RM180

RHEOMAT

RM180 RM180-NT RM180S

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GENERAL INFORMATION

NOTICES

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The product described herein is currently under continuous development. Therefore, product operation may vary from that described in this document.

This document, and RSI Orchestrator Online Help, are the only Rheometric Scientific authorized publications concerning operation and calibration of this instrument.

SAFETY

Do Not Attempt Service

Do not attempt to service this instrument, as it contains no user-serviceable components.

Keep Away from Live Circuits

Do not make physical contact with any component inside the instrument unless a set of procedural steps specifically instructs you to do so. In such cases, follow the procedure step-by-step.

Protect Yourself

While operating this instrument, you must wear eye protection that either meets or exceeds ANSI Z87.1 standards. Additionally, wear protective clothing that has been approved for protection against the materials under test and the test temperatures.

TERMS AND SYMBOLS USED IN THIS MANUAL

Term or Symbol	Meaning
DANGER	An immediately hazardous situation that, if not avoided, will result in either personal injury or death.
WARNING	A potentially hazardous situation that, if not avoided, will result in either personal injury or death.
CAUTION	A situation that, if not avoided, will result in damage to either this instrument or other inanimate property.
NOTE	Information that is emphasized by being placed prior to the procedural step to which it pertains.
	General identification symbol for safety notices. Also instructs user to refer to the manual which defines information pertaining to the portion of the instrument to which the symbol is affixed.

	**CAUTION** **Always leave the ventilation slot of the unit open, but protect against splash water and solvents**

	**CAUTION** **With an empty measurement system, the RM180 should not rotate faster than $D=200s^{-1}$**

	**WARNING** **The RM180 and the power supply and charger unit must be operated only by qualified personnel**

	**WARNING** **The nickel-cadmium battery is considered hazardous waste. Dispose of properly.**

	**WARNING** **No user serviceable parts inside.** **Refer repair and calibration to Rheometric Scientific service personnel**

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1 INTRODUCTION

1-1 OVERVIEW

1-1.1 Description of Instrument

The RM180 is used for simple determination of the viscosity of a wide range of substances in the lab or field. It is equipped with a rechargeable battery that allows it to be operated for approximately one hour at full load without connection to the power supply.

The RM180 is a rotational viscometer. Its open, concentric measurement system allows measurements by immersion. The measuring head and measuring tube are rigidly coupled; the measuring unit is driven by a direct-current motor.

A built-in microprocessor calculates the values for the viscosity with the aid of the measured torque, the set shear rate and the measurement system used. The sample temperature is measured by a Pt100 sensor immersed in the substance.

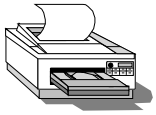
The display shows the following data:

- the sample temperature T in ℃,
- the torque M in mN•m,
- the shear rate D in s^{-1},
- the shear stress τ (tau) in Pa,
- the calculated viscosity η (eta) in Pa•s,
- the measurement system, e.g. 11,
- the program step, e.g. 6 during an automatic step measurement.

1-1.2 Measurement Principle

The RM180 can store 50 measurements of step programs or single point measurements. An optional attached printer records the measurement data. With the aid of the ***RSI Orchestrator*** evaluation software, measurement data can be transferred to an attached computer and evaluated thus allowing the RM180 to be incorporated in computer-aided data acquisition systems. The ***RSI Orchestrator*** control and evaluation software allows you to perform computer-aided measurements.

KEYS	ENTRY	FUNCTION	
		During Operation	Together with ON (I)

1....9	Numbers		
E	Confirm		
O (Zero)	Number		Automatic zero adjustment
←	Delete	Terminates siningle point measurement (without data storage)	Deletes data of all measurement records
	. (Point)	Starting single point measurement (without data storage)	Select language E=0, g=1,f=2, It=3, sp=4, nl=5
	C (Letter)	Starting step programs	Select code Date=1, Sample No.=2,Density=4, Time interval=8 Quick measurement=16, Other measurement sys.=32
	B (Letter)	Prints out measueremnt records or a data line during a single point measurement (without data storage)	Prints out status
	A (Letter)	Transfers data of all measurement records to the computer	

1-2 INSTRUMENT SPECIFICATIONS

DIMENSIONS	WIDTH: 31cm (12in)	HEIGHT: 73cm (28.7in)	DEPTH: 42.5cm (16.7in)
Weight	3.5 lb (1.6 kg)		
	SPECIFICATION		
ELECTRICAL POWER	110-120 VAC (60 Hz) *or* 220-240 VAC (50Hz) switchable ***NOTE:*** Interface and instrument must be plugged into the same phase supply		

Measurement Principle	Rotational viscosimeter with cylindrical measrement systems
Rotation Speed	
Range	5 to 1000 min^{-1}
Accuracy	± 0.5% of the actual value
Shear Rate with DIN Systems	6.5 to 1290 s^{-1}
Torque Range	0.25 to 7.5mNm
Viscosity Range	1 to 10^6 mPa
Interface	Centronics 25-pin fen\male; RS232C; bidirectional 25-pin male
Battery	Rechargeable battery with capacity for 1 hour of measurement Lithium battery memory; 3-year minimum lifetime.
Power Supply/Charger	100-240 VAC; 50/60 Hz

1-3 RSI ORCHESTRATOR SOFTWARE

1-3.1 Software Description

The measured data is transferred from memory to a PC for storage or further evaluation. The RSI Orchestrator software provides graphic evaluation; modeling (Newton, Casson, Bingham, for examples); comparison to a reference material with an off spec optical and acoustic alarm; thixotropy calculation. And finally, the RSI Orchestrator software can be customized for automatic evaluation of routine testing. this ensures that the sample is always evaluated the same way every time.

1-3.2 Introduction to Software

The RSI Orchestrator software is used to control the RM180 and to aquire and then evaluate measurement data. Files containing recorded measuring values can also be loaded from diskette and evaluated at a later time offline, i.e. without an attached rheometer.

