Anton Paar

Instruction Manual and Safety Information

DMA 6002 Sound Velocity CK
DMA 6002 Sound Velocity

Density and Sound Velocity Meter

Full Reference Guide I51IB004 available for download

Find out more

www.anton-paar.com

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1 Safety instructions

Read the documentation

- Read the documentation before using the product.
- Follow all hints and instructions in the documentation to ensure the correct use and safe functioning of the product.

1.1 General safety instructions

General

- Refer to the Reference Guide for a comprehensive description of the instrument.
  Download Anton Paar documents for free from the Anton Paar website: https://www.anton-paar.com
- The documentation is a part of the product.
  Keep it for the complete working life of the product and make it easily accessible to all persons involved with the product. If you receive any additions or revisions from Anton Paar, these must be treated as part of the documentation.

Liability

- This document does not claim to address all safety issues associated with the use of the product and samples. It is your responsibility to establish health and safety practices and to determine the applicability of regulatory limitations.
- Anton Paar only warrants the safe and proper functioning of the product if no modifications are made to mechanics, electronics, or software.
- Use the product only for the purpose described in the documentation. Anton Paar is not liable for damages caused by incorrect use of the product.
- The results delivered by the product depend on the correct function of the product and various other factors. We recommend that you have experts check the results (i.e., perform plausibility testing) before taking consequential actions based on the results.

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.).
- Substances used must be labeled. The corresponding material safety data sheets must be observed and made available near the measuring setup.
- Samples and cleaning liquids that have been used in the measuring system are not suited for human consumption after use.
- Check the wetted parts of the product for chemical resistance to all samples and cleaning liquids.
- Take care that samples, cleaning liquids and gases are chemically compatible when they come into contact with each other. They must not react exothermally or produce hazardous substances.

For products directly connected to electrical supply

- Install the product so that you can easily separate it from the electrical supply (pull the power plug) at any time.

Installation

- The installation procedure shall only be carried out by authorized personnel who are familiar with the installation instructions.
- Never use the product outside the specified ambient conditions and specifications.
- Use only accessories, consumables, or spare parts supplied or approved by Anton Paar.

Using the product

- Ensure that all operators have been trained beforehand to use the product safely and correctly.
- Before you start a measurement or cleaning procedure, take care that all parts of the measurement system are properly connected and in good condition.
- Before you start a measurement or cleaning procedure, check the injection adapters for leak tightness.
- Ensure that the product is sufficiently supervised during operation.
- In case of damage or malfunction, stop operating the product. Do not operate the product under conditions that could result in damage to goods or injuries or loss of life.
- If hazardous substances have been spilled on the product, immediately decontaminate it in an appropriate way.
- If you suspect that spilled substances got into the product, disconnect the product from the electrical supply and have it checked for electrical safety by a service technician authorized by Anton Paar.

Precautions for flammable samples and cleaning agents

- Keep potential sources of ignition, like sparks or open flames, at a safe distance from the product.
- 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 liquids, and other hazardous materials near the product.
- Do not spill sample/cleaning liquids or leave their containers uncovered. Immediately remove spilled sample/cleaning liquids.

- Ensure that the setup location is sufficiently ventilated. The environment of the product must be kept free from flammable gases and vapors.
- Provide fire-extinguishing equipment.

Operation with explosive samples

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

Operation in areas with risk of explosion

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

Service and repairs

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

Disposal

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

1.2 Safety instructions when measuring sulfuric acid or oleum

WARNING

Sulfuric acid (H_2SO_4) and oleum (fuming sulfuric acid) are highly caustic substances, which may cause irritations and serious injuries to skin, eyes, and mucous membranes

- Working with sulfuric acid or oleum requires special training of employees. Ensure that all employees handling these hazardous substances are periodically instructed in all handling, safety, and emergency procedures.
- Always wear protective clothing and eye protection (protective goggles or face shield) when handling sulfuric acid or oleum.
- Ensure that fire extinguishing equipment, first aid kits, overhead drench showers, and eye baths are within reach.

WARNING

Risk of serious injuries due to strong exothermic reactions

Mixing oleum or concentrated sulfuric acid with water or organic solvent will cause a very strong exothermic reaction. An exothermic reaction inside the measuring cells may destroy them.

- Never mix oleum or concentrated sulfuric acid with water nor diluted acid in the measuring cells.
- Always dilute oleum by adding it drop by drop to 98 % w/w H_2SO_4 while stirring and cooling.
- Dilute concentrated sulfuric acid by adding it drop by drop to water while stirring and cooling.
- Before you fill any kind of sulfuric acid or oleum into the measuring cells, ensure that they have been cleaned and dried or that they already contain concentrated sulfuric acid or oleum.
- Do not fill concentrated sulfuric acid or oleum into the measuring cells if there is still water, organic solvent, or diluted acid in the measuring cells.

WARNING

Risk of serious injuries due to chemical reactions caused by sulfuric acid or oleum

Concentrated sulfuric acid and oleum react with oxidizable organic materials and solvents, reducing agents, chlorates, permanganates, ammonia, oxides and hydroxides of alkali and alkaline earth metals. The chemical reaction may lead to serious injuries or may destroy objects containing these substances.

- Never bring sulfuric acid or oleum into contact with these materials and substances.

- Do not leave sample containers uncovered. Immediately remove spilled sample.
- Always use separate waste containers for sulfuric acid waste and ethanol (or other solvent) waste.
- Label the waste containers properly so that no mix-ups are possible.
- Ensure that the material of the sulfuric acid waste container is resistant to sulfuric acid and oleum.
- Place the waste containers behind a safety shield and in a catch basin.
- Never flush sulfuric acid waste and ethanol (or other solvent) waste down the sink.
- Always dispose of the waste according to regional laws and regulations.

1.3 Conventions of safety messages and typography

Conventions for safety messages

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

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.

TIP: *Tip gives extra information about the situation at hand.*

Typographical conventions

The following typographical conventions are used in this instruction manual:

Convention	Description
Names for physical buttons *Labels for tabs, buttons etc. in the software*	The names and labels are written in *italic*.
Menu Level 1 > Menu Level 2	Menu paths are written in *italic*. The menu levels are connected using a closing angle bracket.

2 Overview

DMA 6002 Sound Velocity combines a sound velocity cell with the proven U-tube core technology and its patented evaluation of the oscillation period. It provides highly reliable and precise, but also highly robust density and sound velocity results for the same sample under the same measurement conditions.

The instrument can be combined with a variety of modules for the measurement of additional parameters and with various sample changers for automatic sample filling.

Inside the instrument

- Your instrument is equipped with the world's most advanced digital density measurement technology, the patented Pulsed Excitation Method (AT 516420 (B1)).
- With the additional sound velocity cell, two physical properties of the filled sample can be determined simultaneously with highest precision.
- The oscillation periods of the U-tube and the reference oscillator are measured by optical pickups.
- Two integrated Pt 100 platinum thermometers together with Peltier elements provide an extremely precise temperature control of the sample.
- ThermoBalance™: The additional reference oscillator provides long-term stability and enables precise measurements over the whole temperature range of the instrument, with only one adjustment at 20 °C (68 °F).
- Viscosity-related errors are automatically corrected over the full viscosity range by measuring the damping effect caused by the viscous property of a sample. The result is subsequently used for the calculation of the viscosity-corrected density value.

Condition monitoring

- The built-in sensor for the atmospheric pressure enables the automatic calculation of the current air density required for adjustments and checks of the instrument as the air density is dependent on the atmospheric pressure.
- FillingCheck™: A major source of measuring errors with density meters are gas bubbles in the measuring cell. The instrument automatically detects inhomogeneities by an advanced analysis (e.g. of the density measuring cell's oscillation pattern). Where necessary, a warning message is generated in real time for every single measurement.
- U-View™: Real-time images by a camera with zoom function enable you to visually inspect the density measuring cell.
- Condensation in the density measuring cell or the measuring cell block causes various problems. A built-in sensor determines the air humidity near the measuring cell and gives a warning if the temperature of the measuring cell block lies below the dew point.
- The Pulsed Excitation Method even improves operational safety as the condition of the density measuring cell can be monitored in detail.

