VARIFUEL2 -
AIR/FUEL RATIO MIXER

OPERATING MANUAL

VariFuel2
MOTORTECH AIR/FUEL RATIO MIXER

MOTORTECH Gas Regulation
P/N 01.50.001 – DE | Rev. 08/2015

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1 GENERAL INFORMATION

Read through this operating manual carefully before use and become familiar with the machine. Installation and start-up should not be carried out before reading and understanding this document. Keep this manual readily available so that you can reference it as needed.

1.1 What Is the Purpose of this Operating Manual?

This manual serves as an aid for the installation and operation of the product and supports the technical staff with all operating and maintenance tasks to be performed. Furthermore, this manual is aimed at preventing dangers to life and health of the user and third parties.

1.2 Who Is this Operating Manual Targeted to?

The operating manual provides a code of conduct for personnel tasked with the set-up, operation, maintenance, and repair of gas engines. A certain level of technical knowledge with respect to the operation of gas engines and basic knowledge of electronic ignition systems are necessary. Persons who are only authorized to operate the gas engine shall be trained by the operating company and shall be expressly instructed concerning potential hazards.

1.3 Which Symbols Are Used in the Operating Manual?

The following symbols are used in this manual and must be observed:

Example

This symbol indicates examples, which point out necessary handling steps and techniques. In addition, you receive additional information from the examples, which will increase your knowledge.

Notice

This symbol indicates important notices for the user. Follow these. In addition, this symbol is used for overviews that give you a summary of the necessary work steps.

Warning

This symbol indicates warnings for possible risks of property damage or risks to health. Read these warning notices carefully and take the mentioned precautionary measures.

Caution

This symbol indicates warnings for danger to life, especially due to high voltage. Read these warning notices carefully and take the mentioned precautionary measures.

1.4 Which Abbreviations/Acronyms Are Used in the Operating Manual?

The following abbreviations are used in the operating manual:

Abb.	Term	Description	Explanation
CE	Conformité Européenne	Conformity with EU directives	Mark based on EU legislation for certain products in conjunction with product safety
CPR	Counts Per Revolution	Counter results per revolution	Unit for the resolution of encoders
EMC	Electromagnetic Compatibility		Compatibility of electrical or electronic equipment items with their surroundings
ESD	Electrostatic Discharge	Electrostatic Discharge	
LNG	Liquefied Natural Gas	Liquefied natural gas	Natural gas liquefied by cooling
LPG	Liquefied Petroleum Gas	Liquefied gas	Petroleum gas liquefied by cooling and compressing

2 SAFETY INSTRUCTIONS

2.1 General Safety Instructions

MOTORTECH equipment is manufactured as state of the art and therefore safe and reliable to operate. Nevertheless the equipment can cause risks or damages can occur, if the following instructions are not complied with:

- The gas engine must only be operated by trained and authorized personnel.
- Operate the equipment only within the parameters specified in the technical data.
- Use the equipment correctly and for its intended use only.
- Never apply force.
- For all work, such as installation, conversion, adaptation, maintenance, and repair, all equipment must be disconnected from the power supply and secured against unintentional restarting.
- Perform only such maintenance and repair work as is described in this operating manual, and follow the instructions given while working. For maintenance of the equipment, only use spare parts supplied by MOTORTECH. Further work must only be performed by personnel authorized by MOTORTECH. Non-compliance with the instructions will void any warranties for the proper function of the equipment as well as the responsibility for the validity of the certifications.
- Safety devices must not be dismounted or disabled.
- Avoid all activities that can impair the function of the equipment.
- Operate the equipment only while it is in proper condition.
- Investigate all changes detected while operating the gas engine or ignition system.
- Ensure compliance with all laws, directives and regulations applicable to the operation of your system, including such not expressly stated herein.
- If the system is not entirely tight and sealed, gas may escape and lead to an explosion hazard. Upon completion of all assembly works, always check the system's tightness.
- Always ensure adequate ventilation of the engine compartment.
- Ensure a safe position at the gas engine.

2.2 Electrostatic Discharge Hazards

Electronic equipment is sensitive to static electricity. To protect these components from damage caused by static electricity, special precautions must be taken to minimize or prevent electrostatic discharge.

Observe these safety precautions while you work with the equipment or in its vicinity.

- Before performing maintenance or repair work, ensure that the static electricity inherent to your body is discharged.
- Do not wear clothing made from synthetic materials to prevent static electricity from building up. Your clothing should therefore be made of cotton or cotton mix materials.
- Keep plastics such as vinyl and Styrofoam materials as far away from the control system, the modules, and the work environment as possible.
- Do not remove the circuit boards from the housing of the device.

2.3 Special Safety Instructions for the Device

Explosion hazard!

When the system is powered up, do not remove any connectors unless the system is not located in a potentially explosive atmosphere.

Explosion hazard!

If the system is not entirely tight and sealed, gas may escape and lead to an explosion hazard. Upon completion of all assembly works, always check the system's tightness. Make sure too that the gauge ports on the VariFuel2 are closed.

All works involving gas-carrying parts must be executed by trained personnel only.

Operational safety!

All screws of the connectors must be adequately tightened.

Risk of destruction due to electrostatic discharge!

The VariStep stepper motor card may only be installed by specialized personnel who has been trained in handling ESD sensitive components and with due regard to relevant ESD standards. It must be installed into a control cabinet, and it is necessary to comply with the ESD standard DIN EN 61340-5-1; VDE 0300-5-1:2008-07.

Damages caused by electrostatic discharge are not covered by the guarantee.

Risk of burning!

The surfaces of the system may heat up to high temperatures.

Risk of damage!

The stepper motor of the VariFuel2 is not suitable for carrying or lifting a gas mixer. There is a danger that the stepper motor could break, and if the gas mixer were to fall, it could result in injury or property damage.

Always carry or lift the gas mixer by its exterior housing.

2.4 Proper Disposal

After the expiration of its service life, MOTORTECH equipment can be disposed of with other commercial waste, or it may be returned to MOTORTECH. We will ensure its environmentally friendly disposal.

3 INTENDED USE

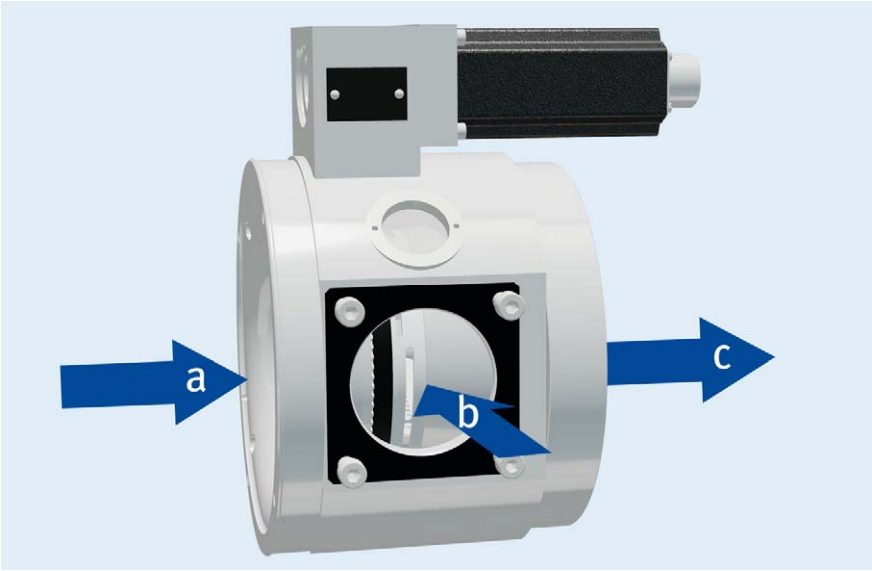
3.1 Functional Description

All graphics used in the functional description represent an example of a VariFuel2 series 200-120 with stepper motor drive. The exact position of the individual parts varies slightly with other series. For the detailed design and exact dimensions, refer to section *Overview Drawings* on page 20.

