SCHNEIDER MESSTECHNIK

Anton Paar

Measure
what is measurable
and make measurable
that which is not.

Galileo Galilei (1564-1642)

Instruction Manual and Safety Information

DMA 4200 M

Density Meter

master instrument software version: from 2.98

(Original Instructions)

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Further information

Published and printed by Anton Paar GmbH, Austria

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Date: November 03, 2022

Document number: E42IB001EN-G

Contents

See the Reference Guide for a comprehensive description of the instrument.
See the General Software Functions Manual for a comprehensive description of the instrument software and instructions for its use.
Download Anton Paar documents for free from the Anton Paar website: https://www.anton-paar.com

1 Safety Instructions

- Read the documentation before using the instrument.
- Follow all hints and instructions in the documentation to ensure the correct use and safe functioning of the instrument.
- The documentation is a part of the product. Keep it for the complete working life of the product and make it easily accessible for all persons involved with the product. If you receive any additions or revisions to the documentation from Anton Paar GmbH, these must be treated as part of the documentation.

1.1 Liability

- This document does not claim to address all safety issues associated with the use of the instrument and samples. It is your responsibility to establish health and safety practices and to determine the applicability of regulatory limitations.
- Anton Paar GmbH only warrants the proper functioning of the instrument if no modifications are made to mechanics, electronics, or software.
- Use the instrument only for the purpose described in the documentation. Anton Paar GmbH is not liable for damages caused by incorrect use of the instrument.
- The results delivered by the instrument depend not only on the correct functioning of the instrument, but also on various other factors. We therefore recommend that you have the results checked (e.g. plausibility tested) by skilled persons before consequential actions are taken based on the results.

1.2 Installation and Use

- The installation procedure shall be carried out only by authorized persons who are familiar with the installation instructions.
- Use only accessories, consumables, or spare parts supplied or approved by Anton Paar GmbH.
- Ensure that all operators have been trained beforehand to use the instrument safely and correctly.
- Ensure that the instrument is sufficiently supervised during operation.
- In case of damage or malfunction, do not continue operating the instrument. Do not operate the instrument under conditions which could result in damage to goods or injuries or loss of life.
- If liquid has been spilled over the instrument, disconnect the instrument from the AC power supply. Clean and dry the housing of the instrument. If you have a suspicion that liquid got into the instrument, have the instrument cleaned and checked for electrical safety by a service technician authorized by Anton Paar GmbH.

Operation in areas with risk of explosion

- The instrument is **not** explosion-proof and therefore must not be operated in areas with risk of explosion.

Operation with explosive samples

- The instrument must not be used for the measurement of samples of explosion group IIC (such as carbon disulfide or acetylene).

General precautions

- Observe and adhere to your national safety regulations regarding the handling of all substances associated with your measurements (e.g. use safety goggles, gloves, respiratory protection, etc.).
- Before a measurement check the wetted parts of the instrument for chemical resistance to the samples and cleaning agents used.

- Take care that the liquids (samples and cleaning agents) or gases that you use are chemically compatible when they come into contact with each other. They must not react exothermally or produce solid particles, which might stick to the inner walls of the measuring cells.
- Before you start a measurement or cleaning procedure, take care that all parts, in particular the measuring cells, the injection adapters, the hoses, and the waste vessel, are properly connected and in good condition.
- Before you start a measurement or cleaning procedure, check the injection adapters for leak tightness.
- Take measures that spilled liquids cannot get into plug connections or venting slots of electrical appliances.
- Connect the measuring system to the AC power supply via a safety switch located at a safe distance from the instruments. In an emergency, turn off the power using this switch instead of the power switch on the instruments.

Precautions for operation with high pressures / high temperatures

- For measurements at high pressures / high temperatures, the instrument is only part of the complete measurement setup. Ensure that:
  - the complete setup is appropriate for the required pressure and temperature ratings,
  - the complete setup has been designed and installed only by authorized persons familiar with the installation instructions and work with high pressure / high temperature equipment,
  - all operators are specifically trained in all aspects related to working with high pressure / high temperature equipment.
- Ensure that all hot surfaces are marked with warning signs and secured in a way that they cannot be touched by accident.
- Secure all components under high pressure by additional safeguards (e.g. safety shields) so that accidental bursts of these components will not lead to injuries.

Precautions for flammable samples and cleaning agents

- Keep potential sources of ignition, like sparks or open flames, at a safe distance from the instrument.
- Place the instrument on a laboratory bench made of fireproof material, preferably bricks, ceramics, or stoneware.
- Store only the minimum required amount of sample, cleaning agents, and other flammable materials near the instrument.
- Do not spill sample/cleaning agents or leave their containers uncovered. Immediately remove spilled sample/cleaning agents.
- Ensure that the setup location is sufficiently ventilated. The environment of the instrument must be kept free from flammable gases and vapors.
- Provide fire-extinguishing equipment.

Transportation

- Empty the measuring cell and all tubes before you move or lift the instrument.
- To move or lift the instrument, grasp the ledge on top of the instrument at the back with one hand. Place the other hand under the display at the front. There is a hollow for your fingers.
- Carry the instrument in front of you and keep it close to your body.

1.3 Service and Repairs

- Service and repair procedures may be carried out only by authorized persons or by Anton Paar GmbH.

1.4 Disposal

- Concerning the disposal of the instrument, observe the legal requirements in your country.

1.5 Conventions for Safety Messages

The following conventions for safety messages are used in this document:

DANGER

Description of risk
Danger indicates a hazardous situation which, if not avoided, **will** result in death or serious injury.

WARNING

Description of risk
Warning indicates a hazardous situation which, if not avoided, **could** result in death or serious injury.

CAUTION

Description of risk
Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Description of risk
Notice indicates a situation which, if not avoided, could result in damage to property.

1.6 Safety Signs on the Instrument

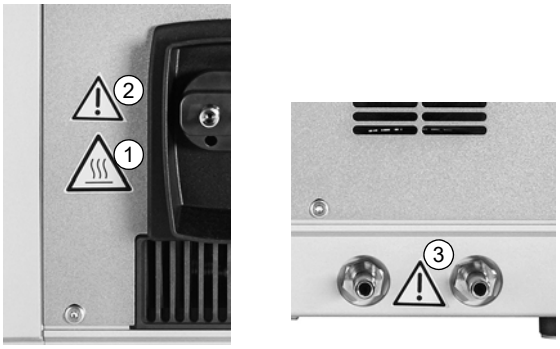


Fig. 1: Position of safety signs on the instrument

Right side of instrument:
1 WARNING – Hot surface
2 WARNING – Max. working pressure

Left side of instrument:
3 WARNING – Max. working pressure for cooling

WARNING

Hot surface
Temperatures of the high-pressure fittings can reach up to 200 °C (392 °F).
- Do not touch these surfaces without adequate protective measures.

WARNING

Too high working pressure may cause measuring cell to explode
The maximum allowable working pressure for DMA 4200 M is **500 bar** (7,250 psi).
- Do not exceed the maximum allowable working pressure.

CAUTION

Too high cooling pressure may cause leaks
The maximum allowable working pressure for the built-in cooling is **0.45 bar** (6.5 psi).
- Do not exceed the maximum allowable working pressure.

2 DMA 4200 M – An Overview

The DMA 4200 M density meter measures the density of liquid and gaseous samples by use of Anton Paar's “Pulsed Excitation Method” based on the oscillating U-tube method. It combines high precision with a robust design that is ready for reliable measurements in demanding environments.

Inside DMA 4200 M

- An integrated Peltier thermostat provides an extremely precise temperature control of the sample.
- Temperfect™: The new feature of DMA 4200 M allows immediate density measurements at any temperature between 0 °C and 150 °C (32 °F / 302 °F) at ambient pressure.
- Viscosity-related errors are automatically corrected over the full viscosity range by measuring the damping effect caused by the viscous property of a sample (at ambient pressure).

Improved sample filling

The optionally available syringe heating accessory heats the sample inlet and outlet to measuring temperature and thereby prevents sample clogging in the measuring cell. In combination with the syringe heating accessory, you can use DMA 4200 M in the temperature range from –10 °C to +200 °C (+14 °F to +392 °F) under atmospheric pressure conditions.

User interface

The touchscreen user interface facilitates easy and intuitive operation in routine applications as well as in demanding scientific research work:

- For the most common applications, 6 measuring methods have been predefined. Just select the method suiting your application, or create your own methods.
- Optionally operate DMA 4200 M via external keyboard, mouse, gesture control or barcode reader.

2.1 Intended Use of the Instrument

DMA 4200 M is a density meter for exceptional conditions. It measures the density of liquids and gases in the temperature range from –10 °C to +200 °C (+14 °F to +392 °F) and can be operated within a pressure range from 0 bar to 500 bar (0 psi to 7,250 psi).

WARNING

When used for high temperature/high pressure applications, DMA 4200 M forms one part of a complete setup. This setup has to be adapted to the particular requirements of the individual application. The complete setup has to be designed according to the engineering and safety rules for high pressure/high temperature equipment.

Typical applications

- Quality control measurements of heavy petroleum samples, such as bitumen, asphalt and heavy crude oil
- Pressure-volume-temperature (PVT) analysis of crude oil
- Determination of an equation of state
- Simulation of production processes

Exclusions

- Do not fill substances that may harden inside the measuring cell.
- Do not mix substances inside the measuring cell if these substances may react chemically.
- Do not use mechanical action for cleaning the measuring cell.

