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# User's Manual of Electrospinning Unit (Electroris)

Labscale Electrospinning Unit (Electroris)



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## Manual Description

This manual is designed to provide all operational and program information required operating and maintaining of fnm labscale electrospinning unit (Electroris).

## Calibrations

All electrical apparatus is calibrated at rated voltage and frequency.

## System grounding (Earth):

Due to the high voltages required for the formation of polymeric nanofibres, it is necessary to ground this product through the grounding conductor of the power cord. **Lack of proper earth connection in addition to electronic systems failure can carry electrical shock risks to the operator.** The screw along the back of the machine can be connected to the laboratory water metal pipes by an appropriate wire.

## Operation

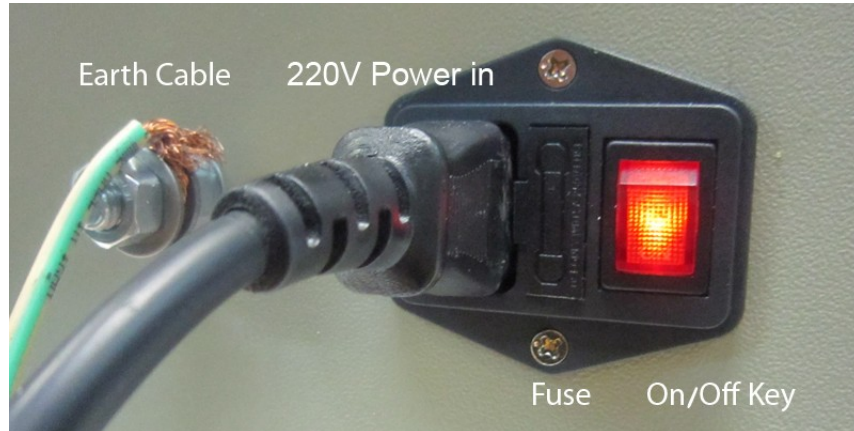
All models of electroris employ a microcontroller which controls a small step angle stepping motor that drives a lead screw and Pusher Block. Micro-stepping techniques are employed to further reduce the step angle and eliminate flow pulsation.

A keypad is used to entry operating data to the subsystems. The microcontroller calculates the cross-sectional area of the syringe selected and calibrates the flow rate and volume accumulation.

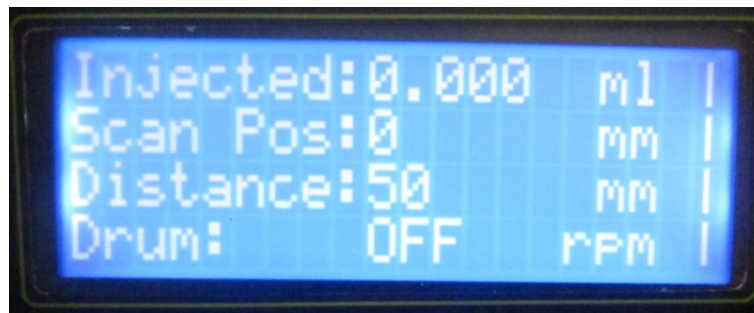
## User Interface

A big four-line-20 character LCD display along with 20 membrane keys makes it a more attractive but powerful and easy-to-use system. A functional key for each line of LCD causes





### System display:



The screen contains four rows that each row displays the situation of each subsystem:

**First line:** the volume of injected solution (ml).

**Second line:** position nozzles (per millimeter)

**Third line:** the distance from the nozzle tip to the drum surface (mm)

**Fourth line:** drum rotation speed based on RPM

**Description 1:** on the left of each row, keys with names L1, L2, L3, and L4 are to set each subsystem.

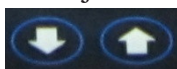
**Description 2:** The last character in the right side of each row indicates the motion (>) or Stop (|) situation.

### Syringe pump (Injection) system:

The pump can take one or two syringes of any make any size. The diameter of the syringe(s) is entered via the keypad and the internal microprocessor calculates the cross-sectional area to calibrate the pump for that syringe. The microprocessor automatically determines if the flow rate is to be expressed in ml/hour depending on the syringe size.