User interface

- The touchscreen user interface guides you in an intuitive way through routine applications as well as demanding scientific research work.
- Freely define your favorites on the home screen and have quick access to the instrument functions that you need every day.
- Define your own products (in addition to the predefined product measurement settings), your own measurement parameters (derived from the parameters coming with the instrument), or the contents of output reports.
- Density and sound velocity values are automatically converted into various predefined quantities / concentration values. You can define further quantities as required.
- Industry profiles allow you to turn the instrument into a measuring tool specific for your industry by activating additional predefined products, dashboards, and quantities.
- Export all measured data as a PDF or CSV file onto any connected storage device or a network share. Data can be printed via USB, network, or serial port.
- If you prefer, you can optionally connect an external keyboard or mouse and a barcode reader.

Compact and robust design

The instrument is ready for reliable measurements also in demanding environments due to:

- compact design
- sealed housing that withstands shocks, dirt, and spillages
- robust housing materials

2.1 Intended use of the instrument

Your instrument is capable of measuring liquids in a wide viscosity range. Concentrations can be determined in binary/quasi-binary and ternary/quasi-ternary mixtures.

Some samples need a special treatment before measurement, like degassing (samples with a tendency to bubble formation), or they need a special filling technique.

Restrictions

- Do not leave bases longer than necessary in the density measuring cell because the glass of the measuring cell is susceptible to attack by alkaline liquids.

Exclusions

- The instrument cannot measure solids.
- Do not measure hydrofluoric acid as it attacks the glass of the density measuring cell.
- 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.

IMPORTANT: *Always check if recommendations of the instrument (e.g. from the instrument's intelligent condition monitoring) are reasonable.*

2.2 Functional components

Fig. 1: *Front and right side of the instrument*

1 Touchscreen
2 Power LED
3 Status light
4 Air pump outlet (5 mm barbed)
5 Socket for U-Dry
6 Sample outlet
7 Sample inlet
8 Extension slot cover plate
9 Recessed grip for transportation

Table 1: Status light

Color & behavior	Status
White constant	Instrument ready / also during checks or adjustments
White pulsed slowly	Instrument busy (ongoing measurement / drying procedure)
Green constant	Measurement finished without error/warning
Yellow constant	Warning during measurement
Red constant	Error during measurement

CAUTION

Prolonged direct viewing of the LED lights may cause eye discomfort or potential damage

Do not stare continuously into the LED-lights.

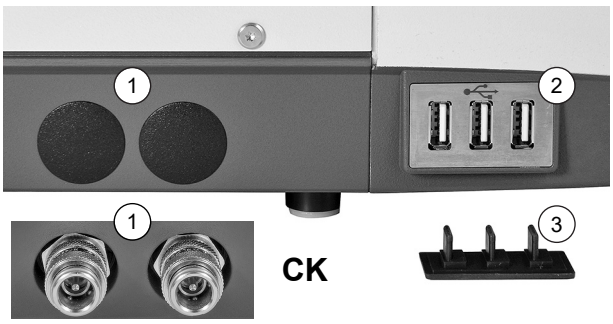


Fig. 2: *Left side of the instrument*

1 Standard models: Blind covers | CK models: Inlet and outlet connectors for the cooling kit
2 USB 2.0 sockets (type A), 3x
3 Protection cover for the USB sockets

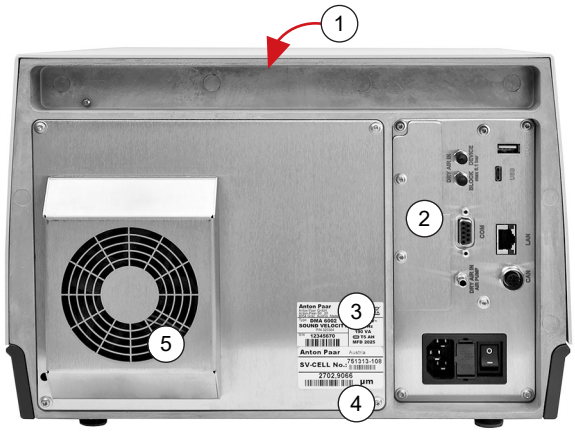


Fig. 3: *Rear of the instrument*

1 *Ledge handle for transportation*
2 *Connectors on the rear*
3 *Type plate with serial number (P/N = mat. no.)*
4 *Factory set path length for the sound measurement*
5 *Fan*

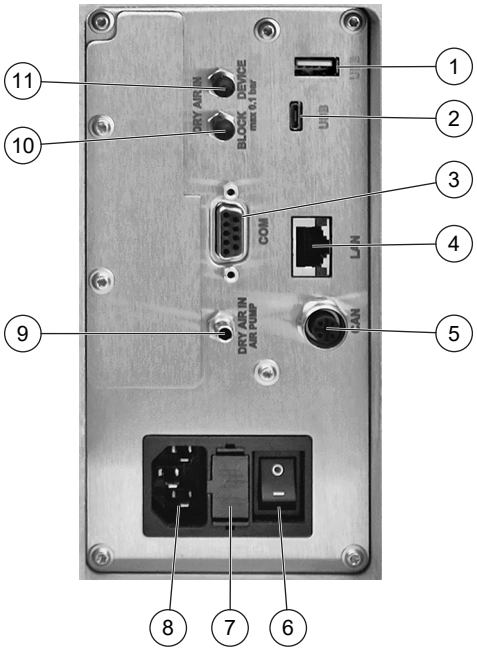


Fig. 4: *Rear connectors of the instrument*

1 *USB 2.0 socket (type A)*
2 *USB OTG socket (Micro-A)*
3 *COM / RS-232 serial port (DE-9F connector)*
4 *Ethernet terminal (RJ45 connector)*
5 *CAN interface (for the connection of further measuring modules)*
6 *Power on/off switch*
7 *Fuse holder*
8 *AC power jack*
9 *"DRY AIR IN AIR PUMP" connector (5 mm barbed): air pump inlet*
10 *"DRY AIR IN BLOCK" connector (3.5 mm barbed), max. 0.1 bar (1.5 psi) rel.: drying of measuring cell block / camera view*
11 *"DRY AIR IN DEVICE" connector (3.5 mm barbed), max. 0.1 bar (1.5 psi) rel.: drying of instrument's interior*

3 Installation

If you install the instrument in a measurement system, proceed as described in the documentation of the measurement system.

Table 2: Installation procedure

	Step	refer to
1	**Place** the instrument on a bench in an appropriate environment.	Section 3.1 [▶ 9]
2	Mount the **connection tube**, the **injection adapters**, and check for **leak tightness**.	Section 3.2 [▶ 10] Section 3.3 [▶ 10] Section 3.4 [▶ 11]
3	Mount **U-Dry** and the **hoses,** and connect the **waste vessel**.	Section 3.5 [▶ 11]
4	*CK model only:* Connect the **cooling**.	Section 3.6 [▶ 13]
5	Connect the instrument to the **power supply** and **switch** it **on**.	Section 3.7 [▶ 13] Section 3.8 [▶ 14]
6	Define basic **instrument settings** and perform **first checks**.	Section 3.9 [▶ 14]

Installation of modules, sample changers, and other optional parts

NOTICE

Risk of damaging the instrument

Never plug or unplug CAN cables while the instrument is switched on.

For the installation of optional parts, refer to the particular instructions coming with the part or to the corresponding section in the Reference Guide.

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 IEC 62368-1 to the interface connectors (except the power inlet) of the instrument.

IMPORTANT: *Connect only Anton Paar equipment with a maximum power consumption of 40 W to the CAN interface. Otherwise the instrument will not work. The CAN power supply, mat. no. 100655, enables you to increase the maximum load.*

3.1 Installation requirements

Read the Safety Instructions in Section 1 [▶ 5].

