

2-PHASE STEPPING MOTOR DRIVER

FE Z5 DISPENSE

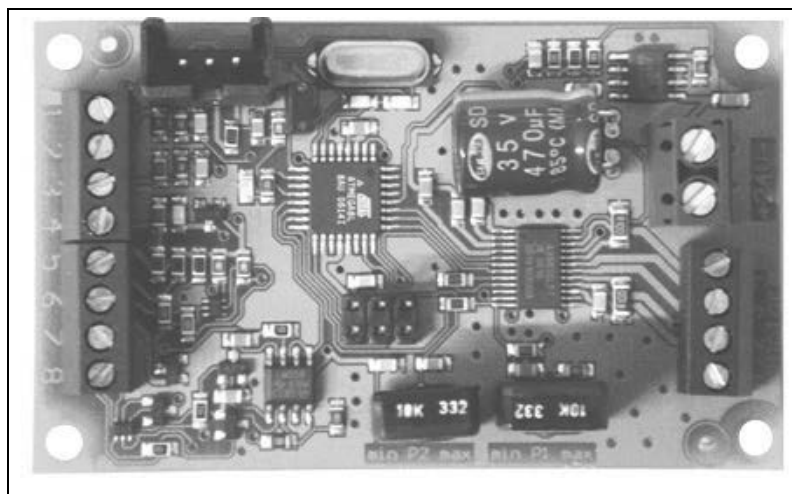
For Diaphragm Dosing Pumps

FEM 1.02_.55 / FEM 1.09_.55

Controller board package, without pump: ID 160536

Operating and Installation Manual

It is important to read and comply with all instructions in this operating and installation manual.



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1. About this document

1.1. Use of the operating and installation manual

The operating and installation manual forms an integral part of the controller.

→ Please be sure to pass the manual on to the next owner of the device.

Project controller

Specifications and instructions for customer-specific project controllers (model numbers beginning with “PL” or “PML”) may differ from those set down in the operating and installation manual.

→ For project controllers, it is also necessary to observe the agreed specifications.

1.2. Symbols and flags

Warning symbol



WARNING

Warning regarding a potential danger.

Possible consequences of failure to comply with the warning. The word used, e.g. “warning”, indicates the level of danger present.

→ Precautions required to prevent the danger and its consequences.

Levels of danger

Word	Meaning	Consequences of non-compliance
DANGER	Warning of an imminent danger	Death or serious injury, or major damage to property
WARNING	Warning of a potential danger	Possible death or serious injury, or major damage to property
CAUTION	Warning of a potentially dangerous situation	Possibility of slight injury or damage to property

Tab. 1: Levels of danger

Other flags and symbols

→ Identifies an action (step) to be carried out.

1. Identifies the first step of an action. Further numbered steps follow.

i Identifies important information.

1.3. Terminology, Definitions

In this document the expression pump is used for a Diaphragm Dosing Pump FEM1.02_.55 or FEM1.09_.55 and controller or pump controller is used for a 2-Phase Stepping Motor Driver for a Diaphragm Dosing Pump FEM 1.02_.55 or FEM 1.09_.55

RPM = revolutions per minute.

2. Use

2.1. Intended use

The controller is exclusively intended to drive the 2-phase stepper motor of the FEM 1.02_.55 and FEM 1.09_.55 pumps.

Owner's responsibility

Only install and operate the controller and the pumps under the operating parameters and conditions described in chapter 4, Technical Data.

The .55 versions of our diaphragm liquid pump range are specially designed to operate together with the FE Z5 controller.

This version the pump is equipped with a hall sensor which generates a reference signal when the eccentric passes the bottom dead centre.

This is necessary to execute and control single dispense strokes.

- i** The FE Z5 controller operates .55 version pumps in single stroke dispense mode..
- i** The FE Z4 controller operates stepper motor driven pumps including .55 version pumps in continuous running mode.
- i** Other pumps than .55 version pumps do not run properly together with the FE Z5 controller.

