BROOKFIELD RS-CPS+ RHEOMETER

Operating Instructions

Manual No. **M08-218-B0212**

(for serial numbers beginning with "304")

BROOKFIELD

SPECIALISTS IN THE MEASUREMENT AND CONTROL OF VISCOSITY

with offices in: Boston • Chicago • London • Stuttgart • Guangzhou

BROOKFIELD ENGINEERING LABORATORIES, INC.
11 Commerce Boulevard, Middleboro, MA 02346 USA
TEL 508-946-6200 or **800-628-8139** (USA excluding MA)
FAX 508-946-6262 INTERNET http://www.brookfieldengineering.com

Table of Contents

I. General Description

This section has general information about the instrument and operating principles.

I.1 Use of the Rheometer

The R/S-CPS+ Rheometer is used in quality control, product development and research. The instrument measures Newtonian and non-Newtonian fluids, records flow curves and determines the viscosity functions in steady shear flows.

I.2 Measuring Principle

The R/S CPS+ Rheometer is a rotational, controlled-stress rheometer. Measuring cones and measuring plates follow DIN (the German industrial standards organization) specification 53018. The measuring substance fills the gap between the bottom measuring plate of the instrument and the rotating measuring element.

The measuring drive developed for this instrument operates with a high-precision dynamic drive system with optical encoder for absolute position measurement of spindle geometry.

The R/S CPS+ Rheometer measuring drive may be used for rotation tests with pre-set speed (shear rate) and measurement of the torque imposed on the measuring element or in shear stress test with control of a pre-set shear stress, to measure the shear deformation of the measured substance by angular deflection of the measuring element. When flow properties of plastic substances are to be determined, the R/S CPS+ Rheometer can be used for shear stress tests that allow precise measurement of the yield point without shearing the measured substance.

There are two measurement types:

- rotational measurement under controlled shear rate (CSR)
- rotational measurement under controlled shear stress (CSS)

Both CSR and CSS measurements can be carried out manually (without PC support) or with a computer system and Rheo 3000 software.

II. System Configuration

The R/S CPS+ Rheometer system consists of:

- Rheometer head containing electronic unit and measuring drive integrated in one housing
- Basic instrument with temperature sensor PT100
- AC Adapter

Available Accessories:

- **Measuring cones and measuring plates (see *Appendix A*)***
- **Bath/Circulator***
- Computer system
- Rheo 3000 software

***The accessories in bold print are necessary for a minimal configuration. See Figure II-1 for illustration of the R/S CPS+ Rheometer System Components.**

Available Accessories:

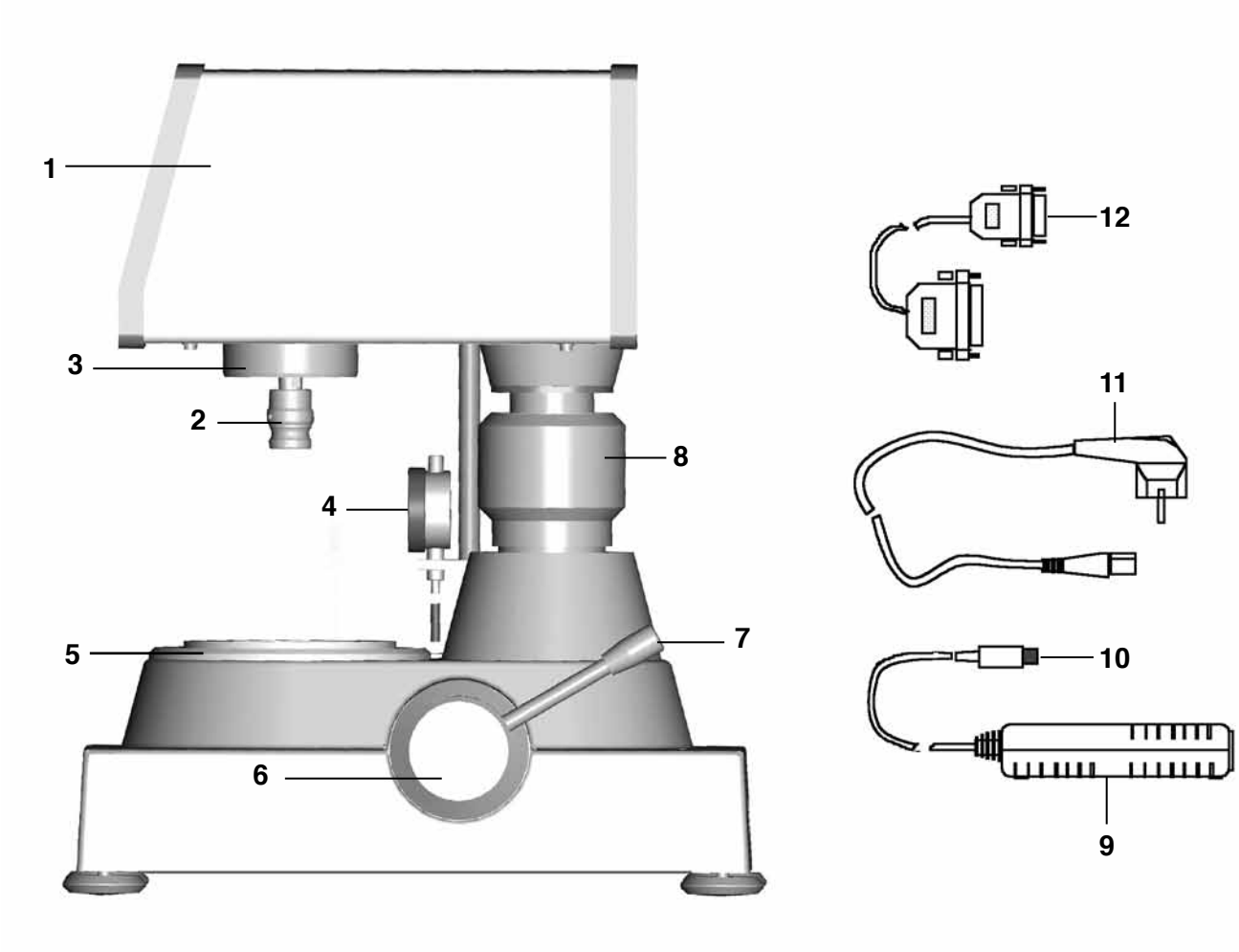
- Start-up Assistance
- Instrument Training
- Rheo 3000 Software Training

II.1 R/S-CPS+ Rheometer

Instrument features include:

- Digital control of rotational speed and torque
- Automatic adjustment of control parameters during measurement.
- Direct indication of measured and calculated values of speed/shear rate, torque/shear stress, viscosity, temperature, and time
- Data storage (measured values)
- Data output to a printer (parallel)
- User support with LCD and keypad
- Built-in system interface with serial standard interface (RS232) for connection to a computer or other serial interface data-logger
- Printing and serial data-transmission during the test

The R/S CPS+ Rheometer can either be operated manually using the keyboard at the front panel or it can be operated under computer control. The R/S CPS+ Rheometer is supplied with direct drive current by the AC Adapter.



1 Measuring Head of R/S-CPS+ Rheometer
2 Measuring Element Coupling
3 Cooling Flange
4 Dial Gauge
5 Bottom Measuring Plate
6 Bank Indicator
7 Height Adjusting Lever
8 Micrometer Ring (Nonius) for fine adjustment
9 AC Adapter
10 DC Connecting Socket
11 Main Connection Cable
12 Data Transmission Cable

Figure II-1: Configuration of the R/S-CPS+ Rheometer

II.2 Measuring Devices

The basic instrument is equipped with a temperature controlled bottom measuring plate. At least one measuring cone or one measuring plate is required as a rotating element for an operational measuring system. These rotating elements are not part of the basic equipment of the R/S CPS+ Rheometer; they must be ordered explicitly depending on your requirements.

II.3 Computer System

The computer system control of the R/S CPS+ is optional and provides automatic measuring, data plots, printing (full reports or data plots) as well as analysis of results and quality control charts.

The recommended computer system has the following minimum requirements:

- CPU / 1 GHz minimum
- 512 MB RAM (main memory)
- 500 MB free hard disk capacity

Compatible operating system includes:

- Microsoft Windows 2000™, Windows XP™, Windows 7™ or Vista™
- mouse and keyboard
- VGA graphic card and monitor
- 1 free serial interface

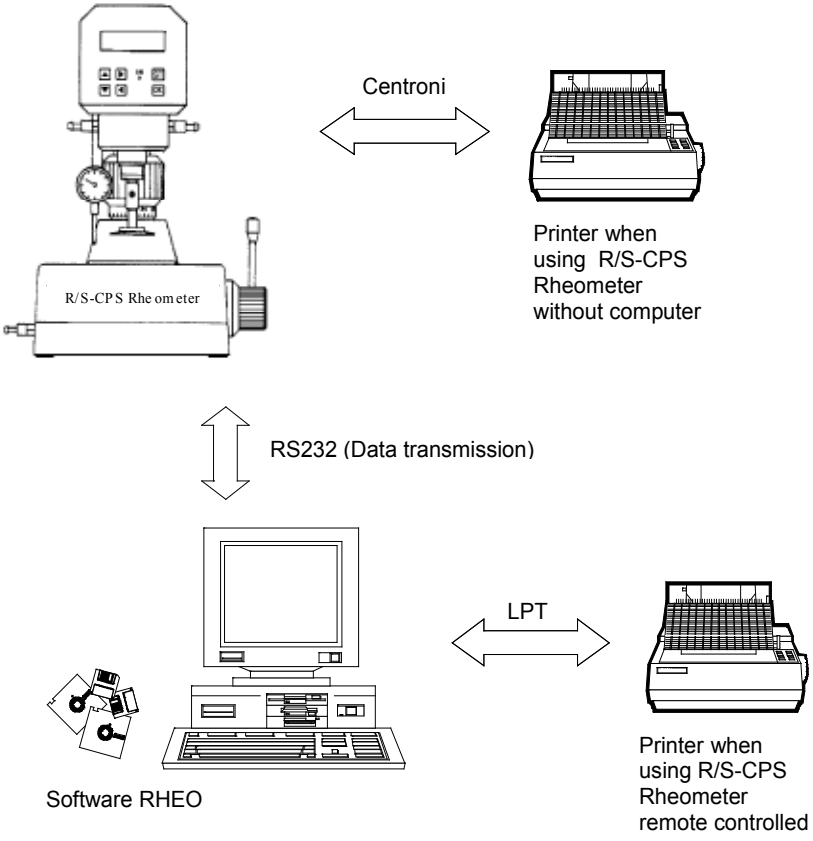


Figure II-2.: Computer System for R/S-CPS+ Rheometer

III. Instrument Installation

In this section you will learn how to set up and use the R/S CPS+ Rheometer for the first measurement, which include:

- Assembly of the R/S CPS+ Rheometer,
- Electric connections
- Installation of accessories such as thermostatting device, cooling device, and measuring systems
- Hose connections

III.1 Mounting the Instrument

The R/S CPS+ Rheometer should be positioned on an even surface, such as a laboratory bench. There should be enough room to easily handle the instrument. Beside the rheometer, place the additional control unit PT-S (peltier temperature controller) to be installed for Models R/S CPS+ P1 and P2 and the controller for electrical heating EHR. Two cables connect the R/S CPS+ and temperature controller. Exposure to direct sunlight and other heat sources is to be avoided in order to ensure optimum temperature control.

III.2 Electrical Connections

Connections for the electrical components of the R/S-CPS+ Rheometer are located on the back of the instrument.

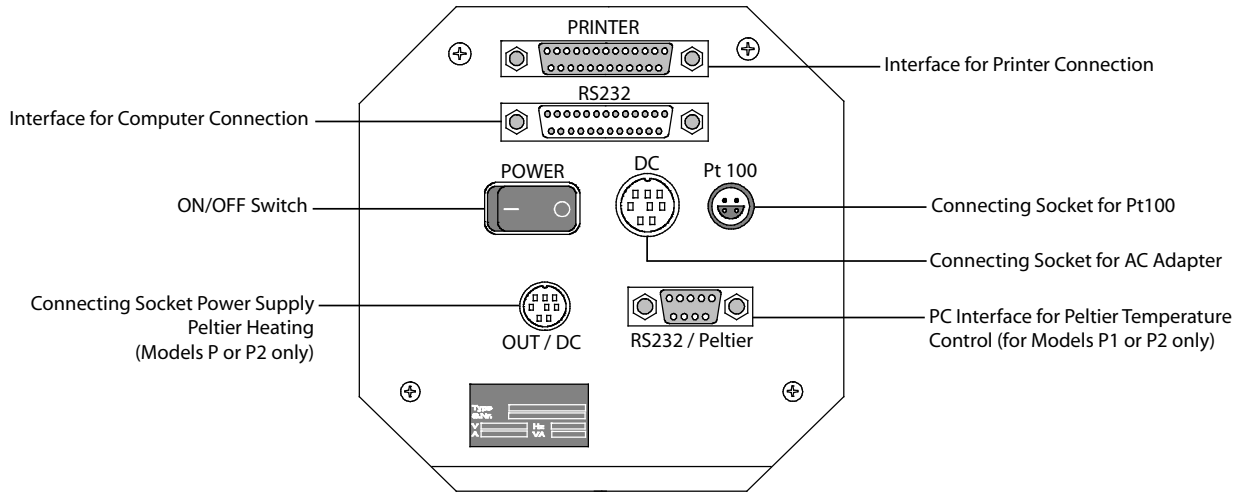


Figure II-3: Operating and connecting elements at the back side of the measuring head

All cables to and from the R/S-CPS+ Rheometer must be connected or disconnected only when the instrument is switched off!

III.2.1 Temperature Sensor

The connecting cable of the temperature sensor Pt 100 (100 ohm DIN alpha RTD) is inserted into the socket labelled “Pt100” at the back side of the rheometer head.

III.2.2 AC Adapter

Do not use a power supply other than the AC adapter delivered by Brookfield for the R/S CPS+ Rheometer.