Basic Design

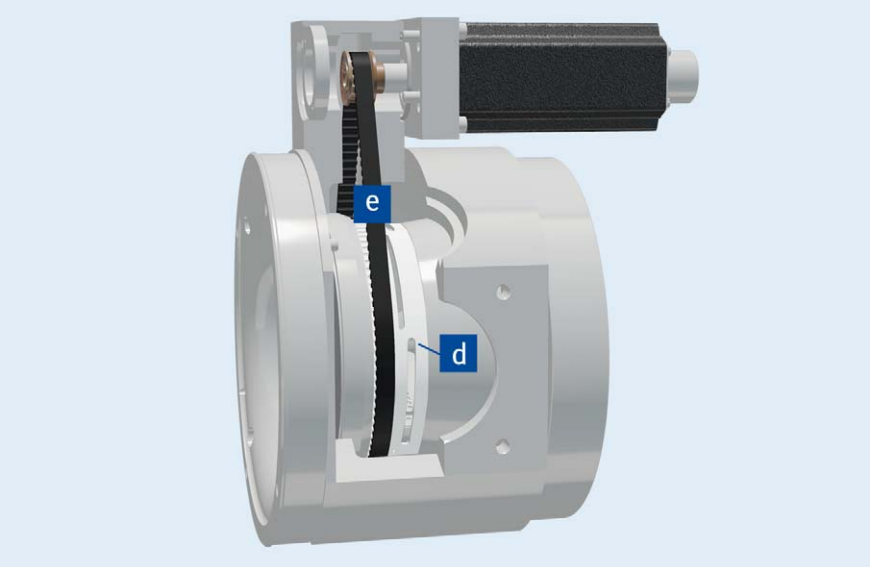
The main task of the gas mixer is to mix the fuel (gas) and air so that the gas engine achieves optimal combustion. Here, the decisive optimization parameters are a high degree of efficiency and low emissions that comply with relevant regulations.

In the VariFuel2, gas and air are mixed based on the Venturi principle. The air is sucked in through the air inlet by the suction pressure of the engine [a] into the Venturi nozzle. This creates an underpressure at the most narrow place, which causes the gas to be sucked in through the gas inlet [b]. In this way, both the gas and the air are mixed and released at the mixture outlet [c]. Based on different design sizes and different flow bodies in the Venturi nozzle, it is possible to achieve various volume flows.



Regulation of the Air/Fuel Mixture

The fuel (gas) is guided into the nozzle using the adjustable openings in a fuel ring d. The openings of the fuel ring are adjusted using a drive belt e either manually or, normally, via a stepper motor, depending on the VariFuel2 type. The stepper motor can be controlled using a stepper motor card. This can process the signals of a master control.



In addition, the VariFuel2 gas mixers are equipped with a gauge port for an air pressure gauge and a connection for the pulse line of a pressure regulator.

3 INTENDED USE

3.2 Applications

The VariFuel2 air-/fuel ratio mixer is designed for use in gas four stroke internal combustion engines. The following substances are approved as fuels:

- Natural gas, biogas, landfill gas, sewage gas, wood gas, drilling-related gas, mine gas, liquefied natural gas (LNG), liquefied petroleum gas (LPG)
- Additional special gases may be used upon approval (there may be restrictions in the case of excessive humidity or impurities in the gas such as tar)

With the appropriate design selected, it is possible to add a fuel gas with a fuel value between 3.0 kWh/m³N to 10.5 kWh/m³N to the air volume flow.

Mixing the air and fuel with the VariFuel2 is designed to be done with the same pressure, therefore it is necessary to use a pressure regulator in the gas train.

The VariFuel2 can mix up to two gases with air. For lean gas applications (such as wood or landfill gas) with a V engine, it is possible to interconnect two VariFuel2 devices to achieve the desired mixing ratio.

If two VariFuel2 gas mixers are being used, two VariStep stepper motor cards are required. An additional splitter is not necessary.

Any use other than the one described in the operating manual shall be considered improper use and will result in the voiding of all warranties.

4 PRODUCT DESCRIPTION

4.1 Technical Data

4.1.1 Certifications

The VariFuel2 air-/fuel ratio mixer are certified according to the following guidelines:

– EMC Directive 2014/30/EU

– Machinery Directive 2006/42/EC

DECLARATION OF INCORPORATION

The company: **MOTORTECH GmbH**
Hogrevestr. 21–23
29223 Celle

declares that the product: **VariFuel2 air-/fuel ratio mixer**

intended purpose: **to be used on gas-Otto-engines**

is a partly completed machine pursuant to Article 2g of the EC Machinery Directive 2006/42/EC.

The following essential health and safety requirements in accordance with Annex I of this Directive are applicable and have been fulfilled:

Annex I, Article
1.1.3
1.1.5
1.3.1
1.3.4
1.5.1
1.5.6
1.5.7
1.6.3

1/2

The relevant technical documentation has been compiled in accordance with part B of Annex VII and will be sent to the relevant national authorities on request as a digital file.

addition, the partly completed machine conforms to all provisions of EC Directive:

EMC Directive 2014/30/EU

The marking of the product is: **P/N 30.45.xxx-xxx**

The partly completed machine may only be commissioned once it has been established that the machine into which the product mentioned above should be incorporated complies with the provisions of the EC Machinery Directive 2006/42/EC.

This declaration is submitted by:

Name: Florian Virchow

Position in company: Managing Director

Celle, dated 2015-04-17

Place, date

Legally binding signature

4.1.2 Mechanical Data

The devices of the VariFuel2 series have the following mechanical characteristics:

Feature	Value
Dimensions	See chapter *Overview Drawings* on page 20
Weight	**Series 100-60** variant with stepper motor: 4.7 kg (10.4 lbs) manual variant: 3.6 kg (7.9 lbs) **Series 140-80** variant with stepper motor: 7.4 kg (16.3 lbs) manual variant: 6.3 kg (13.9 lbs) **Series 200-120** variant with stepper motor: 9.4 kg (20.8 lbs) manual variant: 8.2 kg (18.1 lbs) **Series 250-150** variant with stepper motor: 22.8 kg (50.3 lbs) manual variant: 21.6 kg (47.7 lbs)
Shape of device	See chapter *Overview Drawings* on page 20
Climatic environmental conditions	-10 °C to 80 °C (14 °F to 176 °F) 85 % relative humidity without condensation up to 2000 m (6561') above sea level
Air consumption min./max.	**Series 100-60:** 100 m³/h to 600 m³/h **Series 140-80:** 300 m³/h to 1300 m³/h **Series 200-120:** 850 m³/h to 3200 m³/h **Series 250-150**: 2500 m³/h to 5000 m³/h
Suitable for flow bodies with min./max. diameter	**Series 100-60:** 23 mm to 45 mm **Series 140-80:** 23 mm to 72.5 mm **Series 200-120:** 23 mm to 105 mm **Series 250-150:** 23 mm to 110 mm

4.1.3 Digression: Control of the Stepper Motor

In the standard application, the stepper motor of the VariFuel2 gasmixer is activated by the VariStep stepper motor card. For example, if you want to implement a direct activation from a master control, you receive the technical details for activation of the stepper motor in the following section.

