SINGLE STROKE METERING SYSTEM

FEM 1.02_.55 RC, FEM 1.09_.55 RC

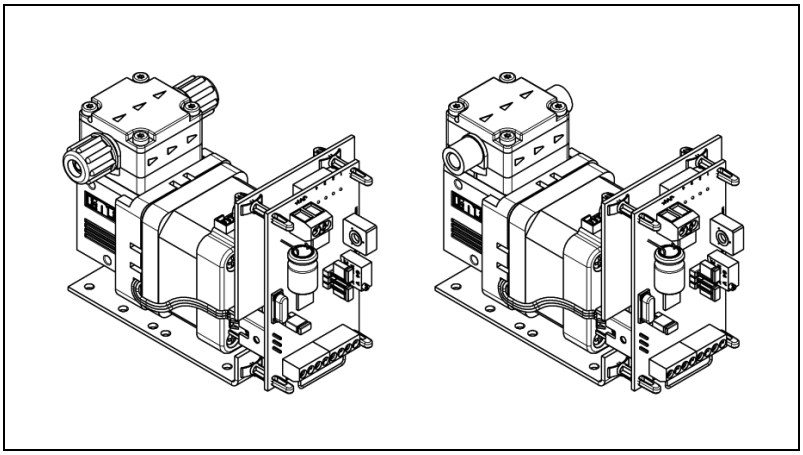
FEM 1.02 KP .55 RC

- RC [Ch. 4, 5]
- .55 / - [Ch. 5]
- KP / KT / TT [Ch. 4]
- 1.02 / 1.09
- FEM / UFEM
- - / PMLxxxx / PLxxxx [Ch. 1]

Operating and Installation Instructions

Read and observe these operating and installation instructions.

An additional letter prefixing the FEM model code is a country-specific designation, with no technical relevance.



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1. About this document

1.1. Use of the operating and installation instructions

The operating and installation instructions are part of the pump.

➔ Pass on the operating and installation instructions to the next owner.

Project pumps

Customer-specific project pumps (pump models which begin with "PL" or "PML") may differ from the operating and installation instructions.

➔ In the case of project pumps, take note of any additionally agreed specifications.

1.2. Symbols and markings

Warning

WARNING

This symbol indicates a potential danger.

It also indicates the possible consequences of failure to observe the warning. The signal word (i.e. "Warning") indicates the level of danger.

➔ This specifies measures for avoiding the danger and the consequences of failure to implement these measures.

Danger levels

Signal word	Meaning	Consequences if not observed
DANGER	warns of immediate danger	Death or serious injuries and/or serious damage to property are the consequence.
WARNING	warns of possible danger	Death or serious injuries and/or serious damage to property are possible.
CAUTION	warns of a potentially dangerous situation	Minor injuries or damage to property are possible.

Tab. 1

Other information and symbols

➔ This indicates an activity (step) that needs to be carried out.

1. This indicates the first step of an activity to be carried out. Any additional steps required are numbered consecutively.

i This symbol indicates important information.

2. Use

2.1. Intended use

The pumps are intended for transferring and metering liquids.

Owner's responsibility

Operating parameters and conditions

Only install and operate the pumps under the operating parameters and conditions described in Chapter 4, Technical data.

The pumps may be operated only when fully assembled.

Requirements for transferred medium

Before transferring or metering a medium, check that it can be transferred without risk in the specific application case.

Before using a medium, check the compatibility of the materials of the pump head, pump housing, diaphragm and valves with the pumped medium.

The temperature of the medium must lie within the permissible range (see Chapter 4).

The pumped medium should not contain particles as these can prevent the pump from working correctly. If this cannot be guaranteed, a filter < 50 µm with a sufficiently large filter area must be used upstream of the pump.

2.2. Improper use

The pumps must not be operated in an explosive atmosphere.

The maximum ambient temperature must not exceed 40 °C.

Do not use the pump controller in a damp environment or under condensing conditions.

The controller must be protected against contamination, and contact with liquids, solvents or vapours must be avoided.

The pump controller must only be operated when adapted to meet the ESD (Electrostatic Discharge) safety standards.

Do not establish uncontrolled connections between the controller and conductive cables and materials.

For special modifications to the pump/controller combination outside the standard technical specifications please contact a KNF pump specialist.

3. Safety

Note the safety precautions in Chapters 6, Installation and connection, and 7, Operation.

The pumps are built according to the generally recognised rules of technology and in accordance with the pertinent occupational safety and accident prevention regulations. Nevertheless, dangers can result during their use which lead to injuries to the user or others, or to damage to the pump or other property.

Only use the pumps in perfect working order and in accordance with their intended use. Always ensure adherence to the operating and installation instructions and work in a safety-conscious manner.

Personnel

Make sure that only trained and instructed personnel or specially trained personnel work on the pumps. This especially applies to assembly, connection and maintenance work.

Make sure that all personnel have read and understood the operating and installation instructions, and in particular the "Safety" chapter.

Working in a safety-conscious manner

Observe the accident prevention and safety regulations when performing any work on the pump and during operation.

Handling dangerous media

When pumping dangerous media, observe the safety regulations for handling such media.

Notes

Always ensure adherence to all information stickers on the pumps, such as flow direction arrows and type plates, and keep stickers in legible condition.

Environmental protection

All replacement parts should be properly stored and disposed of in accordance with the applicable environmental protection regulations. Ensure adherence to the pertinent national and international regulations. This especially applies to parts contaminated with toxic substances.

Disposal

Dispose of all packaging in an environmentally appropriate manner. The packaging materials are recyclable.

Ensure that the pump is disposed of in an environmentally appropriate manner at the end of its useful life. Use appropriate waste collection systems for the disposal of end-of-life equipment. Used pumps contain valuable recyclable materials.

EU directives/standards

The pumps are in accordance with the requirements of the guidelines 2011/65/EU (ROHS2)

The pumps conform to the safety requirements regarding electromagnetic compatibility in EC Directive 2004/108/EC.

For the purposes of the Machinery Directive 2006/42/EC, pumps are “partly completed machinery", and are therefore to be regarded as not ready for use. Partly completed machinery may not be commissioned until such time as it has been determined that the machine in which the partly completed machinery is to be assembled is in conformity with the provisions of the Machinery Directive 2006/42/EC. The essential requirements of Annex I of Directive 2006/42/EC (general principles) are applied and observed.

The following harmonised standards are met:

When used in conjunction with the 2-phase stepping motor controller, Id. No. 162492 (or Id. No. 160762) with up to 1 metre of supply cable, all FEM 1.02, FEM 1.09 and UFEM 1.09 pumps meet the following standards:

- EN 61000-6-2
- EN 61000-6-4

Please note: when used in conjunction with controllers from other manufacturers, compliance with the above standards cannot be guaranteed.

Please note: when used in conjunction with controllers from other manufacturers, compliance with CE standards must be verified by the customer.

Customer services and repairs

All repairs to the pump(s) must be carried out by the relevant KNF Customer Service team.

Only use KNF original parts for maintenance work.

