Calibre SCIENTIFIC

FemtoJet® 4i
FemtoJet® 4x

Service-Manual - English

Calibre SCIENTIFIC

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1 Operating instructions

1.1 Using this manual

- Make sure that the service manual and the operating manual are available in the latest versions. To do so, compare the version numbers. Please visit www.calibrescientific.com to contact Calibre Scientific for the PDF document.
- Read the service manual before commencing work on the device.
- Read the chapters "Installation" and "Operation" of the operating manual.
- Observe the safety instructions in the operating manual.

1.2 Danger symbols and danger levels

1.2.1 Danger symbols

The safety instructions in this manual have the following danger symbols and danger levels:

	**Electric shock**		**Hazard point**
	**Cuts**		**Material damage**
	**Biohazard**		

1.2.2 Danger levels

DANGER	*Will* lead to severe injuries or death.
WARNING	*May* lead to severe injuries or death.
CAUTION	May lead to light to moderate injuries.
NOTICE	May lead to material damage.

1.3 Symbols used

Depiction	Meaning
1. 2.	Actions in the specified order
▸	Actions without a specified order
•	List
	Direction of movement
Text	Display or software texts
	Additional information

1.4 Purpose and scope

1.4.1 Purpose

This document describes all prerequisites and actions necessary to perform installation, diagnosis, repair or maintenance of the product named on the title page.

1.4.2 Scope

This document applies to all service organizations of Biozol Diagnostica Vertrieb GmbH, service providers commissioned by Biozol Diagnostica Vertrieb GmbH, as well as certified Biozol Diagnostica Vertrieb GmbH service technicians.

1.5 Version overview

Version	Issue date	Chapter	Change
00	2014-03	All	Document created
01	2015-05	5, 11	New service functions, new spare parts
02	2020-06	1, 10	Version history, purpose, area of application, and function test added.

2 Product description

2.1 Features

The Microinjector can be used to inject very small amounts of fluid into cells. The parameters for pressure and time are set on the device and controlled by the software. It is possible to trigger the injection on the Microinjector or on a connected micromanipulator by Calibre Scientific. The semiautomatic injection movement is controlled by the Microinjector or the micromanipulator. The required pressure is generated by a soundproof internal compressor.

2.2 Product overview

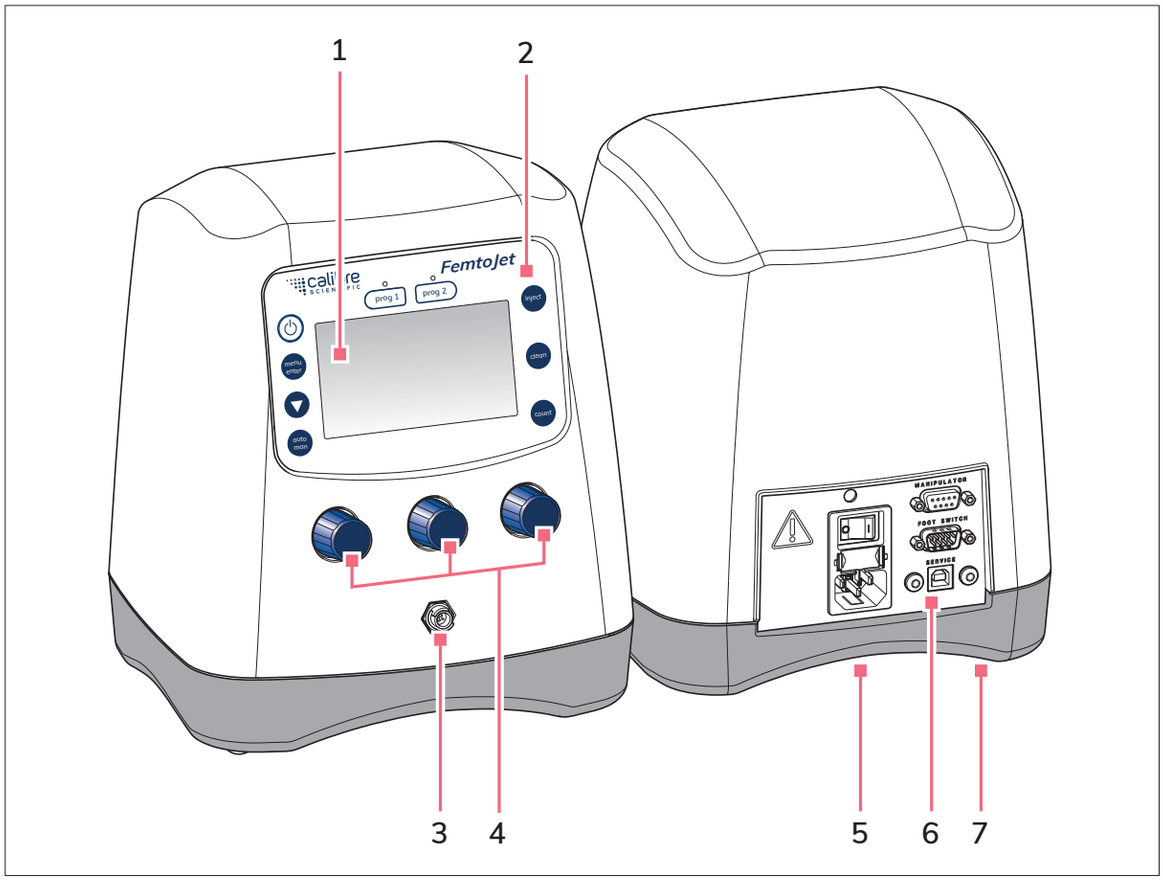


Fig. 2-1: Front and rear side

1 **Display**

2 **Control panel**

3 **Bayonet joint for injection tube**

4 **Rotary knobs for injection parameters**

5 **Name plate**
Bottom of the device

6 **Interfaces**

7 **Venting**
Bottom of the device

2.2.1 Interfaces

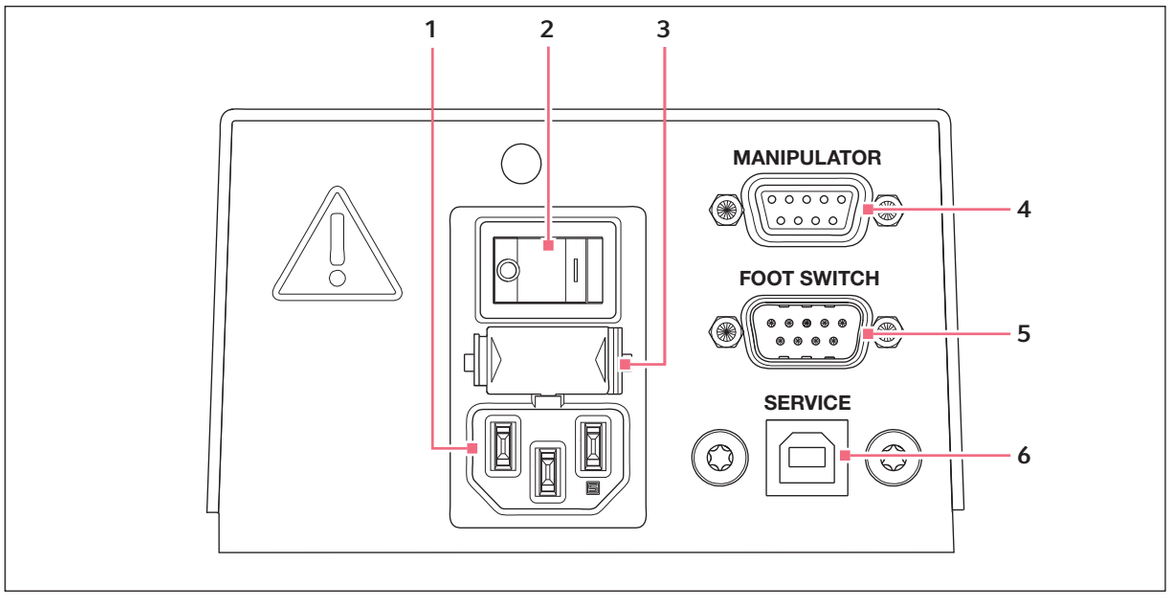


Fig. 2-2: Interfaces

1 Mains/power connection

2 Mains/power switch On/Off

3 Micro fuse

4 Port for micromanipulator or computer

5 Connection for foot or hand control

6 Service connection

2.3 Product overview

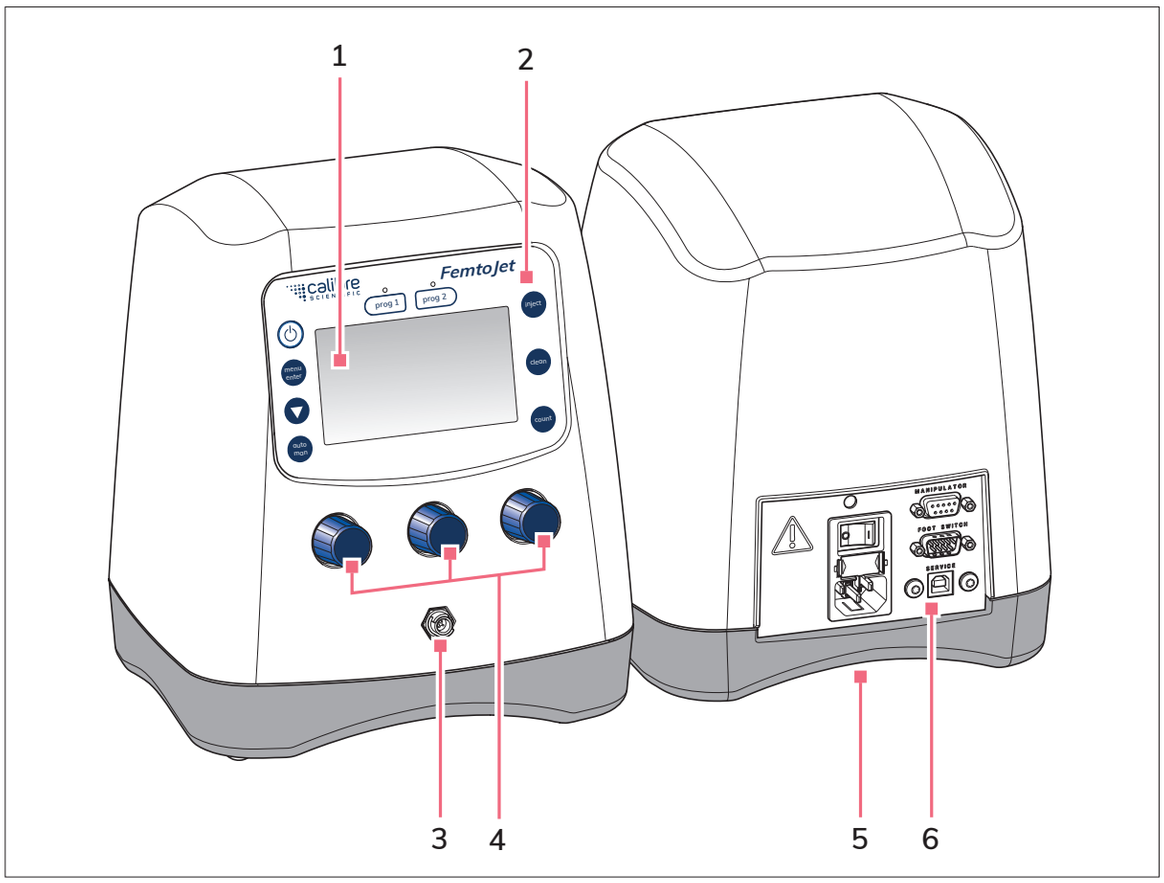


Fig. 2-3: Front and rear side

1 **Display**

2 **Control panel**

3 **Bayonet joint for injection tube**

4 **Rotary knobs for injection parameters**

5 **Name plate**
Lower side of device

6 **Interfaces**

2.3.1 Interfaces

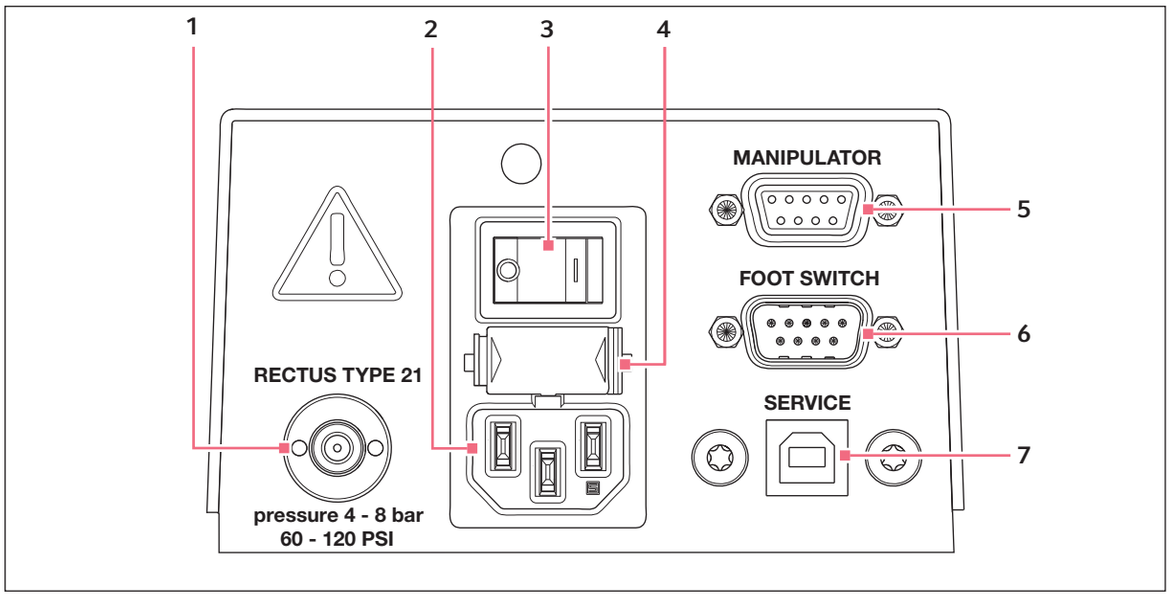


Fig. 2-4: Interfaces

1 **Port for external pressure supply**
2 **Mains/power connection**
3 **Mains/power switch On/Off**
4 **Micro fuse**
5 **Port for micromanipulator or computer**
6 **Connection for foot or hand control**
7 **Service connection**

2.4 Name plate

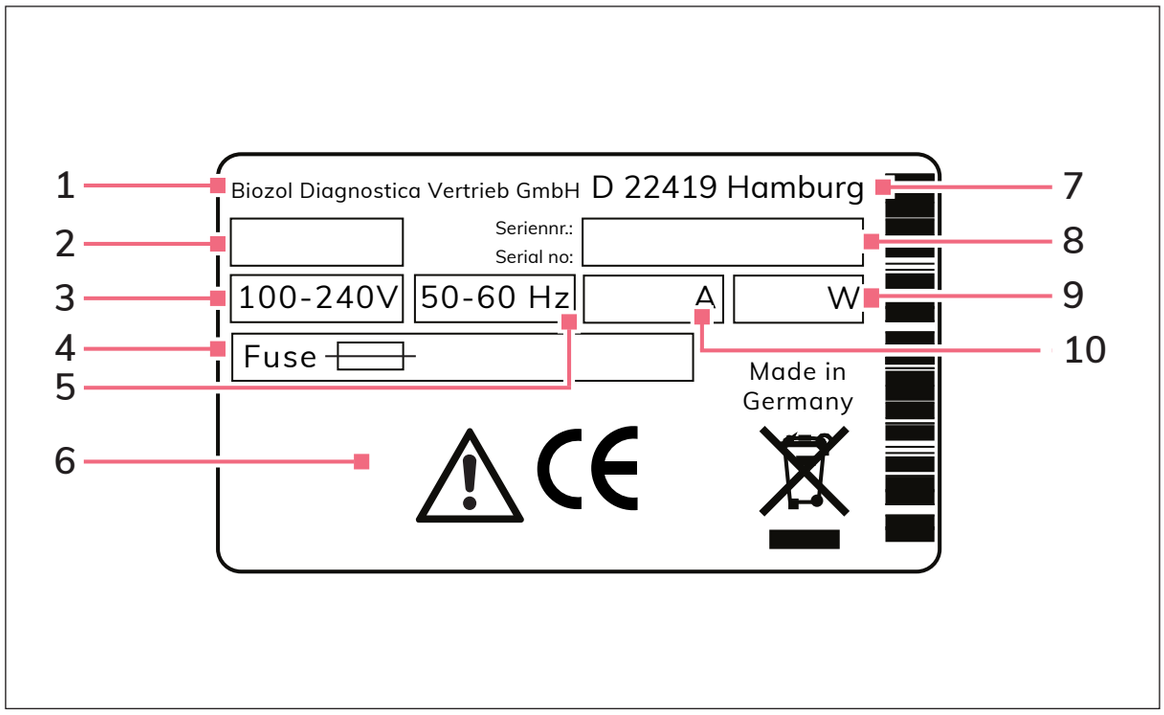


Fig. 2-5: Name plate

1 **Manufacturer**
2 **Product number**
3 **Voltage**
4 **Micro fuse**
5 **Frequency**
6 **Labelings**
7 **Address of manufacturer**
8 **Serial number**
9 **Output**
10 **Current consumption**

2.5 Control panel

The keys of the control panel are used to switch on the Microinjector, to perform functions, to select programs and to navigate through the menu.

