

Operating Instructions

Ring/Plate-Tensiometer TD 1C

06/05
TD 1C_E

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1 Introduction

This instruction provides you the necessary information about the use of the TD 1C

1.1 Short description and applications

The LAUDA automatic Tensiometer TD 1C consists of the measuring stand and the COMMAND unit and is used for measuring surface and interfacial tension, for determining liquid density, as well as for measuring weights. In contrast with other instruments of this type the TD 1C has been specially developed as a low cost easy to handle measuring device to combine high-quality measurement system with documentation and represents an interesting and less expensive alternative to automatic systems. The TD 1C is particularly suitable for:

- universities, colleges, teaching institutes and other educational establishments,
- industrial and quality control laboratories
- research and development departments

There is a wide range of applications, including:

- evaluating and testing of physical properties of the above types on organic and inorganic liquids, solutions, liquid/liquid and liquid/solid dispersions emulsions etc.
- development and testing of surfactants (detergents emulsifiers etc.) and their detection in effluents and streams.

The combination of precision weighing technology with a high- performance electronic system provides for a wide range of measurements using a variety of test bodies.

For surface and interfacial tension measurement these are:

- platinum/iridium plate after Wilhelmy
- platinum/iridium ring according to ASTM D 971 and DIN 53914

and for density measurement:

- glass displacement plunger

By using an optional jacketed vessel (incl. cover) to take the sample beaker it is possible to operate the system over a wide temperature range with the aid of a LAUDA thermostat e.g. of type ECOLINE, RE104

It is strongly recommended to read this manual carefully prior to power-up the TD 1C!

1.2 Operating principle

Determination of the surface or interfacial tension with a plate or ring consists of measuring the vertical force which the surface or interface of the liquid exerts on the test body. For this purpose the TD 1C incorporates a manual driven sample stage which permits upward and downward movement of the test liquid without any vibration. After defining the measuring parameters and the measuring method the movement of the table is started manually by turning a knob. In case of ring method the mechanism allows for automatic detection of the maximum force. In case of plate, the sample table has to be brought into first contact of the plate with the sample and stopped. The surface tension values appear immediately including all corrections on the high resolving screen of the COMMAND and can be stored or printed out buy pushing a buttton. The measurement of this force requires an extremely sensitive force cell which is the core element of the TD 1C.

Displacement free force measurement is achieved by electro- magnetic compensation of the force transmitted by the test body to a measuring beam. The current required to do this is directly proportional to the force. The value obtained by current / voltage conversion is shown in a table of the COMMAND LCD-screen. Determination of the weighing beam position is achieved by an optoelectronic detector.

In addition up to 500 results can be stored within the internal memory of the COMMAND unit and printed out immediately or later.

2 Components and Installation

2.1 Measuring stand

The measuring stand is equipped with a high-resolution load cell and an sample stage smoothly movable by an adjusting knob. The easily accessible sample chamber allows the use of standard sample beakers up to 8 cm in diameter including temperable sample vessels.