4. Technical data

Pump materials

The pump type **KP** stands for:

Assembly	Material[1)]
Pump head*	PP
Valve plates / sealing washers / O-rings	EPDM
Diaphragm	PTFE

Tab. 2 *1) according to DIN ISO 1629 and 1043.1*

The pump type **KT** stands for:

Assembly	Material[1)]
Pump head*	PP
Valve plates / sealing washers / O-rings	FFKM
Diaphragm	PTFE

Tab. 3 *1) according to DIN ISO 1629 and 1043.1*

The pump type **TT** stands for:

Assembly	Material[1)]
Pump head*	PVDF
Valve plates / sealing washers / O-rings	FFKM
Diaphragm	PTFE

Tab. 4 *1) according to DIN ISO 1629 and 1043.1*

* The pump head comprises a connecting plate and an intermediate plate (Chapter 8.3, Fig. 23 and Fig. 24, each with items 3 and 4)

Hydraulic rating

Parameter	Value
Stroke volume FEM 1.02 [µl] [1), 2), 3), 4)]	180
Stroke volume FEM 1.09 [µl] [1), 2), 3), 4)]	520
Permissible pressure [bar_g]	6
Suction head [mWG]	4

Tab. 5

1) Measured with water at 23 °C at atmospheric pressure

2) Flow rates may vary from the values shown, depending on fluid viscosity, pump head material and the hoses/hose connectors used.

3) Nominal stroke volume measured at an input and output rotation speed of 180 min^{-1}

4) Adjustability dependent on controller

Hydraulic connections

Pump type	Connection type
FEM 1.02 (internal thread)	UNF 1/4"-28
FEM 1.02 (hose fitting)	4/6 mm
UFEM 1.09 (hose fitting)	1/8"/1/4"

Tab. 6

Electrical Data

Parameter	Value
Supply voltage [V] DC	10 … 28 (24 V ± 10% for full pump capacity)
Max. current consumption, DC RMS 24 V [A]	0.8
Max. watt consumption [W]	19
Phase current stepping motor [A/Phase] RMS	0 … 0.5 (optional 0 … 1.2)
Stepping motor Step mode	2-phase 8 microsteps

Tab. 7

Control ports

Parameter	Value
Ground (GND) COM1	
	GND is connected internally with PWR-GND. All input and output signals refer to this GND level.
Analog input COM2, 3	
Signal range	0 ... 10 V 4 ... 20 mA
Input resistance[Ω]	20 kΩ at 0 ... 10 V 220 Ω at 4 ... 20 mA
Digital input COM4, 5	
Signal range	Pull up at 24 V
Electric strength TTL	0 ... 24 V DC
Low level (ON)	< 0.8 V = low
High level (OFF)	> 2.0 V = high
Digital output COM7	
Electric strength, open collector TTL	35 V DC
Rating, open collector	20 mA
Output reference COM8	
Output voltage	10 V DC
Rating	10 mA

Tab. 8

Other parameters

Parameter	Value
Permissible ambient temperature range [°C]	+5 to +40
Humidity	No condensation
Permissible media temperature [°C]	+5 to +80
Permissible kinematic viscosity of medium [cSt]	≤150
Connection type	Screw terminals
Motor protection class	IP 40
Electronics protection class	IP 00
Weight [1)] [g]	390

Tab. 9

[1)] The weight may differ slightly from the stated value, depending on the version.

Accuracy/reproducibility

Accuracy

The accuracy of the metering pump is appropriately characterised by the maximum absolute error A (dependent on the nominal value) and the maximum relative error B (dependent on the setting value):

➔ max. inaccuracy ≤ (A + B)

FEM 1.02

Error	Value
Absolute error A	≤ ±0.1% of nominal value
Relative error B	≤ ±1.0% of setting value

Tab. 10

FEM 1.09

Error	Value
Absolute error A	≤ ±0.1% of nominal value
Relative error B	≤ ±1.0% of setting value

Tab. 11

Example: FEM 1.09; the nominal value for stroke volume is 520 µl

For a setting of 260 µl, the accuracy should therefore be within the following error limits:

Inaccuracy ≤ (±0.1% x 520 µl) + (±1.0% x 260 µl)
≤ (±0.52 µl) + (±2.6 µl)
≤ ±3.12 µl
≈ ±1.2% of setting value

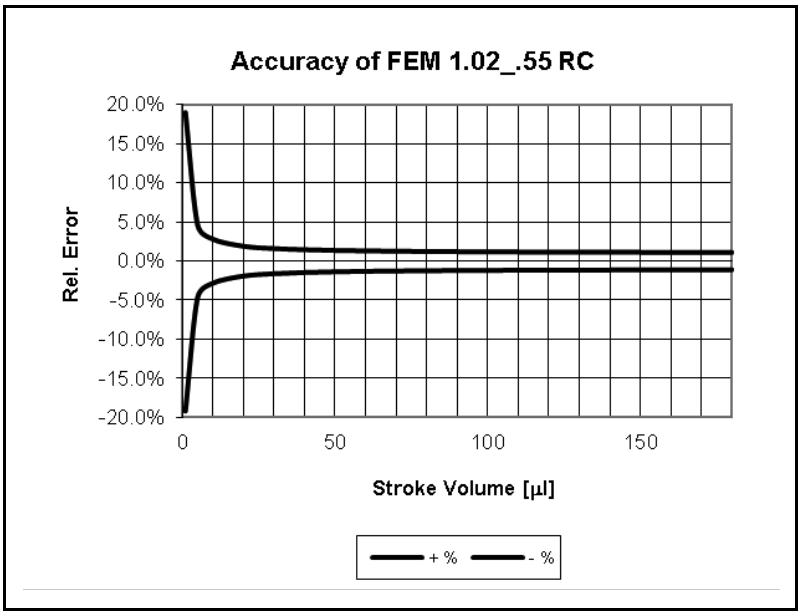

Fig. 1: Trumpet curve (characterisation of accuracy of FEM 1.02_.55)

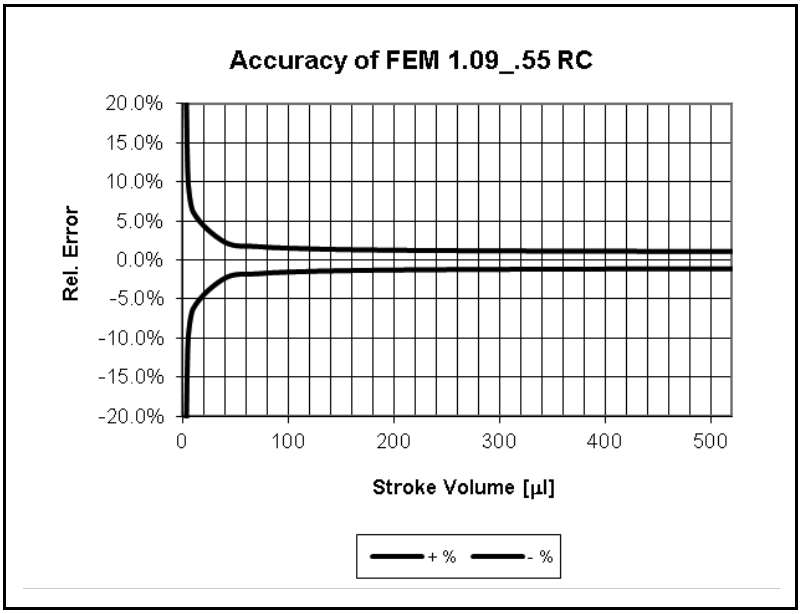

Fig. 2: Trumpet curve (characterisation of accuracy of FEM 1.09_.55)

Reproducibility

Under constant environmental conditions the pump achieves a reproducibility of less than ±1%.

Greater inaccuracies may occur for fluids with a viscosity of > 150 cSt or with a tendency to gassing out. Appropriate adjustments may be made during calibration.

The accuracy of the pump is ultimately a matter of the measurement and pumping system and the parameters with which the pump is operated. The hose types used and the design of the hose end play an important part in precise metering.

Factory calibration

The metering pump was calibrated to its nominal stroke volume in the factory (FEM 1.02_.55 RC; **180 µl** / FEM 1.09_.55 RC; **520 µl**). This setting is for water at 23 ±3 °C with free discharge flow, i.e. against ambient atmospheric pressure.