Technical Data of the Stepper Motor

Feature	Value
Design	2-phase, bipolar
Maximum phase current	2,8 A
Recommended current	1,4 A (full step operation mode) 2 A (microstep operation mode)
Step width	0,9°
Recommended control	1/16 microstep operation mode
Holding torque at maximum phase current	1,75 Nm (15.49 lb-ft)
Rotation angle	**100-60D**: 192° **140-80D:** 250° **200-120D:** 330° **250-150D**: 230°

Technical Data of the Encoder

Feature	Value
Measuring method	magnetic
Operating voltage	5 V
Type	incremental, quadrature signal
Signal form	A, B, index; TTL-compatible
Resolution	4,096 CPR
Index position	Open Position

You can find the assignment of the connectors on the stepper motor and encoder in the section *Pole Connector Stepper Motor/Encoder* on page 29.

4.1.4 Warning Notices on the Device

Warning Notice on Stepper Motor

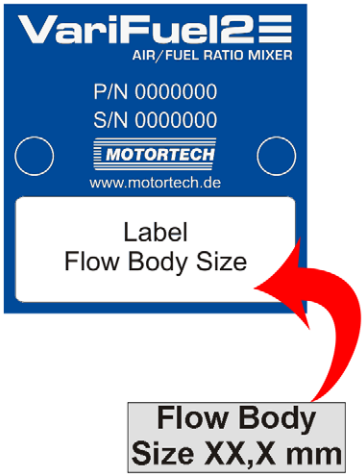
CAUTION! Stepper motor rev. B only for use with VariStep stepper motor card. Do not use stepper motor to lift or carry VariFuel2 air/fuel ratio mixer.

4.1.5 Product Identification – Labeling on the Device

Nameplate Air/Fuel Ratio Mixer on Upper Part of Housing

Abb.	Meaning
P/N	Product number of the air-/fuel ratio mixer
S/N	Serial number of the air-/fuel ratio mixer

Attach the label enclosed with the flow body to the field *Label Flow Body Size* on the nameplate of the VariFuel2. So you can determine the flow body size if the gas mixer is installed.



Nameplate Stepper Motor

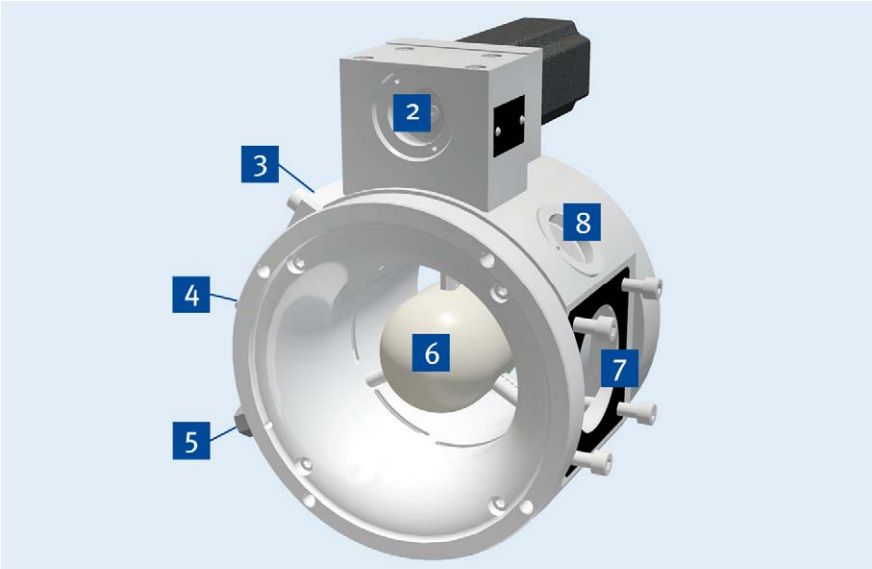
(only in versions with stepper motor)

Abb.	Meaning
P/N	Product number of the stepper motor
PC	Production code
REV.	Revision of the stepper motor

4.1.6 Overview Drawings

Components

The following drawing shows an example of a VariFuel2 series 200-120 with stepper motor drive. The exact position of the individual parts varies slightly with other series. A detailed layout can be found in the subsequent section *Dimensions*.

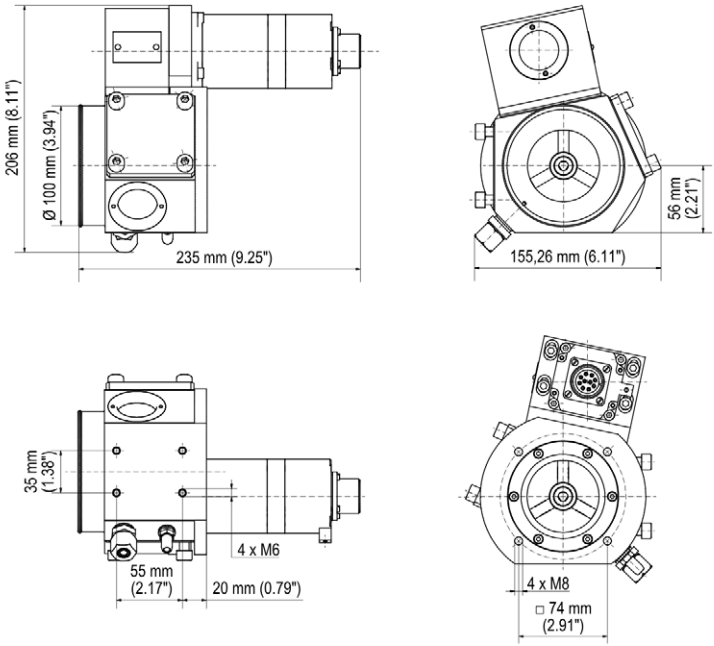


Item no.	Description
1	Stepper motor (not for manual variants)
2	Inspection window
3	Gas connection
4	Gauge port for a pressure measuring device (measures gas underpressure in the mixer)
5	Pulse line connection for a pressure regulator
6	Flow Body
7	Gas connection
8	Inspection window

