



LAMY
RHEOLOGY
INSTRUMENTS

USING MANUAL

DSR 500 CP4000 PLUS

MANUAL N° DSR500-CP4000-UK12/2018



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1. INTRODUCTION

The DSR 500 CP4000 PLUS is a device able to measure the viscosity, which is the capacity of a product to resist to the flow.

The fluid is forced to a shear rate (rotational speed) and the shear stress (motor torque) is measured. The values of shear rate and shear stress then make it possible to calculate the viscosity using the Newton equation and the constants associated with the mobile used.

$$\text{Equation of Newton is: } \eta = \frac{\tau}{\dot{\gamma}}$$

With η for viscosity in Pa.s, τ for shear stress in Pa and $\dot{\gamma}$ for shear rate in s^{-1} .

Shear stress and shear rate are calculated by using constants of each measuring system as:

$$\tau = M \times K_{\tau} \text{ with } M \text{ for motor torque in mNm and } K_{\tau} \text{ in Pa/mNm.}$$

$$\dot{\gamma} = n \times K_D \text{ with } n \text{ for rotational speed in rpm and } K_D \text{ in } s^{-1}/\text{rpm.}$$

The viscometer calculates the viscosity by dividing the shear stress by the shear rate for each measuring point. The K_{τ} and K_D constants used depend on the measuring system selected for the measurement.

Viscosity depends on the temperature, then it must be essential that all viscosity values are associated to a reading of the sample temperature, in order to compare viscosity for different samples.

There are some products for which the viscosity, to a constant temperature, stay unchanged, even if we change the shear rate. Those samples are named **Newtonian fluids**, i.e. : Oils, Water, Glycerol, etc...However, many substances have a variation of viscosity in function of speed of shearing, and the Flow Behaviour of those samples could be determined with measuring instruments able to set many speeds of rotation.

The viscometer is constituted with a continuous current motor and an optical encoder, in order to warranty a great accuracy of rotational speed, on all torque range.

The viscometer has an easy touch screen display, on which you could read the **speed, shear rate** (according to spindle) **measuring spindle** reference, the measured torque and the dynamic **viscosity in mPa.s (=cPoises) or Pa.s**.

The Viscometer DSR 500 CP4000 PLUS can be used with different measuring system. You will find below a list of compatible measuring system with this viscometer:

- **MS CP:** Measuring systems cone or plate compatible with DIN 53019 / ISO 3219 / ASTM D4278-D7395 (316L Stainless Steel). These systems make it possible to set the shear rate in order to carry out viscosity measurements or to obtain curves to study flow behavior, yield stress or thixotropy. They are particularly suitable for measurements on very small quantities for control or development of homogeneous products with or without particles (size <100 μ m), guaranteeing easy cleaning.

1.1. COMPONENTS

Viscometer is delivered inside a foam protection to avoid any problem during transport. DSR 500 CP4000 PLUS is delivered mounted. You will find some cable, measuring system (according to order) and some tools for installation and using.

In detail, you will find different part in your box as shown below.



DSR 500 CP4000 PLUS



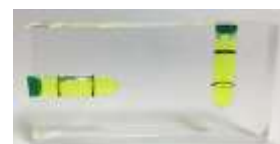
Cable and power supply for measuring head



Cable for CP4000



Tool for levelling of DSR 500 CP4000 PLUS



Level indicator



Cable for connexion of measuring head with CP4000 temperature control.



Cable for connexion of measuring head with CP4000 for lift control.



Bottom plate 40mm or 60 mm (according to order)

1.2. GENERAL VIEW OF YOUR DEVICE

Once your device will be mounted and installed, it looks like this;

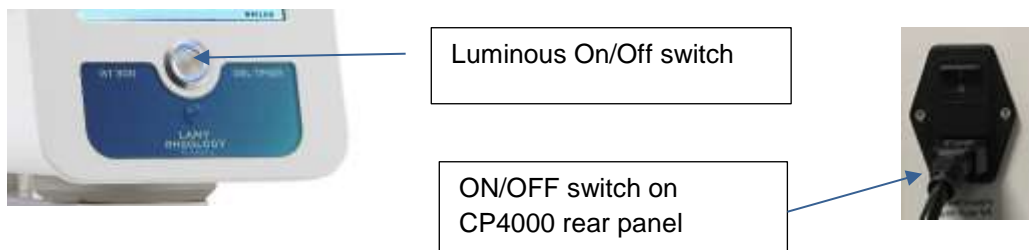


- TOUCH Screen

The new PLUS series is equipped with a 7" colour touch screen. It gives you greater working comfort and a clearer view of your data and analysis results.

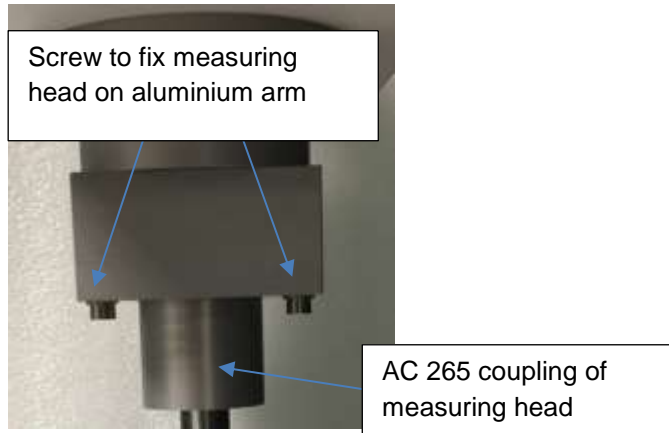
- On / Off Switch

Always with the aim of improving your experience, LAMY RHEOLOGY has decided to equip all of its PLUS range with a luminous and design switch. It has been placed in the centre of the device for greater intuitiveness.



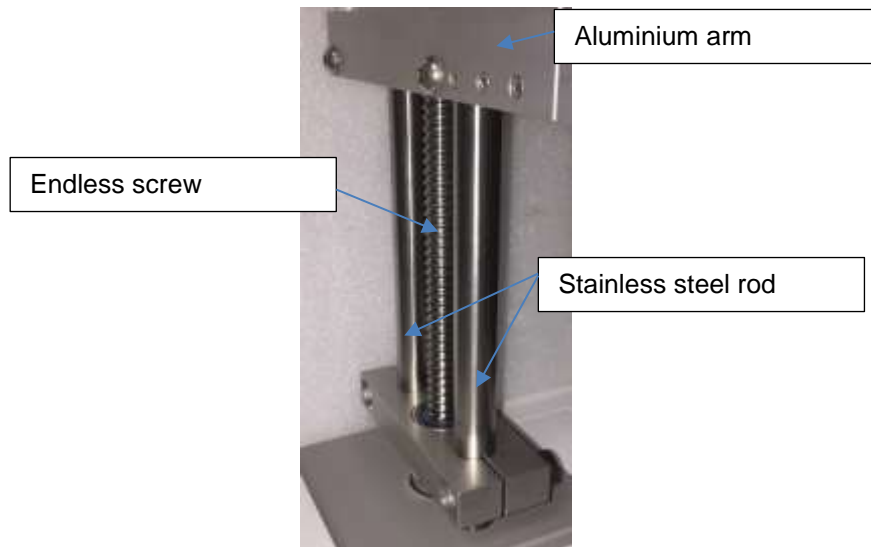
- Aluminium arm

The measuring head is fixed to the arm with tow screw.



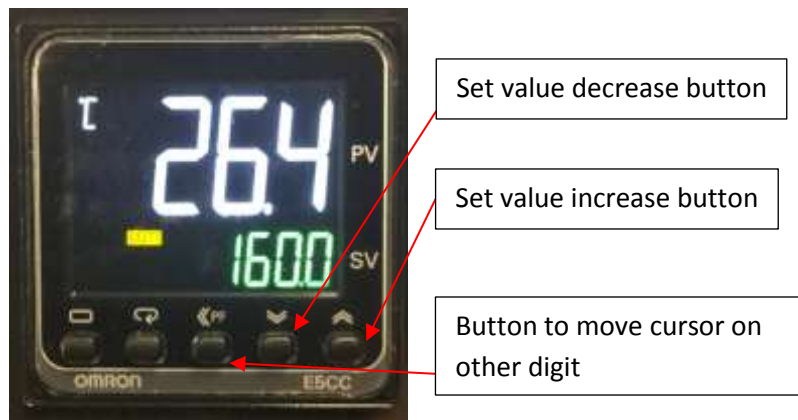
- Stainless steel rod

The support rod is made of stainless steel for a solid hold of the measuring head. It has a very long life. An endless screw in the middle acts as a lift to move the arm and the measuring head.



- Temperature unit CP4000

This device regulates the temperature of your sample. It is equipped with a display / regulator (programmer for certain model) OMRON. It exists in Peltier or electric version.

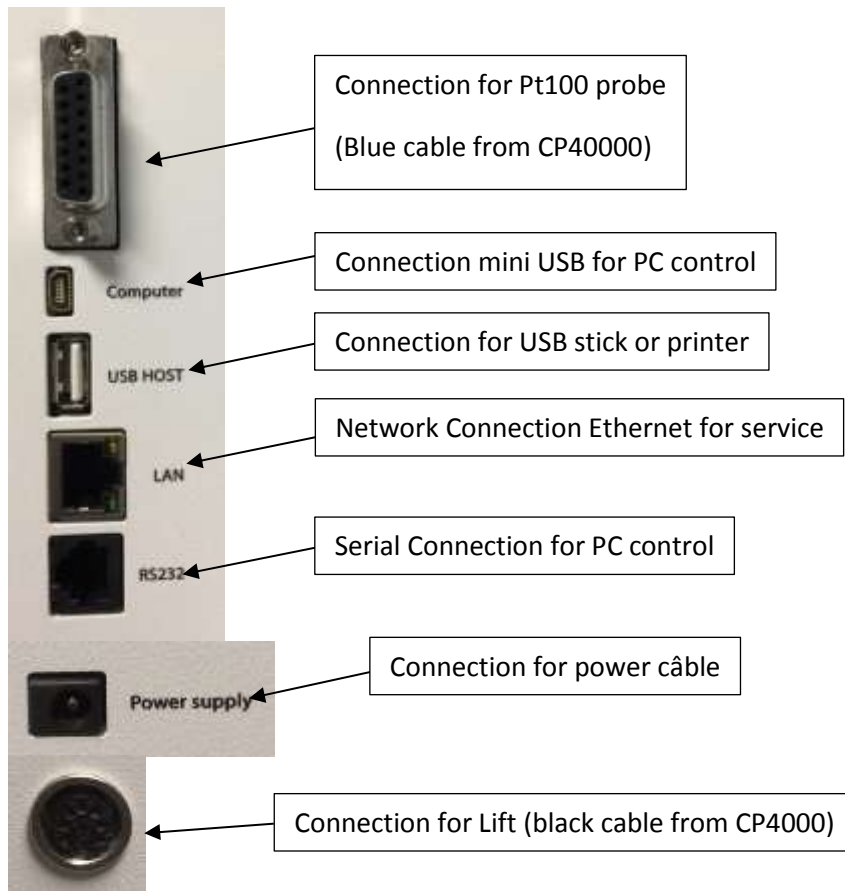


The lower plate is interchangeable to accommodate the diameter of the measuring geometry.