Calibration

The flow rate may differ from the calibrated value in some applications. This is influenced by the following factors: type of medium, its viscosity, density and temperature, pressure and installation type (e.g. cross-section constrictions). For accurate metering it is therefore recommended that the metering pump be calibrated.

5. Assembly and function

Assembly with FE Z5 stepping motor partial stroke controller

1 Inlet
2 Outlet
3 Pump head
4 Stepping motor (2-phase)
5 FE Z5 stepping motor partial stroke controller

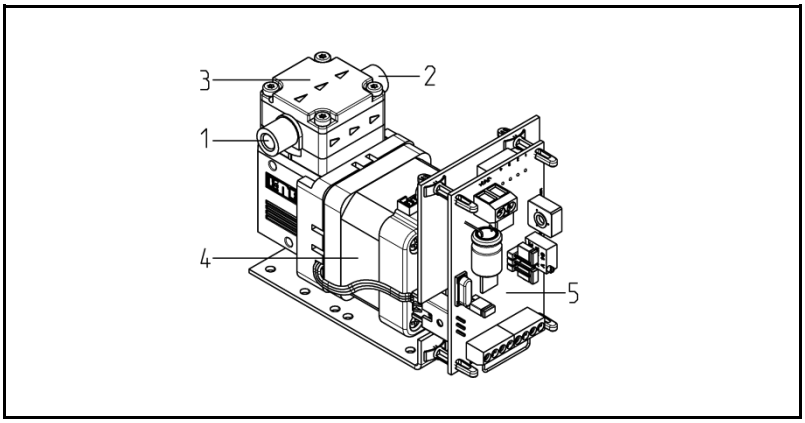

Fig. 3: Stepping motor diaphragm metering pump with FE Z5 partial stroke controller FEM 1.02_.55 RC

1 Exhaust valve
2 Inlet valve
3 Working chamber
4 Diaphragm
5 Eccentric
6 Connecting rod
7 Pump drive

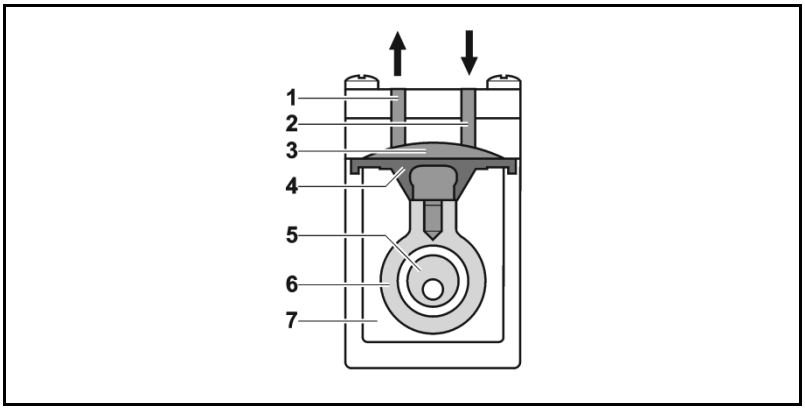

Fig. 4: Pump assembly

Stepping motor diaphragm metering pumps are based on reciprocating displacement pump technology. An elastic diaphragm (**4**) is moved up and down by the eccentric (**5**) and the connecting rod (**6**). During the down stroke, the diaphragm sucks in the medium through the inlet valve (**2**). During the up stroke, it forces medium out of the pump head through the exhaust valve (**1**). The diaphragm hermetically seals off the working chamber (**3**) from the pump drive (**7**).

Pump controller characteristics

- ➔ Simple, precise pump controller which is highly flexible in the ways it can be integrated into processes
- ➔ Wide power supply range 10 ... 28 V DC
- ➔ 2-phase controller with constant power consumption, adjustable from 0 ... 0.5 A rms per phase
  (optional 0 ... 1.2 A rms)
- ➔ Microsteps: 8 microsteps are equivalent to one full step, and 1600 microsteps are equivalent to one full rotation of the motor

- ➔ Possible ways of controlling the metering stroke from 10 ... 170° by means of:
  - Internal potentiometer
  - External voltage signal 0 ... 10 V
  - External current signal 4 ... 20 mA
  - External potentiometer
- ➔ Pump controller with digital I/O's:
  START dispense
  PRIME
  ALARM output
- ➔ 2 different suction rates and 5 different metering rates can be set
- ➔ REF output signal 10 V DC, 10 mA for supplying an external sensor or potentiometer
- ➔ Circuit configuration optimised for thermal load and protection against motor phase short-circuit currents

6. Installation and connection

Only install the pumps under the operating parameters and conditions described in Chapter 4, Technical data.

Observe the safety notes (see Chapter 3).

6.1. Installation

➔ Before installation, store the pump at the installation location to bring it up to ambient temperature.

Mounting dimensions

➔ Mounting dimensions (see Fig. 5 to Fig. 7)

