

InjectMan®

Operating Manual



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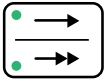
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Brief description of key functions

To fully understand these key functions, it is necessary to read the operating manual beforehand.

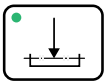
Key functions are activated after keys have been released.



SPEED

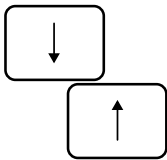
Option key: slow/fast

The speed mode selected is indicated by the corresponding light-emitting diode.



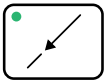
LIMIT

For setting/switching off the Z limit.



Cursor keys

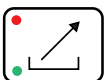
For adjusting the Z limit.



AXIAL

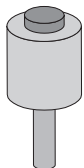
For switching on/off **AXIAL movement**.

For **adjusting angle**.



HOME/CLEAN

For exiting the work area and later relocating the exit point.

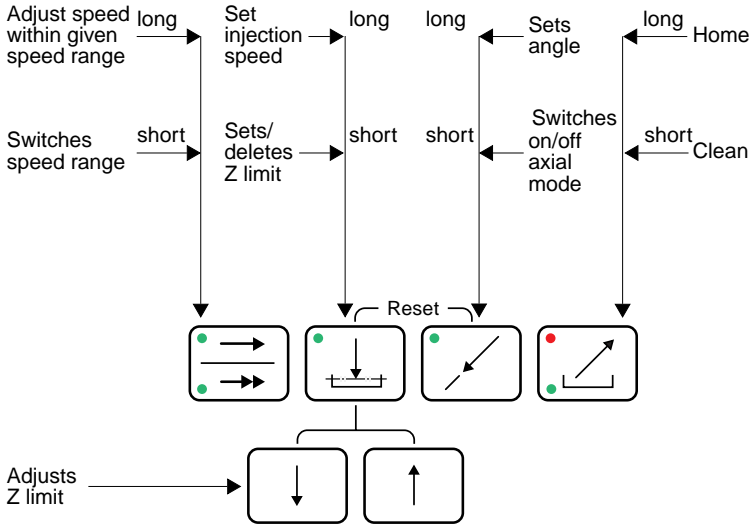


Joystick key

For activating the **INJECT function**.

Brief description of key functions

Overview of key functions:



Note:

- Trigger RESET function by pressing the LIMIT and AXIAL keys simultaneously.
- Change speed setting by pressing the SPEED key again.

1 General information

The Eppendorf Micromanipulator InjectMan[®] has been developed especially for use in the field of microinjection. Its optimal functionality and simple operation make InjectMan the ideal device for problem-free injection. It is particularly suitable for applications involving large numbers of cells.

The Eppendorf Micromanipulator InjectMan[®] combines the classic features of a mechanical system (direct feeling for the movement of the tool) with all the advantages of a precise electromotive system. The Eppendorf Micromanipulator InjectMan[®] is yet another addition to the Eppendorf Micromanipulator family.

Direct mounting of the module unit onto the microscope stage (on either the left- or the right-hand side) and the separate control board prevent oscillation and vibration.

Semi-automatic injection is possible by connecting InjectMan[®] to the Transjector 5246. In this case, injection movement and injection pressure are activated simultaneously at the push of a button.

The extremely careful method of inserting the microcapillary axially into the cell and then removing it axially greatly increases the effectiveness and range of microinjection applications.

Cells remain undamaged even if the user moves the capillary unintentionally by hand. The microelectronics and software of InjectMan guarantee that operating procedures are as "cell-friendly" as possible.

The clear, easy-to-follow keypad ensures that operating errors are kept to a minimum, thus protecting the preparations and tools used.

InjectMan can be attached to all commonly-used microscope with the aid of the appropriate adapter. Capillaries can be fixed onto the module unit at any angle and in any direction.



Work levels can be determined by the user, which minimizes damage to the capillary.

The integrated CLEAN/HOME function greatly facilitates capillary handling and capillary exchange.

Thanks to its simple, self-explanatory operation, InjectMan enables even inexperienced users to rapidly master the art of microinjection into adherent cells.

2 Safety precautions and application

For reasons of personal safety, it is essential to observe the following!

- Observe operating instructions!
- Only use the device for the application described!
- Before starting up the device, please compare your power supply with the voltage requirements on the identification plate!
- Take care when transporting the control board! Do **not** transport the device by the holding joystick!
- When mounting/dismounting take care to ensure that the motor modules (weight 3.5 kg) can be held safely! Failure to do so may result in injury!
- A weight of max. 500 g may be applied to the micromanipulator.
- The motor modules must not be moved against a mechanical obstacle, as this may damage the drive units.
- Before transporting the micromanipulator, the module unit is to be dismantled and, if possible, packed in its original box.
-  Caution when mounting tools!
Mounting must not be performed with pressure. Glass capillaries can be damaged during mounting if they are not handled carefully. Wear eye protection to prevent the risk of injury from glass splinters.
-  Please ensure that all work is carried out in accordance with this manual!
When placed upon a surface, the glass capillaries may break and glass splinters may cause injury. It is therefore essential to wear eye protection!

2 Safety precautions and application

- Never point capillaries at persons!
Capillaries can suddenly be loosened from their capillary grips under high pressure and become a missile.
- Electrical connection with devices not expressly mentioned in this operating manual is permitted only after obtaining prior approval from the manufacturer!
- The device is to be used solely for micromanipulation in accordance with the appropriate legislative requirements!
- Before opening the housing, disconnect the device from the power supply!
- The responsibility for the correct functioning of the device passes onto the owner or user if the device is maintained or serviced improperly by persons not belonging to the Eppendorf – Netheler – Hinz GmbH service team or if used for a purpose other than that intended. Eppendorf – Netheler – Hinz GmbH is not liable for damage occurring from non-observance of these notes. Guarantee and conditions of liability of the terms of sale and delivery of Eppendorf – Netheler – Hinz GmbH are not expanded by the above notes.
- Eppendorf – Netheler – Hinz reserves the right to make technical alterations to this device!

3 Mounting

Before checking that the delivery package is complete and assembling the device, please read the next section carefully.

3.1 Hazards during unpacking and other important notes

- The control board must not be carried/pulled out using its joystick! The joystick is a very sensitive control element for transmitting movements in the 0.1 μm range. When transporting, always hold the housing!
- Never place the control board upside-down onto the joystick!
- Handle the motor modules with care!
- Always disassemble the motor modules before transporting!
- If possible, always transport the motor modules in their original packaging!
- Place motor modules very carefully onto bench when assembled (do not tilt)!
- When assembled, the motors must not be located at the top of the module. They must always be located at the bottom or in a horizontal position.
- Following the warm-up phase (at least 30 minutes), the device is virtually drift-free.
- After the RESET function has been actuated, the joystick may only be deflected after the RESET function has ended. The end of the RESET function is accompanied by an acoustic signal or by the LED display returning to the operating status.
- When using the Eppendorf injection system, enter an injection time of >0.0 . Failure to do so could result in an error message.

3 Mounting

3.2 Overview and accessories

3.2.1 Overall view

The complete Micromanipulator InjectMan[®] with all device components mounted is shown in Fig. 1. In this example, right-hand side mounting has been selected.