2.2 Functional Components

Front and right side

Left side

Rear

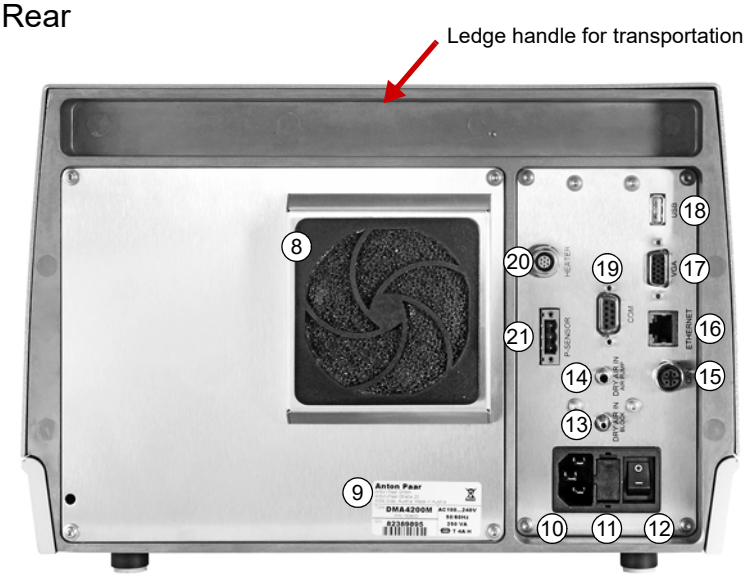


Fig. 2: Views of the instrument

Front

1 Power-on LED
2 Color PCAP touchscreen

Right side

3 Sample inlet (the instrument comes with pre-mounted Luer-lock adapter, mat. no. 161873) and
sample outlet (the instrument comes with pre-mounted connection tube, mat. no. 15333, outer diameter: 1/8" = 3.18 mm)
4 Air pump outlet
5 Cover plate

Left side

6 Inlet and outlet connectors for the cooling kit
7 USB 2.0 sockets (type A), 3x

Rear

8 Fan
9 Type plate with serial number (P/N = mat. no.)
10 AC power jack
11 Fuse holder
12 Power on/off switch

Air connectors on the rear

13 "DRY AIR IN BLOCK" connector
14 "DRY AIR IN AIR PUMP" connector

Interface connectors on the rear

15 CAN interface
16 Ethernet terminal (RJ45 connector)
17 VGA connector (DE-15F connector)
18 USB 2.0 socket (type A)
19 COM / RS-232 serial port (DE-9F connector)
20 Connector for the cable of the heating circuit
21 Analog interface for connection of a pressure sensor

3 Installing the Instrument

3.1 Installation Requirements

To achieve best measurement results, operate the instrument under typical laboratory conditions:

- 15–35 °C (59–95 °F) ambient temperature,
- 10–90 % relative humidity, non-condensing,
- no direct sunlight.

The setup location and surroundings must meet the minimum requirements specified under “Operating conditions” in the technical data (appendix A.2).

Also observe the safety instructions in section 1.

All components that are subjected to high pressures (e.g. the inlet and outlet valves, the tubings, the pressure gauge, the membrane, and the piston) have to be selected according to the required pressure and temperature.

Design the setup so that dead volume is avoided. Gas must not be trapped anywhere.

If you perform measurements below 0 °C,

- put the instrument into a cabinet free of air humidity,
- or connect pressurized air via a drying cartridge to the “DRY AIR IN BLOCK” connector (13, fig. 2)

to prevent ice formation.

WARNING

Risk of serious skin burns caused by hot surfaces
When you design the sampling system, ensure that surfaces which may exceed temperatures of 70 °C (158 °F) are marked with warning signs and cannot be touched accidentally.

WARNING

Risk of injuries caused by liquids escaping at high pressures
Provide protective means so that any bursts of pressurized components cannot lead to injuries. For example, mount suitable safety shields between pressurized parts and the operating area.

NOTICE

- A strong built-in cooling fan dissipates heat through the bottom and the left side of the instrument. Ensure that the airflow is not blocked.
- Ensure that the power plug and the power switch are always freely accessible so that the instrument can easily be disconnected from the AC power supply at any time.

3.2 Installation

3.2.1 Connecting the Air Pump Hose

1. Cut a piece of approx. 25 cm (10 in) length from one of the supplied hoses (choose the material according to your application).
2. Attach the hose to the air pump outlet (4, fig. 2).
3. Attach an adapter Luer cone (from the accessory kit) to the open end of the hose.
4. *With the syringe heating accessory:*
   Attach a PTFE Luer extension 80 mm, mat. no. 175611, to the adapter Luer cone.

3.2.2 Installing the Optional Syringe Heating Accessory

WARNING

Risk of serious skin burns caused by hot surfaces
The sample inlet of DMA 4200 M can reach temperatures up to 200 °C (392 °F).

- Make sure that the cover of the sample inlet is mounted properly.

1. Remove the cover of the sample inlet and outlet.
2. Remove the standard fittings from the sample inlet and outlet.
3. Screw the Luer-lock adapter (1, fig. 3) from the syringe heating accessories into the left-hand thread and tighten the nut by hand.
4. Gently pull back the sample tube.

5. Tighten the slide gland nut another 1½ turns with the wrench.
6. Screw the outlet tubing (2, fig. 3) from the syringe heating accessories into the right-hand thread and tighten the nut by hand.
7. Gently pull back the outlet tube.
8. Tighten the slide gland nut another 1½ turns with the wrench.
9. Put the insulation plate over the fittings. Make sure that the larger hole in the middle is below.
10. Attach the lower part of the heater unit, see fig. 3. Support it with your hand.

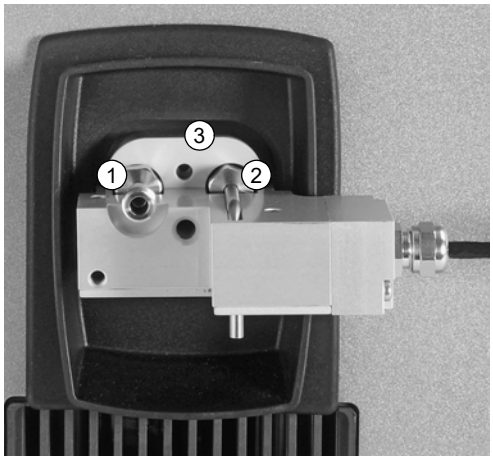


Fig. 3: Lower part of the heater unit attached

1 Luer-lock adapter DMA 4200 M SHA
2 Outlet tubing DMA 4200 M SHA
3 Insulation plate

11. Attach the upper part of the heater unit, see fig. 4.

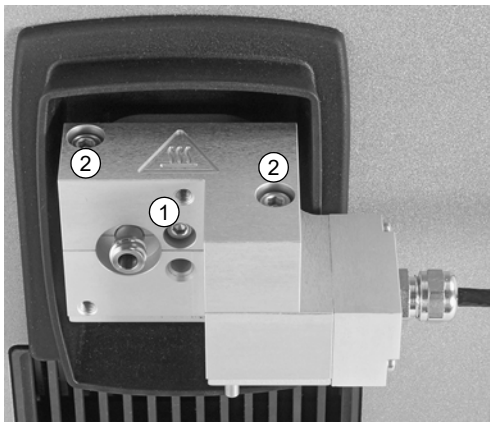


Fig. 4: Upper part of the heater unit attached

1 Fixing screw M3x30
2 Fixing screws M4x20

12. Fix the upper part with the fixing screw M3x30 (1, fig. 4).
13. Fix the upper part to the lower part with two fixing screws M4x20 (2, fig. 4).
14. Mount the syringe holder (1, fig. 5) by fixing it with two screws M4x20 (2, fig. 5). Make sure that the groove (3, fig. 5) is below.

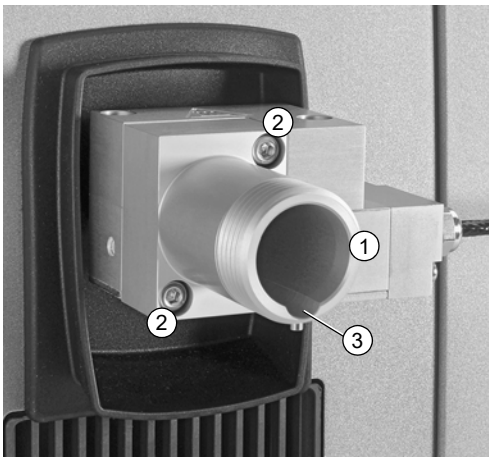


Fig. 5: Syringe holder attached

1 Syringe holder
2 Fixing screws M4x20
3 Groove

15. Slide the insulation cover (1, fig. 6) over the heater unit.
16. Fix the insulation cover with the knurled screw (2, fig. 6).