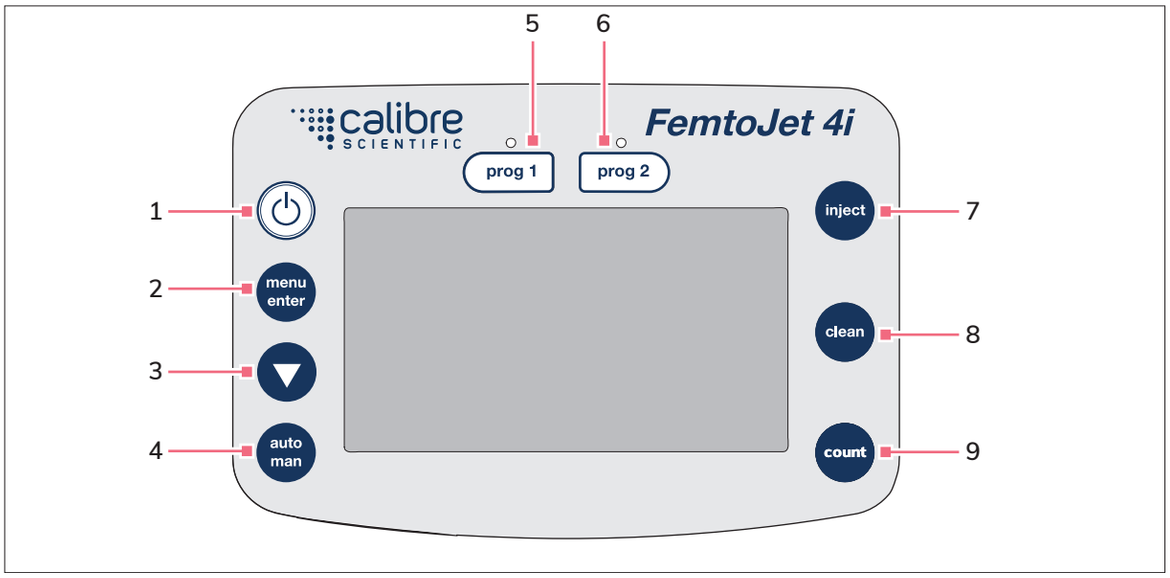


Fig. 2-6: Control panel

1 *standby* **key**
Activate or deactivate standby mode

2 *menu enter* **key**
Select menu or confirm selection

3 **Arrow key**
Navigate the menu

4 *auto man* **key**
Toggle between automatic and manual injection

5 *prog 1* **key**
Select or save parameter set 1

6 *prog 2* **key**
Select or save parameter set 2

7 *inject* **key**
Perform an injection

8 *clean* **key**
Clean the capillary

9 *count* **key**
Set the counter to zero

2.6 Rotary knobs

The rotary knobs are used to set the injection parameters as injection time, injection pressure and compensation pressure.

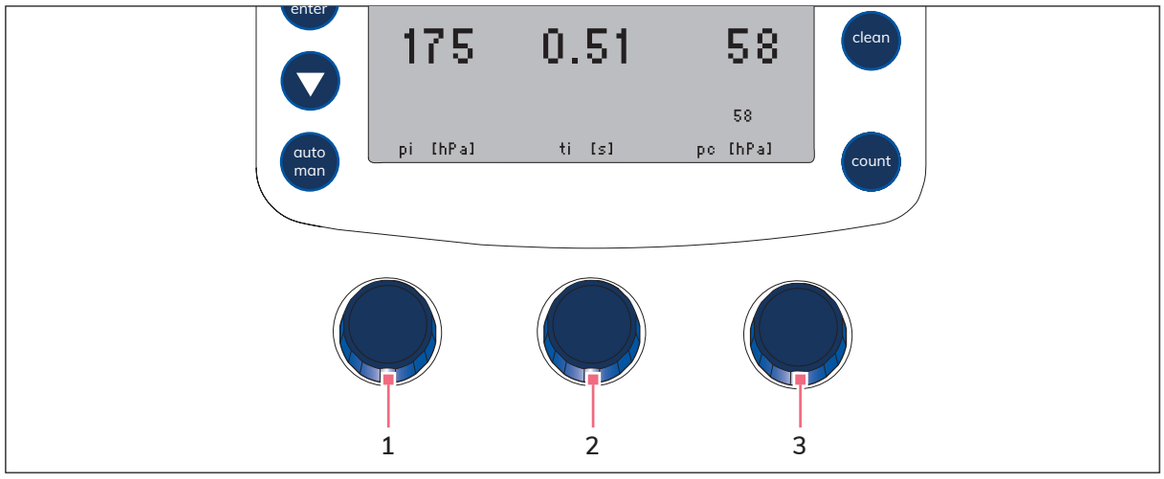


Fig. 2-7: Rotary knobs

1 Rotary knob
Set the injection pressure p_i

2 Rotary knob
Set the injection time t_i

3 Rotary knob
Set the compensation pressure p_c

2.7 Exemplary set-up of a microinjection system

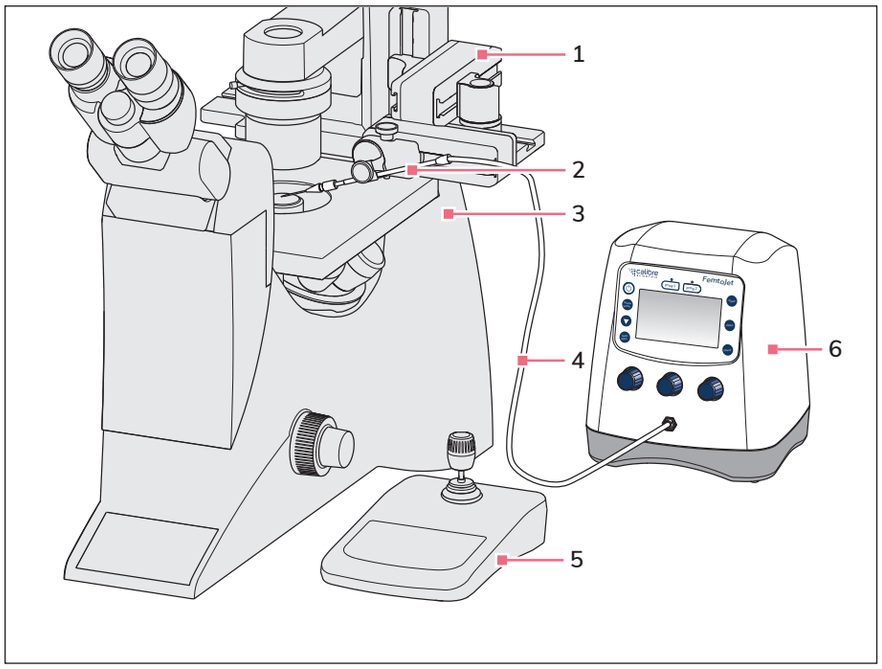


Fig. 2-8: Microinjection system with FemtoJet 4i

1 Micromanipulator InjectMan 4
2 Capillary holder 4 with capillary
3 Inverted microscope
4 Injection tube
5 Control board InjectMan 4
6 Microinjector FemtoJet 4i

2.8 Capillary holder 4

You can insert a capillary or a Femtotip into the capillary holder.

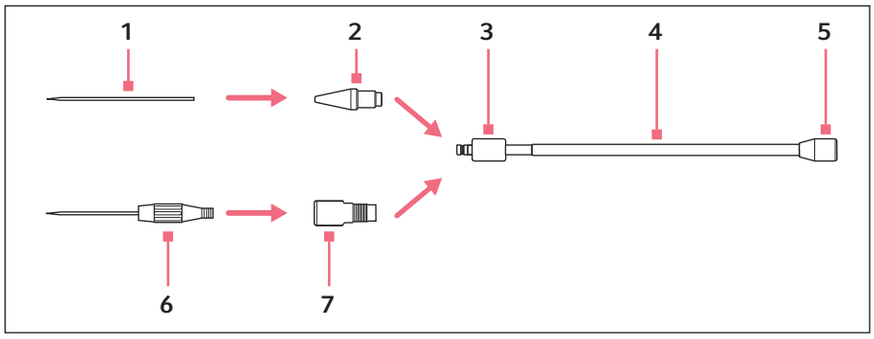


Fig. 2-9: Capillary holder 4

1 Capillary

2 Grip head

3 Knurled screw

4 Capillary holder

5 Connection for injection tube

6 Femtotips

7 Adapter for Femtotips

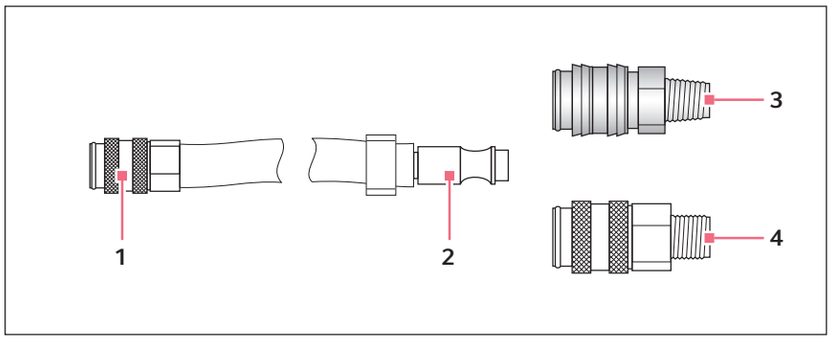
2.9 Pressure tube

The Microinjector is connected to an (external, FemtoJet 4x) pressure supply with a pressure tube.

The installation only must be realized by qualified staff that has received training on compressed air systems.

You can use the following external pressure supplies:

- Compressor
- Compressed gas cylinder with industrial gas
- Compressed air supply by domestic services



1 Quick coupling
Port for Microinjector

2 Plug

3 Quick coupling
Brass with conical thread

4 Quick coupling
Nickel-plated with cylindrical thread

2.10 Pressure parameters

The parameters are used to define the pressure and time for the injection and the cleaning of the capillary.

The pressure parameters include the following parameters:

- Compensation pressure – p_c
- Injection pressure – p_i
- Injection time – t_i
- Operating pressure
- Rinsing pressure

2.10.1 Compensation pressure p_c

The compensation pressure prevents the liquid from rising from the Petri dish into the capillary due to the capillary action. Due to the compensation pressure, some liquid will leak constantly from the capillary tip. This prevents the injection material from clumping together.

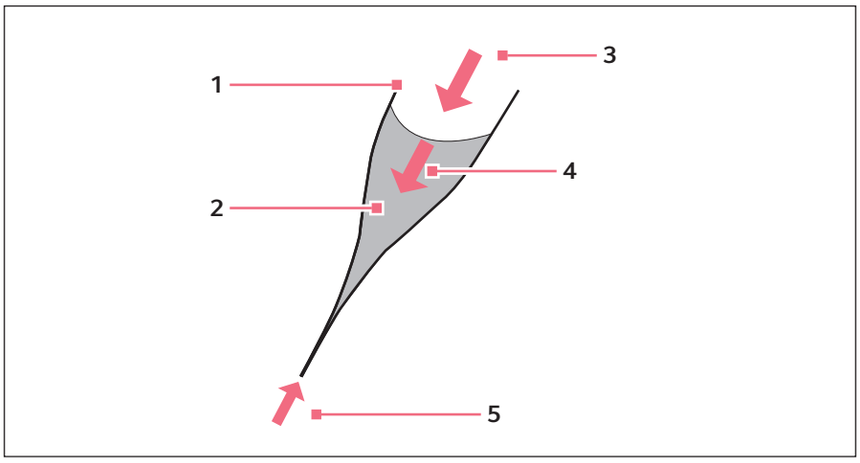


Fig. 2-10: Pressure ratios in the capillary

1 Capillary

2 Liquid with injection material

3 Compensation pressure p_c

4 Hydrostatic pressure

5 Capillary action

2.10.2 Injection pressure p_i

The injection pressure defines the pressure used for injecting liquid into the cell. During the injection process, the injection pressure is applied as long as the injection time is running. To inject liquid into a cell, the injection pressure must be higher than the inside pressure of the cell.

2.10.3 Injection time t_i

The injection time defines the time period for injecting the liquid. The start of the injection time depends on the presettings of the micromanipulator. The injection time begins either when triggering the injection function or when reaching the lower safety limit. The injection pressure is applied as long as the injection time is running.

2.10.4 Rinsing pressure

The rinsing pressure is used to clean the capillary.

2.10.5 Operating pressure p_w

The operating pressure subsumes the injection pressure, compensation pressure and rinsing pressure.

2.11 Hardware description

2.11.1 Features

The FemtoJet 4i and the FemtoJet 4x enable injection volumes of 1 fL to 100 pL to be injected into adherent cells. Injection pressure p_i and injection time t_i are set by means of rotary knobs. The injection movement is triggered by the **Inject** key, a hand control or a foot control. If no injections are being performed, the compensation pressure p_c is applied permanently.

A micromanipulator each can be connected to the FemtoJet 4i and the FemtoJet 4x. Connecting the FemtoJet 4x to an external pressure supply allows injections in rapid succession, even at higher pressures.