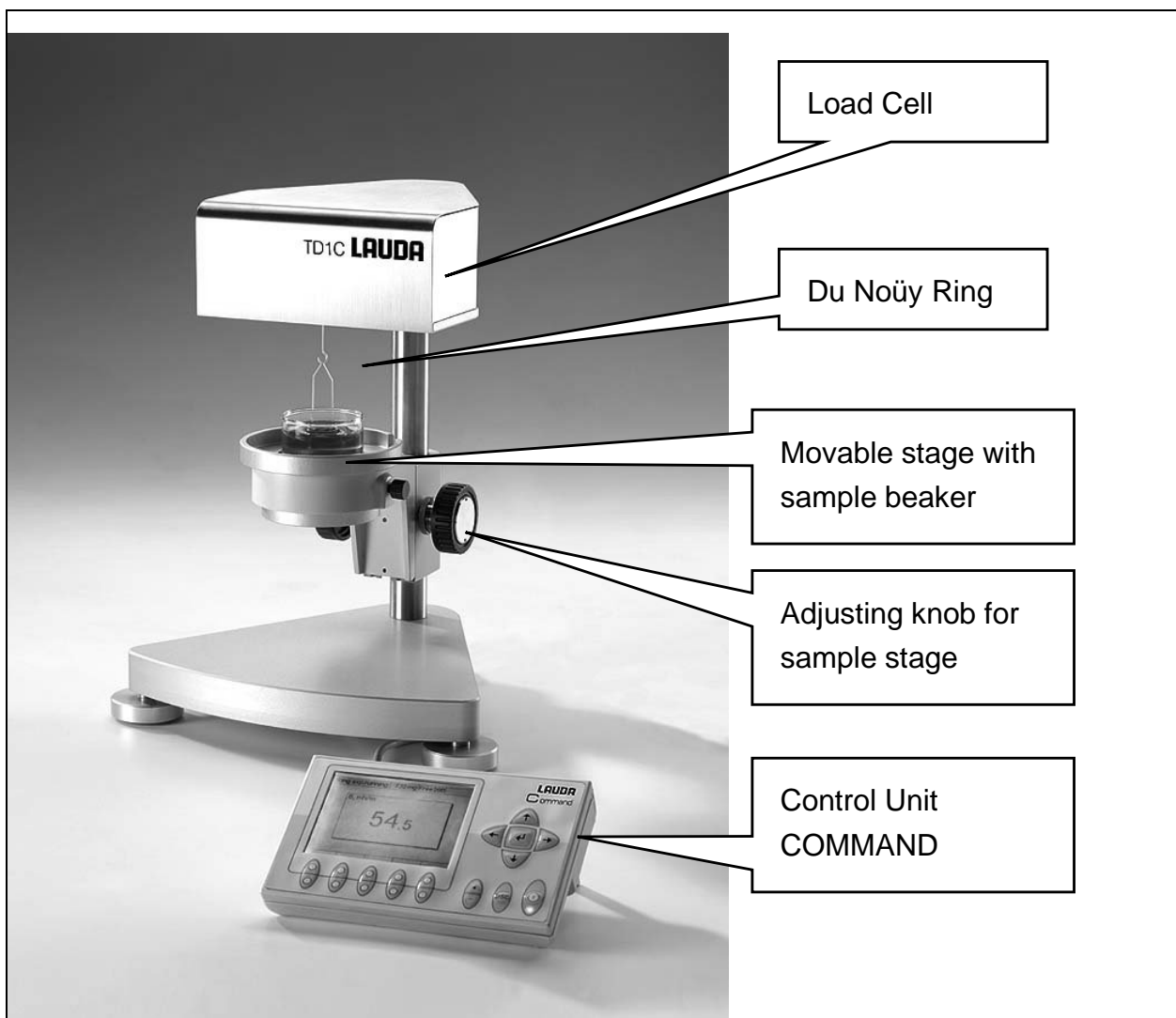


Fig. 1. Front View and description of main components

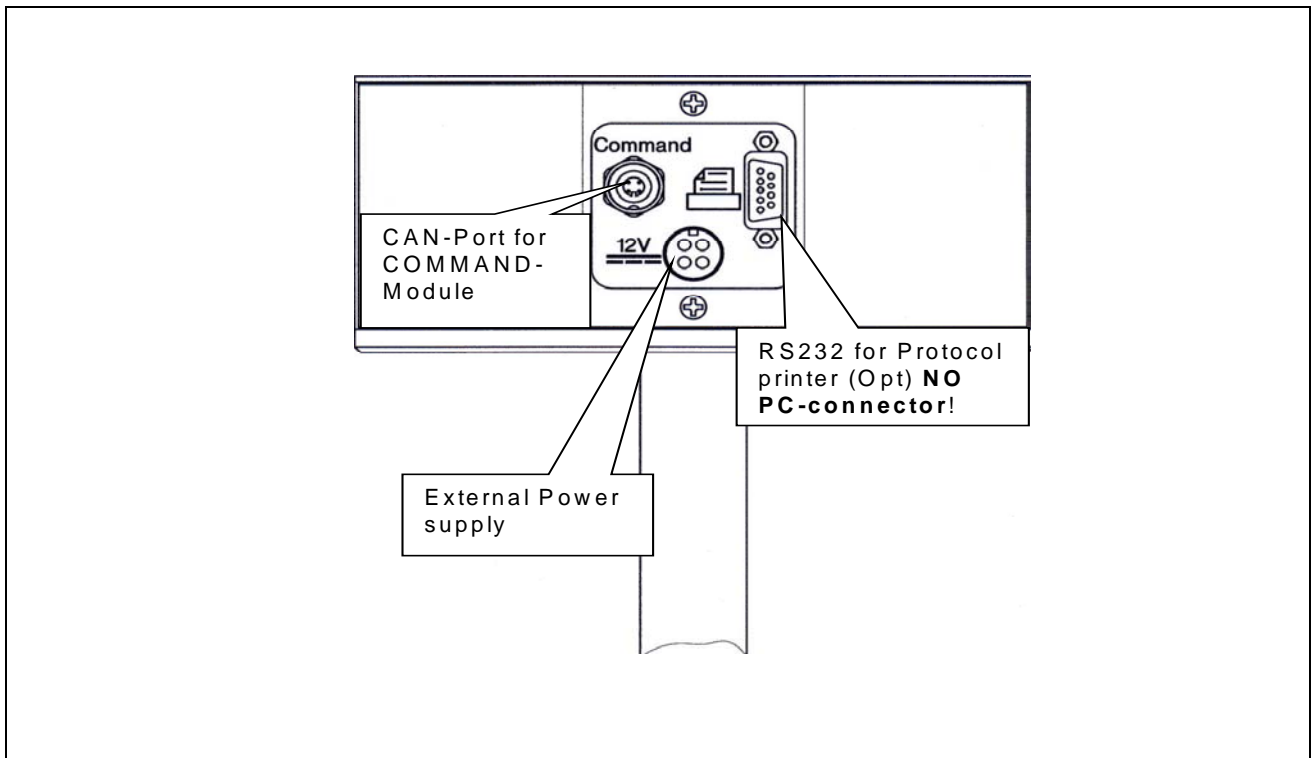


Fig. 2 *Rear side of TD 1C with electrical connections to accessory components*

2.2 Control panel Command

This convenient control panel allows the complete operation, input of measuring parameters, start of measurement and transfer of data to a printer or to internal storage. The high-resolution graphical display offers menu-based user guidance and displays individual measurements and results in tabular format.