Connect the AC adapter using a grounded plug to avoid electric shock or damage to the system components!

Connecting the AC adapter:

- Turn the R/S-CPS+ Rheometer off with the “POWER” switch at the back side of the instrument.
- Connect the RS-CPS+ power cord into the AC adapter.
- Insert the socket of the DC cable into the “DC” connector port at the back side of the rheometer head.
- Plug the power cable into a grounded AC main socket.
- Turn the R/S-CPS+ Rheometer on.

The AC adapter should not remain connected to the main socket while the plug of the DC cable is disconnected from the “DC” connector port at the back side of the rheometer head.

III.2.3 Printer Connection

The printer can be connected directly to the printer port of the R/S CPS+ Rheometer when measuring without PC support. You must pre-set “Printer” as the output device to print the measured values during measurement. The printer should have a parallel printer interface.

- Turn off the rheometer using the “POWER” switch at back of the instrument.
- Insert the printer connecting cable into the “PRINTER” port on back of the instrument.
- Turn the R/S-CPS+ Rheometer on.

A standard parallel printer cable can be used to connect the printer to a PC. This cable is supplied with the printer, in most cases. To print data values from the R/S CPS+ Rheometer, any (parallel) printer which can operate in ASCII character mode may be used.

III.2.4 Computer Connection

If the R/S-CPS+ Rheometer has to be used in "REMOTE" mode with a PC (Rheo 3000 program package) or with serial data-terminal for data-logging, the RS232 cable needs to be connected to the 25 pin connector labelled "RS232" on the back of the instrument.

- Turn the R/S-CPS+ Rheometer off with the "POWER" switch at the back of the instrument.
- Turn the computer system off.
- Connect the rheometer data cable to the 25 pin port labelled "RS232" on the back of the R/S CPS+ Rheometer.
- Connect the Peltier data cable to the port labelled "RS232/Peltier" on the back of the P-TS control unit.
- Turn the R/S CPS+ Rheometer and your computer system on again.

You must use the computer cable supplied by Brookfield - other cables will not work!

III.3 Connecting the Temperature Control Device

The following devices are used to provide temperature control:

- A **Bath/Circulator** for the temperature range -20°C to +250°C.
- The **Peltier temperature control device** for the temperature range 0°C to +135°C or +20°C to +180°C.

III.3.1 Connecting a Bath/Circulator

Hose connections are required to connect a bath/circulator to the R/S CPS+ Rheometer. The hoses for the bath/circulator are connected by means of quick connect couplings. When viewing the instrument from the front, the supply is at the front connection (connected to the bath outlet) and the discharge is the rear connection (to be connected to the bath inlet). In this case, the bath water/oil enters in the middle of the plate and spreads evenly towards the plate periphery.

To connect the hoses, push the coupling sleeve slightly back, insert the hose connecting piece and let the coupling go. It will fasten the hose (without screwing and turning) by locking it in place. Check whether the hose connection is secure by pulling gently.

The R/S CPS+ Rheometer can only be used without additional cooling at temperatures up to +140°C. For operation with higher temperatures (+140°C to +250°C), water has to be fed into the cooling flange!

The water in the Bath Circulator should be changed annually!

The following working fluids are usually used in the temperature bath:

-10°C to +90°C	Water (de-ionized) - Glycol Mixture
-20°C to +250°C	Silicone Bath Oil

Suitable bath fluids can be ordered from **BROOKFIELD**.

We recommend strongly that the upper temperature limit be set at the liquid circulating thermostat to +95°C if water is used and to +250°C if oil is used.

III.3.2 The Peltier Temperature Control Device

If the R/S CPS+ has been equipped with a Peltier temperature control system (i.e. model R/S CPS+ P1 or R/S CPS+ P2), a bath/circulator is not used.

The Peltier temperature sensor Pt100 allows temperature regulation from 0°C to +135°C (Model P1) or from +20°C to +180°C (Model P2).

A switching power supply (15V/60W) in the **Peltier Unit P-TS** supplies the Peltier amplifier with power. A green light indicates that power is on while a red light indicates a fault.

For very low temperature operation with the P1 (under 10°C) tap water circulating through the Peltier plate will improve temperature control.

The Peltier Supporting Unit P-TS shows all existing control elements, indicators and connections in Figures 4-A and 4-B.

Fig. 4-A: Front View of Peltier Supporting Unit P-TS

Fig. 4-B: Back View of Peltier Supporting Unit P-TS

The P-TS is powered via a grounded main socket. The AC voltage must be the same as the rated voltage shown on the plate.

The cables for Peltier control are connected to the related sockets (see *Figure 4-B*). In case cooling processes are supported with cooling water (+10°C to +30°C), the rheometer (Model P1) measuring plate should be connected with appropriate hose connections to the bath/circulator.

After activation of the main switch, the green LED display illuminates on the P-TS. The rheometer display shows the control function in the menu directory as “Thermostat”.

⚠	**The P-TS should be switched off during unsupervised operation (heating or cooling).**

III.3.3 Electric Heating Control

The R/S CPS+ Rheometer with electric heating (R/S CPS+ E1) does not need a bath/circulator. Detailed information on this operation is given in a separate manual for electric heating EHR.

IV. Environment, Handling, Cleaning and Maintenance

IV.1 Operating Environment

Find a comfortable, convenient work place for the installation of the R/S CPS+ Rheometer. There should be enough room to place the Rheometer, the measuring systems, the measuring substances and the peripheral devices (e.g. printer, computer and bath/circulator). You need a grounded AC plug to operate the R/S CPS+ Rheometer and additional plugs for the connection of each peripheral device (i.e. Bath, Peltier). Your operating environment and the place where you store the R/S CPS+ Rheometer should not be extremely hot, extremely cold or extremely moist. Places with strong temperature and air humidity variations should also be avoided. Be sure that the R/S CPS+ Rheometer is not exposed to the following:

- heavy dirt or dust,
- direct sun radiation,
- objects that emit strong heat (e.g. heating radiators),
- objects with a strong electromagnetic field (e.g. loudspeakers, motors etc.),
- liquids or corrosive chemicals.

IV.2 Handling

The R/S-CPS+ Rheometer is designed to endure slight bumps and minor vibration. Avoid dropping it or exposing it to heavy shock!

Never lift your R/S-CPS+ Rheometer by the measuring element or its coupling. Avoid everything that might impair the free rotation of the measuring element coupling.

The rheometer motor will automatically turn off if the maximum torque (50 mNm) is exceeded.

IV.3 Cleaning

The paint coat of the R/S CPS+ Rheometer resists most solvents and weak acids. Use a dry, clean, soft and nap-free piece of cloth to clean the housing. Use neutral detergent liquids, if necessary.

Do not use chemical products such as strong solvents or strong acids to clean the housing, especially the key pad.

Make sure NO liquid penetrates into the housing (e.g. through the instrument connecting sockets) and into the bearings of the measuring drive. This could destroy the instrument!

IV.4 Maintenance

The R/S Rheometer system is designed for long-term operation. Should the instrument require repair, contact Brookfield or your authorized Brookfield dealer.

Only authorized service personnel may work on the control electronics, all accessories, the meauring device, as well as the AC Adapter and all electric circuits and connections!

Measurement accuracy can be checked by the user at any time. We recommend that the measurements be done with Brookfield viscosity standard fluids (mineral oils) as recommended for each individual spindle geometry.

You must:

- Use temperature control
- Select the appropriate measuring system
- Carry out measurements at the following pre-set M (‰ torque) values: 250‰, 500‰ and 750‰
- Read viscosity values from the display on the RS-CPS+

In case of instrument failure (or severe deviation from the mineral oil viscosity value), contact Brookfield or your authorized Brookfield dealer.

V. Measuring Systems

This section covers the various measurement geometries. The following types of measuring systems are suited for use with the R/S CPS+ Rheometer:

a) cone/plate measuring systems
b) plate/plate measuring systems

Please select a suitable measuring system in the measuring range required for your measurements (see Appendix A.1).

When measuring cones are used, the shear rate is the same across the whole measuring gap. The most common cone angles are α=1° and α=2°. The cone is truncated 50µm (0.05 mm) in order to avoid contact and friction with the bottom measuring plate.

Measuring plates are used when large filler particles occur in the measured substance. Gaps between 0.3 to 3.0 mm may be used. In this case, the shear rate in the measuring gap is a function of the radius.

.

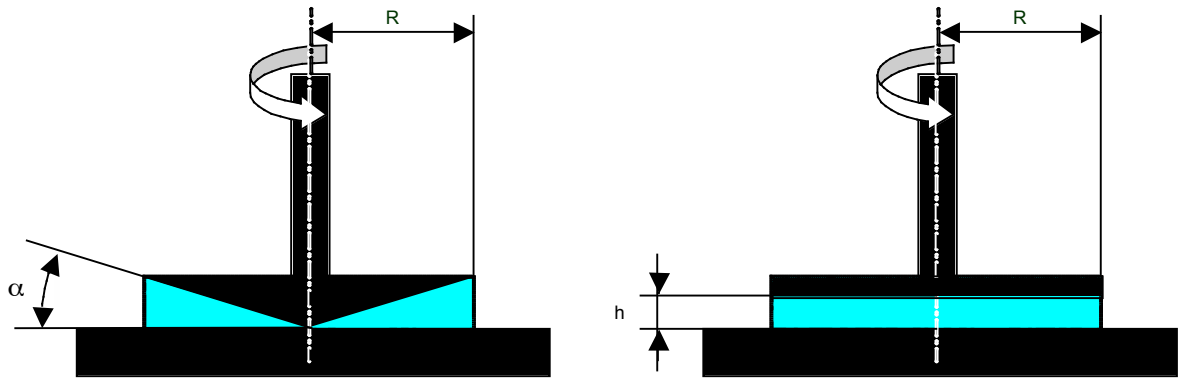


Fig. 5: Measuring Cones and Plates for R/S CPS+ Rheometer

V.1 Inserting and Adjusting the Measuring Elements

The cone/plate and plate/plate measuring systems consist of the fixed bottom plate and the upper measuring cone or plate that is height-adjustable.

The measuring head has to be lifted to insert the measuring element. Move the height adjusting lever towards the front and the measuring head will go up. Push the coupling sleeve of the measuring element up. Insert the measuring element (cone or plate) into the coupling. Push the sleeve of the measuring element coupling down until the measuring element is held tight by the coupling. Loosen the measuring element's hexagon socket screw.

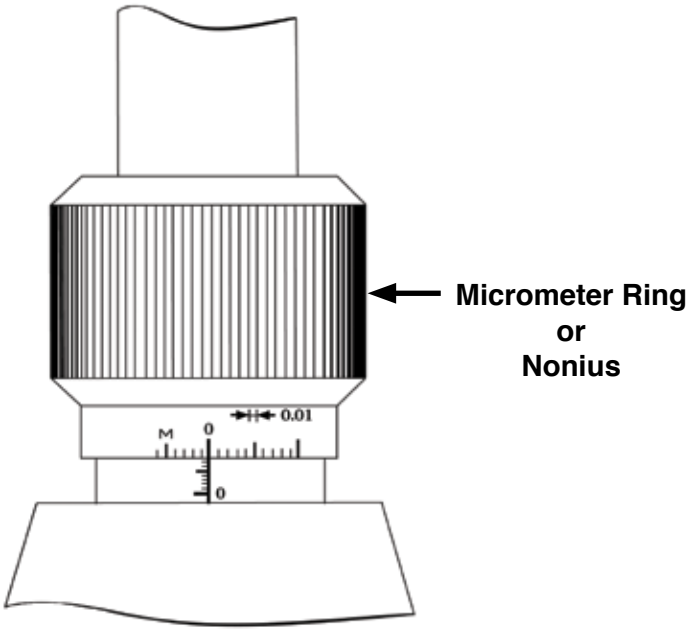


Fig. 6: Setting the gap on the R/S-CPS+ Rheometer

Set the micrometer ring (Nonius) to ZERO (scale division 0.01 corresponds to 10 µm). The micrometer ring (Nonius) bottom line has to be aligned with the ZERO level marking. Looking down onto the micrometer ring (Nonius) from the top, turn it counter-clockwise to lower the head and reduce the gap. Turning the micrometer ring (Nonius) clockwise will raise the head and increase the gap.

Lower the measuring head to the ZERO position to compress the unlocked measuring element slightly. Now, tighten the hexagon socket screw at the measuring element by hand to lock the measuring element in position.

The measuring clock (the position gauge to the left of the micrometer ring (Nonius)) can now be set to ZERO for control purposes.

The measuring head is lifted and the micrometer ring (Nonius) is now set to the gap for the cone (which is taken from the calibration sheet supplied with each cone). The gap is normally in the range of 0.04 - 0.06 mm, however, other gaps can be selected when necessary. The standard distance in a plate/plate measuring system is 1 mm; operation is possible within the range of 0.3 - 3 mm depending on the properties of the measuring substance (particle size!).

The micrometer ring (Nonius) can be locked at the back with a hexagon socket screw M3.

	**The measuring cone/plate may only be adjusted, and the hexagon socket screw may only be tightened, when the measuring temperature is set precisely. Otherwise, the gap distance may be changed due to thermal fluctuations, resulting in faulty measurement or in damage to the measuring system.**

V.2 Filling the Measuring Systems

Place the sample material on the bottom plate with the instrument head in the upper position. Air bubbles in the sample will affect test results and should be avoided. Remove excess sample from around the cone or plate with the provided spatula, taking care not to scratch the surface of the bottom plate.

Remove excess sample from cone or plate edge.

Set the bath/circulator to the required temperature if measurements are to be taken under controlled temperature. Do not begin the measurement until the temperature in the substance has stabalized at set point, e.g. temperature measurement by Pt100 (See *Section VI: Operation and Menu Systems)*.

Now, the measurement can begin.

Take care when measuring at high temperature! Always check the temperature before removing the cone or plate to avoid burned fingers!