Find all Technical Data in Appendix A [▶ 34].

Allow the equipment to reach ambient temperature before installation. This is very important if the equipment has been stored or transported at lower temperatures.

IMPORTANT: *High humidity or a measuring temperature that is significantly below the ambient temperature may lead to condensation in the density measuring cell. In this case take measures to avoid condensation – consider using a drying cartridge.*

The right place

The instrument is designed for operation under typical laboratory benchtop conditions.

The setup location and surroundings must meet the minimum requirements specified under “Operating conditions” in the Technical Data (Appendix A [▶ 34]).

NOTICE

No spray water protection

Consider that the instrument is not protected against spray water.

Place the instrument on a stable, flat bench which is free of vibrations and away from vibrating equipment.

To ensure temperature stability and trouble-free measurement, do **not** position your instrument:

- next to a heating facility
- in a drafty place (e.g., near an air conditioning, ventilation system, or an open window)
- in direct sunlight

NOTICE

Do not inhibit heat dissipation

A strong built-in cooling fan dissipates heat through the bottom and rear of the instrument. Ensure that the air flow is not blocked and provide for a minimal distance of 10 cm (4 in) to walls behind and beside the instrument.

The instrument requires an electrical outlet nearby:

- 100–240 V~, 50/60 Hz, fluctuation ±10 %

3.2 Mounting the connection tube

The connection tube density/sound complete leads the sample from the sound velocity measuring cell to the density measuring cell.

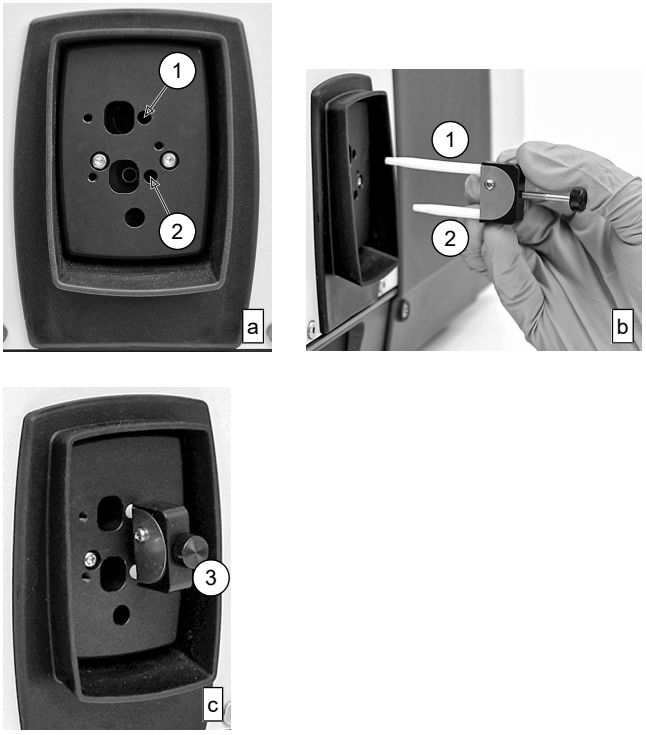


Fig. 5: *Mounting the connection tube*

Refer to Fig. 5 [▶ 10].

1. Take the connection tube, mat. no.182061, from the standard accessory kit.
2. Push the ends of the connection tube (1+2, b) into the openings (1+2, a) on the right side of the instrument.

   Match the longer end (1, b) with the upper opening (1, a) and the shorter end (2, b) with the lower opening (2, a).
3. Fix the connection tube hand-tight with the knurled screw (3, c).

3.3 Mounting the injection adapters

The injection adapter sound UNF ¼” leads to the sound velocity measuring cell and serves as the instrument’s inlet adapter. The injection adapter UNF ¼” leads to the density measuring cell and serves as the instrument’s outlet adapter.

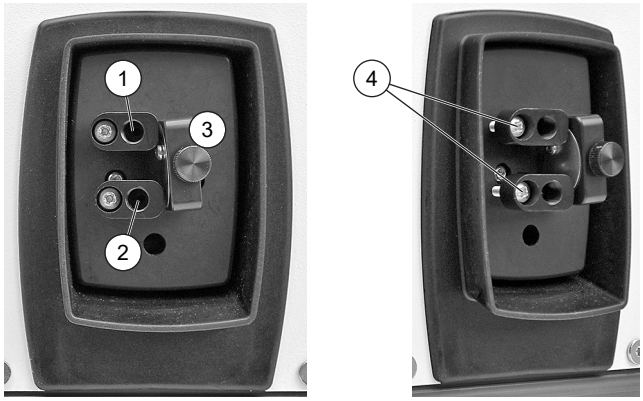


Fig. 6: *Injection adapters and connection tube mounted*

1 Sample outlet: injection adapter UNF ¼", mat. no. 159025 (longer one)

2 Sample inlet: injection adapter sound UNF ¼", mat. no. 159024 (shorter one)

3 Connection tube density/sound complete, mat. no. 182061

4 Fixing screws of the adapters

Refer to Fig. 6 [▸ 11].

1. Take the injection adapter sound UNF ¼", mat. no. 159024, and the injection adapter UNF ¼", mat. no. 159025, with screws from the standard accessory kit.
2. Pull the black plastic transport plugs out of the injection adapters' tips.

TIP: *Keep the transport plugs for later use. In case of leaks, you can widen the tips of the adapters with the transport plugs.*

3. Carefully insert the injection adapter UNF ¼" into the sample outlet opening (1). Push the adapter in with moderate force.

CAUTION

Possible leakage of dangerous liquids

If the fixing screw for the adapter is overtightened, the density measuring cell may get damaged. Dangerous liquids leaking from the instrument may cause injuries or risk of fire.

– Tighten the screw until some resistance against further turning can be felt, then stop to tighten the screw.
The gap left between the holding plate and the adapter, where the thread of the screw can be seen, is approx. 3–8 mm (0.12–0.31 in).

4. Fix the adapter with the screw (4):
Slide the screw through the bore hole of the adapter and tighten it cautiously until some resistance against further turning can be felt.
5. Carefully insert the injection adapter sound UNF ¼" into the sample inlet opening (2). Push the adapter in with moderate force.
6. Fix the adapter with the screw (4):
Slide the screw through the bore hole of the adapter and tighten it cautiously until some resistance against further turning can be felt.

3.4 Leak tightness test

CAUTION

Possible leakage of dangerous liquids

Dangerous liquids leaking from the instrument may cause injuries or risk of fire.

– Check the connections for leak tightness before you fill dangerous liquids.

1. Screw the adapters Luer ¼" UNF, mat. no. 64792 (from the standard accessory kit), into the openings of the injection adapters.
2. Close one adapter tightly with a male Luer plug, mat. no. 63865 (from the standard accessory kit).
3. Draw up air into a plastic syringe (from the standard accessory kit) and attach the syringe to the other adapter.
4. Inject, with moderate pressure, the air in the syringe into the instrument.
5. Wait a few seconds, then release the plunger of the syringe.
   – If the connections are tight, the plunger of the syringe will be slowly pushed back by the pressure in the measuring cell.
   – If the connections are leaky, the plunger of the syringe will not move.
   In this case remount the adapters and repeat the leak tightness test.

TIP: *In case of leaks, you can widen the tips of the adapters with the transport plugs of the adapters.*

3.5 Mounting the hoses and the waste vessel

CAUTION

Possible leakage of dangerous liquids

Dangerous liquids leaking from the instrument may cause injuries or risk of fire.

– Only use the supplied hoses and waste vessel if their materials are resistant to your samples and cleaning liquids.
– If the supplied parts are not suitable, use other parts made of an appropriate material.

3.5.1 U-Dry, all hoses, and waste vessel for standard measurements

For syringe filling, install U-Dry.