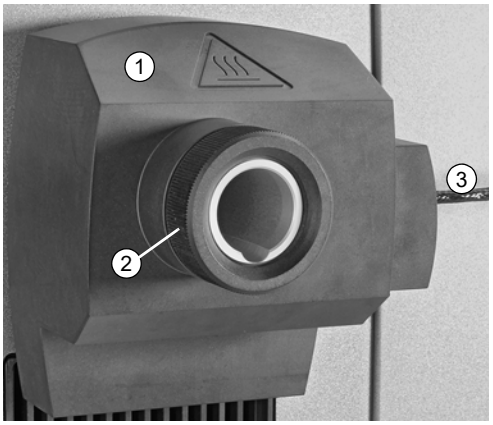


Fig. 6: Syringe heating accessory installed

1 Insulation cover
2 PTFE knurled screw DMA 4200 M SHA
3 Cable of the heating circuit

17. Connect the cable of the heating circuit (3, fig. 6) to the corresponding connector (20, fig. 2) at the rear of DMA 4200 M.

3.2.3 Remounting a High-Pressure Fitting after Opening

Ex-factory DMA 4200 M is equipped with high-pressure fittings for metal tubes with 1/8" outer diameter.

WARNING

Risk of injuries caused by splinters from exploded tubes
Make sure that the wall thickness of the tube used is suited for the required pressure.

WARNING

Risk of serious skin burns caused by hot surfaces
The sample inlet of DMA 4200 M can reach temperatures up to 200 °C (392 °F).
- Make sure that the cover of the sample inlet is mounted properly.

1. First tighten the nut by hand, then continue tightening the nut another ½ turn with the wrench.
2. Make sure that the connected tubings are free of stress and vibrations.

IMPORTANT: *Whenever the fittings are opened, the adjustment of the density cell may be affected. Therefore adjust the measuring cell only with the sample tubing properly connected.*

IMPORTANT: *After opening and remounting the fittings, use appropriate calibration standards to check whether the last adjustment is still valid.*

3. Re-mount the cover of the sample inlet and outlet.

3.2.4 Connecting the Cooling

To perform measurements at temperatures lower than 10 °C (18 °F) below the ambient temperature, connect the built-in thermostat. If your tap water is cool enough, also connecting to a tap water supply will help. Operate the cooling with a moderate flow of water (1 to 3 liters per minute).

Temperature range of the cooling unit	–10 °C to +30 °C (14 °F to 86 °F)
Maximum pressure	0.45 bar (6.5 psi) rel.
Connector	coupling 6 mm

NOTICE
- If measurements below 0 °C (32 °F) are carried out, put the instrument into a cabinet free of air humidity to prevent ice formation.
- Before you measure at measuring temperatures of 30 °C (86 °F) or more, disconnect the cooling from the tap water or the thermostat. Dry the cooling with dry air to avoid that any cooling liquid remains in the cooling.
- Make sure that the wetted parts of the cooling are resistant against the cooling liquids that you use. See appendix A.3.
- Use distilled water as the cooling liquid if you operate the cooling with an external thermostat.

3.2.5 Connecting a Pressure Sensor

To measure the pressure in the measuring system, connect an external pressure sensor (4...20 mA) to the analog interface (21, fig. 2) at the rear of DMA 4200 M. You can use either an active sensor (requires external voltage supply) or a passive sensor (does not require external voltage supply).

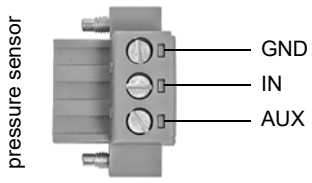


Fig. 7: Pin connections on the connector of the pressure sensor

GND .. ground connection
IN..... input signal
AUX... auxiliary voltage for the analog interface

Depending on the sensor type (passive or active), use the appropriate connections:

- To connect a *passive* sensor, use the pins “AUX” and “IN”.
- To connect an *active* sensor, use the pins “AUX”, “IN”, and “GND”.

Connecting the optional pressure sensor, mat. no. 155228, available from Anton Paar

The pressure transmitter PA-21Y 800 bar is a passive pressure sensor, which requires the pins “AUX” and “IN”.

1. Connect the brown wire (BN: +Vcc 8…32 VDC) to the pin “AUX”.
2. Connect the white wire (WH: OUT/GND 4…20 mA) to the pin “IN”.

Mounting the optional pressure sensor, mat. no. 155228

To mount the pressure transmitter PA-21Y 800 bar at the sample inlet or outlet, a T-piece for pressure sensor, mat. no. 219022, is available.

1. Screw the T-piece onto the high-pressure fitting.
2. Screw the pressure sensor into the lateral of the T-piece.

3.3 Switching the Instrument On/Off

WARNING

High voltage at parts of the instrument can cause serious injuries or death

- Connect the instrument only to an electrical outlet with protective earthing.
- Never connect the instrument to the AC power supply with protective separation or protective insulation.
- Ensure that the non-fused earth conductor of the power cable is connected to earth.

NOTICE

Possible damage due to wrong voltage

Before you switch on the instrument, make sure that the correct line voltage and line frequency are available (AC 100–240 V, 50/60 Hz).
If large voltage fluctuations are to be expected, we recommend using a constant voltage source (UPS).

- Connect the AC power jack of the instrument (10, fig. 2) to a suitable electrical outlet with the supplied power cable.
- Use the power switch on the rear of the instrument (12, fig. 2) to switch the instrument on or off.

The green LED on the front of the instrument (1, fig. 2) indicates that the power is on.

After power-on the instrument requires approx. 15 minutes for temperature equilibration. During this time “temp. equilibration” is displayed.

TIP: *Do not turn off the instrument during the night. This allows the measuring cell to achieve long-term temperature stability.*

3.4 Basic Instrument Settings / First Checks

After hardware installation set the date and time, see General Software Functions Manual, section 6.1.1.

To check the validity of the factory adjustment, perform an air check and a custom check with the supplied density standard S3, mat. no. 188218. The instrument has been factory adjusted over the temperature range of 0...150 °C (32...302 °F), but during transport the density adjustment may have been compromised.

To perform first checks

IMPORTANT: *Wait at least 15 minutes after a restart for the internal temperature to stabilize.*

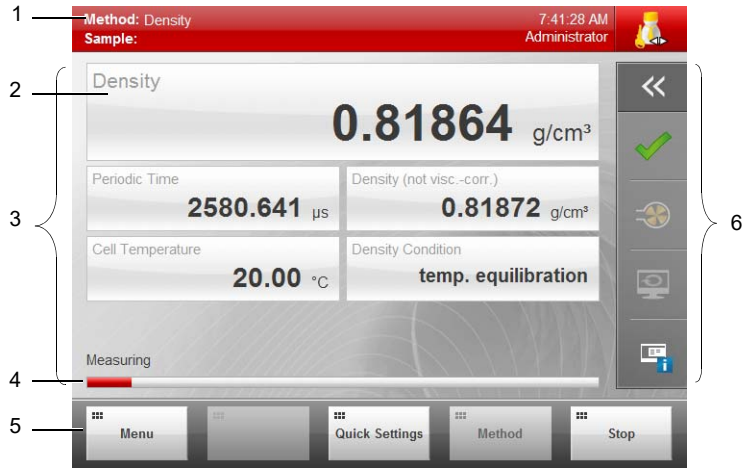
1. To perform an air check, tap <Menu> and select *Checks/Adjustments > Checks*. Proceed as described in section 6.1.2.
2. To perform a custom check with S3, proceed as described in section 6.1.2.

If both checks succeed, your instrument is ready for routine measurements.

- If a check fails, clean the measuring cell thoroughly and repeat the check.
- If the check still fails, perform an air/S3 adjustment as described in section 6.2.1.

4 Operating the Instrument

4.1 Operating Elements on the Main Screen



IMPORTANT: *Corresponding with your user group rights (see the General Software Functions Manual, section 6.5.1), operating elements may be locked.*

Fig. 8: Example main screen

1	*Header*	*4*	*Status bar*
2	*Output field*	*5*	*Buttons area*
3	*Contents area*	*6*	*Quick access area (quick access bar)*

Header

On the left of the header you find the name of the currently active method and the sample number.

On the right of the header you find a clock and the user indicator. The user indicator indicates the type of user that is currently logged in.

Contents area

In the contents area the measuring values are displayed in small, medium, or large output fields. The layout of the contents area can be defined in the settings of the current method according to your needs.

The status bar at the bottom of the contents area shows the status of the instrument or a measurement. If applicable, a progress bar shows the progress of activities.

Monitor mode

If you have not started a measurement yet, or if you have terminated a measurement by tapping <Stop>, the instrument is in the monitor mode and shows a continuous reading of the current measuring values.

Measuring mode

If you have started a measurement, a continuous reading of the current measuring values is shown until the measurement is finished. The final values stay frozen on the screen until the next measurement is started. To unfreeze the screen and change to monitor mode, tap in the quick access area.

Buttons area

The buttons on the main screen have the following functions:

Button	Function
<Menu>	Opens the main menu.
<Quick Settings>	Opens the quick settings list (only available in the “No Sample List” mode instead of the <Sample List> button).
<Sample List>	Opens the current sample list.
<Method>	Opens the method list (to select a method).
<Start>	Starts a measurement.
<Stop>	Stops and aborts a measurement.