Be sure to hold the measuring system with one hand when you disconnect the geometry. Dropping the cone or plate can cause nicks which will affect calibration.

Clean the bottom measuring plate and measuring element carefully without using hard objects to avoid scratches! Store the disassembled measuring element on a soft pad.

Always disconnect the cone or plate by lifting the coupling collar before raising the rheometer head after a measurement!

VI. Operation and Menu System

The following section summarizes the operation and the menu system of the R/S CPS+ Rheometer for both manual and PC-controlled measurement.

Menu prompts for the R/S CPS+ Rheometer are available in the following languages:

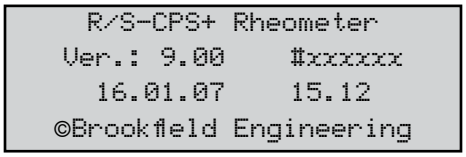
- English
- German

The language is selected via the menu level **Configuration→Language** (if English is active) or **Konfiguration→Sprache** (if German is active). For more details on language selection, see *Section VI.7.6: Configuration → Language*.

After applying power to the R/S-CPS+ Rheometer, the LCD displays the following information for a few seconds:

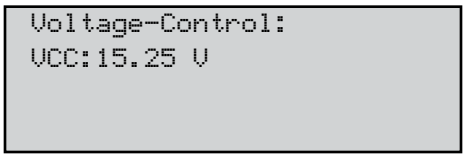
- name of the rheometer
- software version of the firmware installed in the instrument
- serial number of the instrument
- date and time

Example:



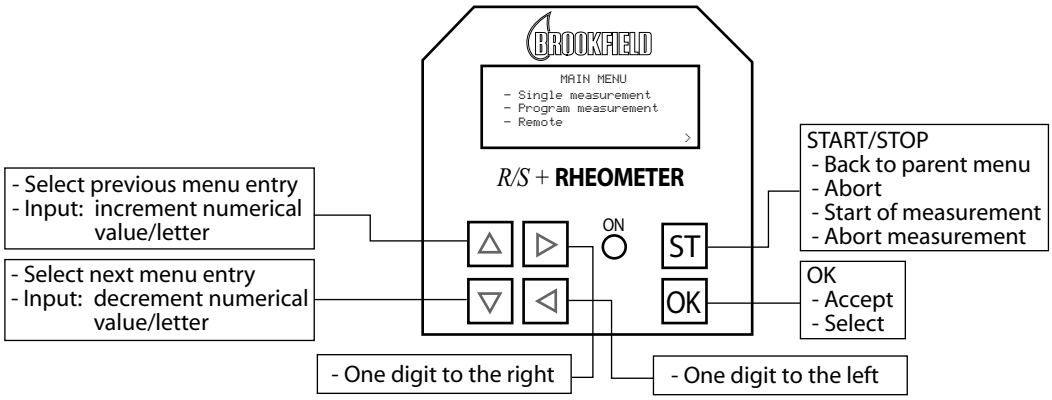
About five seconds later, the instrument checks the voltage of the power supply. The displayed voltage should be in the range of 14.9 to 16V. If the voltage is outside this range, contact Brookfield or your local Brookfield dealer.

Example:



This message is displayed for about 3 seconds and then the MAIN menu is displayed. A brief summary, in *Section VI.1: Keyboard*, of the rheometer keyboard and the corresponding rheometer functions may be helpful before you get to the complete description of the menu.

VI.1 Keyboard



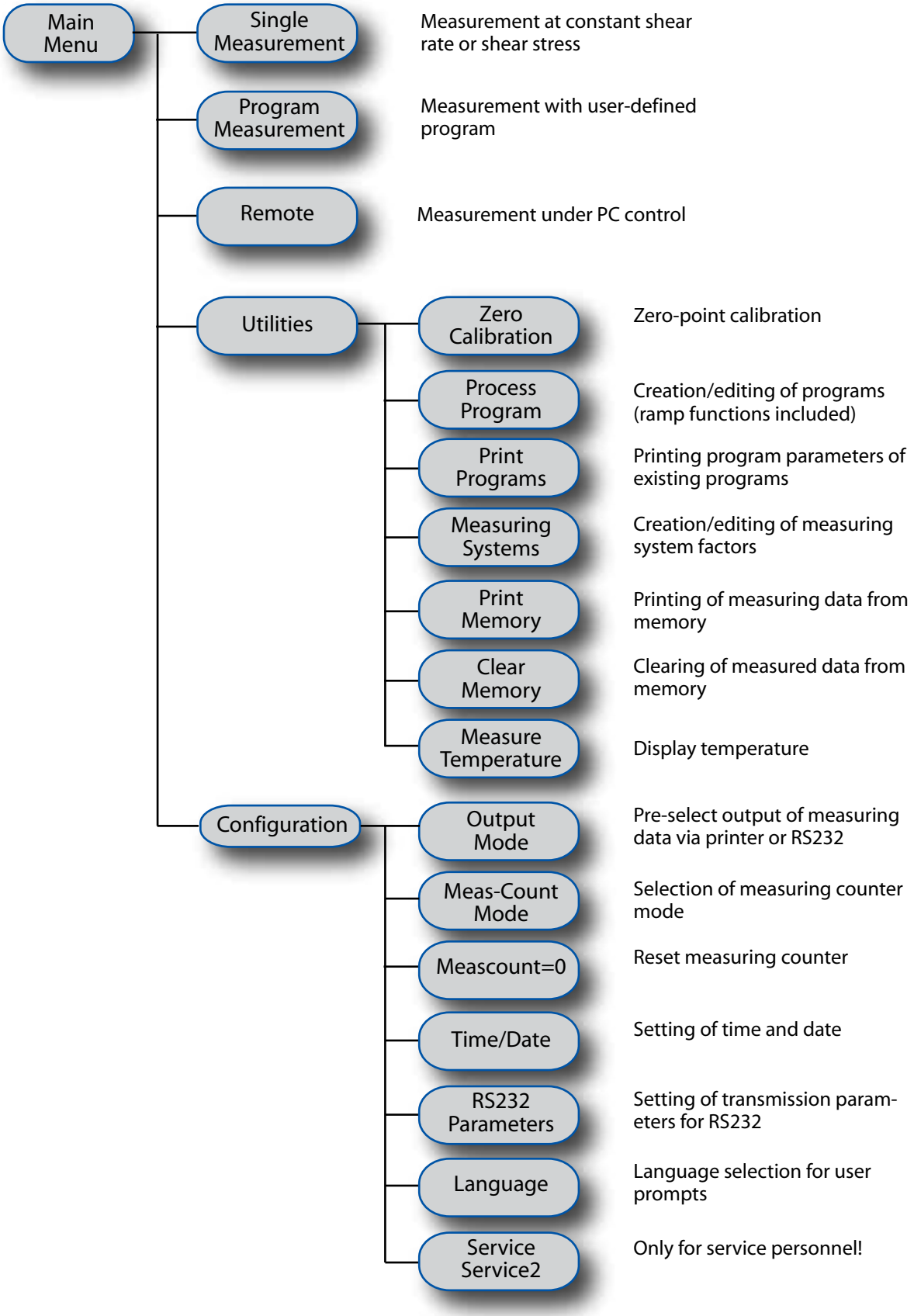
All user inputs are made using the six keys located below the LCD. Some of the keys have multiple uses, i.e. their function depends on the current operation. The following table shows the keyboard functions in detail.

Keypad layout of the R/S-CPS+ Rheometer

Key	Operation	Function of Key	Example
▲	1) Menu	1) Go to previous menu entry (above active one)	1) Utilities → Remote
	2) Input of numerical values	2) Increment	2) 8 → 9 A → B
	3) Selection from list	3) List entry above active entry (previous)	3) Select meas. system C50-2/30 → C50-1/30
▼	1) Menu	1) Go to next menu entry (below active one)	1) Remote Untilities
	2) Input of numerical values	2) Decrement	2) 5 → 4 F → G
	3) Selection from list	3) List entry below active entry (next)	3) Select meas. system C50-1/30 → C50-2/30
▷	1) Menu	1) Go to previous menu entry (above active one)	1) Utilities → Remote
	2) Input of numerical values	2) One digit to the right	2) 100.00 → 100.00 Test → Test
	3) Selection from list	3) List entry above active entry (previous)	3) Select meas. system
◁	1) Menu	1) Go to next menu entry (below active one)	1) Remote → Utilities
	2) Input of numerical values	2) Last digit	2) 100.00 → 100.00 Test → Test
	3) Selection from list	3) List entry below active entry (next)	3) Select meas. system

Key	Operation	Function of Key	Example
ST	1) Menu	1) Return to parent menu (turn page downward)	1) Utilities → Main
	2) Input of numerical values	2) Stop input (only if possible)	
	3) Selection from list	3) Stop selection (only if possible)	3) Select meas. system → back to menu
	4) Measurement	4) Start and stop measure-ment	4) Break when measuring
	5) Remote operation	5) Stop measurement	
		6) Go back to main menu	
OK	1) Menu	1) Select active menu level (open sub-menu)	
	2) Input of numerical values	2) End of input/acceptance	
	3) Selection from list	3) Select active list element	

VI.2 Menu System of R/S-CPS+ Rheometer

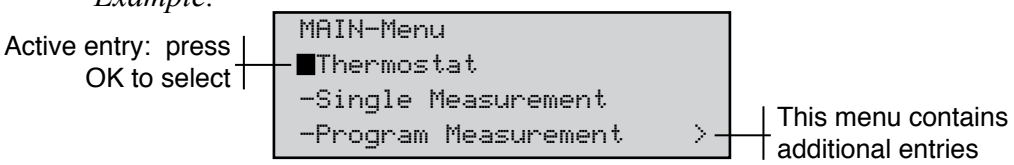


Menu Handling

Since the LCD of the R/S CPS+ Rheometer cannot show all menu items simultaneously, only three entries are displayed on the menu at a time. Arrows (>) on the right side of the display indicate that there are more menu entries. The arrow on the 2nd line indicates there are more menu entries above and the arrow on the 4th line indicates more menu entries below.

The currently active (but not yet selected) entry is marked by a blinking field (cursor) on the left side of the LCD.

Example:



Using the ▲ and ▼ keys, you can move the cursor up and down in the menu until the desired menu entry is reached.

Note: If there are more menu entries in the menu when you have reached the end of the display, the next part of menu will be opened automatically (scrolling).

You can "start" the menu entry by pressing the OK key, as well as open the related sub-menu.

If you are in a submenu and wish to return to the upper menu, press the ST key.

VI.3 Selecting from Lists

The same keyboard and display functions that are in the menu apply if you have to select a pre-existing entry from a list. Selection from a list is required for the following:

- Select a measuring system for measurement, e.g.in "Single measurement" or "Edit Program"
- Select pre-set values for measurement, e.g. in "Single measurement" or "Edit Program"
- Select a program or a measuring system you want to edit in "Edit Program" and "Measuring Systems"
- Answer a request "YES" ↔ "NO".
- Select the program to be started in "Run Program"

The ▲ and ▼ keys move the cursor up and down the list.

The OK key selects the entry, the ST key stops the selection from the list (only if possible).

Example:

```
Select Meas.system:
1) C25-2/30
2) C50-1/30
3) C50-2/30
```

VI.4 Input of Numerical Values and Alphanumeric Texts

Most user defined entries are numbers. User defined values such as the Start and End values of a ramp, number of measuring points, factors, time, date, etc. are entered as numbers with or without decimal digits.

If the display shows the decimal point in a number to be entered, input of a floating-point number is requested. However, the number of digits after the decimal point is limited to the number of displayed decimal digits; i.e. the decimal point cannot be moved during input. The digit to be changed is indicated by a bar under the digit.

The following example indicates the input of numerical values. We will change the value of shear rate (Val.[1/s]) from 0100.00 to 290.00.

In the example below, the cursor bar is located under the"1" in the entered shear rate (currently 100.00 s^{-1}).

```
Input of Values:
Val.[1/s]: 0100.00
Nr. of MP: 010
Time[s]: 0100
```

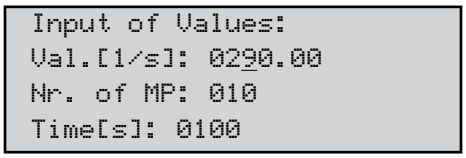
The "1" can be changed (incremented or decremented) by using the ▲ and ▼ keys. Press the ▲ key once to get:

```
Input of Values:
Val.[1/s]: 0200.00
Nr. of MP: 010
Time[s]: 0100
```

The cursor can be moved right or left by using the ▷ and ◁ keys. To change the next digit, press the ▷ key:

```
Input of Values:
Val.[1/s]: 0200.00
Nr. of MP: 010
Time[s]: 0100
```

The next digit can now be changed. In order to insert "9" in place of "0", press the ▼ key once:



Note: If you press and hold one of the ▲ or ▼ keys while entering numbers, the digit will first increment or decrement by +/- 1. However, after a short period of time, the process will continue automatically. This corresponds to the **Repeat Function** of computer keyboards.

In this example, the ▲ key was pressed and held until the "9" was displayed. **The repeat function is only active during numerical and alphanumeric input.**

When the desired number is displayed, accept it by pressing the OK key: the cursor now moves to the first digit of the next field to be entered.

Alphanumeric inputs

Some fields allow for both numbers and letters. These are entered the same way as previously discussed for numeric fields. The available entries are: 0 through 9, A through Z, and the blank symbol " ". If you wish to change the letter "B" to the number "7", press and hold the ▲ or ▼ keys until the "7" appears at the display.

Alphanumeric input is available when assigning a name to a user defined program, or an ID to a user defined test measurement.

VI.5 Menu Entries (MAIN Menu)

Menu entries (see *Section VI.2: Menu System of R/S-CPS+ Rheometer*) either lead to submenus (e.g. Utilities or Configuration), or they start one of the rheometer's functions directly.