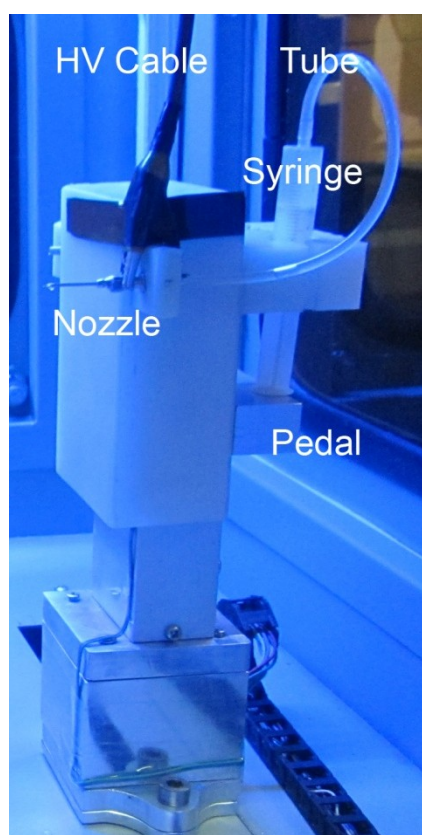
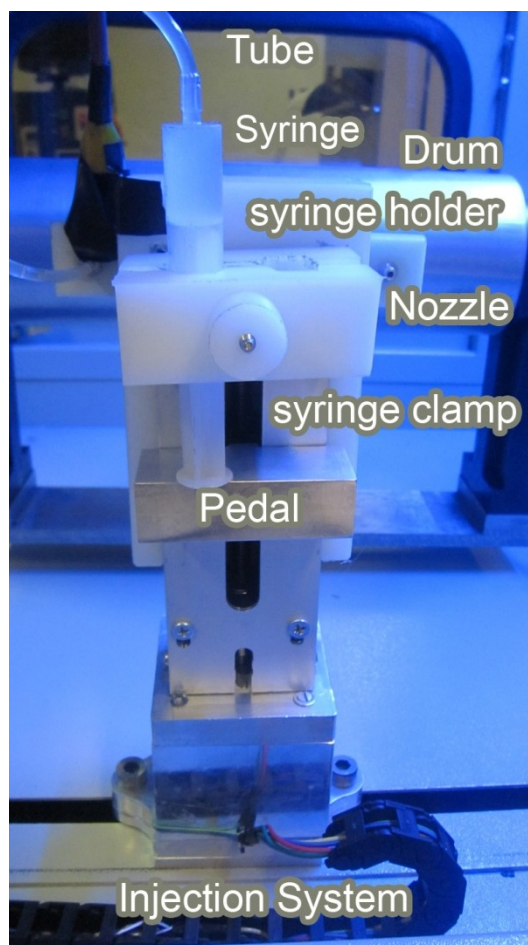
To load the syringes on push/pull end; 1 ml through 25 ml only. Remove the syringe clamp. Place syringes on the syringe holder. Adjust the

syringe pedal using the keys:



Position the holder for correct location. Place the syringe clamp over syringes and lock in place with nut.

**Note:** Please be careful, the tube is not soluble in the solvent. For example, PVC tube can be solved in most organic solvents. In the case, use Teflon or polyethylene tube.

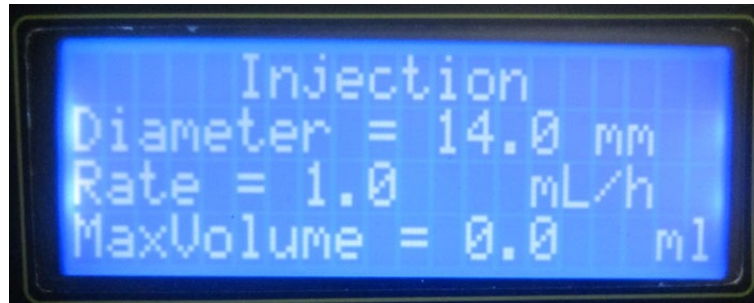


**Note:** After finishing the electrospinning it is necessary to clean within of junction nozzles and tubes, then a thin wire is placed inside the nozzles to prevent drying up of polymers in it.

**Note:** electricity is transferred through the tube to the syringe. So it is important that the syringes must not be contaminated with the solution during filling them. If they are contaminated, especially around the place being kept on the syringe pump, discharge noise will be heard on the pump. In this time should be cleaned off the syringe immediately. Putting a piece of plastic between the syringe and pump can help this.