2.11.2 Functional diagram of the FemtoJet 4i

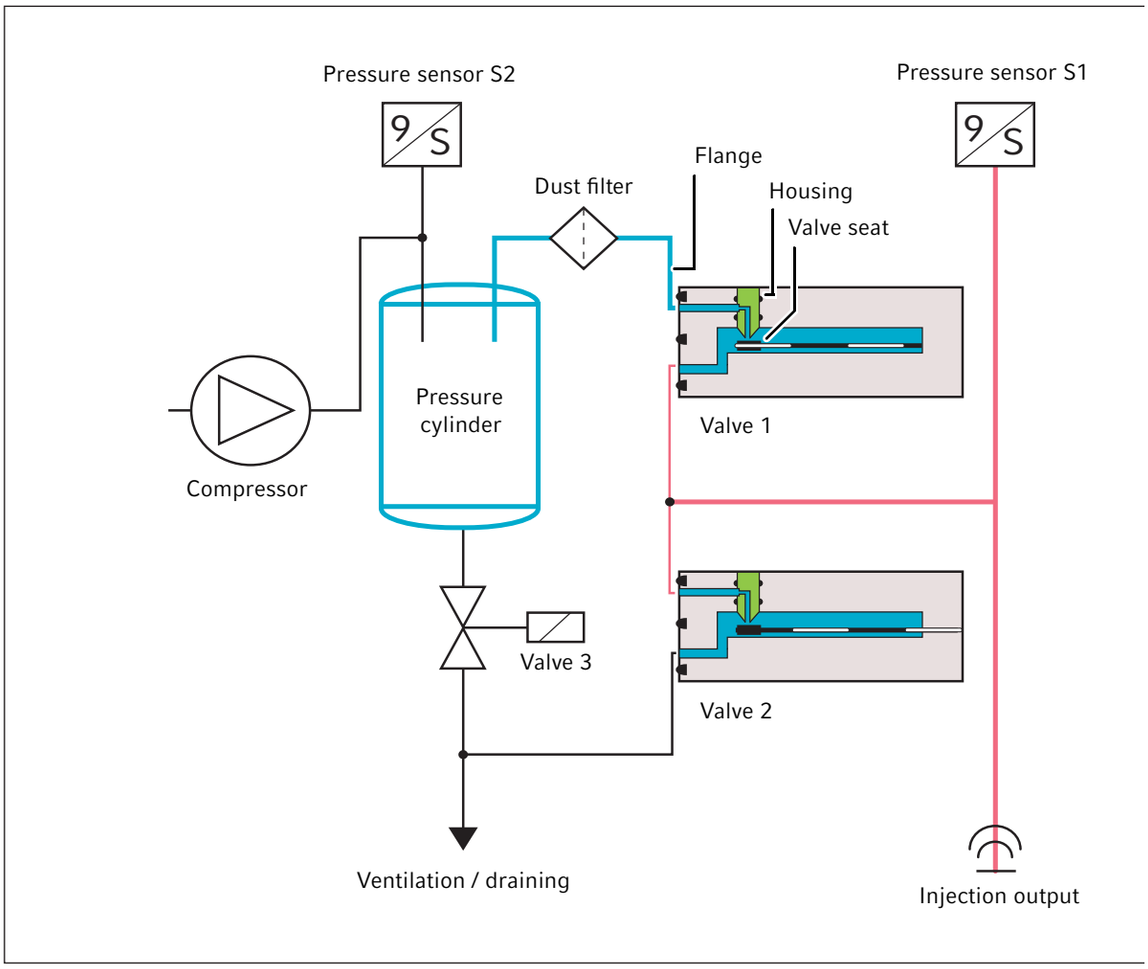


Fig. 2-11: Operating principle of the FemtoJet 4i

The built-in compressor delivers compressed air to a pressure reservoir until a storage pressure p_s of 6000 hPa is reached. This storage pressure is greater than the maximum pressure during an injection. Multiple injections are possible.

If an injection is triggered, valve 1 opens between the pressure reservoir and the injection output. The working pressure sensor measures the injection pressure p_i. The injection pressure rises until the desired value has been reached. Valve 1 is then closed.

Once the end of the injection time has been reached, valve 2 opens. The injection pressure p_i falls until the desired compensation pressure p_c has been reached. Valve 2 is then closed.

The area from the pressure reservoir to the injection capillary must be hermetically sealed. The injection tube must be 2 m long.

2.11.3 Functional diagram of the FemtoJet 4x

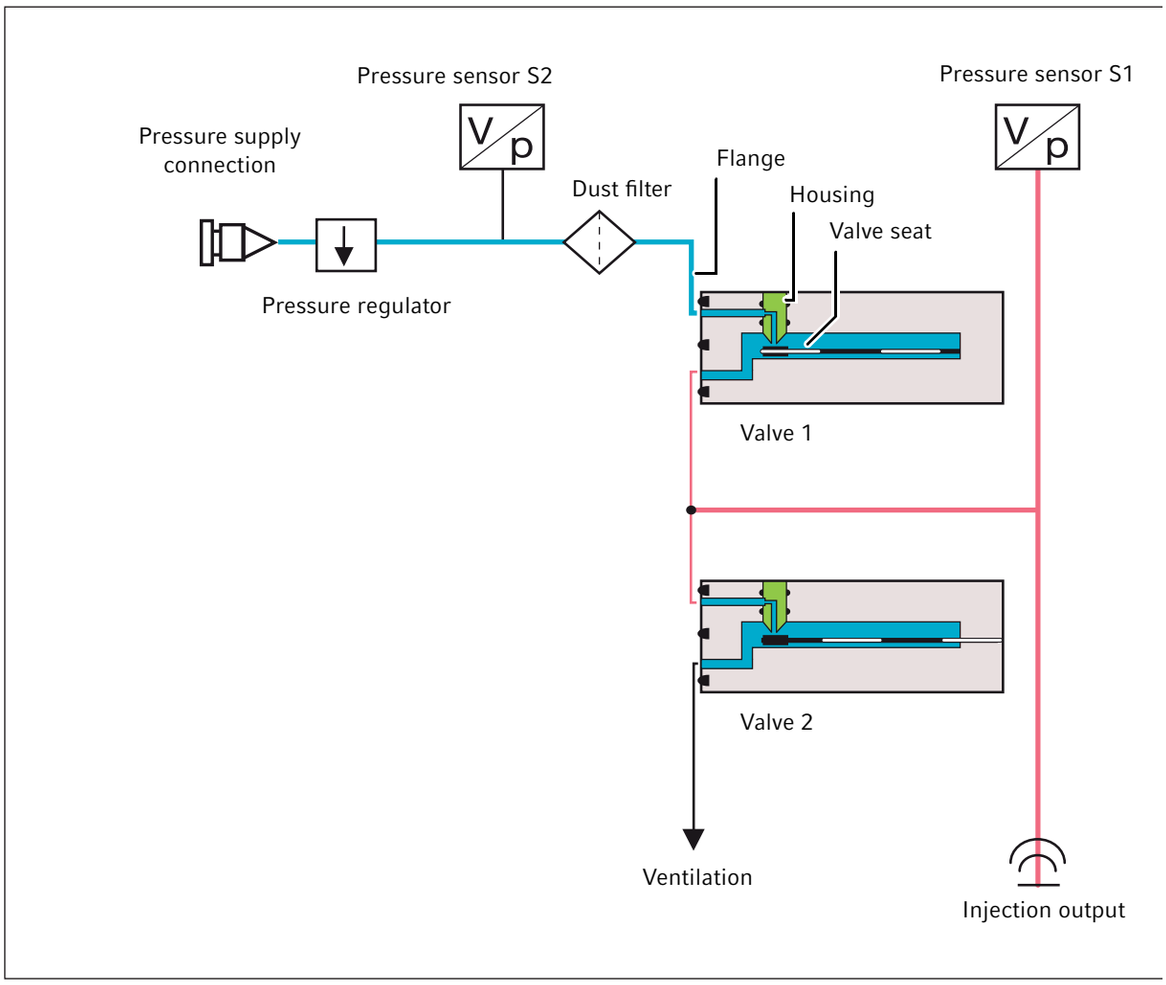


Fig. 2-12: Operating principle of the FemtoJet 4x

The FemtoJet 4x is connected to an external pressure supply. The pressure supply provides the FemtoJet 4x with a pressure between 4000 hPa and 8000 hPa. A pressure regulator limits the external pressure to 6000 hPa. The injection pressure must be 500 hPa less than the pressure from the external pressure supply.

If an injection is triggered, valve 1 opens between the pressure reservoir and the injection output. The working pressure sensor measures the injection pressure p_i. The injection pressure rises until the desired value has been reached. Valve 1 is then closed.

Once the end of the injection time has been reached, valve 2 opens. The injection pressure p_i falls until the desired compensation pressure p_c has been reached. Valve 2 is then closed.

The area from the pressure reservoir to the injection capillary must be hermetically sealed. The injection tube must be 2 m long.

3 Safety

3.1 User profile

The specialist entrusted with maintenance, repair or testing must meet the following prerequisites:

- Successful participation in service trainings with certification by Biozol Diagnostica Vertrieb GmbH for the product that is to be maintained, repaired or tested.
- Qualification as a specialist with knowledge of the applicable local and international standards.
- Qualification to evaluate the work assigned to him.
- Recognition of potential hazards and how to prevent or correct them.

3.2 Information on liability

The Calibre Scientific service organization responsible for servicing, repair, or testing is liable for ensuring that all work is performed in a professional manner.

- The constructive condition of the device must not be altered as a result of repair, servicing, or testing. The safety of the original condition must be maintained.
- Only accessories and original spare parts recommended by Calibre Scientific as well as test and measuring equipment recommended by Calibre Scientific may be used for servicing, repair, and testing.

3.3 Safety instructions

DANGER! Risk of explosion.

- Do not operate the device in areas where explosive substances are handled.
- Do not use this device to process any explosive or highly reactive substances.
- Do not use this device to process any substances which may generate an explosive atmosphere.

DANGER! Electric shock during maintenance.
Electric shocks cause injuries to the heart and respiratory paralysis.

- Switch off the device.
- Disconnect the mains/power plug.
- Then start the repair, service or cleaning of the device.

DANGER! Electric shock due to the ingress of liquid.

- Switch off the device and disconnect it from the mains/power line before starting cleaning or disinfection.
- Do not allow any liquids to penetrate the inside of the housing.
- Do not perform a spray clean/spray disinfection on the housing.
- Only reconnect the device to the mains/power line when it is completely dry, both inside and outside.

WARNING! Infection by contaminated material
There may be contaminated material on the device and the accessories. You may become infected by contaminated material.

- Find out more about the risk of contamination before starting work.
- Check the device decontamination certificate of the device.
- Work on decontaminated devices only.
- Wear your personal protective equipment (protective gloves, protective goggles).

CAUTION! Risk of cuts from broken capillaries.
Capillaries are made of glass. They are very sharp and fragile.

- Wear your personal protective equipment (PPE).
- Always mount capillaries depressurized.
- Never aim capillaries at people.
- Handle the capillaries very carefully.

CAUTION! Risk of injury from sharp-edged components
Sharp-edged components are exposed when the device is open. You may injure yourself on sharp-edged components.

- Wear protective gloves.
- Work with extreme care.

WARNING! Danger due to incorrect voltage supply.

- Only connect the device to voltage sources which correspond with the electrical requirements on the name plate.
- Only use earth/grounded sockets with a protective earth (PE) conductor.
- Only use the mains/power cord supplied.

NOTICE! Damage from UV and other high-energy radiation.

- Do not use UV, beta, gamma, or any other high-energy radiation for disinfection.
- Avoid storage in areas with strong UV radiation.

NOTICE! Damage from the use of aggressive chemicals.

- Do not use any aggressive chemicals on the device or its accessories, such as strong and weak bases, strong acids, acetone, formaldehyde, halogenated hydrocarbons or phenol.
- If the device has been contaminated by aggressive chemicals, clean it immediately using a mild cleaning agent.

NOTICE! Damage to electronic components due to condensation.
Condensate may form in the device when it has been transported from a cool environment to a warmer environment.

- After installing the device, wait for at least 2 h. Only then connect the device to the mains/ power line.

NOTICE! Damage to electronic components due to electrostatic discharge
When electronic components are handled, electrostatic fields are created. When these electrostatic fields are discharged, electronic components are destroyed.

- Minimize the build-up of electrostatic fields.
- Store and transport electronic components and assemblies in antistatic or conductive packing.
- Wear antistatic wrist straps, conductive clothing and antistatic safety boots.
- Use conductive surfaces.
- Grip electronic components by their edges.
- Do not touch any connections or conductors.
- Prevent components on plastic from becoming electrostatically charged.

NOTICE! Damage due to incorrect packing.
Biozol Diagnostica Vertrieb GmbH is not liable for any damage caused by improper packing.

- Only store and transport the device in its original packing.

CAUTION! The pressure tubing becomes bruised when it is removed from an external pressure supply.
Whiplash occurs when the pressure tubing is decoupled, as a result of a brief pressure surge.

- Hold the pressure tubing tightly during decoupling.
- Bleed the pressure after the pressure tubing has been decoupled.

NOTICE! Damage to device due to incorrect mounting of the pressure tubing on an external pressure supply.
Pressure tubing connection to an external pressure supply, e.g., to pressure cylinders, compressors or available compressed air systems, is not described in this operating manual.

- The pressure tubing may only be installed by trained personnel.
- Observe the local regulations.
- Observe the operating manual for the external pressure supply.

NOTICE! Damage to device due to incorrect compressed air.

- Use purified nitrogen or dry, compressed air that has not been oiled.
- Observe the limiting values for the compressed air. The specifications can be found in the Technical Data.

NOTICE! Cracks in the pressure tubing.
If the pressure tubing is bent, it will become cracked and must be replaced.

- The pressure tubing may not be bent.
- Curve the pressure tubing with a radius > 50 mm.

4 Operation

5 Troubleshooting

5.1 Error messages

Problem	Cause	Solution
Error #01	• Software problem	▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #02	• The compressor control signals an unexpected error.	▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #03	• The encoder input signals an unexpected error.	▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #04	• General device electronics error.	▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #05	• Hand or foot control defective.	▸ Check the hand and foot controls. ▸ Replace the defective hand or foot control. ▸ Update the software. ▸ Replace the PCB FemtoJet.
	• Error on the PCB FemtoJet.	
Error #06	• Keyboard defective.	▸ Check the keyboard. ▸ Replace the defective keyboard. ▸ Update the software. ▸ Replace the PCB FemtoJet.
	• Error on the PCB FemtoJet.	
Error #07	• The speaker control signals an unexpected error.	▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #08	• The injection pressure control signals an unexpected error.	▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #09	• The pressure reservoir control signals an unexpected error.	▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #10	• The safety monitor signals an unexpected error.	▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #11	• The RS232 serial interface signals an unexpected error.	▸ Check the RS232 interface using service function SE 06. ▸ Update the software. ▸ Replace the PCB FemtoJet.
Error #12	• The voltage control signals an unexpected error.	▸ Update the software. ▸ Replace the PCB FemtoJet.
	• Error on the PCB FemtoJet.	
Error #13	• The compressor is not working or defective.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The O-ring on the compressor piston is leaky or defective.	

Problem	Cause	Solution
	• The piezo valve (V1, V2) is leaky or defective.	
	• Valve 3 leaky.	
	• Pressure reservoir leaky.	
	• Error on the PCB FemtoJet.	
Error #14	• The pressure control in the FemtoJet 4i is defective.	▸ Check the assemblies. ▸ Replace defective assemblies. ▸ Replace the PCB FemtoJet.
	• The pressure control in the FemtoJet 4x is defective.	
	• Incorrect input pressure.	
	• Control valve defective.	
Error #15	• The compressor is sluggish.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The compressor is blocked.	
	• The compressor is defective.	
Error #16	• Valve 3 is defective.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• Valve 3 is not connected.	
	• Error on the PCB FemtoJet.	
Error #17	• Contact suppressor defective or clogged	▸ Check the assemblies. ▸ Replace defective assemblies.
	• Internal pressure tubes are not connected.	
	• Piezo valve 1 is not connected.	
	• Piezo valve 1 is blocked.	
	• Piezo valve 1 is clogged.	
	• No supply voltage or the supply voltage is interrupted or too low.	
	• Error on the PCB FemtoJet.	
Error #18	• An open injection tube is connected.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• Internal pressure tubes are not connected.	
	• Piezo valve 2 is not connected.	
	• Piezo valve 2 is blocked.	
	• Piezo valve 2 is clogged.	
	• No supply voltage or the supply voltage is interrupted or too low.	

Problem	Cause	Solution
	• Error on the PCB FemtoJet.	
Error #19	• Internal pressure tubes are not connected.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• Internal piezo valves are not connected correctly.	
	• Piezo valves leaky.	
	• Error on the PCB FemtoJet.	
Error #20	• Error on the PCB FemtoJet.	▸ Replace the PCB FemtoJet.
Error #21	• Error on the PCB FemtoJet.	▸ Replace the PCB FemtoJet.
Error #22	• Error on the PCB FemtoJet.	▸ Replace the PCB FemtoJet.
Error #23	• The internal pressure tubes are not connected.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• Assemblies are defective or not connected (compressor, pressure reservoir).	
	• Error on the PCB FemtoJet.	
Error #24	• The adjustment temperature for temperature drift compensation is not reached.	▸ Replace the PCB FemtoJet.
	• Error on the PCB FemtoJet.	
Error #25	• Error on the PCB FemtoJet.	▸ Replace the PCB FemtoJet.
Error #26	• One of the three voltage supplies is defective.	▸ Replace the switched-mode power supply. ▸ Replace the PCB FemtoJet.
	• The switched-mode power supply is defective.	
	• The cabling is defective.	
	• Error on the PCB FemtoJet.	
Error #27	• The 24 V voltage supply is defective.	▸ Replace the switched-mode power supply. ▸ Replace the PCB FemtoJet.
	• The switched-mode power supply is defective.	
	• The cabling is defective.	
	• Error on the PCB FemtoJet.	
Error #28	• The 40 V voltage supply is defective.	▸ Replace the switched-mode power supply. ▸ Replace the PCB FemtoJet.
	• The switched-mode power supply is defective.	