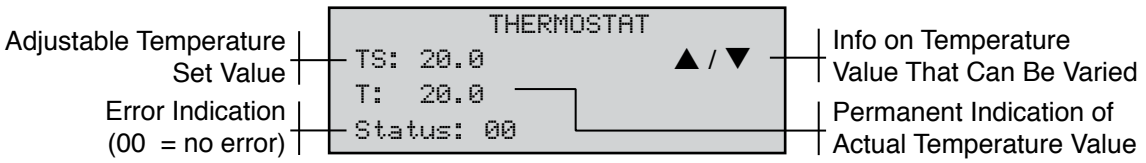
All gray fields in the tree chart in this section that have no further right branches start functions. Those with right branches are submenus.

Recall the keyboard layout from *Section VI.1*. By pressing the ▲ and ▼ keys, the cursor (black rectangle) moves up and down. The OK key starts a function. If a submenu is assigned to the entry it will open, otherwise the function of the rheometer is started. The functions of the R/S-CPS+ Rheometer are described in detail in this section.

VI.5.1 MAIN Menu → Bath/Circulator (only for P1 and P2 models)

This optionally available menu item permits an adjustment of temperature set points on rheometer configurations R/S CPS+ P1 and P2 with Peltier temperature control.

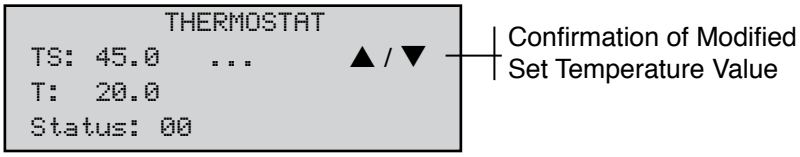
After actuating the main control switch of the rheometer followed by a few seconds required initial self-test, the following display screen is reached automatically:



The last adjusted set point TS is always saved when the rheometer is turned off. When the rheometer is re-started, the Peltier will return to the last set point.

Modify the set point temperature with the ▲ and ▼ keys.

The temporary flashing of three points "• • •" confirms the acceptance of the new set temperature value:



Adjustment of the actual temperature value starts automatically. The main menu can be re-entered with the ST and OK keys.

VI.5.2 MAIN Menu → Single Measurement

This function measures shear stress or shear rate (CSS or CSR) at constant user defined values. The user may select a choice of measurement method from the follwoing:

Shear Rate	D [s^{-1}]
Speed	n [U/min] or [rpm]
Shear Stress	Tau [Pa}
Torque	M[‰] [1000‰ correspond to 50 mNm]

Before you can start the measurement itself, you have to input the following values:

- Selection of the measuring system used (see *Section VI.3: Selecting from Lists*).
- Selection of test method (see *Section VI.3: Selecting from Lists*). This is where you decide if you want a controlled rate measurement (shear rate, RPM) or a controlled stress measurement (shear stress, torque).
- Input of pre-set values (see *Section VI.4: Input of Numerical Values and Alphanumeric Texts*).
  - D [s^{-1}] range of values depends on the measuring system
  - n [rpm] 0.7 to 1,000 rpm
  - Tau [Pa] range of values depends on the measuring system
  - M[‰] 0-999 ‰
- Input of desired number of measuring points (see *Section VI.4: Input of Numerical*

Values and Alphanumeric Texts)

- Input of the measurement duration in seconds. The minimum allowed interval between two measuring points is different for controlled rate and controlled stress, as follows:
  - shear rate measurement $t_{MP} >= 4$ s
  - shear stress measurement $t_{MP} >= 1$ s

Note: The longer the time between two measured values, the higher the accuracy of the physical values determined!

- Input of ID (15 character maximum) for the Test Measurement (see *Section VI.4: Input of Numerical Values and Alphanumeric Texts*)

Before starting a measurement, the rheometer will indicate where the measurement points will be written to:

```
Output of MPs to:
- no output-device
- memory
<▲>menu   <ST>START_
```

Start a measurement by pressing the [ST] key or return to the main menu with the [▲] key.

This example shows that the measurement data will be written into the instrument memory. Output devices are either a printer or the RS232 serial interface of the rheometer. Preselection of these devices is described in the *Section VI.7.1: Configuration → Output Mode*.

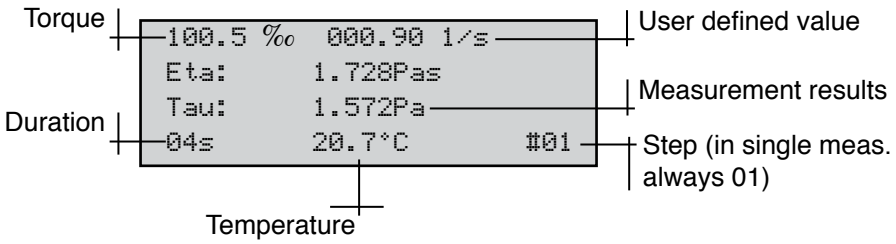
If the memory is full and you want to keep the data, you should stop the "Single Measurement" function, print out the data from the memory or send the data to a PC (see *Section VI.6.5: Utilities → Print Memory*). Then you may clear the data from the memory (see *Section VI.6.6: Utilities → Clear Memory*) and run your test.

Tests may still be run if the memory is full, but the results will not be saved. They will be shown on the LCD as they come from the instrument.

When a measurement is started, the instrument shows:

```
Program running
Wait for 1.MP
                    #01
```

This message will be displayed until the first measuring point is reached and displayed.



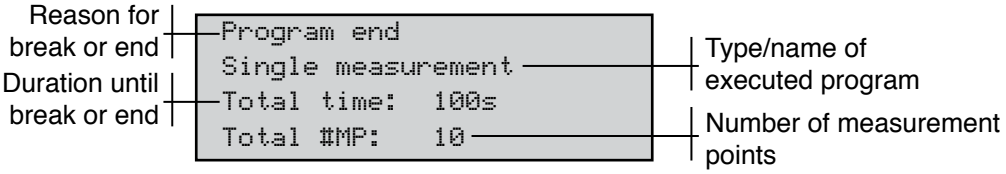
If the torque is below 10‰ (scale is 0‰ to 1,000‰), the measurement results may not be as accurate as desired. In this case the user defined parameters should be changed so the torque is higher than 10%.,

If the display field for the torque indicates: "Mlow!", these values are below the range of resolution of the rheometer.

If the temperature is not displayed, the measuring sensor is not connected and will show as "1000.0°C" on the printout.

The display is updated with every new measuring point. The current measurement can be cancelled at any time with the ST key.

After a measurement is completed or if the ST key is pressed, the display field for Step indicates "END" or "BREAK". The display alternates at intervals of about four seconds between the last displayed measuring point and information about the measurement:



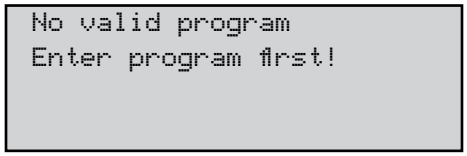
Pressing the OK key stops the alternating display and returns the user to the menu.

Note: The last selected program parameters remain in the memory even after switching off the Rheometer.

VI.5.3 MAIN Menu → Run Program

This function begins a user defined measurement program. With a Program Measurement, the user can also set values as a linear function of time, such as $D[s^{-1}] = f(t)$. It is useful to use "Run Program" when doing repeat measurements involving the same preset values and the same measuring system. The user only needs to run the program rather than select parameters each time they need to run the test. Four standard programs (and more optional ones) may be defined. *Section VI.6.2 Utilities → Edit Program* describes how to prepare or modify such a program.

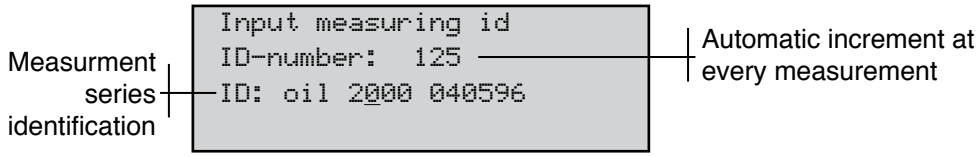
The Run Program function starts one of the available programs defined in the memory. If there is no program available, the following error message is displayed:



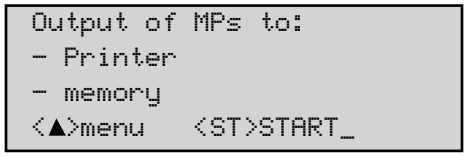
In this case, the user has to define a program first (see *Section VI.6.2: Utilities → Edit Program*). Use the OK key to return to the main menu.

If programs are available, a list appears to select from. Select the program to be started (see *Section VI.3: Selecting from Lists*).

If the OK key is used to select the program (in this example, the program named "Test"), this operation is followed by the option to enter an ID (identification text of the measurement, a maximum 15 characters - see *Section VI.4: Input of Numerical Values and Alphanumeric Texts*).



Next, the rheometer will indicate where the measure points will be written to.



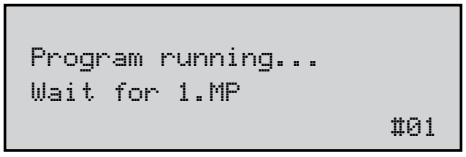
Start a measurement by pressing the ST key or return back to the main menu with the ▲ key.

In the above example, the measurement points will be saved to the memory and printed to the printer connected to the rheometer. Options for output devices include a printer, the RS232 serial interface or no output device. In *Section VI.7.1: Configuration → Output Mode*, this is described in detail.

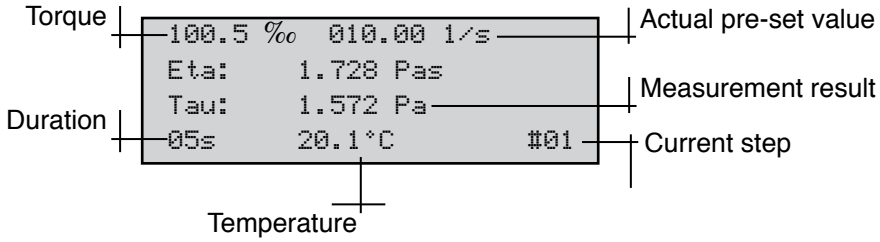
If the memory is full, you should consider cancelling the Run Program function, printing the data from the memory or sending it to a PC (see *Section VI.6.5: Utilities → Print Memory*) and then clearing the data from the memory (see *Section VI.6.6: Utilities → Clear Memory*).

Measurements can be taken with the memory full but the results will only be shown at the LCD and will be lost after completion of the measurement. If you try to send results to a printer and it is not connected or has no paper in it, an error message will be displayed until the printer is connected and operational or until you stop the activity.

When you start the measurement, the instrument shows:



This message will be displayed until the first measuring point is displayed.



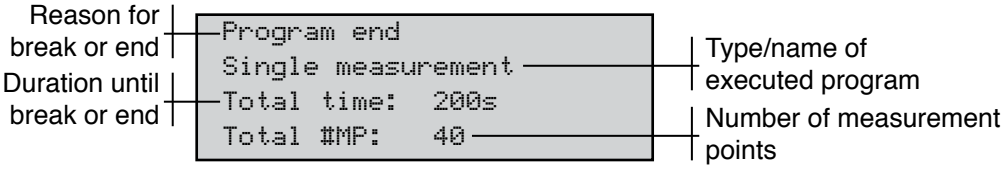
If the torque is less than 30‰, the results may not have the desired accuracy or repeatability. The user should consider changing the user defined test parameters to get a torque higher than 30‰.

If the display field for the torque indicates: "Mlow!", these values are below the range of resolution of the rheometer.

If the temperature is not to displayed, the measuring sensor is not connected and the printout of the temperature will be printed as **"---"**.

The display is updated with every new measuring point. The current measurement can be cancelled at any time with the ST key.

After measurement, or after a stop, the display field for step indicates "END" or "BREAK". The LCD alternates at intervals of about four seconds between the last displayed measuring point and information on the measurement:

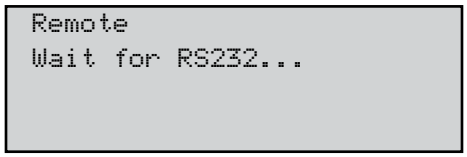


Pressing the OK key stops the alternating display and returns the user to the main menu.

VI.5.4 MAIN Menu → Remote

The "Remote" function initiates measurements to be made under PC control. In this mode, all functions of the R/S-CPS+ Rheometer are controlled by a PC. For PC-controlled measurements, you need the Rheo 3000 Software. This software operates under Microsoft Windows 7™ , Windows 2000™ , Windows XP™ and Vista™ . More detailed information on Rheo 3000 software can be obtained from Brookfield or an authorized dealer.

After selecting the Remote option, the rheometer displays the following:



The rheometer waits for communication with a PC. Data transfer between the PC and the rheometer is performed through the RS232 serial interface of the R/S-CPS+ Rheometer.

If the Rheo 3000 software is installed on the PC, the REMOTE (MEASURE) program can be run. This operation can be ended at any time by pressing the ST key. The current measurement is also cancelled by pressing the ST key in REMOTE operation.

On completion of the communication with the PC, the LCD shows: "Remote done ..." Pressing the ST key will return the display to the Main Menu.

During measurement in REMOTE operation, the LCD will display troubleshooting information in case errors occur.

VI.5.5 MAIN Menu → Utilities

Entry to open the "Utilities" submenu - see *Section VI.6*.

VI.5.6 MAIN Menu → Configuration

Entry to open the "Configuration" submenu - see *Section VI.6*.

VI.6 Menu Entries in the Utilities Menu

The Utilities menu contains several useful functions.

Zero Calibration	Initiates the zero calibration procedure of the rheometer
Edit Programs	Input or modification of programs which are started with Run Program
Print Programs	Prints all parameters of all the programs in memory to the printer
Measuring Systems	Input of the measuring system parameters or generation of new measuring systems
Print Memory	Output of data in memory to the printer or to the serial interface
Delete Memory	Clears all data from memory
Temperature Meas.	Measures temperature without running a measurement

The following sections explain these options in more detail.