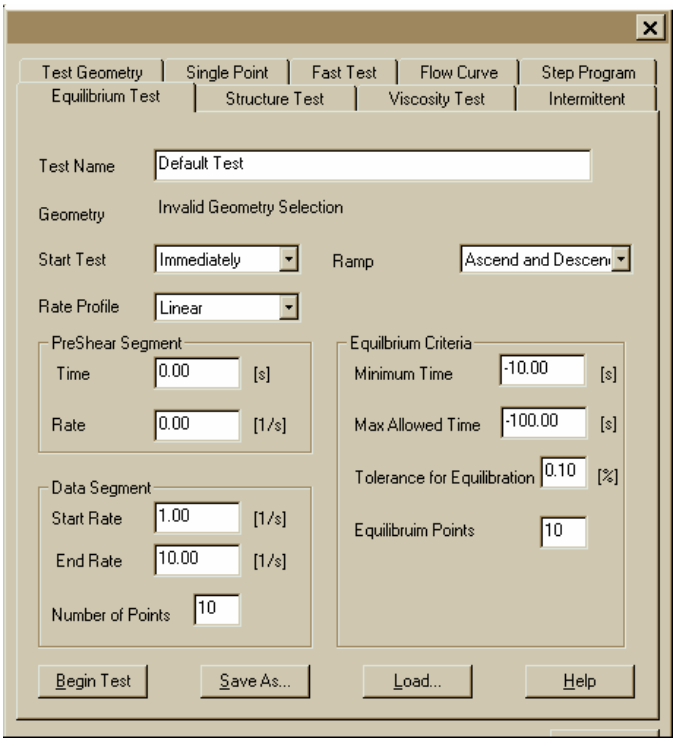


Figure 3-1 Main Screen RSI Orchestrator Software

These operating instructions describe the individual menus and operating steps of the RSI Orchestrator software. Operating steps concerning the rheometer are described in Section 2.

1-3.3 RM180 Operation

The measurement section has been divided into three groups to allow a stepwise investigation of a sample, from the single-point measurement to the sophisticated job streams.

Single-point and Fast measurement - This is the easieast way to get simple results very quickly. It can also be used to check the measurement settings (correct connections configuration and RS-232 communication).

Predefined Measuring Methods - allow the analysis of specific properties of ther sample. The operator selects the measuring method which best suits their needs, entering the measuring parameters according to the sample, and then starts the measuremnt. During the measurement the results are displayed online on the screen as both numeric values and as graphic curves. Once the measurement has been completed, it can be evaluated interactively through the graphic meanu, the resulting curve(s) being displayed on the screen. The evaluation paramters can then be stored as an evaluation method, allowing you to do the same evaluation steps when running the experiment or when performing offline evaluation of the measuring data.

Experiments and Job streams - This deals with automatic measurement. An experiment consists of a measuring method and an evaluation method. Starting an experiment performs the corresponding measuring method followed by the evaluation method. The resulting data files are stored under the same name as the experiment, with increasing indexes (.001, .002, etc.). Several experiments can be linked together in a job stream. Starting the job stream will run the experiments one after the other, in the defined sequence, performing all the measuring methods followed by the corresponding evaluation methods.

1-4 STARTING THE *RSI* ORCHESTRATOR SOFTWARE

1-4.1 Set-up

The installation of the software must have been performed as described in *RSI* Orchestrator manual installation instructions. The devices of the measuremnt station must be properly interconnected.

- Switch on the station devices (computer, printer, RM180).
- Click on the icon or switch to the drive and directory you entered during installation of the *RSI* Orchestrator program.
- Start *RSI* Orchestrator program. Press the <ENTER> key.

NOTE

Before staring any measurements, the configuration has to be set accordingly to the devices of the measuring station. These previous settings must be done under main menu.

1-4.2 Programs

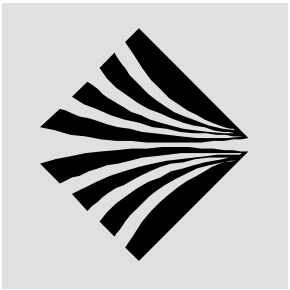
There are four different groups of programs:

Three groups of shear-rate prograns

- Flow curves
- Equililbrium curves
- Structure test

One group of temperature programs:

- Temperature



2 GETTING STARTED

2-1 RM180 CONFIGUATIONS

Model	RM180		RM180-NT		RM180S	
Catalog Number	**Rm180**	**Rm180-220/50/60**	**RM180-NT**	**RM180-NT-220/50/60**	**RM180S**	**RM180S-220/50/60**
Line voltage and Frequency	**115VAC, 60Hz**	**220VAC, 50/60Hz**	**115VAC, 60Hz T**	**220VAC, 50/60Hz**	**115VAC, 60Hz**	**220VAC, 50/60Hz**
Items Included	Yes = Item Included, No = Item optional and can be purchased					
(1) Viscometer	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
(2) Power Supply and Charger Unit	**Yes** 115VAC	**Yes** 220VAC	**Yes** 115VAC	**Yes** 220VAC	**Yes** 115VAC	**Yes** 220VAC
(3) Stand	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
(4) Plastic case	**Yes**	**Yes**	**Yes**	**Yes**	**X No**	**X No**
(5) Rechargable Battery for Viscometer	**Yes**	**Yes**	**Yes**	**Yes**	**X No (see note 1)**	**X** No **(see note 1)**
(6) A Complete Set of 3 Measuring Systems according to DIN 53019	**Yes**	**Yes**	**X No** (see note 1)	**X No** (see note 1)	**X No (see note 1)**	**X** No **(see note 1)**
RSI Orchestrator Software	**Optional**	**Optional**	**Optional**	**Optional**	**Optional**	**Optional**
Notes 1 and 2	***The RM180S and Rm180S-220/50/60 Models do NOT come with Rechargeable Battery or Plastic Case or Measuring System.*** ***The RM180-NT, RM180-NT-220/50/60 Models do NOT come with Rechargeable Battery or the Measuring System but comes with Plastic Case.*** *These four configurations are designed to be used in Stationary (Lab Bench) environment with Stand and Charger.* *Customer should choose an appropriate Measuring System suitable for the viscosity of their sample.*					