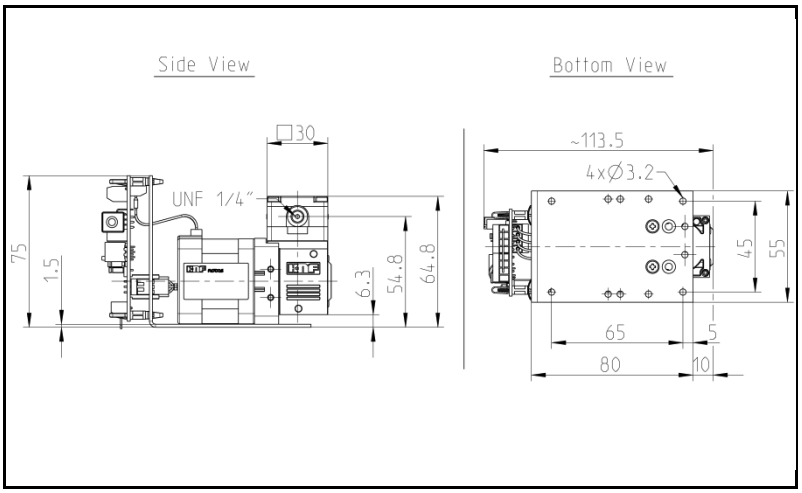

Fig. 5: Mounting dimensions FEM 1.02_.55 RC

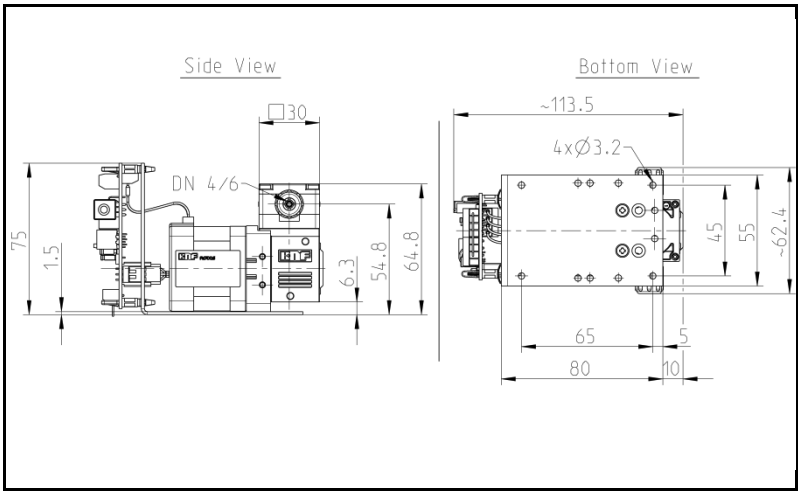

Fig. 6: Mounting dimensions FEM 1.09_.55 RC

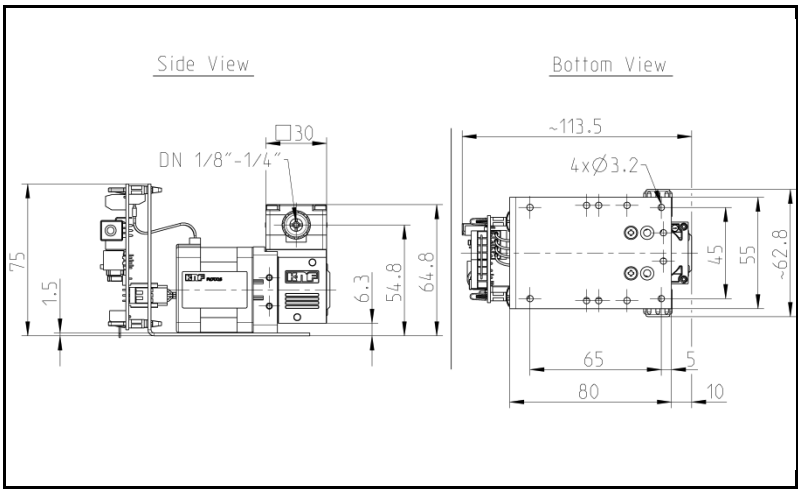

Fig. 7: Mounting dimensions UFEM 1.09_.55 RC

Installation location

➔ Make sure that the installation location is dry and the pump is protected against water in the form of rain, spray, splashes and drips.

➔ Protect the pump against dust.

➔ Protect the pump against vibration and impact.

Installation position

➔ Generally speaking, the pump can be mounted in any installation position. For maximum precision and rapid venting the vertical pumping direction should ideally run from bottom to top.

6.2. Electrical connection

➔ Pump should only be connected by an authorised specialist.

➔ Only connect the pump when the power supply is turned off.

➔ All electrical connection work must adhere to the pertinent norms, directives, regulations and technical standards.

i The controller must only be operated in accordance with the ESD (Electrostatic Discharge) safety standards.

Connecting the pump

1. Make sure that the power supply data match the data on the type plate. The current consumption can be found on the type plate.
2. Depending on the application, connect the control cable to the appropriate COM connections (1 – 8). Description of the individual COM interfaces as shown in Chapter 6, Tab. 12.
3. Adjustment of potentiometers (P1, P2) and jumpers (J1, J2) according to application. The settings correspond to the factory calibration performed prior to delivery. See Chapter 4, paragraph on factory calibration, and Chapters 7.6 to 7.8.
   Any settings and system components which deviate from the factory calibration must always be recalibrated, and this is to be carried out at the appropriate operating point for the application.

4. Connecting the 24 V DC operating voltage to the PWR terminal block. Ensure polarity (+/-) is correct.

i Make sure that the voltage supply provides an operating voltage of at least 0.8 A.

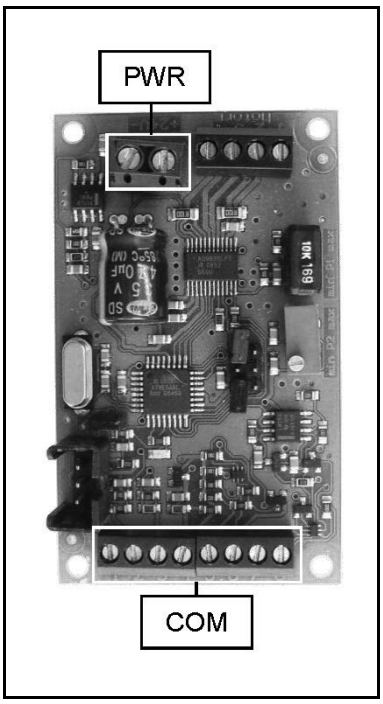

Fig. 8: Control board connection points

Description of connections

	Pin no.	Signal name	Function
PWR	+	+24 V	+ supply voltage 10 … 28 V DC
	-	PWR-GND	- Supply voltage, ground
COM	1	GND	The signal ground is connected internally with PWR-GND. Reference level for COM signals
	2	0 … 10 V Analog input signal	Metering stroke control 0 V = 10° metering stroke 10 V = 170° metering stroke (max.)
	3	4 … 20 mA Analog input signal	Metering stroke control 4 mA = 10° metering stroke 20 mA = 170° metering stroke (max.)
	4	START Digital input signal	Metering stroke triggered by falling signal edge
	5	PRIME Digital input signal	Continuous operation at 10 ... 200 rpm The motor stops at bottom dead centre after at least one full rotation.
	6	--	No function Internally connected with GND
	7	ALARM output	Alarm output signal open collector
	8	REF output	Reference voltage output 10 V DC, max. current load 10 mA
	Please note: all digital input signals are TTL levels. These may be up to 24 V DC.		

Tab. 12

6.3. Hydraulic connection

Connected components

➔ Only connect components to the pump that are designed to handle the hydraulic data of the pump (see Chapter 4, Technical data).

Hoses

➔ Only use hoses that are suitable for the maximum operating pressure of the pump (see Chapter 4).

➔ Only use hoses that are sufficiently chemically resistant to the liquids being pumped.

6.3.1. Connecting the pump

ℹ Arrows on the pump head indicate the flow direction.

FEM 1.02 – Screw-in connection fitting with internal thread

1 Hose
2 Hose connector
3 Clamp ring
4 Connector

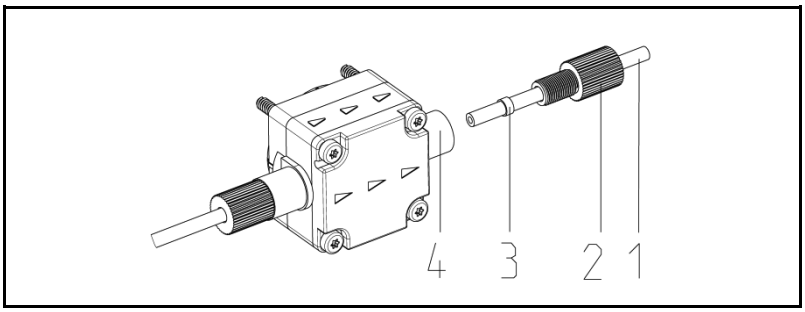

Fig. 9: Hose connector 1.6/3.2 mm (FEM)

1. Remove protective caps
2. Connect the inlet and outlet lines. (Recommendation: UNF 1/4“-28 flangeless connection with 1/16“ hose, see accessories list in Chapter 10)

ℹ Keep the inlet line as short as possible in order to keep the priming process as brief as possible.

3. Check that the hoses (**1**) and transition joints (hose connector/hose) are fitted correctly and securely.
4. Check that the system is leak-tight.

FEM 1.09 / UFEM 1.09 – Clamp ring hose connection fitting

1 Hose
2 Union nut
3 Clamp ring
4 Connector

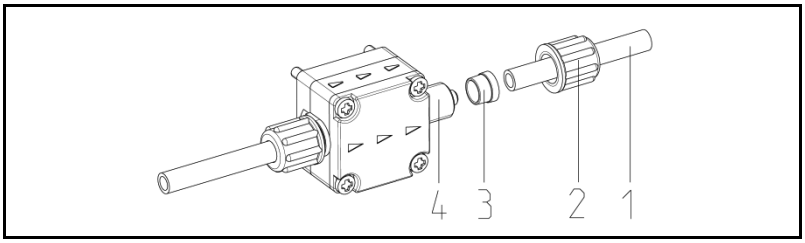

Fig. 10: 4/6 mm hose connection fitting with clamp ring (FEM)
1/8“/1/4“ hose connection fitting with clamp ring (UFEM)

1. Remove protective caps from connections
2. Using a sharp knife, cut the inlet and outlet lines (FEM: hose ID 4 mm, OD 6 mm; UFEM: hose ID 1/8“, OD 1/4“) to the required length, with straight square edges
3. Push the union nut (**2**) and clamp ring (**3**) onto the hose (**1**)
4. Push the hoses onto the connectors as far as they will go
5. Hand-tighten the union nut (**2**)
6. Check that the hoses and transition joints (hose connector/hose) are fitted correctly and securely
7. Check that the system is leak-tight

7. Operation

➔ The pumps should only be used under the operating parameters/conditions described in Chapter 4, Technical data.