VI.6.1 Utilities → Zero Calibration

The Zero Calibration function serves to calibrate the zero point of the rheometer. This function continues for approximately 10 minutes and should be done once a week.

Before starting this function, be sure the R/S-CPS+ Rheometer has warmed up for at least 10 minutes, and that NO measuring element is in the measuring element coupling.

To confirm the command that the measuring system is removed, press the OK key (start of zero point calibration), or press the ST key to return to the Utilities menu.

Zero point calibration will proceed automatically and comprises several measuring series at different speeds. The progress of calibration is shown by the number of executed steps of the total steps. If an error message appears during zero calibration, repeat the zero calibration. If the error message is displayed again there may be a technical fault (See Appendix G: Warranty and Repair Services).

After successful calibration, the values of the zero point are stored internally. These values are preserved until the next calibration.

Press the OK key to save the values. Press any other key to return to the Utilities menu without saving.

Note: You can cancel zero point calibration at any time with the ST key. The zero point values determined up to that point will be ignored.

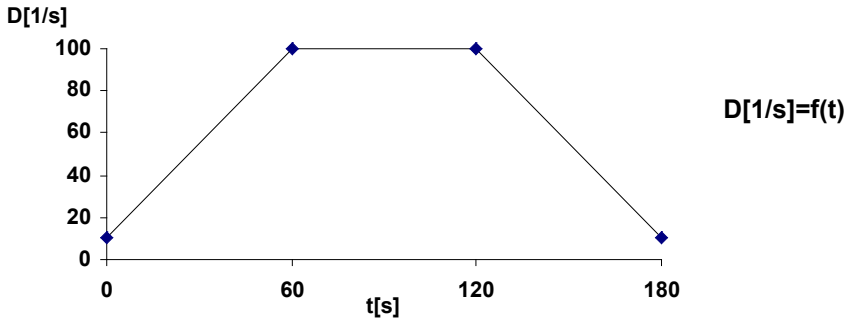
VI.6.2 Utilities → Edit Program

This function allows the input of new programs and the modification of existing programs. The programs may be run after a successful creation via the menu level "Program Measurement" in the main menu.

The following values are user-definable in a program:

- measuring system to be used
- number of steps
- start and end value of each step
- number of measuring points in the program
- duration of measurement

Preset value as a function of time:



A standard measurement is shown in the following example:

- 1st step: shear rate increases within 60 sec from 10.00 to 100.00 s^{-1}.
- 2nd step: shear rate remains at 100. 00 s^{-1} for 60 seconds
- 3rd step: shear rate decreases from 100.00 back to 10.00 s^{-1} within 60 seconds

This measurement consists of three steps, each lasting 60 seconds and containing a number of measuring points.

The following is an example to explain the input of a program.
Apart from the shear rate D [s^{-1}] = f(t), the preset value can also be defined as:

- speed n [rpm] = f(t)
- torque M [‰] = f(t) and
- shear stress Tau [Pa] = f(t)

Steps are always linear, measurement points are also defined as linear; i.e. logarithmic steps are not possible. For logarithmic measurements, you will need the Rheo 3000 software.

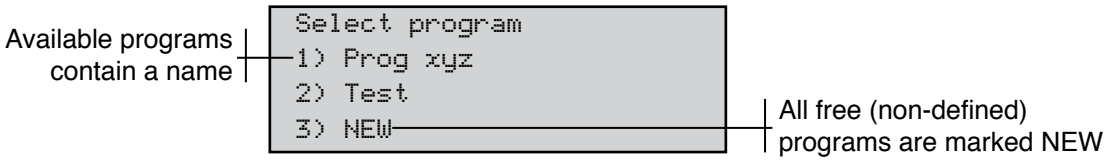
Preset value sub-steps in a defined step are done according to the following equation:

Preset Value = End Value - Start Value/(Number of Measuring points - 1)

The first user defined value (= the first measuring point) is always the start value of the ramp. The last measuring point is determined as the end value of the user defined value range. As in our example, to reach the values D = 10, 20, 30, ... , 100 [s^{-1}] a starting value of 10 [s^{-1}] is used with increments of 10, therefore, 10 measuring points is required. To check: 100-10/(10-1) = 10.

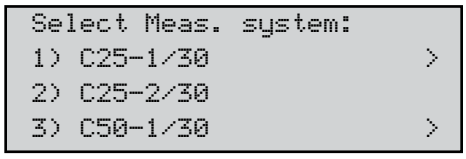
Number of Measurement Points = ((End Value - Start Value)/Pre-set Value - 1)

After selection of the menu level "Edit Program", the user will be prompted to select the program.

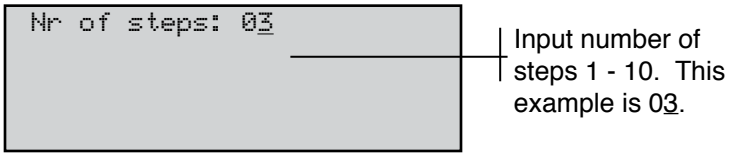


All free programs are initially marked as NEW. To avoid overwriting existing programs, select NEW as a program to be edited and select a measuring system. After the selection of the program with the OK key, you will be requested to select a measuring system.

Attention: Any defined program MUST ALWAYS be executed with the same measuring system, otherwise improper results will be calculated.



After selecting the measurement system, enter the number of steps (number of ramp and straight line functions). The number of steps can range from **1 to a maximum of 10 steps**. In this example, we need three steps, so the number "01" is changed to "03" - (see *Section VI.4: Input of Numerical Values and Alphnumeric Texts*). The message "Range error" will appear if <1 or >10 is entered.

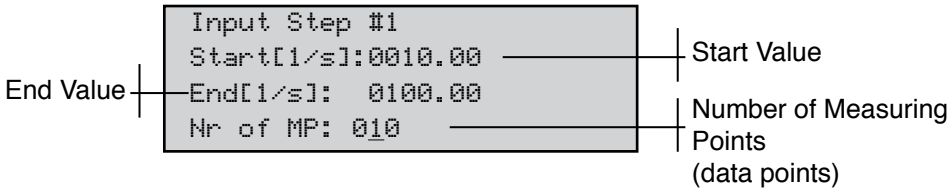


After entering the number of steps, input the type of measurement.

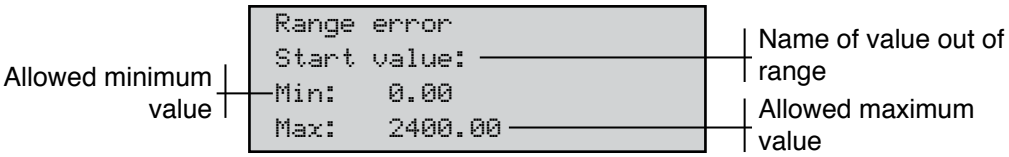
Available Measurement Types	User Defined Range
Shear Rate D{s^{-1}]	Depends on the measuring system
Speed n[rpm]	0.1 - 1,000 rpm
Shear Stress Tau [Pa]	Depends on the measuring system
Torque M[‰]	0 - 999 promille (= 0 to 50 mNm)

Select the type of measurement and press the OK key (in our example "D[1/s]"). Now enter the user defined values for each step one after the other.

The following inputs have to be made for each step:



Minimum and maximum start and end values depend on the selected measuring system for shear rate (D[s^{-1}]) and shear stress (Tau [Pa]). At input, the rheometer checks the start and end values and indicates the message "Range error" if out of range:



For example, a range error message would be displayed if a start value for D[s^{-1}] is not within the range of 0 - 2400.00 s^{-1} when using measuring cone C50-2.

If the start value, end value and number of measuring points are acceptable, the user will be prompted for Step Duration:

Minimum step duration:

Available Measurement Types	User Defined Range
Shear Rate D{s^{-1}]	t_{min} = number of measuring points * 4 s
Speed n[rpm]	t_{min} = number of measuring points * 4 s
Shear Stress Tau [Pa]	t_{min} = number of measuring points * 1 s
Torque M[‰]	t_{min} = number of measuring points * 1 s

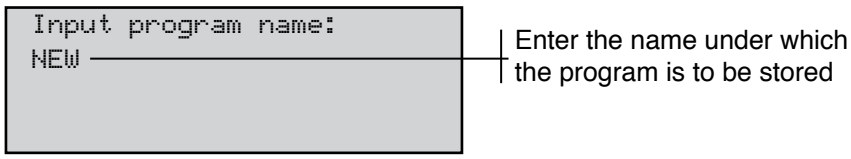
Maximum step duration: 3600 s

The instrument will automatically check the input. If there is a range error, "Range error" would be displayed together with the allowable range.

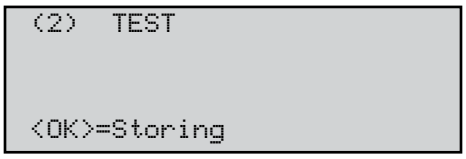
The more time between two measuring points, the higher the accuracy of the determined physical parameters!

The input procedure for start and end value, number of measurement points and step duration is repeated for the next step. The procedure is repeated until all steps have been entered.

The program will then prompt the user for a program name.



For this example, we will use "TEST" (see *Section VI.4: Input of Numerical Values and Alphanumeric Texts*). The instrument will prompt the user to store the Program with the Name:



Press the OK key to store the program.

If any other key besides OK is pressed, the entries are abandoned and those parameters that existed before editing will be preserved.

VI.6.3 Utilities → Print Programs

This function will print the parameters of the defined programs in memory.

If the printer is not ready for operation when the "Print Programs" function is initiated, the following error message will be displayed:

```
ERROR #1
Printer not ready!

<OK>cont.  <ST>stop
```

If this error message appears, ensure the printer is ready and contains paper.

Press the OK key to try printing again or press the ST key to return to the menu.

VI.6.4 Utilities → Measuring Systems

This function provides a method to create new measuring systems or change existing measuring systems.

The following values can be edited:

- name of measuring system
- shear rate factor K([min/s] (k_gamma)
- shear stress factor ‰ [Pa] (tau_prom)

Only authorized personnel are permitted to change constants of the measuring system!

After starting the function, you will be prompted to select the measuring system you want to edit. Select the list item "NEW" to generate a new measuring system.

```
Select Meas. system:
1) C25-2/30            >
2) C25-1/30
3) C50-2/30            >
```

After selection of the measuring system entry, the user is prompted to enter a name, tau_prom and k_gamma.

```
Enter Meas. syst. #4
Name:  C50-1/30
tau_prom:  01.1418
k_gamma:   01.2910
```

The measuring system name is entered in alphanumeric form; the factors tau_ prom and k_gamma are entered as numerical entries (see *Section VI.4: Input of Numerical Values and Alphnumeric Texts*).

After entry, the system will prompt the user to store the new parameters.

```
<OK>=storing
Name:  C50-1/30
tau_prom:  01.1418
k_gamma:   01.2910
```

Use the OK key to store the new information, otherwise press the ST key to return to the menu without storing.

VI.6.5 Utilities → Print Memory

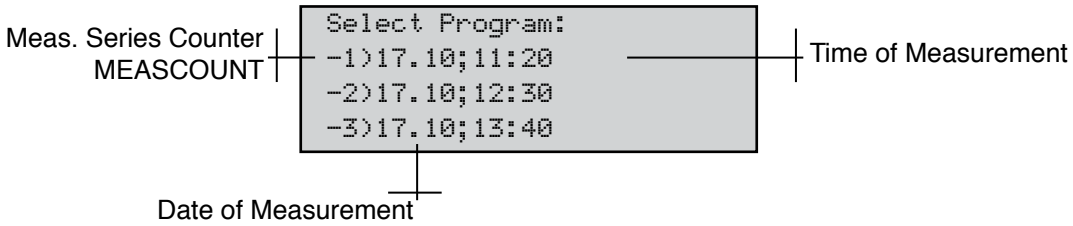
This function allows the output of the data stored in the instrument memory to either a printer or to the RS232 serial interface of the rheometer.
The instrument will prompt you to select the output device, as follows:

```
Sel. output-device:
-Printer
-RS232
```

a) Output to printer:
The printer must be connected to the rheometer and ready for operation.

b) Output to the RS232 serial interface:
The data receiving side (typically a PC) must be set to the data transfer parameters from the rheometer. If the receiving side is not set up properly, the data will either not be transmitted or transmitted to Null. (see *Section VI.8: Serial Data Transfer via the RS232 Interface*).

After choosing the output device, you are prompted to select the program to be printed or transferred.

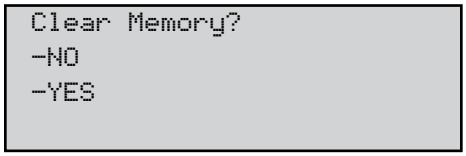


The data of the program will print as a table to a printer or will be transferred via the serial interface. After completion of data transfer, the rheometer returns to the Utilities Menu.

VI.6.6 Utilities →Clear Memory

This function deletes all measured data stored in the memory of the R/S-CPS+ Rheometer.

Before deleting, ensure that the data has been archived to a printer or PC. Before the memory is cleared, the following prompt is displayed:

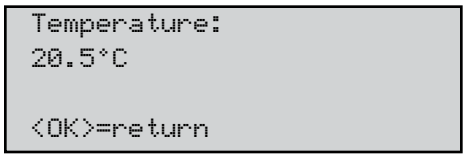


If "YES" is selected, the results will be cleared from the memory; if "NO" is selected, no deletions are made and the user is returned to the menu.

VI.6.7 Utilities →Measure Temperature

This function displays the temperature with the temperature sensor connected to the rheometer.

After initiating this function, the temperature is measured continuously:



Push the OK key to return to the Utilities menu.