All parts required for this installation come with the standard accessory kit, mat. no. 388075.

For all instructions refer to Fig. 7 [▸ 12].

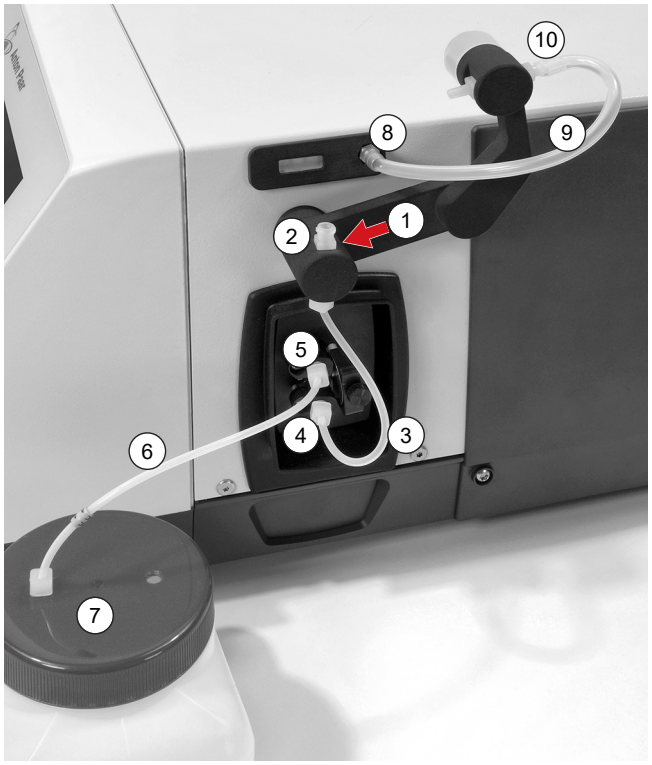


Fig. 7: *Mounting U-Dry, all hoses, and waste vessel for standard measurements*

1	*U-Dry / direction of insertion into socket (tapered dovetail on the back)*
2	*Adapter Luer ¼" UNF (locked by a fixing screw)*
3	*Hose 140x3x2 PTFE 2x¼"–28 UNF, mat. no. 187223*
4	*Sample inlet adapter*
5	*Sample outlet adapter*
6	*Hose 300x3x2 PTFE "AA", mat. no. 3443*
7	*Waste vessel*
8	*Air pump outlet*
9	*Air pump hose*
10	*U-Dry Luer cone*

U-Dry

1. Take U-Dry (1) from the accessory kit.
2. Insert the tapered dovetail of U-Dry into the socket on the instrument (figure below).

   It may be necessary to loosen the fixing screw first with the Phillips screwdriver from the accessory kit.

   Push U-Dry in firmly until you hear a clicking sound.
3. Tighten the fixing screw in the socket to secure U-Dry in place.

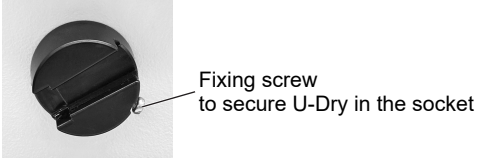


Fig. 8: *Socket and fixing screw*

To unmount U-Dry, loosen the fixing screw and pull U-Dry out of the socket. Do not push it from the opposite side.

Filling hose

1. Screw one end of the hose 140x3x2 PTFE, mat. no. 187223, into the lower screw hole of U-Dry (3).
2. Screw the other end of the hose into the sample inlet (lower) adapter (3+4).

Waste hose / waste vessel

You can use hose 140x3x2 PTFE, mat. no. 187223, or hose 300x3x2 PTFE, mat. no. 3443, as the waste hose, whichever suits you better.

1. Screw one end of the waste hose into the threaded hole in the cap of the waste vessel (6+7).
2. Screw the other end of the waste hose into the sample outlet (upper) adapter (5+6).

IMPORTANT: *Always keep the waste vessel closed with the lid during operation.*

Air pump hose

1. Cut a piece of approx. 18 cm (7 in) length from the supplied silicone hose 4x6, mat. no. 57024.
2. Connect one end of the hose piece to the air pump outlet (8+9).
3. Connect the other end of the hose piece to the Luer cone of U-Dry (9+10).

3.5.2 Mounting the syringe holder as an air hose dock

If you do not use syringe filling via U-Dry, install the syringe holder 02, mat. no. 387520, as a parking place for the air pump hose adapter.

1. Take the syringe holder from the accessory kit.
2. Insert the tapered dovetail of the syringe holder into the socket for U-Dry on the instrument.

   Depending on which side of the syringe holder you slide into the socket, you can switch between two parking positions. Choose the position that suits your needs better.

   Push the syringe holder in firmly until you hear a clicking sound to ensure it is securely in place.

Air pump hose for the syringe holder

1. Cut a piece from the supplied silicone hose, mat. no. 57024. Its length depends on your measurement setup. You should be able to reach all connectors that require air from the air pump.
2. Attach the supplied adapter Luer cone PTFE black, mat. no. 384626, to one end of the air pump hose.
3. Connect the other end of the air pump hose to the air pump outlet.

4. Stick the adapter on the air pump hose into the top hole of the syringe holder to keep the air pump hose from hanging loose while not used for drying.

3.5.3 Hoses for measurements of aggressive samples

All parts required for this installation (in addition to the parts of the standard accessory kit) come with the optional accessory kit DMA for chemical industry, mat. no. 232013.

For all instructions refer to Fig. 9 [▸ 13].

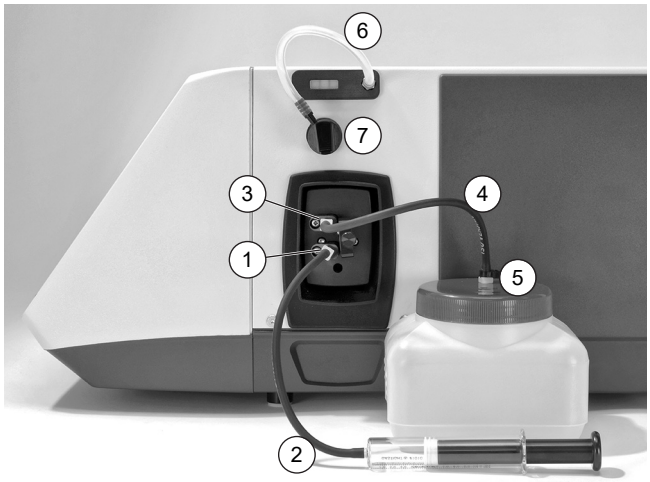


Fig. 9: *All Viton hoses mounted*

1 Sample inlet adapter
2 Viton hose 3x5 (filling hose)
3 Sample outlet adapter
4 Viton hose 3x5 (waste hose)
5 Adapter UNF ¼" Luer male on waste vessel
6 Air pump hose
7 Syringe holder 02 (parking position for air pump hose)

Viton filling hose

1. Screw an adapter UNF ¼" Luer male, mat. no. 64793, into the inlet (lower) adapter (1).
2. Cut a piece of approx. 25 cm (10 in) length from the supplied Viton hose 3x5, mat. no. 54629.
3. Connect one end of the Viton hose (2) to the adapter at the sample inlet (1).
4. Fix the connection with a hose clamp (from the standard accessory kit).

Viton waste hose / waste vessel

NOTICE

- Use a suitable waste vessel, depending on the concentration of the sample measured.
- Always place the waste vessel below the level of the filling adapter to prevent a sample backflow from the waste vessel into the instrument.

1. Screw an adapter UNF ¼" Luer male, mat. no. 64793, into the outlet (upper) adapter (3).
2. Screw another adapter UNF ¼" Luer male, mat. no. 64793, into the threaded hole in the cap of the waste vessel (5).
3. Cut a piece of approx. 25 cm (10 in) length from the supplied Viton hose 3x5, mat. no. 54629.
4. Connect the ends of the Viton hose (4) to the adapters at the sample outlet (3) and on the waste vessel (5).
5. Fix the connections with hose clamps (from the standard accessory kit).