➔ Ensure that the pumps are being used correctly (see Chapter 2.1).

➔ Improper use of the pumps must be prevented (see Chapter 2.2).

➔ Observe the safety notes (see Chapter 3).

➔ The pumps are components that are intended to be incorporated into another machine. Ensure that the machinery/equipment in which the pumps are installed comply with the pertinent regulations before putting them into service.

CAUTION

Risk of burning
The stepping motor heats up even when at a standstill if the motor is actuated.

➔ Avoid contact with the pump drive

➔ Avoid contact with flammable materials

Excessive pressures and the inherent dangers thereof can be prevented by using a bypass system with a pressure relief valve between the pressure and suction side of the pump. Further information is available from your KNF specialist (telephone number: see first page).

Pump standstill

➔ If the pump stops running, restore the system to normal atmospheric pressure.

Turning the pump off

➔ KNF recommends that after pumping aggressive media the pump should be rinsed thoroughly before being turned off (see Chapter 8.2.1) in order to prolong the life of the membrane.

➔ Restore the system to normal atmospheric pressure (release hydraulic pressure in pump).

Suction side filter

The pumped medium should not contain particles as these can prevent the pump from working correctly. If this cannot be ensured, a < 50 µm filter with a sufficiently large filter area must be used upstream of the pump.

7.1. Operation without external control of metering volume

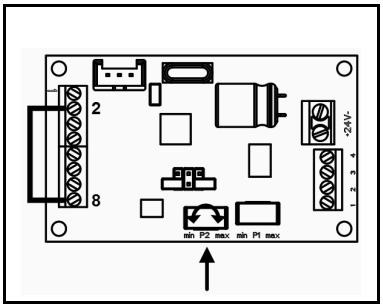

Fig. 11: Without external input signal

➔ Connect COM8 with COM2 (cf. Fig. 11).
The 10 V reference signal from COM8 is now connected with the 0 ... 10 V input signal from COM2. This allows the metering stroke to be controlled by means of the potentiometer P2.

➔ Connect the start signal to COM4 (cf. Fig. 12).

i The metering stroke is triggered by the falling edge of the start signal at COM4.

The start signal can be generated by means of the following:

- Switch
- Relay contact
- Process control unit

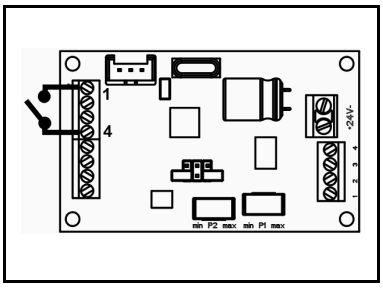

Fig. 12: Start signal

➔ Connect the voltage supply to the PWR connecting terminals.

➔ Adjust potentiometer P2 until the pump produces the desired metering volume.

7.2. Set metering stroke with external potentiometer

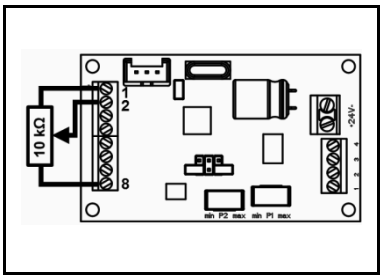

Fig. 13: External potentiometer

➔ Remove the lead between COM2 and COM8

➔ Connect the start signal to COM4 (cf. Fig. 12)

➔ Use an external potentiometer with a resistance of 10 kΩ
Connect both fixed connections to COM1 and COM8
(cf. Fig. 13)
Connect the adjustable connection to COM2 (0 … 10 V analog input)

➔ The metering stroke can now be set by adjusting the external potentiometer.

Pump type	Min. volume [µl]	Max. volume [µl]
FEM 1.02_.55	5	180
FEM 1.09_.55	10	520

Tab. 13

The metering volume may vary from one pump to another, because the individual components are subject to different geometric tolerances.

Cf. Chapter 7.6, Calibration

The maximum metering volume is set using potentiometer P2.

➔ Use COM4 for initiating the metering stroke.

7.3. Controlling the metering stroke by means of an analog signal of 0 ... 10 V or 4 ... 20 mA

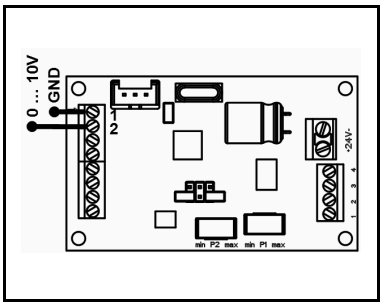

Fig. 14: Control 0 ... 10 V

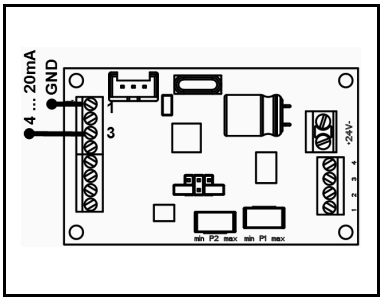

Fig. 15: Control 4 ... 20 mA

➔ Remove the lead between COM2 and COM8.

➔ Connect the start signal to COM4 (cf. Fig. 12).

➔ Connect analog signal:
COM2 for 0 ... 10 V control signals (cf. Fig. 14)
COM3 for 4 ... 20 mA control signals (cf. Fig. 15)

➔ The metering stroke is proportionate to the analog signal applied (cf. Fig. 16 and Fig. 17).

The metering volume may vary from one pump to another, because the individual components are subject to different geometric tolerances.

Cf. Chapter 7.6, Calibration

The maximum metering volume is set using potentiometer P2.

The signal to COM3 (4 ... 20 mA) has higher priority than the signal to COM2 (0 ... 10 V).
Any signal which arrives at COM2 at the same time is therefore ignored.

➔ Use COM4 for initiating the metering stroke.

Stroke volume depending on analog signal

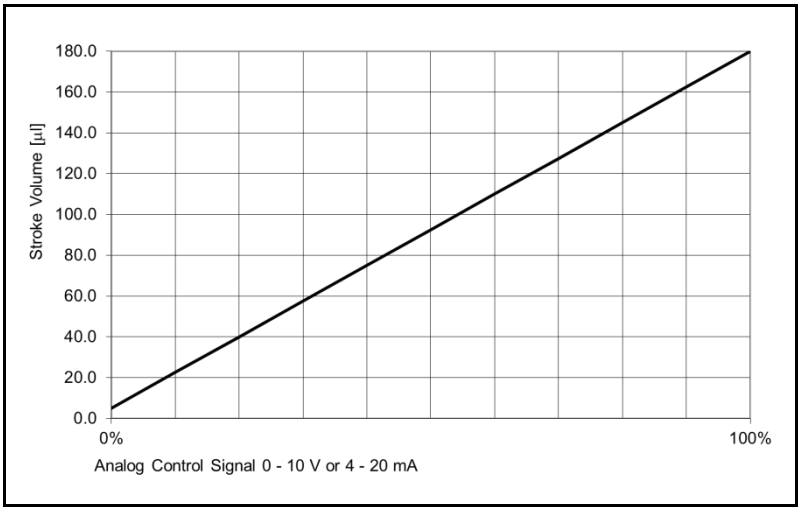

Fig. 16: Stroke volume depending on analog signal (measurement without counterpressure); Pump FEM 1.02_.55 RC