Table 2-1 RM180 Configurations

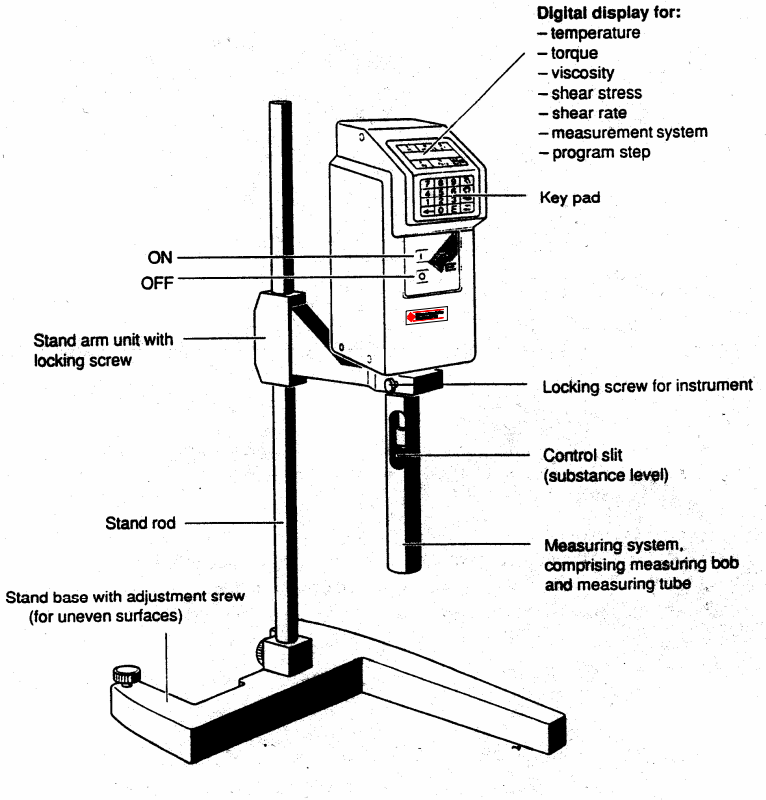
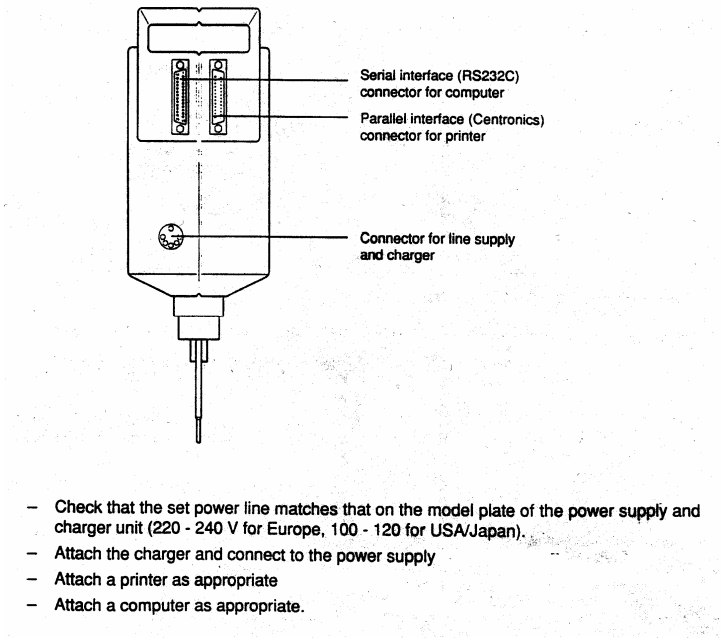


Figure 2-1Front View



- Check that the set power line matches that on the model plate of the power supply and charger unit (220 - 240 V for Europe, 100 - 120 for USA/Japan).
- Attach the charger and connect to the power supply
- Attach a printer as appropriate
- Attach a computer as appropriate.

Figure 2-1Rear View

2-2 POWER SUPPLY AND CHARGER UNIT

2-2.1 Charger Unit Description

The unit has a microprocessor that controls the charging of the RM180 battery in a manner which ensures a long battery life.

There are two models of the Power Supply and Charger Unit available, depending on the line (AC) voltage. For North America (USA, Canada) and countries using 115VAC, 60Hz power, the unit is protected by an internal fuse rated at .315 mA. The second type of unit is for 220VAC, 50/60 Hz line voltage and uses a 160mA fuse.

Other than the internal fuses and the external power cord, the two units operate identically.