VI.7 Menu Entries of the Configuration Menu

The configuration menu allows the user to set parameters on the rheometer.
The entries:

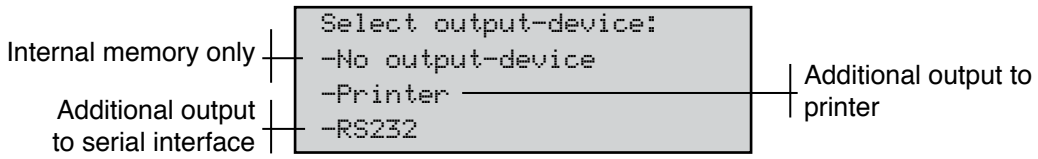
- **Set Output-mode:** Defines if data is output to a printer or to the serial interface during measurement.
- **Set Meascount mode:** Defines whether the measurement counter MEASCOUNT is reset daily or not.
- **Set Meascount=0:** Resets the MEASCOUNT counter to 0.
- **Set Time/date:** Inputs date and time.
- **RS232 Parameters:** Sets data transfer parameters of the serial interface RS232.
- **Language:** Selects language for user prompts.
- **Service:** For service personnel only
- **Service2:** For service personnel only

These functions are explained in more detail in the following sections.

VI.7.1 Configuration → Output Mode

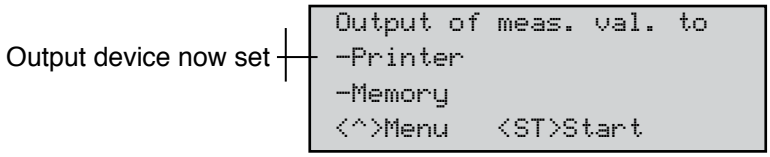
This function defines the output device (printer, serial interface) which will receive the results. This setting is independent of the internal memory in the rheometer for data storage. When tests are run, the data is automatically stored in memory in addition to being sent to the configured output device.

After selecting this function, you are prompted to select an output device:



Choice of an output device is stored in the instrument by pressing the OK key. **This selection remains stored even after switching off the instrument!**

The set output device is prompted before the start of every measurement (see *Section VI.5.2: Main Menu → Single measurement* and *Section VI5.3: Main Menu → Run Program*).



After selecting an output device and before the start of every measurement, be sure that:

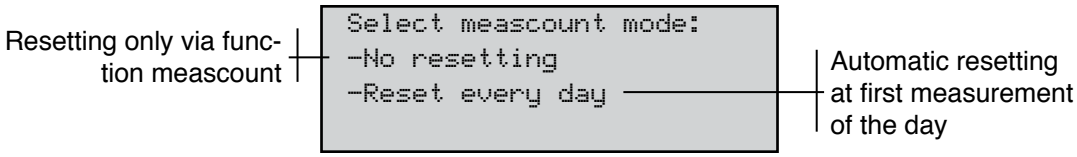
a) the printer is connected to the rheometer and is ready for operation. If the printer is not ready, you cannot start the measurement.

or

b) the RS232 is connected to the receiving device (normally a PC), which is set to the data transfer parameters of the rheometer (see *Section VI.7.5: Configuration → RS232 Parameters*) and ready to receive data. If the receiving side is not ready, the data will not be transmitted or will be transmitted to Null (see *Section VI.8: Serial Data Transfer via the RS232 Interface*).

VI.7.2 Configuration → MeasCount Mode

The measurement series counter MEASCOUNT increases by 1 before each measurement is started. The measurement series counter serves to identify a measurement series. The counter increments until it is reset manually (“MeasCount=0”) or automatically. The user defines whether the measuring counter is reset daily or not.



After choosing one of two reset modes, the user will be returned to the Configuration Menu.

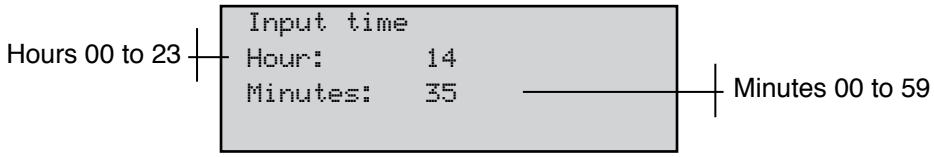
VI.7.3 Configuration → MeasCount=0

This function resets the measurement series counter regardless of how the MEASCOUNT is set.

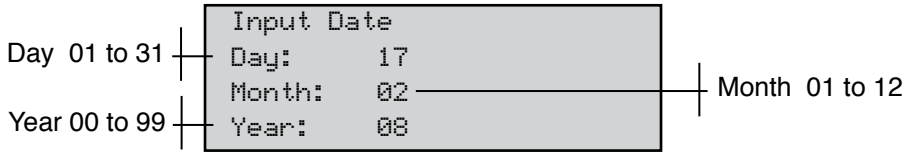
VI.7.4 Configuration → Time/Date

This function allows the user to set the internal clock and internal calendar.

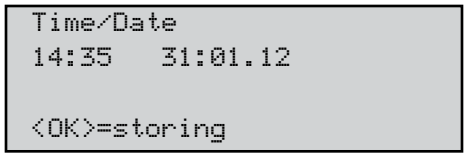
The time is set in 24 hour format.



The date is set as dd.mm.yy format:



After setting the time and date, you will be prompted to store the clock to the new time.



Set the time using the OK key, or return to the menu without storing by pressing ST.

Note: The new time is entered into the clock only after the OK key is pressed. Note that storing of the time sets the seconds to 00.

VI.7.5 Configuration →RS232 Parameters

This function allows the preselection of interface parameters.
The serial interface operates **without handshake**.
Data is transferred as **ASCII text**.

Parameters to Set	
Baud rate [Baud]	110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200
Parity	n(= no parity) e(=even) o(=odd)
Stopbits [Bit]	1 or 2
Databits [Bit]	7 or 8

The standard setting is:
Baud rate = 4800
Parity = n
Stopbit = 1
Databits = 8

If you change these settings, you also have to set the new transfer parameters of the receiving device!

After starting the RS232 Parameters function, you will be prompted to enter the baud rate:

```
RS232:  4800,8,n,1

Change RS232-Par.?
<OK>YES      <ST>NO
```

Press the OK key to initiate the input of parameters.

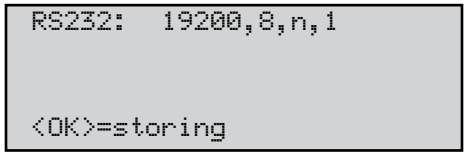
You may enter the following parameters in succession:
- Baud rate [Baud]: 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200
- Databits [Bit]: 7 or 8
- Parity: n (=none) e(=even) o (=odd)
- Stopbits [Bit]: 1 or 2

Select the required parameter from the list of available parameters and accept the selection by pressing the OK key.

Example: Baud rate

```
Baud rate:
-4800
-9600
-19200
```

When all parameters have been selected, the new parameters are displayed:



Accept the set parameters by pressing the OK key.

The new settings are now stored and will remain in the rheometer memory even after switching off the instrument.

VI.7.6 Configuration → Language

This function selects the user language of the R/S-CPS+ Rheometer. Available languages are:
- German
- English

Select the desired language and press the OK key. The selected language will be preserved in the instrument even after it is switched off.

VI.7.7 Configuration → Service

These functions are for service personnel only. Password-protected!

VI.8 Serial Data Transfer via the RS232 Interface

Serial data transfer should only be done when the user of the rheometer has basic knowledge of data processing and is capable of changing the data transfer parameters on the sending and receiving sides.

Data can only be transferred successfully when the transmitter (R/S-CPS+ Rheometer) and receiver (e.g. a PC) fulfill the following requirements:

1. The instruments are properly connected by the interface cable which is delivered with the instrument. **Caution: Both instruments must be switched off while the connection is made!** (see Appendix A.3).
2. The transmitter (R/S-CPS+ Rheometer) and the receiver are set to identical data transfer parameters (for R/S-CPS+ Rheometer, see *Section VI.7.5: Configuration → RS232 Parameters*).
3. The receiver has enough computing and memory capacity to receive or store the data.

The following example demonstrates reception by means of the terminal program under Microsoft™ Windows.

1. Switch the rheometer and the PC off.
2. Connect the rheometer (RS232 connector port at the back side of the instrument) to a free serial interface (e.g. COM2) of the PC. Use the cable supplied by Brookfield.
3. Switch the PC and the rheometer on.
4. Set the data transfer parameters at the rheometer (see *Section VI.7.5*). Here: Standard setting 4800 Baud, Parity n, Stopbit 1, Databit 8.
5. Select the RS232 interface as the output device at the rheometer (see *Section VI.7.1*).
6. Open the "Windows Accessories" program on the PC.
7. Start the "Terminal" program.
8. Select the menu level "Settings" →"Data transfer."
   A window will appear where you can set the data transfer parameters:
   - Select from "Connection" the COM-port to which the rheometer is connected.
   - Set "Baud rate" to "4800".
   - Set "Databits" to "8".
   - Set "Stopbits" to "1".
   - Set "Parity" to "No parity".
   - Set "Protocol" to "No protocol".
   - Deactivate "Parity check" checkbox (if crossed).
   - Deactivate "Carrier signal detection" checkbox (if crossed).
   - Finish input by pressing the OK key.
9. Select the menu option "Settings" → "Terminal Settings".
   A window will appear where you can set the data transfer parameters:
   - Select "English" option.
   - Activate "IBM in ANSI" (if not crossed yet).
10. 10. Parameters of the terminal program that have been changed up to this time can be stored under the menu option "File" → "Save" by entering the file name, e.g. "R/S-CPS+ Rheometer.TRM". (When the terminal program is started again, this file with can be opened by: "File" → "Open" and load the parameters for data transfer with the R/S-CPS+ Rheometer.)
11. Now select the menu level "Transfer" → "Text file reception".
    - Enter the file name for the stored data sent from the rheometer (e.g "TEST.TXT").
    - The message "Receving: TEST.TXT" will then appear in the status line of the terminal program.
12. The terminal program is now ready to receive data.
13. Start measurement with the rheometer. Measuring points should appear as text on the PC display after a short period of time.
14. When the data of one or several measurements have been transferred into the selected text file, terminate the data transfer and end the terminal program.

Should a receiver other than a PC be used for serial data transfer, the pin assignment of this receiver must be checked before the connection is made. See Appendix A.3 to find the pin assignment of the serial interface plug as well as the data link cable.

VII. Measuring

VII.1 Measuring in Manual Operation

You can measure in manual mode by following these brief instructions:

- Install the R/S-CPS+ Rheometer (see *Section III: Instrument Installation*).
- Connect the AC adapter (see *Section III.2.2: AC Adapter*).
- Connect the printer, which is optional (see *Section III.2.3: Printer Connection*).
- Fill and mount the measuring system (see *Section V: Measuring Systems*).
- Make sure no substance or solvent enters the measuring element coupling, the measuring drive or the electronic unit.
- Wait until the sample reaches the desired temperature.
- Start a Single Point Test or Run Program (see *Section VI.5: Menu Entries*).
- After running the test, remove the sample and clean the measuring system.

VII.2 Measuring in Remote Operation

- Install the R/S-CPS+ Rheometer (see *Section III: Instrument Installation*).
- Connect the AC adaptor (see *Section III.2.2: AC Adapter*).
- Connect the RS232 cable between the rheometer and the PC.
- Switch on the R/S-CPS+ Rheometer and select the menu level “Remote” on the main screen.
- Switch on the computer and all peripheral devices.
- Start the Rheo 3000 software.
- Load a program within the Rheo 3000 software.
- Fill and mount the measuring system (see *Section V*).
- Make sure no substance or solvent enters the measuring element coupling, the measuring drive or the electronic unit.
- Wait until the sample reaches the desired temperature.
- Start a Single Point Test or Run Program (see *Section VI.5: Menu Entries*).
- After running the test, remove the sample and clean the measuring system.

VIII. Technical Data

R/S-CPS+ Rheometer	
Dimensions	480 mm x 300 mm x 290 mm
Weight	12 kg
Nominal operating voltage Power consumption (average) Power consumption (maximum)	± 15V, 5V 12W 22W
Ambient Conditions Temperature in operation out of operation Relative humidity (not condensable) in operation out of operation	 10° to 40°C 10° to 45°C 20% to 80% 10% to 90%
Accuracy	± 3% of viscosity standard fluid value where M>30 ± 1 digit
Torque range	1.5 to 50 mNm
Torque resolution	0.01 mNm
Speed range	0.01 to 1,000 min^{-1}
Angle resolution	15.7μrad
Temperature range	-20° to +250°C depending on the geometry used
Range of shear rate	0 to 6,000 s^{-1} depending on the geometry used
Range of shear stress	0 to 16,300 Pa depending on the geometry used
Viscosity range The given range is a standard value (not maximum value)	0.0008 to 125,000 Pa•s depending on the geometry used. Practical low limit is .050 Pa•s for cone/plate measurement.