Dimensions

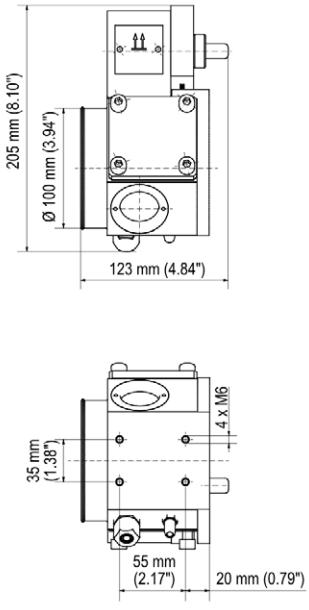
Series 100-60

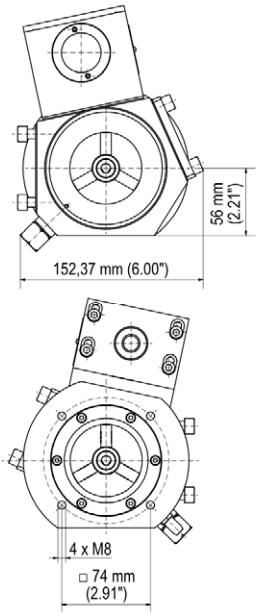
Variant with stepper motor



Series 100-60

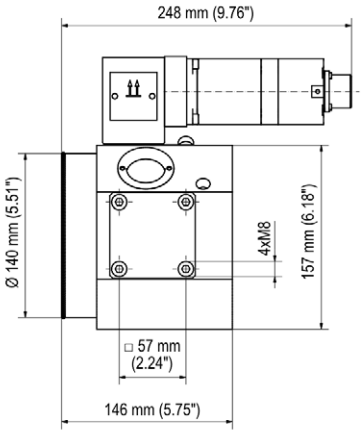
Manual variant

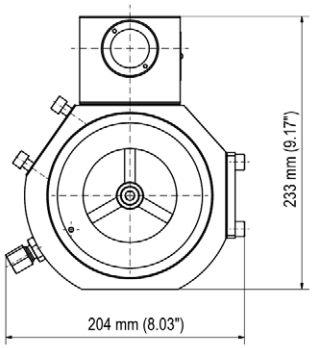


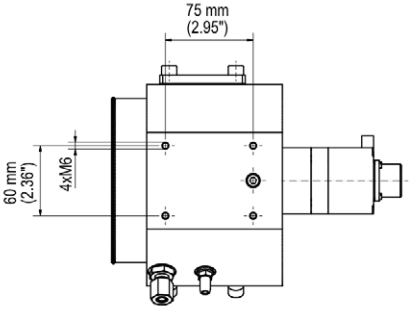


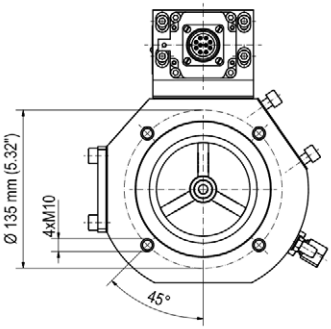
Series 140-80

Variant with stepper motor

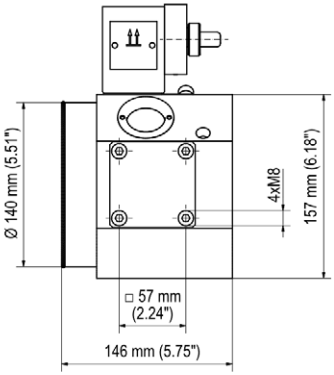


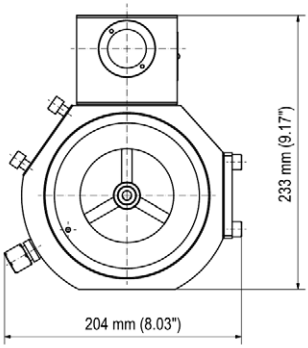


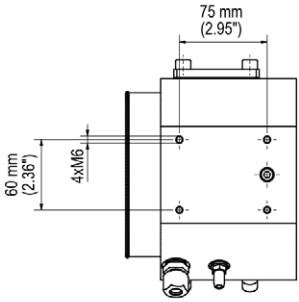


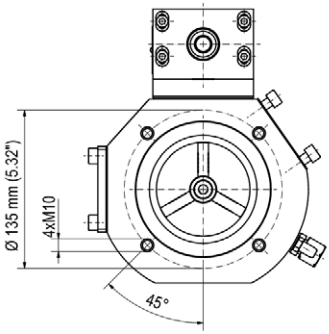


Series 140-80
Manual variant



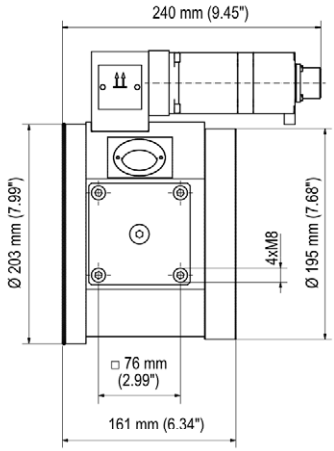


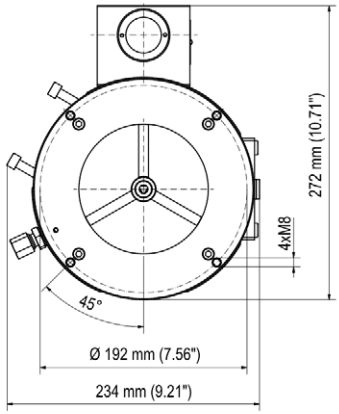


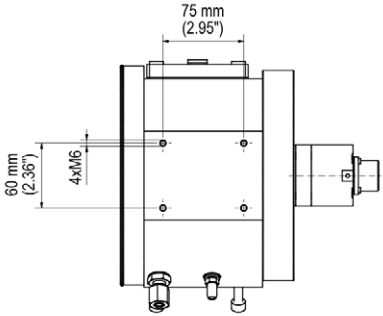


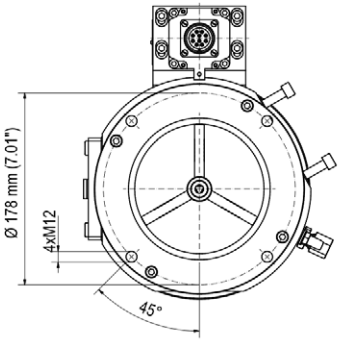
Series 200-120

Variant with stepper motor

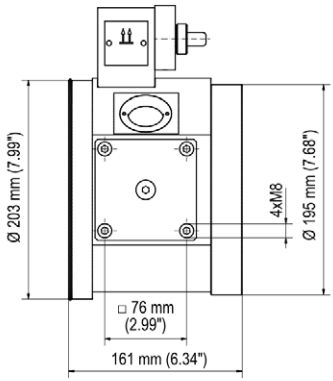


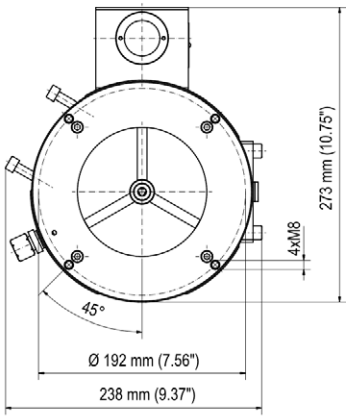


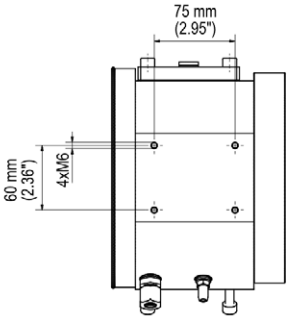


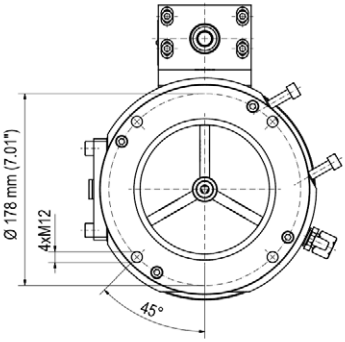


Series 200-120
Manual variant



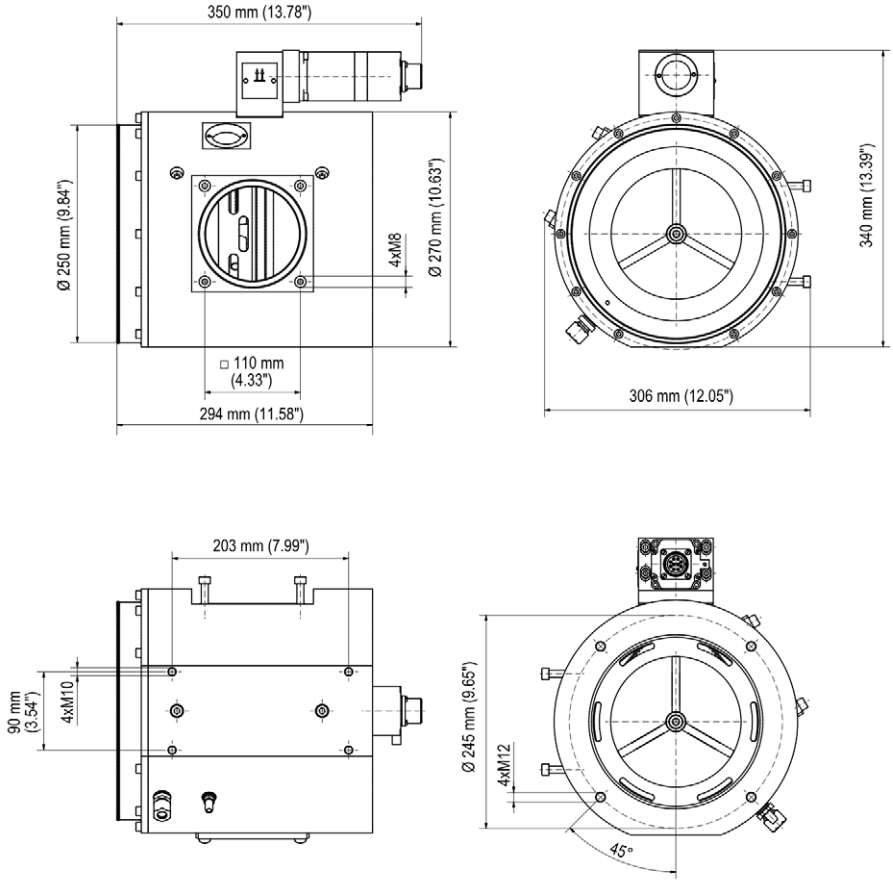




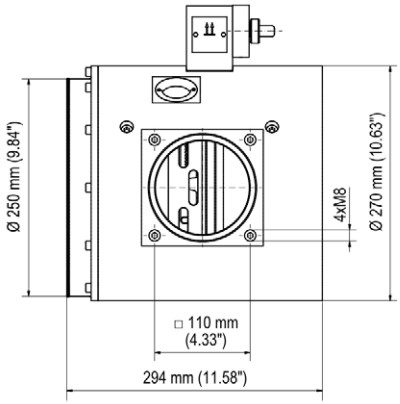


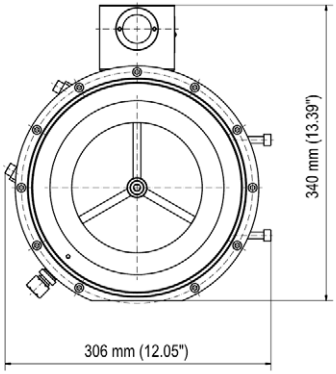
Series 250-150

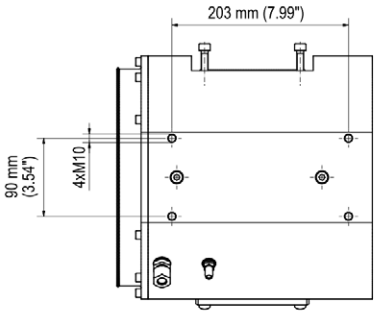
Variant with stepper motor

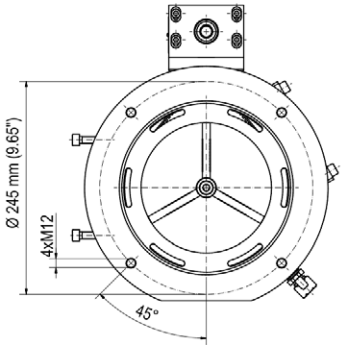


Series 250-150
Manual variant





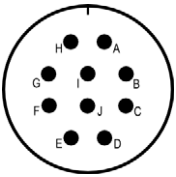




5 WIRING OF THE DEVICE

5.1 Pole Connector Stepper Motor/Encoder

The connection of the stepper motor to the VariStep stepper motor card is carried out using the original MOTORTECH harness via the 10-pin connector on the stepper motor:



Pin stepper motor / encoder	Description
A	Stepper motor phase A1
B	Stepper motor phase A2
C	Stepper motor phase B1
D	Stepper motor phase B2
E	Encoder A
F	Encoder B
G	Encoder I (index)
H	Earth
I	Encoder 5 V supply voltage
J	Encoder earth

6 INSTALLATION INSTRUCTIONS

6.1 Unpacking

Unpack the device, taking care not to damage it, and ensure that the operating manual is always stored with the device and is easily accessible. Check the contents for completeness and verify that the device type meets your application requirements.

Risk of destruction due to electrostatic discharge!