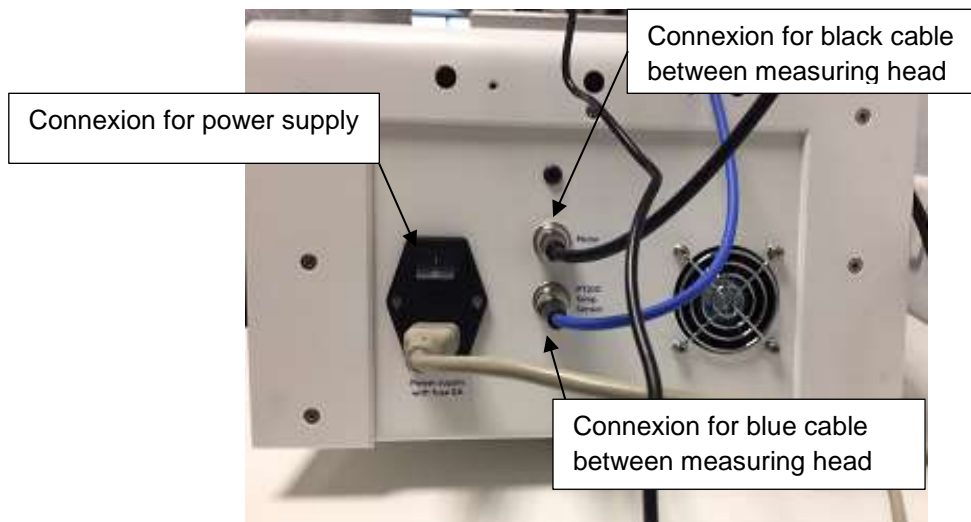


1.3. CONNEXIONS

According to your order, rear panel of device get this available connexions.



The rear panel of CP4000 Temperature unit get this connections:



1.4. SPECIFICATIONS

Type of instrument: Rotating springless rheometer with imposed speeds and 7" Touch screen

Rotation speeds: Unlimited number of speeds between 0.3 and 1500 rpm

Torque range: From 0.05 to 30 mNm

Temperature: Temperature range from – 20°C to + 300 °C (according to models)

Accuracy: +/- 1 % of the full scale

Repeatability: +/- 0,2 %

Display: Viscosity – Speed – Torque – Time –Temperature - Choice of viscosity units: cP/Poises or mPa.s / Pa.s – Shear rate – Shear Stress.

Language: French/English

Compatible measuring system: MS CP

Supply voltage: 90-240 VAC 50/60 Hz

Analog output: 4 – 20 mA

PC connections: Port RS232 and USB

Printer connection: USB Host Port – Compatible PCL/5

Option: Software (N311000 + License N311504)

Dimensions and weight: Head: L180 x W135 x H250 mm, CP 4000: D610 x W340 x H650 mm, Weight: 22 kg

This is the available models:

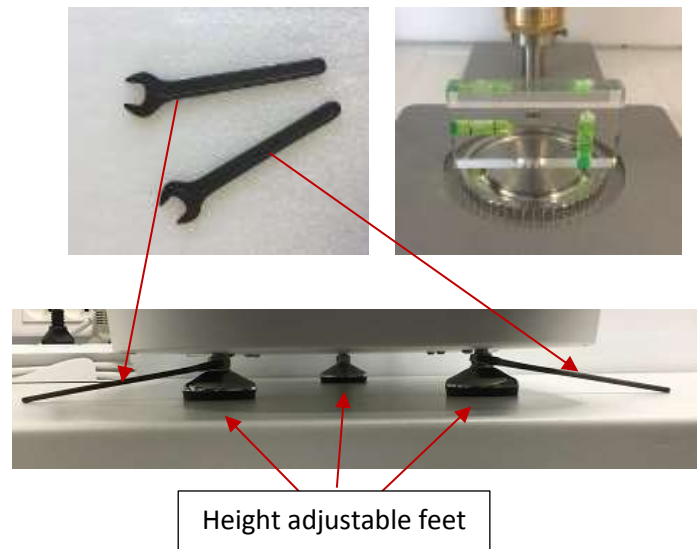
Part Number	Designation Instrument
N500400	DSR 500 CP4000 PLUS RHEOMETER AIR-AIR PELTIER (+10 à + 70 °C)
N500401	DSR 500 CP4000 PLUS RHEOMETER AIR-AIR PELTIER (+10 à + 70°C) with programmer*
N500410	DSR 500 CP4000 PLUS RHEOMETER AIR-AIR PELTIER (0°C à +150°C)
N500411	DSR 500 CP4000 PLUS RHEOMETER AIR-AIR PELTIER (0°C à +150°C) with programmer*
N500420	DSR 500 CP4000 PLUS RHEOMETER LIQUID PELTIER** (-20 à + 120 °C)
N500421	DSR 500 CP4000 PLUS RHEOMETER LIQUID PELTIER** (-20 à + 120 °C) with programmer*
N500430	DSR 500 CP4000 PLUS RHEOMETER H (Amb à +300°C)
N500431	DSR 500 CP4000 PLUS RHEOMETER H (Amb à +300°C) with programmer*

* Allow temperature setting by RheoTex software or measuring head

** Need a chiller. Not included

1.5. INSTALLATION

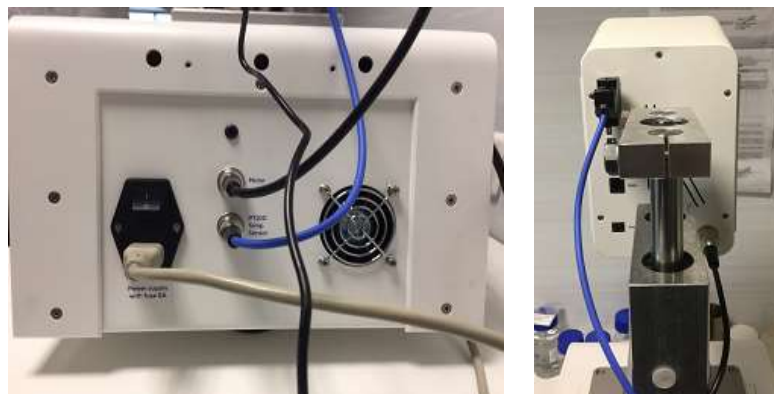
Install the DSR 500 CP4000 on a solid bench. Place the level on the plane and adjust the level using the 2 keys provided by playing on the three adjustable feet in height.



Connect the power cable. Connect the temperature reading cord (blue): SUB-D 15 connector on rear of the DSR 500 to the DIN plug on the back of the CP4000 stand.

Connect the black cable for lift control between measuring head and CP4000.

Connect the DSR 500 PLUS and CP4000 power cable.



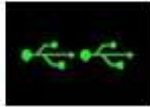






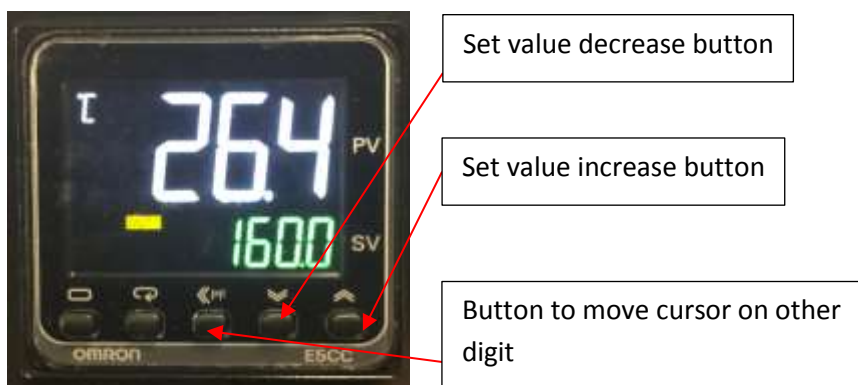
2. GETTING STARTED

Once power cable has been plugged on rear panel of device (see section 1.3), you can click on button to switch on your device (see section 1.2).

2.1. STATE ICONS


Once your device is switched on, you will see some icons on Touch Screen.

	No Device is connected to the instrument.
	Only one Device is connected to the instrument.
	Two Devices are connected to the instrument.
	Give you the temperature of probe in the sample.
	Enable to go to parameters of instrument.
	Enable to come back to Main Menu.
	Enable to come back to previous menu.

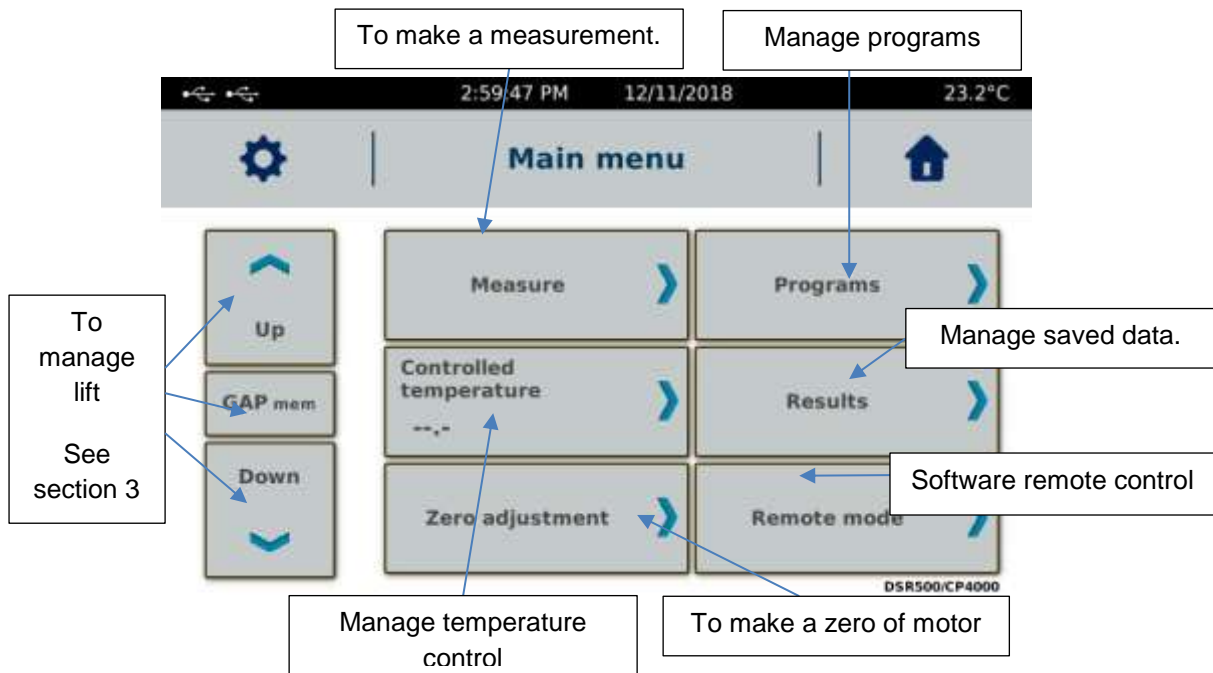


2.2. PRIMARY CONCEPTS

2.2.1. MAIN MENU

Main menu enable to you to browse between different tabs of your DSR 500. Acces is always available by clicking on home button .