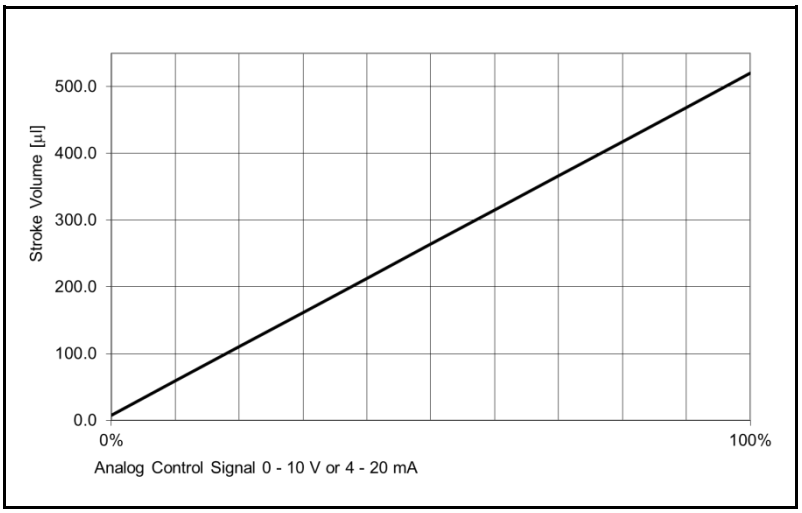

Fig. 17: Stroke volume depending on analog signal (measurement without counterpressure); Pump FEM 1.09_.55 RC

Setting the operating point by adjusting P2

In order to obtain higher resolution when setting the metering stroke, the maximum stroke can be limited with the aid of potentiometer P2. (See also the following Chapter 7.7, Tab. 16)

If P2 is set to half its range (cf. also Chapter 7.6, Calibration), the maximum stroke volume is limited to half. When limited in this way, it is still possible to further reduce (control) the stroke volume with the full range of 0 ... 10 V of the analog signal applied to COM2. The same conditions apply to 4 ... 20 mA at COM3.

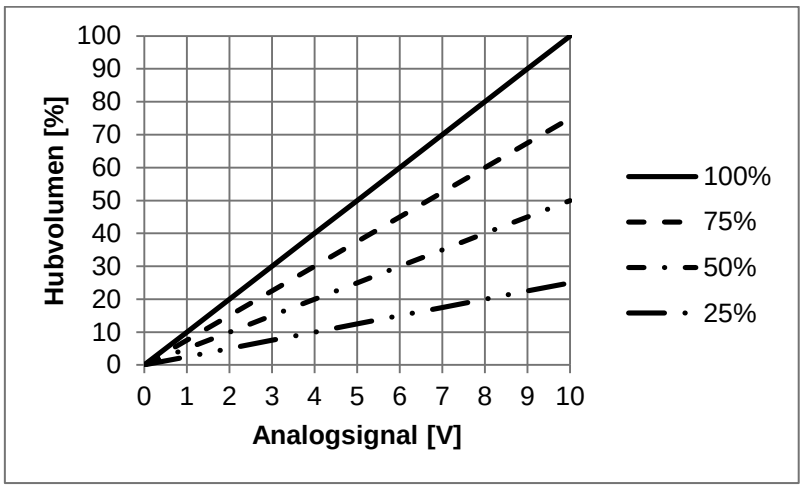

Fig. 18: Limiting of maximum stroke by P2
The diagram shows 4 settings for P2: 100%, 75%, 50% and 25%

This adjustment allows the desired stroke volume range to be adjusted, and also improves adjustability. The smaller the stroke volume selected, the better the resolution.

Example:

➔ P2 is set to 50%.

➔ At maximum analog signal (10 V / 20 mA), this reduces the stroke volume to 50% of the maximum stroke volume.

➔ In this reduced range, the stroke volume behaves linear to the analog signal (see Fig. 18, 50% line).

7.4. Prime

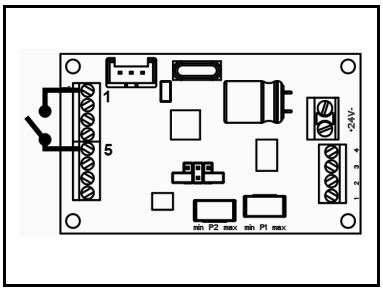

Fig. 19: Prime function

The prime function is used to fill or empty the hose system at maximum pump speed.

➔ Connect the prime signal to COM5 (cf. Fig. 19)

Pump type	Prime [ml/min]
FEM 1.02_.55	1.5 – 20
FEM 1.09_.55	4.5 – 90

Tab. 14

i The pump will run continuously at priming speed for as long as a low level signal is applied to COM5.
The priming speed can be continuously adjusted between 10 ... 200 revolutions per minute using the analog signal applied to COM2 or COM3.

i The priming speed remains constant for one complete revolution. At the start of each subsequent revolution it adjusts itself to any change in the analog signal.

i The prime signal at COM5 has higher priority than the other commands. The prime signal overrides any metering cycles that are currently active.

7.5. ALARM output

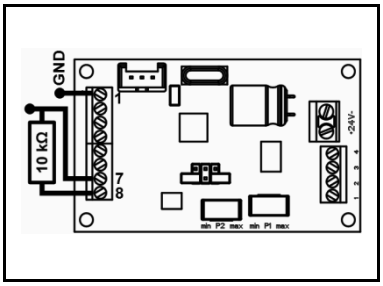

Fig. 20: Open collector alarm

In order to output simple errors the controller is equipped with an open collector output.

➔ Connect COM7 to a process control unit.
Please note: the process control unit must be capable of reading open collector signals.

➔ In order to generate a voltage signal (10 V / GND), connect a 10 kΩ resistance between COM7 and COM8 (cf. Fig. 20).

The alarm signal indicates that the pump controller has detected one of the following failure modes:

- General controller malfunction
- Initial position of pump could not be detected, i.e. the next metering stroke will not discharge a precise volume.
- Overpressure in pump: during the last metering stroke an overpressure occurred which obstructed the functioning of the pump.

i No distinction is made between the various alarm signals.

i COM4 (Start) or COM5 (Prime) will reset the alarm once a pump stroke has been completed.

7.6. Calibration

Factory calibration

The pump is calibrated to its nominal stroke volume by default (see Chapter 4, Technical data).

Calibration

The metering volume of a stroke may vary slightly from one pump to another. The reasons for this are as follows:

- Geometric tolerances
- Different hose systems
- Viscosity of fluid

For precise metering it is strongly recommended that the desired operating point be calibrated.

➔ Perform precise measurement of the metered volume.

➔ Adjust potentiometer P2 (cf. Tab. 15).

➔ Check calibration by repeating measurement.