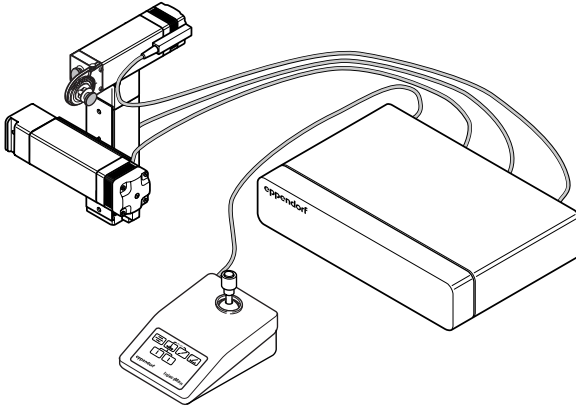
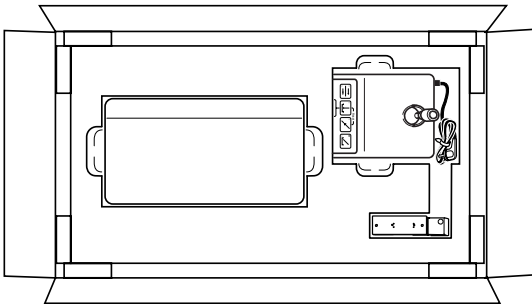


Fig. 1: Overall view of InjectMan[®]
Module unit for mounting on right-hand side

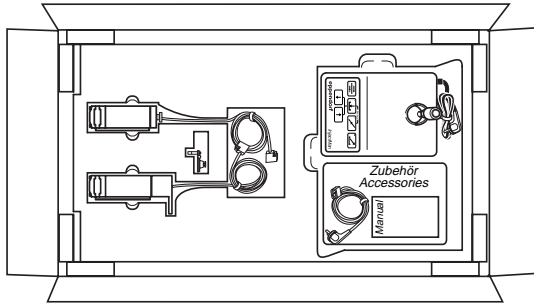
3.2.2 Packaging

The packaging should be kept for transport at a later date. It has two levels. The first level contains the power unit and a motor module.



3 Mounting

The second level contains the accessories, the operating manual, the other two modules and the control board.



The standard accessories consist of:

- 1 Operating manual
- 1 Main power cable
- 2 Oval head screws, M3x6
- 1 Phillips screwdriver
- 1 Allen wrench, 4 mm
- 1 Connecting plate
- 4 Oval head screws, M2x4
- 1 Transmission cable 5246

3 Mounting

3.2.3 Components of the module unit

The module unit consists of the following components (Fig. 2):

- 1 Fastening head
- 2 Y module
- 3 Connecting plate with 4 fastening screws
- 4 Z module
- 5 Connection head
- 6 Cannula holder
- 7 Adapter block
- 8 X module

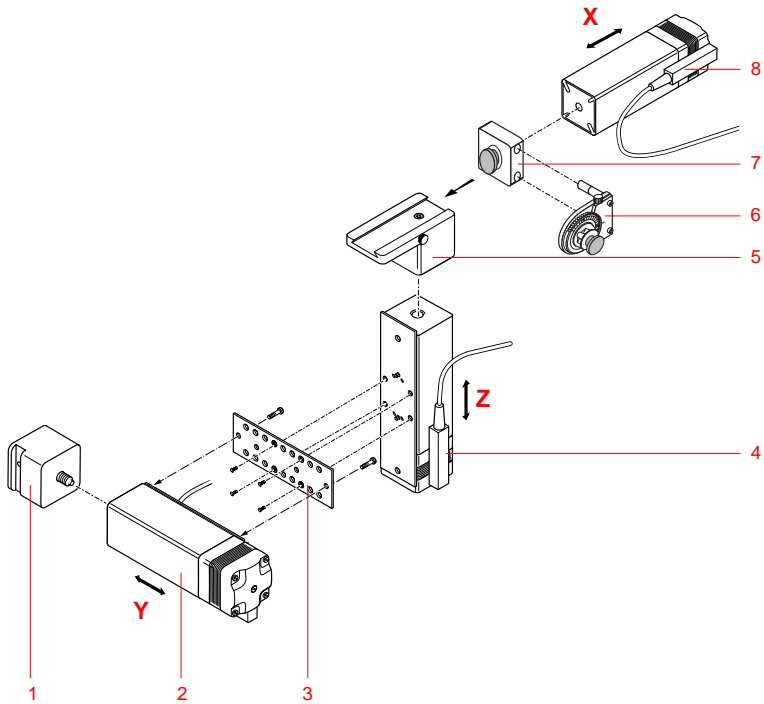


Fig. 2

3 Mounting

Delivery status

Z module

The Z module is connected to the Y module via the connecting plate (Fig. 6). The X module is fastened using the connecting head (Fig. 3.1).

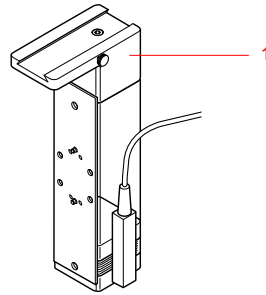


Fig. 3
1 Connecting head

Y module

The Y module is connected to the Z module via the connecting plate (Fig. 6). The module unit is connected to microscope with the aid of the fastening head (Fig. 4.1) and the corresponding adapter.

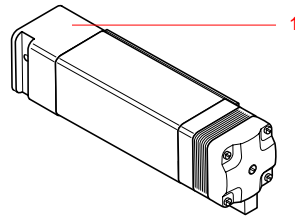


Fig. 4
1 Fastening head

X module

The adapter block with cannula holder (Fig. 5.1) is located on the X module, on which the tool (e.g. capillary holder) can be mounted.

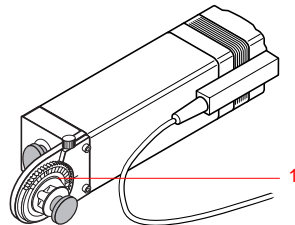


Fig. 5
1 Adapter block with cannula holder

3 Mounting

Connecting plate

The Y module and the Z module are connected using the connecting plate. The connecting plate can be screwed onto either the Y module or the Z module (see mounting instructions for the corresponding microscope). The module unit must be assembled according to whether it has been mounted on the left-hand side or right-hand side of the microscope. Note that distances a and b vary in size.

Connecting plate on the Y module:

Distance a is at the top

Connecting plate on the Z module:

Distance a is at the rear.

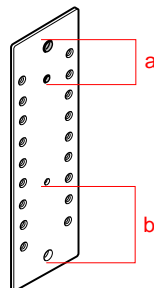


Fig. 6: Connecting plate

3.3 Mounting the module unit

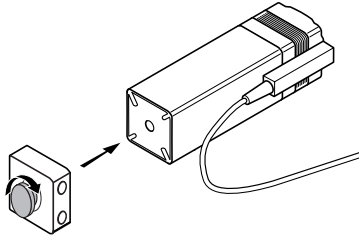
The module unit can be mounted onto all commonly-used microscopes (usually inverse microscopes). It is assembled onto the microscope tripod via adapters which differ according to the microscope used and which must be ordered separately. If a different type of mounting is necessary, special adapters are required. See appendix B "Examples of Application".

3 Mounting

3.3.1 Mounting the cannula holders

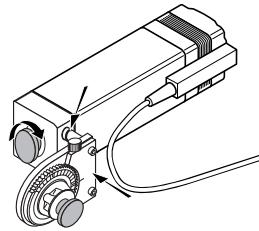
Mount the adapter block with the fastening screw as shown in the diagram.

Do not tighten the fastening screw fully.



Insert the cannula holder into the bores of the adapter block via the two metal pins. Ensure that the markings of the metal pins disappear completely into the adapter block

Tighten the fastening screw.



3.3.2 Right- and left-hand side mounting

Mounting the module unit is dependent on the microscope used as well as on the selected side of the microscope.

The exact procedure for mounting the module unit is described in the mounting instructions for the adapter used.