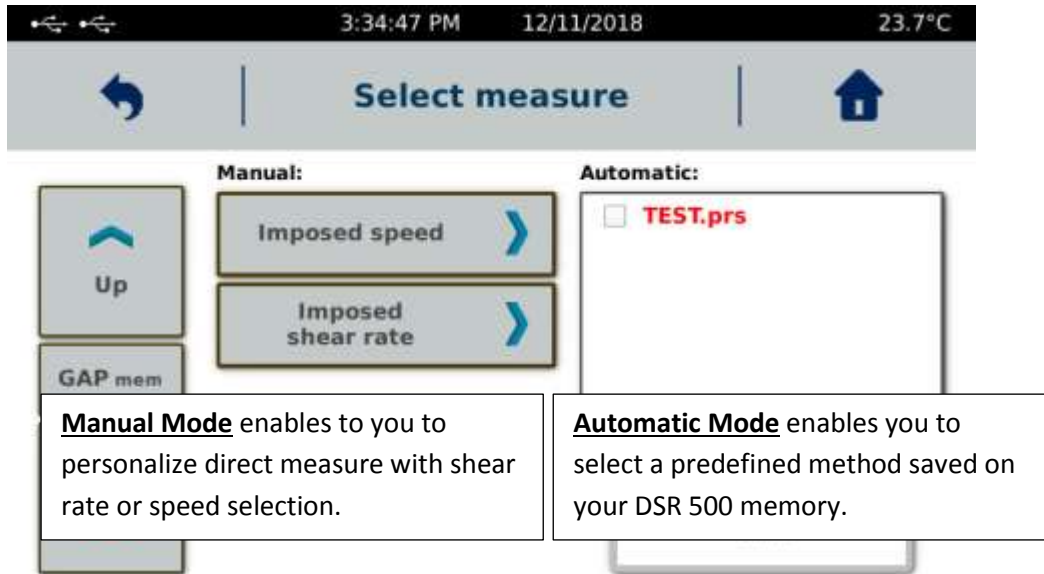
Depending on the factory settings of your DSR 500, the temperature set button is visible when your device is paired with controllable temperature control (see models concerned section 1.4). This function is not visible if your device is delivered with non-programmable temperature control (according to order).



2.2.2. MEASURE

Before making a measurement, you will need to install your measuring system and make a zero gap then go to the measurement position. Please see section 3.1, 3.2 and 3.3 before making your measurement. Don't forget to make a zero of motor (see section 2.2.6).

Then you click on "Measure tab", you will get this window

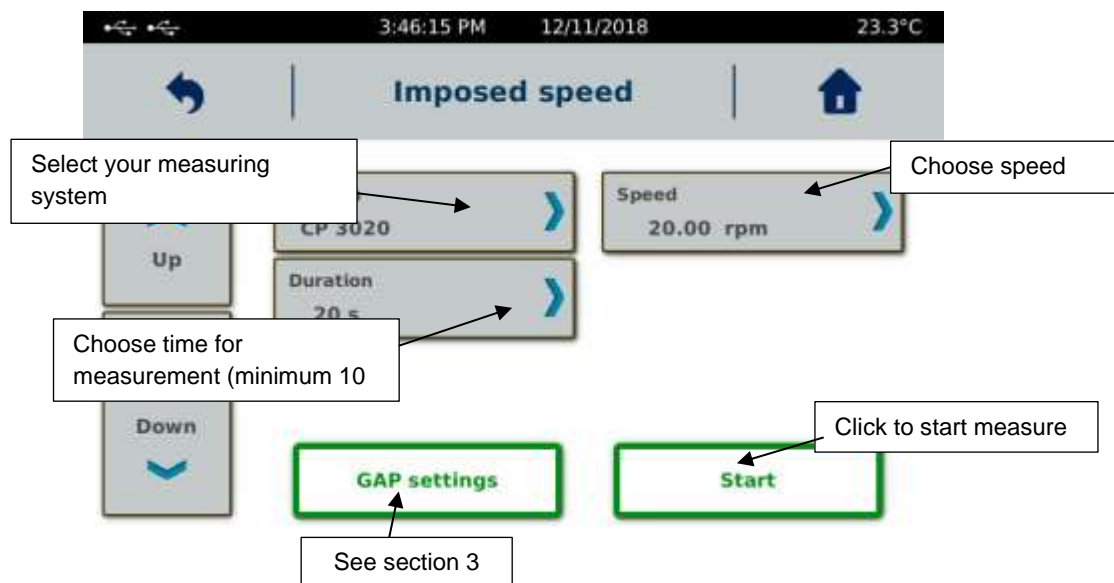


Arrows and elevator functions are explained in section 3.

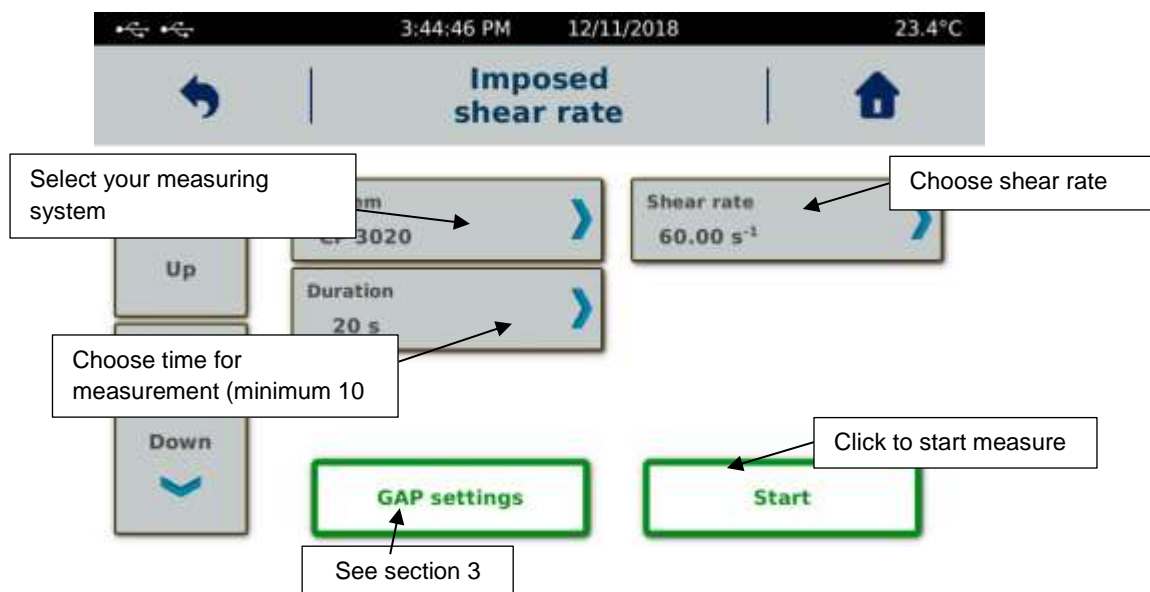
2.2.2.1. MANUAL MODE

Manual_Mode enables to choose your measurement parameters like «Measuring System », « Speed or shear rate» then « Time of measurement ».

This mode is interesting when a simple measurement of viscosity at a constant speed or shear rate is sufficient. When your test has to incorporate ramps, it will be necessary to create a program (see section 2.2.3).



"Imposed Shear rate" mode is recommended when using MS CP geometries.



Rq : If « Time » = 0, you could modify « speed » during the measurement. This could help you to define the best conditions to work on your sample.

If your measuring system is not in list, you may have to create it. Please refer to section 2.2.8.6.

Choice between “Speed” or “Shear rate” is according to your measuring system. For MS CP, you should have only possibility to set the shear rate. If you need to know what is the corresponding speed then you are using shear rate, you have to use constant K_D of your measuring system (information available in section 2.2.8.6).

$$\text{SPEED} = \text{SHEAR RATE} / K_D$$

With speed unit in rpm, shear rate in s⁻¹ and K_D is rpm/s⁻¹.

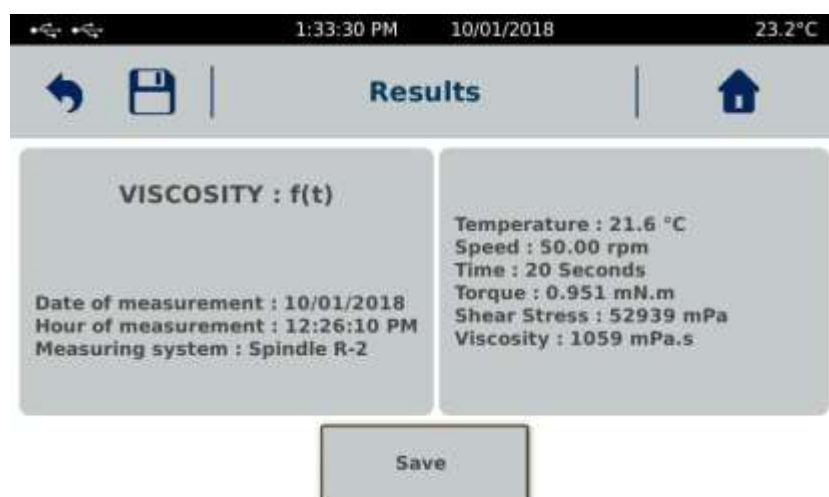
Then parameters are set, you can select “Start” to launch your measure if you set your gap before. If not, please select “Gap settings (see section 3).



During your measurement, you will see a torque gauge (on the right side of the display). You must verify that the measured torque is not too close to the upper or lower limit, because you can get message as “Lower Torque” or “Torque Overload” and measurement will stop automatically. If this is the case, increase the speed / gradient or take a larger measurement system if you are close to the lower limit. Please decrease the speed / gradient or choose a smaller measurement system if the torque reading is close to the upper limit.

You will find several information available on the screen such as torque (mN.m), stress (Pa), temperature (° C), time (s) or viscosity (mPa.s). If the units do not suit you, you can change them in parameters (see section 2.2.8.5).

When your measurement is complete, you will get the window below. You will find all the data you need and will be able to save it in the internal memory or print it (if a printer is connected). If you choose "Save", the rheometer will ask you to give a name to your measure. You will have the opportunity to read it later (see section 2.2.4.).



2.2.2.2. AUTOMATIC MODE

Automatic mode allows you to select pre-recorded programs (see section 2.2.3).



The methods in green are programs whose control is in Shear stress/torque and the methods in red relate to the control in speed or shear rate. The format of the methods is as follows:

- Files in "***.prs**" for speed/shear rate ramp method.
- Files in "***.pss**" for speed/shear rate step method.
- Files in "***.prc**" for shear stress/torque ramp method.
- Files in "***.psc**" for shear stress/torque step method.

