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Eppendorf Research[®] plus

Factory Adjustment

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Eppendorf Research® plus
English (EN)

1 Factory adjustment

The piston stroke of Research plus pipettes with adjustable volume settings can either be changed by user adjustment or by factory adjustment.

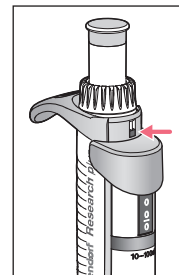
i Users cannot change the factory adjustment of Research plus fixed volume pipettes. Only user adjustment is available.

Changing the factory adjustment is more complex than changing the user adjustment and is primarily intended for those users who regularly calibrate their pipettes themselves and who want to carry out the corresponding adjustment, comparable to the previous Research pipette.

This document provides information about what needs to be considered when changing the factory adjustment. User adjustment is particularly suitable if the change should only apply for a temporary period of time as you can easily reset the adjustment to its original state. The process of how to change the user adjustment of a Research plus is described in the document *User Adjustment* on the Research plus CD.

The color of the safety plug behind the ejector indicates who carried out the factory adjustment and the subsequent calibration.

- **Gray safety plug:**
Factory adjustment and calibration performed by Eppendorf AG
- **Light gray safety plug:**
Change of factory adjustment and calibration performed by an Eppendorf AG authorized service technician
- **Red safety plug:**
Change of factory adjustment and calibration performed by the user



1.1 Adjusting pipettes



NOTICE! Incorrect dispensing volume with special liquids and from temperature differences.

Solutions which differ greatly from water in terms of their physical data, or temperature differences between the pipette, pipette tip and liquid, can result in incorrect dispensing volumes.

- ▶ Avoid temperature differences between pipette, pipette tip and liquid.
- ▶ Make sure that the temperature is constant, between 20 and 25°C and at $\pm 0.5^\circ\text{C}$.
- ▶ Check the dispensing volume and make sure that you can affirm all the questions listed in the general information.



The random and systematic errors recorded upon delivery can be drawn from the *Eppendorf Certificate*. This certificate is included in the delivery. Changes to the factory adjustment will render the certificate void.

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1.1.1 General notes on user and factory adjustment settings

The Research plus was adjusted, tested and fitted with a gray adjustment seal with the abbreviation "ADJ" before delivery. The adjustment display on the side reads "0".

Changing the adjustment of the Research plus is sometimes recommended for solutions which are very different from water with regard to their density, viscosity, surface tension and/or vapor pressure etc. If the density of an aqueous solution changes by approximately $\pm 10\%$, for example because of the salt concentration, the volume changes by approximately $\pm 0.2\%$. This statement does not apply if other relevant properties of the liquid also change.

If the pipette is used at extremely high altitudes, it must be calibrated to the ambient air pressure. At 1 000 m above sea level, the volume error of a 100 μL pipette is about -0.3% .

When using special tips, that is, tips that significantly differ from standard tips in their geometry, changing the adjustment can improve the dispensing accuracy (systematic error).

Please follow the recommendations regarding the adjustment of epT.I.P.S. long contained in the *User Adjustment* document on the Research plus CD.

Adjustment changes can be reset by simple steps.

In addition to changing the user adjustment, a Research plus with variable volume setting can be permanently changed by altering the factory adjustment .

Changes made to the user or factory adjustment do not affect dispensing precision (random error). Precision can be improved by exchanging worn parts. Precision is also considerably affected by handling.

Before changing the adjustment or factory calibration, you must check the existing dispensing volume.

The actual volume can be checked by weighing:

$$\text{Actual volume} = \frac{\text{Mean value of the weighings}}{\text{Density liquids at weighing temperature}}$$

The density of distilled water is approx. 0.9982 mg/ μL at 20°C and 0.9965 mg/ μL at 27°C.

If the set volume corresponds to the actual volume, no correction is necessary.