Air pump hose

Mount the air hose dock and the air pump hose as described in Section 3.5.2 [▸ 12].

3.6 Connecting the cooling

(Only for CK models of the instrument)

When you perform measurements at temperatures more than 15 °C (27 °F) below ambient temperature, connect the cooling to an external 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 (1–3 liters per minute).

Table 3: Requirements for the cooling unit

Temperature range	5 °C to 30 °C (41 °F to 86 °F)
Maximal pressure	1 bar (14.5 psi) relative
Connector	self-locking coupling 8 mm, type Rectus 21KBTS08MVN, mat. no. 75090

Example

Your ambient temperature is 25 °C (77 °F), and you want to perform measurements at 0 °C (32 °F).

1. Connect the instrument to an external thermostat or a tap water line delivering water at a constant temperature between 5 °C (41 °F) and 15 °C (59 °F).
2. Set the measuring temperature to 0 °C (32 °F).

3.7 Power connection

WARNING

Risk of electric shock or fire

- 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.
- Ensure that the current rating of the power cable is at least 10 A.

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).

Use the supplied power cable to connect the AC power jack of the instrument with a suitable electrical outlet.

3.8 Switching the instrument on/off

Use the power switch on the rear of the instrument to switch the instrument on or off.

- When the instrument is switched on, the home screen will come up on the display.
- After power-on wait at least 15 minutes for the internal temperature to stabilize.

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

IMPORTANT: *After you have switched off the instrument, the electrical components stay live for a few seconds. If you have to restart the instrument, switch it off and wait approx. 15 seconds before switching it on again.*

3.9 Basic instrument settings and first checks

IMPORTANT: *Select the industry profile that suits your applications before changing other instrument settings (refer to Industry profiles).*

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

1. After installation, set the instrument settings (refer to Section 5 [▸ 14]).
2. If you don't want to use the predefined products, you may define your own products or other measurement settings (refer to Section 6 [▸ 18]).

   If you want to use product settings already defined on another instrument, you can import them (refer to Section 6.1.1 [▸ 18]).
3. Conclude initial setup with an air check and a water check (refer to Section 8.1 [▸ 27]) to verify that your instrument is in perfect condition. Your instrument has been factory adjusted over the whole temperature and viscosity range, but during transport the density adjustment may have been compromised.
   - 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/water density adjustment as described in Section 8.2 [▸ 28].
4. *For diet measurements with industry profile Beverages:*

   Perform initial diet adjustments for all your diet products as diet measurements will not be possible without them:
   - For each diet product create a measurement and start a process water adjustment and a concentration adjustment there (missing adjustments are preselected).

     A process water adjustment is only necessary for the first diet product. It will be automatically used for all other diet products.

TIP: *The process water adjustment and the concentration adjustment for the first diet product will be performed in one run.*

4 Operation

Refer to the Reference Guide for a comprehensive description of the instrument software and all available settings and functions.

TIP: *If you do not see all functions described in this manual, if you cannot access certain settings, or if you cannot perform some procedures, this may be due to restricted user permissions. Refer to the Reference Guide for a description of system security and user management.*

5 Instrument settings

IMPORTANT: *Select the industry profile that suits your applications before changing other instrument settings.*

Refer to the Reference Guide for a comprehensive description of all instrument settings.

For the configuration of installed options, refer to the instructions that come with the option.

5.1 Industry profiles

Turn the instrument into a measuring tool specific for your industry with industry profiles.

Industry profiles show only predefined products, dashboards, and quantities relevant for your applications.

TIP: *All changes that you have made to dashboards and dashboards that you have created will be kept.*

1. Select *Industry profiles* in the menu.
2. Select an industry profile from the list.

   Select *None* to reset the filter.
3. Tap *Change*.

   After a reboot the instrument will show only the predefined products, dashboards, and quantity groups according to your industry profile.

TIP: *The industry profile “None” is factory-set to display only density and sound velocity values.*

The industry profile “Beverages” makes available additional quantities and products required to analyze sugared soft drinks and syrups with inversion. It also activates special product functions for the adjustment of diet products with your lab reference method.

The industry profile “Chemicals” makes available additional quantities and products for various chemicals (for example sulfuric acid and oleum, acetic acid).

Table 4: Industry profiles and available predefined products

Industry profile	Product name	Dashboard	Application / Measurement
None	Generic liquids	Density & sound velocity	Density and sound velocity of a fluid
	Generic liquids (density)	Density	Density of a medium
	Generic liquids (sound vel.)	Sound velocity	Sound velocity of a fluid
Beverages	Generic liquids	Density & sound velocity	Density and sound velocity of a fluid
	Diet soft drink	Diet	Diet concentration of diet soft drinks
	HFCS-42	HFCS-42	All types of soft drinks and syrups based on HFCS-42
	HFCS-55	HFCS-55	All types of soft drinks and syrups based on HFCS-55
	Soft drink	Invert sugar	All types of soft drinks based on sucrose
	Syrup	Invert sugar	All types of syrups based on sucrose
Chemicals	Generic liquids	Density & sound velocity	Density and sound velocity of a fluid
	Acetic acid	Acetic acid	Acetic acid in the range 0 to 100 % w/w
	Formald./MeOH/H2O	Formald./MeOH/H2O	Ternary solution in the ranges 0 to 10 % w/w methanol, 30 to 50 % w/w formaldehyde, and water at 50 °C
	Sulfuric acid & oleum@ 20 °C	Sulfuric acid & oleum	Sulfuric acid (H_2SO_4) and oleum in the ranges 0 to 100 % w/w H_2SO_4 and 0 to 23 % w/w SO_3 at 20 °C
	Sulfuric acid & oleum@ 40 °C	Sulfuric acid & oleum	Sulfuric acid (H_2SO_4) and oleum in the ranges 0 to 100 % w/w H_2SO_4 and 0 to 65 % w/w SO_3 at 40 °C

Table 5: Industry profiles and available quantity groups

Quantity group	None	Beverages	Chemicals
Acids / bases	–	●	●
Alcohols	–	●	●
Custom quantities	●	●	●
Density	●	●	●
Density expert	●	●	●
Diet	–	●	–
Extract / sugar	–	●	●[a]
Inorganic salts	–	–	●
Measurement	●	●	●
Other quantities	–	–	●
Sound velocity	●	●	●
Special adjustment	●	●	●
System monitoring	●	●	●
Temperature	●	●	●
Viscosity	●	●	●

[a] *No sugar inversion quantities included*

5.2 Language and regional settings

– Select *Settings* in the menu, then under *System* select *Time & language*.

First of all you will want to set the system **language** so that you feel comfortable on the instrument:

– Set *Language* to a language that you prefer.

On the occasion set the number format (decimal symbols etc.) and the date and time **formats**:

– Select *Format* according to your requirements.

Finally select the **keyboard layout** for the onscreen keyboard and the **keymap** for an optional USB keyboard:

– Set *Keyboard layout* and *HW keyboard keymap* appropriately.

5.3 Time settings

Set the system time correctly so that the time stamps of measurements and system events are correct and traceable:

1. Select *Settings* in the menu, then under *System* select *Time & language*.
2. Set *Region* and *City* to your time zone.

   Daylight saving time will be calculated automatically.

TIP: *The date and time formats are defined with the Format setting (refer to Section 5.2 [▶ 16]).*

*To set date and time **manually**:*

– Set *Date* to the current date.

– Set *Time* to the current time.