Quick access area

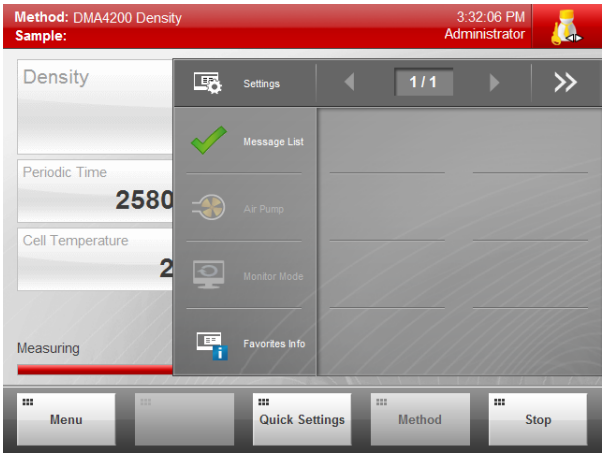


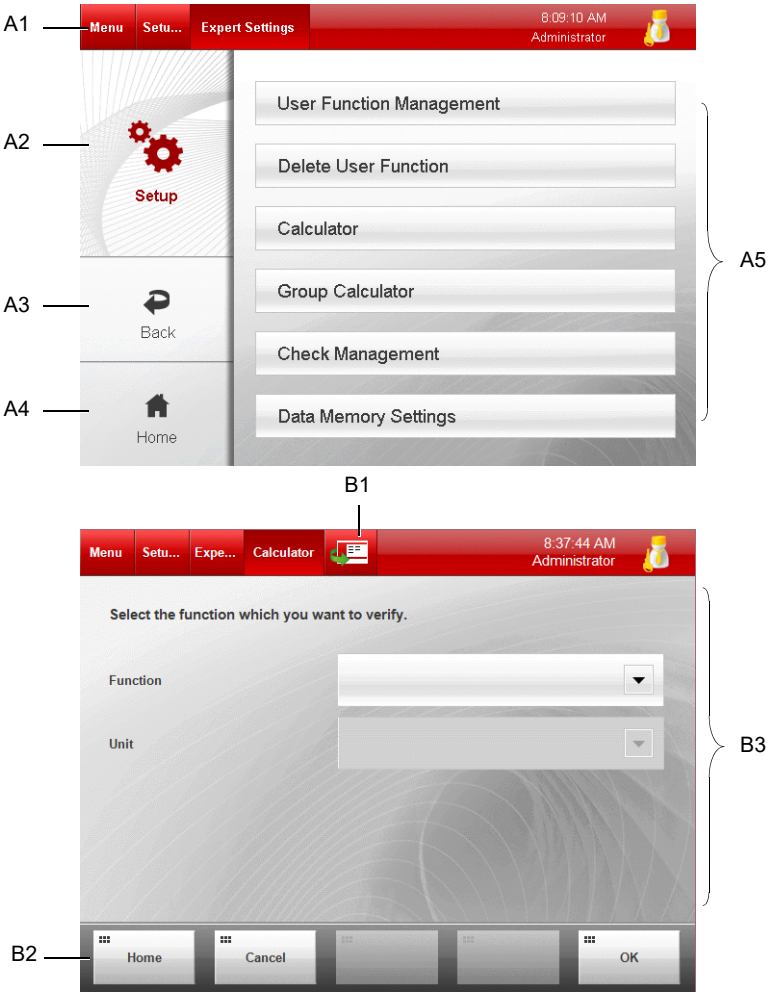
Fig. 9: Expanded quick access area

- To expand the quick access area, tap « on the quick access bar.
- To collapse the quick access area, tap » in the upper right corner of the expanded quick access area.
- To browse items, use the page navigation 1/1 in the header of the expanded quick access area.
- To rearrange the items in the quick access area, tap (settings) in the upper left corner of the expanded quick access area. For details see the General Software Functions Manual, section 4.8.

	Function
	Opens the message list. The general instrument status as well as all measuring errors that have occurred during the measurements of the currently active sample list are described in this list. The button changes its appearance depending on the current error status: • *Green OK sign:* The general instrument status and the error status of all measured samples of the current sample list are OK. • *Yellow warning sign:* - The instrument (or system) has a minor problem (e.g. an air or custom check is overdue, there is a printer problem etc.). - There has been a filling error with one or more samples of the currently active sample list. • *Red error sign:* - The instrument (or system) has a major problem that needs to be fixed before you continue with measurements. - One or more samples of the current sample list could not be measured (e.g. the measuring cell is partly empty so that it cannot oscillate). To reset the message list button to the green OK sign, confirm all error messages by tapping on the <X> button on the right of the message. To confirm all messages in the list in one step, tap “Delete all” at the end of the list. The message list button will also be reset to the green OK sign if you delete the currently active sample list, see General Software Functions Manual, section 7.6.
 	Starts/stops the air pump. The air pump is off. The air pump is on.
 	Unfreezes the screen after a finished measurement. The screen is frozen. The screen is unfrozen. A continuous reading of the current measuring values is shown.
	Displays information on using favorites.

4.2 Operating Elements on the Menu Screens

To access the menu, tap <Menu> on the main screen.



IMPORTANT: *Corresponding with your user group rights (see the General Software Functions Manual, section 6.5.1), operating elements may be missing.*

Fig. 10: Example menu screens

A1 Header
A2 Menu level 1
A3 <Back> button
A4 <Home> button
A5 Contents area
B1 <Add to Favorites> button
B2 Buttons area
B3 Contents area

Header

On the left of the header you find the navigation path to your current position in the menu. You can go back to any menu position in your current path by directly tapping on the respective box of the navigation path. For details on using the <Add to Favorites> button, see the General Software Functions Manual, section 4.8.

Contents area

In the contents area you find the menu options of the current menu level and the menu dialogs.

Buttons area

The buttons on menu screens have the following functions:

Button	Function
<Back>	Moves to the next higher menu level.
<Home>	Returns to the main screen.
Buttons at the bottom of screens	Functions depending on the current menu or dialog

5 Performing a Measurement

Table 1: Steps of a typical measurement routine

		Step	see
A		Check that the **measurement system** is properly installed and in good working order, and that all conditions for a good measurement are met.	section 3
		Measurements in the temperature range from 0 °C to 150 °C (from 32 °F to 302 °F):	
B		Perform a **check** to verify the instrument's accuracy before you start your daily routine measurements.	section 6.1
C	1	Select the **method** with the required **measurement settings**.	Reference Guide
	2	**Prepare** your **sample** if required.	
	3	**Fill** the **sample**.	section 5.2
	4	**Perform** the **measurements**.	section 5.3
	5	**Clean and dry** the measuring cell.	section 7.1
D		Perform an **air check** to verify the efficiency of your cleaning and drying procedure.	section 6.1
		Measurements using a special or wide-range adjustment:	
B		Perform the **special** or **wide-range adjustment** covering the required range.	section 6.2.2 section 6.2.3
C	1	Select the **method** with the required **measurement settings**.	Reference Guide
	2	**Prepare** your **sample** if required.	
	3	**Fill** the **sample**.	section 5.2
	4	**Apply** the required **pressure**.	
	5	**Perform** the **measurements**.	section 5.3
	6	**Clean and dry** the measuring cell.	section 7.1

Preparatory steps

Before you start a measurement, check that:

- *(without syringe heating accessory:)*
  - the metal tubes are connected correctly and tightly,
  - the waste hose leads into the waste container,
- *(with syringe heating accessory:)*
  - the waste container is positioned under the sample outlet,
- the volume of the waste container is large enough for the number of samples and with-stands hot solvents,
- suitable cleaning liquids are at hand,
- the method settings are set correctly,
- the correct adjustment has been defined.

To speed up measurements

- Use automatic sample naming (see General Software Functions Manual, section 6.3).
- Bring the sample to measuring temperature in advance to reduce the time necessary for the temperature equilibration.
- Using precision class “Ultrafast” reduces the measuring time significantly.

WARNING

Risk of injuries or fire caused by hot liquids spurting out of the measuring cell
In the unlikely case of a malfunction or damage of the Peltier elements, the heating control of the measuring cell is affected, and the measuring cell could heat up to 250 °C (482 °F).
To avoid injuries and fire:
- Ensure that the waste vessel is properly installed.
- Use method settings that constantly display the temperature of the measuring cell.
- Check the temperature of the measuring cell before you fill a sample or start a measurement.
- If you measure aggressive, toxic, or flammable samples, use only the smallest possible sample amount.
- If your sample is toxic or highly flammable, always handle it in an appropriate environment, e.g. under a fume hood, and ensure that the location is sufficiently ventilated.
- Wear heat-protective gloves, protective clothing, and safety goggles.

5.1 Sample Name

If you have defined automatic sample name parts (see General Software Functions Manual, section 6.3), they will be added to each sample name after the measurement has finished.

The complete sample name, including automatic sample name parts, can be up to 50 characters long.

5.2 Filling Samples

WARNING

Risk of serious injuries and destruction of the instrument caused by flammable liquids
Before you fill any sample or cleaning liquid into the instrument, make sure that:
- all safety instructions concerning the use of chemicals and the use of flammable chemicals are met, see section 1;
- all wetted parts are resistant to the chemicals used, see appendix A.3;
- suitable cleaning liquids for cleaning the measuring cell are at hand, see section 7.1.

To achieve highly accurate measuring results, fill the samples into the measuring cell homogeneously and without bubbles.

Depending on the type of sample, different filling methods have to be applied. Several verified modes of sample filling are presented in this manual.