If there is a difference between the actual volume and the set volume of distilled water, please check the following:

- Is there any liquid dripping from the tip?
- Is the pipette tip fitted leak-proof?
- Is the tip cone undamaged?
- Are the piston and the cylinder leak-proof?
Adequate leak tightness is ensured when no drop is formed at the pipette tip after aspiration of the nominal volume with distilled water and a waiting time of approx. 15 s. Hold the pipette vertically, making sure not to touch the pipette tip. Prewet the tip several times in the case of nominal volumes $\leq 20 \mu\text{L}$.
- Does the temperature of the pipetted liquid correspond to:
 - the temperature of the device?
 - the ambient air temperature?
- Is the weighing location free from drafts?
- Does the work method and pipetting speed permit complete aspiration and dispensing of the liquid?
- Has the correct numerical value for "Density liquids at weighing temperature" been used for the calculation of the actual volume?
- Is the set volume correct?
- For very small volumes ($<10 \mu\text{L}$): is the fine balance sufficiently sensitive (balance resolution: 0.001 mg)?
- Were original epT.I.P.S pipette tips used for testing?
For the pipette tip used for testing please refer to the Technical Data (see p. 13).

No adjustment changes are allowed unless you can answer all the questions with "yes". In all other cases, the problems associated with the questions answered with "no" must be eliminated. If the problem is remedied by exchanging a complete lower part or other parts that have an effect on the volume, proper assembly must be verified by carrying out a gravimetric test. Information on the systematic and random errors to be met can be found in the "Technical Data" chapter.

Factory adjustment

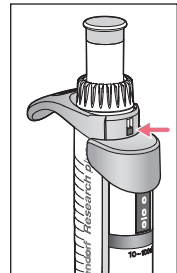
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1.1.2 Changing the factory adjustment

Auxiliary equipment

- Supplied safety plug tool
- Supplied pin to loosen the safety plug

It is possible to change the factory adjustment with the corresponding accessories for a Research plus with variable volume setting. If the factory adjustment of the Research plus has been changed by a user, this can be recognized by a red safety plug behind the ejector. If the Research plus has been adjusted and calibrated by Eppendorf AG, this is indicated by a gray safety plug.



The random and systematic errors recorded upon delivery can be drawn from the *Eppendorf Certificate*. This certificate is included in the delivery. Changes to the factory adjustment will render the certificate void.

If the dispensing accuracy is only to be changed temporarily, the correct method is to change the user adjustment. Before changing the user or factory adjustment, observe the general notes (see *General notes on user and factory adjustment settings on p. 6*) and the associated gravimetric tests.

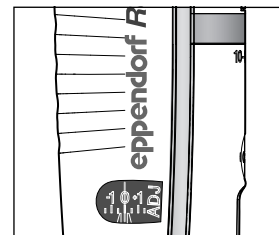


In the case of Research plus fixed-volume pipettes, modifications are only possible by changing the user adjustment.

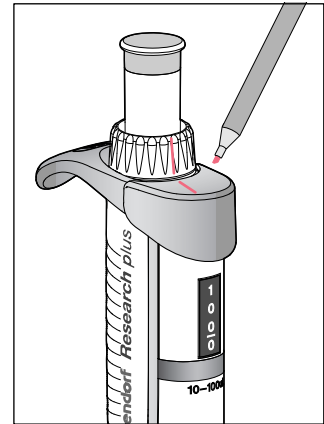
1.1.3 Research plus variable - changing the factory adjustment

If a gravimetric test indicates that an error needs to be corrected and you are required to carry out a change to the factory adjustment, proceed as follows:

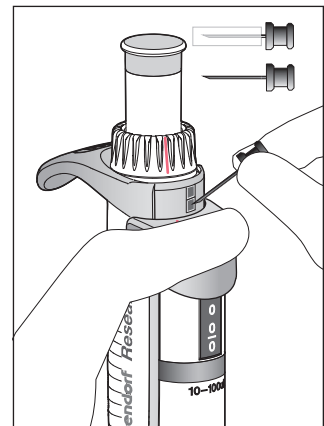
1. Check whether the adjustment display on the side is set to "0".
If the adjustment display is not set to "0", you will first need to set it to "0" with the adjustment tool. In this case, instead of continuing with the factory adjustment changes, carry out a gravimetric test of the Research plus with the adjustment display set to "0".