3.3.3 Pre-positioning

The module unit must be pre-positioned manually. The tool is then inserted. By manual shifting of the X,Y and Z modules, the tip of the tool is taken approx. 5–10 mm by eye over the center of the objective.

3 Mounting

Z direction

By removing and moving the connecting plate on the Y module, the height of the X and Z module, and thereby the height of the tool, can be changed. Altogether, the connecting plate on the Y module can be mounted at six different levels. Ensure that the middle bores with the shorter distance (a) on the connecting plate are at the top.

Y direction

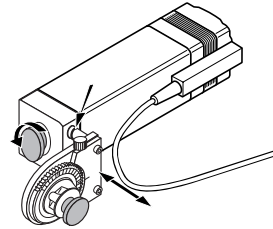
In order to shift the X and Z module in Y direction, the connecting plate can also be mounted on the Z module. The X and Z module are positioned at one level.

Altogether, the connecting plate can be mounted on the Z module in six different positions. Distance a must be at the rear.

It is also possible to position the cannula holder in the Y direction by shifting it in the adapter block. To do so, loosen the fastening screw slightly and pull the cannula holder slightly out of the adapter block.

Do not pull the metal pins further out than the marking as the cannula holder will then no longer be connected correctly.

Retighten the fastening screw.



X direction

By loosening the setscrew (Fig. 7.2), the X module (Fig. 7.1) can be shifted. The tightening screw must then be refastened.

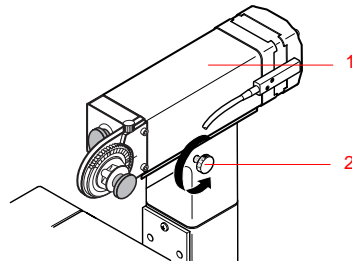


Fig. 7

- 1 X module
- 2 Setscrew

3 Mounting

3.4 Connecting the cables – Startup

The connections between control board, power unit and modules may only be made or interrupted when the device is switched off.

The three plugs of the Z, Y and X modules are connected to the corresponding sockets on the rear panel of the power unit in this order. The plug of the control board is also connected to the power unit.

Note: Tighten screws at the plugs!

Before plugging in the device, compare your power supply with the electrical requirements listed on the ID plate (rear panel).

If the module axes are interchanged because of connection of the module unit to the microscope, this must be taken into consideration during assignment of the plugs to the sockets.

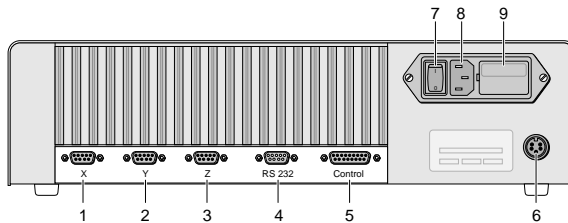


Fig. 8: Rear panel

- 1 Connection for X module
- 2 Connection for Y module
- 3 Connection for Z module
- 4 Serial interface for computer (RS 232)
(is not used with InjectMan[®])
- 5 Connection for control board
- 6 Connection for transmission cable 5246 or 5242
or foot control (option)
- 7 Main power switch
- 8 Main power socket
- 9 Fuse panel

3 Mounting

3.4.1 Transmission cable 5246

For ideal use of the INJECT function (see Sec. 5.4), the micromanipulator must be connected to the Eppendorf Transjector 5246.

Connecting the cables:

You require the transmission cable 5246 and the optional foot control.

- Connect the 6-pin plug to the corresponding socket on the rear panel of the power unit.
- Plug the 5-pin plug into the right socket on the rear panel of the Eppendorf Transjector 5246.
- Connect the connector at the short end of the transmission cable to the plug on the foot control (option).

Note: The transmission cable 5246 cannot be used to combine the Eppendorf Micromanipulator InjectMan[®] with the Eppendorf Microinjector 5242. The older transmission cable 5242 is required for this purpose.

The older transmission cable 5242 can be used with limitations as a connection to the Transjector 5246. In this combination, only pressure control is initiated with the INJECT key of the Transjector and not injection movement. The cable is connected accordingly.

3 Mounting

3.5 Inserting the tool holder

If the large fastening screw (Fig. 9.1) is loosened counterclockwise, the tool holder (4 mm diameter) can be inserted into the upper groove.

In this diagram, the tool holder is the universal capillary holder.

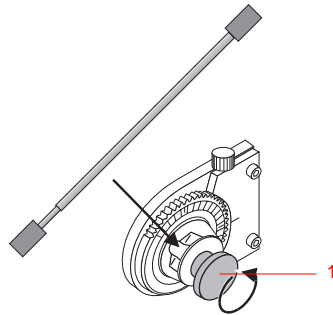
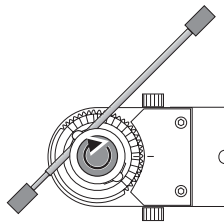
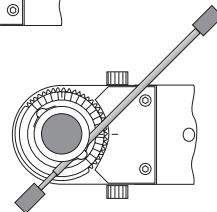


Fig. 9

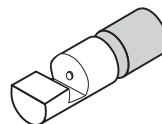
The universal capillary holder is fixed into place by retightening the fastening screw.



The universal capillary holder can be inserted into the lower groove.



The clamping piece can be used to fix the position of the universal capillary holder following removal.

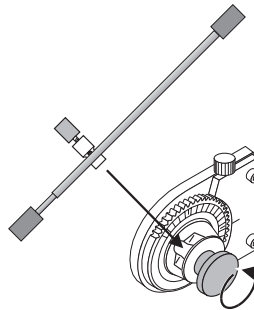


3 Mounting

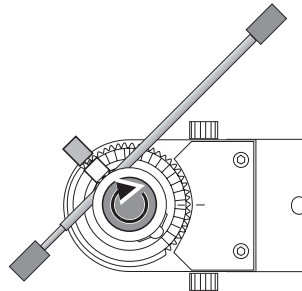
To do so, the clamping piece is fastened to the universal capillary holder as shown in the diagram.



The universal capillary holder is then inserted into the groove together with the clamping piece.



The universal capillary holder is fixed using the large fastening screw. The position is determined exactly using the clamping piece.



3 Mounting

3.5.1 Setting the angle

The angle can be preset by turning the adjusting screw (Fig. 10.1) on the cannula holder. The angle can be read directly using the scale.

Note: When the angle is changed, the height of the universal capillary holder and the tool also changes. A downward movement may destroy the tool.

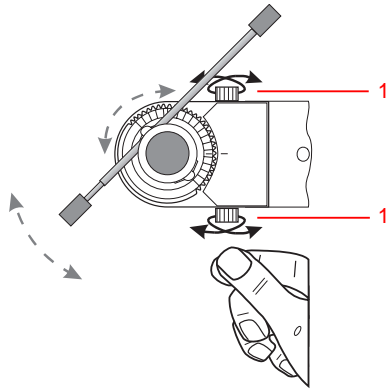


Fig. 10

4 Device description

4.1 Device components

The Eppendorf Micromanipulator InjectMan[®] consists of the following three components:

- Module unit
- Control board
- Power unit

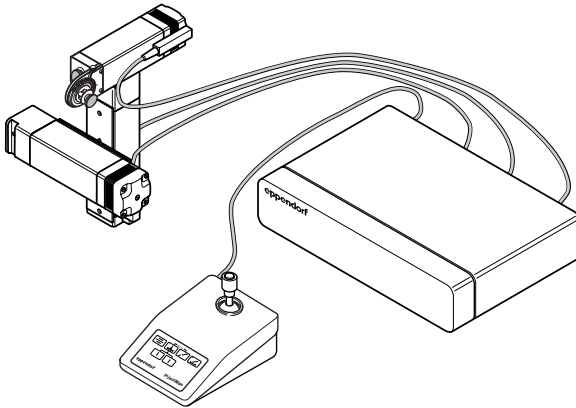


Fig. 11: Micromanipulator InjectMan[®], complete,
Module unit for mounting on right-hand side

4.2 Module unit

The module unit can be mounted on all commonly-used microscopes on the left- or the right-hand side using an appropriate adapter.