The VariStep stepper motor card may only be installed by specialized personnel who has been trained in handling ESD sensitive components and with due regard to relevant ESD standards. It must be installed into a control cabinet, and it is necessary to comply with the ESD standard DIN EN 61340-5-1; VDE 0300-5-1:2008-07.

Damages caused by electrostatic discharge are not covered by the guarantee.

Scope of Supply

The following components are included in the VariFuel2 device delivery:

- VariFuel2 air-/fuel ratio mixer
- Gasket for mixture outlet flange
- Operating Manual

Accessory

- Flow Body
- Optional: Adaptors for gas inlet and mixture outlet
- Wiring harness for the connection between VariFuel2 and stepper motor card (not applicable with manual drive)
- VariStep stepper motor card incl. configuration software and USB interface cable (not included with manual drive)

6.2 Assembly

Risk of damage!

The stepper motor of the VariFuel2 is not suitable for carrying or lifting a gas mixer. There is a danger that the stepper motor could break, and if the gas mixer were to fall, it could result in injury or property damage.

Always carry or lift the gas mixer by its exterior housing.

The following steps must always be carried out and are specified in more detail in the following:

- Install Flow Body
- Install VariFuel2 into intake section (air and gas inlet plus mixture outlet)
- Connect stepper motor card

Install Flow Body

Explosion hazard! Risk of damage!

The self-locking nut of the flow body secures itself against loosening by buckling a plastic ring in the slot of the nut by force-fit after tightening. If the self-locking nut is loosened, the plastic ring buckles again, so that the nut can no longer be securely tightened. If the flow body were to fall apart due to the use of a no longer securable nut, parts of the system will be destroyed and it could cause an explosion.

For the safe operation of the VariFuel2, please observe the following guidelines:

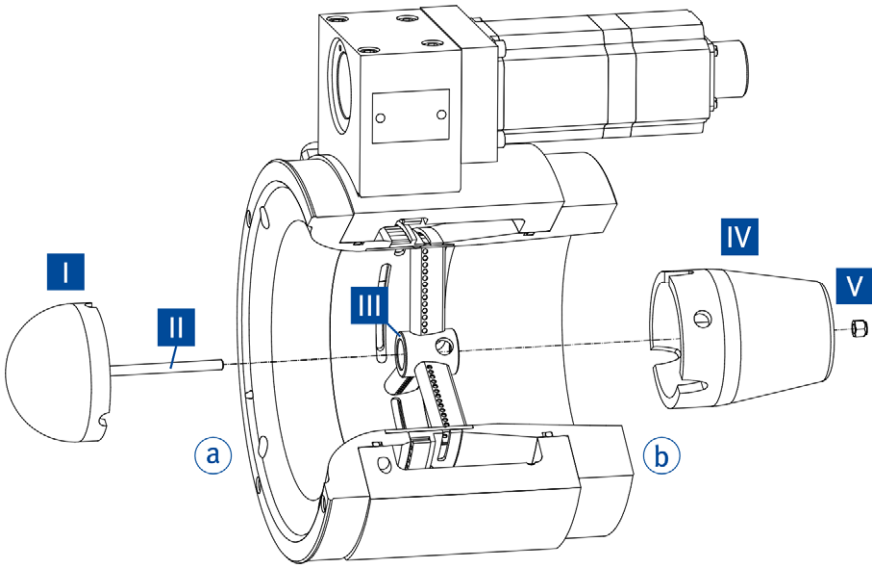
- The self-locking nut is pre-mounted on unused MOTORTECH flow bodies. For installation, the self-locking nut may be removed one time, and then used only one time for secure attachment.
- Under no circumstances may the used self-locking nut be used again in the event of flow body replacement.