TIP: *The temperature of the sample has to be slightly above the cell temperature to prevent outgassing during the measurement.*

5.2.1 Filling Samples Using a Syringe

You can fill viscous samples by pressing or by sucking them into the measuring cell with a syringe.

TIP: *For measuring samples that are highly viscous or solid at room temperature, and that have to be heated over 150 °C to enable filling, we recommend using the syringe heating accessory.*

TIP: *For measurements above 100 °C, use a syringe that withstands the temperature, e.g. a PFA syringe with Luer-lock, mat. no. 175899.*

TIP: *Fill 8 mL to 10 mL of the sample to ensure that the cell is filled properly.*

Filling the sample by pressing

1. Lead a suitable hose from the sample outlet of the instrument into an empty waste vessel.
2. Fill the sample into a syringe.
3. Connect the filled syringe to the sample inlet.
4. Push the plunger slowly into the syringe until the sample enters the waste hose.
5. Wait until the sample stops moving into the hose. This may take a few minutes, depending on the viscosity of the sample.
6. Continue with the measurement procedure, see section 5.3.

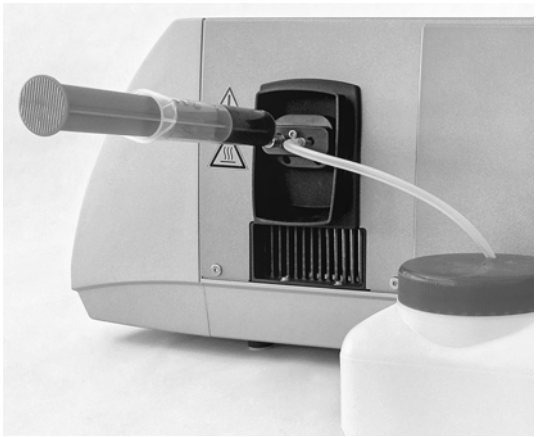


Fig. 11: Filling the sample by pressing

Filling the sample by sucking

1. Connect a suitable hose to the sample outlet of the instrument.
2. Fill the sample into a vessel.
3. Place the vessel so that the hose from the sample outlet is immersed in the sample.
4. Connect a suitable hose to the sample inlet of the instrument using a Luer cone.
5. Connect an empty syringe to the other end of this hose.
6. Pull back the plunger of the syringe to suck the sample into the measuring cell until the sample enters the hose at the sample inlet.
7. Wait until the sample stops moving into the hose. This may take a few minutes, depending on the viscosity of the sample.
8. Continue with the measurement procedure, see section 5.3.

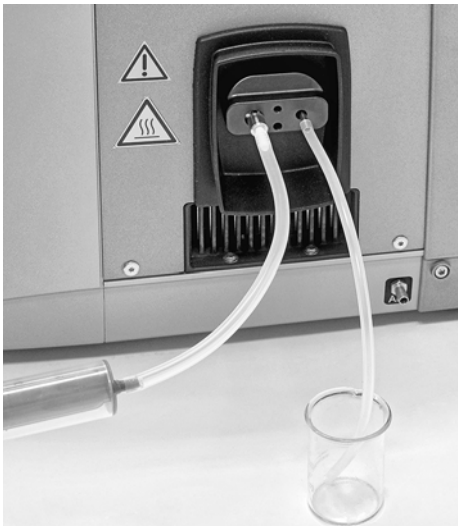


Fig. 12: Filling the sample by sucking

5.2.2 Filling Sample into a DMA 4200 M with Syringe Heating Accessory

WARNING

Before you fill any hot sample or cleaning liquid into the syringe or the instrument, make sure that:
- all safety instructions concerning the use of chemicals and the use of flammable chemicals are met, see section 1;
- all wetted parts are resistant to the chemicals used and to the temperature of the syringe heating accessory, see appendix A.3.

WARNING

Risk of burns caused by hot surfaces
Mount the insulation cover of the syringe heating accessory when you measure at temperatures higher than 60 °C (140 °F).

WARNING

Risk of injuries or fire caused by hot liquids spurting out of the sample inlet or outlet
In the unlikely case of a malfunction or damage of the heating control, the temperature of the syringe heating accessory might rise up to 220 °C (428 °F).
To avoid injuries and fire:
- Use method settings that constantly display the temperature of the measuring cell and the syringe adapter.
- Check the temperature of the measuring cell and the syringe adapter before you fill a sample or start a measurement.
- If your sample is toxic or highly flammable, always handle it in an appropriate environment, e.g. under a fume hood, and ensure that the location is sufficiently ventilated.
- Wear heat-protective gloves, protective clothing and safety goggles.

1. Place the waste vessel under the sample outlet of the instrument and heat the syringe heating accessory.
2. Attach the PTFE Luer extension at the tip of the heat resistant syringe.
3. Use an oven to bring both the sample and the heat resistant syringe with the PTFE Luer extension to the measuring temperature.
4. Take the sample and the syringe with the PTFE Luer extension out of the oven.
5. Put the tip of the PTFE Luer extension into the liquid sample and slowly pull back the plunger of the syringe to draw up the sample into the syringe.
6. Detach the PTFE Luer extension from the tip of the syringe.
7. Insert the syringe into the heated syringe heating accessory, and connect the syringe to the Luer-lock adapter mounted on DMA 4200 M.
8. Turn the syringe clockwise to tighten the connection.

9. Push the plunger of the syringe slowly until the sample emerges from the sample outlet tube.
10. Continue with the measurement procedure, see section 5.3.

Fig. 13: Filling the sample when the syringe heating accessory is installed

5.3 Measurement Procedure

Proceed by the following steps:

- Select a method.
- Define the measuring type.
- Select an appropriate adjustment.
- Select the appropriate viscosity correction mode.
- Activate or deactivate the FillingCheck™.
- Fill the sample and apply pressure if required.
- Perform the measurement.

To perform a measurement

1. Enter a sample name if required (see also section 5.1).
2. Tap <Start> and wait until the measurement is finished.

   If you use the manual viscosity correction mode, enter the viscosity [mPa·s] of the sample, and tap <OK>.

   When the measurement is finished, the result values are saved in the data memory and can be viewed, printed, exported, or deleted.

   The result values on the screen are frozen. Tap in the quick access area to unfreeze the screen.

Measure the next sample or clean and dry the instrument.

6 Checks, Adjustments, Calibrations

6.1 Checks

By checks, carried out in regular intervals, you can ensure that your density measurements consistently deliver results of high and stable accuracy.

With a density check, you fill a medium of known density (air or any standard liquid specific to your needs) into the measuring cell and compare the measured density with the target value.

The instrument performs checks at the measuring temperature of the currently active method.

IMPORTANT: *Be sure to set the temperature for a custom check according to the specified reference value.*

The precision class used for the check is also according to the currently active method.

With custom checks, the target value will be calculated for the set temperature. With air checks, the target value will be calculated for the set temperature and the measured air pressure.

When to do checks

- Use **custom checks** to verify that the instrument is measuring with satisfactory accuracy.

  We recommend to perform a custom check every day before you start your measurements.

  Perform additional custom checks as required and at your own discretion, e.g. when you get unexpected results or when you change the temperature.
- Use **air checks** to verify the efficiency of your cleaning and drying procedure.

  We recommend to perform an air check every day after the measurements have been finished and the measuring cell has been cleaned and dried.

  Perform additional air checks as required and at your own discretion, e.g. after the measurement of critical samples that might stick to the measuring cell (e.g. very heavy or highly viscous samples).

6.1.1 Check Settings

You can edit the name, method (custom check only), time interval, and the tolerance of density checks.

Tolerance

The factory preset for air checks is 0.0002 g/cm^3 (max. deviation from the target value).

Editing the settings of the air check

1. Tap <Menu> and select *Setup* > *Expert Settings* > *Check Management* to open the check administration list.
2. Highlight “AirCheck” and tap <Edit> to open the three-step “Check Administration” wizard.
3. Enter a name for the check and tap <Next>.
4. Perform the following settings:
   - Use the check box “Check execution reminder” to define whether the check is obligatory, and enter a time interval in days.
   - Use the check box “Prohibit measurements after check expiration” to define whether checks are obligatory for subsequent measurements.
5. Tap <Next>.
6. Define the maximum allowed “Lower deviation” and “Upper deviation”.
7. Tap <OK>.

Defining a custom check

TIP: *We recommend for each method to define custom checks according to the specifications for your adjustment medium.*

1. Tap <Menu> and select *Setup* > *Expert Settings* > *Check Management* to open the check administration list.
2. Tap <New> to open the three-step “Check Administration” wizard.
3. Perform the following settings:
   - Enter a name for the check.
   - Select the method to define detailed method settings for the check.
4. Tap <Next>.
5. Perform the following settings:
   - Use the check box “Check execution reminder” to define whether the check is obligatory, and enter a time interval in days.
   - Use the check box “Prohibit measurements after check expiration” to define whether checks are obligatory for subsequent measurements.

6. Tap <Next>.
7. Perform the following settings:
   - Select a quantity and the corresponding unit.
   - Define the check tolerance by the “Lower limit” and “Upper limit”.
   - Optionally define the settings for further quantities in the same way.
8. Tap <OK>.

Editing the settings of a custom check

1. Tap <Menu> and select *Setup* > *Expert Settings* > *Check Management* to open the check administration list.
2. Highlight a “CustomCheck” and tap <Edit> to open the three-step “Check Administration” wizard.
3. Change the settings as required.