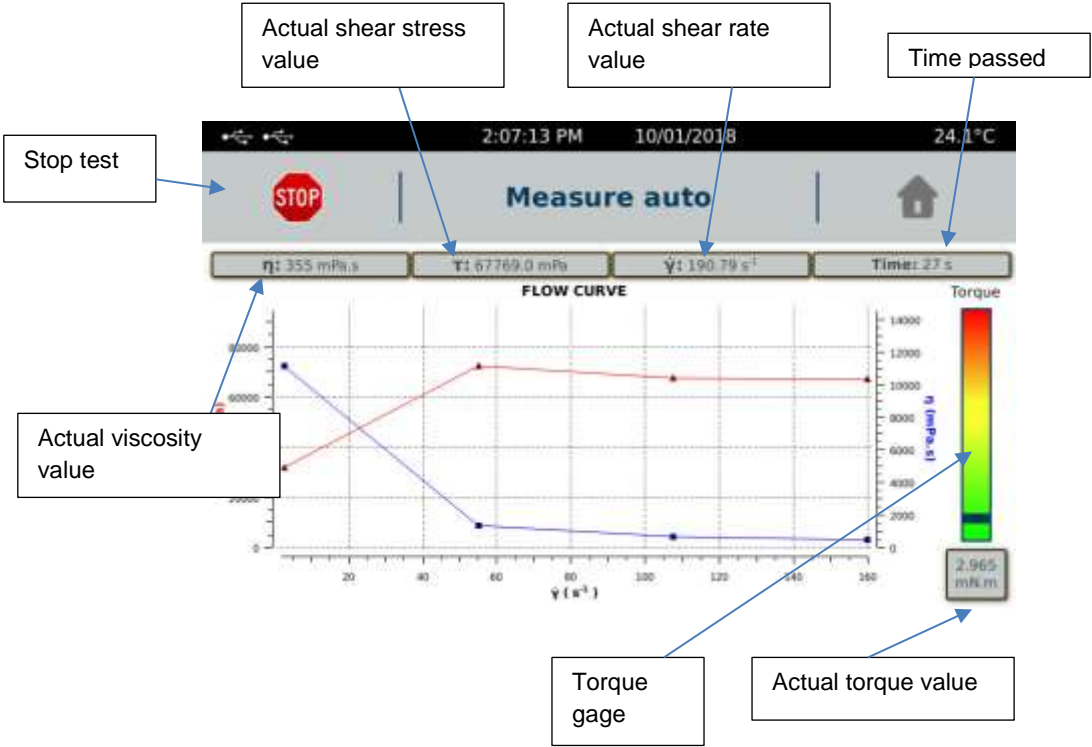
Select the program from the list and click "Valid" to start your measurement. The display adjusts automatically to show you the parameters of the chosen program.



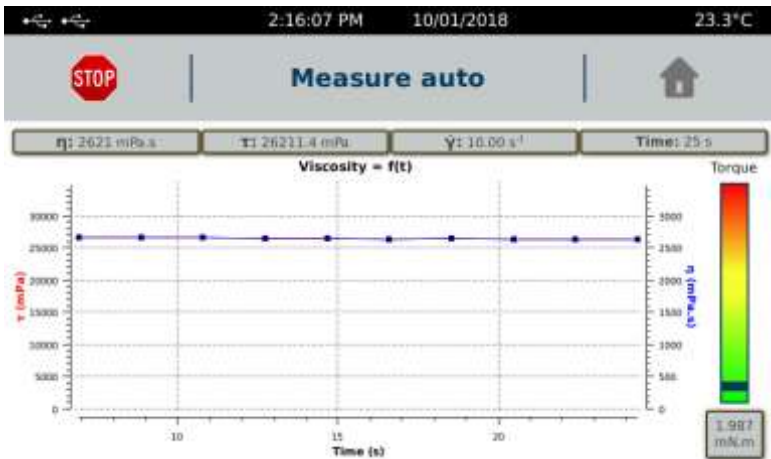
Then parameters are verified, you can select "Start" to launch your measure if you set your gap before. If not, please select "Gap settings (see section 3).

Whatever type of program selected, the instrument will ask you to save your measurement when you click on "Start". If you wish to see in detail the contents of each method, we invite you to consult the paragraph 2.2.3.2.

Depending on selected program, the current display may be different. For all ramp and step modes (see section 2.2.3) the rheometer will display a curve with the shear rate or velocity as x-axis, and two axes on the y-axis showing shear stress for one and viscosity for the other.



Some methods in step mode (format **pss** or **psc**) contain only one step. These methods are intended for constant parameter measurements over time. The display of the curve will be different with time on x-axis. The name of the graph is also different (here Viscosity = f(t)).



At any time you have the option to stop the measurement by clicking on the "Stop" button. The device will then ask you whether you want to save the measurement or not.

Some methods contain an analysis at the end of the measurement. When the measurement comes to an end, you will be able to see the result of this analysis as well as the curves obtained.



All saved results can be read later (see section 2.2.4.)

2.2.3. PROGRAMS

In the Programs tab you will be able to create your Measurement methods as well as edit / modify or delete them. The last two buttons are accessible only after selecting a saved method.



2.2.3.1. NEW PROGRAM

When you click on the "New Program" button, the rheometer will offer you four different types of programs. Each of them can be declined in "ramp" or "landing" mode.

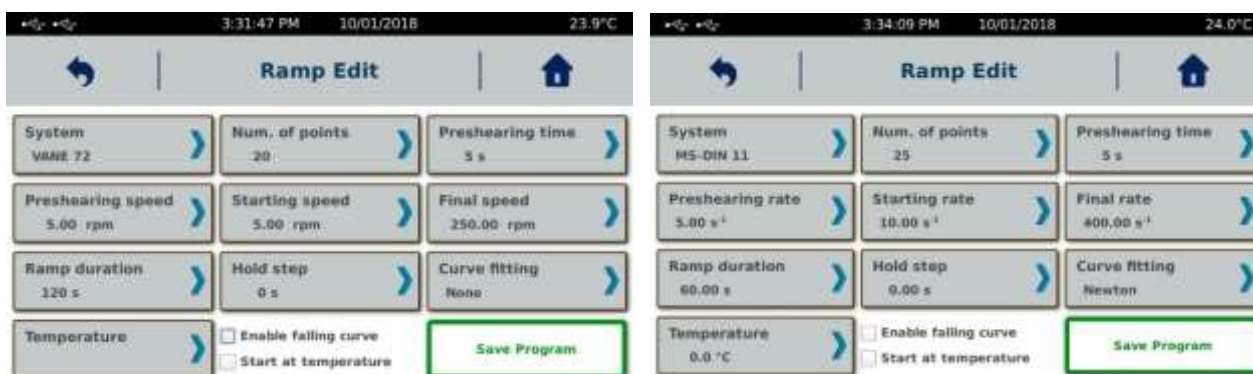


2.2.3.1.1. Speed/shear rate ramp mode

This programming mode makes it possible to carry out a speed / gradient ramp

Imposed Speed

Imposed shear rate

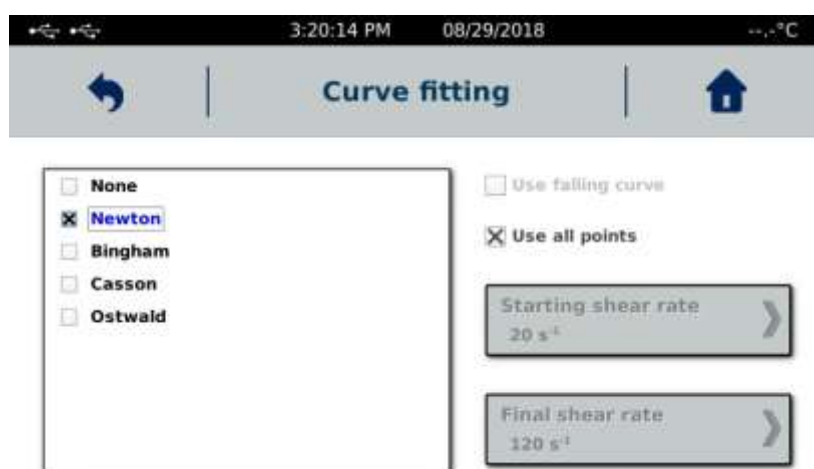


At the beginning of your programming, all the buttons are grey except for the "System" button. Selecting the measurement system and validating will automatically activate the next button and so on. You will then be able to indicate the number of points (here of the rising ramp), the duration of the pre-shear (can be set to 0 if it is not necessary) as well as the speed/shear rate (a value must be indicated here even if pre-shearing is not necessary). Next is the speed/shear rate of the beginning of the ramp, the final speed/shear rate value (for information the speed range of the DSR500 is from 0.3 to 1500 rpm and for the shear rate range see the tables in paragraph 3 concerning each type of measuring system) and its duration in seconds. The "Hold Step" button is used to set a time when the speed/shear rate will be the same at the end of the rising ramp. This function is often necessary when you want to make a ramp up-hold-down. The number of points for the hold step is fixed and will be 1 point/second. For the descending

part, it will be activated by selecting "Enable falling curve" and will be strictly identical to the rising ramp in terms of number of points and duration.

The "Temperature" button is only available if your device is delivered with temperature device controllable by the DSR 500. By default this function is inactive. If you subsequently acquire such a warm-up unit, you must contact LAMY RHEOLOGY to activate the function on the DSR 500 which will allow you to set a constant set point temperature for the duration of the measurement. The "Start temperature" function allows you to wait for the set temperature to be reached before starting the measurement.

The "Regression" button allows you to perform a rheological analysis on your measurement at the end of it. You will have to indicate which model you wish, which part of the measure will be used, specifying the zone concerned (complete or partial). The regression will be automatically started at the end of the measurement, except if it stops before its end.



Click on the back arrow to return to ramp programming

Once your programming is complete, click on "Save" and give a name to your method.

2.2.3.1.2. Speed/shear rate step mode

In the ramp mode (see above) the number of points sets the number of steps and duration of each of them is identical and calculated according to "Duration of the step = Duration of the ramp / number of points". In the step mode, you can set the number of steps, the speed/shear rate and duration of each one.

The "Step" mode also makes it possible to perform a measurement as a function of time at constant speed/shear rate. In this case, only one step must be set and the display being measured will be different (see section 2.2.2.2).

Imposed speed



Imposed shear rate



At the beginning of your programming, all the buttons are grey except for the "System" button. Selecting the measurement system and validating will automatically activate the next button and so on. You can then specify the duration of the pre-shear (can be set to 0 if it is not necessary) as well as the speed/shear rate (a value must be indicated here even if the pre-shearing is not necessary).

When you select the "Nbr. of bearings ", you get this view.



Clicking on "New step" will display the instrument's display on it.