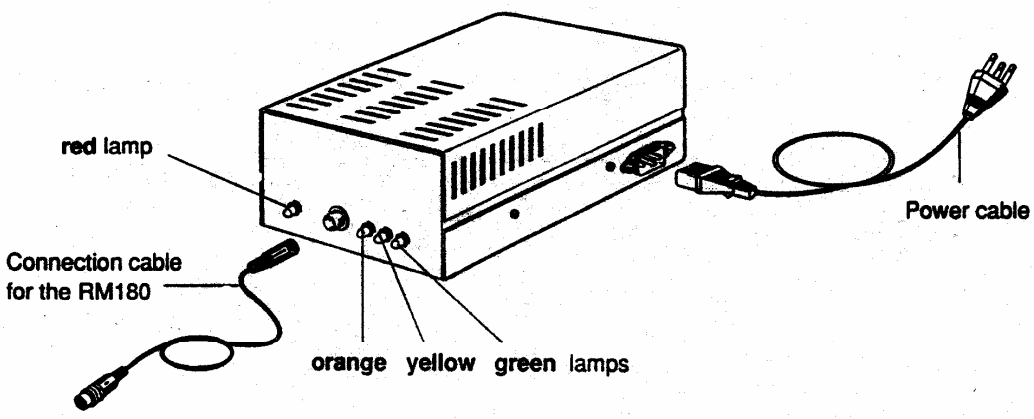


Figure 2-3 Charger Unit

2-3 SYSTEM INTERCONNECTION

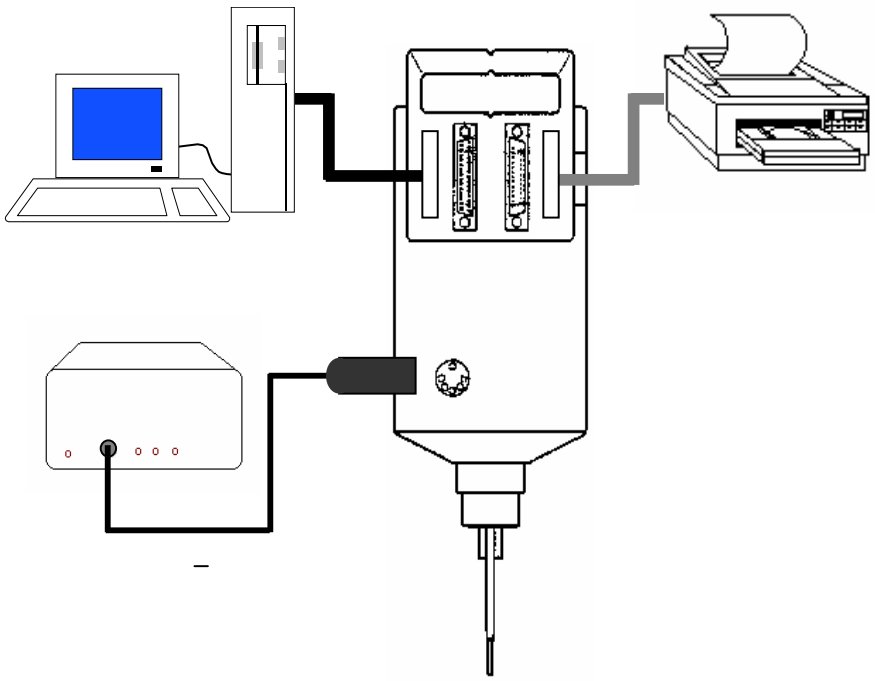


Figure 2-1 Interconnection Diagram

2-3.1 Indicator Lamps Older Charger

The RM180 Charger Unit contains several lamps for indicating system status information. The chart on the following page shows the various lamps and their indications.

RM180 Charger Unit Indicator Lamp Chart	
Red: Constantly lit	The RM180 is not connected
Flashing	The battery is defective (call Rheometric Scientific Technical Services)
Orange: lit for 5 seconds	The battery is being tested: • If battery is OK, the yellow lamp lights after approx. 5 seconds. • If drained, the charger attempts to "revive" the battery over a period of 1.5 hours; if this is unsuccessful, the red lamp flashes.
flashes	Battery protection The temperature of the battery is too low (±5℃) or too high (±45℃). The admissible ambient temperature for the RM180 is +10 to +40℃. At an elevated ambient temperature (>35℃), the internal battery temperatu re can reach 45℃ with: • A 100% torque load over a period of hours, and • At the end of a charging operation, which alone heats up the battery by around 10℃. The battery will be protected and no longer charged, but you can perform measurements.
Yellow: constantly on	The battery is charged: you can perform measurements. (Charging of the battery takes 1.5 to 2 hours).
Green: constantly on	The battery is fully charged; it receives a so-called trickle charge. The battery can remain permanently connected to the power supply and charger unit. Because it will not be over charged, there is no adverse effect on the life of the battery.

Table 2-2 Indicator Lamps

Note

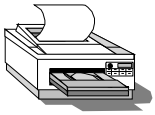
When the battery is fully charged, you can perform measurements for approx. one hour without the power supply

Following every successful battery test, operation of the power supply and charger unit of the RM180 starts with the charging, regardless of the discharge degree of the battery.

CAUTION

Always leave the ventilation slot of the unit open, but protect against splash water and solvents

2-4 KEYPAD CHARACTERS

KEY(s)	FUNCTION
Numbers	Entry of numeric values, code or program numbers
E	Confirmation of an entry
0 (zero)	Select **Zero Adjustment** (see section xx) Simultaneously press this key when switching the unit on: the display shows **...>0<...**
←	• Delete **Data** (see sect. Xx) Simultaneously press this key when switching on: all data of stored measurements are deleted (display: **----CLEAR---**). • With entry of letters/numbers, deletes from right to left. • Terminates the single point measurement in the measurement mode **HAND**
HAND 	• Select **Language** (see sec.xx): Simultaneously press this key when switching on: the display shows ***LANGUAGE.*** • Select single point measurement (without data storage): when *MEASURE MODE?* is shown on the display. • (Decimal) point during entry.
AUTOMATIC 	• Select **Code** for instrument settings and own measurement systems (see section xx). Simultaneously press this key when switching on: the display shows *CODE.* • *Select step programs or single point measurement (with data storage):* when *MEASURE MODE?* Is shown on display. • Letter **C** during the entry of the sample number.
PRINTER 	• Print out status (see section xx) Simultaneously press this key when switching on: the instrument settings stored in the RM180 are printed. • Prints out a data line in the measurement mode HAND. • Prints out the stored measurement data. • Letter **B** during the entry of a sample number
COMPUTER 	• Transfers the measurement data after a step program. • Letter **A** during the entry of a sample number.