Pump type	Number of revolutions	
	4	10
FEM 1.02_.55	36 µl	90 µl
FEM 1.09_.55	104 µl	260 µl

Tab. 15

7.7. Description of potentiometer settings

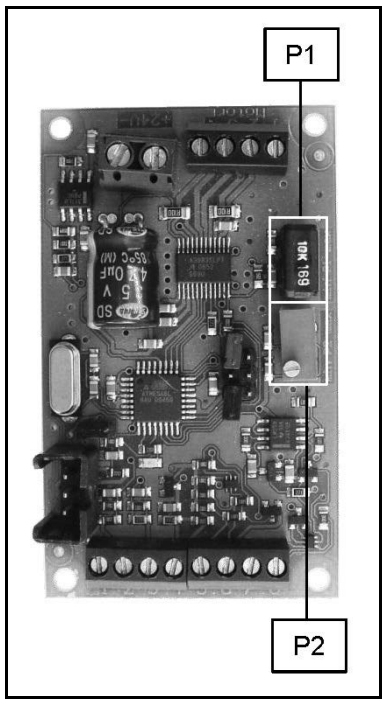

Fig. 21: Potentiometers P1 and P2

	Function
P1	Setting motor current The default setting is 0.5 A rms per phase. This corresponds to the maximum setting of P1. ℹ A high motor current allows metering to be performed against higher pressures. Higher settings result in higher motor temperature. ℹ A low motor current setting reduces motor temperature. ⚠ **CAUTION** High motor currents cause high motor temperatures! Hot surface! Risk of burns! Motor temperatures of over 100 °C will damage the motor.
P2	Setting stroke volume Max. = Bottom dead centre to +170° Min. = Bottom dead centre to +10° Setting P2 limits the control of the pump with an external input signal of 0 ... 10 V or 4 ... 20 mA.

Tab. 16

P2 is a 20 level potentiometer which means that by turning the calibration screw the total stroke volume can be smoothly altered (20 turns for the whole range). On delivery the pump is pre-calibrated using the P2 adjustment to the maximum stroke of the nominal volume (see section 4, paragraph on factory calibration).

7.8. Setting suction and exhaust speeds

Description of jumper

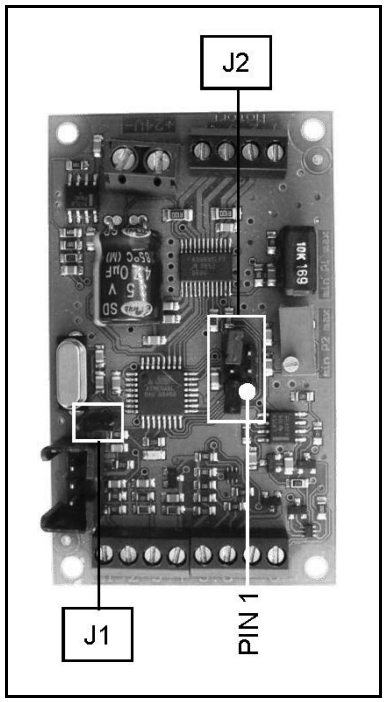

Fig. 22: Jumpers J1 and J2

	Setting	Function	
J1	Suction stroke speed [min^{-1}]		
	Closed	Suction	180 rpm
	Open	Suction	20 rpm
J2	Exhaust stroke speed [min^{-1}]		
	Open	Exhaust	180 rpm
	Pins 3 – 4	Exhaust	60 rpm
	Pins 1 – 3	Exhaust	20 rpm
	Pins 4 – 6	Exhaust	5 rpm
	Pins 1 – 3 Pins 4 – 6	Exhaust	1 rpm

Tab. 17

Pin numbering of J2

6	5
4	3
2	1

Tab. 18

Before the jumpers are repositioned the supply voltage must be switched off, otherwise the altered jumper setting will have no effect.

Appropriate positioning of the jumpers allows the following characteristics to be changed or optimised:

- Adjustment of metering time
- Slow suction for viscose or outgassing media
- Gentle metering
- Avoidance of spray if the medium exits the metering opening too fast
- Improvement of dripping behaviour

8. Maintenance

8.1. Maintenance schedule

Component	Maintenance interval
Pump	- Regular inspection for external damage or leaks
Pump head	- Clean if the flow rate decreases, the pump does not work or no vacuum is created (Chapter 8.2)
Diaphragm and valve disks	- Change as soon as pumping capacity decreases, preferably sooner

Tab. 19

8.2. Cleaning

Information on procedure

WARNING

Health hazard due to dangerous substances in the pump
Depending on the medium pumped, risk of caustic burns or poisoning.

➔ Wear protective clothing if necessary, e.g. protective gloves.

➔ Rinse the pump with a neutral liquid and pump empty.

8.2.1. Flushing the pump

➔ When pumping aggressive media, KNF recommends flushing the pump with air (or an inert gas if necessary for safety reasons) under atmospheric conditions for a few minutes before switching off in order to extend the service life of the diaphragm.

8.2.2. Cleaning the pump

➔ Where possible, wipe the components with a dry cloth. Do not use cleaning solvents as these may corrode plastic parts.

➔ If there is compressed air available, blow off components.

Prior requirements

- Pump or drive must be switched off and disconnected from mains
- The pump must be free of any hazardous substances
- Hoses must be disconnected from the pump head
- We recommend replacing the diaphragm when head parts are removed.

Tools

Qty.	Tool
1	Torx screwdriver no. 10

Tab. 20

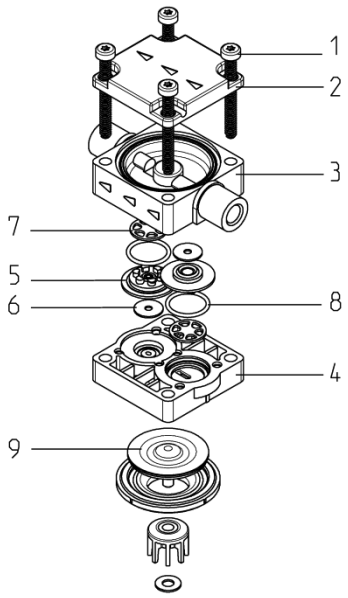

Fig. 23: Cleaning the head, FEM 1.02

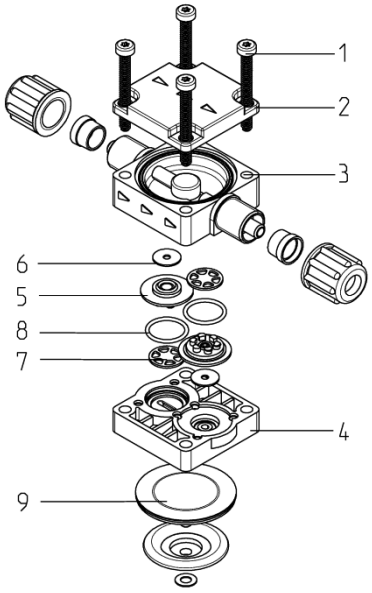

Fig. 24: Cleaning the head, FEM 1.09

1 Head screw
2 Head plate
3 Connecting plate
4 Intermediate plate
5 Valve seat
6 Seal
7 Valve disk
8 O-ring
9 Membrane

8.3. Dismantling the pump head (FEM 1.02 / FEM 1.09 / UFEM 1.09)

1. Use a screwdriver to undo the head screws (**1**)
2. Remove the head plate (**2**), connecting plate (**3**) and intermediate plate (**4**)

Removing the valves and seals

3. Remove valve seats (**5**)
4. Remove seals (**6**), valve disks (**7**) and O-rings (**8**)

Cleaning the parts

5. Clean the diaphragm (**9**), valve disk (**7**), seals (**6**) and O-rings (**8**) with a cloth and then blow off with compressed air
6. Blow off the intermediate plate (**4**) and the connecting plate (**3**) with compressed air

Mounting the valves and seals

7. Mount O-rings (**8**) and valve disk (**7**) on valve seat (**5**)
8. Insert seal (**6**) in connecting plate (**3**)
9. Insert valve seats with valve disk (**7**) and O-rings (**8**) in connecting plate (**3**) (slight pressure required)
10. Insert the seal (**6**) in the intermediate plate (**4**)

Mounting the pump head

11. Remove the intermediate plate (**4**), connecting plate (**3**) and head plate (**2**)
12. Push the assembled components onto the pump housing with finger pressure
13. Secure the pump head to the housing using the 4 head screws (**1**)

The maximum tightening torque for the head screws is 1 Nm.