Problem	Cause	Solution
	• The cabling is defective.	
	• Error on the PCB FemtoJet.	
Error #29	• The 16 V voltage supply is defective.	▸ Replace the switched-mode power supply. ▸ Replace the PCB FemtoJet.
	• The switched-mode power supply is defective.	
	• The cabling is defective.	
	• Error on the PCB FemtoJet.	
Error #30	• The voltage supply of piezo valve 1 is defective.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The switched-mode power supply is defective.	
	• The piezo valve is defective.	
	• The cabling is defective.	
	• Error on the PCB FemtoJet.	
Error #31	• The voltage supply of piezo valve 2 is defective.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The switched-mode power supply is defective.	
	• The piezo valve is defective.	
	• The cabling is defective.	
	• Error on the PCB FemtoJet.	
Error #32	• The voltage supply of piezo valve 1 or 2 is defective.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The switched-mode power supply is defective.	
	• The piezo valve is defective.	
	• The cabling is defective.	
	• Error on the PCB FemtoJet.	
Error #33	• The storage pressure vessel is leaky.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The internal tube system is leaky.	
	• Solenoid valve 3 is defective.	
	• The piezo valves are defective.	
Error #34	• The internal tube system is defective.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The supply voltages are not correct.	

Problem	Cause	Solution
	• The piezo valves are not connected or not connected correctly or defective.	
	• Error on the PCB FemtoJet.	
Error #35	• The supply voltage of piezo valve 1 is not correct.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The piezo valves are not connected or not connected correctly or defective.	
	• Error on the PCB FemtoJet.	
Error #36	• The supply voltage of piezo valve 2 is not correct.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The piezo valves are not connected or not connected correctly or defective.	
	• Error on the PCB FemtoJet.	
Warning #37	• The micromanipulator is not connected correctly.	▸ Check the micromanipulator. ▸ Check the connecting cable. ▸ Check the interfaces to the FemtoJet and to the micromanipulator.
	• The micromanipulator is still executing another action or is taking too long to complete the current action.	▸ Wait for the action of the micromanipulator. ▸ Reduce the traveling distance of the micromanipulator by moving the capillary closer to the Z-limit. ▸ If necessary, set the *Synchr. inject* parameter to *IMMEDIATE* at the micromanipulator. ▸ If necessary, extend the injection time t_i.
Error #38	• The compressor is blocked.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The compressor is sluggish.	
	• The compressor has a short circuit.	
Warning #39	• The capillary is broken.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The injection tube is not disconnected from the device when the device is switched on.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The injection tube has been connected without a filled capillary.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The storage pressure is too low.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The internal pneumatic system is leaky.	▸ Check the assemblies. ▸ Replace defective assemblies.

Problem	Cause	Solution
	• Leak at the capillary, capillary holder, injection tube or their connections.	▸ Check all connections and gaskets from the FemtoJet up to the capillary. ▸ Replace defective O-rings.
	• The warning appears immediately after connecting the tube.	▸ Connect the tube using the *Change capillary* function. ▸ Switch off the *Fluctuation detection* function.
Warning #40	• The capillary is broken.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The injection tube is not disconnected from the device when the device is switched on.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The injection tube has been connected without a filled capillary.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The storage pressure is too low.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• The internal pneumatic system is leaky.	▸ Check the assemblies. ▸ Replace defective assemblies.
	• Leak at the capillary, capillary holder, injection tube or their connections.	▸ Check all connections and gaskets from the FemtoJet up to the capillary. ▸ Replace defective O-rings.
	• The warning appears immediately after connecting the tube.	▸ Connect the tube using the *Change capillary* function. ▸ Switch off the *Fluctuation detection* function.

5.2 Service functions

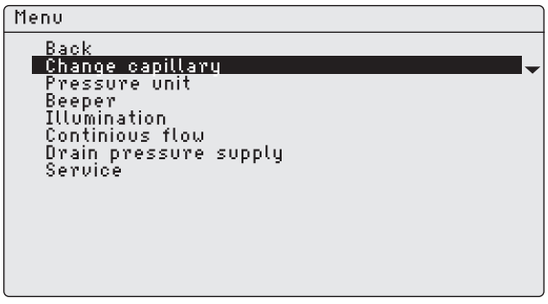
5.2.1 Calling service functions

Prerequisites

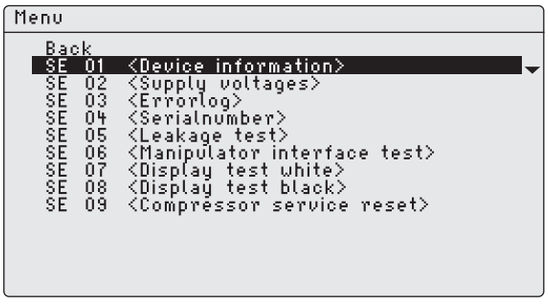
- The FemtoJet is switched off.

1. Touch and hold the *count* key.
2. Switch on the FemtoJet.
   The display shows the start screen.

5.2.2 Selecting service functions



1. Press the *menu enter* key.
   The display shows the main menu.
2. Use the arrow key to select the *Service* menu.

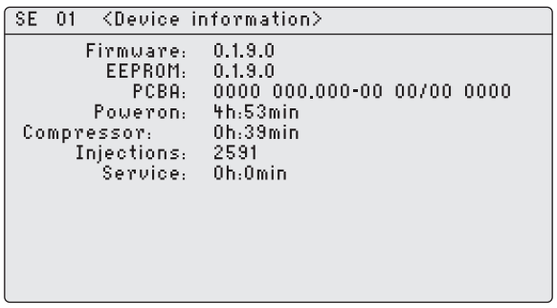


3. Press the *menu enter* key.
   The display shows the service functions.
4. Use the arrow key to select a service function.
5. Press the *menu enter* key to start the service function.

5.2.3 Exiting service functions

- Press the *menu enter* key to exit the service function.
  The display shows the service functions.

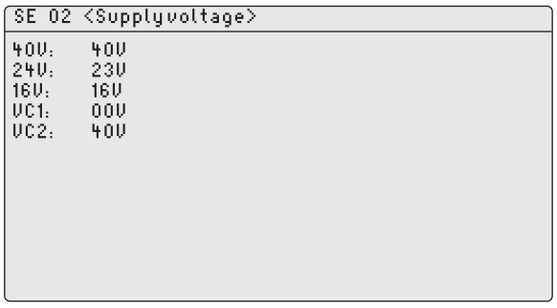
5.2.4 SE 01 – Device information



The *Device information* service function shows information on the device

- *Firmware*: software version
- *EEPROM* software version
- *PCBA*: internal number, production date and sequential number of the FemtoJet PCB
- *Power on*: operating hours
- *Compressor*: run time of the compressor
- *Injections*: number of injections
- *Service*: time of the last service, in relation to the run time of the compressor

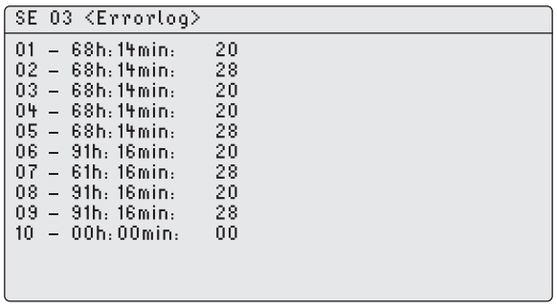
5.2.5 SE 02 – Supply voltage



The *Supply voltage* service function shows the current voltages in the device.
If an error occurs in the voltage supply, an error message appears.

- *40V/24V/16V*: supply voltage of the FemtoJet PCB
- *VC1/VC2*: voltage on the piezo valves

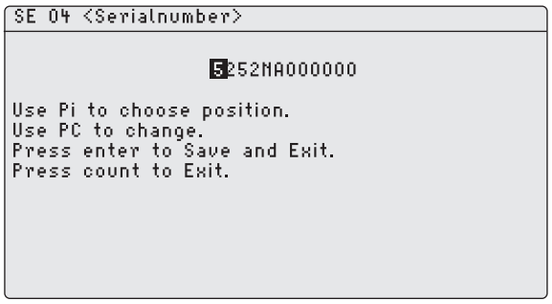
5.2.6 SE 03 – Error log



The *Error log* service function displays the last 10 error messages.

- Column 1: sequential number
- Column 2: time when the error occurred in relation to the operating hours
- Column 3: error code

5.2.7 SE 04 – Serial number



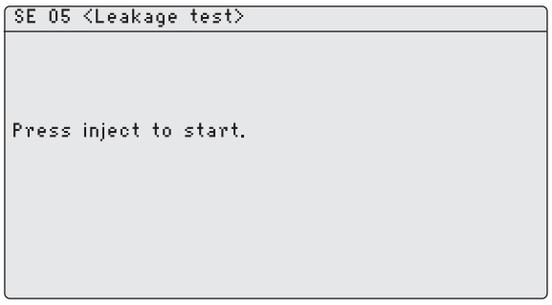
The *Serial number* service functions shows serial number of the device.

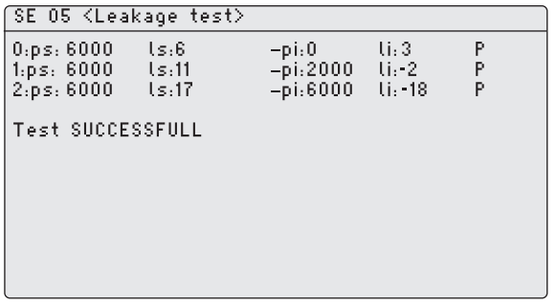
- ▸ Read the serial number from the name plate of the device.
- ▸ Enter the serial number.

Enter using the:

- Left rotary knob (p_i): Activate number.
- Right rotary knob (p_c): Change the value.
- *menu enter* key: Exit the service function. The serial number will be saved.
- *count* key: Exit the service function. The serial number will not be saved.

5.2.8 SE 05 – Leakage test





The *Leakage test* service function checks the pressure loss within the device. The leakage test includes 3 tests.

- ▸ Press the *inject* key to start the leakage test.
- ▸ Analyze the error messages using the error list, if required.
- ps: pressure in the pressure reservoir
- ls: pressure loss in the pressure reservoir
- pi: injection pressure/operating pressure
- li: pressure loss in the injection range/working range
- P: test passed
- f: error
- Test *SUCCESSFUL*: The test has been successfully completed.
- Error message: The test has not been successfully completed.

5.2.9 SE 06 – Manipulator Interface Test

The *Manipulator Interface Test* service function checks the RS-232 port. The interface tester (order no. 5192 851.906) has a port for the FemotJet 4x and a port for the TransferMan 4x.

Fig. 5-1: Interface tester on the device

1. Select the port of the interface tester according to the device.
2. Connect the interface tester to the RS-232 port of the device.
   The RS-232 port of the device will be checked.

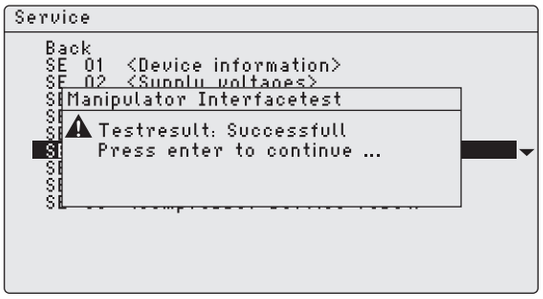


Fig. 5-2: Message after successful test

3. If the test was successful, the message *Testresult: Successful* appears.

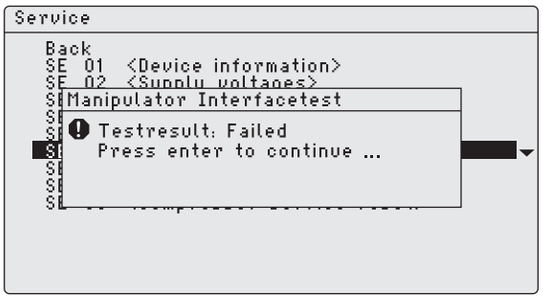


Fig. 5-3: Message in case of problems during the test

4. If problems occur during the test, the message *Testresult: Failed* appears.
   The interface is defective.
   The interface tester is not connected properly.

5.2.10 SE 07 – White display test

The *Display test white* service function checks the display.

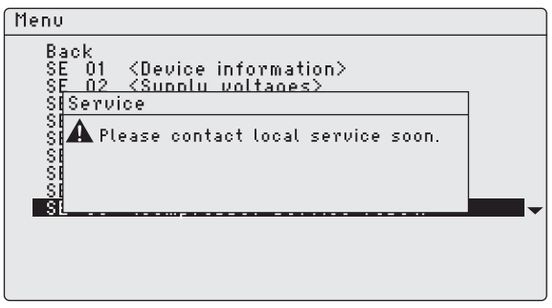
- If only light pixels are displayed, the display works correctly.
- The display is faulty if individual dark pixels are displayed.

5.2.11 SE 08 – Black display test

The *Display test black* service function checks the display.

- If only dark pixels are displayed, the display works correctly.
- The display is faulty if individual light pixels are displayed.

5.2.12 SE 09 – Compressor service reset



The *Compressor service reset* service function sets the run time of the compressor to 0 hours.

▸ Press the *menu enter* key.

6 Disassembly/assembly

6.1 Tools and auxiliary equipment

- T 8 torx screwdriver
- T 10 torx screwdriver
- T 20 torx screwdriver
- Torque screwdriver for 20 Ncm
- Allen key 2.5 mm
- Allen key 4 mm
- Installation aids
- Lubrication aid

This chapter describes how to assemble and disassemble the FemtoJet 4x and the FemtoJet 4i. Instructions that apply to only one of the devices are separately marked.

6.2 Pressure tube (internal, 10 mbar)

6.2.1 Removing the pressure tube

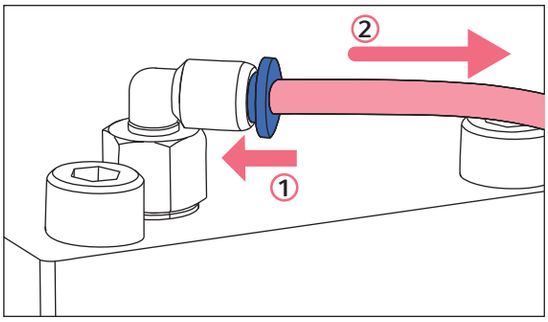


Fig. 6-1: Pressure tube and L-plug-in coupling

1. Press the blue release ring into the L-plug-in coupling (1).
2. Pull the pressure tube out of the L-plug-in coupling (2).

6.2.2 Mounting the pressure tube

▸ Insert the pressure tube into the L-plug-in coupling.
The pressure tube is clamped in the L-plug-in coupling.