6.1.2 Performing a Check

1. Tap <Menu> and select *Checks/Adjustments* > *Checks* to open the checks list.
2. Highlight an air check or a custom check in the list.
3. Tap <Start> and follow the instructions on the screen.

   For an air check, clean and dry the measuring cell thoroughly.

TIP: *If you dry the measuring cell during the cleaning process with the internal air pump, wait five minutes before starting an air check.*

   When the check is finished, the following information is displayed:

   - Check name/type and check result (“Passed” or “Not passed”)
   - Date and time
   - Method used
   - Check result
   - User name
   - *For air checks:*
     - Reference value calculated for the set temperature
     - Lower deviation
     - Upper deviation
     - Measured value
     - Check result
     - Air pressure
     - Set temperature
   - *For custom checks:*
     - Lower limit
     - Upper limit
     - Measured value
     - Check result
     - Set temperature
4. Tap <Print or Export> if you want to print or export the results of the check.
5. Tap <OK> or <Home> to exit the check routine.

If the air or custom S3 check has failed

We recommend taking corrective actions until the check is valid again:

- Make sure that the standard has been filled free from bubbles.
- Check the quality and the date of expiry of the standard.
- Clean the measuring cell thoroughly.
- If above actions do not help, perform an air/S3 adjustment.

6.2 Density Adjustments

For comprehensive and detailed information on all available adjustments, adjustment data management, resetting to factory adjustment, see the Reference Guide.

An adjustment ensures further correct measurements: A sample of exactly known measurement properties (standard) is measured, and the instrument constants are adjusted in a way that the instrument delivers the known correct results.

For a successful adjustment, usually at least two standards are needed with measurement properties that encompass the expected measurement results of your samples.

Samples have to be filled free from bubbles and are best preheated to the measuring temperature.

In case that the measuring temperature changes, we recommend to allow for a conditioning time of 1 hour per every 10 °C (18 °F) temperature change in order to achieve the highest repeatability.

The instrument comes factory-adjusted over the temperature range from 0 °C to 150 °C (32 °F to 302 °F) at ambient pressure.

6.2.1 Air/S3 Adjustment

The air/S3 adjustment at one single temperature point is an adjustment at a certain temperature point between 0 °C and 150 °C (32 °F/302 °F) at ambient pressure. This adjustment improves the adjustment constants of the temperature range adjustment for the specific temperature point and results in very accurate measurements if the measuring conditions regarding temperature are reproducible.

The adjustment media are dry air and the oil standard S3, mat. no. 188218.

Managing reference standard data

You can store the data of reference standard liquids that you plan to use for the adjustment. The density and viscosity values are required for the air/S3 adjustment.

TIP: *The easiest way to enter the data of the reference standard is via barcode reader (e.g. mat. no. 189615) from a certificate with QR code. Anton Paar standard S3, mat. no. 188218, comes with QR code. Alternatively, you can enter the data with an external keyboard or on the instrument's touchscreen.*

1. Tap <Menu> and select *Setup* > *Measuring System Settings* > *Standards Management*.
2. Tap <New>.
3. *If you use a barcode reader:*
   a. Tap <Scan QR code>.
      The screen displays a barcode that you can use to configure your barcode reader if it cannot process the QR code properly.
   b. Scan the barcode from the certificate of the standard.
      All reference values, the lot number, standard type, certificate number, and expiry date are automatically read.

   If you use the touchscreen or a keyboard:
   a. Enter the standard type, the lot number, the certificate number, and the expiry date.
   b. Tap <Next>.
   c. Enter the required data from the certificate:
      The reference density for the adjustment temperature has to be stored on the instrument.
4. Tap <OK>.

To perform an air/S3 adjustment

1. Tap <Menu> and select *Checks/Adjustments* > *Air/S3 Adjustment*.
2. Enter the atmospheric pressure.
   The atmospheric pressure displayed is measured automatically by a built-in sensor.
3. Select the reference standard with the correct lot number.
4. Enter the temperature at which the air/S3 adjustment shall be improved.
5. Tap <Next>.
6. Rinse and dry the measuring cell.
   Tap <Air Pump on> to dry the measuring cell.
7. Tap <OK>.
   The air adjustment routine is carried out.
8. Fill oil standard S3 into the measuring cell and tap <OK>.
   Be careful to fill the standard without air bubbles.
   The S3 adjustment routine is carried out.
   When the adjustment is finished, the following information is displayed:
   - Old value air
   - New value air
   - Deviation rel.
   - Deviation abs.
   - Old value S3
   - New value S3
   - Deviation rel.
   - Deviation abs.
9. Check the recommendation on the screen and select one of the options <Reject>, <Print>, or <Apply>.

6.2.2 Special Adjustment

Special adjustments can be performed at any set temperature and pressure within the measuring range of your instrument. A special adjustment can be used if the measuring conditions do not fit the factory air/S3 adjustment.

29 different slots are available for special and wide-range adjustments.

Hints for measurements using special adjustments

- If you measure using a special adjustment, the set measuring temperature and pressure must be the same as the temperature and pressure at which the special adjustment has been performed. Otherwise no density results can be obtained.
- No viscosity correction and no FillingCheck™ are available if the instrument is operated using a special adjustment.
- No adjustment history is available for special adjustments.
- You can use an external pressure sensor for measuring the pressure in the measuring system. See section 3.2.5 for installation instructions.

Prerequisites for the standards

The special adjustment is performed with two standards with known density and with properties (e.g. viscosity) similar to those of the subsequently measured samples.

The densities of the two liquids used for a special adjustment have to differ by at least

- $\Delta\rho = 0.003$ g/cm^3 if both densities are below 0.6 g/cm^3 or
- $\Delta\rho = 0.01$ g/cm^3 if one of the reference densities is above 0.6 g/cm^3.

To perform a special adjustment

1. Tap <Menu> and select *Checks/Adjustments* > *Special Adjustment (T, p)*.
2. Select the slot for the adjustment.
3. Enter a name for the adjustment.
4. Tap <Next>.
5. Perform the following settings:
   - Enter the temperature at which the adjustment and measurements have to be performed.
   - Enter the pressure at which the adjustment and measurements have to be performed.
   - Enter the reference density for the first standard (lower density).
   - Enter the reference density for the second standard (higher density).
6. Tap <Next>.
7. Rinse and dry the measuring cell.

   Tap <Air Pump on> to dry the measuring cell.
8. Fill the first standard into the measuring cell and tap <OK>.

   Be careful to fill the standard without air bubbles.

   The first adjustment routine is carried out.
9. Rinse and dry the measuring cell.

   Tap <Air Pump on> to dry the measuring cell.
10. Tap <OK>.
11. Fill the second standard into the measuring cell and tap <OK>.

    Be careful to fill the standard without air bubbles.

    The second adjustment routine is carried out.

    When the adjustment is finished, the following information is displayed:

    - Slot number
    - Temperature of adjustment
    - Pressure of adjustment
    - Reference density of first standard
    - Reference density of second standard
    - Coefficient A
    - Coefficient B
12. Select one of the options <Reject>, <Print>, or <Apply>.

6.2.3 Wide-Range Adjustment

Wide-range adjustments can be performed over a wide temperature and pressure range. It is used for measurements if the measuring conditions are not reproducible (e.g the pressure is varying).

29 different slots are available for special and wide-range adjustments.

Hints for measurements using wide-range adjustments

- The wider the ranges of temperature and pressure, and the fewer points are measured, the less accurate the adjustment will become.
- No viscosity correction and no FillingCheck™ are available if the instrument is operated using a wide-range adjustment.

Hints for the adjustment measurements

For the wide-range adjustment, the adjustment measurements are performed via single measurements using the measuring type “Density at 0–150 °C”.

TIP: *When you use the measuring type “Density at 0–150 °C”, density values are displayed in the temperature range from 0 °C to 150 °C (32 °F to 302 °F). If the set temperature is outside this range, only the periodic time can be determined.*

Therefore, several measuring points of at least two standards with known density and with properties (e.g. viscosity) similar to those of the subsequently measured samples have to be collected at specific temperatures and/or pressures.

RECOMMENDATION: *We recommend to start at the highest temperature point and the lowest pressure point.*

The adjustment measurements must cover the whole measuring range (density, temperature, and pressure) required for your measurements later on, and they should be equally distributed (temperature and pressure).

The number of measuring points influences the order of the polynomials. Coefficients that are not used must be set to zero, except for coefficients A and B, which must be greater than zero.

The number of the measuring points must be greater than or at least equal to the number of coefficients used.

If densities in the required measuring range differ by more than 1.5 g/cm^3 (wide density range), and if the pressure and temperature conditions vary, at least 11 measurements are required.

If densities in the required measuring range differ by less than 1.5 g/cm^3, and if only the pressure conditions vary, at least 6 measurements are required.

After the adjustment measurements the measured periodic times have to be related to the reference densities at the specific conditions, and the adjustment coefficients need to be calculated using the DMA 4200 M Wide-Range Adjustment Tool. This Excel-based tool can be requested from your Anton Paar representative.

For each temperature and pressure range, a separate polynomial must be determined.