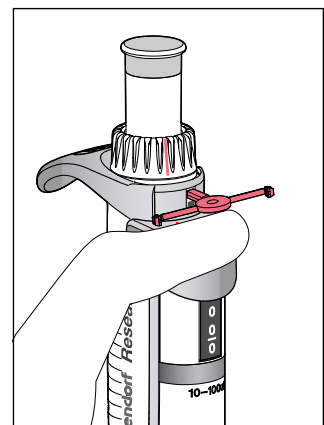
2. Provide the volume setting ring and the ejector with a common mark with a pen. This mark serves as an orientation for factory adjustment changes. When changing the factory adjustment, you can turn the volume setting ring, without the volume display changing. The mark on the volume setting ring and the ejector informs you how far you have moved from the factory setting.



3. Keep the ejector pressed and remove the safety plug with the pin.



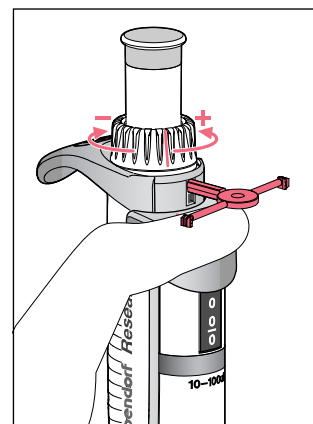
4. Continue to keep the ejector pressed. Insert the safety plug tool such that the counter locking mechanism is pushed down.



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5. Turn the volume setting ring slightly to change the volume.
Proceed as shown in the figure.



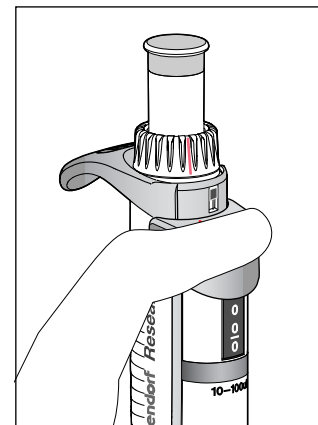
This results in the following approximate volume changes:

Single-channel				
Nominal volume Color code	+½ revolution	+¼ revolution	-¼ revolution	-½ revolution
2.5 µL dark gray	0.106 µL	0.053 µL	-0.053 µL	-0.106 µL
10 µL medium gray	0.53 µL	0.27 µL	-0.27 µL	-0.53 µL
20 µL light gray	1.06 µL	0.53 µL	-0.53 µL	-1.06 µL
20 µL yellow	1.07 µL	0.54 µL	-0.54 µL	-1.07 µL
100 µL yellow	5.4 µL	2.7 µL	-2.7 µL	-5.4 µL
200 µL yellow	10.8 µL	5.4 µL	-5.4 µL	-10.8 µL
300 µL orange	10.7 µL	5.4 µL	-5.4 µL	-10.7 µL
1 000 µL blue	54 µL	27 µL	-27 µL	-54 µL
5 mL purple	271 µL	135 µL	-135 µL	-271 µL
10 mL turquoise	542 µL	271 µL	-271 µL	-542 µL

multi-channel				
Nominal volume Color code	+½ revolution	+¼ revolution	-¼ revolution	-½ revolution
10 µL medium gray	0.53 µL	0.27 µL	-0.27 µL	-0.53 µL
100 µL yellow	5.4 µL	2.7 µL	-2.7 µL	-5.4 µL
300 µL orange	10.7 µL	5.4 µL	-5.4 µL	-10.7 µL

The values mentioned are theoretical values and are for orientation purposes only. The volume changes mentioned apply to each volume setting. For the volume change, you should first set the optimal value for 10% of the nominal volume and then carry out a gravimetric test. Afterwards carry out gravimetric tests to check 50% and 100% of the nominal volume with this setting. Change the selected setting again if necessary to achieve the best possible correction for all volumes. Use the error limits in accordance with ISO 8655-2 (see p. 13) and the technical data provided by Eppendorf AG (see p. 15) to decide whether the data obtained meets your requirements.

- Slide the locking mechanism up and carry out a gravimetric test of the changes which have been made.

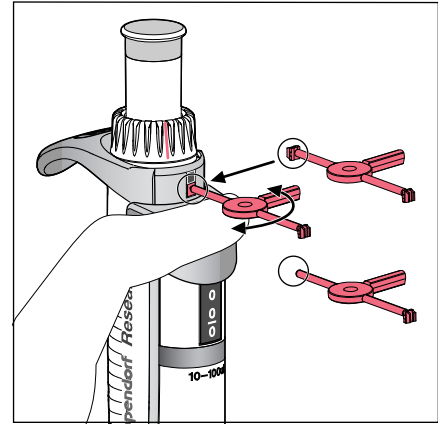


- If the measured gravimetric values meet your requirements: Slide the locking mechanism up.