The module unit is made up of three modules (X, Y, Z). Each module consists of a drive unit with stepper motor and special head piece.

The cannula holder for tool insertion is located on the X module. The angle of inclination of the cannula holder can be adjusted by up to 90°.

Tools with a diameter or a width of 4 mm and a weight of max. 500 g can be used (e.g. capillary holder for microinjection, pipette holder and piezotranslators).

4 Device description

The motor position is indicated by the two markings on the guiding plate of the appropriate motor module. Figure 12 shows the center of the module. If the gap between the module housing and the motor is located above the external ends of the markings, the motor can only operate in one direction (reverse).

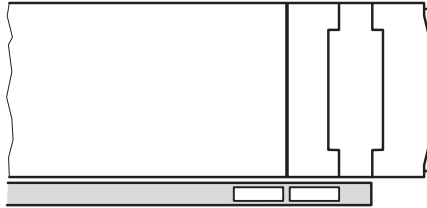


Fig. 12: Marking of motor position

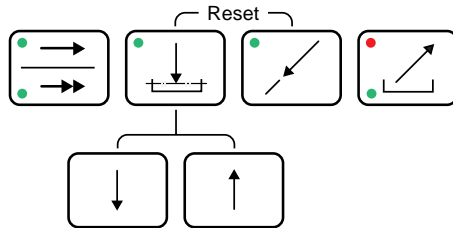
4.3 Control board

The keypad and the joystick, which also has a key, are located on the control board. The movement applied to the joystick is transmitted via the power unit to the module unit. Type of movement, direction and speed as well as series of movements are set and activated using the keypad and the joystick.

4 Device description

4.3.1 Keypad

The keypad is used to make certain adjustments and to initiate series of movements by direct control. Adjustments that are rarely used can be entered using key combinations. The light-emitting diodes indicate the active status of a function.

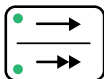


Defining, programming and amending operating parameters and functions is described in Sec. 5.

4 Device description

4.3.2 Direct key functions

Functions are activated after keys have been released.

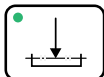


SPEED (see Sec. 5.2.1)

Key for selecting the speed range (SLOW/FAST). After switching over, the corresponding light-emitting diode lights up.

The speed SLOW can be set between 700 $\mu\text{m/s}$ and 50 $\mu\text{m/s}$ (at intervals of 50 $\mu\text{m/s}$), and the speed FAST between 5500 $\mu\text{m/s}$ and 500 $\mu\text{m/s}$ (at intervals of 500 $\mu\text{m/s}$).

If the key is held down for three seconds, the speed setting at that moment decreases. This alteration is by a flashing light-emitting diode and by a short acoustic signal for every speed alteration of 50 $\mu\text{m/s}$ in the SLOW range, or of 500 $\mu\text{m/s}$ in the FAST range. After switching over from 50 $\mu\text{m/s}$ to 700 $\mu\text{m/s}$ in the SLOW range, or from 500 $\mu\text{m/s}$ to 5500 $\mu\text{m/s}$ in the FAST range, a long acoustic signal is emitted and the speed then decreases.



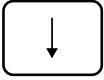
LIMIT (see Sec. 5.3.1)

This key is used to set a level (the Z limit) outside of which the tool (capillary) cannot move downwards. The light-emitting diode switches on after this level has been defined. If the key is pressed, the Z limit which has been defined is deleted and the light-emitting diode goes out.

This key can also be used to set the injection speed between 700 $\mu\text{m/s}$ and 50 $\mu\text{m/s}$.

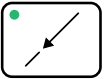
If the key is held down for three seconds, the current setting for the injection speed can be decreased. This alteration is acknowledged by a flashing light-emitting diode as well as a short acoustic signal for each alteration of 50 $\mu\text{m/s}$. After switching over from 50 $\mu\text{m/s}$ to 700 $\mu\text{m/s}$, a long acoustic signal is emitted and the decrease in speed begins. The factory-set value of 300 $\mu\text{m/s}$ is indicated by a short, interrupted signal.

4 Device description



Limit correction (see Sec. 5.3.2)

These keys can be used to adjust the Z limit upwards or downwards. Each time the key is pressed, the Z limit moves one step (approx. 160 nm). If the key is held down, the Z limit moves several steps accordingly. The current position of the capillary is not affected by limit correction.



AXIAL (see Sec. 5.2.2)

This key is used to switch on/off the axial movement. If the axial movement is activated, this is indicated by a light-emitting diode.

If the key is held down for three seconds, the angle between 90° and 15° can be decreased. This alteration is acknowledged by a flashing light-emitting diode and a short, acoustic signal for each alteration of 15°. After switching from 15° to 90°, a long acoustic signal is emitted. The factory-set value of 45° is indicated by a short, interrupted signal.



HOME/CLEAN (see Sec. 5.2.4)

The tool exits axially from the work area.

HOME: Holding the key allows the tool to exit up to the limit position of the motors.

The upper red light-emitting diode flashes rapidly during movement and switches on at the end point. Actuating the HOME function automatically deletes the Z limit which has been set.

CLEAN: Pressing the key quickly allows the tool to exit up to a previously defined level.

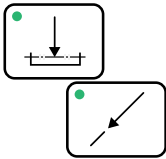
The lower green light-emitting diode flashes until the tool has returned to its end position.

Pressing the key once more returns the tool exactly to the original position.

The selected setting is active when the appropriate key has been released.

4 Device description

4.3.3 Combined key functions



RESET function

This key combination is used to reset the device, i.e. to simulate a powering-down operation without switching the device off and on again. In order to activate the RESET function, hold down the LIMIT and AXIAL key simultaneously. When the RESET function is triggered, all the light-emitting diodes are lit up for approx. 1 second.

The RESET function is used to delete the Z limit which has been defined and to cancel the HOME or CLEAN function.

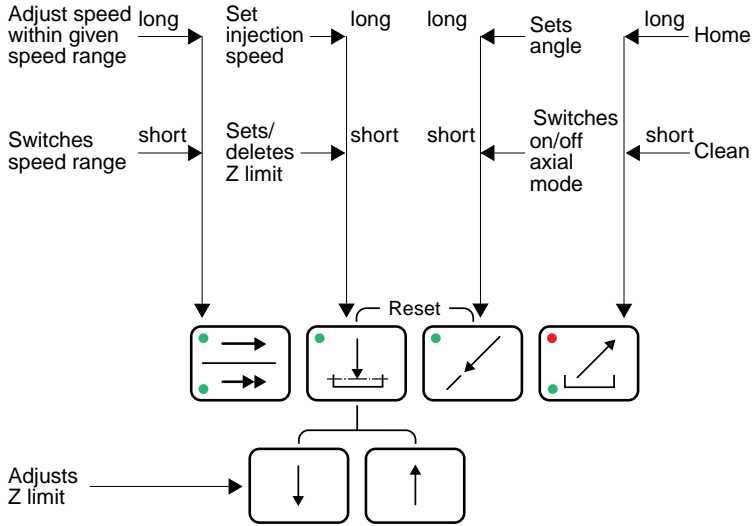
General Reset

If the device should be set back to the factory settings, the AXIAL key must be pressed for two more seconds. The triggering of this General Reset is acknowledged by an additional acoustic signal. The General Reset eliminates axial inversion, resets the AXIAL and INJECT parameters and sets the speeds back to their maximum values.

