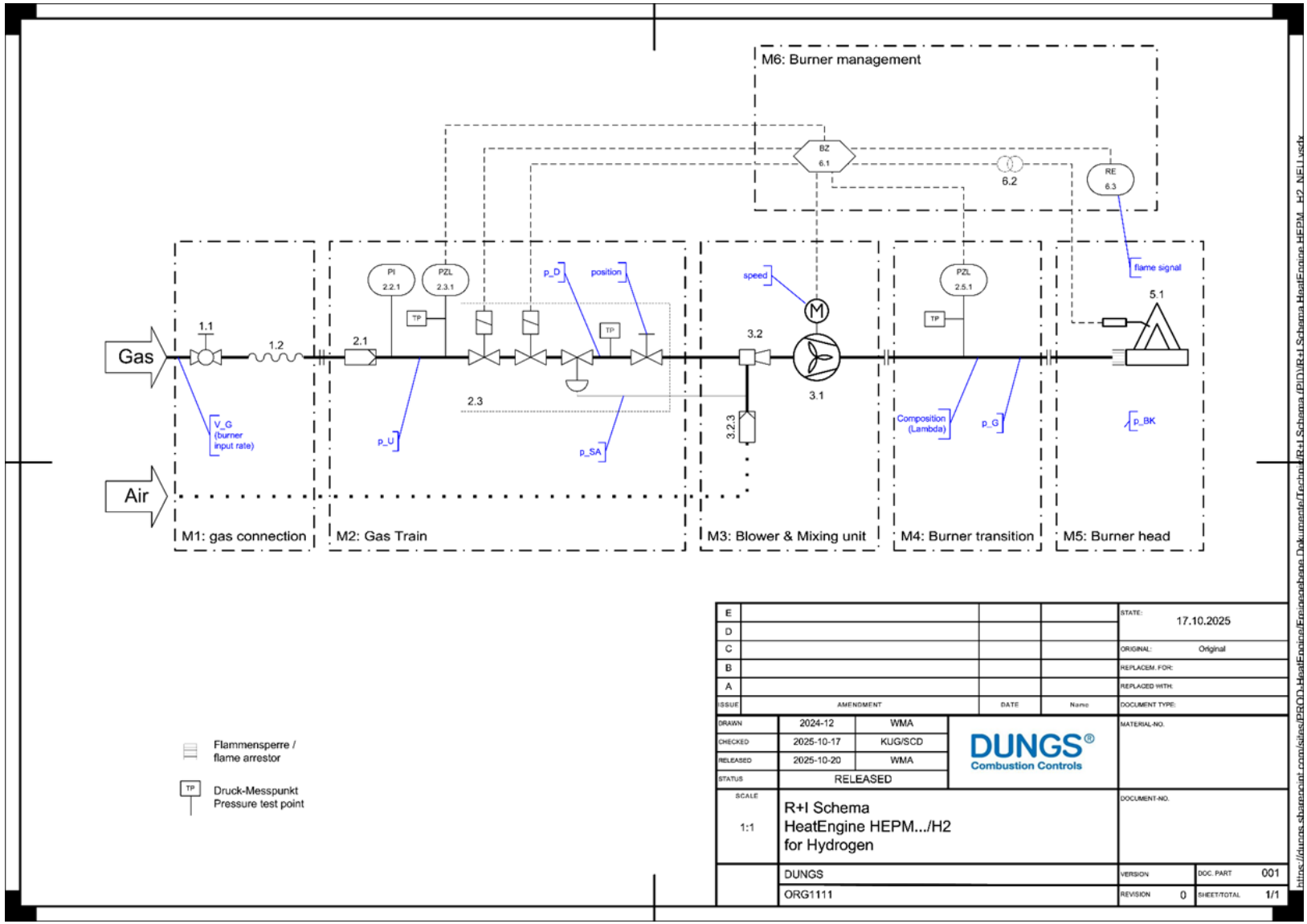
13 Documents and drawings

These instructions include the appendices listed below.