Operating parameters and conditions

.55 Version – Version especially for the controller FE Z5

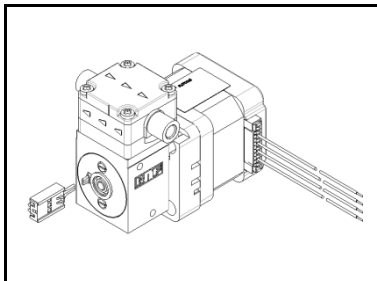


Fig. 1: FEM 1.02_.55

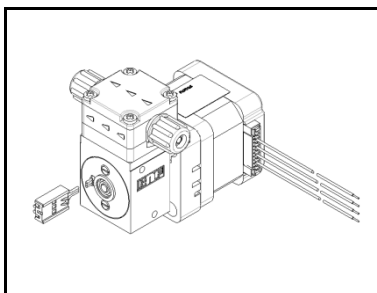


Fig. 2: FEM 1.09_.55

2.2. Improper use

The controller and the pumps must not be operated in a potentially explosive atmosphere.

The ambient temperature for the controller board is limited to 40° Celsius maximum.

Handle this pump controller only conform to ESD protection standards (Electrostatic Discharge).

Do not use this pump controller board at high humidity or condensing conditions.

Prevent the controller from being contaminated or contacted with any liquids, solvents or vapours.

Prevent the controller from being uncontrolled connected to conductive wires or materials.

3. Safety

i Read the safety instruction in sections 5. Installation and connection, and 6. Operation.

i For security reasons consult first the KNF Flodos “Operating Instruction ID 157639 - Diaphragm Dosing Pump FEM1.02 or FEM1.09” before starting a pump application. Take notice of all the related description, especially concerning the safety, the technical data and the pump performance.

The controller is constructed according to the generally accepted rules of the technology, and occupational health and safety and accident prevention provisions. Hazardous situations with the possibility of injuries to the user or other persons, or damage to the controller or other property, may, however, occur during use of the device.

The controller must be operated only in technically sound condition and for its intended purpose, with due regard for safety and potential hazards and in accordance with this operating and installation manual.

Personnel	<p>Make sure that all persons working with the controller have been appropriately trained and familiarised with its use, or are qualified personnel. This applies particularly to the assembly, connection and maintenance of the equipment.</p> <p>Make sure that the relevant personnel have read and understood this operating and installation manual, particularly the chapter on safety.</p>
Safety awareness	Accident prevention and safety rules must be observed at all times while working on or using the controller or the pump.
Hazardous media	When pumping a hazardous medium, always observe the safety rules for the medium in question.
Signs	Always comply with instruction signs placed on the pump, such as flow direction arrows and the type plate, and keep these in a clearly legible condition.
Environmental protection	All replacement parts must be stored and disposed of in accordance with the precautions required under environmental protection provisions. It is important to comply with both national and international regulations. This applies particularly to parts that have been contaminated with toxic materials.
Disposal	<p>Dispose of all packaging in an environmentally appropriate manner. The packaging materials are recyclable.</p> <p>Ensure that the controller 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 controllers contain valuable recyclable materials.</p>



EU directives/standards	<p>The pumps are in accordance with the requirements of the guidelines 2011/65/EU (ROHS2)</p> <p>The diaphragm liquid pumps conform with the EU safety requirements and guidelines for the electromagnetic compatibility 2004/108/EC.</p> <p>According to the machinery directive 2006/42/EG pumps are incomplete machines and are thus to be considered as not ready for use. The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of the Directive 2006/42/EC. The Basic requirements of the machinery directive 2006/42/EC according to appendix I (general principles) are applied and fulfilled.</p> <p>The pump controller board connected to a Diaphragm Dosing Pump FEM1.02 or FEM1.09 with maximum 1 meter of power supply cables are in accordance to the following standards:</p> <ul style="list-style-type: none">▪ EN 61000-6-2▪ EN 61000-6-3
Customer service and repairs	<p>All repairs to the pumps must be carried out solely by the accredited KNF customer service team.</p> <p>Use only KNF original parts for all maintenance work.</p>

4. Technical data

4.1. Electrical data

Parameter	Value
Supply voltage [V DC]	10 V ... 28 V (24 V \pm 10% for full pump performance)
Max. current consumption, DC RMS 24 V [A]	0.8 A
Stepper driver Current [A/Phase] RMS	0 ... 0.5 (optional 0 ... 1.2)
Stepper driver Stepping mode	2-Phase 8 Micro steps
Protection class	IP 00
Connection	Connector with leads