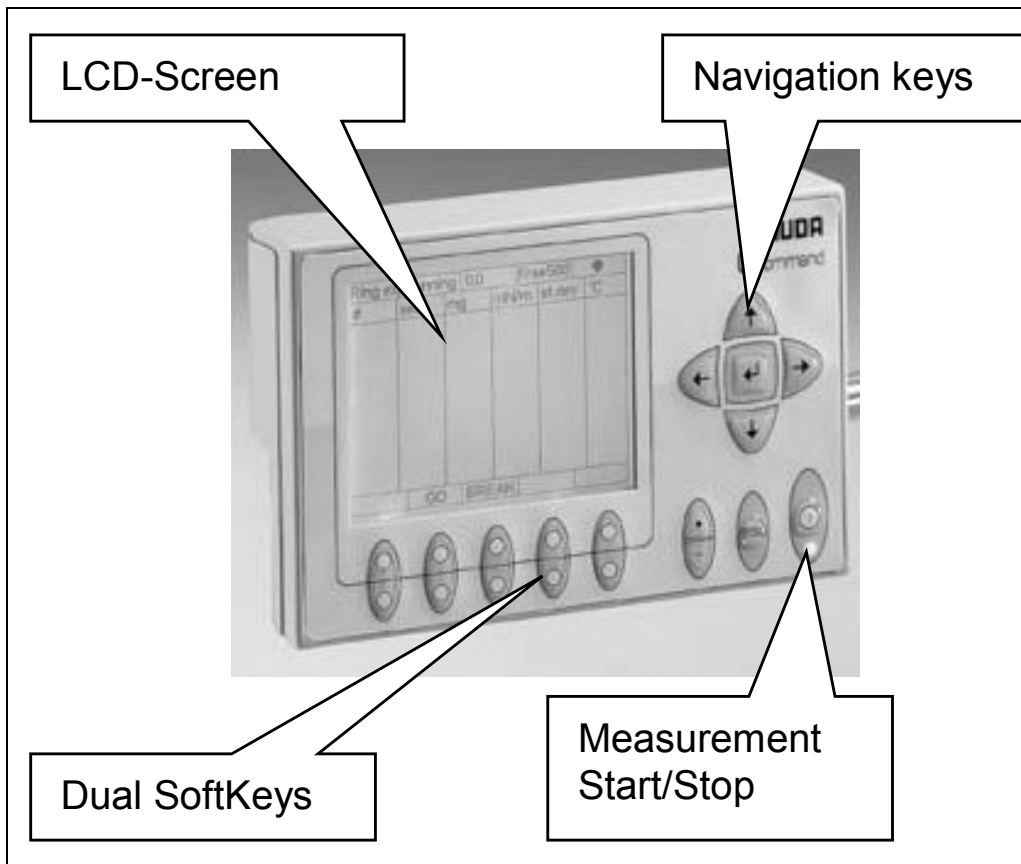


Fig. 3 Parts of the COMMAND-unit

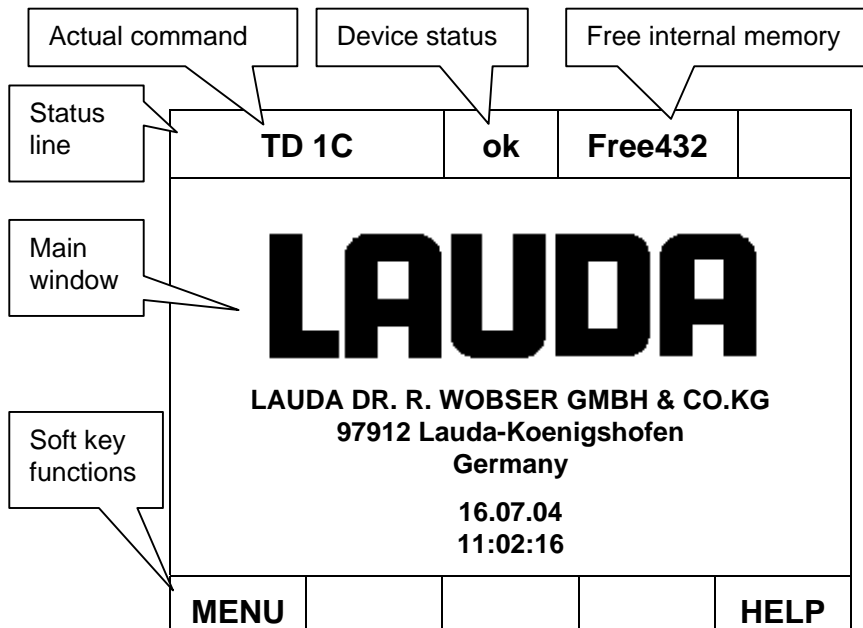


Fig. 4 Segmentation of the LCD Screen.
Here the information screen immediately after switching on is shown,

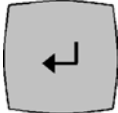
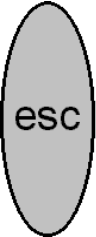

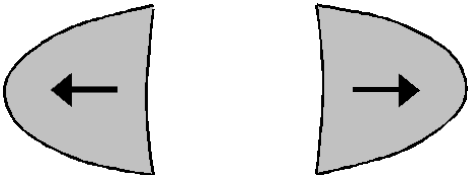
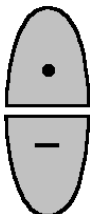
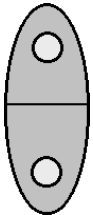
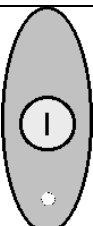
2.3 Setting up the TD 1C

The following points should be observed when setting up the tensiometer:

1. Select its location on an accurately horizontal table so that any effect of building vibrations is largely excluded.
2. Check that the voltage marked on the back of the external power unit agrees with the local supply voltage
3. Plug-in the supply cable coming from external power supply into the COMMAND
4. Plug-in COMMAND cable to the TD 1C measuring stand.
5. Plug-in the power supply cable into the mains socket. Before doing this take care that the mains switch of the external power supply should be set to 'OFF'.
6. The optional printer is connected at the back (9-pole) of TD 1C
Note: this Connector is ONLY for the printer NOT for data transfer to PC
7. After checking all connections the TD 1C can be switched on at external power supply. The information screen appears (Fig. 3)
8. Take off the plastic tube carefully which is clamped between sample table and transducer housing to protect the measuring system and the hook. Therefore the table is moved down turning the adjusting knob.

Command control functions

2.4.1 Description of keys.

Command Key Pad	
	<i>Enter Key</i> , confirmation of the selection and/or accepting the changes.
	<i>Escape Key</i> : 1. to get back to previous screen without accepting the changes at menus "Measurement Parameters", "Settings" and "Tools" 2. interrupts taring and calibration without changes
	<i>Menu navigation keys: up/down</i> 1. to select menu items up and down 2. to increment/decrement numerical values of parameters
	<i>Menu navigation keys (left/right)</i> 1. To switch between selection menus: Right: first item of the sub-menu is selected Left: last item of the main menu is selected 2. Select letter/digit of parameters
	<i>Duo keys</i> above: decimal point key below: minus sign (not used)
	<i>Soft keys</i> 5 keys, which have the functions shown in the display above. Soft key inputs are marked in the manual with a frame. Example: To print the results, press the duo key below PRINT .
	If NOT illuminated, the preselected measurement will be started from measurement screen. If illuminated, the measurement is running By pressing the key the measurement will be stopped immediately. The evaluation will be done over the last completed cycles.

<i>Soft Keys at Start and "Main menu" screen</i>	
MENU	Screen switches to the Main Menu (Fig.3)
HELP	Not available yet

<i>Soft Keys at Result Screen</i>	
MENU	Screen switches to the Main Menu (Fig.4)
SAVE	The data of the result line, together with the numerical sample ID code, and measurement parameters are saved in the internal memory of the COMMAND. Max. 500 sets can be stored. The free number of sets is displayed in the status line of the result screen (here: Free432)
PRINT	The data of the result line, together with the numerical sample ID code, and measurement parameters will be printed out at the protocol printer.
NEW	Defines a new measurement followed by the menu " Experiment new " opens

2.4.2 Main Menu

TD 1C	ok	Free432	
Experiment new Experiment view Settings Tools	Density Plate Ring Weight		
ABOUT			HELP

After entering MENU the main menu opens which enables the selection of following sub menus using the navigation keys:

Experiment new:
Selection of measuring mode for a new measurement

Experiment view:
Viewing results of previously saved measurements

Settings
Defining and changing important base settings concerning date ,display, language

Tools
test functions for system and printer. Memory cleaning

2.4.3 Sub-Menu „Experiment New“

TD 1C	ok	Free432	
Experiment new Experiment view Settings Tools	Density Plate Ring Weight		
ABOUT			HELP

After selecting **Experiment new** and confirmation the corresponding Sub-Menu opens, where following modes can be selected:

Density
Enables determination of density of liquids by measuring buoyancy using a displacement plunger

Plate
Surface/Interface tension measurement using Wilhelmy method

Ring
Surface/Interface tension measurement using du Noüy method

Weight
Measurement of small weights (max. 5g)

2.4.4 Sub-Menu „Experiment View“

TD 1C	ok	Free432	
Experiment new	Density Plate Ring Weight		
Experiment view			
Settings			
Tools			
ABOUT			HELP

After selecting **Experiment view** by cursor the results of experiments of the different modes can be displayed.