AC Adapter	
Dimensions	160 mm x 85 mm x 35 mm
Weight	0.5 kg
Power supply Operating voltage Output voltage Output current Output power	 100 to 240 VAC 5V, ± 15V DC 2A, 0.9 / -0.2A 20W
Frequency	50 to 60 Hz
Ambient Conditions Temperature in operation out of operation Relative humidity (not condensable) in operation out of operation	 +10° to +40°C +10° to +45°C 20% to 80% 10% to 90%

Preset, Measured and Evaluated Values

Value	Symbol	Physical Unit
Speed	n	[min^{-1}]
Torque (relative) (1000 ‰ = 50 mNm)	M	[1}
Temperature	T	[°C]
Time	t	[s]
Shear rate	$\dot{\gamma}$	[s^{-1}]
Shear stress	τ	[Pa]
Dynamic viscosity	η	[Pas]

Appendix A

A.1 Data Sheets of Standard Measuring Systems

Table A-1: ***Cone/Plate Measuring Systems according to DIN 53018***
(consisting of measuring cone and the bottom measuring plate of the instrument)

Measuring System	RC3-25-1	RC3-25-2	RC3-50-1	RC3-50-2	RC3-75-1	RC3-75-2
Shear rate range [s^{-1}]	0-6,000	0-3,000	0-6,000	0-3,000	0-6,000	0-3,000
Shear stress range [Pa]	0-12,223	0-12,223	0-1,528	0-1,528	0-452	0-452
Viscosity range [Pa•s]	0.25-1,629	0.5-3,259	0.03-203	0.06-407	0.009-60	0.02-120
Filling volume [ml]	0.08	0.3	0.7	1.5	2.0	3.9
Shear rate factor $K\dot{\gamma}$ [min/s]	6.00	3.00	6.00	3.00	6.00	3.00
Shear stress factor $\tau‰$ [Pa]	12.223	12.223	1.528	1.528	0.4527	0.4527
Radius of measuring cone R [mm]	12.5	12.5	25	25	37.5	37.5
Angle of measuring cone α [°]	1	2	1	2	1	2
Cone truncation [µm]	50	50	50	50	50	50

The data in the following table is for plate/plate systems and is valid for a measuring gap of 1 mm. For other plate distances, please calculate $K\dot{\gamma}$ with the formula:

$K_\gamma = (2\pi/60) * (R/H)$ R = radius, H = gap

Table A-2: ***Plate/Plate Measuring Systems according to DIN 53-018***
(consisting of measuring plate and the bottom measuring plate of the instrument)

Measuring System	RP3-25	RPS-50	RP3-75
Shear rate range [s^{-1}]	0-1,308	0-2,600	0-3,925
Shear stress range [Pa]	0-16,298	0-2,037	0-603
Viscosity range [Pa•s]	1.56-9,960	0.097-623	0.02-122
Filling volume [ml]	0.5	2.0	4.5
Shear rate factor $K\dot{\gamma}$ [min/s]	1.309	2.6175	3.927
Shear stress factor $\tau‰$ [Pa]	16.2975	2.037	0.6036
Radius of measuring plate R [mm]	12.5	25	37.5

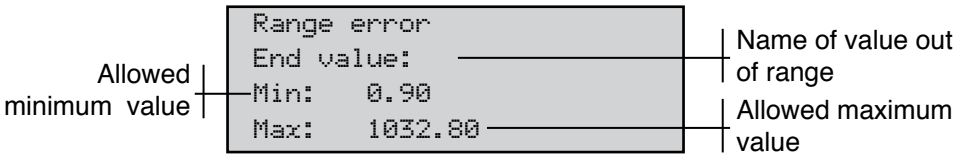
A.2 Error Messages

The R/S-CPS+ Rheometer is user-friendly regarding errors. When errors occur, they are trapped, and the user is informed on the LCD. The most frequent error messages are explained in this chapter.

Range Error

Cause: User's error at input. The user has tried to input a value that is less than the allowed minimum value or is more than the allowed maximum value.

Example of Faulty Input of a Preset Value:



What to Do: Enter the value again. Be sure that the new value is within the allowed value range.

Printer Error

Cause: The printer has been selected as the output device but is not ready for printing. Possible reasons include:
a] printer cable is not connected to the rheometer
b] paper is out, printer is not on line, other printer errors

Example of Print Error Message

What to Do: a] make sure printer cable is connected to the rheometer
b] make sure paper tray has paper
c] check that the "ready" LED lights of the printer are on
d] remove the error cause at the printer and press the OK key at the rheometer
e] press the ST key to stop the process if you cannot find the error cause.

Zero Calibration Error

Cause: An impermissibly high value was measured during the zero point calibration of the rheometer.

Example Message

```
Error #3
Zero cal. error!
Please retry cal.
<OK> cont.     <ST> stop
```

What to Do:

a] press the ST key
b] ensure the measuring system has been removed from the rheometer
c] retry zero point calibration - if error occurs again, this is an indication of a fault in the measuring instrument

ABORT: Torque Max

Cause: The maximum torque has been exceeded during a measurement. Possible reasons:
a] the measuring range is inappropriate for the measured sample
b] the cone or plate spindle cannot rotate on the measuring plate

Example Message

```
ABORT:torque max!
Single measurement
total time:      60 s
total no. of MP: 10
```

What to Do:

a] press the OK key
b] check whether the measuring system has been fastened properly at the rheometer
c] if fastened properly, select smaller shear rates or speeds for this measurement or use a measuring system with a higher shear stress factor

Abort: Speed Max

Cause: The maximum speed has been exceeded during a measurement. Possible reasons:

a] the selected shear stress or torque value for this measurement is too high

b] a torque or shear stress measurement has been started without sample in the measuring cup

Example Message

```
ABORT:speed max!
Single measurement
total time:      60 s
total no. of MP: 10
```

What to Do:

a] press the OK key

b] select smaller shear stress or torque for this measurement

A.3 Pin Assignment of the Serial Data Cable

The R/S -CPS+ Rheometer is equipped with a serial interface with a 25-pin sub D-connector (male) at the back side of the intrument. The serial interface is marked as RS232.

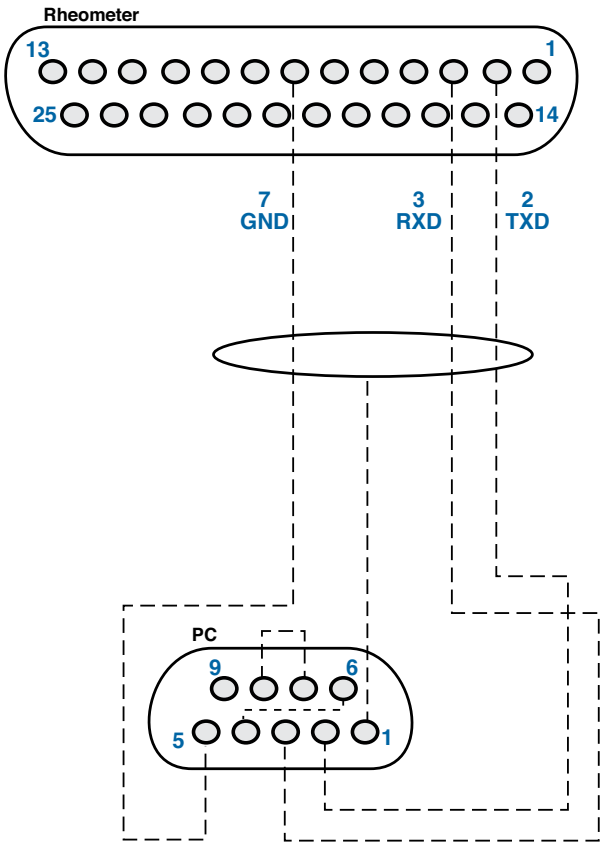
The signal levels are in the range of +12 V and -12 V in accordance with RS232.

The pin assignment of the serial data cable for serial data transfer to a PC is as follows:

Note: Unmarked pins must not be connected!

Rheometer side:
25-pin Sub-D-connector (female)
View on soldered connections
All other pins must not be connected!

PC side:
9 pin, sub-D-connector (female)
View on soldered connection



A.4 Requirements to the AC Power Connecting Cables

The AC adapter unit of the R/S-CPS+ Rheometer permits operation of the rheometer with supply voltages ranging from 100 to 240 VAC with frequencies from 50 to 60 Hz.

The main connecting cable supplied with the R/S-CPS+ Rheometer may not, in some cases, meet the requirements of every country. It is absolutely necessary that you use a main connecting cable that meets the specific requirements and regulations of the relevant country.

The following information explains the requirements that are to be taken into account when choosing the main connecting cable.

General information

- The connecting cable must be permitted (authorized) in the country where it is used.
- The mains cable should be at least 2 m and at the most 3 m long.

USA and Canada

- UL-permission and CSA Certificate are required for the mains connecting cable.
- The following minimal requirements are valid for the cable:
  - No. 18 AWG
  - Type SV or similar
  - 3-phase
- The cable must have a nominal rating of at least 10 A.
- The main plug of type NEMA 5-15P (15A, 125V) or NEMA 6-15P (15A, 250V) must have grounding contact.

Japan

The following cable types and connection values are required in Japan:

- All parts of the cables (cable, socket and plug) must have brand name and registration number according to the Dentori law.
- The following minimal requirements apply to the cable:
  - 0.75 mm2, 2-phase
  - Type VCT or VCTF
  - 3-phase
- The cable must have a minimum nominal rating of 7 A.
- The mains plug must be a 2-pin plug with grounding contact according to the Japanese Industrial Standard C8303 (15A, 125V).

Other countries

- The connectors of the mains connecting cable must be approved and certified by the responsible authorities in the respective countries. These authorities are:

Australia — EANSW	Great Britain — BSI
Austria — OVE	Italy — IMQ
Belgium — CEBEC	Netherlands — KEMA
Denmark — DEMKO	Norway — NEMKO
Finland — SETI	Sweden — SEMKO
France — UTE	Switzerland — SEV
Germany — VDE	

- The cable must be three-phase HAR-cable, type HO5VV-F3, with a minimal phase cross-section of 1.0 mm^2. The main connecting cable must be permitted for a rating of at least 10 A and, depending on country, a nominal voltage of 125 V or 250 VAC.

Appendix B Calibration Check Procedure

B.1 Equipment

- R/S-CPS+ Cone/Plate Rheometer with appropriate cables
- Temperature control apparatus[1]
- Flat edged non-metal spatula
- Cone Spindle and Certified Mineral Oil Viscosity Standard:

One of the following[2]:

- RC3-25-1 Cone Spindle with Fluid B41000
- RC3-50-1 Cone Spindle with Fluid B11000
- RC3-50-2 Cone Spindle with Fluid B41000
- RC3-75-1 Cone Spindle with Fluid B4900
- RC3-75-2 Cone Spindle with Fluid B4900

- Rheo 3000 Applications Software loaded onto a PC (optional)

Reminders/Comments:

- A calibration check can be performed with or without software.
- The rheometer should always be allowed 10 minutes minimum to warm up.
- Never lift your rheometer by the head, shaft, coupling element, or measuring element coupled to the machine.
- After the spindle has been lowered onto a sample, detach the spindle from the rheometer head before raising the head.
- Total time to perform a calibration check is approximately 50 minutes.

[1]Temperature Control apparatus consists of one of the following: Peltier System, Water bath, Oil Bath or Electronic Heat

[2] Calibration check using either an RC3-25-1 or RC3-25-2 is not advised. To achieve the best results, use RC3-50-1.

B.2 Setup Prrocedure

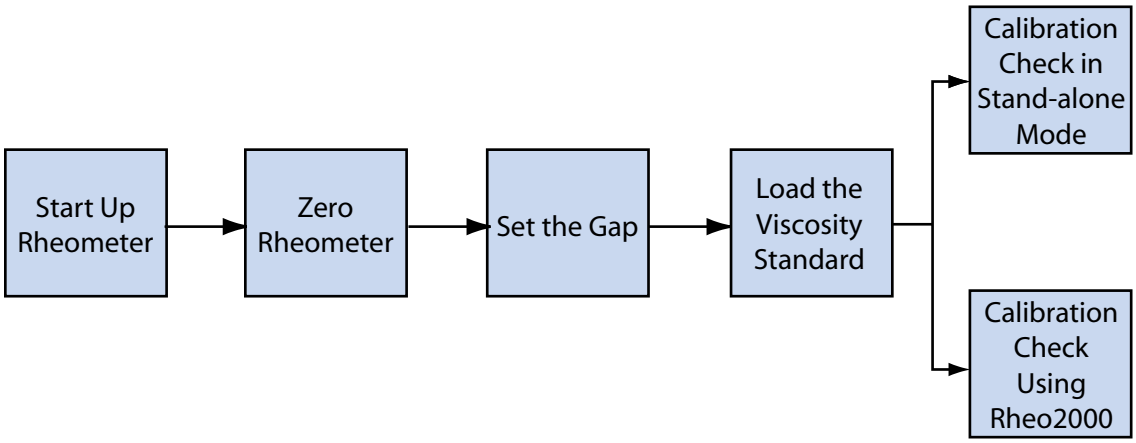
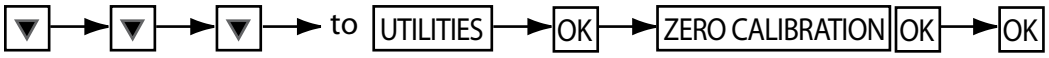


Figure B-1: Flow Chart for Calibration Check Procedure

1. Turn on the R/S-CPS+ Rheometer.
2. Turn on the temperature controller. Set the controller to 25°C.
3. Allow the R/S-CPS+ Rheometer to be on for a minimum of 10 minutes prior to taking measurement data or running a zero calibration.
   - Zero Calibration does not have to be executed prior to every test, but should be run no less than once a week.
   - Zero Calibration takes approximately eight (8) minutes.
   - *Best Practice:* run the R/S-CPS+ Rheometer at 100 rpm for 30 minutes just prior to zero calibration.
4. Ensure the spindle is not installed on the R/S-CPS+ Rheometer.
5. Lower the rheometer head.
6. Lower the spindle coupling collet.
   Select the zero calibration option and push the OK button.



7. Upon a successful completion of the zero calibration procedure, the rheometer head will display a message. Press the OK key to save the information. If an error message appears, see Appendix B.5.3: Troubleshooting. If the problem cannot be fixed, contact Brookfield or an authorized dealer for troubleshooting advice.

B.3 Setting the Gap

1. Raise the rheometer head (handle forward).
2. Attach the designated spindle on the rheometer.
3. Loosen the set screw so the spindle shaft cone moves freely up and down by hand.
4. Lower the rheometer head so spindle and plate are in contact.
5. Allow the spindle to come to temperature.

   NOTE: The greater the difference between the test temperature and ambient, the greater the time to come to temperature.

6. Raise the rheometer head.
7. With the rheometer head up, turn the micrometer ring to the zero point. Confirm this by observing the horizontal line on the instrument column and the vertical line on the micrometer ring line up as crosshairs. Turning the micormeter ring clockwise lowers the head; turning the micrometer ring counter-clockwise raises the head.
8. Move the micrometer ring clockwise past zero by one half revolution.
9. Move the micrometer ring counter-clockwise to the zero position and stop there.