Imposed speed



Imposed shear rate

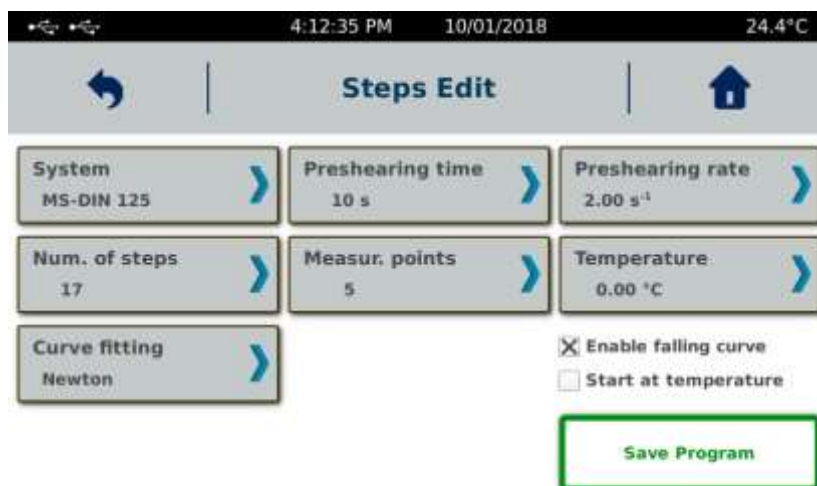


Once the first step appears in the list, you can change the value of speed/shear rate and its duration by clicking on the buttons provided for this purpose. If you want other step, you have

to click on the button "New step" as many times as desired levels. By default, the "New step" function copies the selected step (whose corresponding box is checked) and places a copy after it. This will allow in the case where all steps have the same duration to limit the actions. You can also delete a step by selecting it and then clicking on "Delete step".

Once programming is complete, you must click on the back arrow (top left of the screen).

The new display now shows the number of steps in your program. The function "Nbr. number of points desired for each step, the ideal value being 1. However, when programming a method containing only one step, it is recommended to put a larger number of points.



The "Enable falling curve" function is used to automatically generate a measurement based on the steps and the number of points already filled in but made in the opposite direction (decreasing value).

The temperature management is the same as that described in paragraph 2.2.3.1.1.

The use of the "Curve fitting" button is identical to that described in section 2.2.3.1.1. The only important difference is that instead of taking into account the measuring points of a ramp, it is a part or all steps that will be involved in the analysis. The regression will be automatically started at the end of the measurement, except in case of stop before the end.



Click the back arrow to return to the schedule of the bearings.

Once your programming is complete, click on "Save" and give a name to your method.

2.2.3.1.3. Torque/shear stress ramp mode

This programming mode makes it possible to perform a torque/shear stress ramp.



The programming of this type of method is similar to that for speed or shear rate programming (see section 2.2.3.1.1). Only the variable to be set is different. For information, the torque range of the DSR500 is 0.05 to 30 mNm. For the shear stress range, multiply the torque values by the Ktau constant of your measuring system given in section 2.2.8.6.

The "Speed Limit" button is used to program an automatic stop of the measurement when the motor reaches a speed limit, thus preventing ejection of product. By default, the maximum speed of the DSR 500 is 1500 rpm. The measurement will therefore stop when the measured speed reaches this limit, even if you have not indicated anything in this part. It is therefore advisable to set a speed limit less than 1500 rpm.

It is not possible to make a regression on your method of control in shear stress or torque as it is the case for the control in speed or shear rate.

However, the temperature management is identical and described in paragraph 2.2.3.1.1.

Once your programming is complete, click on "Save" and give a name to your method.

2.2.3.1.4. Torque/shear stress step mode

The use and programming of the stress or torque mode is the same as that described in paragraph 2.2.3.1.2.

As described in section 2.2.3.1.3, you can set a speed limit.

The temperature management is the same as that described in paragraph 2.2.3.1.1.



2.2.3.2. EDIT PROGRAM

This function allows you to edit a program to view its content or edit it. Just select it from the list and click on "Edit Program". When you have made changes, you can save the new method by giving it a new name or rewrite the old method with the same name. If you only want to view the settings, just click the back arrow to return to the previous view.

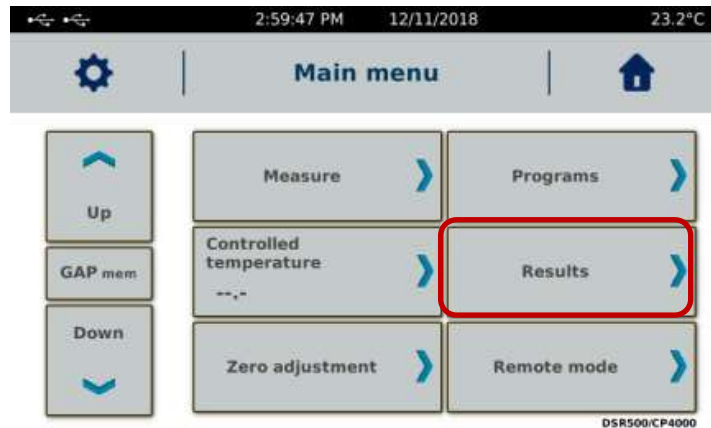


2.2.3.3. DELETE PROGRAM

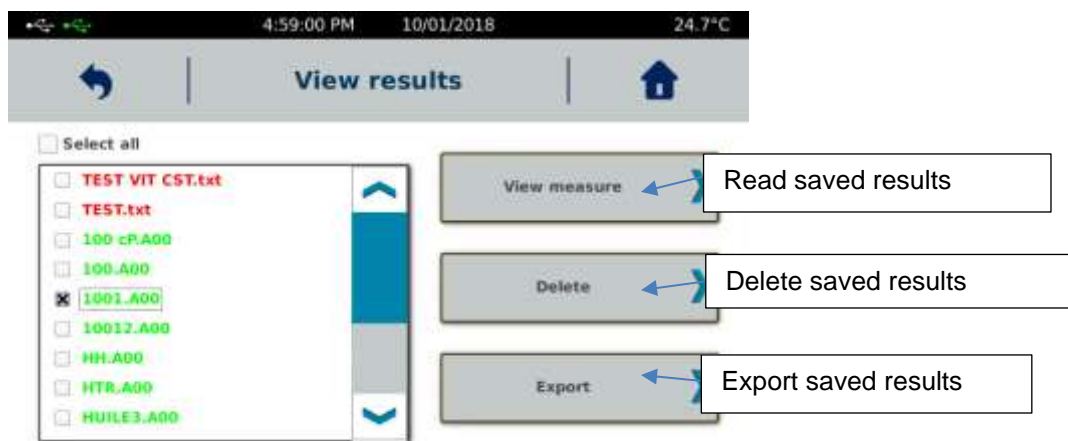
This function allows you to delete a program from the memory. Just select it from the list and click on "Remove Program". The instrument will ask for confirmation of the deletion. If you do not want it anymore, just press the return arrow to return to the previous display.

2.2.4. RESULTS

This menu allow you to read, export or delete data from internal memory. Press on «Results» tab in Main menu.



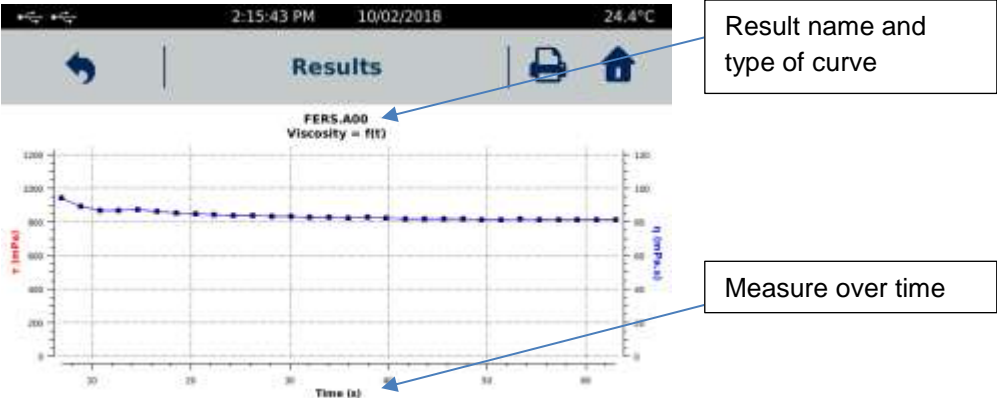
Once you are on the screen below, simply select the measurement in the list and choose the desired option. The measurements in green correspond to results obtained with a programmed method while the measurements in red come from measurement in manual mode (see paragraph 2.2.2).



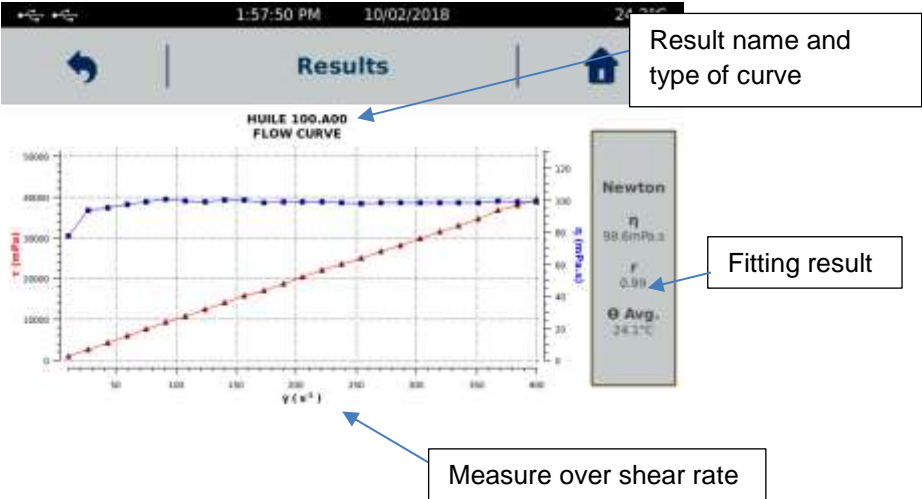
When you select measurements did in manual mode, you will get this view with all important information saved with the result.



When you select a measurement obtained through a programmed method, you will get two different displays. The first display concerns the measurements obtained with a step method containing only one step.



The following display concerns all other types of methods.



Note that the measurements obtained with torque or shear stress control methods are also displayed with the shear gradient in the X axis. The box for regression is only present if your method allowed the calculation.

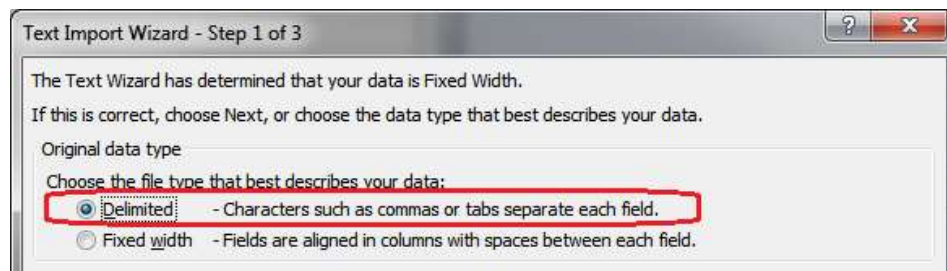
When a printer is installed and connected to your rheometer (see section 2.2.8.9.), A symbol next to the "Home" button allows you to directly print your curve or result.