2.4.5 Sub-Menu „Settings“

TD 1C	ok	Free432	
Experiment new	Calendar Clock Display brightness Display contrast Language Acoustic signal Date view format		
Experiment view			
Settings			
Tools			
ABOUT			HELP

Calendar
A date can be entered or modified

Clock
A time can be entered or modified

Display brightness
can be modified in 8 levels

Display contrast
can be modified in 8 levels

Language
English or German language can be selected

Acoustic signal
Loudness can be adjusted in 4 steps

Date view format
DD.MM.YY or MM.DD.YY can be selected

2.4.6 Sub-Menu „Tools“

TD 1C	ok	Free432	
Experiment new Experiment view Settings	Selftest Keyboard test Data memory clean		
Tools			
ABOUT			HELP

Self test
Results of the self test, always performed after switching on is displayed, showing system information and the status CPU and RAMs

Keyboard test
Is a functional test of all keys of the COMMAND module

Data memory clean
To erase all stored results

3 Testing surface tension

3.1 Using the plate

3.1.1 Preparation of measurement

The following preparation is required for this measurement:

- ✓ The TD 1C is switched on by means of the external power supply switch
- ✓ Use adjusting knob to move the table in a position giving space enough for changing of beakers and to attach the plate
- ✓ The plate supplied is attached to the hook of the measuring system. Ensure that the plate has no contact with the test liquid.

3.1.2 Checking and Setting plate parameters

Select "Experiment new". After confirmation the sub-menu "New Plate exp" opens:

MENU -> Experiment new ->Plate ↵

New plate exp.	ok	Free432	
Measuring parameters Plate parameter set Tare Calibrate	L = 19.90 mm D = 0.10 mm		
MENU			HELP

L
The exact length of the plate has to be entered. Here the values of the accessory plate, according DIN 53914, is shown. It can be adjusted between 10 and 30 mm in case of deviations or other.

D
The exact thickness of the plate has to be entered. Here the value according DIN53914 is shown, which is appropriate to the accessory plate. It can be adjusted between 0.05 and 0.5 mm in case of deviations or other plates are being used.

New plate exp.	ok	Free432	■
Measuring parameters Plate parameter set Tare Calibrate	Exp.ID = 123		
MENU			HELP

Exp.ID
A numerical value (max. 3 digits) can be assigned by using soft keys to the sample

3.1.3 Taring

The probe weight has to be tared prior to the first measurement or in case of the measuring probe being changed before the plate touches the liquid by using the function “Tare” in the “New plate exp.” -menu

New plate exp.	ok	Free432	■
Measuring parameters Plate parameter set		<div style="border: 1px solid black; padding: 5px;"> Stable Unstable Very unstable </div>	
<div style="border: 1px solid black; padding: 5px;"> Tare Calibrate </div>			
MENU			HELP

Stable
Has to be selected if the surrounding is very stable and free of vibrations or winds.

Unstable / Very Unstable
Has to be selected if a taring in mode **Stable (Unstable)** is not possible because of outer conditions.


Note that reproducibility of results will eventually be reduced.

If no successful taring is possible in mode “**very unstable**” the instrument has to be moved to a more disturbance free position.

New plate exp.	ok	Free432	■
<div style="border: 1px solid black; padding: 20px; width: 80%; margin: 0 auto;"> Taring in progress </div>			

Taring in progress
This message appears when taring is executed
Do not disturb this process. Prevent system from vibrations

Taring successful
This message appears after completing the taring procedure. Confirm to switch the screen back to previous sub menu.

Taring can be interrupted using 

3.1.4 Calibrating

A calibration check should be done with accessory calibration weights prior to the first measurement and in case the measuring probe has been changed,.

New plate exp.	ok	Free432	
Measuring parameters Plate parameter set Tare Calibrate		Stable Unstable Very unstable	<p>Stable Has to be selected if the surrounding is very stable and free of vibrations or winds.</p> <p>Unstable / Very Unstable Has to be selected if a taring in mode Stable (Unstable) is not possible because of outer conditions.</p> <p>Note that reproducibility of results will eventually be reduced.</p> <p>If no successful taring is possible in mode “very unstable” the instrument has to be moved to a more disturbance free position.</p>
MENU			HELP

New plate exp.	ok	Free432							
<table border="1" style="margin: auto; border-collapse: collapse;"> <tr> <td colspan="2" style="padding: 5px;">Calibration weight,mg</td> </tr> <tr> <td colspan="2" style="font-size: 2em; text-align: center; padding: 20px;">500.01</td> </tr> <tr> <td style="padding: 5px;">Min 100.00</td> <td style="padding: 5px;">Max 510.00</td> </tr> </table>				Calibration weight,mg		500.01		Min 100.00	Max 510.00
Calibration weight,mg									
500.01									
Min 100.00	Max 510.00								
1	2	3	4						
6	7	8	9						
		0							

Calibration weight, mg
The precise weight of the calibration stirrup has to be entered using the Duo-soft keys now assigned with digits

Therefore the corresponding digit has to be selected and changed via soft key. The digits can be incremented or decremented using or

In this case the last digit was changed into „1“, according to the precise weight of the stirrup (500.01 mg). With ↵ calibration is started.

Calibration has to be done as follows


1. The 500 mg calibration weight supplied is attached to the hook in addition to the plate.
2. Exact weight is entered.

3. After ↵ the calibration starts with the following message:

New plate exp.	ok	Free432	
<div style="border: 2px solid green; padding: 20px; width: fit-content; margin: 0 auto;"> <p>Calibrating in progress</p> </div>			

Calibrating in progress
 This message appears during the calibration
Do not disturb or interrupt this process. Prevent system from vibrations

Calibration successful
 This message appears once the calibration procedure is completed . Confirm to switch the screen to the previous sub menu.

Calibration can be interrupted using 

4. After confirmation (↵) the calibration weight is removed. If not successful , the calibration have to be repeated.

3.1.5 Performing the plate measurement

A measurement with the plate is performed in the following steps:

1. The sample table is moved down by adjusting knob and the test liquid in the beaker supplied is placed on the table.
2. The sample table with the liquid is moved up carefully.
3. If the force sensor feels the contact with the liquid surface or interface the movement has to be stopped. stops. Immediately on contact with the surface the display shows a jump of the force value. This value is the absolute surface/interface tension in 'mN/m'.
4. The force values and the evaluated surface tension is shown in the result screen (see below)

Note that this value is correct only if the plate is completely wetted, i.e. a uniform meniscus can be observed at the bottom end of the plate and the liquid film on the plate shows no visible non-uniformities. -

3.2 Using the ring

Unlike in the case of the plate, measurement with the ring does not show a direct proportionality between measured force and surface /interface tension, because of the lamella drawn up with the ring the measurement includes a weight in addition to the surface tension.

Further information on ring measurement and its correction can be found in the following publications:
 Du Noüy, P. L.,: J. Gen. Physiol. New York, 1(1919), S.521

Harkins, M. + Jordan H. : J. Am. Soc. 52 (1930), S.I 751 Zuidema, H. + Waters C. W. : Ind. Eng. Chem. Analyt. 13 (1941), S.312

Fox, H. W. + Chrisman C. H.: J. phys. Chem. 56 (1952), S.284

In addition reference should be made to the literature reference section attached.