The drawing can be found at the end of the general section of the instructions in the system documentation, and the corresponding documentation is also enclosed for each component of the burner system.

We reserve the right to make changes in the interest of technical progress.

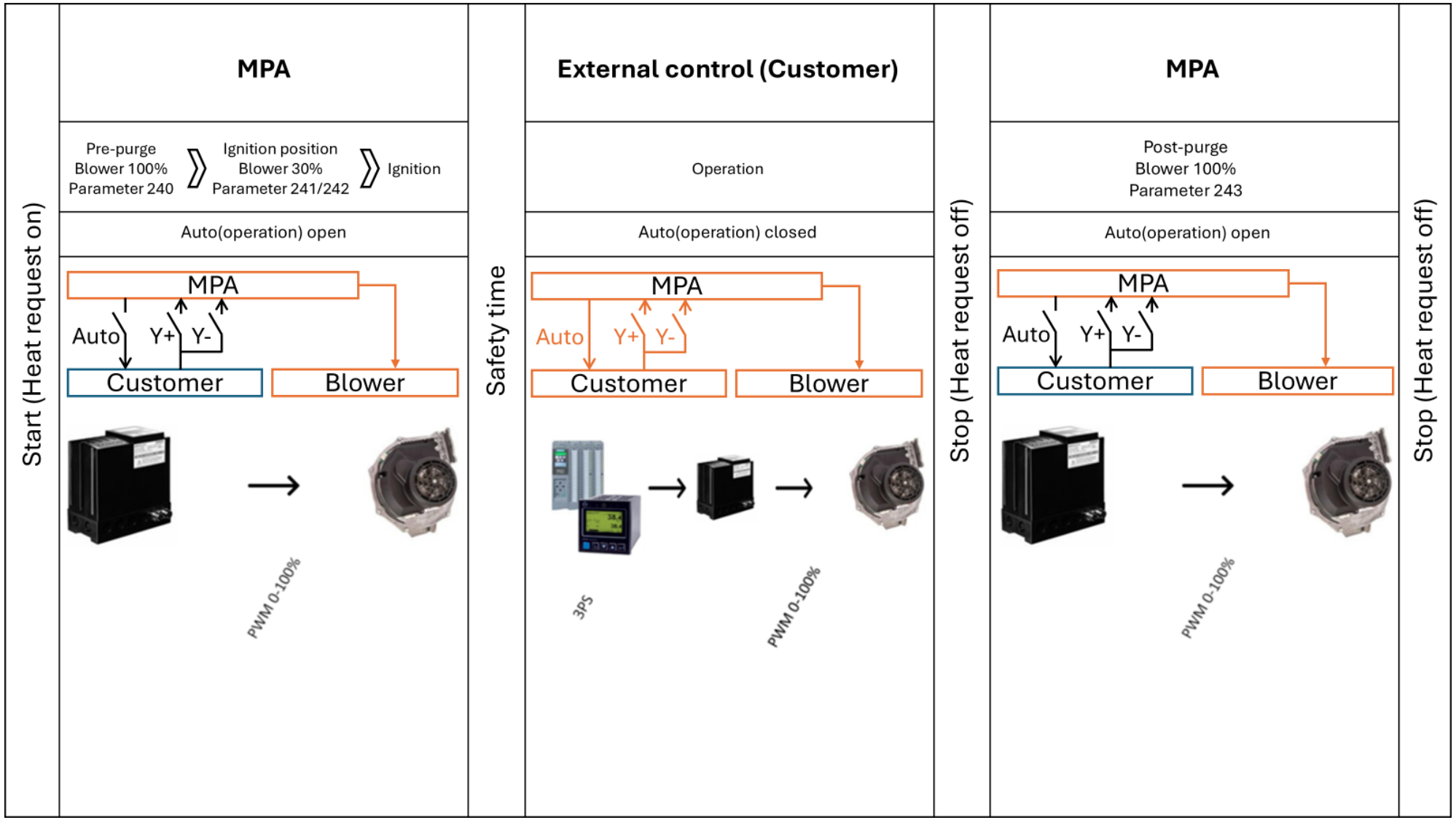