The "Export" function is accessible only when a USB key is connected to the back of the DSR 500 (see connection section 1.3). If you want to export all the measurements at the same time, you can do this by checking the "Select all" box. Whatever the program used for the measurement, only the recorded data can be exported. It is not possible to export or copy a diagram.

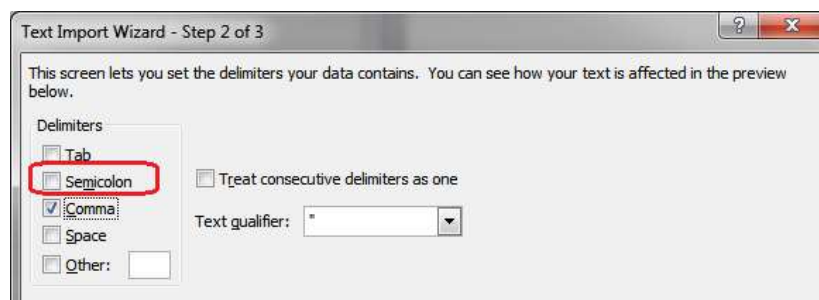
The format of the data generated and saved by the rheometer is ASCII (*.csv). Once your data has been copied to the USB drive, you can open the files using the EXCEL spreadsheet. To do this, simply copy the data from the USB stick to your computer. Then open Excel, then

choose "File", "Open", taking care to select "All files *. *". The Excel spreadsheet will offer you to convert your data by displaying three successive windows

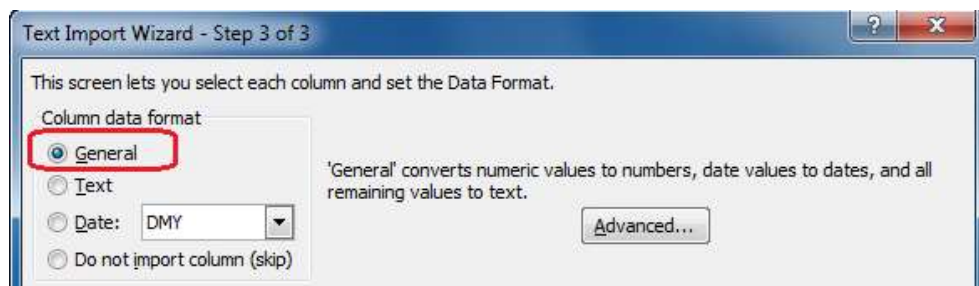
Verify that the "Delimited" function is selected and then click next.



On the next window, be sure to select the "semicolon" as the separator and click next



On the window below, select the general mode and click on finish. You will get a table with all the information.

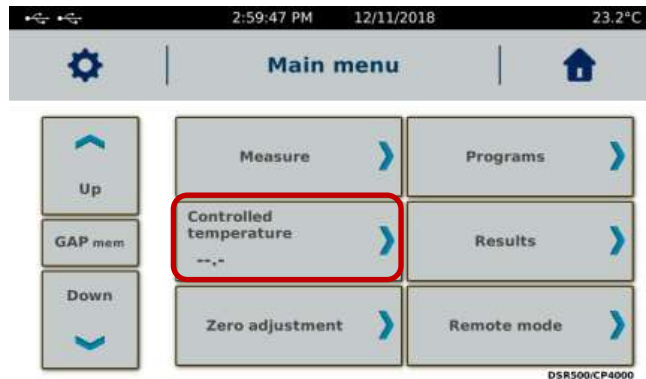


To delete a result, simply select your measurement in the list and click on "Delete". The deletion will be complete only after confirmation from you. You can also delete all measurements by clicking on "Select all" then "Delete".



2.2.5. TEMPERATURE SETTING

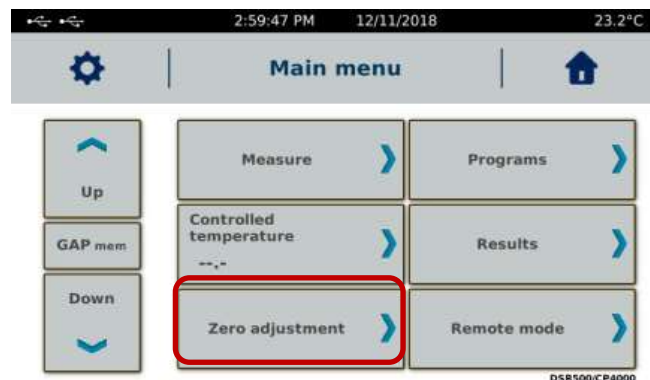
This function is available on main menu display.



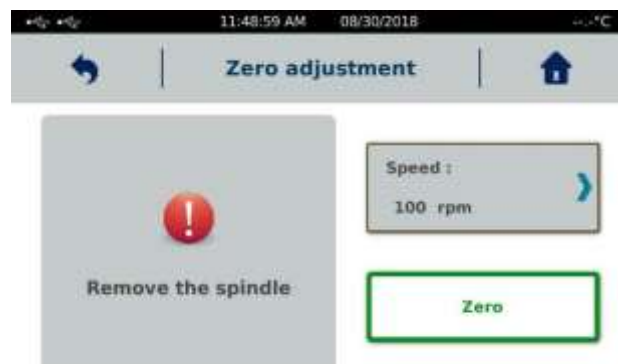
As described in section 2.2.2, this function is only available if your device is delivered with temperature control controllable by the DSR 500 (see section 1.4 for models). This function on the DSR 500 will allow you to set a constant set-point temperature for the duration of the measurement. It may be different from the temperature set-point set in the registered method. If so, temperature set in method will be automatically used then test will be launched.

2.2.6. ZERO SETTING

The zero setting allows you to calibrate your DSR 500 to take account of the engine's empty friction. This function is available on main menu.



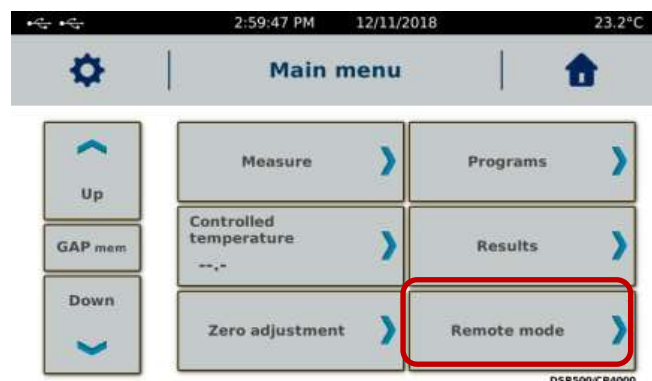
The rotation speed for zero adjustment can be changed to suit your needs, giving you much more precise measurements at specific speeds close to your measurement parameters.



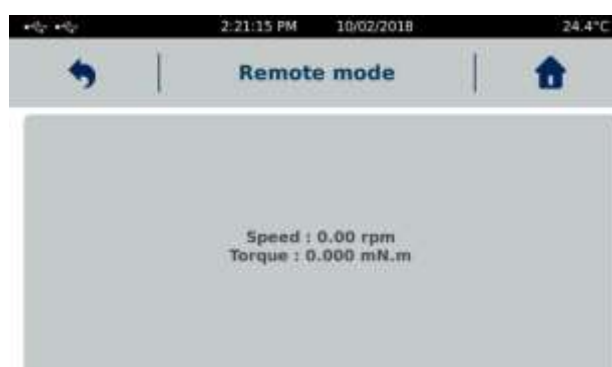
This operation must be done without measuring system. Then zero is finish you can click on OK and internal motor friction will be automatically saved inside memory of rheometer. If problem occur during zero setting, please try again. If problem still present, please contact your local distributor or society LAMY RHEOLOGY.

2.2.7. REMOTE CONTROL


This mode enables to drive DSR 500 by external RheoTex software, supplied on option. This function is available on main menu.



Once the device is connected to the PC, you must select the type of port (USB, RS232 or Bluetooth for some models) and click on "Ok" to start the communication. Bluetooth mode must use an editable PIN code to pair the instrument with a computer. As long as communication is not established, a "Waiting Connection ..." message appears on the screen. Then launch the software and check that the screen switches to the display below. If this is not the case, check the connections and make sure that the COM port number set in the default settings of the RheoTex software is correct and identical to that recognized by WINDOWS in "Control Panel", then "System and "Device Management" (see the operating instructions for the RheoTex software).



2.2.8. SETTINGS

This parameters menu allow you to change settings of your device. It is reachable by clicking on icon  in upper left corner of touch screen which is only available then you are in “Main menu”.



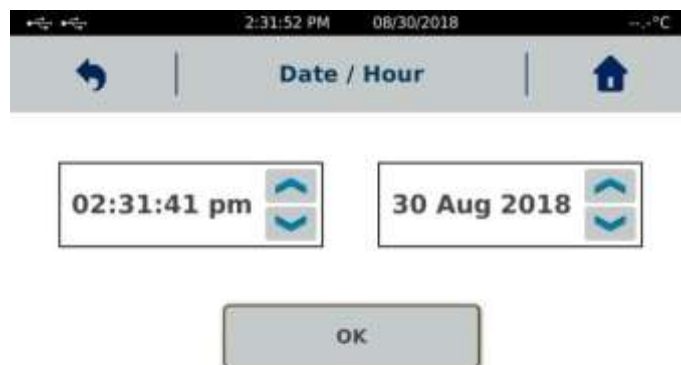
2.2.8.1. LANGUAGES

Enable you to select language of your DSR 500. You have choice between French or English. Then you have selected your desired language, you have to click on “Ok” and device will reboot automatically to show new language. In this menu you will be able to see Firmware version of your device.



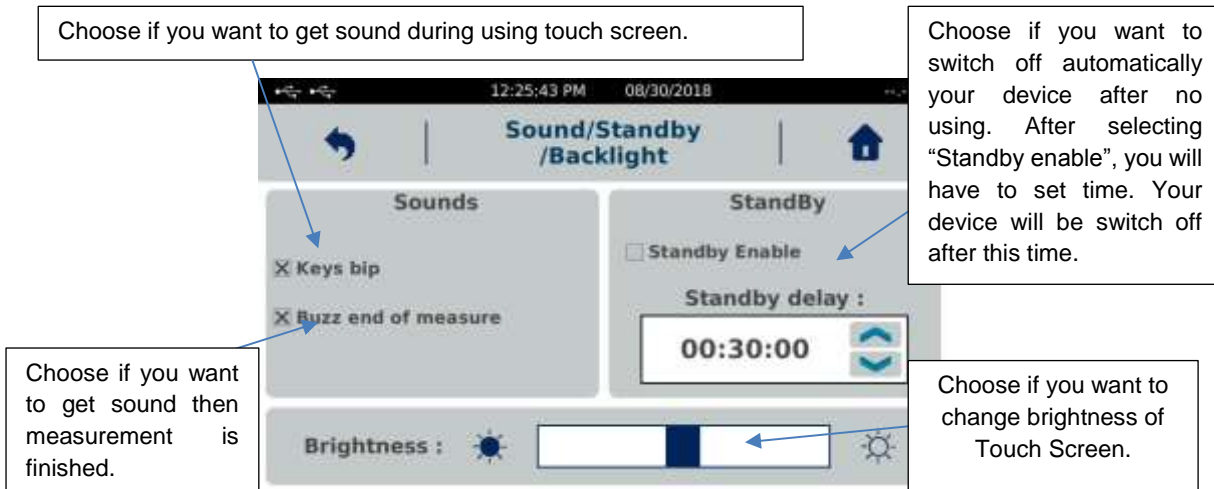
2.2.8.2. DATE / HOUR

Enable you to adjust hour and date of your DSR 500.