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8. Insert the red safety plug on the tool into the opening of the Research plus and break it off from the tool.
The red safety plug on the pipette indicates that the Research plus has been adjusted by the user. If the adjustment display had also been set to "0" before, you must close the opening with a new, red adjustment seal at the position for the adjustment seal.



9. Document the changes made and the measurements conducted. Remove the mark on the volume adjustment ring and the ejector. The red safety plug on the pipette indicates that the Research plus has been adjusted and calibrated by the user.

1.1.4 Error limits according to ISO 8655-2

Error limits in accordance with ISO 8655-2 - Research plus adjustable single-channel						
Model	Test tip epT.I.P.S. Color code Volume range Length	Testing volume	Error limits ISO 8655			
			Error			
			systematic		random	
			± %	± µL	± %	± µL
0.1 - 2.5 µL Increment: 0.002 µL	dark gray 0.1 - 10 µL 34 mm	0.1 µL	± 100.0	± 0.1	± 75.0	± 0.075
		0.25 µL	± 50.0	± 0.125	± 30.0	± 0.075
		1.25 µL	± 10.0	± 0.125	± 6.0	± 0.075
		2.5 µL	± 5.0	± 0.125	± 3.0	± 0.075
0.5 - 10 µL Increment: 0.01 µL	medium gray 0.1 - 20 µL 40 mm	0.5 µL	± 24.0	± 0.12	± 16.0	± 0.08
		1 µL	± 12.0	± 0.12	± 8.0	± 0.08
		5 µL	± 2.4	± 0.12	± 1.6	± 0.08
		10 µL	± 1.2	± 0.12	± 0.8	± 0.08
2 - 20 µL Increment: 0.02 µL	light gray 0.5 - 20 µL L 46 mm	2 µL	± 10.0	± 0.2	± 5.0	± 0.1
		10 µL	± 2.0	± 0.2	± 1.0	± 0.1
		20 µL	± 1.0	± 0.2	± 0.5	± 0.1
2 - 20 µL Increment: 0.02 µL	yellow 2 - 200 µL 53 mm	2 µL	± 10.0	± 0.2	± 5.0	± 0.1
		10 µL	± 2.0	± 0.2	± 1.0	± 0.1
		20 µL	± 1.0	± 0.2	± 0.5	± 0.1
10 - 100 µL Increment: 0.01 µL	yellow 2 - 200 µL 53 mm	10 µL	± 8.0	± 0.8	± 3.0	± 0.3
		50 µL	± 2.0	± 0.8	± 0.6	± 0.3
		100 µL	± 0.8	± 0.8	± 0.3	± 0.3
20 - 200 µL Increment: 0.02 µL	yellow 2 - 200 µL 53 mm	20 µL	± 8.0	± 1.6	± 3.0	± 0.6
		100 µL	± 2.0	± 1.6	± 0.6	± 0.6
		200 µL	± 0.8	± 1.6	± 0.3	± 0.6
30 - 300 µL Increment: 0.02 µL	orange 20 - 300 µL 55 mm	30 µL	± 13.0	± 3.9	± 5.0	± 1.5
		150 µL	± 3.0	± 3.9	± 1.0	± 1.5
		300 µL	± 1.3	± 3.9	± 0.5	± 1.5
100 - 1 000 µL Increment: 1 µL	blue 50 - 1 000 µL 71 mm	100 µL	± 8.0	± 8.0	± 3.0	± 3.0
		500 µL	± 2.0	± 8.0	± 0.6	± 3.0
		1 000 µL	± 0.8	± 8.0	± 0.3	± 3.0

Error limits in accordance with ISO 8655-2 - Research plus adjustable single-channel