Appendix 1: P&ID diagrams



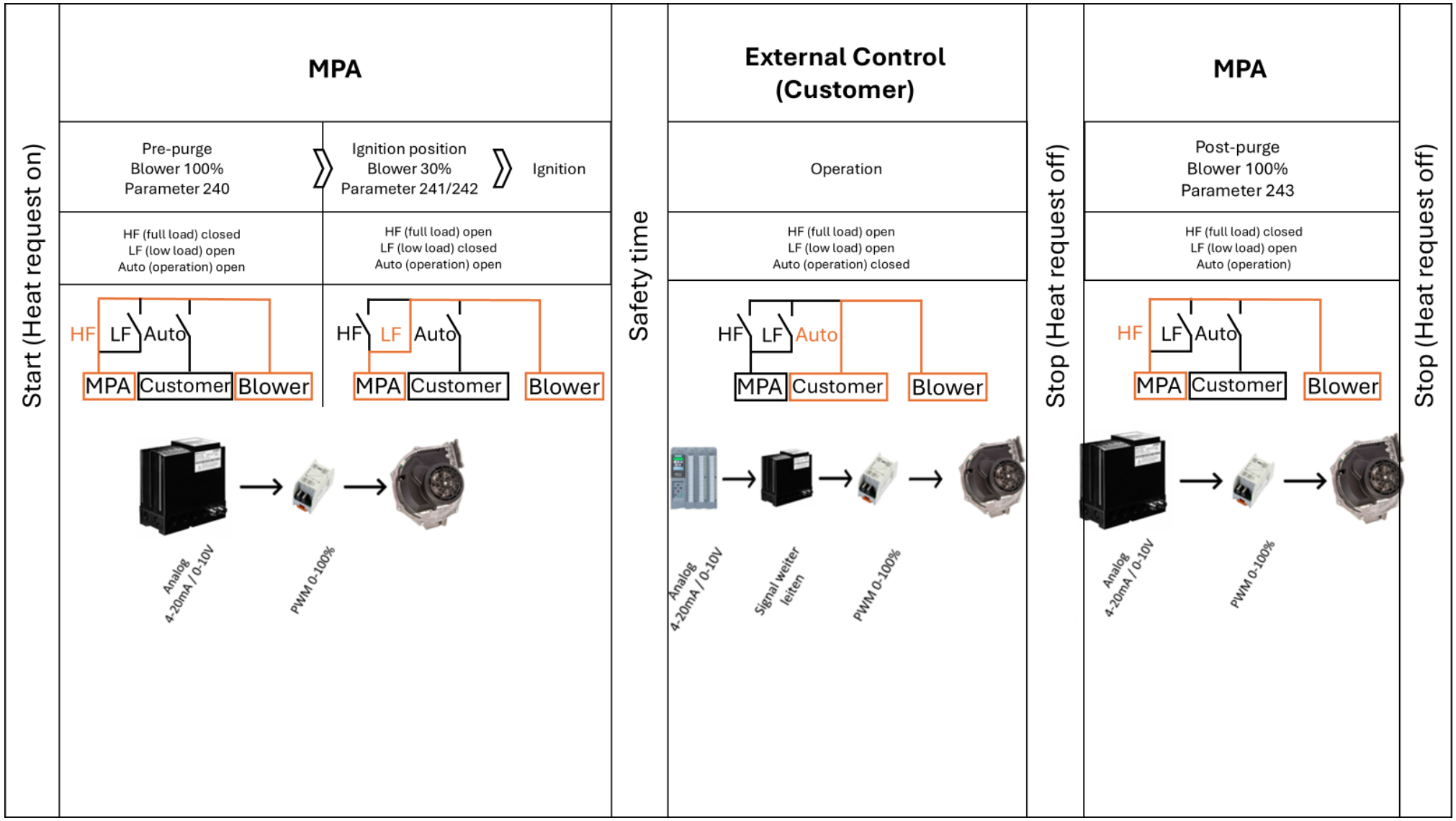
1 Standard P&ID diagram for ISO 13577-2

Appendix 2: Block diagrams

Appendix 2.1: Block diagram 3-point step



Appendix 2.2: Block diagram Analog control



Appendix 3: Important parameters of the automatic burner control MPA V2 and their standard setting