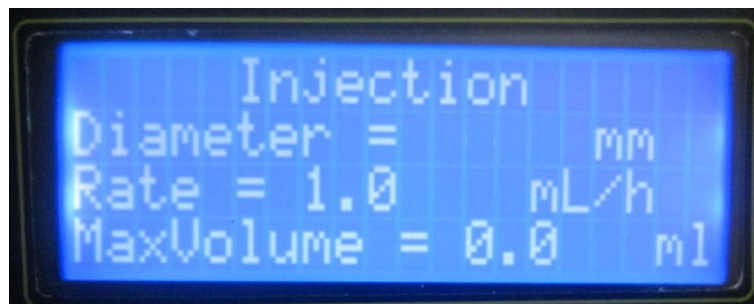
**Note:** Most existing tube is not enough strength to avoid passing high voltage electricity, so should be avoided the tube approach to devices such as syringe pumps.

Pressing L1 key display will be as follows.




In this page, 3 injection parameters are adjustable.

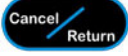
**Second line (L2):** inner syringe diameter (per mm). If the inside diameter of the syringe is known, enter the value. Otherwise, its internal diameter should be measured by caliper or other measuring devices. Since this parameter has a large effect in calculation of injection speed, it is necessary to measure its value accurately and enter to the system. To set the value, press L2 to its registered number is blink. At this stage, use the panel numeric keys (●0●1●2●3●4●5●6●7●8●9) to enter the new value.



**Description 1:** Press the backspace (⌫) key to clean up the last entered number.

**Register or cancel the new value:** After entering the new value, the same row key should be pressed to record it in the memory of device. For example, L2 key should be pressed to record syringe diameter. For withdrawal from entering the new value you simply press the

key . In this case, the previous value will be shown again.

**Note:** Press the key  at any stage causes cancel and return to the higher stage.

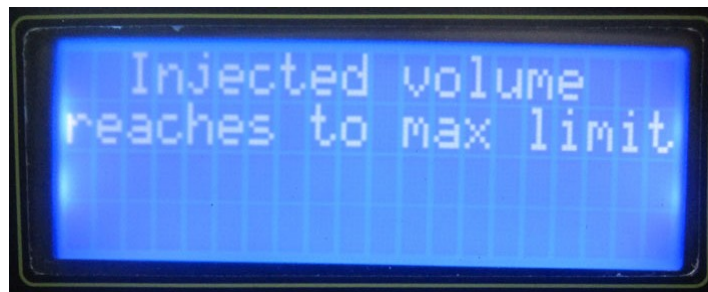
**Third line (L3):** injection (infusion) rate (ml per hour) indicates the amount of injected volume in an hour.

**Minimum and maximum injection rate:** According to the selected syringe, the maximum and minimum injection rate may be low or high. To increase the accuracy of injection, it is proposed to the use of proper syringe size. (See page 14)


**Description:** If the amount of entered injection rate is more than the amount defined for the system, the device will display a message below (The minimum and maximum permitted rates vary depending on the diameter of the syringe). If this message is shown while entering the rate, try using a different syringe for your application.





**Fourth line (L4):** The maximum injection volume (per ml). If you want to stop the system after injection of certain volume of the solution, you can use this section. In this case after injection of the specified volume, the system stops and the following message will be displayed.

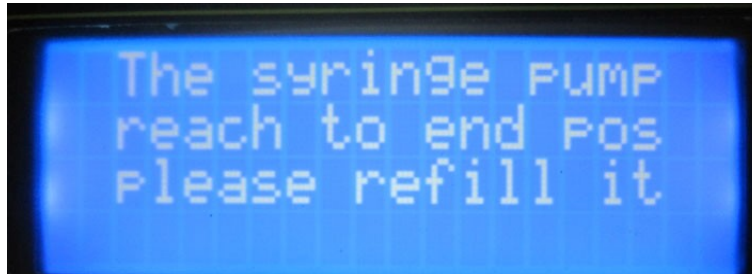


**Continuous infusion:** to continuous, the injection value should be set at zero.

**Set zero injected value:** to do this, you simply press the  key twice.

**Finishing total Solution:** If the pedal (Retaining Bracket) reaches the last point, the system will stop to prevent damage to the engine and screw, then the following message will be shown. It is necessary to bring down the pedal position by   keys and exchanging the syringe.