*Alternatively, set date and time via **time server**:*

1. Configure a network connection first.
2. Switch *Use time server* to *Yes*.

   The *Time servers* input field replaces the input fields *Date* and *Time*.
3. The *Time servers* setting depends on your network settings.
   – If you have set up an **automatic** network configuration, you can leave the *Time servers* input field empty.
   – If you have set up a **manual** network configuration, or if you want to specify a time server anyway:
   Specify the address(es) of your time server(s) in the *Time servers* input field.
   Put each time server in a new line. Do not separate addresses by commas or semicolons etc.
4. It depends on your time server when the system time will be synchronized. It may also be necessary to restart the instrument.

5.4 Display brightness

1. Select *Settings* in the menu, then under *Hardware* select *Instrument settings*.
2. To set the *Display brightness*, drag the slider to a convenient position.

5.5 Status light brightness

1. Select *Settings* in the menu, then under *Hardware* select *Instrument settings*.
2. To set the *Status light brightness*, drag the slider to a convenient position.

   Set the slider to 0 to deactivate the status light.

5.6 Camera settings

To set the properties of the camera image, select *Settings* in the menu, then under *Hardware* select *Camera*.

– Use the arrow buttons to browse through the camera settings.

– Tap to align the camera image with the density measuring cell:

   a. Drag the red frame representing the camera view and position it over the measuring cell.

   b. Tap ✔ to confirm the position.

5.7 Cell illumination

Illumination of the density measuring cell can be deactivated. This may be necessary if exposure to the particular light spectrum could lead to an undesirable change of sample properties.

1. Select *Settings* in the menu, then under *Hardware* select *Instrument settings*.
2. Switch *Cell illumination active* to *No* if you want to deactivate cell illumination.

   When you deactivate cell illumination, U-View™ is not available anymore. The camera image will not be included in reports.

   To suppress reflections of IR light (required for the measurement) in U-View™, lower the brightness in the camera settings (Section 5.6 [▶ 16]).
3. For light-sensitive samples, also consider deactivating the status light (Section 5.5 [▶ 16]).

5.8 Silent mode

The noise of the idle instrument can be greatly reduced by activating silent mode:

1. Select *Settings* in the menu, then under *Hardware* select *Instrument settings*.
2. Switch *Silent mode* to *Yes*.

   In silent mode, the instrument will reduce the amplitude of the oscillators when it has been idle for 20 minutes.

5.9 Speaker volume

You can set the volume of the sound signaling the end of a measurement:

1. Select *Settings* in the menu, then under *Hardware* select *Instrument settings*.
2. Set the volume with the slider *Speaker volume*.

   To silence the speaker, set the volume to 0.

5.10 Global units

Global units will be used as default units on the instrument:

1. Select *Settings* in the menu, then under *System* select *Global units*.
2. Set the global units that you prefer.

5.11 Automatic sample names

You can set the instrument so that it generates pattern-based automatic sample names.

1. Activate the function:
   a. Select *Settings* in the menu, then under *System* select *Sample naming*.
   b. Switch *Use automatic sample naming* to *Yes*.
2. After the function has been activated, define a pattern for the automatic sample names:
   – Tap *Configure*.

     The current elements of the name pattern are shown in an ordered list on the right, which shows their position in the pattern.
3. Assemble the name elements of the pattern:
   – To add a name element, select it from the list of available elements in the area on the left (tap ✚).
   – Tap on any of the elements in the name pattern on the right to select it. You can then change its position in the pattern or remove it from the pattern.
   – Tap on a selected element in the name pattern again to deselect it.
   – You can arrange name elements in any order and you can repeat elements in the pattern (for example a separator).
   – Special name elements:

     Separator is the character "_", which can be used to separate name elements.

     User input will be replaced with the sample name that you specify when you start a measurement.

     Text inserts a text string into the name. To define the text string, select the particular name element in the name pattern, then enter the text string in the input field *Text*.
4. Tap *Save* to save the name pattern.

5.12 Automatic printout or export of result reports

You can configure the instrument so that after a measurement, check, or adjustment, result reports are automatically printed or exported onto an external storage device in addition to the internal data memory (for example to process them in a LIMS).

1. Select *Settings* in the menu, then under *Reports* select *Automatic printout* or *Automatic export*.
2. Configure the automatic transfer:
   – *Automatic printout:*

     Set the switch to *Yes* for any data type to activate the function for the corresponding data.

     After you have activated the function, you can select a printer and configure the format of the printout.
   – *Automatic export:*

     Set the switch to *activated* for any data type to activate the function for the corresponding data.

     After you have activated the function, you can select and configure a file format, specify a location where the exported data shall be stored, and specify whether the measurement or check data shall be automatically removed from the instrument after export.

TIP: *Before you can use a network share, you have to register it on the instrument.*

IMPORTANT: *Adjustments of measuring modules are currently not included in the automatic printout and export.*

6 Measurement settings – products

TIP: *Make sure that you have selected an industry profile that suits your applications.*

6.1 Products

You can individually define the measurement settings for each of your products or sample varieties and save them for repeated use:

1. Select *Products* in the menu.
2. Tap *Create product*.
3. Specify a name and a description for the product.
4. Define measurement settings (refer to Section 6.2 [▶ 18]) and optionally configure limits.

   For **diet products** (see below), set the switch *Diet concentration measurement* to *Yes*.
5. Tap to select an image for the representation of the product.
6. Tap *Save* to save the collection of measurement settings for the product.

TIP: *The instrument comes with several predefined product settings, which you can use as a template.*

Diet products

Diet concentration measurements can only be performed with diet products and only after diet adjustments have been performed with the diet product.

The diet adjustments are stored with the diet product.

Measurements with diet products have to be performed with the highest possible accuracy. Therefore, some settings are fixed for diet products (the measurement performance in particular).

– Create a diet product for every diet beverage / package type combination for which you intend to perform diet measurements.

6.1.1 Importing/exporting products

You can define the measurement settings for a product on one instrument and transfer the product settings to another instrument of the same type.

Export of products

1. Select *Data explorer* in the menu, then tap on *Products*.
2. Tap *Select* in the action box, then select the product settings that you want to export.
3. Tap in the action control for the selection and specify where the export file shall be stored.

IMPORTANT: *Diet adjustments, measurement modes, and auto air check definitions are currently not included in the export.*

Import of products

1. Select *Products* in the menu.
2. Tap *Import products*, then select a file with the product settings that you have exported before.

   You can select which products to import from the file.
3. Tap *Import* to import the selected products.

   The instrument will restart.

6.2 Measurement settings

Measurement settings comprise the measurement parameters (Section 6.3 [▶ 19]), the assignment of a dashboard, and a report configuration for the results.

– For measurements without predefined product, assign dashboard and report configuration under *Setup* on the *Measurement* spot.

  It is not possible to perform diet concentration measurements from the *Measurement* spot.

6.2.1 Dashboards / measuring quantities

Dashboards serve to monitor your measurements.

The instrument already comes with dashboards predefined for various generic products. You can adapt them to your needs or define new dashboards according to your requirements.

You can place the following widgets onto a dashboard of the instrument:

– the live camera image of the density measuring cell (U-View™)

– measurement information (giving information about the current status of the measurement)

– display boxes for any measuring quantity

  (Select *Quantities* in the menu for a complete reference of available quantities. Tap on any of the quantities to see a comprehensive description.)

6.2.2 Reports

Measurement results are presented as reports, which you can access in the data explorer.

TIP: *The report configuration can also be changed after the measurement. It is independent of the dashboard configuration.*

6.2.3 User-defined measurement information

If you want to record additional specific information with every sample or product measurement, you can activate custom data fields. These data fields will show as input fields before you start a sample measurement. The text that you enter in a field can be included in the measurement report.

You find all activated custom data fields in the data group *Measurement*.

Defining custom data fields

1. Select *Settings* in the menu, then under *System* select *Custom data fields*.
2. Activate any of the available custom data fields with the corresponding switch.
3. Define a name for the custom data field.

   This name will identify the custom data field and serve as a label.
4. Optionally declare the custom data field as mandatory with the corresponding switch.

   If a custom data field is mandatory, you cannot start a measurement before you have entered text in the input field.