–

To install or replace the flow body, free access must be provided at the VariFuel2 both on the air inlet and on the mixture outlet.

6 INSTALLATION INSTRUCTIONS

Proceed as follows:



1. Attach the label enclosed with the flow body to the field L*abel Flow Body Size o*n the nameplate of the VariFuel2. So you can determine the flow body size if the gas mixer is installed.
2. First, completely disassemble the flow body by unscrewing the self-locking nut V and disconnecting the two body halves I IV.
3. To install the flow body, first slide the round half I over the central nozzle ring III on the air inlet side ⓐ. Please note that the smallest flow body (ø 23 mm / 0.9") cannot be put on the central nozzle ring, but must be put in front of it.
4. Now, please put the second half of the flow body IV on the mixture outlet side ⓑ over the threaded rod II of the first half and the central nozzle ring III.
5. Secure the threaded rod II with the self-locking nut V. Use the appropriate torque:
   - Aluminum flow body: 5 Nm (3.7 lb-ft)
   - Plastic flow body 3 Nm (2.2 lb-ft)

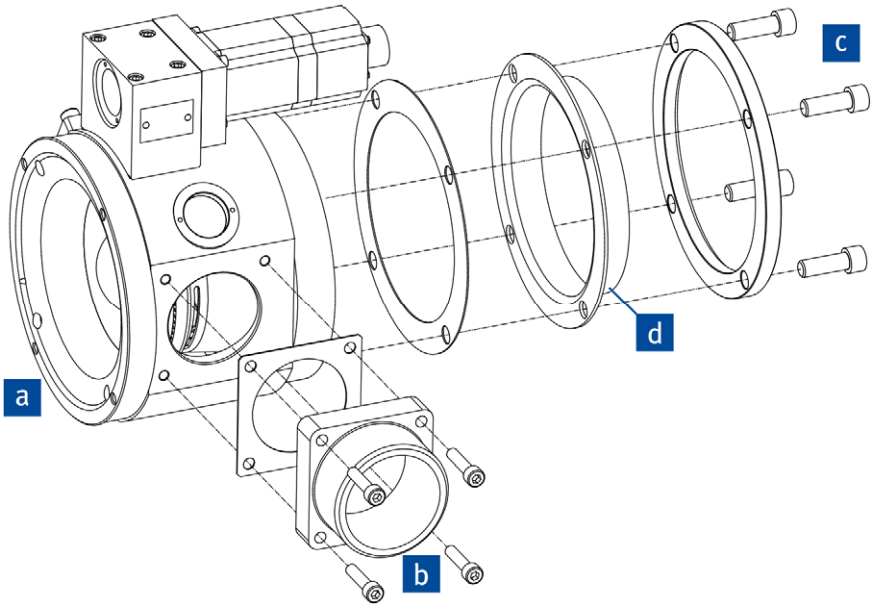
Install VariFluel2 into Intake Section

The mounting position of the VariFuel2 is arbitrary. For mounting, use the four M6 threaded holes and the flat surface on the bottom side of the device.

The following must be observed during installation:

- The VariFuel2 mounting must be tension-free, or in other words, all holes in the flange must be aligned with housing bore holes.
- For the mixture outlet, consider the additional depth of the engine-specific mounting flange.
- For the air inlet, gas inlet and mixture outlet, use only galvanized hexagon bolts.
- Ensure that the inspection window on the fuel ring 8 remains freely accessible and is for example not covered by a pipe.
- Take care that the inspection window on the drive belt 2 remains easily available for checking and setting the belt tension.

Generally, you need to connect the following ports:



Explosion hazard!

If the system is not entirely tight and sealed, the combustible gas mixture may escape and result in explosion hazard. Therefore, all ports and connections must be gas-tight. Always use suitable sealing and connecting material.

Air inlet a

Hose connection (such as with clamp, seal and counter flange)

– Gas inlet b
  Connection of a flexible gas line via a mounting flange. It is particularly important that the gas line is flexible if the gas mixer is rigidly coupled with the engine. The VariFuel2 has two connections (3 7) for the gas connection. If required, it is possible to modify the relevant cover. For two-gas operation another adaptor must be ordered in order to be able to use both gas connections simultaneously.
– Mixture outlet c
  Connection via a bolt hole circle for engine specific mounting flange d (available with clamp, seal and counter flange)

If needed, you can also create the following additional connections:

– Gauge port 4
  Connection for the measuring lead of a pressure measuring device
– Pulse line connection 5
  Connection for the pulse line connection of a pressure regulator

Connect Stepper Motor Card

The connection of the control of the stepper motor is described in detail in the operating manual for the VariStep stepper motor card.

Risk of damage!

Please observe the following procedure when connecting the stepper motor to the VariStep stepper motor card:

1. Configure the VariStep stepper motor card for the desired VariFuel2 gasmixer (see section *External device* in the operating manual for the VariStep stepper motor card).
2. Separate the stepper motor card from the power supply.
3. Connect the stepper motor of the VariFuel2 carburetor to the stepper motor card.
4. Connect the VariStep stepper motor card again to the power supply.
   ▸ Now, the stepper motor card will initiate a reference run. The VariFuel2 gasmixer is ready for operation.

Reference numbers 2, 3, 4, 5, 7 and 8

For reference numbers 2, 3, 4, 5, 7 and 8, refer to section *Overview Drawings* on page 20.

7 OPERATION

7.1 Start up

Explosion hazard!

If the system is not entirely tight and sealed, the combustible gas mixture may escape and result in explosion hazard. Upon completion of your works, please make sure that you close the test port on the VariFuel2.

Basic Settings of the System

With an ideal design, the VariFuel2 is operated in a range between 15 and 70 % of the fuel ring's opening. In this way the prescribed emission values should be complied with nominal load.

Problems When Starting

Often the gas engine's problem is its starting behavior. With the starting speed the air speed in the gas mixer is very low, which will cause very low suction pressure at the gas inlet. This can lead to not enough gas being sucked into the engine to make the mixture ignite. The following procedures may be helpful:

- In the case of gases with low heating value it may be necessary for the engine start to set the pressure regulator to a low overpressure (max. 5 mbar at starting speed). Do not set the overpressure too high, because too much gas content in the engine can lead to start problems. As soon as the engine is running, set the zero pressure regulator back to pressure balance in idle at nominal RPM. This setting guarantees that adequate suction pressure exists at the gas inlet at engine start.
- Another cause might be that the diameter of the gas connecting flange is too small to deliver adequate gas to the engine at a low suction pressure. In this case, use a larger gas connecting flange. To do so, please contact MOTORTECH.

Engine Does Not Reach Nominal Power

With the prescribed emissions, the engine does not reach its nominal output. The following scenarios might be possible:

Scenario 1:

- The opening of the fuel ring is in the range between 15 % and 70 %.
- The nominal output is reached by enriching the mixture.
- At the gauge port of the VariFuel2 an underpressure greater than 30 mbar is measured.

In this case, it is necessary to increase the air supply. This can be achieved based on the following measures:

- Check the underpressure in the air intake line (standard value: -5 mbar to -25 mbar)
- Install a smaller flow body. To do so, please contact MOTORTECH.