2.2.8.3. SOUNDS / STANDBY / LIGHTING

Allow you to modify sounds, lighting and activate or not the Standby mode of your DSR 500.



2.2.8.4. USER NAME

Operator mode will allow you to create different operators for your DSR 500. This function allows you to identify operator doing measurement and lock some functions of instrument. It can be combined with the "Locked mode" to increase protection level of settings and data (see section 2.2.8.7).



Operator management must always start with the creation of the first account, which will become the administrator and thus be able to create other operator accounts or delete them. The administrator account must be associated with a password (here called PIN).



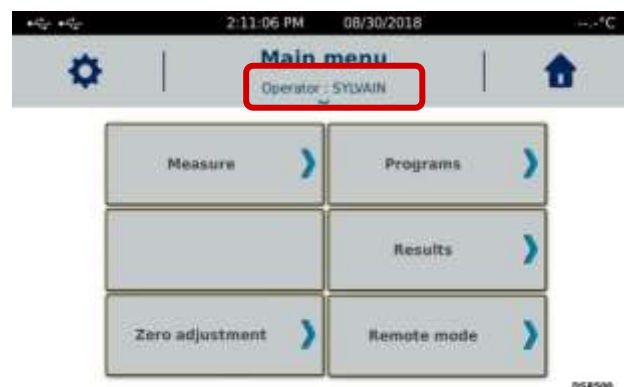
To create the administrator account, click on "Add user with code PIN". Fill in the name and the associated PIN code.

After indicating the name and password, the administrator thus created will have his name in red in the list. You can now create other operators with or without a PIN. All other accounts will be indicated with black colour.



To delete an account, administrator account must be used. Select the account to be deleted from the list and click on "Remove user". The administrator account can only be deleted when it is the last available account.

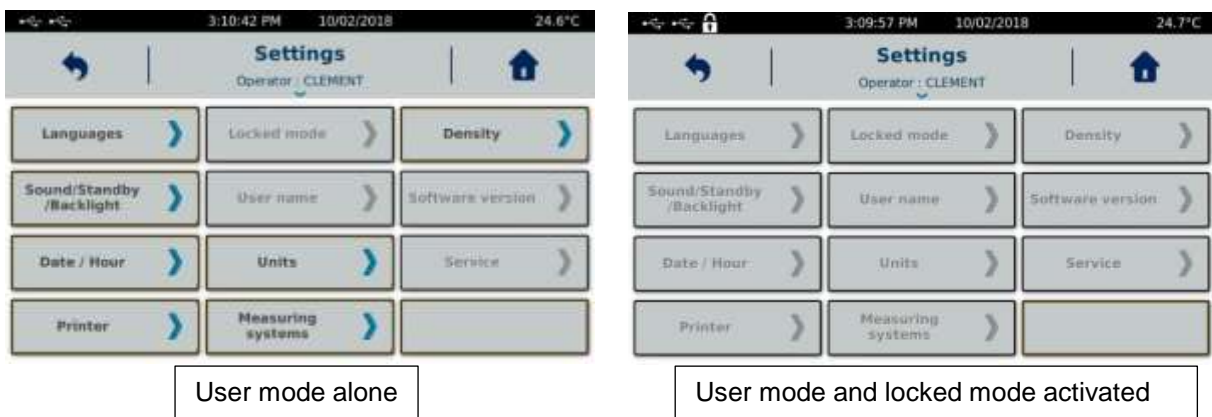
To use the operator accounts you must activate mode by selecting "Enable user mode". Once activated, you must select an operator and enter the PIN code if necessary. By returning to the Main Menu, you will be able to see the name of the operator in use under "Main Menu". By clicking on the arrow below the name of the operator, you can turn off the DSR 500 or change operator.



If the instrument is turned off and on while operator mode is on, it will be asked you to select the desired operator. Select the operator, enter the PIN code if necessary and confirm.



When an operator account other than the administrator account is used, some functions of the "Settings" menu are disabled. They are all if the "Locked mode" is activated (see section 2.2.8.7).



To disable the "User" mode, the administrator account must be used. Then click on "Disable user mode". This deactivation doesn't lead to the deletion of created accounts.



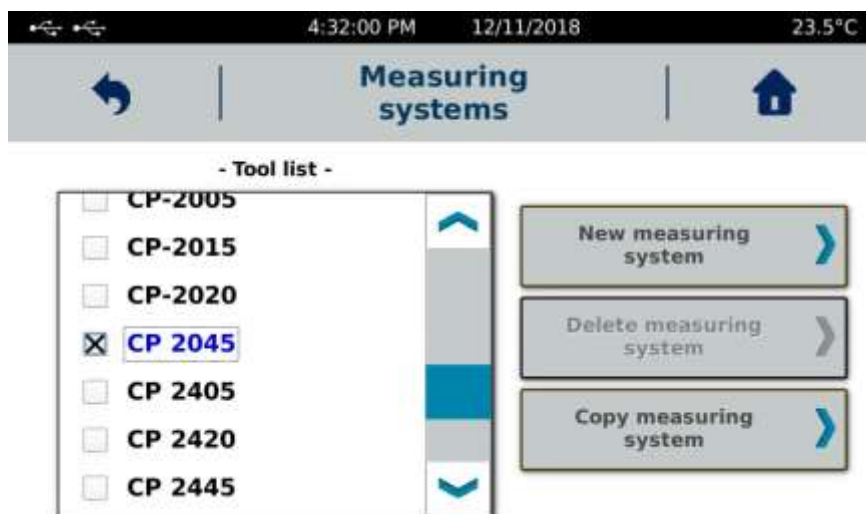
2.2.8.5. UNITS

Allows you to change units of viscosity and stress used for programming methods and displaying results and diagrams.



2.2.8.6. MEASURING SYSTEMS

Allows you to add or remove a Measuring System.



All measurement systems stored by default in memory are not removable. Only those you have created yourself can be removed. To delete a measuring system, select it from the list and choose "Delete Measuring System". If this function remains greyed out when you have selected a system, it is part of the default mobile stored in the instrument's memory.

To add a new measuring system, you have two possibilities. Either create it using the "New measuring system" function, or select an existing system using the "Copy measuring system" function.

You are not allowed to change the constant of an existing measuring system. If you want to use a new constant for an existing measuring system, you have to copy this measuring system by renaming it and then enter the constants you want to use. Note that the KD constant is used to convert rotational speed to shear rate and K τ to convert torque to shear stress. Shear rate and shear stress are used to calculate the viscosity value. If you use a different constant value, you will get a different viscosity result. Here is the list of constants used for measuring systems compatible with the DSR 500 CP4000.

MS CP

SYSTEM	K τ / 1 mNm in Pa	Kd / 1 RPM in S-1	Ri / Ra
CP 2005	477.5	12	1
CP 2015	477.5	3.8	1
CP 2020	477.5	3	1
CP 2045	477.5	13.3	1
CP 2405	276.3	12	1
CP 2420	276.3	3	1
CP 2445	276.3	13.3	1
CP 2520	244.5	3	1
CP 3020	141.5	3	1
CP 3520	89.1	3	1

SYSTEM	Ktau / 1 mNm in Pa	Kd / 1 RPM in S-1	Ri / Ra
CP 4005	59.7	12	1
CP 4015	59.7	3.8	1
CP 4020	59.7	3	1
CP 4040	59.7	1.5	1
CP 4221	51.6	3.8	1
CP 4530	41.9	2	1
CP 5005	30.6	12	1
CP 5010	30.6	6	1
CP 5020	30.6	3	1
CP 6005	17.7	12	1
CP 6010	17.7	6	1
CP 6020	17.7	3	1
PP 25 0.5	326	2.618	1
PP 25 (1mm)	326	1.309	1
PP 25 (2mm)	326	0.654	1
PP 40 (0.5mm)	79.5	4.188	1
PP 40 (1mm)	79.5	2.094	1
PP 40 (2mm)	79.5	1.047	1

For other measuring system, please contact LAMY RHEOLOGY.

2.2.8.7. LOCKED MODE

"Locked Mode" protects all data, settings, results and methods stored in the instrument's memory. It is indicated by the presence of a small padlock next to the USB symbols. It should be used if you want to protect some settings on your device. All the functions in the "Settings" menu will be locked, except for the "Locked mode" button to enable deactivation.

This function will also block the parameters for the measurement. This way, if you want to always use the same measurement settings, you must enable this locked mode to make sure that no one will change the measurement settings. Automatic mode is normally accessible for method selection.

In protected mode, it is not possible to change the temperature set-point or to access the program creation or editing mode. The visualization of results is accessible as well as the export of data. But no suppression is possible. The "zero adjustment" is accessible but it is not possible to change the speed of rotation used.

After selecting "Locked Mode", you must click "Enable". The DSR 500 will ask you to register a 4-digit code that will be required to disable this protected mode. Each activation is independent and can be done with a different code and the deactivation of the mode will always be done with the code used to activate it. To disable protected mode, you must return to "Settings" and "Locked Mode" and click "Disable" by entering the 4-digit code.

This function can be combined with the "User" mode, thus increasing the protection level of this mode. If you want to combine these two mode, you must first activate the user mode (see section 2.2.8.4). Then use the administrator account to enable the " Locked mode ". When a simple user account is used, we will find the features of the protected mode.



Disabling the protected mode in this configuration will be done only when the administrator is connected.

2.2.8.8. DENSITY

Enable you to enter density value of your product in order to measure his kinematic viscosity. If you set a density value, you will get all the time viscosity in cStoke. Please remove density information if you want to get back Pa.s or Poise for unit of viscosity.



2.2.8.9. PRINTER

Allows you to connect a printer, print a test page, and choose the print interval time you want during measurement.

The DSR 500 can be connected to all printers with a PCL5 print protocol. This includes many A4 printers. The connection is made to the "USB host" port on the back of the instrument.

Once the printer is connected, simply click on "Install Printer".



Once the printer is recognized and installed, you can see its name on the screen.

Printing a test page verifies good communication. If you choose to connect your instrument to another printer, be sure to delete the one already installed.