Tab. 2: Electrical data

4.2. External drive

Parameter	Value
<i>Signal Ground</i> <i>COM 1</i>	
	GND is internally connected to PWR-GND, all input and output signals are referenced to this GND level.
<i>Analogue input</i> <i>COM 2,3</i>	
Signal range	0–10 V, 4–20 mA
Input resistance [Ω]	20 k Ω at 0–10 V 220 Ω at 4–20 mA
<i>Digital input</i> <i>COM 4,5</i>	
Signal range	Pull up at 24 V
Electric strength [V] TTL	24 V DC
Low level (ON)	< 0.8 V = low
High level (OFF)	> 2.0 V = high
<i>Digital output</i> <i>COM 7</i>	
Electric strength, open collector [V] TTL	35 V DC
Load capability, open collector [mA]	20 mA
<i>Reference output</i> <i>COM 8</i>	
Output voltage [V DC]	10 V
Load capability [mA]	10 mA

Tab. 3: External drive

4.3. Other parameters

Parameter	Value
Permitted ambient temperature	+5 to +40°C
Humidity	Not condensing
Weight of the controller ¹⁾ [g]	24

Tab. 4: Other parameters

1) Weight without connecting wires.

5. Structure and operation

5.1. Introduction

The 2-Phase Stepping Motor Driver is a stepper motor controller to operate the KNF Flodos Diaphragm Dosing Pump FEM 1.02_.55 or FEM 1.09_.55.

The operating instructions are to be used together with the operating instructions

ID 157639 "Diaphragm Dosing Pump FEM1.02 or FEM1.09"

5.2. Features

- Easy and precise pump control with high flexibility in process integration
- Wide supply voltage range 10 ... 28VDC
- Constant current 2-phase stepper motor driver, adjustable 0 ... 0.5 A rms per phase
(Optional 0 ... 1.2 A rms)
- Micro stepping: 8 micro steps = 1 full step, 1600 micro steps = 1 full revolution
- Dispense stroke control 10° ... 170° by:
 - internal Trimmer
 - external Voltage 0 ... 10 V
 - external Current 4 ... 20 mA
 - external Potentiometer
- Digital I/Os for pump motor control: START Dispense, PRIME and ALARM output
- Integrated supply and connector for HALL type position sensor for dispense stroke monitoring
- Two different suction stroke speeds and five different pressure stroke speeds possible
- REF – output 10 VDC, 10 mA, to supply an external sensor or potentiometer
- On-board circuits for thermal protection and short circuit protection of motor phase current
- Compact size 72mm x 43mm x 25mm, fits into DIN-Rail housings for 72mm PCB

6. Assembly and connection

Only install and operate the controller under the operating parameters and conditions described in chapter 4, Technical Data. Observe the safety instructions in chapter 3.

6.1. Assembly

i Handle this pump controller only in accordance to the ESD standards (Electrostatic Discharge).

Mounting dimensions → Mounting dimensions (see fig. 3)

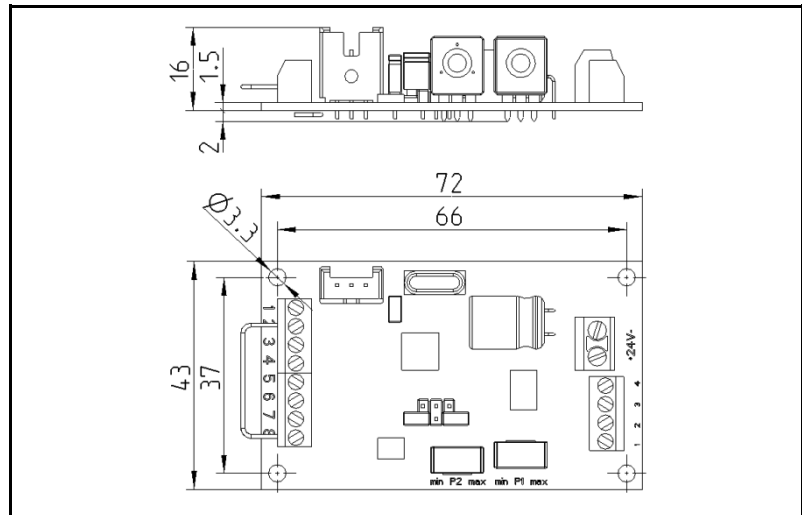


Fig. 3: Dimension FE Z5

- Installation → Make sure that the installation location is dry and the controller is protected against rain, splash, hose and drip water.
- Protect the controller from dust.
- Protect the controller from vibrations and jolts.