Parameter-No.	Parameter description	Possible values	Presetting
239	Extension module	0, 1 (= EM installed)	1
General			
10	Release parameter settings***	0 = No, 1 = Yes	0
11	Fieldbus address configuration	0…254 (255 = off)	255
12	Number of restart attempts	0, 1, 2, 3, 4, 5	5
13	Number of restart attempts when flame is missing	0, 1, 2, 3, 4, 5	0
14	Number of restart attempts after flame lift-off	0, 1, 2, 3, 4, 5	0
15	Locking with open safety chain	0 = Restart attempt 1 = Immediate malfunction lockout	1
16	Operating mode for LDW 1	0, 1, 2, …, 15	13
17	Temperature controller: Operating mode	0, 1, 2, 3, 4	0
18	Input X17	0, 1, 2, 3, …15	3
19	Configuration of output for operation	0, 1, 2, 3, … 11	3
20	Safety chain open duration	0…65534 [1/ 16 s] (65535 = infinite)	65535
21	Shutter test for flame detector device	0, 1, 2, 3	0
22	FM mode	0, 1	1
23	POC tolerance time	16…48 (in 1/16 s)	16
26	Input X16	see parameter 18	2
27	Input X18	see parameter 18	9
28	Input X19	see parameter 18	10
29	Input X20	see parameter 18	11
60	Network adress 3	0…255	192
61	Network adress 2	0…255	168
65	Behaviour when waiting for air purge / cooling	0, 1	0
Start-up			
30	Pre-aeration duration	0…32767 [1/16 s]	32767
31	Duration of pre-ignition time	2…65534 [1/16 s]	0
32	Safety time for start-up / first safety time	16…960 [1/16 s]	48
33	Active flame detector device(s) for safety time for start-up	1, 2, 3, 4	1
34	Stabilization time A	0…65534 [1/16 s]	48
35	Second saftey time during start-up	16…480 [1/16 s]	16

36	Active flame detector device(s) for phase 2	1, 2, 3, 4	1
37	Stabilization time B	0…65534 [s]	0
38	Operating mode V1 V2	0, 1, 2, … 5	1
39	Maximum waiting time for start release	0…65534 [1/16 s] (65535 = infinite)	2400
48	Ionization threshold	12…60 [0,1 µA]	12
49	Operating release control	0, 1 (= active)	1
Operation			
40	Duration of normal operation	1…65534 [min] (65535 = infinite)	65535
41	Safety time operation FLW 1	12…48 [1/16 s]	16
42	Safety time operation FLW 2	3…48 [1/16 s]	16
43	Duration for new start of pilot burner	8…960 [1/16 s]	16
Shutdown			
50	Follow-up time	16…65534 [1/16 s]	16
51	Post-purge time	16…65534 [1/16 s]	96
52	Restart protection	16…65534 [1/16 s]	0
Extension module			
25	Maximum waiting time until motor position is reached	0…1920 [1/16 s]	480
240	Pre-aeration position	0…100 [%]	100
241	Ignition position	0…100 [%]	30
242	Stabilization	0…100 [%]	30
243	Post-aeration	0…100 [%]	100
244	Start value	0…100 [%]	25
245	Minimum speed	0…100 [%]	23
246	Maximum speed	0…100 [%]	100
247	Schrittweite Drehzahländerung	0…100 [%]	1
248	Increment for speed changes	0…4095,875 [s]	5
249	Bit functionns	PWM / Analog	PWM

Note: The default setting may differ from customized settings. Please pay attention, in the case of customer-specific parameterization, to the parameter setting supplied.

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