When a printer is connected, the printer symbol appears when viewing a result or at the end of the measurement.



You have the possibility to print the measurement information (date, operator, result name, geometry used), a table with all the recorded values, the diagram and the result of the regression if they are present.

2.2.8.10. SOFTWARE VERSION

This menu allows you to update the firmware of your DSR 500. This function is used when updating the machine data is necessary. Do not go in this menu without being invited by the company LAMY RHEOLOGY. The update is done via a USB key connected to the "USB" port. You can then click on "Update" to update your instrument. At the end, your device will turn off and you will have to turn it on again.



2.2.8.11. SERVICE

Reserved to LAMY RHEOLOGY engineers.

3. MEASURING WITH YOUR DEVICE

This section will show how use the different measuring system with your device.

Viscometer need to be installed before next section of this manual (see section 1.5).

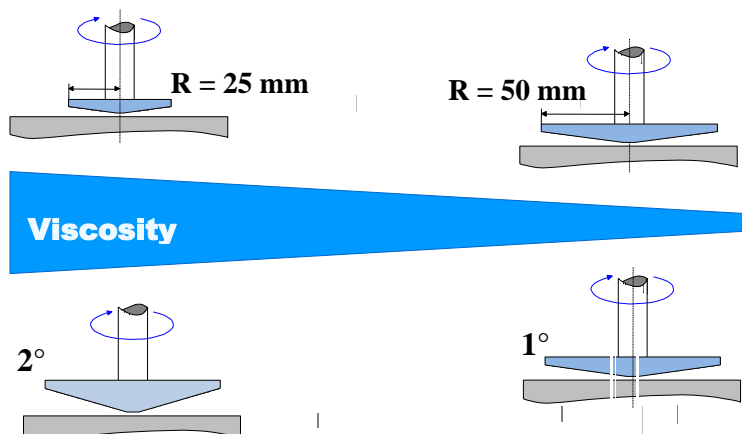
3.1. INSTALLATION OF MEASURING SYSTEM

Read the installation of your measuring system in the following sections before inserting it on your viscometer. Indeed some measuring systems require the installation of accessory before the insertion of the spindle. And don't forget to make zero of motor before installing measuring system (see section 2.2.5).

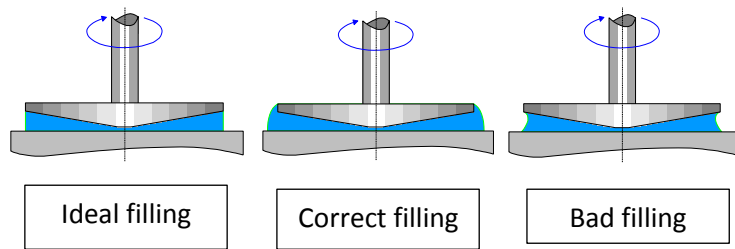
Unlike the DSR 500 PLUS, the CP4000 version can only be used with cone-plane or plane-to-plane geometries. The coupling of the DSR 500 CP4000 PLUS is of type AC 265. It is a system allowing the insertion and the quick fixing of the measuring mobiles. A simple vertical action of the ring upwards (release) or downwards (locking) allows easy manipulation of the measuring tool.



Choice of measuring system must be done according to the product to be measured. Favor wide diameters for low viscosities as shown on diagram below.



The amount of sample should be sufficient to completely fill the space between the cone and the bottom. In the case of a liquid sample, you can take the recommended volume for the dimensions of your cone-plane (see table below). For thicker samples, you need to draw enough with a spatula or similar tool.



Sample volume for Plate measuring system depends on gap used. But filling need to be perfect as for cone.

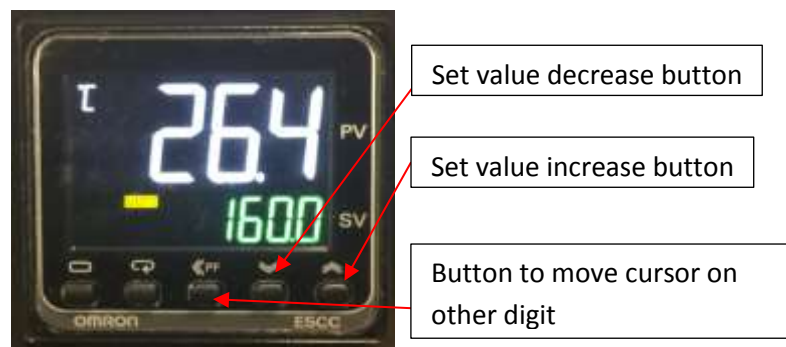
Diameter (mm)	Angle (°)	Sample volume (ml)
10	0.5	0.0023
20	0.5	0.018
20	0.5	0.018
20	1.59	0.058
20	2	0.073
24	0.5	0.031
24	2	0.126
40	0.5	0.146
40	1.59	0.465
40	2	0.585
40	4	1.17
50	0.5	0.285
50	2	1.142
60	0.5	0.5
60	1	1
60	2	2
60	3	3

3.2. TEMPERATURE SETTING

The value read on this display is the set temperature. The value read on the screen of the DSR 500 CP4000 PLUS is the actual value of temperature.

Some models of DSR 500 CP4000 with programmer (see section 1.4) allow temperature setting by software RheoTex (see software manual).

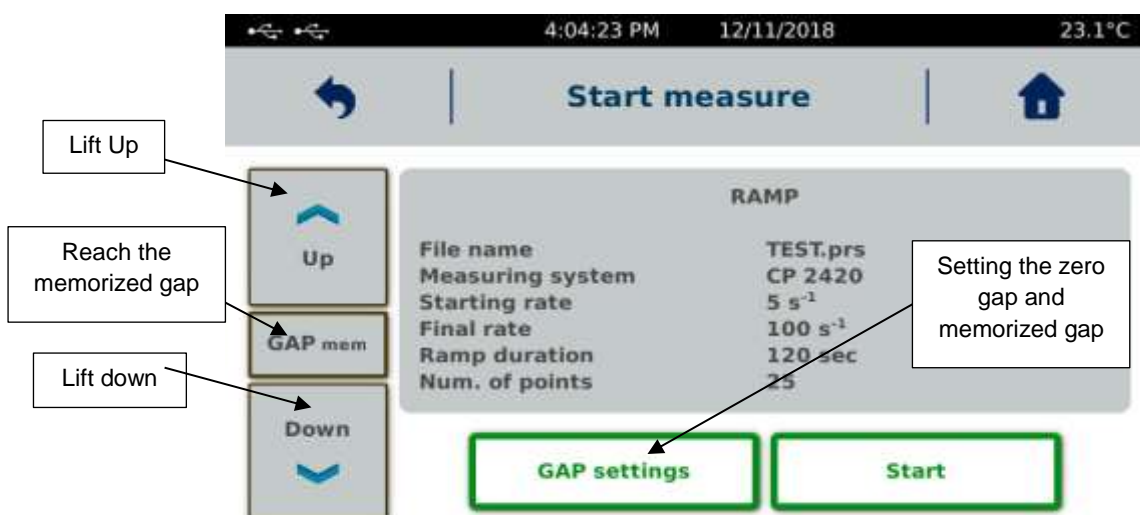
To change the set point, press the arrows to adjust the desired temperature, the new set point will be taken into account after a few seconds without validation



3.3. GAP SETTING

Gap adjustment is required before each measurement. It allows you to realize the contact position (also called zero gap), to memorize the measuring position and to place the geometry at this position in order to realize your measurement. Lift functions can be also controlled by software RheoTex (see software notice).

Elevator functions are available when you select the "Measure" tab on the main screen. Then you are in Measure windows, you can see settings for gap.



Each Measuring system can have its own positioning gap for measurement. To set this memorized gap or to make zero gap, you have to click on "GAP setting".

Your DSR 500 CP4000 PLUS is equipped with an automatic lift device. Setting the zero gap is very important for the measuring position to be as ideal as possible. This adjustment must be done with the mobile, without sample, at the measuring temperature and be renewed temperature is different.

The first step is to select the mobile you have chosen for your measurement by pressing "Measuring System" then you are on manual mode. Indeed if you change mobile later, the zero gap will no longer be valid and must be redone for the new measuring system you have selected. In the case of a measurement using a program (see section 2.2.2 and 2.2.3), it is preferable to load the protocol by selecting it before setting the zero gap. You must then warm up your measuring platform (see section 3.2). You must also, especially if the set temperature is different from that of the room, put the measuring geometry on the lower plate to put it also in temperature.



When the temperature is stabilized, you must leave your geometry at least 5 minutes in this position.

You can then fix the mobile on the measuring head (see section 3.1) before accessing the next step.

Select "GAP Setting" to access this screen.



Enter the desired measuring position value by selecting "GAP value". For a measuring system with truncation (part number starting with 365...), this value must be set to 0.05mm. For a system without truncation, the position must be set to 0.01mm. For a plate geometry, the measuring position can be set between 0.150 mm and 2 mm.

Once the position has been memorized, press the "down" arrow to reach a position above 1cm from the base and select "Start" to reach the zero gap. Device will show this screen.



Once the zero gap has been found, the lift will automatically place the geometry at the memorized position.

Once this step is completed, go to the "Measure" tab by pressing "Home" button and then "Measure". You can pull up the measuring head by pressing the arrow upwards, leaving enough space to place your product to measure. Then place your product as explained in paragraph 5 and then press the "mem GAP" button. The measuring head will go to the measuring position. Remove excess product if necessary by using a nonmetallic soft tool with 90° angle.

You can make your measurement after that (see section 2.2.2)

4. VERIFICATION OF YOUR DEVICE

Your device has been calibrated and checked before delivery according to an internal procedure using a cylindrical MS DIN 11 mobile, an oil viscosity 1000 mPa.s and a temperature control system (EVA DIN) at 23 ° C.

We inform you that the cone-plane geometries are never used internally for our checks and calibrations. Indeed, this type of geometry can lead to measurement errors due, for example, to the problems of gap filling, slippage, product ejection or wrong gap distance.

You can nevertheless check your DSR 500 CP4000 PLUS using your own geometry and a Newtonian standard oil of known and certified viscosity (preferably close to 1000 mPa.s). The tolerance on the accuracy of the viscosity measurement is at best 10% of the expected value with a cone-plane at a temperature whose viscosity value is known. Here is the procedure to follow for your verification:

Here is the procedure to follow for your verification:

- 1) Perform a motor zero (see section 2.2.5).
- 2) Warm up your geometry and the lower plane according to the procedure described in paragraphs 3.2 and 3.3.
- 3) Install your measuring system (see section 3.1).
- 4) Set Gap as described in section 3.3.
- 5) Put standard oil on lower plate and lowering measuring cone in measuring position (see section 3.1 to check good filling of gap).
- 3) Select a measurement method in manual mode by choosing a measuring time of 120s minimum and a shear of 100 s⁻¹ (see section 2.2.2).

The measured value must be within the tolerance of 10%. If the value is out of tolerance, check that all previous steps have been completed. If the problem persists, please contact LAMY RHEOLOGY.



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