6.3 Display with keypad

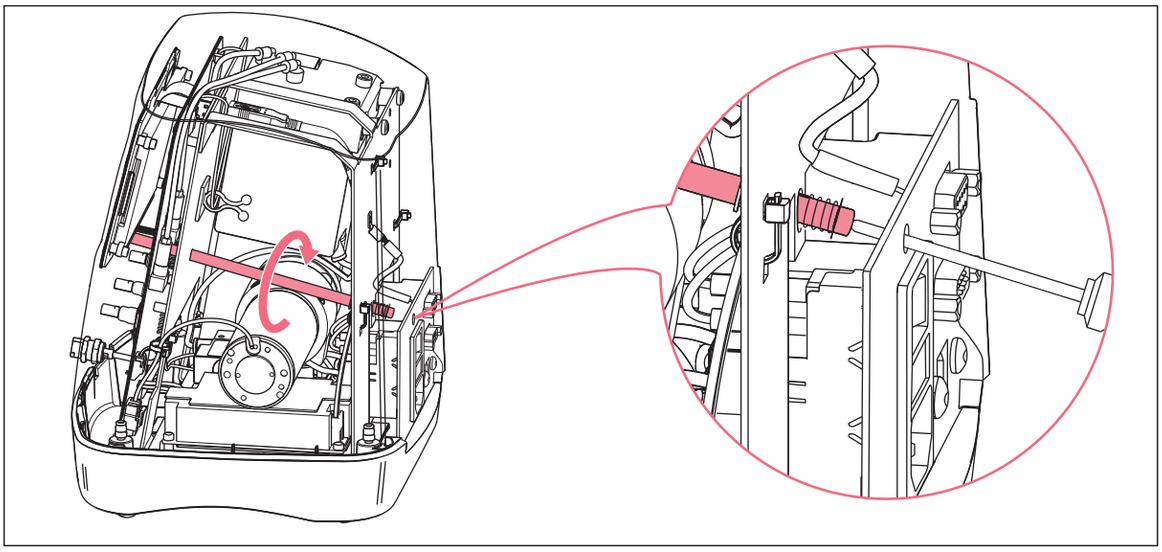


Fig. 6-2: Mounting column of the display during assembly

6.3.1 Removing the display with keypad

Prerequisites

- T10 torx screwdriver

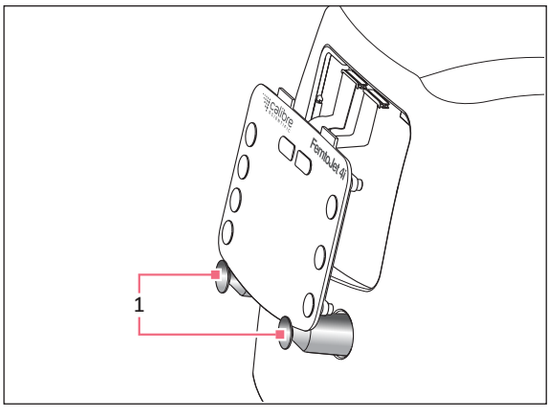


Fig. 6-3: Installation aids (1)

1. Loosen the mounting column of the display. The mounting column can be accessed via the bore at the rear of the device.
2. Remove the rotary knobs.
3. Fit the installation aids (1) on the left and right controller.
4. Pull the lower edge of the display away from the housing.
5. Remove the display downwards without damaging the cables.
6. Put the display on the installation aids (1).
7. Remove the connector plug for the power supply from the FemtoJet PCB.
8. Unlock both zero insertion force sockets. Remove the data cable.
9. Remove the display with keypad.

6.3.2 Mounting the display with keypad

1. Put the display on the installation aids (1).
2. Insert the data cable into the zero insertion force sockets and lock the zero insertion force sockets.
3. Attach the connector plug for the power supply to the FemtoJet PCB.
4. Hook the display upwards into the housing.
5. Press the display against the housing.
6. Press the mounting column against the set screw of the display and tighten.
7. Remove the installation aids (1).
8. Attach the rotary knobs.

6.4 Upper part of housing

6.4.1 Removing the upper part of housing

Prerequisites

- The display with keypad has been removed.

1. Remove the spherical feet under the front of the device.
2. Loosen the screw in each corner of the lower part of housing.
3. Lift up the upper part of housing without damaging the pressure tube.
4. Remove the pressure tube from the pressure reservoir.
5. Remove the upper part of housing without damaging the pressure tube.

6.4.2 Assembling the upper part of housing

Prerequisites

- The 3 grounding springs are present on the lower part of housing.

1. Connect the pressure tube to the valve block.
2. Lift the upper part of housing over the chassis and place it on the lower part of housing.
3. Mount the upper part of housing with 4 screws.
4. Put the spherical feet into the recesses in the lower part of housing.
5. Engage the spherical feet supports into the lower part of housing.

6.5 FemtoJet PCB

Prerequisites

- The display with keypad has been removed.
- The upper part of housing has been removed.

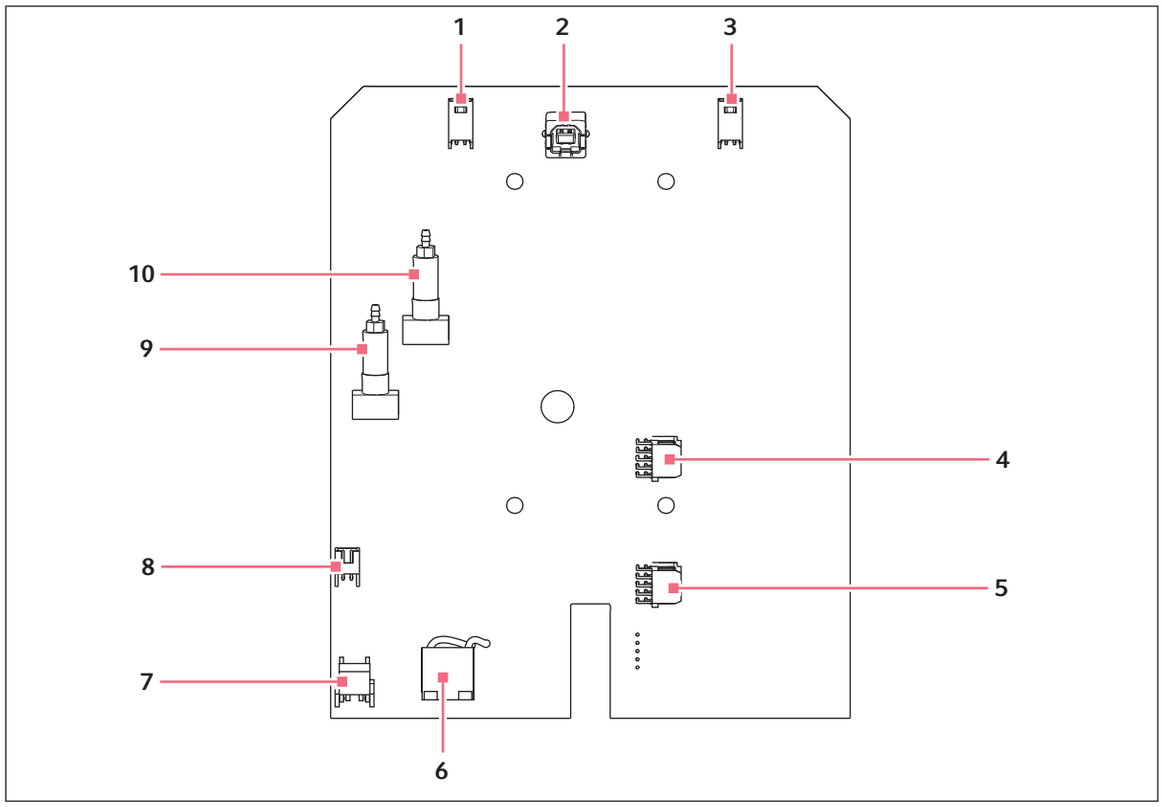


Fig. 6-4: FemtoJet PCB

1 **Piezo valve 2**
Port X1200

2 **USB**
Port X1100

3 **Piezo valve 1**

4 **RS-232 port "Micromanipulator"**
Port X304

5 **RS-232 port "Foot Switch"**
Port X303

6 **Power supply of the power supply device**

7 **Power supply of the compressor motor**

8 **Solenoid valve**
Port X200

9 **Pressure sensor**

10 **Pressure sensor**

6.5.1 Removing the FemtoJet PCB

1. Remove the tube connections from the valve block.
2. Remove the plug connectors from the FemtoJet PCB.
3. Loosen and remove the 4 screws from the FemtoJet PCB.
4. Remove the FemtoJet PCB.

6.5.2 Mounting the FemtoJet PCB

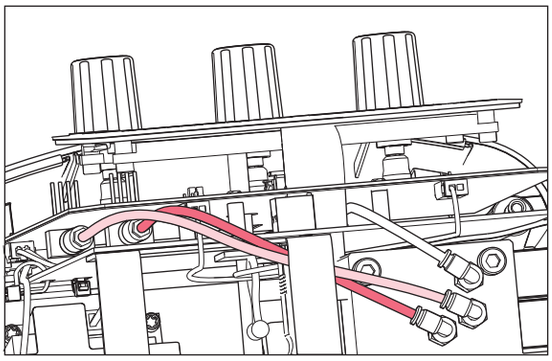


Fig. 6-5: Tube connections between the Femtojet PCB and the valve block

1. Connect the electrical connections to the FemtoJet PCB.
2. Fix the FemtoJet PCB with the screws. Do not tighten the screws.
3. Connect the pressure tube from the right pressure sensor to the middle L-plug-in screw coupling.
4. Connect the pressure tube from the left pressure sensor to the rear L-plug-in screw coupling.
5. Attach the upper part of housing without damaging the pressure tube.
6. Fit the installation aids on the left and right rotary knobs.
7. Press the upper part of housing onto the lower part of housing.
8. Tighten the top 2 screws of the FemtoJet PCB.
9. Remove the installation aids.
10. Remove the upper part of housing.
11. Tighten the bottom 2 screws of the FemtoJet PCB.

6.6 Switched-mode power supply unit

6.6.1 Disassembling the switched-mode power supply

Prerequisites

- The display with keypad has been removed.
- The upper part of housing has been disassembled.
- The FemtoJet PCB has been removed.

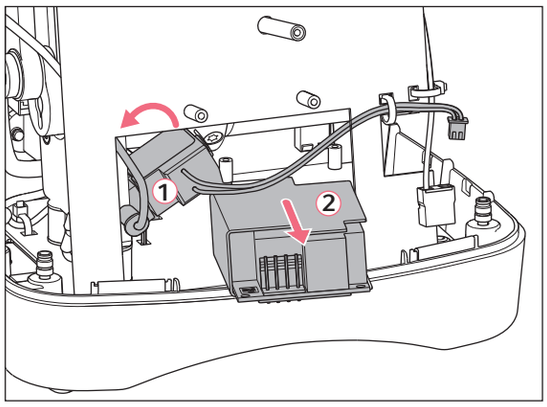


Fig. 6-6: Moving the switched-mode power supply unit (2) past the exhaust valve (1)

1. Unscrew the exhaust valve (only FemtoJet 4i).
2. Remove the connector plug from the switched-mode power supply unit to the mains input module.
3. Remove the screw in each corner of the switched-mode power supply unit.
4. Fold up the exhaust valve (1).
5. Pull out the switched-mode power supply unit past the exhaust valve (2).

6.6.2 Assembling the switched-mode power supply

1. Push the switched-mode power supply unit past the exhaust valve under the motor (only FemtoJet 4i).
2. Put the switched-mode power supply unit onto the distance pieces and mount it.
3. Mount the connector plug to the mains input module on the switched-mode power supply unit.
4. Mount the exhaust valve (only FemtoJet 4i).

6.7 O-ring on the compressor piston – FemtoJet 4i

6.7.1 Removing the O-ring

Prerequisites

- The display with keypad has been removed.
- The upper part of housing has been disassembled.

When the valve block is removed, there is an uncontrolled escape of compressed air from pressure reservoir.

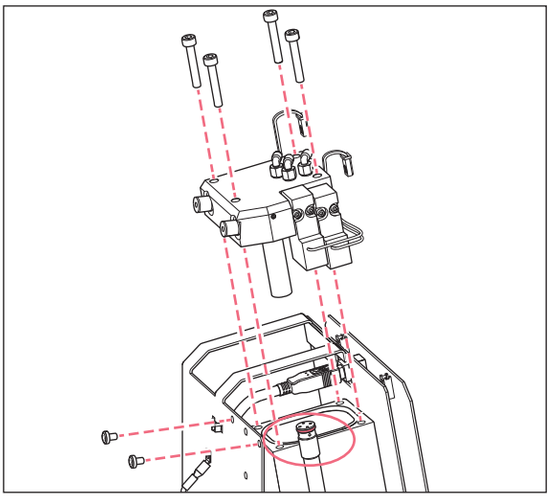


Fig. 6-7: Disassembling the valve block

1. Remove the tube connections of the pressure sensors from the valve block.
2. Remove the electrical connections to the piezo valves from the PCB.
3. Loosen the 4 hex-head screws on the valve block without removing them.
4. Remove the 2 screws by which the valve block is mounted on the chassis.
5. Remove the 4 hex-head screws on the valve block.
6. Remove the valve block.
7. Remove the O-ring on the compressor piston.
8. Clean the piston with benzine or isopropyl alcohol.

6.7.2 Mounting the O-ring

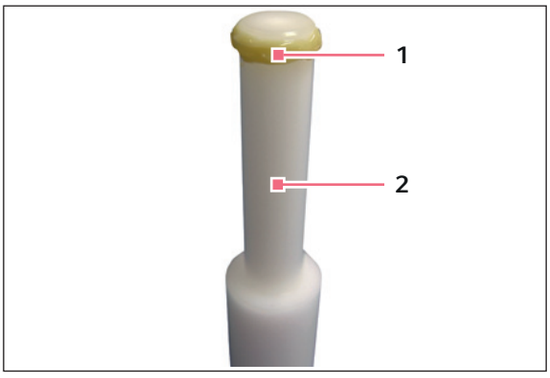
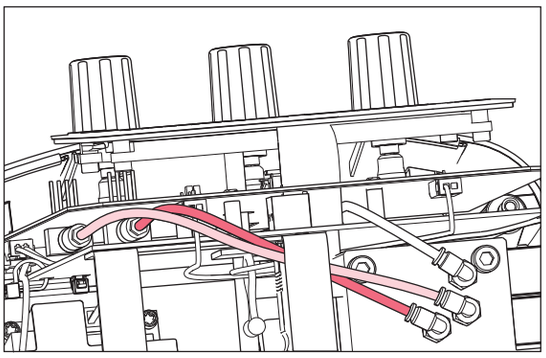


Fig. 6-8: Lubrication tool (2) with grease (1)

1. Push the O-ring into the groove of the compressor piston.
2. Grease the lubrication tool.
   The front of the lubrication tool remains free of grease.
3. Grease the inside of the cylinder tube.
4. Push the cylinder tube onto the compressor piston. Put the valve block onto the pressure reservoir.
5. Hand-tighten the valve block with 4 hex-head screws on the pressure reservoir.
6. Mount the valve block on the chassis. For this purpose, tighten the 2 screws.
7. Tighten the 4 hex-head screws on the valve block.



8. Connect the tube connections of the pressure sensors to the valve block.
9. Connect the electrical connections to the piezo valves to the PCB.
10. Check that the piston can move freely.

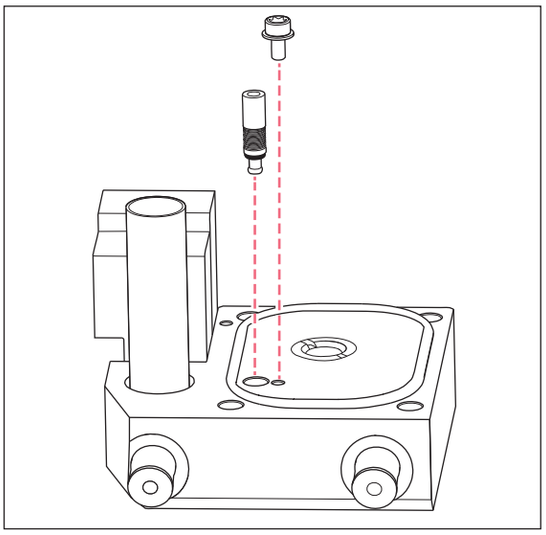
Fig. 6-9: Tube connections between the Femtojet PCB and the valve block

6.8 Check valve in the valve block – FemtoJet 4i

Prerequisites

- The display with keypad has been removed.
- The upper part of housing has been removed.

6.8.1 Removing the check valve



1. Remove the screw from the valve block.
2. Remove the white spacer, spring and check valve.

6.8.2 Cleaning the check valve

Do not grease the check valve.