6.2. Electrical Connection

1. Connect the 4 wires of the pump motor to the **MOT** terminals of the controller (see tab. 5).
2. Plug the hall sensor connector of the pump into the **HALL**-terminal of the controller.
3. Connect the wires for remote control to the **COM** connector (see tab. 5 and section 6). As needed for the application.
4. Adjust trimmers and jumpers according to the application. (see tab. 6, 7 and section 6)
5. Apply 24 VDC supply voltage to the **PWR** power supply terminals.

i Make sure your power supply can deliver at least 0.8A.

6.3. Connectors

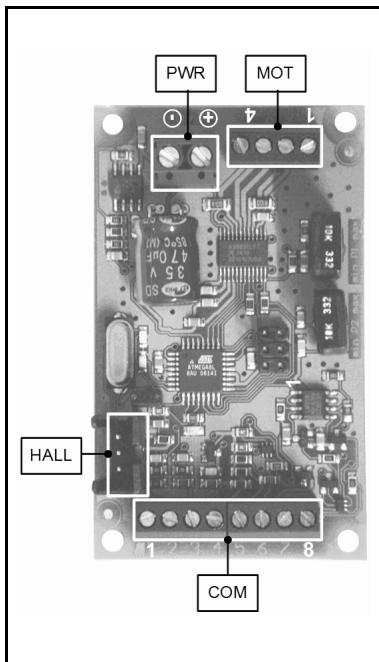


Fig 4: Location of connectors

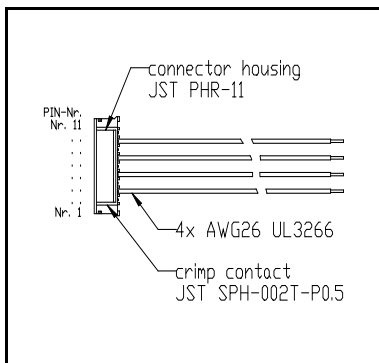


Fig. 5: Motor wire

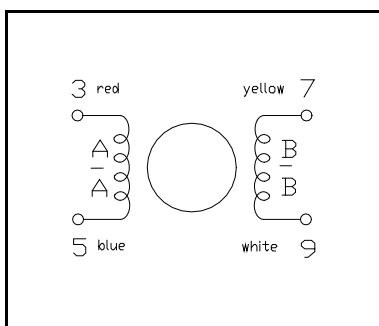


Fig. 6: Motor windings bipolar

	Pin No.	Signal Name	Function
PWR	+	+24V	+ Power supply 10 ... 28 VDC.
	-	PWR-GND	- Power supply, Power Ground
MOT	1	B-	Motor phase B- (white wire)
	2	B+	Motor phase B+ (yellow wire)
	3	A-	Motor phase A- (blue wire)
	4	A+	Motor phase A+ (red wire)
COM	1	GND	Signal Ground internally connected to PWR-GND Reference level for COM signals
	2	0 ... 10 V Analogue Input	Dispense Volume control 0V = 10° Pump stroke 10V = 170° Pump stroke max.
	3	4 ... 20 mA Analogue Input	Dispense Volume control 4mA = 10° Pump stroke 20mA = 170° Pump stroke max.
	4	START Digital Input	Start of dispense stroke at the falling signal edge.
	5	PRIME Digital Input	Continuous operation with 10 - 200 RPM Motor stops after minimum one full motor revolution at the bottom dead centre
	6	-	No function Internal connected to GND
	7	ALARM – Output	Alarm output signal Open collector
	8	REF – Out- put	Reference voltage output 10 VDC, 10mA max load current
Note: All Digital Input levels are TTL levels, but they can be driven up to 24 VDC			
HALL	Connect the hall sensor cable of the FEM1.02_.55 or FEM1.09_.555 pump to the HALL-terminal.		