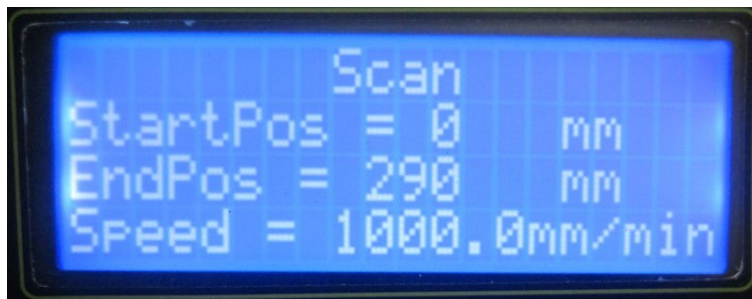
**Note:** Because the dimensions of syringes are different and therefore the last point determination by automatic injection device is very difficult, it is recommended the maximum volume (L4) be set in the amount of solution. For example, if the syringe contains 2 ml of solution, the maximum volume must be set in 1.9 ml to turn the device off automatically after injection of total solution.



### Nozzles scan system:

One or two nozzles can be placed in this syringe pump. Using two syringes increases produced nanofiber. However, due to interaction of the polymer jets formed in each nozzle, using more than one syringe can alter the nanofiber size and morphology. Therefore, to optimize the process, one syringe is recommended. If you use more than one syringe, the distance between two nozzles is at least about 5 cm. Although this distance depending on the polymer, voltage and ... could be less or more. (If you need more than two syringes, contact with Fnm co.)

Press L2 Key to display the following:



Here are 3 injection parameters that are adjustable:

**Second line (L2):** The point of scan starting (per mm). Adjust the beginning point of the scan.

**Description:** This point cannot be more than the end point.

**Third line (L3):** The point of scan ending (per mm). Adjust the end point of the scan.

**Description:** This point cannot be less than starting point.

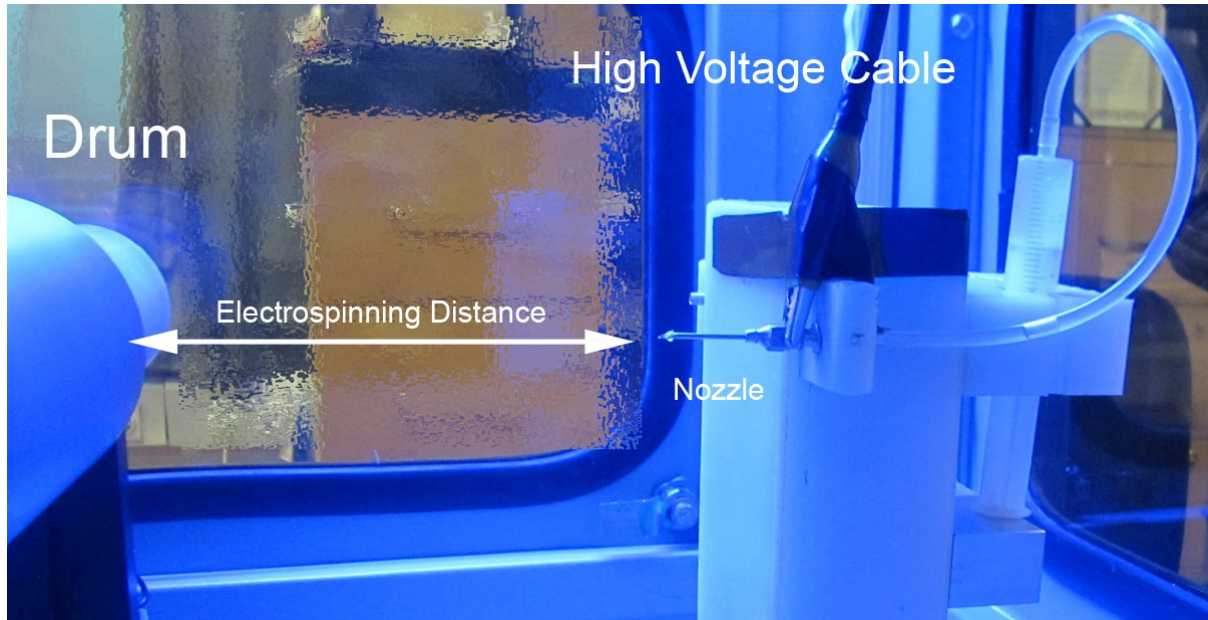
**Fourth line (L4):** scan rate (mm / min)

**Example 1:** StartPos = 100; EndPos = 250; Speed = 500

Setting the values according to the above list causes scanning from point 100mm to 250mm with 500 mm/min speed.

**Example 2:** StartPos = 150; EndPos = 150; Speed = 0

Setting the values according to the above list causes to adjust nozzles in point 150 mm and stay constant.