6.3 Measurement parameters

Refer to the Reference Guide for a comprehensive description of all measurement parameters.

6.3.1 Measurement mode

(Cannot be changed for diet products)

– Select *Standard* for a standard single measurement of the filled sample.

Refer to the Reference Guide for a comprehensive description of all measurement modes.

6.3.2 Set temperature

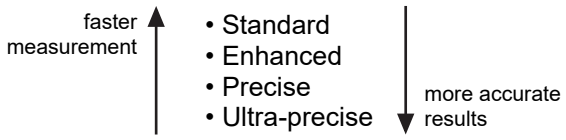
(Cannot be changed for diet products)

Set the measuring temperature here.

TIP: *Mind that some measuring quantities may be only valid at a specific temperature.*

6.3.3 Measurement performance

Select a measurement performance class for the measurement:



TIP: *For diet products, the measurement performance class Ultra-precise cannot be changed because the highest accuracy is required for diet measurements.*

The density value of measurements with measurement performance classes *Standard* and *Enhanced* is a value pre-calculated to the set temperature, even if the cell temperature is not stable.

TIP: *We recommend to add the quantity T (set) to the report configuration when you use measurement performance classes Standard or Enhanced.*

6.3.4 Check density and sound velocity stability

(Only available for the highest measurement performance class)

Yes	The measurement result is determined when the temperature value as well as the density or sound velocity values are stable within a defined deviation range.
No	The measurement result is determined when the temperature value is stable.

Generally, temperature stability is reached faster than density stability.

TIP: *Yes is the recommended standard setting for most precise measurements. Select No if the characteristics of your sample prevent achieving stability (inhomogeneous or unstable samples).*

IMPORTANT: *With diet products, density stability is always checked.*

6.3.5 Hold time

The instrument will wait this time span after all specified stability conditions are met, and then determines the measurement result. This gives the sample time for temperature conditioning.

6.3.6 Timeout

If a stable measurement result cannot be achieved, the instrument will abort the measurement process after the specified timeout (for example 10 minutes).

The time span begins when minimum temperature stability has been reached.

TIP: *A timeout may be caused by a filling error: In this case repeat the measurement. Or your sample is inhomogeneous or unstable: In this case deactivate checking for density stability.*

6.3.7 FillingCheck™

Yes	FillingCheck™ is active.
No	FillingCheck™ is deactivated.

FillingCheck™ is an automatic bubble detection based on an advanced analysis of the U-tube's oscillation pattern.

If applicable, a filling warning will be shown in the measurement information widget on the dashboard.

TIP: *Additionally check the filling visually by means of the built-in live camera (U-View™).*

TIP: *Yes is the standard setting. Select No if the detection of filling errors by FillingCheck™ obviously contradicts what you see in the live camera image.*

TIP: *FillingCheck™ provides excellent support to the operator for samples of low and medium viscosity ranges.*

The sensitivity of this feature depends on a combination of density, viscosity, and temperature, and is not constant. For example, certain samples with high density (approx. 1.5 g/cm³) and medium viscosity (approx. 550 mPa·s) might generate a filling warning also for correctly filled samples. In all such cases, changing the measuring temperature may influence this combination so that FillingCheck™ continues working as expected.

Some samples may generate a filling warning even when filled without bubbles, for example highly viscous samples or samples containing inhomogeneities. In these cases, we recommend to disable FillingCheck™ and perform repeated measurements to validate the quality of filling.

6.3.8 Diet product concentration measurement settings

(Only available for industry profile Beverages)

Diet concentration measurement

Yes	The product is used for diet concentration measurements. Process water and concentration adjustments are necessary before any measurement.
No	The product cannot be used for diet concentration measurements.

IMPORTANT: *If you set Diet concentration measurement to Yes, product settings are changed automatically to meet the performance requirements. The previous settings are irrecoverably lost.*

Blending ratio

Enter the blending ratio of the final beverage product. (*Example:* If the product sample consists of 1 part syrup and 6 parts water, the blending ratio is 1:6. Therefore, enter 6 in the input field.)

The blending ratio is relevant for every new process water adjustment, which affects the concentration of the sample. Therefore, the blending ratio is automatically taken account of when the concentration is recalculated.

Unit

Select the “unit” for the diet concentration measurement. If you change it, new diet adjustments are required for the particular diet product.

6.3.9 Other measurement parameters

Other measurement parameters may be available with installed options. For details refer to the respective manual of the option.

Refer also to the Reference Guide.

7 Performing a measurement

Table 6: Steps of a typical measurement cycle

		Step	refer to
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 3.1 [▶ 9] and below
B		Perform a **water check** to verify the instrument’s accuracy before you start your daily routine measurements. After the check, dry the measuring cell.	Section 8.1 [▶ 27]
C	1	Choose a way to start your measurement: Use pre-defined **product settings** or define the **measurement settings** on the fly.	Section 7.1 [▶ 21] Section 6 [▶ 18]
	2	**Prepare** your **sample** if required.	Section 7.2 [▶ 22]
	3	**Fill** the **sample**.	Section 7.3 [▶ 22]
	4	**Start** the **measurement**.	Section 7.4 [▶ 24]
	5	**Clean and dry** the measuring cell.	Section 9.1 [▶ 30] Section 9.2 [▶ 31]
D		Perform an **air check** to verify the efficiency of your cleaning and drying procedure after you have finished your daily routine measurements and the measuring cell has been cleaned and dried.	Section 8.1 [▶ 27]

Refer to Section 8.2 [▶ 28] for recommendations when to perform an adjustment before a measurement.

WARNING

Risk of fire and injuries

In the very rare case of a malfunction of the temperature control, the measuring cell could heat up to 120 °C (248 °F), potentially causing liquids to spurt out.

- Ensure that the waste vessel is properly installed.
- Have a widget on the dashboard 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, for example under a fume hood, and ensure that the location is sufficiently ventilated.
- Measure only samples with an ignition point over 120 °C (248 °F).
- Wear protective clothing and safety goggles.

Preparatory steps

Before you start a measurement, check that:

- the measuring cells are clean and dry
- hoses are connected correctly
- hose connections are tight
- the waste hose leads into the waste container
- the volume of the waste container is large enough for the number of samples
- suitable cleaning liquids are at hand

To speed up measurements

- Use automatic sample names (Section 5.11 [▸ 17]).
- Set the measuring temperature on the instrument in advance using the header control.
- Bring the sample to measuring temperature in advance.
- **Not for diet products:** Select a faster measurement performance class and set measurement parameters so that the time for temperature conditioning of the sample becomes shorter (Section 6.3 [▸ 19]).

  Consider, however, that your measurement results will become less accurate by proceeding so.

7.1 Starting a measurement

Product measurements

For routine measurements, define your measurement settings as a product. You can add your routine product measurements to the home screen as favorites in order to start measurements directly from there.

- **Setting a product measurement as favorite**
  a. Select *Products* in the menu, then open the specific product.
  b. Verify that the product settings are correct, then tap *Create measurement*.
  c. Add the spot with the measurement setup as favorite (tap ☆).
  From here you can start a measurement by tapping *MEASURE*.
- **Starting a product measurement from the home screen**

  The favorite on the home screen combines two links.
  - Tap *Measure* ❯ on the favorite to directly start a quick or routine product measurement that requires no sample details.

    If you have activated a mandatory sample name or mandatory custom data fields, you will not be able to start a measurement directly. Tap on the product name instead.
  - Tap on the product name to start a measurement from the measurement setup.

    There you can add a sample name or verify the product settings (tap *Details…*).

    A measurement with a **diet product** requires previous diet adjustments of the diet product, which can be performed at this point. Refer to Section 8.2.2 [▸ 28] for detailed information on diet adjustments.

    To start a measurement, tap *MEASURE*.