Head screws that have been undone before should be carefully screwed in by hand so that the screws engage in the existing threads.

9. Troubleshooting

➔ Before working on the pump disconnect it from the power supply.

➔ Ensure that the pump is de-energised.

Pump does not perform metering stroke	
Cause	Fault remedy
Pump not connected to mains power supply	➔ Connect pump to mains supply
Pump not connected or not fully connected to controller	➔ Connect motor cable and/or Hall effect sensor cable to controller
Power supply is not switched on	➔ Switch on power supply
Electrical signal is not within the defined limits	➔ Check the specifications defined in Chapter 4
Controller input channels not properly connected	➔ Check connections (see Chapter 6.2)
GND signal not connected	➔ Connect GND to COM1
Connections or pipes are blocked	➔ Check connections and pipes ➔ Remove blockage
System valve is closed or filter is blocked	➔ Open system valve ➔ Clean filter
Diaphragm or valve disk are worn out	➔ Replace diaphragm and valve disk (see Chapter 8.3)

Tab. 21

Motor becomes hot	
Cause	Fault remedy
Phase current setting too high	➔ Set potentiometer P1 to a lower level (see Chapter 7.7)
Ambient temperature too high	➔ Provide ventilation in machine housing to allow the pump to be operated within the specified temperature range (see Chapter 4)

Tab. 22

Pump rattles or does not perform complete metering stroke	
Cause	Fault remedy
Pressure in pump system too high	➔ Reduce system pressure to the permitted limits (see Chapter 4)
Phase current setting too low	➔ Set potentiometer P1 to a higher level (see Chapter 7.7)
Phase current setting much too high (overheating)	➔ Set potentiometer P1 to a lower level (see Chapter 7.7)
Ambient temperature too high	➔ Provide ventilation in machine housing to allow the pump to be operated within the specified temperature range (see Chapter 4)
System valve is closed or filter is blocked	➔ Open system valve ➔ Clean filter
P2 has been set too low	➔ Set potentiometer P2 to the correct level for the metering stroke required (see Chapter 7.7)

Pump rattles or does not perform complete metering stroke	
Cause	Fault remedy
Analog input signal too low	➔ Check whether the signal level complies with the specified values (see Chapter 6.2)
Analog GND signal not connected to controller	➔ Connect analog GND signal to COM1

Tab. 23

Metering time too short / too long	
Cause	Fault remedy
Position of J1 or J2 incorrectly selected	➔ Position jumper correctly to produce the correct speeds (see Chapter 7.8)

Tab. 24

Pump is not priming	
Cause	Fault remedy
Suction side of pump not connected	➔ Connect the suction side of the pump
Liquid in the priming container is too low	➔ Fill priming container
Hose connections are not leak-tight	➔ Secure transition joints between hose and connections with clamps or other clamping elements
System valve is closed or filter is blocked	➔ Open system valve ➔ Clean filter
Pump head is filled with gas; the system is unable to handle the pressure on the pressure side	➔ Reduce pressure on pressure side
Particles in the pump	➔ Clean pump head (see Chapter 8.2)
The pump parts are not resistant to the medium to be pumped	➔ Replace the pump head with a compatible version
Incorrect interchange of outlet and inlet line connections	➔ Remove outlet and inlet lines and re-connect correctly

Tab. 25

Metering performance, suction head or pressure head is too low The pump does not achieve the performance stated in the Technical Data or on the data sheet.	
Cause	Fault remedy
Components in the system connected to the suction and pressure sides, such as hoses, valves or filters, are causing too much resistance	➔ Modify installation, check cross-sections of components
Hose connections are not leak-tight	➔ Secure transition joints between hose and hose connections with clamps or other clamping elements
Particles in the pump	➔ Clean the pump head, install suction-side filter if required (see Chapter 8.2)
Viscosity of the pumped medium is too high	➔ Contact KNF
Incorrect interchange of outlet and inlet line connections	➔ Remove outlet and inlet lines and re-connect correctly
The pump parts are not resistant to the medium to be pumped	➔ Replace the pump head with a compatible version

Tab. 26

Fault cannot be rectified

If you are unable to identify any of the above causes, please send the pump to KNF customer services (see address on first page).

1. Flush the pump to clear the pump head of any hazardous or aggressive fluids (see Chapter 8.2.1)
2. Remove the pump
3. Clean the pump (see Chapter 8.2.2)
4. Send the pump, with completed decontamination declaration (see Chapter 11), to KNF stating the nature of the pumped medium

10. Spare parts and accessories

Spare parts kit for FEM 1.02

Spare part	Order no.
Spare parts kit for FEM 1.02 KP head	157875
Spare parts kit for FEM 1.02 KT head	157876
Spare parts kit for FEM 1.02 TT head	157877

Tab. 27

Spare parts kit for FEM 1.09 / UFEM 1.09

Spare part	Order no.
Spare parts kit for FEM 1.09 KP head	157881
Spare parts kit for FEM 1.09 KT head	157882
Spare parts kit for FEM 1.09 TT head	157887

Tab. 28

Accessories

Accessory	Order no.	FEM 1.02	FEM 1.09	UFEM 1.09
Screw-in nipple, PP (1/8“ or 3 mm)	151762	x		
Screw-in nipple, PVDF (1/8“ or 3 mm)	151763	x		
Connection fitting UNF 1/4“-28 (1/8“/1/4“)	157858	x		
Hose, DN 4/6, PA	019490		x	
Hose, DN 4/6, PE	019491		x	
Hose, DN 4/6, PTFE	019241		x	
Hose, DN 4/6, silicone	019238		x	
Hose, PTFE, 1.6 x 3.2 mm	069684	x		
Hose, FEP, with UNF 1/4“, 1 m	069963	x		
Hose, FEP, with UNF 1/4“, 2 m	069964	x		
Hose, FEP, with UNF 1/4“, 3 m	069965	x		
UNF adapter, PP, for hose ID 2.25 mm (3/32“)	151340	x		
UNF adapter, PP, for hose ID 3.2 mm (1/8“)	151762	x		
UNF adapter, PP, for hose ID 4.75 mm (3/16“)	150520	(x)		
UNF adapter, PP, for hose ID 6.4 mm (1/4“)	068272	(x)		
UNF adapter, PVDF, for hose ID 2.25 mm (3/32“)	151339	x		
UNF adapter, PVDF, for hose ID 3.2 mm (1/8“)	151763	x		
UNF adapter, PVDF, with female Luer	150988	x		
UNF flangeless connection, 1.6 x 3.2 mm	150213	x		

Tab. 29

10.1. Optional versions

The pumps can be configured to meet requirements on a project basis.
Further information is available from your KNF specialist (telephone number: see last page).

11. Decontamination declaration

KNF shall only undertake to repair the pump on condition that the customer provides certification of the transferred media and the cleaning of the pump (decontamination declaration).

➔ Copy this page.

Enter the pump model, the Serial No. and the transferred media in the form below and send the signed form together with the flushed and cleaned pump to KNF customer services (see address on last page)

Customer decontamination declaration for repair order

We confirm that the pump below has been used to pump the following media, and that the pump has been flushed and cleaned.

Pump model	
Serial No.	
Pumped media	

The pump does not contain aggressive, biological, radioactive, poisonous, or other dangerous media.

Company

Date/Signature

KNF worldwide

Please find your local KNF partners at: www.knf.com