1. Fill benzine into the cylinder tube until the valve bore is filled.
2. Allow the benzine to take effect for 2 minutes.
3. Blow out the valve bore with compressed air.
4. Repeat cleaning.

6.8.3 Mounting the check valve

1. Insert the check valve into the valve block.
   First insert the side with the O-ring into the bore.
2. Put the spring on the check valve.
3. Put a spacer on the spring.
4. Place a flat washer on the screw.
5. Press the spacer into the bore and fix it with the screw.

6.9 Control valve on the valve block – FemtoJet 4x

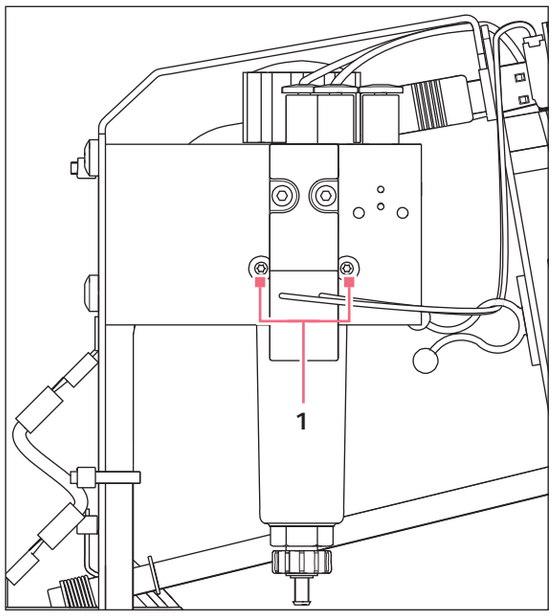


Fig. 6-10: Attaching the control valve

1 Screws

6.9.1 Removing the control valve

Prerequisites

- The display with keypad has been removed.
- The upper part of housing has been removed.
- The piezo valve 2 has been removed.
- The pressure tube has been removed from the control valve.

1. Loosen the screws.
2. Remove the control valve.

6.9.2 Mounting the control valve

Prerequisites

- The seal on the piezo valve is present.

1. Screw on the control valve.
2. Put piezo valve 2 onto the valve block.
3. Fix piezo valve 2 with the screws to the valve block. Do not tighten the screws.
4. Align piezo valve 2 parallel to the edge of the valve block.
5. Tighten the screws of the piezo valve to 20 Ncm.
6. Attach the pressure tube to the control valve.

6.10 Piezo valve

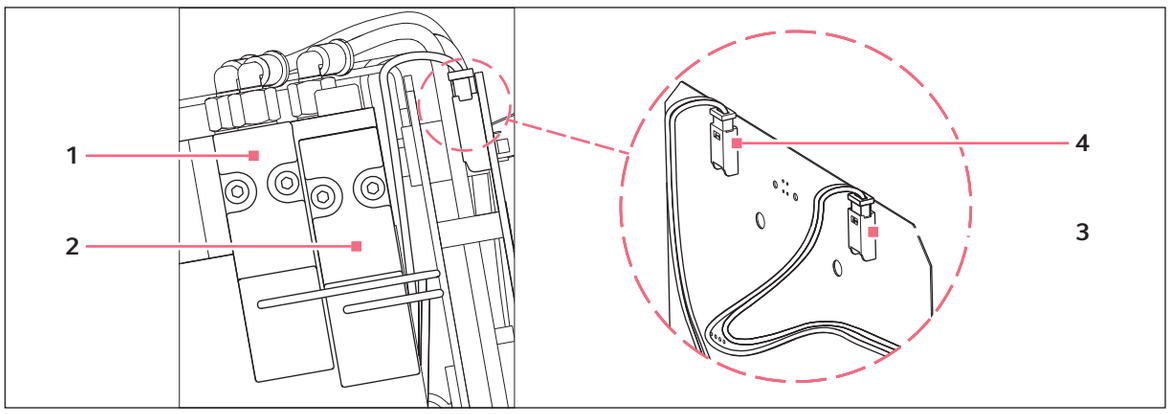


Fig. 6-11: Ports for the piezo valves

1 Piezo valve 1

2 Piezo valve 2

3 Port X1100
for piezo valve 1

4 Port X1200
for piezo valve 2

6.10.1 Removing piezo valve 1 and piezo valve 2

Prerequisites

- The display with keypad has been removed.
- The upper part of housing has been removed.

1. Remove the plug connectors to the FemtoJet PCB.
2. Alternately loosen the screws on the valves.
3. Remove the screws.
4. Remove the piezo valves.

6.10.2 Mounting piezo valve 2

Prerequisites

- The seal on the piezo valve is present.

1. Put piezo valve 2 onto the valve block.
2. Fix piezo valve 2 with the screws to the valve block. Do not tighten the screws.
3. Align piezo valve 2 parallel to the edge of the valve block.
4. Tighten the screws to 20 Ncm.
5. Connect the connector plug to the FemtoJet PCB.

6.10.3 Mounting piezo valve 1

1. Put piezo valve 1 on the valve block.
2. Fix piezo valve 1 with the screws to the valve block. Do not tighten the screws.
3. Align piezo valve 1 parallel to piezo valve 2.
4. Tighten the screws to 20 Ncm.
5. Connect the connector plug to the FemtoJet PCB.

6.11 Replacing the contact suppressor

1. Remove the contact suppressor with flat pliers.
2. Screw in the new contact suppressor.

7 Alignment/adjustment

7.1 Checking the pressure with an external measuring instrument – FemtoJet 4i

Check the pressure after the following components have been replaced:
- FemtoJet PCB
- O-ring
- Valves
- Internal pressure tubes
- Coupling with check valve

A measuring instrument is available to measure the pressure, order no. 055000316.
An additional pressure sensor (055000318) is available.

Tab. 7-1: Pressure sensors

Test pressure	Pressure sensor
100 hPa – 2000 hPa	Pressure sensor 0 bar – 2.5 bar
6000 hPa	Pressure sensor 0 bar – 7 bar

7.1.1 Calibrating the device

1. Allow the pressure measuring device to run for 15 minutes.
2. Connect the pressure measuring device to the FemtoJet using the connecting hose or injection tube.
3. Set the test pressure using the **Compensation pressure p_c** rotary knob.
4. Read the measured value after 30 seconds.
5. Compare the measured value with the tolerances in the table.

Test pressure [hPa]	FemtoJet 4i tolerance [hPa]	Measuring instrument tolerance [hPa]	Total tolerance [hPa]
100	0.5	2.5	3
1000	1.0	3.0	4
2000	4.0	3.0	7
6000	12.0	14.0	26

8 Software

8.1 Software update

Printed circuit boards do not always have the latest software or firmware versions installed.

- Check the software and firmware versions after replacing the PCBs.
- Update the software and firmware if necessary.

You can update the device software with a computer via the USB interface of the device.

The USB interface is located on the rear of the device.

To enable communication between the devices and the computer you need to install the "Universal Device Firmware Upgrade (UDFU)" software (version 1.1.7.0 or higher), the required drivers and Microsoft.NET Framework on your computer.

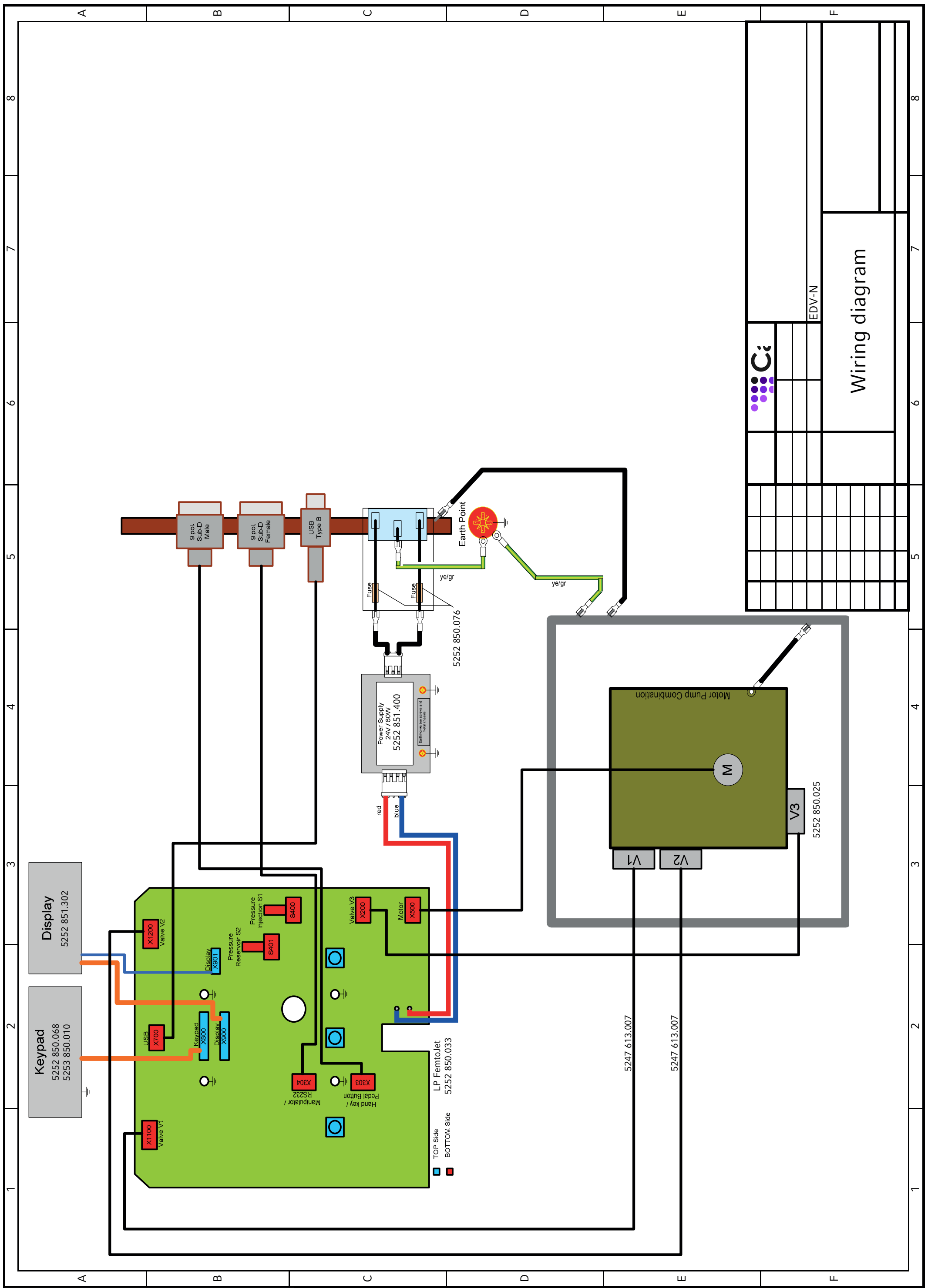
Please visit www.calibrescientific.com to contact Calibre Scientific for the PDF document.

Read the UDFU software operating manual and the firmware installation instructions before starting to download, install or update the software or firmware.

Please use the latest validated versions of device software and UDFU flash loader which are released according to the validation plan.

Device software shown in the UDFU flash loader must be identical with the version released. Please visit www.calibrescientific.com to contact Calibre Scientific for the PDF document.

9 Diagrams

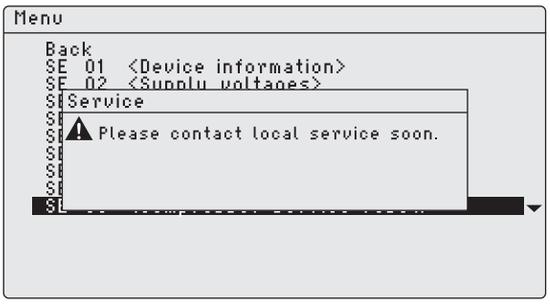

Wiring diagram
EDV-N
Display
5252 851.302
Keypad
5252 850.068
5253 850.010
LP FemtoJet
5252 850.033
TOP Side
BOTTOM Side
Power Supply
24V / 60W
5252 851.400
5252 850.076
Earth Point
ye/gr
Fuse
red
blue
9 pol. Sub-D Male
9 pol. Sub-D Female
USB Type B
Motor Pump Combination
M
V1
V2
V3
5252 850.025
5247 613.007
5247 613.007

10 Maintenance

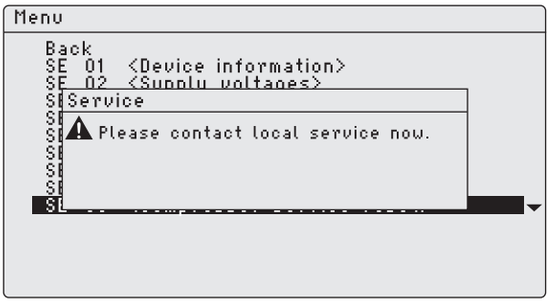
10.1 Service interval for O-ring on the compressor piston – FemtoJet 4i

The O-ring of the FemtoJet 4i must be replaced at regular intervals.

To order an authorized service for replacing the O-ring, 2 messages are displayed to the user. One message is always displayed when the FemtoJet 4i is switched on.



1. After 170 operating hours, a message will appear asking the user to contact the authorized service in the near future.



2. After 200 operating hours, a message will appear asking the user to contact the authorized service immediately.

The process of replacing the O-ring is described in the chapter "Disassembly/assembly".

10.2 Cleaning

DANGER! Electric shock due to the ingress of liquid.

- Switch off the device and disconnect it from the mains/power line before starting cleaning or disinfection.
- Do not allow any liquids to penetrate the inside of the housing.
- Do not perform a spray clean/spray disinfection on the housing.
- Only reconnect the device to the mains/power line when it is completely dry, both inside and outside.

NOTICE! Damage from the use of aggressive chemicals.

- Do not use any aggressive chemicals on the device or its accessories, such as strong and weak bases, strong acids, acetone, formaldehyde, halogenated hydrocarbons or phenol.
- If the device has been contaminated by aggressive chemicals, clean it immediately using a mild cleaning agent.

Clean the device at least every 4 weeks.

1. Wipe the painted parts and the aluminum surfaces with a cloth and mild detergent.
2. Polish with a dry cloth.

10.3 Disinfection/decontamination

- Select disinfection methods that comply with the legal regulations and guidelines for your area of application.
- If you have any questions regarding cleaning, disinfection and decontamination, please contact Biozol Diagnostica Vertrieb GmbH.

Prerequisites

- All device parts are cleaned.
- A disinfectant with an alcohol base (e.g., isopropanol or ethanol) is prepared.

- Wipe down all devices with a cloth and the disinfectant.

10.4 Shipping the device

WARNING! Risk of personal injury due to contamination.
People may become contaminated if you store or ship a contaminated device.

▸ Clean and decontaminate the device before shipping or storage.

NOTICE! Risk of damage due to improper packaging.
Biozol Diagnostica Vertrieb GmbH is not liable for any damage caused by improper packaging.

▸ Only store and transport the device in its original packaging.
▸ If you do not have the original packaging, request original packing from Biozol Diagnostica Vertrieb GmbH.

Prerequisites

- The device has been cleaned and decontaminated.
- The original packaging is available.

1. Please visit www.calibrescientific.com to contact Calibre Scientific for the PDF document.
2. Complete the decontamination declaration.
3. Pack the device.
4. Put the decontamination declaration into the packaging.
   Deliveries shipped without a decontamination certificate will not be processed.
5. Send the device to Biozol Diagnostica Vertrieb GmbH or an authorized service center.

10.4.1 Packing the rotary knobs

Rotary knobs must be packed separately in order to protect them from damage or loss.

1. Remove the rotary knobs.
2. Place the rotary knobs into the enclosed air bubble bag.
3. Put the air bubble bag into the transport package.

10.5 Inspection after repair

10.5.1 Notes on the electrical safety check

Notes on the inspection procedure:

- The electrical safety check may only be carried out by an electrically skilled or instructed person.
- Check the electrical safety after repairs or carrying out work on the electrical system of the device (incl. the PE conductor system).
- Measure on a grounded, metallic point that is not insulated and can be touched from the outside (e.g., on housing screws).
- Never measure at an interface. The device's electronics may be damaged.
- Due to the electrical design of the device, the equivalent leakage current (e.g., VDE 701/702) cannot be measured correctly.
  Always measure the real leakage current (direct measurement or differential current measurement).