3.2.1 Checking and Setting ring parameters

MENU -> Experiment new -> Ring ↵

New ring exp.	ok	Free432	
Measuring parameters Ring parameters Tare Calibrate		R = 9.55 mm r = 0.20 mm	<p>R The exact radius of the horizontal ring has to be entered. Here the (default) value according DIN 53914 is shown, which is appropriate to the accessory ring. It can be adjusted to the real dimensions between 9.00 and 9.99 mm in case of deviations or a ring with other dimensions is used.</p> <p>r The exact radius (= diameter/2) of the wire has to be entered. Here the (default) value according DIN 53914 is shown, which corresponds to the accessory ring. It can be adjusted between 0.10 and 0.30 mm in case of radius changes (i.e. by corrosion or coatings) or a ring with different wire is being used.</p>
MENU			HELP

3.2.2 Preparation of measurement

1. Use adjusting knob to move the table in a position giving space enough for changing of beakers and to attach the ring
2. The ring supplied is attached to the hook of the measuring system without any contact with the test liquid surface or in case of interface tension dipped into the lower phase without any contact to the interface. (this has to be done before pouring the upper phase on top)
3. Select **Experiment new -> Ring**". After confirmation the sub-menu "New Ring experiment" opens:

New ring exp.		ok	Free432	
Measuring parameters		Exp.ID = 123 $\Delta\rho = 0.99 \text{ g/cm}^3$		
Ring parameters				
Tare				
Calibrate				
MENU				HELP

Exp.ID
A numerical value (max. 3 digits) can be assigned by using soft keys to characterize the sample

$\Delta\rho$
The density, in case of surface tension or *density difference (in case of interface tension)* has to be entered here. This value is needed for the automatical ring correction according Zuidema & Waters. For diluted aqueous solutions a value of 0.99 g/cm^3 at room temperature (18-25°C) is sufficient.

3.2.3 Taring

The probe weight has to be tared prior to the first measurement or in case of the measuring probe being changed before the ring touches the liquid by using the function "**Tare**" in the "**New ring exp.**" -

New ring exp.	ok	Free432	
Measuring parameters Plate parameter set		Stable Unstable Very unstable	
Tare Calibrate			
MENU			HELP


Stable
Has to be selected if the surrounding is very stable and free of vibrations or winds.

Unstable / Very Unstable
Has to be selected if a taring in mode **Stable (Unstable)** is not possible because of outer conditions.
Note that reproducibility of results will eventually be reduced.
If no successful taring is possible in mode “**very unstable**” the instrument has to be moved to a more disturbance free location.

New ring exp.	ok	Free432	■
<div style="border: 2px solid black; width: 80%; margin: 0 auto; padding: 10px;"> <p style="font-size: 1.2em; margin: 0;">Taring in progress</p> </div>			

Taring in progress
This message appears during the calibration
Do not disturb this process. Prevent system from vibrations

Taring successful
This message appears once the calibration procedure is completed . Confirm to switch the screen to the previous sub menu.

Taring can be interrupted using 

3.2.4 Calibrating

A calibration check should be done prior to the first measurements and in case the measuring probe is changed by using accessory calibration weights.

New ring exp.	ok	Free432	
Measuring parameters Plate parameter set Tare Calibrate		Stable Unstable Very unstable	
MENU			HELP

Stable
Has to be selected if the surrounding is very stable and free of vibrations or winds.

Unstable / Very Unstable
Has to be selected if a taring in mode **Stable (Unstable)** is not possible because of outer conditions.

Note that reproducibility of results will eventually be reduced.

If no successful taring is possible in mode **“very unstable”** the instrument has to be moved to a more disturbance free position.!

New ring exp.	ok	Free432							
<table border="1" style="margin: auto; border-collapse: collapse;"> <tr> <td colspan="2" style="padding: 5px;">Calibration weight,mg</td> </tr> <tr> <td colspan="2" style="text-align: center; font-size: 2em; font-weight: bold; padding: 10px;">500.01</td> </tr> <tr> <td style="padding: 5px;">Min 400.00</td> <td style="padding: 5px;">Max 510.00</td> </tr> </table>				Calibration weight,mg		500.01		Min 400.00	Max 510.00
Calibration weight,mg									
500.01									
Min 400.00	Max 510.00								
1	2	3	4						
6	7	8	9						
			5 0						

Calibration weight, mg
The precise weight of the calibration stirrup has to be entered using the Duo-soft keys now assigned with digits

Therefore the corresponding digit has to be selected and changed via soft key. The digits can be incremented or decremented using or

In this case the last digit was changed into „1“, according to the precise weight of the stirrup (500.01 mg). With calibration is started.


Calibration is performed as follows:

1. The 500 mg calibration weight supplied is attached to the hook in addition to the ring.
2. Exact weight is entered.
3. After the calibration starts with the following message:

New ring exp.	ok	Free432	
<div style="border: 2px solid green; padding: 20px; width: fit-content; margin: 0 auto;"> <p>Calibrating in progress</p> </div>			

Calibrating in progress
This message appears during the calibration
Do not disturb this process. Prevent system from vibrations

Calibration successful
This message appears once the calibration procedure is completed . Confirm to switch the screen to the previous sub menu.

Calibration can be interrupted using 

- After confirmation (↵) the calibration weight is removed. If not successful , the procedure has to be repeated.

3.2.5 Performing a ring measurement

A measurement with the ring is performed in the following steps:

- The sample table is moved down by turning adjusting knob to the a low position, to allow the change of sample beaker.
- The test liquid in a sample beaker (different sizes possible) is placed on the table.
- The ring supplied with the equipment is attached to the hook of the measuring system.
- The table with the liquid is moved up again until the ring is at least 2 - 3 mm below the liquid surface.
- Only in case of interface tension::* The second lighter phase (Oil) is poured carefully on top of the heavier phase (water) until the sheet gets a thickness of about 1 cm. Be sure that during this the liquid surface is not disturbed and the ring does not to touch the oil.
- For the test the table has to be moved downwards carefully and a lamella attached to the ring is shown
- The force displayed at COMMAND will increase until a maximum is reached.
- The passing the maximum and the detection of it is marked by a “beep”
- The movement has to be stopped, if possible before detachment of lamella.
- The surface tension calculated from the measured maximum force is displayed and can be stored or printed out.
- The correction factor for the ring is calculated by the COMMAND software according to Zuidema & Waters.

3.3 The display of measured surface /interface tensions

3.3.1 Plate measurement

Before plate touches the sample),

New plate exp.	0 mg	Free432	
σ , mN/m <h1>0.0</h1>			

After touching the liquid

New plate exp.	932 mg	Free432	
σ , mN/m <h1>72.0</h1>			
MENU	NEW	SAVE	PRINT

σ , mN/m

here the surface tension calculated from the actual measured force is displayed.