Scenario 2:

– The opening of the fuel ring is › 95 %
– The nominal output is not reached by enriching the mixture.
– An underpressure less than 60 mbar has been measured at the gauge port of the VariFuel2.

In this case, it is necessary to increase the gas supply. This can be achieved by carrying out one of the following measures:

– Install larger flow body or use larger gas connecting flange. To do so, please contact MOTORTECH.

8.1 Special Tools for Troubleshooting

Special tools have been developed at MOTORTECH which are needed to carry out certain work safely and conveniently for the maintenance and repair of VariFuel2 air-/fuel ratio mixer. The following tools can be obtained from MOTORTECH:

– VariFuel2 Locking Tool for the Toothed Pulley
  With this tool, you turn the toothed pulley of a VariFuel2 to tighten or loosen the hexagon socket head cap screws with which the toothed pulley is attached to the shaft.
– VariFuel2 Tool for Inspection Window
  You use the VariFuel2 Tool for Inspection Window to mount and demount the inspection window on the upper part of the housing of a VariFuel2.
– VariFuel2 Adjustment Tool for Belt Tension
  The VariFuel2 Adjustment Tool for Belt Tension is ideal for adjusting the tension of the drive belt of a VariFuel2 air-/fuel ratio mixer.

The tools are supplied with brief operating instructions, which must be taken into account during use.

8.2 Possible Faults

Explosion hazard!

If the system is not entirely tight and sealed, the combustible gas mixture may escape and result in explosion hazard.

The device's tightness is checked and guaranteed by MOTORTECH after production. If the device is opened by the customer for installation or maintenance purposes, the customer is responsible for restoring the system's leak tightness. If the customer cannot guarantee this, the device must not be opened and must be replaced and returned to MOTORTECH to remedy any failures.

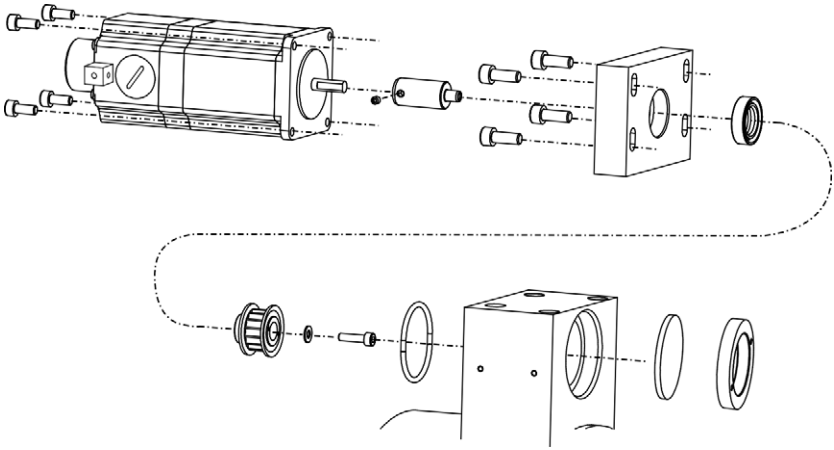
Troubleshooting

Problem	Possible cause	Solution
Movement of the fuel ring lags.	Shaft has loosened from the stepper motor.	Tighten the shaft with the set screw (see *Fix Shaft* on page 40). Upon completion, check if the system is properly sealed!
	Belt tension is too low.	Adjust belt tension with the VariFuel2 Adjustment Tool for Belt Tension and adjust the fuel ring (see *Adjust the Fuel Ring* on page 43).
Fuel ring does not move.	Fuel ring is dirty.	Disassemble and clean the VariFuel2 and replace all wearing parts. For this operation, you need special repair kits from MOTORTECH.
	Influence of master control	Check the master control.
	Shaft has loosened from the stepper motor.	Tighten the shaft with the set screw (see *Fix Shaft* on page 40). Upon completion, check if the system is properly sealed!
	Stepper motor is damaged.	Replace the stepper motor. For this operation, you need special repair kits from MOTORTECH.
	Stepper motor card is in error mode.	Confirm all error messages.

Problem	Possible cause	Solution
	Wrong configuration of the stepper motor card.	Configure your VariStep stepper motor card via the MICT. Afterwards if necessary adjust the fuel ring (see *Adjust the Fuel Ring* on page 43).
	Stepper motor card is not compatible.	Use a compatible stepper motor card.
	Wiring of stepper motor and/or stepper motor card is faulty.	Check the wiring and make sure that the required supply voltage is applied.
	Toothed pulley has come off the shaft of the stepper motor.	Tighten the toothed pulley with the VariFuel2 Locking Tool for Toothed Pulley and adjust the fuel ring (see *Adjust the Fuel Ring* on page 43).
	Belt tension is too high.	Adjust the belt tension with the VariFuel2 Adjustment Tool for Belt Tension. Afterwards, adjust the fuel ring (see *Adjust the Fuel Ring* on page 43).
Traverse range of the fuel ring corresponds to the size of one opening of the fuel ring. However, the location of the movement is wrong.	Incorrect adjustment of the fuel ring	see *Adjust the Fuel Ring* on page 43
Traverse range of the fuel ring is too small / too big.	A wrong VariFuel2 is configured in the stepper motor card.	Configure your VariStep stepper motor card via the MICT. If necessary adjust the fuel ring (see *Adjust the Fuel Ring* on page 43).
Fuel ring scale is not in the inspection window.	Home position lost.	see *Adjust the Fuel Ring* on page 43
POWER-LED of the stepper motor card does not light up although it is connected to the supply voltage.	Stepper motor card is defective.	Replace the stepper motor card.
Stepper motor does not move without interruptions.	This is **not** a malfunction. When the air/fuel ratio is correct, the motor remains in its position.	

8.3 Fix Shaft

To fix the shaft between stepper motor and VariFuel2 the stepper motor must be completely demounted. The explosion view provides information on how the stepper motor has been installed.



Demounting

1. Remove the inspection window in the upper part of the housing with the VariFuel2 Tool for Inspection Window. For this purpose read the instruction for the VariFuel2 Tool for Inspection Window.
2. Remove the adapter plate with the stepper motor and O-ring from the housing of the VariFuel2.
3. Disconnect the toothed pulley from the shaft of the stepper motor.
4. Remove the adapter plate from the stepper motor.
5. Loosen the set screw from the shaft.

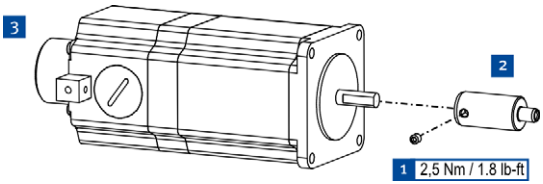
Installation

1. Moisten the set screw 1 with thread lock fluid.
2. Replace the shaft 2 on the axis of the stepper motor 3 and tighten the set screw with the torque stated in the following drawing.

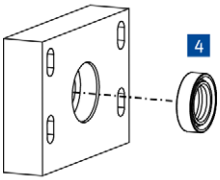
Alignment and positioning of the shaft

Observe the following while positioning the shaft.

- The drill hole in the shaft must be aligned with the flattening of the axle.
- The shaft must be 1 mm from the stepper motor.



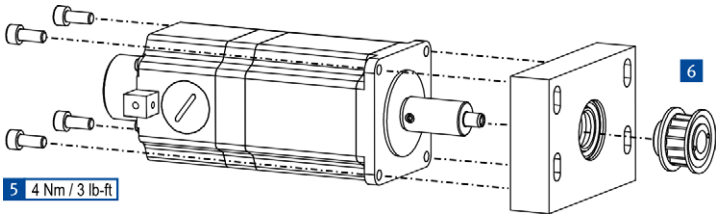
3. Moisten the shaft seal ring 4 with silicone spray.
4. Press the shaft seal ring 4 with the flat side first into the adapter plate.