10.5.2 Inspections

	Micromanipulator 4	FemtoJet 4	CellTram 5176 CellTram 4	PiezoXpert	Eporator	Multiporator
Check the serial number.	X	X	X	X	X	X
Perform a test run.	X	X	X	X	X	X
Perform an electrical safety check.	X	X	X	X	X	X

Task/inspection	Procedure	Criterion/result
Check the serial number.	• Select the service function (if available). • Observe the notes provided in the service manual. • Enter the serial number, if necessary. • Check if the serial number entered matches the serial number on the name plate.	The saved serial number matches the serial number on the name plate.
Perform a test run for the micromanipulator 4.	• The three motor axes move over the entire area. The limit switches are detected. • The injector interface test was performed without errors. • The self test was performed without errors. • The module can be swung out to exchange the capillaries.	The test run was successfully performed without any error messages.

Task/inspection	Procedure	Criterion/result
Perform a test run for the FemtoJet 4.	• Select the service function. • The FemtoJet 4 displays the correct device version when it is switched on. • The leakage test was successful. • The manipulator interface test was performed without errors. • Check the pressure using an external measuring device. • The set pressure range is displayed on the FemtoJet 4 and on the external measuring device. • The pressure deviations are within the permissible tolerances.	The test run was successfully performed without any error messages.
Perform a test run for the CellTram 5176 or the CellTram 4.	• The cells can be suctioned in, held and transferred. • The system does not leak oil. (CellTram Oil/Vario) • The vent valve is working correctly. (CellTram Air) • The coarse drive and the fine drive move smoothly. (CellTram 4/Vario) • Check the pressure using an external measuring device. • The pressure drop is within the permissible tolerances.	The test run was successfully performed without any error messages.
Perform a test run for the PiezoXpert.	• Set the following values for the parameter sets A and B: – Intensity = 50 – Speed = 10 – Number of piezo impulses = infinite • The pulses are audible after pressing rotary knob A or B.	The test run was successfully performed without any error messages.
Perform a test run for the Eporator.	Perform a function test. Observe the notes provided in the service manual (chapter 5.4).	The test run was successfully performed without any error messages.
Perform a test run for the Multiporator.	Perform a function test. Observe the notes provided in the service manual (chapter 7).	The test run was successfully performed without any error messages.
Electrical safety check	Perform an electrical safety check in accordance with the country-specific standard. Observe the notes provided in the SOP Electrical safety check checklist.	The thresholds defined in the standard are complied with.

10.6 Performance Plans

Calibre offers maintenance services for micromanipulators in the form of Performance Plans.

Performance Plans for centrifuges are available with the following levels:

- Essential Check
- Advanced Maintenance
- Premium Service
- Installation Qualification
- Operational Qualification

Maintenance services are defined for every level of a Performance Plan. This chapter shows which maintenance services are defined.

We recommend to perform servicing at least every 12 months.

10.6.1 Overview

Inspection	Essential Check	Advanced Maintenance	Premium Service	IQ	OQ
Cleaning the housing	X	X	X		
Checking the display		X	X		X
Checking the compressor service interval	X	X	X		
Checking the leak tightness	X	X	X		X
Performing a software update		X	X		
Checking the delivery				X	
Setting up and configuring the devices				X	
Instructing users				X	
Checking the device	X	X	X		X
Analyzing error statistics	X	X	X		X

10.6.2 Service provisions

10.6.2.1 Cleaning the housing

▸ Clean the housing as described in the Maintenance chapter.

10.6.2.2 Checking the display

▸ Check the display as described in the *Display test white* and *Display test black* service functions.

10.6.2.3 Checking the compressor service interval

1. Check whether the O-ring on the compressor piston must be replaced.
2. Replace O-ring if necessary.

10.6.2.4 Checking the leak tightness

- Check the leak tightness as described in the *Leakage test* service function.

10.6.2.5 Performing a software update

- Perform a software update as described in the Software chapter.

10.6.2.6 Checking the delivery

- Check the delivery as described in the IQ.

10.6.2.7 Setting up and configuring the devices

- Set up the device as described in the IQ.

10.6.2.8 Instructing users

- Instruct the users as described in the OQ.

10.6.2.9 Checking the device

- Check the pressure using an external measuring instrument, see chapter *Alignment/adjustment*.

10.6.2.10Analyzing error statistics

1. Use the *Error log* service function to call the error statistics.
2. Analyze the errors and fix them if necessary.

11 Technical data

11.1 Mode of operation

Mode of operation	S1 (IEC 60034-1)

11.2 Weight/dimensions

Width	213 mm
Depth	207 mm
Height	250 mm
Weight FemtoJet 4i	5.0 kg
Weight FemtoJet 4x	3.5 kg

11.3 Power supply

Voltage	100 V – 240 V, AC, 10 %
Frequency	50 Hz – 60 Hz
Power consumption	40 W
Protection class	I
Overvoltage category	II (IEC 61010-1)
Micro fuse	T 2.5 A/250 V

11.4 Interfaces

11.4.1 USB

Type	Slave
Use	Service

11.4.2 RS 232

Baud rate	9600
Start bit	1
Data bits	8
Parity	none
Stop bit	2

11.4.3 Injection time t_i

Time interval	0.10 s – 99.99 s
Increment	0.01 s

11.4.4 Injection pressure p_i

Pressure range, controlled	5 hPa – 6000 hPa
	0.07 PSI – 87.0 PSI
Increment	1 hPa
	0.01 PSI
Pressure, uncontrolled	0 hPa
	0 PSI

11.4.5 Compensation pressure p_c/p_w

Pressure range, controlled	5 hPa – 6000 hPa
	0.07 PSI – 87.0 PSI
Increment	1 hPa
	0.01 PSI
Pressure, uncontrolled	0 hPa
	0 PSI

11.4.6 Rinsing pressure

Pressure range	4000 hPa – 6000 hPa
	58.01 PSI– 87.02 PSI

11.4.7 Accuracy

6000 hPa 87.02 PSI	±8 hPa
	±0.12 PSI
2500 hPa 36.26 PSI	±6 hPa
	±0.09 PSI
1000 hPa 14.50 PSI	±3 hPa
	±0.04 PSI
100 hPa 1.45 PSI	±2 hPa
	±0.03 PSI
50 hPa 0.73 PSI	±1 hPa
	±0.01 PSI
15 hPa 0.22 PSI	±1 hPa
	±0.01 PSI

11.5 External compressed air supply

Pressure range	4000 hPa – 8000 hPa
	60 PSI – 120 PSI
Connection	G 1/4"
Source of compressed gas	Compressor, compressed gas cylinder, in-house compressed air supply
Compressed gas	Compressed air, nitrogen

11.6 Ambient conditions

Ambience	Only for use indoors.
Ambient temperature	15 °C – 40 °C
Relative humidity	10 % – 75 %, non-condensing.
Atmospheric pressure	795 hPa – 1060 hPa Use up to a height of 2000 m above sea level.
Degree of pollution	2 (IEC 664)

12 Ordering information

12.1 FemtoJet

12.1.1 Device

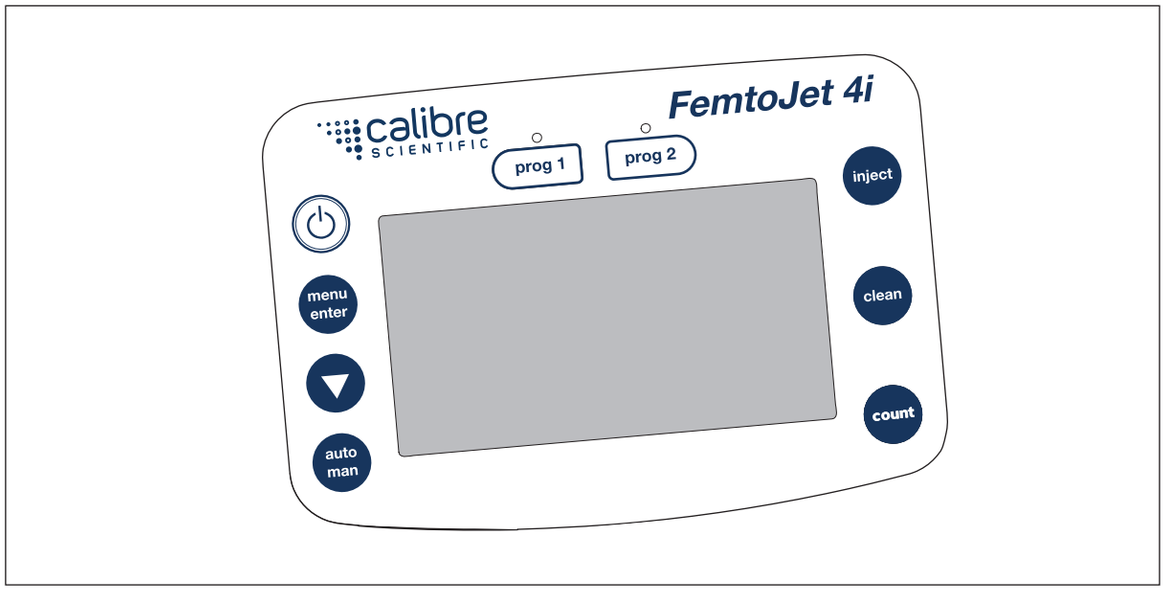


Fig. 12-1: FemtoJet 4i keypad

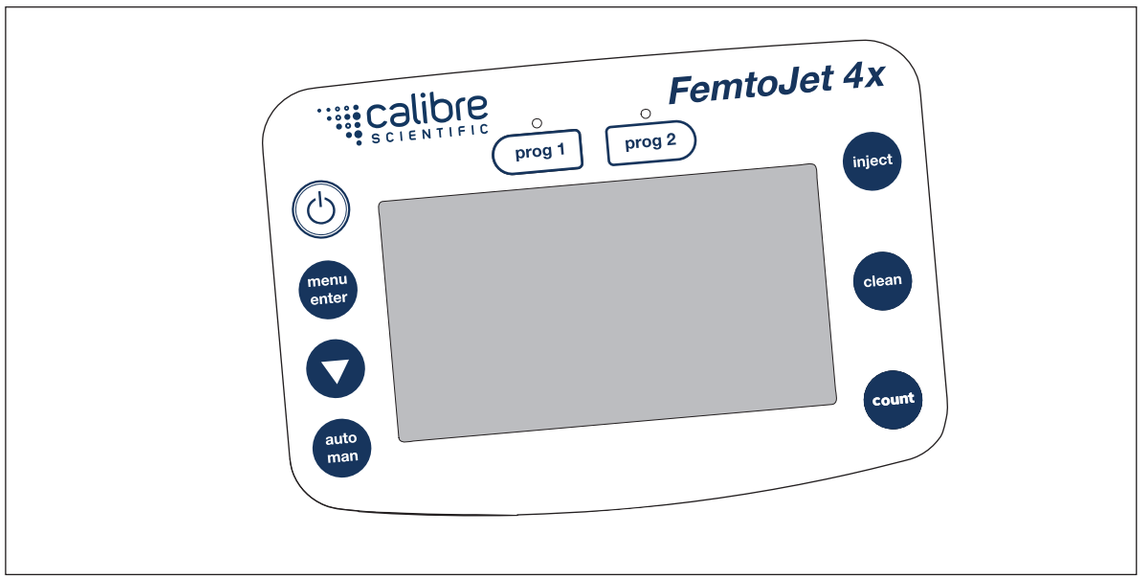


Fig. 12-2: FemtoJet 4x keypad

Fig.	Item	Order no. (International)	Description
			Keypad
		EPE-5252850068	FemtoJet 4i
		EPE-5253850010	FemtoJet 4x

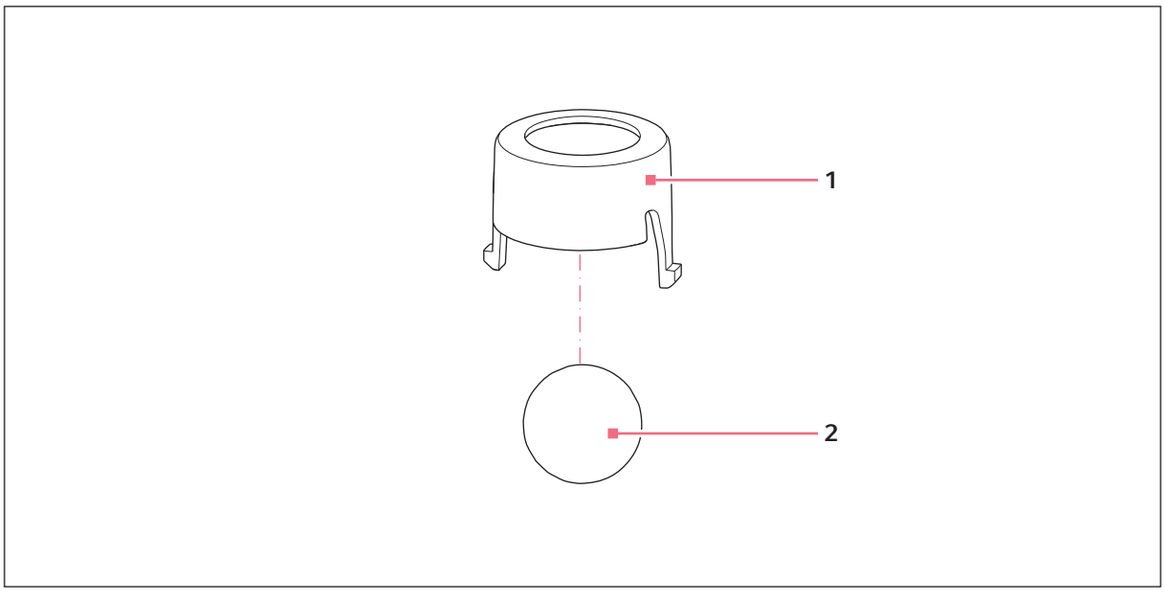


Fig. 12-3: Spherical foot and spherical support

Fig.	Item	Order no. (International)	Description
	1	EPE-5353861001	**Spherical support** 4 pieces
	2	EPE-5355863001	**Spherical foot** 4 pieces