2-5 SELECTING LANGUAGE AND CODE

2-5.1 Set Language

When you switch the RM180 on for the first time, the display is in English. To ensure that the text appears in the language most appropriate to your needs, you are offered a choice of 6 languages. Exceptions are the words ***Language, CODE, TRY AGAIN*** and ***CLEAR.***

- Press the **HAND** key and at the same time switch the instrument on: ***LANGUAGE*** appears on the display. Enter one of the following numbers for your language:

0	English	1	Deutsch
2	Français	3	Italiano
4	Español	5	Nederlands

- Press the E key to confirm the entry. Your language is stored by the RM180 until you choose a different one.

2-6 CODE FOR INSTRUMENT SETTINGS AND OTHER MEASUREMENT SYSTEMS

2-6.1 Instrument Settings

With the entry of a code, you can set the following features of the RM180. The corresponding configuration will be stored until you define a new code.

Record **Date** (sub-code **1**)

Each measurement is recorded with a date. The stored date is displayed before every measurement.

- If it is current, you can confirm with **E**, otherwise you must first overwrite it with the current date (max 8 digits).

NOTE

To enable the evaluation software to recognize entry of the date, you must enter it in the format xx.yy.zz.

Record **Sample Number** (sub-code **2**)

Each measurement is recorded with a sample number. Entry of a sample number is requested before every measurement; input format: max. 16 characters.

Calculate **Kinematic Viscosity** (sub-code **4**)

In each measurement, the measured dynamic viscosity is divided by the inputted density to calculate the kinematic viscosity; this is displayed and recorded. Entry of the density is requested before every measurement.

The kinematic viscosity ν (nu) is the quotient of the dynamic viscosity η (eta) and the density ρ (rho): $\nu = \eta / \rho$

2-6.2 Time

Time interval measurement (sub-code **8**):

In the **HAND** measurement mode (single point measurement without data storage), the values remain in the display for the inputted time interval (stopwatch function). If a printer is attached, the current viscosity is printed out in accordance with the time interval. This allows you to determine the viscosity as a function of time, e.g. with thixotropic or reactive samples.

Before every measurement, the stored interval is displayed and you can either confirm it with **E** or overwrite it.

Quick single point measurement (sub-code **16**)

In the HAND measurement mode (single point measurement without data storage), the torque is measured for approx. 1 second at all shear rates.

If measured values determined in this manner are not sufficiently stable at low rotational speeds, you should not set sub-code 16; in such a case the measurements last longer at a lower shear rate ($D < 80\ s^{-1}$), e.g. approx. 12 s at $D = 6.5\ s^{-1}$.

You can determine the instrument settings by entry of a code comprising the **sum** of the respective sub-codes.

→ Press the automatic key and at the same time switch on the instrument. ***CODE:*** appears on the display.

- 0-- None of the instrument settings active
- 1---Date
- 2---Sample number
- 4---Density
- 8---Time interval in s for single point measurements
- 16--Quick single point measurement

Example: a. If you wish to enter the date (1) and the sample number (2), enter **3** (=1+2).

b. With code **31,** you activate all instrument settings.

- Press the E key to confirm the entry.

The display shows: ***MEASURE MODE?***

TEMPERATURE*

2-6.3 Setting Other Measurement Systems

You can use measurement systems that are not listed in accessories (secxx) if you store these under a number in the RM180. To ensure that the RM180 calculates the correct shear rate and shear stress for these measurement systems, you have to determine and enter the appropriate conversion factors. These factors are stored.

- Press the automatic key and at the same time switch the unit on. ***CODE:*** appears on the display.
- Enter **32** and confirm with **E**.

  SYSTEM No.:

  The numbers **90...97** are available for your own measurement systems.
- Enter number and confirm with **E**

  kD:
- Enter the conversion factor for the shear rate (kD) and confirm with E; the RM180 calculates this using the formula:

  $D = kD \cdot n$ (n = speed) D in s^{-1}

  N in min^{-1}

kTAU:

- Enter the conversion factor for the shear stress (kTau) and confirm with E; the RM180 calculates this using the formula:

  $T = kTAU \cdot M$ (M: torque). T in Pa

  M in mN·m

NOTE

You can always overwrite the number and factors of a measurement system by reentering the appropriate numbers/values using the above procedure

2-7 STATUS RECORD

2-7.1 Procedure

You can have a printout of the language, instrument settings, your own measurement systems with the appropriate conversion factors and the step programs 3 - 9 with the appropriate shear rates (see sectionxx) that are stored in the RM180.

- Press the printer key and at the same time switch the instrument on: you obtain the status record.

2-8 MEASUREMENTS

2-8.1 Zero Adjustment	You should perform a zero adjustment with the system measurement system in the absence of sample every day and following a change in the measurement system. You have already connected your measurement system (see sectionxx). • Phold in the O (zero) and simultaneously switch on the instrument. As long as the instrument executes the zero adjustment, the display shows...>0<... Then the following appears: ***MEASURE MODE?*** ***TEMPERATURE **. ****

NOTE

You can always overwrite the number and factors of a measurement system by reentering the appropriate numbers/values using the above procedure

	**CAUTION** **With an empty measurement system, the RM180 should not rotate faster than $D=200s^{-1}$**

2-9 MEASUREMENT MODE *HAND*:

2-9.1 Single Point Measurement Without Data Storage	Select this type of measurement if you wish to determine the viscosity of the sample at **one** shear rate. The RM180 **does not** store the measured data of this measurement mode! To store single point measurements, you must perform these under **AUTOMATIC** measurement mode (see secxx).
2-9.2 Single-Point Procedure	• immerse system without cap in sample or add the sample to the closed measurement system (fill volume: see sec.xx) • Switch the RM180 on and wait until the display shows: ***MEASURE MODE?*** ***TEMPERATURE*** **.*

NOTE

If you have to thermostat the sample, wait until the desired temperature is displayed before starting the measurement (see secxx)

	• Press the **HAND** key

	• Enter the measurement system and confirm with **E**. • Enter the values/designation of the subsequent instrument settings that you have selected (see secxx and confirm with **E** in each case.

NOTE

If you confirm *DENSITY* with E without entering a value, the message: *TRY AGAIN* appears.