5. Moisten the hexagon socket head cap screws M5x12 5 with thread lock fluid.
6. Screw the adapter plate to the stepper motor and place the toothed pulley 6 on the shaft.

Observe alignment of stepper motor

Align the stepper motor and adapter plate as shown in the illustrations. The ground block and the elongated holes on the adapter plate serve as orientation.

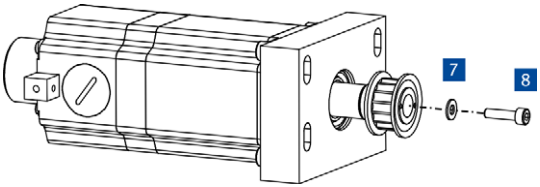


7. Attach the toothed pulley with the washer 7 and the hexagon socket head cap screw M4x16 8 to the shaft of the stepper motor.

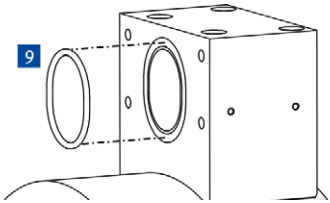
NOTICE

Do not tighten the screws

Do not tighten the hexagon socket head cap screw M4x16 8. The toothed pulley must be rotatably mounted on the shaft to allow the fuel ring to be adjusted.



8. Insert the O-ring 37.5x2.65 9 into the housing of the VariFuel2.

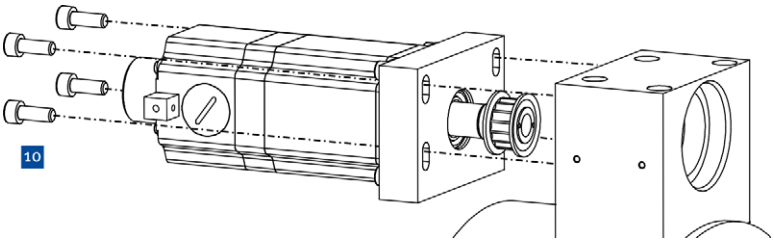


9. Attach the stepper motor with the hexagon socket head cap screw M6x16 10 to the adapter plate to the VariFuel2.

NOTICE

Do not tighten the screws

Do not tighten the hexagon socket head cap screw M6x16 10. The stepper motor has to remain movable to enable the correct belt tension to be set.

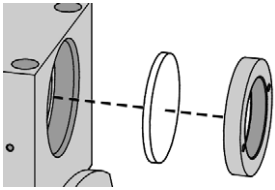


10. Tighten the drive belt with the VariFuel2 Adjustment Tool for Belt Tension. For this purpose read the instruction for the VariFuel2 Adjustment Tool for Belt Tension.
    - ▸ The stepper motor has been installed. You can continue with the adjustment of the fuel ring (see *Adjust the Fuel Ring* on page 43).

8.4 Adjust the Fuel Ring

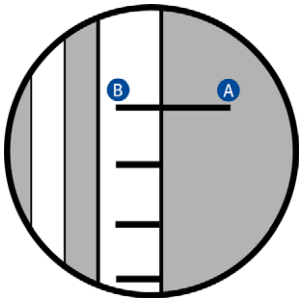
In order to adjust the fuel ring, the VariFuel2 must be connected with the VariStep stepper motor card. Adjust the fuel ring as follows:

1. Stop the gas supply.
2. Remove the inspection window from the upper part of the housing with the VariFuel2 Tool for Inspection Window.



3. Loosen the toothed pulley in the upper part of the housing with VariFuel2 Locking Tool for Toothed Pulley and a hex key.
4. Connect the stepper motor to the VariStep stepper motor card. For this purpose read the operating manual of the stepper motor card.
5. Move the stepper motor into the closed position.

6. Move the toothed belt by hand to turn the reference scale of the fuel ring into the inspection window on the side of the VariFuel2. Set the closed position of the fuel ring – indicator A must point at the upper line of the reference scale B.



7. Hold the toothed pulley with the VariFuel2 Locking Tool for the Toothed Pulley. For this step read the instruction for the VariFuel2 Locking Tool for the Toothed Pulley. Tighten the toothed pulley with the hexagon socket head cap screw M4x16 on the shaft (torque 2.5 Nm / 1.9 lb-ft).

Conduct in the event of an error message

If you move the stepper motor while tightening the screw, you will get an error message from the stepper motor card. Confirm this via the MICT.

8. Initiate a reference run with the stepper motor card.
   - The fuel ring has been adjusted and the stepper motor approaches all positions correctly again.
9. Close the inspection window in the upper part of the housing with the VariFuel2 Tool for Inspection Window

8.5 Customer Service Information

You can reach our customer service during business hours at the following phone and fax number, or by e-mail:

Telephone: +49 5141 93 99 0

Fax: +49 5141 93 99 99

Email: service@motortech.de

8.6 Returning Equipment for Repair / Inspection

Get a return form and return number from MOTORTECH to return the device for repair and inspection.

Fill the return form out completely. The completely filled out return form guarantees fast, smooth processing of the repair order.

Send the device and the return form to one of the two addresses below or to the nearest MOTORTECH representative:

MOTORTECH GmbH
Hogrevestr. 21-23
29223 Celle

Germany

Telephone: +49 5141 93 99 0
Fax: +49 5141 93 99 98

www.motortech.de
motortech@motortech.de

MOTORTECH Americas, LLC
1400 Dealers Avenue, Suite A
New Orleans, LA 70123

USA

Telephone: +1 504 355 4212
Fax: +1 504 355 4217

www.motortechamericas.com
info@motortechamericas.com

8.7 Instructions for Packaging the Equipment

For return shipment, equipment should be packaged as follows:

- Use packaging material that does not damage the equipment surfaces.
- Wrap the equipment with sturdy materials and stabilize it inside the packaging.
- Use sturdy adhesive film to seal the packaging.

9 MAINTENANCE

9.1 Maintenance Instructions

Explosion hazard!

If the system is not entirely tight and sealed, the combustible gas mixture may escape and result in explosion hazard.

The device's tightness is checked and guaranteed by MOTORTECH after production. If the device is opened by the customer for installation or maintenance purposes, the customer is responsible for restoring the system's leak tightness. If the customer cannot guarantee this, the device must not be opened and must be replaced and returned to MOTORTECH to remedy any failures.

Observe the following maintenance instructions:

- Examine the VariFuel2 for contamination as a part of the regular maintenance intervals customary for your system. To have your VariFuel2 cleaned, please contact your MOTORTECH contact person.
- All maintenance works which require to open the VariFuel2 (such as adjusting the fuel ring) must only be carried out by personnel trained by MOTORTECH.
- Spare parts (e. g. drive belts, fuel ring) can be obtained from MOTORTECH as repair sets. If a safe repair cannot be carried out, since the gas tightness for example cannot be tested, the device must be returned to MOTORTECH. MOTORTECH will provide an exchange unit for the duration of the repair.

9.2 Spare Parts and Accessories

For spare parts and accessories, please refer to our current Product Guide, which is available for you to download on the Internet at *www.motortech.de* .

10 INDEX

Original MOTORTECH® accessories for stationary gas engines

As a supplier, MOTORTECH develops, produces and distributes accessories as well as spare and wearing parts for nearly all kinds of stationary gas engines worldwide: Ignition control and monitoring, industrial spark plugs and high tension leads, wiring systems and gas regulation– from detonation to speed control and complete gas engine management. On-site support and special training courses complete our service.

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