Settings for the adjustment measurements

1. Tap <Menu> and select *Method* > *Method Settings* > method name > *Density Module*.
2. In the drop-down box “Measuring Type”, select “Density at 0–150 °C”.
3. Enter the measuring temperature.
4. Tap <Next>.
5. In the drop-down box “Precision class”, select a precision class according to your measuring conditions.

RECOMMENDATION: *We recommend to use the precision class “Ultrafast” with a measurement delay of 10 minutes in order to achieve a high precision and valid results independent of your measuring setup as a whole.*

6. Tap <OK>.

To perform the adjustment measurements

1. Before starting a measurement, check that
   - the measuring system is properly installed,
   - the components of the measuring system have been selected according to the required temperatures and pressures,
   - the measuring cell of the instrument is clean and dry,
   - the correct method settings are applied,
   - suitable cleaning liquids are at hand.
2. Fill the sample and apply pressure if required.
3. Enter a sample name.
4. Tap <Start> and wait until the measurement is finished.
5. Repeat the procedure for all pressure and temperature points required for the wide-range adjustment.

Exporting the results of the adjustment measurements

When you have finished all adjustment measurements, export the results in order to calculate the coefficients with the DMA 4200 M Wide-Range Adjustment Tool.

1. Tap <Menu> and select *Checks/Adjustments* > *Wide Range Adjustment* > *Export Measured Data*.

TIP: *Use one or more filter criteria to export only data relevant for the adjustment. See the General Software Functions Manual for more information.*

2. Tap <Export>.
3. Define the storage location and enter a file name.
4. Tap <OK>.

The data set is exported as an XML file, which can be directly imported into the DMA 4200 M Wide-Range Adjustment Tool.

Importing the adjustment coefficients into DMA 4200 M

1. Save the XML file containing the adjustment coefficients onto a USB memory device.
2. Connect the USB memory device to the USB socket of DMA 4200 M.
3. Tap <Menu> and select *Checks/Adjustments* > *Wide Range Adjustment* > *Import Adjustment Constants*.
4. Select the XML file in the “Storage Location”.
5. Select an empty slot under which the adjustment constants shall be saved on the instrument.
6. Enter the name of the adjustment.
7. Tap <OK>.

6.3 Pressure Sensor Adjustment

Not for systems with syringe heating accessory mounted

If measurements with DMA 4200 M are to be performed under pressure, carry out a pressure sensor adjustment beforehand, so that the pressure can be used as an input parameter.

The pressure sensor adjustment serves to relate the mA values delivered by the pressure sensor to the actual pressure values.

You need to repeat the pressure sensor adjustment only when you connect a new pressure sensor or if the pressure sensor has been re-calibrated by a calibration laboratory.

To obtain adjustment values

- We recommend that you have the pressure sensor calibrated by an accredited calibration laboratory.

  In this case, you will receive a calibration certificate for the pressure sensor.
- Alternatively, you may go by the following makeshift solution:

IMPORTANT: *Perform the measurement at ambient pressure.*

a. Connect the external pressure sensor to the analog interface (21, fig. 2) of DMA 4200 M.
b. Tap <Menu> and select *Service* > *Live Raw Data* > *DMA 4200 M*.
c. Write down the value of “Pressure Sensor Current” with a precision of at least three decimal places.
d. Disconnect the external pressure sensor.

To enter the adjustment values

1. Tap <Menu> and select *Checks/Adjustment* > *Pressure Sensor Adjustment*.
2. Enter the values.
   - With a **calibration certificate** by an accredited calibration laboratory:
     Take all values from the calibration certificate.
   - After you have performed a **live raw data measurement** as described above:
     Use the values from the data sheet of the pressure sensor or from your measurement:
     - Lower current value: from live raw data
     - Lower pressure value: from data sheet
     - Upper current value: from data sheet
     - Upper pressure value: from data sheet
3. Tap <OK>.

6.4 Calibration

See the Reference Guide.

7 Upkeep and Cleaning

To ensure a constant and high accuracy of your measurements, clean your instrument frequently.

Before you store the instrument for more than one day, clean and dry the measuring cell.

Cleaning frequency

Clean and dry the measuring cell at least after each working day or working shift.

Cleaning more frequently can be necessary ...

- before you perform adjustments,
- before you want to measure using a minimum sample amount,
- before you measure a sample that is not miscible with the previous sample,
- before you measure a sample that could chemically react with the previous sample.

7.1 Cleaning and Drying the Measuring Cell

WARNING

Risk of injuries and fire by liquids leaking
Before you fill any sample or cleaning liquid into the instrument:

- Strictly follow all safety instructions concerning the use of chemicals and the use of flammable chemicals, see section 1;
- Make sure that all wetted parts are resistant, see appendix A.3.

WARNING

Risk of serious injuries and destruction of the instrument caused by flammable liquids
Before you clean the measuring cell with flammable liquids:

- Make sure that the measuring cell has cooled down below the flash point of the liquids.

NOTICE
Never leave any sample in the measuring cell longer than necessary.

TIP: *Immediate cleaning is the easiest and gives the best results.*

In most cases, the filling procedure of the cleaning liquid is the same as the filling procedure of the sample.

Depending on the type of sample residues in the measuring cell, one of the following cleaning liquids may be appropriate:

Depending on the type of sample residues in the measuring cell, one of the following cleaning liquids may be appropriate:

- toluene
- naphtha
- ethanol
- acetone
- white spirit
- mesitylene
- water
- ...

See the Reference Guide for recommended cleaning liquids depending on the sample.

Clean the measuring cell together with the complete sampling system.

Cleaning and drying procedure

1. Empty the measuring cell.
2. Rinse the measuring cell with cleaning liquid.

TIP: *For the cleaning of highly viscous samples, we recommend to use 20–40 mL of cleaning liquid.*

TIP: *For difficult samples leave the cleaning liquid in the measuring cell for 5–10 minutes.*

3. Purge the measuring cell with a volatile liquid to wash out cleaning liquid of low volatility.
4. Empty the measuring cell.
5. Drying:
   - If you measure at temperatures **higher than 100 °C** (212 °F), the cleaning routine is finished.
   - If you measure at temperatures **lower than 100 °C** (212 °F), insert the air pump hose with the adapter Luer cone into one of the injection adapters.
     (*With the syringe heating accessory:* Attach the PTFE Luer extension to the air pump hose using the adapter Luer cone. Insert the PTFE Luer extension into the sample inlet).

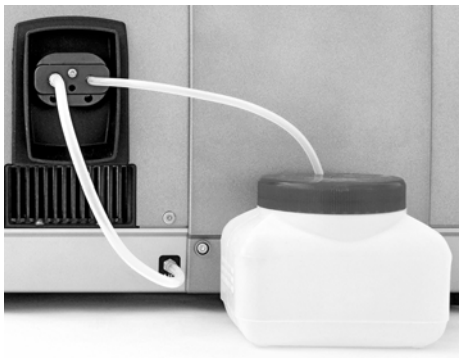


Fig. 14: Drying the measuring cell

6. Tap in the quick access area to start the air pump.
7. Wait until the measuring cell is dry (stable density reading).

   The time needed depends on the vapor pressure of your cleaning liquid and the temperature of the measuring cell.

   A drying time of 300 s is recommended. (Set the drying time in the menu *Setup* > *Measuring System Settings* > *Air pump*).
8. Tap in the quick access area to stop the air pump, or wait for the pump timeout.

7.2 Cleaning the Optional Syringe Heating Accessory

Dismounting and cleaning the insulation cover

WARNING

Risk of serious skin burns caused by hot surfaces
The insulation cover of the syringe heating accessory can reach temperatures of up to 100 °C (212 °F).
- Wear heat-protective gloves.
- Before you dismount the insulation cover of the syringe heating accessory, set the measuring temperature to 20 °C (68 °F) and wait until the temperature has dropped below 60 °C (140 °F).

1. Unscrew the black knurled screw (2, fig. 6) from the syringe heating accessory.
2. Remove the insulation cover (1, fig. 6).
3. Remove sample residues with a soft tissue, which can be wetted with an appropriate cleaning agent.

Cleaning the inside of the syringe heating accessory

WARNING

Risk of serious skin burns caused by hot surfaces
The metal block of the syringe heating accessory can reach temperatures of up to 150 °C (302 °F).
- Wear heat-protective gloves.
- Before you dismount the insulation cover of the syringe heating accessory, set the measuring temperature to 20 °C (68 °F) and wait until the temperature has dropped below 60 °C (140 °F).

1. Unscrew the black knurled screw (2, fig. 6) from the syringe heating accessory.
2. Remove the insulation cover (1, fig. 6).
3. Unscrew the fixing screws (2, fig. 5) of the syringe holder.
4. Remove the syringe holder (1, fig. 5)
5. Remove sample residues with a soft tissue, which can be wetted with an appropriate cleaning agent.

7.3 Cleaning the Filter of the Fan

Clean the filter of the rear fan at least twice a year.

1. Remove the cover of the fan.
2. Take out the filter and clean it with compressed air.
3. Put the filter back into the cover.
4. Re-mount the cover of the fan.

Fig. 15: Cleaning the filter of the rear fan

7.4 Cleaning the Instrument Housing and the Touchscreen

WARNING

Before using any cleaning agents for the instrument's housing and touchscreen:

- Strictly follow all safety instructions concerning the use of chemicals and the use of flammable chemicals, see section 1.
- Make sure that all parts of the housing are resistant, see appendix A.3. In case of uncertainties contact Anton Paar GmbH.
- Decontaminate and remove aggressive sample residues on the instrument.