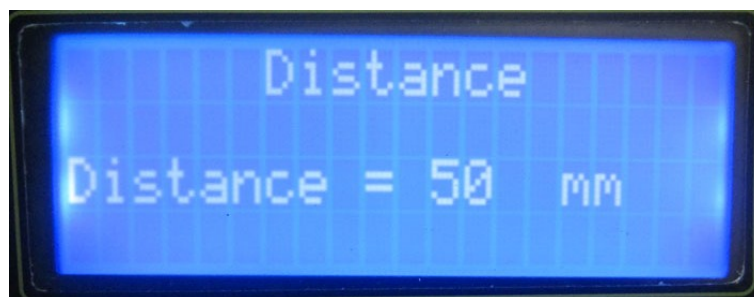


#### **Electrospinning distance adjustment system:**

Distance between the nozzle head and the collector is called "electrospinning distance". It is usually from 10 to 20 cm that can be less or more due to the conditions. In most systems, the collector is grounded. However, connecting a negative voltage to the collector can have interesting results.


**Note:** According to different nozzle size, the electrospinning distance could be lower or higher than the calculated value. It must be corrected by the user.

By pressing L3 key, the screen will be shown as follows:



This page has only one adjustable parameter.


**Third line (L3):** It is to set the distance. Previous data change to blink mode and new data is requested. To record new data the numerical keys (0 1 2 3 4 5 6 7 8 9) must be used and L3 key should be pressed again to set the new data.

**Note:** After entering the new data, the previous data remain until L3 key is not pressed. In this step,  key can be used.

### Drum rotation speed regulating system:

Depending on the type of electrospinning system, minimum or maximum drum rotation speed can be variable. In high speed systems (up to 3000 rpm), the minimum rotation speed is about 350 rpm.



**Fourth line (L4):** Pressing L4 key causes "OFF" changes to 0. In this case, by pressing the  button, the drum will begin to rotate and the rotation speed is displayed in the fourth line. In the picture below, the drum speed is 2788 rpm.





In this image, 127 microliter of solution was injected (in motion), the nozzle is in 198 mm point (moving) and the electrospinning distance is 50 mm (fixed).

**Adjusting the drum rotation speed:** To increase and decrease the rotation speed of drum, a 10-turn potentiometer is placed in the left side of the panel.



**Note:** If volume is set at low levels, due to the low voltage applied to the drum motor, when the system starts, the drum will not begin to move. It is better to set the potentiometer in 3, and if it is necessary, adjust the rotation speed of drum after starting. If you do not want the rotation of drum, you can use L4 key and put it in "OFF" mode.


### Setting the temperature inside the chamber:

The maximum temperature inside the chamber has been set at 50 °C. Red LED  indicates that the heating system of device is ON and blue LED  indicates that the ventilation system is ON.

The right key is used to turn this system On/Off.



**Need to adjust the temperature:** Temperature can effect directly on surface tension of polymer solutions, so that temperature is one of the most important parameters in the electrospinning process, especially in research works.

**Temperature adjustment:** To set the desired temperature inside the chamber  button should be pressed. In this case, to increase or decrease the temperature, "Up and Down" keys



can be used.

**Note:** The maximum adjustable temperature is 50°C. However it is possible to set higher values, it is recommended that not use higher temperature for a long time to avoid the damage to the electronic parts and Power supply. (It is recommended to set the temperature below 45 °C).

**Description:** In this system you cannot adjust the temperature inside the chamber less than the ambient temperature.

**Ventilators:** As you know, the polymer solvent must be evaporated to form nanofibers, so that any factor leads to decrease the evaporation process that can lead to impair the formation of nanofibres. According to the closed chamber, after a little time, the solvent vapor saturates the environment of the chamber and the evaporation process will be slow. To avoid it you must exhaust the solvent from the chamber without affecting on the temperature; therefore, a small ventilation fan is placed behind the device. The fan is controlled by a thermostat timer and is automatically turned on and off.

**Description:** If it is necessary to work at the room temperature, instead of turning off the heating system which makes the fan is off, it is better the desired temperature is set in lower than the room temperature.

#### **Lightening inside the chamber:**

Using the key below to turn the chamber light on.



**High Voltage Power Supply (HVPS):**

The power Supply embedded in the device has a positive 35 kV output. Two different types of HVPS are available in this system.

**OV Series** have only output voltage indicator (Accuracy=0.1 kV).

**OC series** have an output high voltage indicator (Accuracy=0.1 kV) and an output current display (Accuracy=1 micro-amp).