Tab. 5 Connectors

6.4. Trimmers

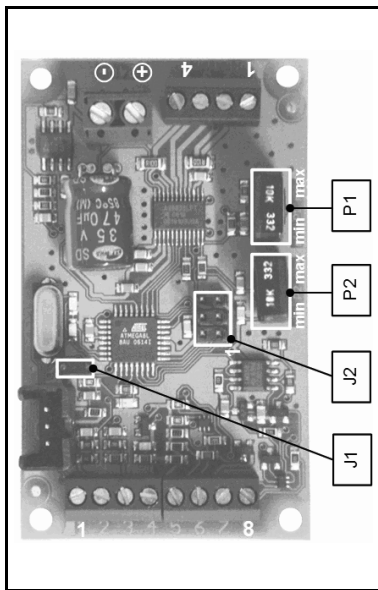










Fig 7: Location of trimmers and jumpers

	Function
P1	<p>Motor current setting</p> <p>The default setting is 0.33 A rms per phase. This is about the middle position of trimmer P1.</p> <p>i High motor current settings increase the pump performance for higher pressure. Higher settings increase the motor temperature.</p> <p>i Low motor current settings reduce the motor temperature. High pumping pressures may not be achieved.</p> <p> High motor current causes high motor temperature.</p> <p>CAUTION Hot surface danger of burns</p> <p>Motor iron temperature above 100°C causes motor damage.</p>
P2	<p>Dispense stroke volume limit setting.</p> <p>max = bottom dead centre to +170° min = bottom dead centre to + 10° (Fig. 6)</p> <p>Setting of P2 limits the pump stroke range controllable by an external control signal 0V - 10V respectively 4 - 20mA.</p>

Tab. 6 Trimmers

6.5. Jumpers

	Setting	Function
J1	Suction stroke RPM	
	Closed 	Suction RPM = 180 RPM
	Open 	Suction RPM = 20 RPM
J2	Pressure stroke RPM	
	Open 	Discharge RPM =180 RPM
	Pin 3 – 4 	Discharge RPM = 60 RPM
	Pin 1 – 3 	Discharge RPM = 20 RPM
	Pin 4 – 6 	Discharge RPM = 5 RPM
	Pin 1 – 3 Pin 4 – 6 	Discharge RPM = 1 RPM

Tab. 7 Jumper settings

i Before changing position of the jumper, turn the power supply at the PWR connector off. Otherwise the jumper settings will not apply.

7. Operation

- The controller should only be used under normal operating parameters / conditions which are described in section 4 – technical data.
- Ensure that the controller is used correctly (see section 2.1).
- Improper use of the controllers must be avoided (see section 2.2).
- Observe the safety notes (see chapter 3).
- The controller is a component which has to be integrated into a machine. Before it is put into operation it is important to ensure that the machine / equipment complies with the appropriate regulations.



Danger of burning
The motor heats up

→ Don't touch the motor

CAUTION → Don't let the motor come in contact with flammable materials

7.1. Operation without external control of dispense volume

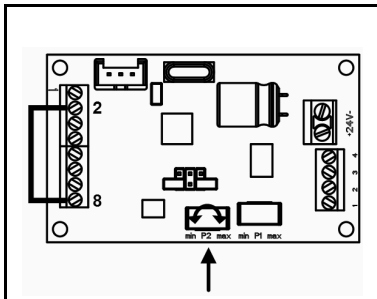


Fig. 8: No external volume control

- Connect COM 8 to COM 2 with a wire (see fig. 8)
This loops the 10v reference voltage of COM8 to the 0-10V input of COM2 and enables the dispense volume control by trimmer P2

- Connect the start signal to COM 4 (see fig. 9)



The dispense stroke will start with the falling impulse edge on COM 4

The start signal may be generated by:

1. a switch
2. a relay contact
3. a process controller unit

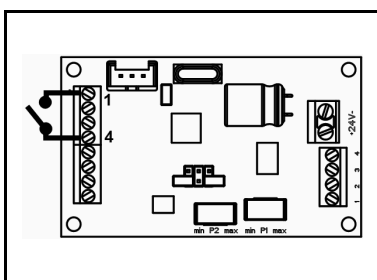


Fig 9: Start impulse

- Connect Power supply to the PWR DC Power Clamps
- Adjust trimmer P2 until the pump dispenses the volume needed.