Please note:

This value corresponds to the real surface tension of sample if the plate just touches the surface without dipping in and if the plate is perfectly wetted.

Note: take sure by thoroughly cleaning that wetting of plate is optimum.

To get the "static" equilibrated surface/interface tension it has to be waited until this value will become stable.

This result at each time can be saved using **SAVE** into internal storage or printed out using **PRINT** together with sample ID and parameters

For the next measurement with the plate use "**NEW**" If the measuring mode has to be changed go back via "**MENU**"

3.3.2 Ring measurement

before ring is in contact with the sample) and after dipping in

Ring exp. running	0 mg	Free432	
σ , mN/m 0.0			

During extraction form the liquid


Ring exp. running	476 m	Free432	
σ , mN/m 34.7			

σ , mN/m

here the wetting force of the lamella units of mN/m tension calculated from the actual measured force is displayed.

Please note:

As long no "beep" sound can be heard and the values still increasing by lowering the table this value does *not* corresponds to the real surface tension of sample..

After "beep" measurement has to be stopped using again  to get the result.

After stop of the measurement (detecting the maximum)

Exp. end:user	476 m	Free432	
σ , mN/m <h1 style="font-size: 2em;">72.0</h1>			
MENU	NEW	SAVE	PRINT

Following message appears in status line:
"Exp. end: user"

Buttons for saving and storing appear After "

σ , mN/m

here the surface tension calculated from the detected maximum force is displayed and should correspond to the surface tension.

This result can be saved using **SAVE** into internal storage or printed out using **PRINT** together with sample ID and parameters

For the next measurement with the plate use "NEW". If the measuring mode has to be changed go back via "MENU"

4 Measuring density and weight

4.1 Density measurement

4.1.1 Setting of parameters

MENU -> Experiment new -> Density ↵

opens the following „Measuring Parameter menu: where the conditions for the test have to be specified.

New density exp.	ok	Free432	
Meas. parameter	Exp.ID = 815		
Tare			
Calibrate			
MENU			HELP

Exp.ID

A numerical value (0-999) can be assigned by using soft keys to characterize the sample

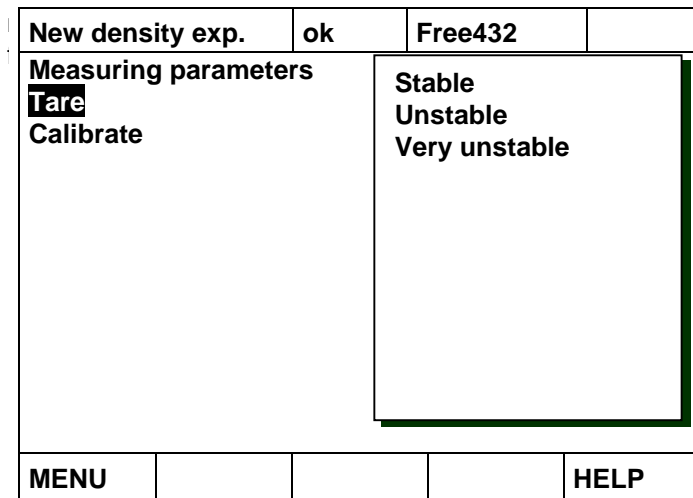
4.1.2 Preparation of measurement

The following preparation is required for this measurement:

1. The dry and clean accessory plunger is attached to the hook of the measuring system.
2. Select a sample beaker or bottle which is deep enough that the plunger can be submerged completely into sample or pure water (in case of calibration) without touching the bottom.
3. The table is moved down as far as possible using adjusting knob.
4. The test glass filled with sample or water is placed onto the table without touching the plunger

4.1.3 Taring

The plunger weight has to be tared in air prior to the first



Stable

Has to be selected if the surrounding is very stable and free of vibrations or winds.

Unstable / Very Unstable

Has to be selected if a taring in mode **Stable (Unstable)** is not possible because of outer conditions.

Note that reproducibility of results will eventually be reduced.

If no successful taring is possible in mode "**very unstable**" the instrument has to be moved to a more disturbance free position.




Taring in progress

This message appears during the calibration

Do not disturb this process. Prevent system from vibrations

Taring successful

This message appears once the calibration procedure is completed. Confirm to switch the screen to the previous sub menu.

Taring can be interrupted using 

4.1.4 Calibrating

A calibration check should be done before the first measurements and always if the measuring probe is changed. This has to be done using distilled water as reference liquid

1. The plunger is fully immersed in the distilled water by moving the table up using adjusting knob

New density exp.	ok	Free432	
Measuring parameters Tare Calibrate	Stable Unstable Very unstable		
MENU			HELP

Stable
Has to be selected if the surrounding is very stable and free of vibrations or winds.

Unstable / Very Unstable
Has to be selected if a taring in mode **Stable (Unstable)** is not possible because of outer conditions.

Note that reproducibility of results will eventually be reduced.

If no successful taring is possible in mode "**very unstable**" the instrument has to be moved to a more disturbance free position.

New density exp.	ok	Free432	
Calibrate density, g/l <h1 style="margin: 0;">997.00</h1> Min: 900.00 Max: 999.00			
1	2	3	4
6	7	8	9
			0

Calibrate density, g/l
The precise density of the calibration liquid (water) has to be entered

Therefore the corresponding digit has to be selected and changed via soft key. The digits can be incremented or decremented using or .

In this case the default value was changed to the precise density of water at the measuring temperature (table see below) e.g. 997.00 g/l at 20°C.

With calibration is started.

Temperature [°C]	Density [g/l]
15	998
16 - 22	997
23 - 26	996
27 - 29	995
30 - 33	994
33 - 35	993


In this table the commonly used density values of pure water are shown. Because of restricted accuracy of the buoyancy the reference density has to be entered only with 3 significant digits.

The calibration starts with the following message:

New density exp.	ok	Free432	
<div style="border: 2px solid black; width: 80%; margin: 0 auto; padding: 10px;"> <p style="text-align: center; font-weight: bold; font-size: 1.2em;">Calibrating in progress</p> </div>			

Calibrating in progress
 This message appears while the calibration procedure is running.
Do not disturb this process. Prevent system from vibrations

Calibration successful
 This message appears once after finishing the calibration procedure is completed. Confirm to switch the screen to the previous sub menu.


Calibration can be interrupted using 

The table is moved down again until the plunger is released.

The test glass with water is removed from the TD 1C and the plunger is thoroughly cleaned and dried.

4.1.5 Performing a density measurement

A density measurement is performed in the following steps:

1. The table with the sample moved up using adjusting knob
2. The motion has to be stopped in the moment where the top of the plunger is at least 3 mm below the liquid surface.
3. If all preparations are complete the force measurement is started by pushing: 

Measurement is performed automatically until the maximum time and/or the user defined stability criterion is reached.