Note: After the RESET function has been actuated, the joystick may only be deflected after the RESET function has ended. The end of the RESET function is accompanied by an acoustic signal or by the LED display returning to the operating status.

4 Device description

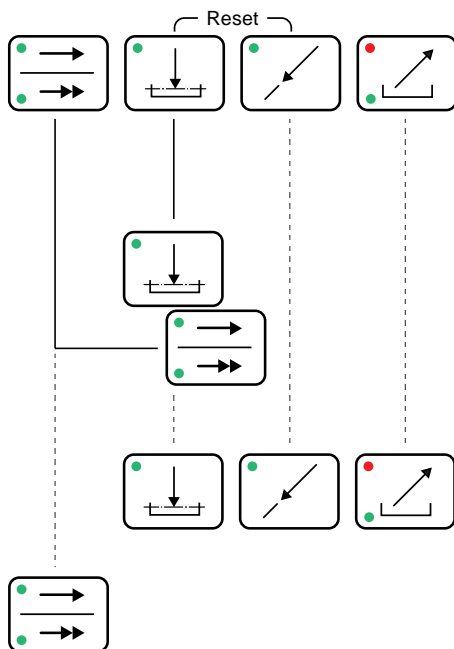
General overview of the key functions:



4 Device description

4.3.4 Adapting the direction of movement to the type of mounting (axis inversion)

The direction of movement of the axes can be changed using this function. This function is required primarily for the installation of InjectMan® on the left-hand side of the microscope for the X axis. For this purpose, the X axis must be inverted once for installation or after every General Reset.



1. Beginning of inversion: Press down the keys LIMIT and SPEED keys simultaneously until both light-emitting diodes of the SPEED key light up.

Note: The RESET function discontinues inverting without amendments being stored.

4 Device description

2. Inverting the axes:

Axes inversion "normal": Short acoustic signal.
Axes inversion "invert": Long acoustic signal.
Delivery status: X,Y and Z axis "normal",
in accordance with modular structure
mounting the module on the right-hand side,
Sec. 3.2.3 Components of the module unit.

General Reset sets back the axes to the delivery status.

Inverting the X axis: In order to invert the X axis, you have to hold down the LIMIT key. This results in the X module moving in the opposite direction, although the joystick deflection remains unchanged. In order to restore the previous status, press the key again.

Inverting the Y axis: In order to invert the Y axis, you have to hold down the AXIAL key. This results in the Y module moving in the opposite direction, although the joystick deflection remains unchanged. In order to restore the previous status, press the key again.

Inverting the Z axis: In order to invert the Z axis, you have to hold down the HOME/CLEAN key. This results in the Z module moving in the opposite direction, although the direction of rotation of the joystick remains unchanged. In order to restore the previous status, press the key again.



Caution: If the Z axis is inverted, ensure that the movement of the Z axis corresponds with the correct direction of rotation of the joystick. If not, the Z axis must be inverted again. Failure to do so could result in damage to the capillary, the object or the modules.

Glass splinters from broken capillaries may cause eye injuries. It is therefore strongly recommended to wear eye protection!

4 Device description

3. Storing inversion: Press the SPEED key. Both light-emitting diodes switch off and then the light-emitting diode for the previous speed range lights up.

These settings remain permanently stored until the axes are inverted again.

4.3.5 Joystick

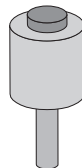
The joystick provides horizontal movement (X and Y axis) and vertical movement (Z axis). Vertical movement is initiated by rotating the joystick: Clockwise rotation: Downward movement. Counterclockwise rotation: Upward movement. This is shown on the control board.

Multidirectional movement on all three axes is possible. The direction of movement along individual axes can be reversed.

Increasing the deflection/rotation causes an increase in speed. Decreasing the deflection/rotation causes the tool to move more slowly. Maximum deflection/rotation allows maximum speed in the selected speed range.

Injection

The key integrated in the joystick is used to actuate the INJECT function (see Sec. 5.4). If the Z limit has been set and an injection system is connected, injection occurs automatically when this key is pressed.



Note: After the RESET function has been actuated, the joystick may only be deflected after the RESET function has ended. The end of the RESET function is accompanied by an acoustic signal or by the LED display returning to the operating status.

4 Device description

4.3.6 Power unit

The power unit contains the entire power electronics for the Micromanipulator InjectMan[®].

The main power switch, the connection sockets for the individual modules, as well as the control board, the serial interface and a connection for a foot control switch are located on the rear panel.

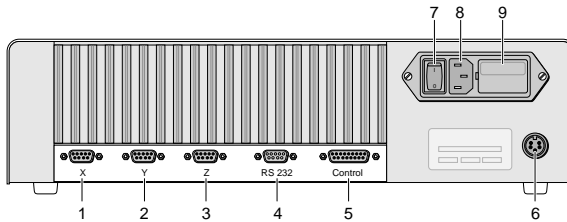


Fig. 13: Rear panel

- 1 Connection for X module
- 2 Connection for Y module
- 3 Connection for Z module
- 4 Serial interface for computer (RS 232)
(is not used with InjectMan[®])
- 5 Connection for control board
- 6 Connection for transmission cable 54246 or 5242
or foot control (option)
- 7 Main power switch
- 8 Main power socket
- 9 Fuse panel

5 Mode of operation

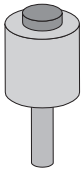
5.1 General

Switch on the device by pressing the toggle switch located on the back of the power unit. The device is then in the following basic mode:

- Slow speed
- No special function

If a combination of keys is disabled, an acoustic signal is emitted. The device remains in the previously selected mode. The maximum movement for each of the three motors is 2.5 cm; the joystick then has to be moved in the opposite direction. If the tool cannot be moved into the optical axis/focal point, the device must be repositioned again (see Sec. 3.3.3).

5.2 Positioning the tool

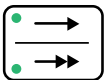


The device is operated using the joystick:

Increasing the deflection or rotation of the joystick increases the speed of the tool. After the joystick is released, it returns to the center and the tool stops moving. This permanent dynamic mode allows the tool to cover long distances quickly while remaining exactly positioned.

Increasing the joystick deflection progressively increases the speed to the set speed value of max. 700 $\mu\text{m/s}$ in the SLOW mode or max. 5500 $\mu\text{m/s}$ in the FAST mode (individual settings possible).

5.2.1 Defining the speed range



You can switch between SLOW/FAST using the SPEED key.

SLOW is designed for fine positioning and for working with higher magnification.

FAST is designed for rapid positioning of the tool and thus replaces the mechanical coarse adjustment. It is also useful when working with lower magnification.

The SPEED key can be used to set the speed to SLOW (max. 700 $\mu\text{m/s}$) and FAST (max. 5500 $\mu\text{m/s}$). A change in speed is possible using the keypad (Sec. 4.3.2).

5 Mode of operation

In order to prevent damage to the tool when it returns to the work position, the tool should be moved upwards slightly using the joystick before activating the HOME function to change the tool.

The CLEAN function makes it possible to remove cell particles and similar matter which accumulates on the tool tip. For this purpose, the tool is removed axially from the medium by a defined distance and the particles are wiped off during passage through the boundary between liquid and air. The tool returns to the original position. The factory setting for this value is 5 mm.

Initiating the HOME/CLEAN function:

Pressing down the HOME/CLEAN key when one of the two functions is activated removes the tool from the work level.