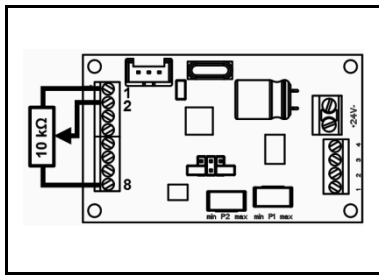


Fig. 10: External potentiometer

7.2. Setting to a dispense stroke by using an external potentiometer*

- ➔ Remove the wire between COM 2 and COM 8
- ➔ Connect the start signal to COM 4 (see fig. 9)
- ➔ Use an external potentiometer of 1kΩ to 10kΩ resistance. Connect the fixed terminals of the external potentiometer to COM 1 and COM 8. (see fig. 10)
Connect the adjustable potentiometer terminal to COM 2 (0 ... 10 V Analogue Input)
- ➔ The dispense stroke volume can now be changed by adjusting the external potentiometer

Pump type	min. volume [μ l]	max. volume [μ l]
FEM 1.02_.55	5	190
FEM 1.09_.55	20	540

Tab. 8: Dispense stroke volume range

i The dispense volume may vary from pump to pump due to geometric tolerances.

See section 7.6 for pump calibration

i The maximum dispense volume is limited by the setting of trimmer P2

- ➔ Use COM 4 to execute dispense strokes

7.3. Controlling dispense stroke volume by analogue signal 0 - 10V or 4 – 20mA

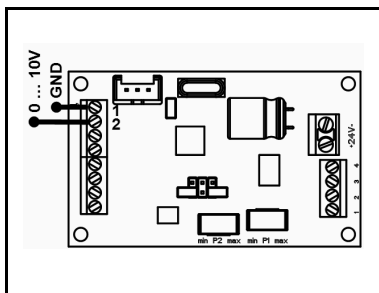


Fig. 11: Control 0 – 10V

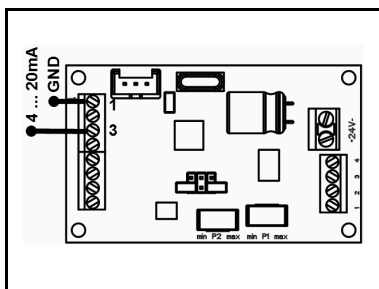


Fig. 12: Control 4 – 20mA

- ➔ Remove the wire between COM 2 and COM 8
- ➔ Connect the start signal to COM 4 (see fig. 9)
- ➔ Connect the analogue signal to:
COM 2 for 0 – 10v control (see fig. 11)
COM 3 for 4 – 20mA control (see fig. 12)
- ➔ The dispense stroke volume is now proportional to the analogue signal applied.

i The dispense volume may vary from pump to pump due to geometric tolerances.

See section 7.6 for pump calibration

i The maximum dispense volume is limited by the setting of trimmer P2

i The signal at COM 3 (4 - 20mA) has a higher priority than the signal at COM 2 (0 - 10V) and will therefore override any connected analogue signal 0 - 10 V at COM 2.

- ➔ Use COM 4 to execute dispense strokes

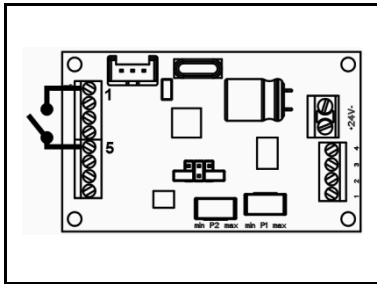


Fig. 13: Priming

7.4. Priming

The priming function may be used to fill or empty the piping of the application with maximum pumping speed.

→ Connect the priming signal to COM 5 (see fig. 13)

Pump type	priming [ml/min]
FEM 1.02_.55	1.5 - 30
FEM 1.09_.55	4.5 - 90

Tab. 9: Priming speeds

i The pump runs with priming speed of 10 - 200 rpm according to the analog signal COM 2 or COM 3 as long as the priming signal COM 5 is low level.