	Shear Rate: • Enter a value appropriate to the sample and confirm with **E**.

NOTE

The values/numbers for interval, measurement system and shear rate are stored so that for the next measurement you can either confirm these with E or enter new values/numbers.

The shear rate range is 6.5...1291 s^{-1} for the DIN measurement systems 11, 22 and 33 (for other measurement systems, see secxx). If you enter a number outside this range, *SHEAR RATE* immediately appears on the display to allow the "correct" value to be entered

	The measurement starts. You are shown the following data after approx. 5 sec.: • The sample temperature T in °C • The torque M in mN·m • The shear rate D in s^{-1} • the shear stress in τ in Pa·s • the calculated viscosity η in Pa·s • the measurement system, e.g. 11. The RM180 acquires several measured values per second and displays the recalculated mean values. During the measurement you can change the shear rate: • Press one of the numeric keys (1 to 9): ***SHEAR RATE*** appears on the display. • Enter new value and confirm with **E**.

NOTE

If the torque is too large (>7.5 mN·m), you are shown the message: *M TOO HIGH* (M = torque). In operation with the power supply and charger unit, the RM180 switches itself off at a torque of approx. 11 mN·m. You can either enter a lower value for the shear rate or, if possible, use a more suitable measurement

system.
If the torque is too low (<0.25 mN · m) you are shown the message: *M TOO LOW*. In this case you can enter a larger value for the shear rate or use a more suitable measurement system.

2-9.3 Terminating a Single Point Measurement	To terminate a single point measurement, either: • press the arrow ← key, or • switch off the instrument
2-9.4 Time Interval	If you have attached a printer, the recalculated viscosity is printed out.

NOTE

a. The time intervals outputted by the printer do not always coincide with the inputted value owing to rounding and the time response.

b. With low shear rates, the measurement time can be larger than the inputted time interval. If this interferes: Select *QUICK SINGLE POINT MEASUREMENT* as an instrument setting (sub-code 16)

c. If no printer is attached, the display stops after the interval time has elapsed until you switch the instrument off or attach a printer (stopwatch function)

2-9.5 Printing Out Data	If you have attached a printer and have selected ***INTERVAL***, the data is printed out online. The instrument settings you have selected and those values you have entered are printed out as a title. Exceptions are the titles ***DATE*** and ***SAMPLE NO.***, which are always printed out. If you have not selected ***INTERVAL*** or have entered **0** (zero) as its value, you can press the printer key during the measurement: the data currently displayed is printed out.

2-10 MEASUREMENT MODE: *AUTOMATIC*:

2-10.1 Step Programs With Data Storage	Select this measurement mode if you wish to use step programs to measure the viscosity of the sample at several shear rates. The samples are automatically measured at 8 different shear rates and the results are stored. You can use the resulting data to plot a flow curve to characterize the sample. As a special case , you can perform single point measurements in this measurement mode to store your data (see below) You have a choice of 10 programs:

PROGRAM	DEFINITION
0	You can enter the lowest and highest shear rate (D MIN, D MAX). The RM180 calculates the **linear** intermediate steps. D MIN and D MAX of the program 0 are **not stored**, but the results are. You can use this program for rapid scanning of a shear rate range to determine the suitable D MIN / D MAX values for further measurements.
1	Measurement is performed at rotational speeds between 50...1000 min^{-1} in **geometric** steps. You **can not** change this program.
2	Measurement is performed at rotational speeds between 5...100 min^{-1} in geometric steps. You **can not** change this program.
3-9	You can enter the lowest and highest shear rate (D MIN, D MAX) for 7 programs. D MIN and D MAX remain **stored** for every program. The RM180 calculates the linear intermediate steps in each case. You can change and print out theses programs.

2-10.2 Single Point Measurement With Data Storage	If you enter the value 0 (zero for D MAX in the step programs 3...9, a single point measurement with data storage follows. The measurement is performed with a shear rate D=d MIN. The measurement time is 15s with the mean value being calculated from the measurements during the last 10 seconds.
2-10.3 Single Point Procedure	• Immerse measurement system without cap in the sample or add the sample to the closed measurement system. • Switch the RM180 on and wait until the display shows: ***MEASURE MODE?*** ***TEMPERATURE**.****

NOTE
If you have to thermostat the sample, wait until the desired temperature is displayed before starting the measurement

- Press the **AUTOMATIC** key
- Enter the measurement system and confirm with **E.**
- Enter the values/designation of the subsequent instrument settings that you have selected and confirm with **E** in each case.

NOTE
a. If you confirm DENSITY with E with out entering a value, the message TRY AGAIN appears.
b. The measurement system remains stored so that for the next measurement you can either confirm it with E or enter a new number

PROGRAM No.

- Enter the desired number and confirm it with **E**.

If you have selected program **1...9**, the RM180 immediately starts the measurement. If you have entered **0**, the display shows: **D MIN:**

- Enter the initial shear rate and confirm with **E.** **D MAX**
- Enter the final shear rate and confirm with **E**.

NOTE

a. If no shear rates have been entered for the programs 3...9 the display shows D MIN followed by D MAX.
b. The shear rate range is 6.5.... 1291 s -1 for the DIN measurement systems 11, 22 23. If you enter a number outside this range, D MIN or D MAX immediately reappears on the display to allow the "correct" value to be entered.
c. If you enter a value for D MAX that is less than that of D MIN, the RM180 first acquires the 8 measurement points in descending then in ascending order.
d. With D MAX = D MIN, the 15 measurement points are acquired at the same shear rate.
e. With D MAX = 0 the RM180 performs a single point measurement.

The display shows ***PLEASE WAIT*** for approx. 5s. before the measured value appears. You can then view the following data:

- The sample torque T in ℃
- The torque M in mN · m
- The shear rate D in s-1
- The shear stress τ in Pa.
- The calculated viscosity η in Pa · s
- The measurement system, e.g. 11
- The program step, e.g. 6.