12.1.2 Display

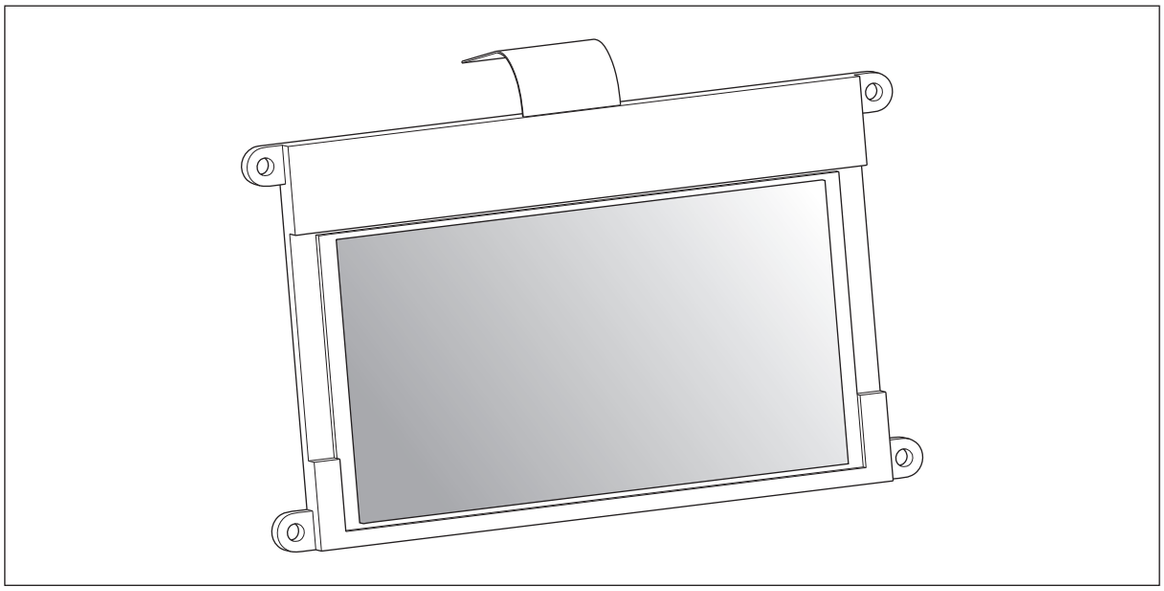


Fig. 12-4: Display

Fig.	Item	Order no. (International)	Description
		EPE-5192851302	**LCD-display**

12.1.3 Solenoid valve

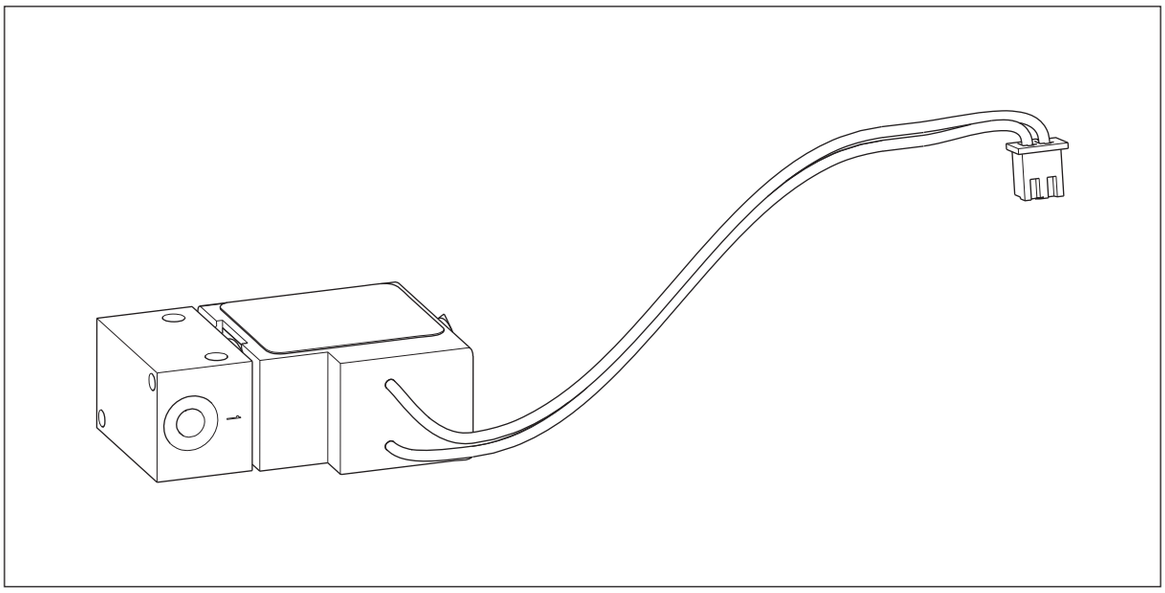


Fig. 12-5: Solenoid valve

Fig.	Item	Order no. (International)	Description
		EPE-5252850025	**Solenoid valve**

12.1.4 Contact suppressor

Fig. 12-6: Contact suppressor and push-on connector

Fig.	Item	Order no. (International)	Description
		EPE-5252850130	**Acoustic Silencer** Set with 5 x acoustic silencer + 5 x plug-in fitting for FemtoJet 4

12.1.5 Piezo valve

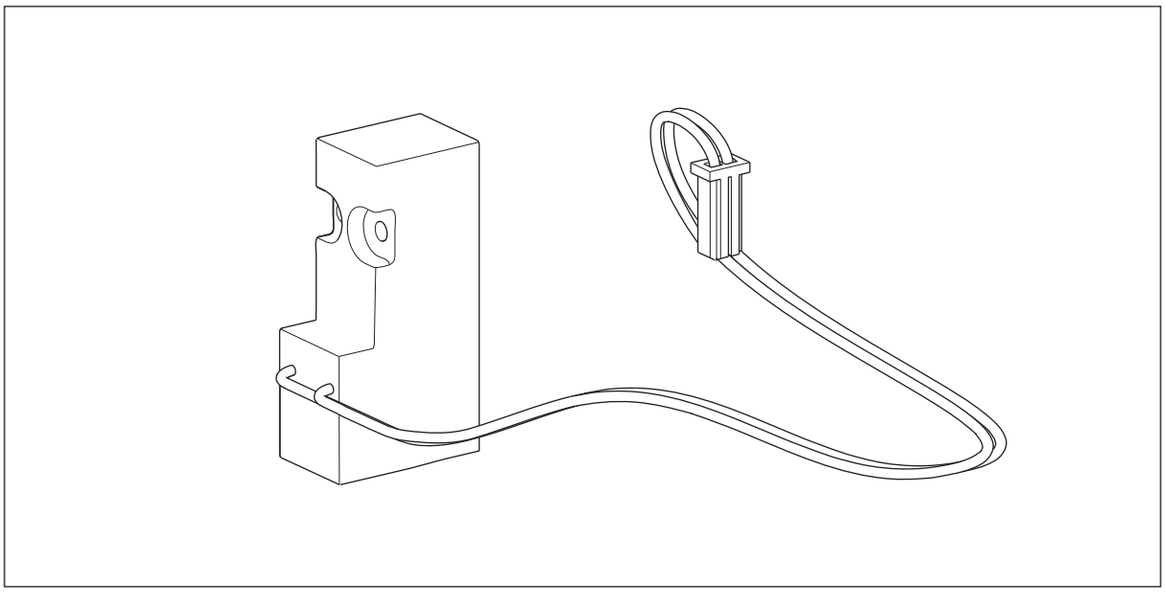


Fig. 12-7: Piezo valve

Fig.	Item	Order no. (International)	Description
			Valve 1+2
			Piezo valve
		EPE-5247613007	with wires

12.1.6 Electronics

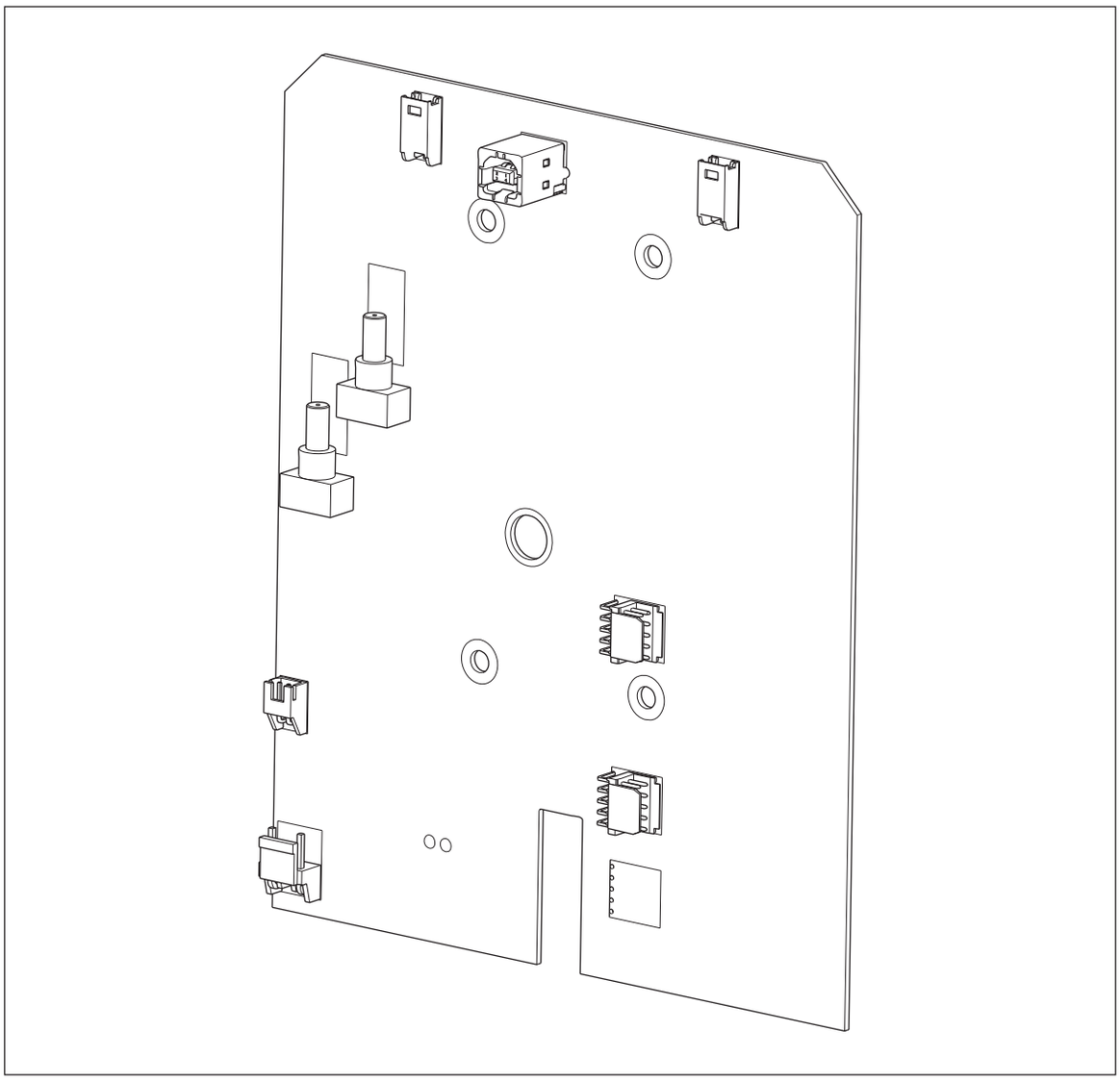


Fig. 12-8: PCB FemtoJet

Fig.	Item	Order no. (International)	Description
		EPE-5252850033	**PCB FemtoJet**
		EPE-5192851400	**PCB Switched-mode power supply**

12.1.7 Exhaust valve

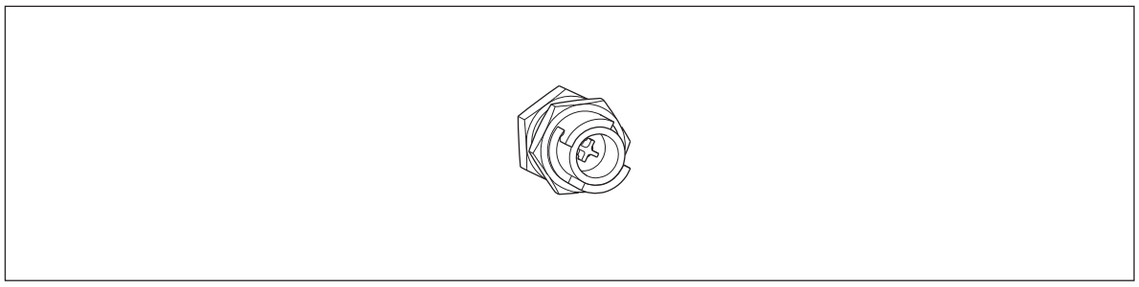


Fig. 12-9: Check valve

Fig.	Item	Order no. (International)	Description
		EPE-5247160002	**Outlet valve** 1 piece couplers with check valve
		EPE-5252850092	**Check valve pressure reservoir repair kit** consists of: check valve with o-ring, o-ring piston, Festo special grease, 20 g tube, lubricating tool

12.1.8 Pressure tube

Fig.	Item	Order no. (International)	Description
		EPE-5252850041	**Pressure tube (internal)** Festo Pneumatic 10 bar
		EPE-5248200008	**Pressure tube (external)** for connecting the FemtoJet express/4x to an external pressure supply Length 2.5 m, incl. 2 couplings G1/4 inch and 1/4 inch 18 NPT
		EPE-5248202000	**Adapter for nitrogen pressure reducer** Coupling G 1/4 inch 18 NPT

12.1.9 Control valve

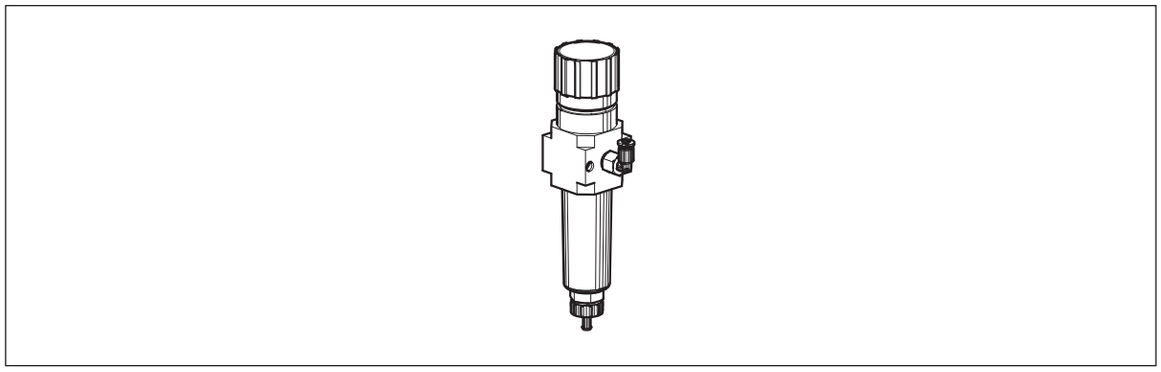


Fig. 12-10: Control valve

Fig.	Item	Order no. (International)	Description
		EPE-5248851009	**Control valve** for connecting the FemtoJet express/4x to an external pressure supply

12.1.10 Accessories for service

Fig.	Item	Order no. (International)	Description
		EPE-5252850050	**Plug for interface sheet**
		EPE-5247861000	**Cover cap** for bayonet connector for injection tube 5 pieces
		EPE-5252850076	**Main/power fuse** 10 pieces T 2,5 A
		EPE-5252850149	**Pressure reservoir**

12.2 Auxiliary aids

Fig.	Item	Order no. (International)	Description
		EPE-0055000316	**Pressure measuring device**
		EPE-0055000318	**Pressure sensor** 0 bar - 2.5 bar
		EPE-5247864000	**Connecting hose** for pressure measuring device
		EPE-5252850084	**Installation aid**
		EPE-5192851906	**Interface tester** Measuring instrument for the interfaces of a device
		EPE-5252850408	**Transport packaging** FemtoJet 4

12.3 Accessories for FemtoJet 4i

Fig.	Item	Order no. (International)	Description
		EPE-5192082007	**Connecting cable** TransferMan 4r/InjectMan 4 - FemtoJet 4i/4x
		EPE-5252070038	**Connecting cable** InjectMan NI 2 - FemtoJet 4i/4x
		EPE-5252070011	**Hand control** for remote-controlling for FemtoJet 4i/4x
		EPE-5252070020	**Foot control** for FemtoJet 4i/4x
		EPE-5192080004	**Y-cable FJ4**
		EPE-5252070054	**Injection tube** 2 m, for universal capillary holder and capillary holder 4
		EPE-5252070046	**O-ring** for injection tube, Bayonet connection, 10 pcs

12.4 Capillary holder 4 and accessories

Fig.	Item	Order no. (International)	Description
		EPE-5176190002	**Capillary holder 4** For holding Femtotips, Femtotips II or grip heads Including grip head 0, adapter for Femtotips and spare O-rings
		EPE-5176210003	**Grip head set 4 size 0** For microcapillaries with an outer diameter of 1.0 mm to 1.1 mm, set of 2
		EPE-5176212006	**Grip head set 4 size 1** For microcapillaries with an outer diameter of 1.2 mm to 1.3 mm, set of 1
		EPE-5176214009	**Grip head set 4 size 2** For microcapillaries with an outer diameter of 1.4 mm to 1.5 mm, set of 1
		EPE-5176207002	**Grip head set 4 size 3** For microcapillaries with an outer diameter of 0.7 mm to 0.9 mm, set of 1
		EPE-5176196000	**O-ring-set 4 for Grip head sets 4** O-ring replacement for Grip head 4 sizes 0-3, incl 10 o-rings large, 10 o-rings small, 2 distance sleeves, removal tool

13 Technical information