   ***NOTE*: AFTER THIS STEP, NEVER TURN THE MICROMETER RING CLOCKWISE. A PRECISE GAP SETTING CANNNOT BE ASSURED OTHERWISE.**

   If the micrometer ring IS turned clockwise after this step, the gap setting procedure will need to be repeated starting from Step 7.

10. Lower the rheometer head (by moving the handle away from you), so that the spindle makes contact with the bottom plate of the rheometer base and the rheometer head is bottomed out on the micrometer ring.

11. Manually turn the outside ring of the dial indicator so that the needle is on zero.

    Note: Each division on the dial indicator corresponds to 0.01 mm (or 10μm).

12. Move the rheometer head up and down to confirm that the dial indicator needle remains at zero when the rheometer head is in the down (measuring) position.
13. When the following three conditions are met: (1) rheometer head down, (2) micrometer ring set to zero and (3) the dial indicator needle reading zero - tighten the hexagonal nut on the spindle shaft.
14. Raise and lower the rheometer head, to confirm the dial indicator needle reads zero when the rheometer head is in the down (measuring) position.
15. Obtain the spindle truncation from the spindle data sheet that came with the cone spindle.
16. Raise the rheometer head.
17. Turn the micrometer ring counter-clockwise to the truncation point from the spindle data sheet.
18. Lower the rheometer head.

    Note: The dial indicator needle will provide visual confirmation of a proper gap setting. For example, a gap setting of 0.05mm will produce a dial indicator reading of 45. A gap setting of 0.04mm will produce a dial indicator reading of 46. A gap setting of 0.06mm will produce a dial indicator reading of 44.

19. Raise and lower the rheometer head to confirm the dial indicator reading remains consistent.

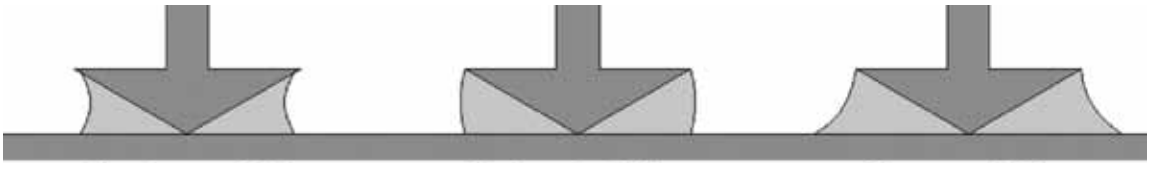
B.4 Loading the Viscosity Standard

1. With the spindle attached and the gap setting confirmed, raise the rheometer head (handle forward).
2. Using a non-metal spatula, place the viscosity standard onto the bottom plate of the rheometer directly below the spindle.

Measuring System (Spindle)	RC3-50-1	RC3-50-2	RC3-75-1	RC3-75-2
Approximate Fluid Volume (mL)	1	2	2.5	5

   Lower the rheometer head onto the viscosity standard so the dial indicator needle reads the proper gap setting for that spindle.

3. There should be viscosity standard visible around the entire edge of the spindle.
4. Trim excess viscosity standard from the edge using a non-metal spatula:



Under Fill **Ideal Fill** **Over Fill**

5. Wait fifteen minutes or more to allow the sample to come to temperature.

B.5 Calibration Check Procedure

The R/S-CPS+ calibration check can be performed with or without software. If software is not being used, proceed to *B.5.1 Calibration Check in Stand-alone Mode*. If software is being used, proceed to *B.5.2 Calibration Check with Rheo3000 Software*.

B.5.1 Calibration Check in Stand-alone Mode

1. Input Measuring System's Constants
   a. On the rheometer head, select "Measuring System" within the **Utilities** menu.
   b. Select the appropriate measuring system.
   c. Set Tau-prom and K_gamma to value specified on the spindle's measuring system data sheet.

      Note: Tau-prom (Kt) is the Shear Stress Factor
      K_gamma (Kxxx) is the Shear Rate Factor

   d. Set Distance Dependence to zero.
   e. Save
2. Run Single Program
   a. Select "Run Single" within the Main-Menu
   b. Select the appropriate measuring system (e.g. C50-1)
   c. Select input mode: M[‰.]
   d. Input steps

Input Value:	
Val. [‰]:	250
Nr. Of Mp:	1
Time [s}:	120

   e. Input ID or leave blank. Press the [OK] key.
   f. Press the [ST] key to start.
   g. Allow the program to complete.
3. Check the temperature on the display (refer to the main manual for this procedure). The temperature should read 25.0°C.
4. Check the viscosity reading. The measured viscosity should fall within 3% of the stated viscosity value of the viscosity standard at the appropriate temperature.
5. Repeat Steps 2 through 4 with the torque ‰ (Val. [‰]:) set to 500 and 750.

B.5.2 Calibration Check with Rheo 3000 Software

1. Launch Rheo 3000 Software.
2. Enter Measure/Analysis Menu.
3. Select Remote on the R/S front display.
4. Open communication between the rheometer and the PC.
5. Load your Calibration Program. Refer to the Rheo 3000 User's Manual for the block programming procedure. Calibration program parameters should be set up as follows:

Step Nr 1	
Start [‰] :	250
End [‰] :	250
Nr. Of Mp:	40
time [s] :	60

Step Nr 2	
Start [‰] :	500
End [‰] :	500
Nr. Of Mp:	40
time [s] :	60

Step Nr 3	
Start [‰] :	750
End [‰] :	750
Nr. Of Mp:	40
time [s] :	60

6. Enter the following information in the general block data:
   a. Viscosity Standard Name (e.g. B11000)
   b. Lot Number
   c. Expiration Date
   e. Viscosity Value
   f. Spindle Serial Number
7. Upon test completion, click the Analysis button. The average viscosity of each step will appear in the bottom window.
8. An average viscosity reading should be within ±3% of the standard's stated viscosity value at the appropriate temperature.

B.5.3 Troubleshooting

Check each of the items below if your measured values fall outside the range of uncertainty:
   a. Assure that the gap is set properly.
   b. Assure that the temperature is set properly.
   c. Assure that correct amount of calibration fluid is present and the gap is filled properly.
   d. Assure that correct spindle constants are being used.
   e. Assure that the rheometer has been zero calibrated.

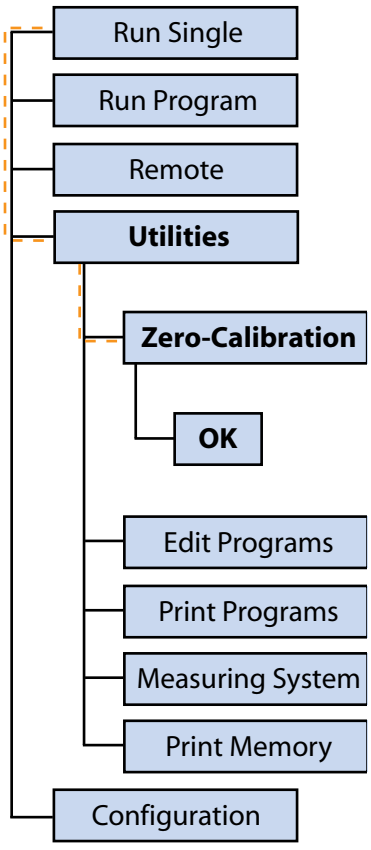
Error Messages

Message	Cause	Solution
Range Error	User input a value less than the allowed minimum value or greater than the allowed maximum value (Speed or Torque)	Check values. The R/S will advise the maximum and minimum values when this error is displayed.
Zero Cal. Error!	An unacceptable value was measured during the zero point calibration.	Ensure the spindle is not mounted to the R/S. Re-try zero calibration. If this fails, call for service.
ABORT: Speed Max!	Fluid is too thin to be run at requested Shear Stress/ Torque level. Alternatively, no fluid is present.	This should not happen following the proceding procedure.

Other Faults

Indication	Possible Cause	Solution
Dial indicator reading is inconsistent.	Set pin has lost hold power.	Pin may need to be replaced. Call for service.
Viscosity reading is low.	Micrometer ring was not lined up with zero on shaft. Head is too high.	Ensure spindle is not mounted to R/S. Re-try zero calibration. If it fails, call for service.
Viscosity reading is low and spindles does not mvoe freely when hex nut is disengaged.	Contamination has entered the gap between the spindle cone piece and spindle shaft.	Loosen set screw. Extend spindle to maximum length. Clean shaft. Repeat if needed. If the spindle cannot be cleaned sufficiently, call for service of spindle.
Viscosity reading is low.	Rheometer has been placed in a drafty location.	Utilize solvent trap; shield unit from drafts.

B.5.4 Flow Diagram for Zero Calibration



B.5.5 Cone Spindle Data Example

BROOKFIELD

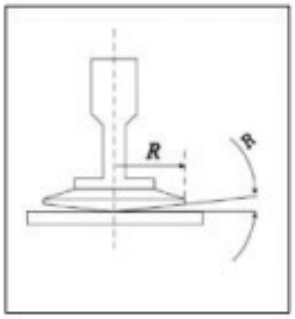
Measuring System Data

Cone/Plate Systems according to DIN 53018

Shear Rate = $K\gamma.n$

Shear Stress = τ_{prom} .M

$K\gamma$ (K_gamma) = Shear Rate factor (s^{-1}/rpm)
n = rotational speed (RPM)
τ_{prom} (Tau_Prom) = Shear Stress factor (Pa/%)
M = torque (%)



Cone Number:			**680**			
Measuring System	C25-1	C25-2	**C50-1**	C50-2	C75-1	C75-2
Shear Rate Factor (K_gamma)			**5.8312**			
Shear Stress Factor (Tau_Prom)	12.223	12.223	**1.528**	1.528	0.4527	0.4527
Sample Volume (mL)	0.08	0.15	**0.6**	1.2	2	3.9
Radius R (mm)	12.5	12.5	**25**	25	37.5	37.5
Cone Angle a (.)			**1.029**			
Cone Truncation (mm)			**0.051**			

www.brookfieldengineering.com
The Brookfield website is a good resource for additional information and self-help whenever you need it. Our website offers a selection of "how-to" videos, application notes, conversion tables, instruction manuals, material safety data sheets, calibration templates and other technical resources.

http://www.youtube.com/user/BrookfieldEng
Brookfield has its own YouTube channel. Videos posted to our website can be found here as well as other "home-made "videos made by our own technical sales group.

Viscosityjournal.com
Brookfield is involved with a satellite website that should be your first stop in viscosity research. This site serves as a library of interviews with experts in the viscosity field as well as Brookfield technical articles and conversion charts. Registration is required so that you can be notified of upcoming interviews and events, however, this information will not be shared with other vendors.

Article Reprints
- **Available in Print Only**
- Brookfield has an extensive library of published articles relating to viscosity, texture and powder testing. Due to copyright restrictions, these articles cannot be emailed. Please request a hardcopy of articles by calling our customer service department or by emailing: marketing@brookfieldengineering.com.
- **Available online**
- Brookfield has a growing number of published articles that can be downloaded directly from the Brookfield website. These articles can be found on our main website by following this path: http://www.brookfieldengineering.com/support/documentation/article reprints.

More Solutions to Sticky Problems
Learn more about viscosity and rheology with our most popular publication. This informative booklet will provide you with measurement techniques, advice and much more. It's a must-have for any Brookfield Viscometer or Rheometer operator. More Solutions is available in print and/or as a downloadable pdf on the Brookfield website by following this path: http://www.brookfieldengineering.com/support/documentation.

Training/Courses
Whether it is instrument-specific courses, training to help you better prepare for auditing concerns, or just a better understanding of your methods, who better to learn from than the worldwide leaders of viscosity measuring equipment? Visit our Services section on our website to learn more about training.

**Downloads will require you to register your name, company and email address. We respect your privacy and will not share this information outside of Brookfield.

Appendix D: Warranty and Repair Service

Brookfield Viscometers are guaranteed for one year from date of purchase against defects in materials and workmanship. They are certified against primary viscosity standards traceable to the National Institute of Standards and Technology (NIST). The Viscometer must be returned to **Brookfield Engineering Laboratories, Inc.** or the Brookfield dealer from whom it was purchased for no charge warranty service. Transportation is at the purchaser's expense. The viscometer should be shipped in its carrying case together with all spindles originally provided with the instrument.

For repair or service in the **United States**, return to:

Brookfield Engineering Laboratories, Inc.
11 Commerce Boulevard
Middleboro, MA 02346 U.S.A.
Telephone: (508) 946-6200 FAX: (508) 946-6262
http://www.brookfieldengineering.com

For repair or service **outside the United States**, consult **Brookfield Engineering Laboratories, Inc.** or the dealer from whom you purchased the instrument.

For repair or service in the **United Kingdom**, return to:

Brookfield Viscometers Limited
1 Whitehall Estate
Flex Meadow
Pinnacles West
Harlow, Essex CM19 5TJ, United Kingdom
Telephone: (44) 27/945 1774 FAX: (44) 27/945 1775
sales@brookfield.co.uk

For repair or service in **Germany**, return to:

Brookfield Engineering Laboratories Vertriebs GmbH
Hauptstrasse 18
D-73547 Lorch, Germany
Telephone: (49) 7172/927100 FAX: (49) 7172/927105
info@brookfield-gmbh.de

or

Rheotec Messtechnik GmbH
Schutterwälder Strasse 23
D-01458 Ottendorf-Okrilla, Germany
Telephone: ++49 (035205) 5967-0 FAX: ++49 (035205) 5967-30
info@rheotec.de

For repair or service in **China**, return to:

Guangzhou Brookfield Viscometers and Texture Instruments Service Company Ltd.
Suite 905, South Tower, Xindacheng Plaza
193 Guangzhou Da Dao Bei, Yuexiu District
Guangzhou, 510075 P.R. China
Telephone: (86) 20/3760-0548 FAX: (86) 20/3760-0548
www.brookfield.com.cn