The RM180 acquires several measured values per second and displays the recalculated mean values. The measurement time for a step is 10 sec. The Rm180 stores the mean of the calculated values for every step in each case. Before every step the message ***PLEASE WAIT*** is displayed for approx. 5 sec. During this time, the RM180 acquires no measured values.

NOTE

a. If the torque is too large (>7.5 mN·m), you are shown the message: *M TOO HIGH* (M+ torque). In operation with the power supply and charger unit, the RM180 switches itself off at a torque of approx. 11 mN·m. you can either enter a lower value for D MAX or D MIN or, if possible, use a more suitable measurement system.

b. If the torque is too high during the measurement, the RM180 automatically returns to the step preceding that which it has just reached, in other words instead of 8 steps performs e.g. 6.

c. If the torque is too low (<0.25 mN·m) you are shown the message: *M TOO LOW*. In this case you can enter a larger value for the shear rate or use a more suitable measurement system.

2-10.4 Programs 3...9: Changing Shear Rates

If you wish to change the shear rate of one of the programs, when PROGRAM No. is displayed, you must enter the appropriate number.

- Three times, e.g. 444 (you can not see the last number),
- Confirm with E,
- Enter the new value of D MIN then that of D MAX and confirm with E: the new values are stored and the RM180 starts the measurement.

2-10.5 End of Measurement

When the measurement is at an end, the display shows:

MEMORY FREE: 23 (example)

READY

The RM180 can store the data of 50 step programs or single point measurements.

To start the next measurement immediately, press any key (except the printer key). The display shows:

MEASURE MODE?

***TEMPERATURE**.**

2-11 PRINTING OUT DATA

2-11.1 Printout Procedure

In the **AUTOMATIC** measurement mode, the data of step programs and single point measurements are **not** printed out online.

- On completion of a measurement (or after the instrument has been switched on), PRESS THE PRINTER KEY. The RM180 immediately starts with the printout of the last measurement and the display shows: ***26*** (example)

<E> ALL RECORDS (26 = number of measurements not yet printed out)

- If you wish to have data of **all** measurements that are **not yet printed out**, press the **E** key: The RM180 continues the printout until the first stored measurement.
- If you wish to print out the measurement before last, press the printer key: The measurement before last is printed out: the display shows the number of measurements not yet printed out. You can repeat this procedure until the data of all measurements has been printed out.
- To start the next measurement, press any key (except the printer or **E** key). The message:

MEASURE MODE?

TEMPERATURE **.* appears.

2-11.2 Deleting Measurement Data

To delete the stored data of all measurements, proceed as follows:

- Switch off the RM180.
- Press the **← (arrow)** key and simultaneously switch the RM180 back on: during the clearing of all measurement data, the display shows: **---CLEAR----**

2-11.3 Data Transfer

- You can transfer the measurement data if you have loaded the ***RSI Orchestrator*** evaluation software on your computer. If you press the computer key at the end of every measurement, the data is transferred. After the data has been transferred, the display shows: ***MEASURE MODE?***

  TEMPERATURE**.*

  In other words, you can start the next measurement.

NOTE

a. If after several measurements, you transfer the data of the last measurement, the data of *all* measurements stored up to this point are always transferred. If you switch off the RM180 and press the computer key after switching it back on, once again, *all* stored measurements are transferred.

b. To avoid this, you must delete the stored data before starting a new measurement:
- **Switch off the RM180**
- **Press the arrow← key and simultaneously switch it back on: during the clearing of all measurement data, the display shows: ---*CLEAR*---**

2-11.4 Thermostating (Bath)

You can use a commercial thermostat for thermostating.

- Close the measuring tubes with the caps and then immerse as far as possible in the thermostat bath ensuring that the thermostating medium can not splash into the substance.

The fill level of the measurement medium should be as high as possible in the temperature sensor is deeply immersed in the substance. Inside of the measuring tubes, a filling mark (small groove) indicates the filling volume for a DIN measurement system without the measuring bob (take into account the thermal expansion of the thermostating medium and of the substances being measured).

With temperature above 50˚c, you should take into consideration the heat loses due to air circulation around the measurement system as well as condensation. We advise covering the top of the thermostat bath around the measuring tube.

3 MAINTENANCE

	**WARNING** **The RM180 and the power supply and charger unit must be operated only by qualified personnel**

3-1 CARE OF THE INSTRUMENT

3-1.1 Cleaning Instrument Parts

- If the measuring head, drive shaft coupling or stand are really dirty or badly contaminated, clean only with a cloth moistened with soapy water or alcohol.
- Before cleaning the measuring head and measuring tube, always uncouple them from the RM180
- You can use appropriate solvents for the measurement systems.
- Never place the O-rings of the caps in organic solvents. Lightly grease them with silicone grease.

O-rings: material: NBR/butadiene-acrylonitrile elastomer. Internal thickness: 26/3mm, 20/3mm, 9/3mm

3-1.2 Battery Disposal

The battery of the RM180 comprises 10-nickel cadmium cells. When changing a defective battery, take care of its proper disposal.

	**WARNING** **The nickel-cadmium battery is considered hazardous waste. Dispose of properly.**

3-2 CALIBRATING AND TESTING

	**WARNING** **No user serviceable parts inside.** **Refer repair and calibration to Rheometric Scientific service personnel**

3-2.1 Checking Calibration

To test whether the instrument is measuring properly and /or proper measurements have been performed, you can use calibration oils for viscosity measurements (available from Rheometric Scientific).

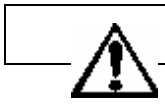
Another way of checking the unit is to measure a suitable substance with the RM180 after purchase or a calibration and test the unit at regular intervals under identical measuring conditions (particularly at the same temperature). You should obtain the same results. This method determines whether the instrument has undergone any changes.

- Suitable substances are those viscosity behavior does not change over a lengthy period of time (e.g. motor oils, silicon oil, paraffin). You should keep ample quantities of such oil in stock and use it only once for the measurement; in other words do not use the sample over again since degradation will have occurred.