During measurement running::

Density running.	997	Free432	
Density (ρ), g/l: <div style="font-size: 2em; font-weight: bold; margin: 10px 0;">997</div>			

During measuring of the density 100 single force values are measured approx. ca. 2 seconds while the mean value and standard deviation are calculated..

Then the measurement will be stopped by the system (**Exp.end: Time**)

Exp.end: user	997	Free432	
Density (ρ), g/l: <div style="font-size: 2em; font-weight: bold; margin: 10px 0;">997</div>			
MENU	NEW	SAVE	PRINT

After stop of measurement the density measurement is displayed in the result window.

This result can be printed via the external printer using the appropriate Soft-Keys. Alternatively the data can be stored in the internal memory.

4.2 Weight measurement

4.2.1 Setting of parameters

MENU -> Experiment new -> Weight ↵

opens the following „Measuring Parameter menu: where the conditions for the test have to be specified.

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; padding: 2px;">New weight exp.</td> <td style="width: 10%; padding: 2px;">ok</td> <td style="width: 25%; padding: 2px;">Free432</td> <td style="width: 40%;"></td> </tr> <tr> <td style="padding: 2px;">Meas. parameter</td> <td colspan="3" style="padding: 2px;">Exp.ID = 815</td> </tr> <tr> <td style="padding: 2px;">Tare</td> <td colspan="3"></td> </tr> <tr> <td style="padding: 2px;">Calibrate</td> <td colspan="3"></td> </tr> <tr> <td style="padding: 2px;">MENU</td> <td></td> <td></td> <td style="padding: 2px;">HELP</td> </tr> </table>	New weight exp.	ok	Free432		Meas. parameter	Exp.ID = 815			Tare				Calibrate				MENU			HELP	<p>Exp.ID A numerical value (0-999) can be assigned by using soft keys to characterize the sample</p>
New weight exp.	ok	Free432																			
Meas. parameter	Exp.ID = 815																				
Tare																					
Calibrate																					
MENU			HELP																		

4.2.2 Preparation of measurement

The following preparation is required for this measurement:

1. The table is moved down far enough to mount the holder for the material to be measured at the hook.
2. The actual weight of the hook together with the holder has to be tared.

4.2.3 Taring


Taring has to be done prior to the first measurement using the function “Tare” in the “New weight exp.” – menu

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; padding: 2px;">New weight exp.</td> <td style="width: 10%; padding: 2px;">ok</td> <td style="width: 25%; padding: 2px;">Free432</td> <td style="width: 40%;"></td> </tr> <tr> <td style="padding: 2px;">Measuring parameters</td> <td colspan="3" style="padding: 2px;">Stable</td> </tr> <tr> <td style="padding: 2px;">Tare</td> <td colspan="3" style="padding: 2px;">Unstable</td> </tr> <tr> <td style="padding: 2px;">Calibrate</td> <td colspan="3" style="padding: 2px;">Very unstable</td> </tr> <tr> <td style="padding: 2px;">MENU</td> <td></td> <td></td> <td style="padding: 2px;">HELP</td> </tr> </table>	New weight exp.	ok	Free432		Measuring parameters	Stable			Tare	Unstable			Calibrate	Very unstable			MENU			HELP	<p>Stable Has to be selected if the surrounding is very stable and free of vibrations or winds.</p> <p>Unstable / Very Unstable Has to be selected if a taring in mode Stable (Unstable) is not possible because of outer conditions. Note that reproducibility of results will eventually be reduced. If no successful taring is possible in mode “very unstable” the instrument has to be moved to a more disturbance free position.</p>
New weight exp.	ok	Free432																			
Measuring parameters	Stable																				
Tare	Unstable																				
Calibrate	Very unstable																				
MENU			HELP																		

New weight exp.	ok	Free432	
<div style="border: 2px solid green; width: 80%; margin: auto; padding: 10px;"> <p style="font-size: 1.2em; margin: 0;">Taring in progress</p> </div>			

Taring in progress
 This message appears during the calibration
Do not disturb or interrupt this process. Prevent system from vibrations

Taring successful
 This message appears once the calibration procedure is completed . Confirm to switch the screen to the previous sub menu.

Taring can be interrupted using 

4.2.4 Calibrating

A calibration check should be done before the first measurements and always if the measuring probe is changed using accessory calibration weights.

New weight exp.	ok	Free432	
Measuring parameters Plate parameter set Tare Calibrate		<div style="border: 2px solid green; width: 80%; margin: auto; padding: 10px;"> <p style="margin: 0;">Stable</p> <p style="margin: 0;">Unstable</p> <p style="margin: 0;">Very unstable</p> </div>	
MENU			HELP

Stable
 Has to be selected if the surrounding is very stable and free of vibrations or winds.

Unstable / Very Unstable
 Has to be selected if a taring in mode **Stable (Unstable)** is not possible because of outer conditions.
 Note that reproducibility of results will eventually be reduced.
 If no successful taring is possible in mode "**very unstable**" the instrument has to be moved to a more disturbance free position.

New weight exp.	ok	Free432	
<div style="border: 2px solid black; padding: 10px; margin: 0 auto; width: 80%;"> <p style="margin: 0;">Calibrate weight, mg:</p> <h1 style="margin: 0; text-align: center;">499.77</h1> <p style="margin: 0;">Min: 490.00 Max: 510.00</p> </div>			
1	2	3	4
6	7	8	9
5	0		

Calibration weight, mg
 The precise weight of the calibration stirrup has to be entered using the Duo-soft keys now assigned with digits

Therefore the corresponding digit has to be selected and changed via soft key. The digits can be incremented or decremented using or

In this case the last digit was changed into „7“, according to the precise weight of the stirrup (499.77 mg). With calibration is started.

After the calibration starts with the following message:

New weight exp.	ok	Free432	
<div style="border: 2px solid black; padding: 10px; margin: 0 auto; width: 80%;"> <p style="margin: 0; font-size: 1.2em;">Calibrating in progress</p> </div>			

Calibrating in progress
 This message appears while the calibration procedure is running.

Do not disturb or interrupt this process. Prevent system from vibrations

Calibration successful
 This message appears once after finishing the calibration procedure is completed. Confirm to switch the screen to the previous sub menu.

Calibration can be interrupted using

The calibration weight is removed from the TD 1C

4.2.5 Performing a weight measurement

A weight measurement is performed in the following steps:

1. The probe to be measure in to the holder attached or attached directly to the hook of the measuring
2. If all preparations are complete the measurement is started by pushing:

During measurement running::

Weight running.	125	Free432	
Weight, mg/l: <div style="font-size: 2em; font-weight: bold; margin: 10px 0;">125</div>			

During measuring of the weight the actual value is displayed.