NOTICE

Corrosion due to unsuited means of cleaning

Using substances for cleaning that are not suitable causes corrosion of the instrument housing.

Never use:

- any chemicals aggressive against glass,
- strong acids or bases (e.g. nitric acid, sulfuric acid, hydrochloric acid, caustic soda),
- strong mechanical action (steel brush).

To clean the instrument housing or the touchscreen, use a soft tissue, which can be wetted with ethanol or warm water, if necessary with a mild cleaning agent added (pH < 10).

8 Maintenance and Repair

8.1 Maintenance Performed by an Authorized Anton Paar Service Engineer

The instrument requires no periodical maintenance. However, optional services are available from your local Anton Paar representative upon request.

Following parts are generally excluded from the warranty (wear and tear parts)

- syringes
- hoses
- adapters, connectors, fittings
- pump diaphragms
- filters
- O-rings, seals, gaskets
- cables
- fuses
- batteries
- desiccants
- protection foils and covers

All parts damaged in consequence of a fall of the instrument are generally excluded from the warranty as well.

8.2 Repair Performed by an Authorized Anton Paar Representative

In case your instrument needs repair, contact your local Anton Paar representative, who will take care of the necessary steps. If your instrument needs to be returned, request an RMA (Return Material Authorization Number). It must not be sent without the RMA and the filled “Safety Declaration for Instrument Repairs”. Please make sure it is cleaned before return.

TIP: *Contact your local Anton Paar representative from the Anton Paar website under “Contact” (https://www.anton-paar.com).*

IMPORTANT: *You must not return instruments that are contaminated by radioactive materials, infectious agents, or other harmful substances that cause health hazards.*

Appendix A: Technical Data

A.1: Specifications

Density	
Resolution	0.00001 g/cm^3
Repeatability s.d.[ab]	0.00005 g/cm^3
Reproducibility s.d.[ab]	0.0001 g/cm^3
Accuracy[bc]	0.0002 g/cm^3
Measuring range	0 g/cm^3 to 3 g/cm^3
Temperature	
Accuracy	0.03 °C (0.05 °F)
Measuring temperature DMA 4200 M DMA 4200 M incl. syringe heating accessory	 –10 °C to +200 °C (+14 °F to +392 °F) –10 °C to +200 °C (+14 °F to +392 °F)
Max. allowable working temperature	200 °C (392 °F)
Pressure	
Pressure range DMA 4200 M DMA 4200 M incl. syringe heating accessory	 0 bar to 500 bar (0 psi to 7,250 psi) absolute ambient pressure
Max. allowable working pressure DMA 4200 M DMA 4200 M incl. syringe heating accessory	 500 bar (7,250 psi) absolute ambient pressure
Amount of sample in the measuring cell	approx. 2 mL
Accuracy and convenience features	ambient air pressure sensor | full range viscosity correction | FillingCheck™ | Temperfect™
Standards	ASTM D1475, ASTM D4052, ASTM D4806, ASTM D5002, ASTM D5931, ASTM D6448, ASTM D7961, ASTM D8188, ISO 12185, USP 841 - Specific gravity

a According to ISO 5725
b Depends on factors such as repeatability of the pressure control system and thermal expansion of the sample
c Under ideal measuring and sample conditions (at ambient pressure)

Table 2: Precision classes

Precision class	Stability temperature	Stability density
Ultrafast	< 0.1 °C for 10 s	< 0.00005 g/cm^3 for 60 s
Fast	< 0.05 °C for 10 s	< 0.00004 g/cm^3 for 80 s
Standard	< 0.01 °C for 10 s	< 0.000015 g/cm^3 for 120 s
Precise	< 0.005 °C for 10 s	< 0.000004 g/cm^3 for 140 s

A.2: Instrument Data and Operating Conditions

Dimensions (L x W x H) DMA 4200 M DMA 4200 M incl. syringe heating accessory	 510 mm x 330 mm x 230 mm (20 in x 13 in x 9 in) 510 mm x 340 mm x 230 mm (20 in x 13.4 in x 9 in)
Weight DMA 4200 M DMA 4200 M incl. syringe heating accessory	 27.7 kg (61.1 lbs) 29.9 kg (65.9 lbs)
Power supply	100 to 240 V~, 50/60 Hz, fluctuation ±10 %
Power consumption	250 VA
Power inlet	according to IEC/EN 60320-1/C14, protection class I
Fuses	ceramic tube fuses 5x20 mm; IEC 60127-2; AC 250 V; T 4A H
Environmental conditions (EN 61010)	indoor use only
Ambient temperature	+15 °C to +35 °C (+59 °F to +95 °F)
Air humidity	10 % to 90 % relative humidity, non-condensing
Altitude	max. 3000 m (9800 ft)
Pollution degree	2
Overvoltage category	II
Touchscreen	10.4" PCAP, 640 x 480 px
Memory	1000 measuring results
Interfaces	4 x USB (2.0 full speed) 1 x Ethernet (100 Mbit) 1 x CAN Bus 1 x RS-232 1 x VGA
External analog interface	e.g. for connecting a pressure sensor Range: 4–20 mA; Accuracy: 0.1 % of Fs (= 0.02 mA)
RS-232 C printer settings	Baud rate: 9600; Parity: none; Stop bit: 1; Data bits: 8
Cooling unit	
Temperature range	–10 °C to 30 °C (14 °F to 86 °F)
Maximum pressure	0.45 bar (6.5 psi) relative
Flow rate	1–3 L/min
Connector	Coupling 6 mm

WARNING

Risk of electric shock
Connect only voltages that comply with PELV (protective extra-low voltage) according to EN 61140 or with SELV (safety extra-low voltage) according to EN 60950 to any of the electrical interface connectors of the instrument.

IMPORTANT: *Connect only Anton Paar equipment or equipment with a maximum power consumption of 40 W to the CAN interface.*

A.3: Wetted Parts and Housing Materials

The following materials are in contact with the samples and cleaning agents:

DMA 4200 M

Material	Part
Hastelloy C-276	measuring cell, filling adapters

DMA 4200 M – Cooling unit

Material	Part
Copper	cooling tubes
Nickelized brass	nozzles
Silicone	hoses (do not use silicone hoses when measuring silicone oil)
Viton	O-rings

Standard accessories

Material	Part
HDPE	waste vessel DMA 4200 M
PFA	syringe PFA 10 mL Luer-lock
Polypropylene/polyethylene	disposable plastic syringes
POM-C	Luer extension 70 mm
PTFE	Luer extension 80 mm
Silicone	hoses
Tinplate	waste vessel syringe heating accessory

Syringe heating accessory

Material	Part
Anodized aluminum	syringe holder
PTFE	insulation cover, knurled screw

Housing materials

DMA 4200 M	
top	aluminum, coated
back	aluminum
front, cover plate	polystyrene/butadiene
Syringe heating accessory	PTFE

Appendix B: Declarations of Conformity

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EU Declaration of Conformity

(original)

Anton Paar

The Manufacturer **Anton Paar GmbH,** Anton-Paar-Str. 20, A-8054 Graz, Austria – Europe hereby declares that the product listed below

Product designation:	**DMA 4200 M AP**
Model:	**DMA 4200 M**
Material number:	183400

is in conformity with the relevant European Union harmonisation legislation. This declaration of conformity is issued under the sole responsibility of the manufacturer.

Electromagnetic Compatibility (2014/30/EU, OJ L 96/79 of 29.3.2014)

Applied standards:

▪ EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

Low Voltage Directive (2014/35/EU, OJ L 96/357 of 29.3.2014)

Applied standards:

▪ EN 61010-1:2010 +A1:2019 +A1:2019/AC:2019	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
▪ EN 61010-2-010:2014	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-010: Particular requirements for laboratory equipment for the heating of Materials

RoHS Directive (2011/65/EU, OJ L 174/88 of 1.7.2011)

Place and date of issue: Graz, 2022-10-20

DocuSigned by:
17130DDD5260426...
DI Steffen Riemer, MBA
Executive Director
Business Unit Measurement

DocuSigned by:
66833374CFAF464...
DI Dr. Wolfgang Baumgartner
Head of Lab Density & Concentration
Business Unit Measurement

DocuSign Envelope ID: 30A9FBD7-24FD-4A3C-BC0F-04209CAF231F

UK Declaration of Conformity

Anton Paar

The Manufacturer **Anton Paar GmbH,** Anton-Paar-Str. 20, A-8054 Graz, Austria – Europe hereby declares that the product listed below

Product designation:	**DMA 4200 M AP**
Model:	**DMA 4200 M**
Material number:	183400

is in conformity with all the relevant UK legislation

Electrical Equipment (Safety) Regulations 2016, 2016 No. 1101

Electromagnetic Compatibility Regulations 2016, 2016 No. 1091

Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012, 2012 No. 3032

complies with the designated standards:

- EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019
- EN 61010-2-010:2014
- EN 61326-1:2013

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Importer: Anton Paar Ltd, Unit F, The Courtyard, Hatfield Rd, St Albans AL4 OLA, United Kingdom;

Place and date of issue: Graz, 2022-10-20

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