HOME: After the HOME/CLEAN key is held down, the red light-emitting diode flashes during movement; when the tool is in the home position, the light-emitting diode is permanently switched on.

CLEAN: After the HOME/CLEAN key is pressed briefly, the green light-emitting diode flashes when the tool is moving. In the CLEAN position, the light-emitting diode is permanently switched on.

Pressing the HOME/CLEAN key again returns the tool to the previous work position.

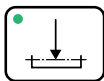
When the tool is located in the HOME/CLEAN position, all other keys are disabled.

Note: When the tool is located in the HOME/CLEAN position, joystick control of the tool is disabled. If you wish to remove the tool from this position with the joystick into the original position, you have to RESET (combination of LIMIT key with AXIAL key).

5 Mode of operation

5.3 Setting the Z limit

5.3.1 Defining the Z limit as a work level



The work level can be set in the Z plane. The tool cannot be moved beyond the set plane. At the same time, the work level defines the final position of tool movement for the INJECT function. The INJECT function cannot operate without a defined LIMIT.

The work level is set to avoid damage to the tool and preparation and to determine the injection depth in the case of the INJECT function.

The main application for the Z limit is microinjection of adherent tissue culture cells (see Fig. 14).

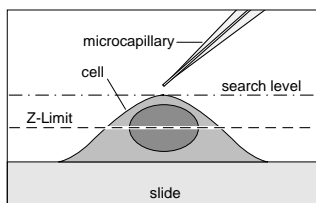


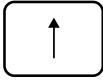
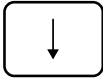
Fig. 14: Z limit

The tool, i.e. the capillary, is moved into the desired position. The capillary is either moved to the desired position by lightly pressing the cell or it is moved next to the cell, into the same focus level as the injection depth. The Z limit is defined by pressing the LIMIT key, and the light-emitting diode then switches on. The Z limit is deleted by pressing the LIMIT key again and the light-emitting diode switches off. The Z limit can be overwritten by deleting and then redefining the Z limit value. The Z limit can also be deleted using the RESET function.

After the work level has been successfully defined, the tool is returned to the search level above the cell.

5 Mode of operation

5.3.2 Fine correction of the Z limit (work level)

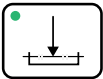


Uneven surfaces (especially when working with plastic Petri dishes), and various kinds of cell morphology require the work level to be corrected from time to time. To avoid the work involved in redefining the Z limit each time as described above, the limit plane can be easily readjusted with the cursor keys in single steps of 160 nm. This can be carried out from the current position and is not effective until the next time INJECT is activated.

The Z limit is stored internally in microsteps. The Z limit is moved downwards or upwards by pressing the appropriate arrow key. Each time the appropriate arrow key is pressed, the definition of the Z limit moves one microstep up or down. If the key is held down, the Z limit is changed by several microsteps. When extensive changes are made, each step of approx. 1 μm is accompanied by an acoustic signal.

The success of these changes can be checked by direct initiation of an INJECT function.

5.3.3 Deleting the current Z limit (work level)

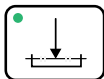


To define a completely new Z limit or to enable work to continue without a Z limit, the current Z limit must be deleted by pressing the key. The light-emitting diode switches off. A new Z limit can now be defined if required.

If the HOME function is initiated, the Z limit which has been defined is automatically deleted. This prevents the (changed) capillary from being damaged during subsequent injection.

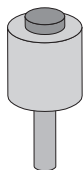
5 Mode of operation

5.3.4 Changing the injection speed



If the key is held down for three seconds, the current setting of the injection speed must be adapted to the requirements of the experiment. This alteration changes in a downward direction to 50 $\mu\text{m/s}$. Each alteration of 50 $\mu\text{m/s}$ is acknowledged by a short acoustic signal. When switching over from 50 $\mu\text{m/s}$ to 700 $\mu\text{m/s}$, a long acoustic signal is emitted. The factory-set value of 300 $\mu\text{m/s}$ is indicated by a short, interrupted signal.

5.4 Initiating the INJECT function



The INJECT function is initiated by pressing the key in the joystick. The capillary moves automatically from its current position (search level) to the work level (the Z limit). After injection has taken place, the capillary returns along the same path to its starting position in the search level. For control purposes, the light-emitting diode in the LIMIT key flashes during the injection procedure.

When there is no defined Z limit, the injection pressure is switched on when the joystick key is pressed.

The preset angle of injection of 45° for the INJECT function can be modified by pressing the AXIAL key (see Sec. 5.2.3). The capillary should be mounted accordingly, at the same angle.

Injection takes place at the angle which has been set by means of an overlay of the X and Z movement in an axial direction. This guarantees safe injection.

5 Mode of operation

Fig. 15 shows a schematic injection with set Z LIMIT (factory-set).

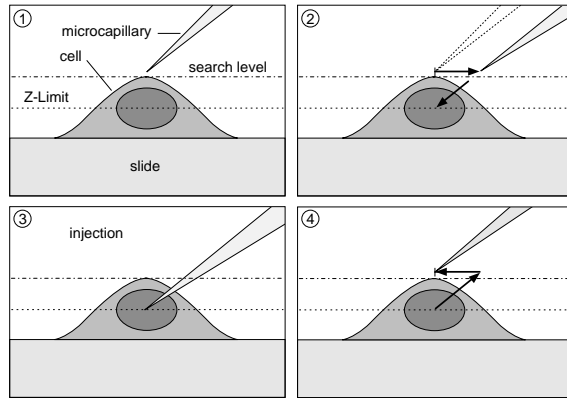


Fig. 15: INJECT function

- 1 Original position, capillary in search level.
- 2 The manipulator travels in the X direction.
- 3 The capillary pierces the cell in axial direction down to the Z limit.
- 4 After an injection has ended, the capillary returns to the original position.

This procedure takes place automatically.

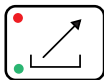
The initiation of the INJECT function does not require use of the joystick key. Alternatively, the sequence can be initiated by the Transjector 5246 or by foot/hand control.

If the injection time for the "Automatic" setting of the Transjector 5246 has been set to 0.0 seconds, no injection takes place and the light-emitting diode on the LIMIT key flashes permanently. An injection time of at least 0.1 seconds must then be set on the Transjector 5246 and the joystick key must be pressed again. The injection movement then takes place and the light-emitting diode on the LIMIT key stops flashing.

If the Transjector 5246 is set to manual or, if no Transjector 5246 is connected, the duration of the INJECT function is determined by the length of time that the joystick key is held down.

5 Mode of operation

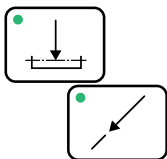
5.5 Cleaning and changing the tool



The CLEAN/HOME key enables you to remove any particles which have accumulated on the tool rapidly and easily; if necessary, you can also change the tool.

This function is designed to remove the tool quickly from the work area and return it accurately to its original position. Before the CLEAN/HOME function is actuated, the tool should be moved upwards slightly.

5.6 Initiating the RESET function



With the key combination LIMIT – AXIAL, the device is reset to the basic mode, i.e. "power on" is simulated without the device being switched off and on again

The RESET function is initiated by pressing the LIMIT and AXIAL keys simultaneously. When the RESET function is initiated, all light-emitting diodes light up for approximately one second. The RESET function terminates the HOME/CLEAN function and deletes the Z limit which has been defined.

Note: After the RESET function has been initiated, the joystick may only be deflected after the RESET function has ended. The end of the RESET function is accompanied by an acoustic signal or by the LED display returning to the operating status.

General reset

With the key combination LIMIT – AXIAL, all parameters of the device can also be reset to their factory-set values.