The measurement can be stopped by the user (**Exp.end: user**)

Result screen for weight test:

Exp.end: user	125mg	Free432	
Weight, mg/l: <div style="font-size: 2em; font-weight: bold; margin: 10px 0;">125</div>			
MENU	NEW	SAVE	PRINT

After stop of measurement the weight measurement is summarized in the result window.

These data can be printed via the external printer using the appropriate Soft-Keys. Alternatively the data can be stored in the internal memory.

5 Viewing measured results

5.1 Results overview

MENU -> Experiment view -> {Method} ↵

Opens the following „View {method} exp.“: where all end results of the selected method (ring, plate, density or weight) are shown in the following way:

Result overview screen for ring experiments

View ring exp.		overview	Free0	■
Mem	Date	Time	ID	σ [mN/m]
5	27.04.03	11:10:33	815	46.26
6	27.04.03	11:15:58	816	46.14
7	27.04.03	11:20:43	817	46.25
8	27.04.03	11:45:10	818	46.17
12	28.04.03	17:13:03	711	72.65
15	02.05.03	09:20:35	521	29.37
16	02.05.03	09:25:54	522	27.45
17	02.05.03	09:33:47	523	28.36
20	10.05.03	13:34:01	123	65.43
MENU				HELP

Mem

Number of the location where the results together with parameters are stored in the internal memory. In this case at locations 9-11, 18-19 results of other methods are stored and hence NOT displayed here

Date

The date of the test completion. Two different formats can be set. -> menu **settings**

Time



The clock time of the test completion. Two different formats can be set. -> menu **settings**



ID

The sample identification code given from user in menu „**meas. parameters**“

σ [mN/m] or ρ [g/l] or mg

The end results of the selected method as displayed in the result line of the menu „**experiment**“

Scroll the list using keys,  up and  down.

To select a specific result for details or to print use keys  and .

5.2 View of details

Results detail screen for ring data

View ring Exp.	Mem 5	Free432									
<table border="1"> <tr> <td>Date 27.04.03</td> <td>$\Delta\rho = 0.99 \text{ g/cm}^3$</td> </tr> <tr> <td>Time 11:10:33</td> <td>R = 9.55 mm</td> </tr> <tr> <td>Exp. ID = 815</td> <td>r = 0.20 mm</td> </tr> <tr> <td>$\sigma = 72.0 \text{ mN/m}$</td> <td></td> </tr> </table>				Date 27.04.03	$\Delta\rho = 0.99 \text{ g/cm}^3$	Time 11:10:33	R = 9.55 mm	Exp. ID = 815	r = 0.20 mm	$\sigma = 72.0 \text{ mN/m}$	
Date 27.04.03	$\Delta\rho = 0.99 \text{ g/cm}^3$										
Time 11:10:33	R = 9.55 mm										
Exp. ID = 815	r = 0.20 mm										
$\sigma = 72.0 \text{ mN/m}$											
MENU			PRINT								

After selection of a result line in the overview window and confirmation by \downarrow the details of the selected measurement will be shown, together with all parameters associated.

In this example all ring data which are located in the memory position "5" (Mem 5) are displayed here and can be printed out at an optional protocol printer.

The data can not be changed afterwards.

For the other measurement methods the window is the same but filled with different result units and parameters.

6 Appendix

6.1 Reference values for checking the TD 1C

To verify the accuracy of the equipment it is possible to carry out tests on known systems.

It is important to note, however, that these values taken are from the literature. Verification requires *considerable effort and can usually only be achieved over brief periods*. Certain deviations can therefore be expected.

Surface tension [mN/m]:

System	15°C	20°C	25°C
Water	73.5	72.8	72.00
Benzene	29.5	28.9	28.2
Ethanol	22.7	22.3	21.4
Diethylether		17.0	

Interfacial tension referred to water [mN/m]

System	20°C
Benzene	35.0
Chloroform	10.7
Diethylether	32.8

6.2 Cleaning test glasses and materials used

6.2.1 Platinum test bodies

1. First Rinsing by an appropriate liquid able to solve the sample (e.g. water in case of aqueous solutions) to remove the sample residues.
2. If the cleaning solvent used before is not volatile enough to dry at ambient air, perform a second rinsing by a volatile solvent (e.g. ethanol or water) to remove the traces of former rinsing agent
3. Heating of the wetted parts to red heat in the flame of a gas or liquid which burns without any residue.

The use of ethanol or methanol (analytical grade) in an alcohol burner has proved very successful. In order to avoid damage it is important not to heat to white heat or for prolonged periods.

6.2.2 Test glasses and glass body

Prior to the first time use, wetted glass parts should be cleaned with chromic-sulfuric acid and then rinsed with BI-distilled water until a neutral reaction is obtained.



DANGER: Chromic-sulfuric acid is highly corrosive!

The following safety recommendations should be observed:

1. Never work without goggles!
2. Always avoid contact with the skin (gloves!)
3. Avoid breathing the fumes (always work in a fume cupboard!) In addition observe the appropriate regulations for disposal!

For cleaning in-between measurements it is usually sufficient to rinse with pure ethanol or acetone or to use a special glass cleaner. It is very important that any residue of the cleaning agent is completely removed by rinsing in distilled water. It is essential to avoid accelerated drying by use of volatile solvents such as ethanol, acetone etc.

6.3 Literature references

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An / To / A:

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Von / From / De :

Firma / Company / Entreprise: _____

Straße / Street / Rue: _____

Ort / City / Ville: _____

Tel.: _____

Fax: _____

Betreiber / Responsible person / Personne responsable: _____

Hiermit bestätigen wir, daß nachfolgend aufgeführtes LAUDA-Gerät (Daten vom Typenschild):

We herewith confirm that the following LAUDA-equipment (see label):

Par la présente nous confirmons que l'appareil LAUDA (voir plaque signalétique):

Typ / Type / Type :	Serien-Nr. / Serial no. / No. de série:

mit folgendem Medium betrieben wurde

was used with the below mentioned media

a été utilisé avec le liquide suivant

Darüber hinaus bestätigen wir, daß das oben aufgeführte Gerät sorgfältig gereinigt wurde, die Anschlüsse verschlossen sind, und sich weder giftige, aggressive, radioaktive noch andere gefährliche Medien in dem Gerät befinden.

Additionally we confirm that the above mentioned equipment has been cleaned, that all connectors are closed and that there are no poisonous, aggressive, radioactive or other dangerous media inside the equipment.

D'autre part, nous confirmons que l'appareil mentionné ci-dessus a été nettoyé correctement, que les tubulures sont fermées et qu'il n'y a aucun produit toxique, agressif, radioactif ou autre produit nocif ou dangereux dans la cuve.

Stempel Seal / Cachet.	Datum Date / Date	Betreiber Responsible person / Personne responsable

Formblatt / Form / Formulaire:

Unbedenk.doc

Erstellt / published / établi:

LSC

Änd.-Stand / config-level / Version:

0.1

Datum / date:

30.10.1998

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