NOTE

—**Substances exhibiting Newtonian behavior are always preferred (there should be a straight line between several measurement points and the zero point).**
—**Glycerol (hygoscopic) and water are too unstable**

3-3 TROUBLESHOOTING



WARNING

	No user serviceable parts **Refer service to Rheometric Scientific service personnel.**

3-3.1 Errors and Malfunctions

The following is a chart to help solve some minor difficulties should they arise.

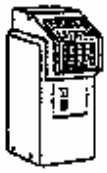
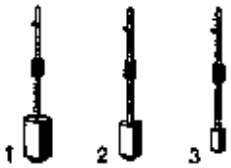
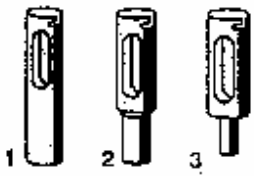
Should you need further assistance, please call the Rheometric Scientific Technical Services Department at: **1-732-560-8990 please have model and serial number information available when you call.**

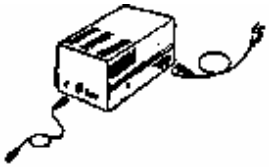
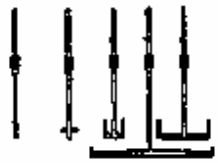
ERROR / MALFUNCTION	Possible Cause	MEASURES
THE RED LAMP OF THE POWER SUPPLY AND CHARGER UNIT DOES NOT LIGHT UP	**-NOT ATTACHED TO POWER SUPPLY OR POWER SUPPLY DEFECTIVE** -Fuse of charger blown or battery of RM180 defective	**CHECK POWER SUPPLY** Call Rheometric Scientific Customer Service
THE DISPLAY SHOWS > ***READY***	**-THE ENTRIES ARE WRONG OR NOT STORED CORRECTLY** -Internal buffer battery is discharged	**SWITCH OFF THE RM180 AND SIMULTANEOUSLY PRESS THE** HAND **KEY. RE-SELECT OR REENTER LANGUAGE AND CODE.** Call Rheometric Scientific Customer Service
THE RM180 SWITCHES ITSELF OFF	**- THE BATTERY IS DISCHARGED (BATTERY OPERATION ONLY)** -Battery faulty Power supply and charger unit disconnected from power supply. Torque too high (with single point measurement) -Torque too high (with step program)*	**ATTACH THE RM180 TO THE CHARGER UNIT AND CHARGE BATTERY.** Call Rheometric Scientific Customer Service Attach power unit to the power supply On restart, either enter lower value for shear rate or select a smaller measurement value. On restart, enter lower value for D MAX

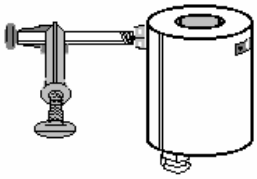
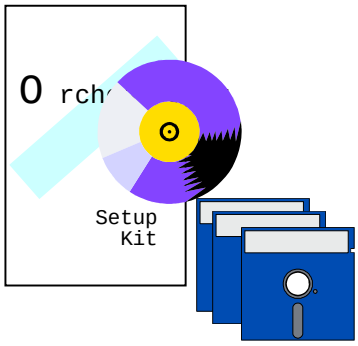
* After an increase in the speed (shear rate), a test is first performed to check that the torque is lower than 7.5 mN·m. if it is higher, all later steps are skipped. If, however, e.g. in step 6 a torque of 7.5 mN·m is almost reached, the next speed is tested. If the difference between the steps is large, the torque can be so high that the instrument switches itself off when in operation with the power supply and charger unit, or when the battery is almost completely discharged.

4 ACCESSORIES

4-1 ACCESSORIES WITH PART NUMBERS

ITEM	DISCRIPTION	PART NUMBER
	Measuring Instrument RM180 RM180-NT RM180S	
	Stand, Comprising: • Stand Base with adjustment screw • Stand rod • Stand arm with locking screws	 210-111962 210-111855 210-113111
	Measurement system of stainless steel, comprising: • Measuring bob 1 (ϕ30mm, l=45mm) • Measuring bob 2 (ϕ 24mm, l=36mm) • Measuring bob 3 (ϕ 14mm, l=21mm)	 210-112820 210-112821 210-112822
	• Measuring tube 1(ϕ32.54mm) • Measuring tube 2 (ϕ 26.03mm) • Measuring tube 3 (ϕ 15.18mm)	210-112932 210-112937 210-112938
	• Cap 1(for measuring tube 1) • Cap 2 (for measuring tube 2) • Cap 3 (for measuring tube 3)	210-112872 210-112877 210-112878

	Power Supply Unit, 115VAC 60Hz or 220VAC50/60 Hz	210-651003 210-113123 (battery pack)
	Measuring tube of aluminum For one-time use. Set of 100	210-111931
	Measuring bob N0. 4(ϕ14mm, 1= 10.5mm) (for high viscosities)	210-111906
	Measuring bob No. 9 (ϕ31.5mm, 1=45mm) (forms with measuring tube 1 measuremnt system 1: for high shear rates and low viscosities)	210-111875
	Measurement system 50 (double slit system for low viscosities)	210-112823
	Measurement system TV (set)	210-111949

	Measurement system ISO2555 (set)	210-111948
	Connection cable (RS232C) for computer (DB, 25-pin, 9-pin female/, 9-pin female) included, adapter cable(9-pin, male/25-pin female)	707-00701
	Thermostating Unit	705-00050
	Software The optional software for control of RM180 and evaluation of data is available on CD format as well as 3.5" Foppy-disk set. T**he software must be revision 6.5.0 or higher** to function with RM180. Future versions of RSIOrcestrator may not be available on 3.5" disks, we strongly recommend users have a CD-ROM drive available on their PCs	CD 8999-00016 Floppy-disks 8999-00010

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