In order to achieve this with the key combination LIMIT – AXIAL described above, the AXIAL key is pressed and held down. The LIMIT key is then released first, meaning that the AXIAL key is held down longer. A reset to the preset values using General Reset is acknowledged by a second acoustic signal. General Reset also cancels axes inversion, resets the AXIAL and INJECT parameters and sets the speeds back to their maximum values.

6 Care and maintenance

6.1 Cleaning

Before cleaning the Micromanipulator InjectMan[®], disconnect the plug.

Ensure that no fluids enter into the inside of the micromanipulator in order to avoid short-circuits in the electrical installation as well as corrosion.

Wipe painted parts and aluminum surfaces using a cloth and mild detergent and then with a dry cloth.

Warning: Do not use any corrosive, solvent or abrasive detergents or polishes.

6.2 Disinfection

Clean the Micromanipulator InjectMan[®] before disinfecting.

Wipe every part of the micromanipulator, including accessories and connector cables, with disinfectant.

Spray disinfection is not advisable, as disinfectants can enter into the micromanipulator.

The disinfection method used must comply with current disinfection regulations and guidelines.

6.3 Maintenance

Regular maintenance is not required.

The dealer is responsible for warranty and service.

7 Troubleshooting

7.1 Possible operating errors

- When the joystick is moved, the tool moves in the wrong direction.
Solution: In this case, check the direction of movement of the individual axes and, if necessary, change the direction as described in Section 4.3.4.
- With the HOME function, the tool moves downwards.
Solution: Invert the axes for the Z axis (Sec. 4.3.4).
- The device does not react to the joystick movement and to the key being pressed and the HOME function is still active.
Solution: Press the HOME key once again; the tool moves downwards. Alternatively, execute a RESET.
- The tool does not move far enough downwards.
Solution: Cancel the LIMIT function or readjust the tool.
- After the joystick has been rotated, it does not move straight downwards, but also moves to the side.
Solution: Switch off the AXIAL function.
- During injection, the tool moves straight downwards.
Solution: Adjust the angle setting according (Sec. 4.3.2).

7.2 Error messages

In the event of an error occurring, error numbers can be given via the light-emitting diodes on the keypad. These are for internal control purposes only. If one of these error messages occurs, it can be deleted using the RESET function.

The error messages are displayed as a code in the dual system. Please note that each key with light-emitting diodes corresponds to a dual number. Counting is carried out from the left to the right. For example, the error 06 can be displayed as a dual code 0110. When this occurs, the LEDs in the outer keys light up, in accordance with dual code 0. The LEDs in the middle keys flash, in accordance with dual code 1. This produces the error message 06, in accordance with the dual-code calculation:
 $0 \times 1 + 1 \times 2 + 1 \times 4 + 0 \times 8 = 6$

This error may occur as a result of a misadjustment of the zero point of the joystick during a General Reset. In this case, the joystick must be moved into a middle position and a General Reset must be executed.

7 Troubleshooting

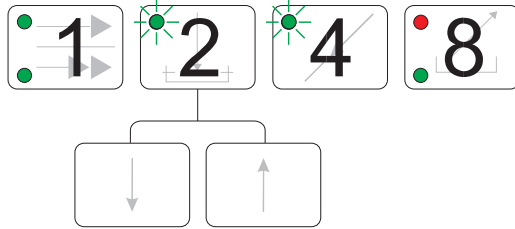



Fig. 16: Arrangement and method of counting for the error codes displayed.

Example for error code 06: The LEDs on keys 2 and 4 flash.

Error code	Description	Possible cause	Solution
01	Not used	---	---
02	Internal error	Internal error	RESET, Service
03	Internal error	Internal error	RESET, Service
04	Internal error	Internal error	RESET, Service
05	Internal reset	Power failure	RESET, Service
06	Zero-point shift	General Reset with deflected joystick	Move the joystick into the central position and execute a General Reset.
07	Old software version on the power unit	Incorrect software, incorrect power unit	Replace the software on the power unit with a newer version.
08 – 15	---	---	---

8 Technical data

Voltage/Frequency:	100/115/127/230 V \pm 10 %, 50–60 Hz		
Set voltage:	See identification plate Modifications can only be performed by the service team.		
Fuses:			
For 230 V–250 V:	time-lag 0.4 A – 5x20 mm (2 fuses)		
For 100 V–127 V:	time-lag 0.8 A – 5x20 mm (2 fuses)		
Power consumption:	66 W		
Overvoltage category:	II		
Contamination level:	I		
Pollution degree:	2		
Ambient temperature:	max. 40 °C		
Ambient relative humidity:	max. 80 %		
Weight:	Module unit:	3.5 kg	
	Control board:	2.5 kg	
	Power unit:	5.5 kg	
Dimensions of power unit:	Width:	385 mm	
	Depth:	210 mm	
	Height:	95 mm	
Vertical travel:	Manual:	depends on mounting	
	Motor:	25 mm	
Horizontal travel:	X axis: manual:	65 mm	
	motor:	25 mm	
	Y axis: manual:	depends on mounting	
	motor:	25 mm	
	Angle of inclination:	0–90° to microscope stage	
Resolution per microstep:	157 nm		
Max. tool travel speed:	5,500 μ m/s		

The device is -approved and has UL and CSA authorization (cUL: E 158089).

Technical specifications subject to change!

9 Ordering information

Order no.

5179 000.018	InjectMan [®] 115/230 V / 50–60 Hz Delivery package: 1 InjectMan [®] 1 Tool 1 Power Cable 1 Operating Manual
5246 621.006	1 Transmission Cable 5246 for connection to the Transjector 5246

Installation

An adapter (non-standard) is required for mounting onto the microscope

Adapter for direct mounting of the InjectMan[®] on the microscope

5171 035.009	Adapter for Leica DMIRB (E)
5171 051.004	Adapter for Leica DMIL
5171 027.006	Adapter for Nikon Diaphot 300/200 and Nikon Eclipse TE 300/200
5171 054.003	Adapter for Nikon Diaphot / Diaphot TMD
5171 063.002	Adapter for Nikon TMS
5171 048.003	Adapter for Olympus IX50/IX70
5171 055.000	Adapter for Olympus IMT-2
5171 053.007	Adapter for Olympus CK-2, CK-40
5171 042.005	Adapter for Zeiss Axiovert 100/135/135M/S100
5171 058.009	Adapter for Zeiss Axiovert 10/35
5171 046.000	Adapter for Zeiss Axiovert 25

Adapter for mounting the InjectMan[®] on the microscope using the fastening clamp

5171 045.004	Anchoring clamp
5170 081.007	Adapter for Leitz Labovert, Fluovert, DMIL

Prices for microscopes, microscope accessories, additional adapters, video cameras and monitors available on request.