Model	Test tip epT.I.P.S. Color code Volume range Length	Testing volume	Error limits ISO 8655			
			Error			
			systematic		random	
			± %	± µL	± %	± µL
0.5 – 5 mL Increment: 5 µL	purple 0.1 – 5 mL 120 mm	0.5 mL	± 8.0	± 40.0	± 3.0	± 15.0
		2.5 mL	± 1.6	± 40.0	± 0.6	± 15.0
		5.0 mL	± 0.8	± 40.0	± 0.3	± 15.0
1 – 10 mL Increment: 10 µL	turquoise 1 – 10 mL 165 mm	1.0 mL	± 6.0	± 60.0	± 3.0	± 30.0
		5.0 mL	± 1.2	± 60.0	± 0.6	± 30.0
		10.0 mL	± 0.6	± 60.0	± 0.3	± 30.0

Error limits in accordance with ISO 8655-2 - Research plus adjustable multi-channel

Model	Test tip epT.I.P.S. Color code Volume range Length	Testing volume	Error limits ISO 8655			
			Error			
			systematic		random	
			± %	± µL	± %	± µL
0.5 - 10 µL Increment: 0.01 µL	medium gray 0.1 - 20 µL 40 mm	0.5 µL	± 48.0	± 0.24	± 32.0	± 0.16
		1 µL	± 24.0	± 0.24	± 16.0	± 0.16
		5 µL	± 4.8	± 0.24	± 3.2	± 0.16
		10 µL	± 2.4	± 0.24	± 1.6	± 0.16
10 - 100 µL Increment: 0.01 µL	yellow 2 - 200 µL 53 mm	10 µL	± 16.0	± 1.6	± 6.0	± 0.6
		50 µL	± 3.2	± 1.6	± 1.2	± 0.6
		100 µL	± 1.6	± 1.6	± 0.6	± 0.6
30 - 300 µL Increment: 0.02 µL	orange 20 - 300 µL 55 mm	30 µL	± 26.0	± 7.8	± 10.0	± 3.0
		150 µL	± 5.2	± 7.8	± 2.0	± 3.0
		300 µL	± 2.6	± 7.8	± 1.0	± 3.0

1.1.5 Eppendorf AG technical data

Research plus single-channel variable						
Model	Test tip epT.I.P.S. Color code Volume range Length	Testing volume	Error limits Eppendorf AG			
			Error			
			systematic		random	
			± %	± µL	± %	± µL
0.1 - 2.5 µL Increment: 0.002 µL	dark gray 0.1 - 10 µL 34 mm	0.1 µL	± 48	± 0.048	± 12	± 0.012
		0.25 µL	± 12	± 0.03	± 6	± 0.015
		1.25 µL	± 2.5	± 0.031	± 1.5	± 0.019
		2.5 µL	± 1.4	± 0.035	± 0.7	± 0.018
0.5 - 10 µL Increment: 0.01 µL	medium gray 0.1 - 20 µL 40 mm	0.5 µL	± 8	± 0.04	± 5	± 0.025
		1 µL	± 2.5	± 0.025	± 1.8	± 0.018
		5 µL	± 1.5	± 0.075	± 0.8	± 0.04
		10 µL	± 1.0	± 0.1	± 0.4	± 0.04
2 - 20 µL Increment: 0.02 µL	light gray 0.5 - 20 µL L 46 mm	2 µL	± 5	± 0.1	± 1.5	± 0.03
		10 µL	± 1.2	± 0.12	± 0.6	± 0.06
		20 µL	± 1.0	± 0.2	± 0.3	± 0.06
2 - 20 µL Increment: 0.02 µL	yellow 2 - 200 µL 53 mm	2 µL	± 5	± 0.1	± 1.5	± 0.03
		10 µL	± 1.2	± 0.12	± 0.6	± 0.06
		20 µL	± 1.0	± 0.2	± 0.3	± 0.06
10 - 100 µL Increment: 0.1 µL	yellow 2 - 200 µL 53 mm	10 µL	± 3	± 0.3	± 1	± 0.1
		50 µL	± 1	± 0.5	± 0.3	± 0.15
		100 µL	± 0.8	± 0.8	± 0.2	± 0.2
20 - 200 µL Increment: 0.2 µL	yellow 2 - 200 µL 53 mm	20 µL	± 2.5	± 0.5	± 0.7	± 0.14
		100 µL	± 1	± 1	± 0.3	± 0.3
		200 µL	± 0.6	± 1.2	± 0.2	± 0.4
30 - 300 µL Increment: 0.2 µL	orange 20 - 300 µL 55 mm	30 µL	± 2.5	± 0.75	± 0.7	± 0.21
		150 µL	± 1	± 1.5	± 0.3	± 0.45
		300 µL	± 0.6	± 1.8	± 0.2	± 0.6
100 - 1 000 µL Increment: 1 µL	blue 50 - 1 000 µL 71 mm	100 µL	± 3	± 3	± 0.6	± 0.6
		500 µL	± 1	± 5	± 0.2	± 1
		1 000 µL	± 0.6	± 6	± 0.2	± 2