The priming keeps a constant rpm for each full revolution and then adjust the rpm to the analog signal for the next revolution.

i The priming signal COM 5 has higher priority than other commands. The priming signal overrides currently active dispense cycles.

7.5. ALARM output

The controller is equipped with an open collector output to indicate basic controller alarms.

→ Connect COM 7 of the controller to the process control unit.
Note: The process control unit needs to read an open collector output.

→ To generate a voltage signal (10V / GND) connect a 10kΩ resistor from COM 8 to COM 7 (see fig. 14).

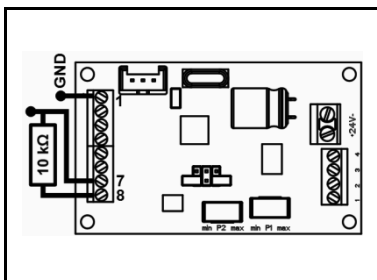


Fig. 14: Open collector alarm

This alarm signals that the controller detected one of the following alarm states:

1. General controller malfunction
2. Pump init position not detected i.e. the next dispense volume will not be an exact volume
3. Pump overpressure: During the last dispense stroke overpressure occurred and blocked the pump function

i There is no differentiation between the alarms.

i COM 4 "Start" or COM 5 "Prime" will reset the error after execution of one pump stroke.

7.6. Calibration

Factory calibration Per default is the controller not calibrated. If a calibrated pump system is needed ask for project specific calibration of the pump system.

Calibration The dispense volume may vary from pump to pump due to the following reasons:

- Geometric tolerances.
- Differences in piping
- Viscosity of the fluid

For accurate metering, it is therefore desirable to calibrate the pump.

- Take an accurate measurement of the dispensed volume.
- Adjust the setting of trimmer P2. (See tab 12 for setting width)
- Check the calibration with a repeat measurement.

Pump type	1/4 Turn	1/8 Turn	Mid position
FEM 1.02_.55	+ / - 60µl	+ / - 30µl	~90µl
FEM 1.09_.55	+ / - 130µl	+ / - 65µl	~260µl

Tab. 10: Dispense stroke volume calibration

8. Troubleshooting

- ➔ Remove the power from the controller.
- ➔ Check that there is no current flowing.

No pump stroke is being carried out	
Cause	Fault remedy
Controller is not connected to power supply.	➔ Connect the controller to the power supply. Check for correct polarity of the PWR connector.
Pump is not connected to the electronic controller.	➔ Connect the pump to the MOT connector of the controller.
Power supply is not switched on.	➔ Switch on power supply.
Electrical signal is not within the defined limits.	➔ Check the specifications (chapter 4).
Controller Input channels are not connected correctly.	➔ Check Input connection according to section 6.3.
Signal ground not connected	➔ Connect COM1 signal GND

Tab. 11

Pump motor gets hot	
Cause	Fault remedy
Too high motor phase current setting.	➔ Adjust trimmer P1 to lower current setting (section 6.4).
Too high ambient temperature.	➔ Increase airflow in the housing to stay below ambient temperature limit (section 4.3).

Tab. 12

Pump rattles or does not execute full dispense strokes	
Cause	Fault remedy
Too high pump system pressure	➔ Reduce system pressure to the allowed limits of the pump.
Too low motor phase current setting.	➔ Adjust trimmer P1 to higher current setting (section 6.4).
Far too high motor phase current setting (Overheating).	➔ Adjust trimmer P1 to lower current setting (section 6.4).
Too high ambient temperature.	➔ Increase airflow in the housing to stay below ambient temperature limit (section 4.3).
System valve is closed or filter is blocked.	➔ Open the valve. ➔ Clean / replace filter.
Setting of trimmer P2 too low.	➔ Adjust trimmer P2 to the needed maximum dispense stroke.
Analogue signal too low.	➔ Check signal levels according to section 4.5.
Analogue ground not connected to controller.	➔ Connect the ground of the analogue signal to COM 1.

Tab. 13

The dispense time is too short / too long	
Cause	Fault remedy
Setting of Jumper J1 or J2 wrong.	➔ Adjust Jumper J1 or J2 to correct RPM.

Tab. 14

KNF worldwide

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