9 Ordering information

Accessories (not standard)

5242 952.008	20 Femtotips [®]
5242 957.000	20 Femtotips [®] II
5242 956.003	200 Microloaders
5242 009.012	Filling stand for Femtotips [®]
4910 000.018	Eppendorf Reference pipette, variable, 0.5 to 10 μ l
3110 000.021	Eppendorf Research pipette, variable, 0.5 to 10 μ l
5211 058.007	Foot control for microinjection
5176 190.002	Universal capillary holder for accommodating Femtotips [®] , Femtotips [®] II or capillary grip heads
5176 210.003	Grip head 0 for universal capillary holder for microcapillaries with an outer diameter of 1.0 to 1.1 mm
5176 212.006	Grip head 1 for universal capillary holder for microcapillaries with an outer diameter of 1.2 to 1.3 mm
5176 214.009	Grip head 2 for universal capillary holder for microcapillaries with an outer diameter of 1.4 to 1.5 mm
5176 207.002	Grip head 3 for universal capillary holder for microcapillaries with an outer diameter of 0.7 to 0.8 mm
5176 196.000	O-ring set for grip heads 0–3 with extraction tool
5176 195.004	Service kit for grip head and capillary holder, consisting of O-ring set, adapter for Femtotip [®] and clamping piece

9 Ordering information

Microinjection

5246 000.010	Transjector 5246 basic Fully programmable microinjector with integrated pressure supply and two independent pressure outputs
5176 000.025	CellTram Oil manual piston pump for transferring cells (sperms, ES cells) with universal capillary holder for capillaries with an outer diameter of 1 mm
5176 000.017	CellTram Air manual piston pump for holding cells (e.g. oocytes) with universal capillary holder for capillaries with an outer diameter of 1 mm CELLocate Glass coverslips with integrated microgrid for relocating cells in light and electron microscopy, individually sealed, with log pad
5245 952.009	Grid size 175 μm , sterile, set of 80
5245 962.004	Grid size 55 μm , sterile, set of 80

Appendix A

Short instructions

Notes on microinjection using the INJECT function

By combining the micromanipulator with the Eppendorf Transjector 5246 or Microinjector 5242, microinjection in culture cells can be carried out easily. We recommend the following procedure:

- Set parameters on manipulator and on transjector or microinjector.
- Define injection level.
- Carry out trial injection.
- Adjust injection level to correct height (if required).
- Carry out further injections.

1. Set parameters on manipulator and on transjector or microinjector

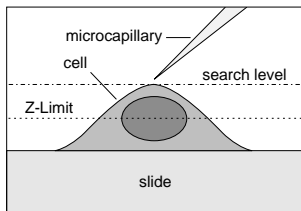
- Set "Automatic" on the transjector or microinjector.
- Set injection time for test purposes to 0.5 s.
- Set the work table to an angle of 45° (when using other angles, adjust the angle using the AXIAL key)

2. Define injection level

- Focus the microscope on any cell.
- Rotate the joystick to lower the capillary until the tip produces a sharply defined image next to the cell.
- Press the LIMIT key. The "injection level" is now set.
- Rotate the joystick counterclockwise to position the capillary at a safe distance above the cells = "search level".

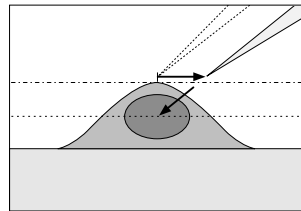
Appendix A

3. Carry out trial injection



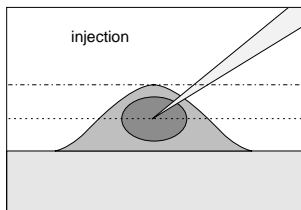
- a) Position the capillary above the cell (search level)

Press the INJECT key

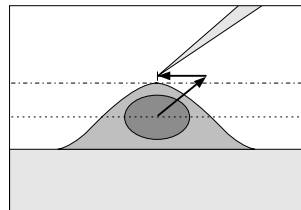


The next phases run automatically:

- b) The manipulator travels in X direction



- c) The capillary pierces the cell in axial direction up to the Z limit.



- d) After injection is completed the capillary returns to the search level

4. Adjust injection level to correct height (if required)

- Correct the injection level using LIMIT and the cursor keys. Capillary movement and injection can be performed immediately.
- Correct the injection pressure and time on the Transjector 5246 or Microinjector 5242.

5. Carry out further injections

- Proceed in the same way as with trial injections.
- If the image field changes, adjust the injection level using LIMIT and the cursor keys (if necessary).

Appendix A

Notes: For reproducible injections and a high number of injections, we recommend our Eppendorf Femtotips, pulled ready-to-use capillaries for microinjection (see Sec. 8, Ordering information).

Always enter the injection time at the Transjector 5246 or Microinjector 5242. Otherwise the INJECT function is not executed.

In the manual mode of the Transjector 5246, injection is initiated and executed by pressing and holding down the joystick button, the foot control of the microinjector and the INJECT key of the Transjector.

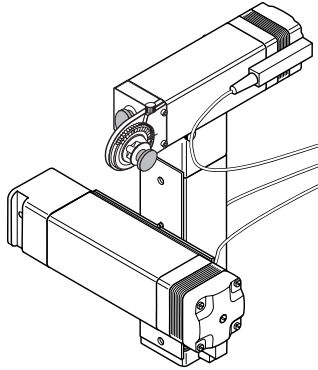
In the "Manual" mode on the Microinjector 5242, the INJECT function is initiated by pressing the foot control. The capillary remains in the cell until the injection is terminated by pressing the foot control. The capillary then returns to the final position. The injection time is measured by the Microinjector 5242 and, after the injection has been completed, appears in the device display. This setting enables you to determine the injection time measured for the respective cells. This time can then be used for the "Automatic" mode.

Appendix B

Examples of application

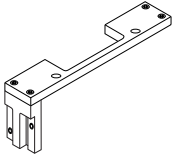
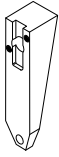
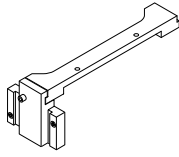
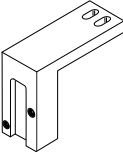
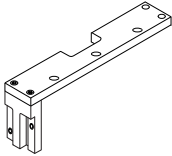
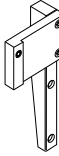
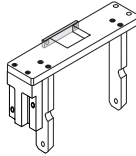
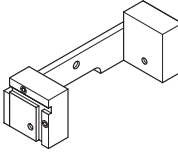

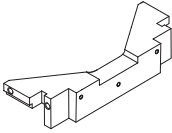
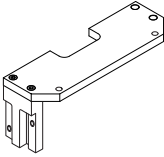
Mounting on the Y module

(as described in Sec. 3.3.2 – right-hand side mounting is shown here – or in the mounting instructions for the adapters)



Appendix B

Connection for the microscope via the adapter

<i>Leica</i>	<i>Zeiss</i>	<i>Nikon</i>	<i>Olympus</i>
DMIRB / DMIRBE	Axiovert 100 / 135	Diaphot 200/300 / Eclipse TE 300/200	IX 50 / IX 70
			
Order no. 5171 035.009	Order no. 5171 042.005	Order no. 5171 027.006	Order no. 5171 048.003
DMIL	Axiovert 25	Diaphot / Diaphot TMD	IMT-2
			
Order no. 5171 051.004	Order no. 5171 046.000	Order no. 5171 054.003	Order no. 5171 055.000
	Axiovert 10 / 35	TMS	CK-2
			
	Order no. 5171 058.009	Order no. 5171 063.002	Order no. 5171 053.007

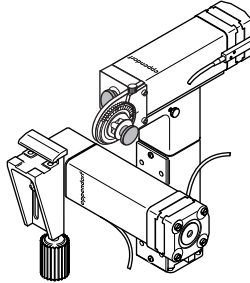
Additional adapters for those microscopes not listed are also available.

Appendix B

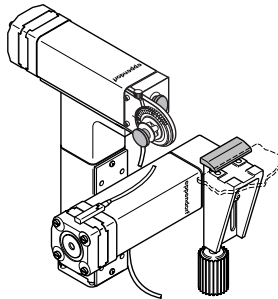
Further assembly possibilities

Connection to all microscopes whose microscope tables or other components allow fastening with a clamp.
(Anchoring clamp: Order no. 5171 045.004)

Right-hand sided assembly,
e.g. on the microscope table



Left-hand sided assembly,
e.g. on the microscope table



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