Research plus single-channel variable

Model	Test tip epT.I.P.S. Color code Volume range Length	Testing volume	Error limits Eppendorf AG			
			Error			
			systematic		random	
			± %	± µL	± %	± µL
0.5 – 5 mL Increment: 0.005 mL	purple 0.1 – 5 mL 120 mm	0.5 mL	± 2.4	± 12	± 0.6	± 3
		2.5 mL	± 1.2	± 30	± 0.25	± 6
		5.0 mL	± 0.6	± 30	± 0.15	± 8
1 – 10 mL Increment: 0.01 mL	turquoise 1 – 10 mL 165 mm	1.0 mL	± 3	± 30	± 0.6	± 6
		5.0 mL	± 0.8	± 40	± 0.2	± 10
		10.0 mL	± 0.6	± 60	± 0.15	± 15

Research plus multi-channel variable

Model	Test tip epT.I.P.S. Color code Volume range Length	Testing volume	Error limits Eppendorf AG			
			Error			
			systematic		random	
			± %	± µL	± %	± µL
0.5 - 10 µL Increment: 0.01 µL	medium gray 0.1 - 20 µL 40 mm	0.5 µL	± 12	± 0.06	± 8.0	± 0.04
		1 µL	± 8.0	± 0.08	± 5.0	± 0.05
		5 µL	± 4.0	± 0.2	± 2.0	± 0.1
		10 µL	± 2.0	± 0.2	± 1.0	± 0.1
10 - 100 µL Increment: 0.1 µL	yellow 2 - 200 µL 53 mm	10 µL	± 3.0	± 0.3	± 2.0	± 0.2
		50 µL	± 1.0	± 0.5	± 0.8	± 0.4
		100 µL	± 0.8	± 0.8	± 0.3	± 0.3
30 - 300 µL Increment: 0.2 µL	orange 20 - 300 µL 55 mm	30 µL	± 3.0	± 0.9	± 1.0	± 0.3
		150 µL	± 1.0	± 1.5	± 0.5	± 0.75
		300 µL	± 0.6	± 1.8	± 0.3	± 0.9

2 Patents

U.S. Patent No.	7,434,484	Is used by Research plus pipettes with variable volume setting (single-channel and multi-channel) and fixed volume with following nominal volumes:	2.5 µL, 10 µL, 20 µL, 25 µL, 50 µL, 100 µL, 200 µL, 250 µL, 300 µL, 500 µL and 1000 µL
U.S. Patent No.	7,674,432	Is used by Research plus pipettes with variable volume setting (single-channel and multi-channel) and fixed volume with following nominal volumes:	2.5 µL, 10 µL, 20 µL, 25 µL, 50 µL, 100 µL, 200 µL, 250 µL, 300 µL, 500 µL, 1000 µL, 5 mL and 10 mL
U.S. Patent No.	7,673,532	Is used by Research plus pipettes with variable volume setting (multi-channel) with following nominal volumes:	10 µL, 100 µL, 300 µL
U.S. Patent No.	8,133,453	is used by Research plus pipettes with variable volume setting (single-channel and multi-channel) and fixed volume with following nominal volumes:	2.5 µL, 10 µL, 20 µL, 25 µL, 50 µL, 100 µL, 200 µL, 250 µL, 300 µL, 500 µL, 1000 µL, 5 mL and 10 mL
U.S. Patent No.	8,297,134	is used by Research plus pipettes with variable volume setting (single-channel and multi-channel) and fixed volume with following nominal volumes:	2.5 µL, 10 µL, 20 µL, 25 µL, 50 µL, 100 µL, 200 µL, 250 µL, 300 µL, 500 µL, 1000 µL, 5 mL and 10 mL

Evaluate your manual

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