**Output voltage regulation:** There is a voltage regulator (10-turn potentiometer) to increase or decrease the voltage from 0 to rated voltage.

**Turn the HVPS on:**

Use On/Off key that is at right side of HVPS.

**Note:** For more safety; before turning the HV on, set the potentiometer at a low voltage and then adjust it in the desired value. It will cause any unwanted connection in the system to be identified and fixed in lower voltages.

**Kilo-voltmeter:** accuracy 0.1 kV (100 V).

**Description:** For more safety of users, four switches are located on the doors that causes to stop HV when one of the doors is open.

**Note:** If HVPS is on, but Kilo Voltmeter shows zero voltage, check the doors closed.

**Micro-amperemeter (in OC series):** it is to display the current in high voltage output that provides interesting information about the electrospinning process.

**Note:** Due to very low current consumption in the electrospinning process, any increasing in the current shows that there is discharge in the system. In this case, the device should be turned off and discharge locations, especially connecting sites on the syringe pump, should be investigated.

## GENERAL SAFETY SUMMARY

Please read the following safety precautions to ensure proper use of your electrospinning unit. To avoid potential hazard and product damage, use the device only as instructed in this manual.

### To Prevent Hazard or Injury:

#### Use a Proper Line Cord

Use only the specified line cord for this device and be sure that the line cord is certified for country of use.

#### Ground the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, the grounding conductor must be connected to earth. **Before making any connection to the input or output terminals of the product, ensure that the product is properly grounded.**

#### Make Proper Connections

Make sure all connections are made properly and securely.

#### Observe all Terminal Ratings

Review the operating manual to learn the ratings on all connections.

#### Use Proper Fuse

Use only specified fuse with the product.

#### Avoid Exposed Circuitry

Do not touch any electronic circuitry inside of the product.

#### Do Not Operate with Suspected Failures

If damage is suspected on or to the product, do not operate the product. Contact qualified service personnel to perform inspection.

#### Place the Product in a Proper Environment

Place product in proper operating environments.

#### Observe all Warning Labels on Product

Read all labels on product to ensure proper usage.

#### Lubrication

The two guide rods, the lead screw and drum should be sparingly lubricated periodically.

#### Cleaning

Any kind of Solvent should never be used to clean the display and keypad. A mild detergent solution may be used to clean.

**Proper syringe selection:****High Precision (High Rate) model:**

Min Rate (Microliter/hour) =  $0.5 * \text{Syringe diameter (mm)}^2$

Max Rate (Mililiter/hour) =  $0.80 * \text{Syringe diameter (mm)}^2$

**Example:**

Syringe 10mm in diameters: Min rate: 50 ul/h; Max rate: 80 ml/h

Syringe 1mm in diameters: Min rate: 0.5 ul/h; Max rate: 0.8 ml/h

**High Precision (Low Rate) model: (optional)**

Min Rate (Microliter/hour) =  $0.125 * \text{Syringe diameter (mm)}^2$

Max Rate (Mililiter/hour) =  $0.20 * \text{Syringe diameter (mm)}^2$

**Example:** syringe 10mm in diameters: Min rate: 12.5 ul/h; Max rate: 20 ml/h

**Example:** syringe 1mm in diameters: Min rate: 0.125 ul/h; Max rate: 0.2 ml/h

**Medium Precision model: (Old electroris models)**

Min Rate (Microliter/hour) =  $8 * \text{Syringe diameter (mm)}^2$

Max Rate (Mililiter/hour) =  $0.80 * \text{Syringe diameter (mm)}^2$

**Example:** syringe 10mm in diameters: Min rate: 800 ul/h; Max rate: 80 ml/h

**Example:** syringe 1mm in diameters: Min rate: 8 ul/h; Max rate: 0.8 ml/h

## Guarantee

Fnm co. guarantees this instrument for one year from date of purchase. At its option, Fnm co will repair or replace the unit if it is found to be defective as to workmanship or material. This guarantee does not extend to damage resulting from misuse, neglect or abuse, normal wear and tear, or accident. This warranty extends only to the original customer purchaser.

Warranty does not cover following cases:

- Any contents in the warranty card have been altered in any way of made illegible.
- User should consider that the high voltage wire must not be connected to the body of device like drum, syringe pump and else and this fault is not under warrantee.
- Repairs have been executed by anyone except our team.
- Lake of earthing the systems (the all parts of the system should be connected to a good earth.
- Voltage fluctuations, misuses, abuses, negligence and accidents.

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