Measurements without predefined product

(Not possible for diet measurements)

You can also perform a measurement without predefined product and define all measurement settings on the fly:

1. Select *Measurement* in the menu.
2. Define the measurement settings.
3. To start a measurement, tap *MEASURE*.

Additional measurement information on the measurement setup

- *Sample name*:

  The name entered here may be included in the pattern of an automatic sample name as *User input* (Section 5.11 [▸ 17]).

  Sample names can be declared as **mandatory**:

  - Select *Settings* in the menu, then under *System* select *Custom data fields*.
  - Switch *Sample name mandatory* to *Yes*.

    In this case, you cannot start a measurement before you have entered a sample name.
- *Custom data fields* (if defined, refer to Section 6.2.3 [▶ 18]):

  Text entered in a custom data field will be included in the measurement report.

7.2 Degassing samples

There are various methods to degas liquid samples. The preferable method for your application depends on the kind of sample and the amount of gas that is dissolved in the sample. Pay attention to always treat all samples the same way in order to get reproducible measuring results.

IMPORTANT: *Be aware of the fact that the composition of some samples may slightly change during the pretreatment due to the evaporation of volatile components.*

TIP: *Degassing efficiency also depends on the sample's temperature. Pre-condition cold samples to the measurement temperature before you begin the degassing procedure.*

Boiling the sample

WARNING

Health risk with toxic components

Samples containing toxic volatile components can cause irritation and serious injuries to your eyes, skin, and mucous membranes as well as toxication.

- If your sample contains volatile components that are toxic, always handle it in an appropriate environment like under a fume hood, particularly when you boil your sample.

WARNING

Risk of fire and burns with flammable liquids

When you boil flammable liquids, there is a risk of fire. Serious injuries are possible.

- Do not boil flammable liquids.

1. Boil the liquid for several minutes to remove dissolved gas.
2. Fill the boiled liquid into a clean glass flask and cover it.
3. Wait until the liquid has cooled down approximately to measuring temperature.

Stirring the sample

Stir your sample vigorously for 5 to 15 minutes (depending on the stirring equipment) until bubbling ceases.

You can pour the sample through a paper filter after stirring to degas it even more efficiently.

Using an ultrasonic bath

Put your sample for approx. 5 to 10 minutes into an ultrasonic bath until bubbling ceases.

7.3 Filling sample

WARNING

Rupture of adapters or hoses due to high temperature and high pressure

At high sample temperatures in combination with high pressure adapters or hoses may break. Liquids leaking or spurting out and flying particles may cause injuries.

- At measuring temperatures of 50 °C (122 °F) and higher the applied pressure must be limited to 5 bar (72.5 psi) absolute pressure.

WARNING

Dangerous liquids leaking due to unsuited components in a pressurized system

Unsuited components can cause rupture of hoses and connections coming loose when pressure is applied to the measurement system. Dangerous liquids spurting out or leaking may cause injuries or risk of fire.

- In pressurized measurement systems:
  Do not use the supplied hoses and injection adapters for filling. Exchange them with pressure-resistant components.
  Use only the injection adapters density pressure (mat. no. 159537) and sound pressure (mat. no. 159578) with polyurethane hoses 2x4 (mat. no. 135259).
- Do not exceed the maximal operating pressure of any single component.
- Before you start a measurement using high pressure, check the pressure tightness of the system with air.

WARNING

Risk of injuries and fire by liquids leaking

Filling samples and cleaning liquids that the wetted parts are not resistant to will corrode the wetted parts. Sample leaking from corroded parts may cause serious injuries.
Before you fill any sample or cleaning liquid, in particular hazardous or flammable chemicals, into the instrument:

- Strictly follow all safety instructions concerning the use of chemicals (in particular sulfuric acid and oleum) and the use of flammable chemicals (refer to Section 1 [▶ 5]).
- Make sure that all wetted parts are resistant to the filled-in liquid. Consider also the wetted parts of installed options.
- The chemical resistance depends on the temperature and concentration of the liquid. Do not exceed the maximal temperature of 40 °C (104 °F) when you measure sulfuric acid or oleum.
- Make sure that you have suitable cleaning liquids at hand for cleaning the measuring cells.

NOTICE

Corrosive samples require special care

Samples with a moderate tendency to corrode borosilicate glass, such as strong alkali solutions (for example caustic soda), can be measured with the instrument. However:

- Remove corrosive samples immediately after measurement and rinse the measuring cell thoroughly.
- Check the validity of the adjustment more frequently than generally recommended. Perform a new adjustment if necessary.
- The measuring temperature for strong alkali solutions should not be higher than 20 °C (68 °F). Higher temperatures dramatically increase the speed of corrosion.

To achieve highly accurate measuring results, fill the sample into the measuring cell steadily and without bubbles.

TIP: *Sample containing dissolved CO_2 will cause bubbles in the measuring cell, which render the measurement results invalid. Degas your sample carefully as described in Section 7.2 [▶ 22].*

If you measure samples at temperatures that are significantly **higher than ambient temperature**, the tendency to form gas bubbles in the measuring cell will dramatically increase. To ensure precise results, degas your sample directly before measuring as described in Degassing samples, or treat it in the following way:

- Heat the sample up to a temperature significantly higher than the measuring temperature. Stir it during heating.

IMPORTANT: *For high accuracy measurements, be sure to apply exactly the same filling procedure for checks, adjustments, and measurements.*

Sample amount

WARNING

If you measure any aggressive, poisonous, or flammable sample at high pressure, use only the smallest possible sample amount.

If the measuring cells are clean and dry, you need approx. 3.5 mL of sample.

If you measure without cleaning and drying between samples, you will need a higher amount of sample because you have to flush residues of the previous sample out of the measuring cell to avoid cross-contamination.

Bubble detection – FillingCheck™ and U-View™ (live camera image)

FillingCheck™ helps you detect bubbles during filling. Activate the function in the measurement settings.

Additionally, check the filling visually by means of the built-in live camera (**U-View™**):

- Place the camera widget on the dashboard assigned to your measurement.
- Watch the live camera image on the dashboard during filling:
  - Tap on the image to open the camera screen.
  - Tap to zoom in, tap to zoom back out.
  - You can drag the zoomed image left or right to examine all parts of the measuring cell.
  - Tap ✔ to close the camera screen.

The camera image will be saved with the measurement results (unless deactivated with cell illumination).

7.3.1 Filling with a syringe (Luer tip)

WARNING

Risk of injuries by dangerous liquids leaking or spurting out

If you push the plunger of the syringe too hard, or if, for example, the measuring cell breaks, dangerous liquids may leak or spurt out of ruptures causing injuries.

- Wear safety goggles and protective gloves when you fill dangerous liquids.

IMPORTANT: *Do not use syringes that contain lubricants. The lubricants can dissolve into your sample and lead to a systematic measuring error.*

7.3.1.1 Standard measurements

Filling position

Refer to Fig. 7 [▶ 12].

– To achieve best measurement results, fill with the syringe attached to the adapter Luer ¼" UNF on U-Dry (2).

  This is the standard filling position.

– *Only in the case that the available amount of sample is very limited:*
  – Take an adapter Luer ¼" UNF, mat. no. 64792, from the accessory kit and screw it into the sample inlet adapter (4) instead of the inlet hose (3).
  – Fill through this adapter using a 5 mL syringe.

To fill with a syringe (Luer tip)

1. Connect the syringe (filled with sample) to the adapter Luer ¼" UNF on U-Dry (or mounted directly on the sample inlet adapter).
2. Push the plunger of the syringe slowly and steadily until a drop emerges from the sample outlet adapter.
3. Leave the syringe in the filling position during the measurement.

TIP: *For high accuracy measurements, inject the entire sample volume.*

7.3.1.2 Measurements of aggressive samples – glass syringe (Luer tip)

(Filling, for example, sulfuric acid, oleum, acetic acid >40 %)

Mount Viton hoses (refer to Section 3.5.3 [▶ 13]) and connect the glass syringe to the free end of the Viton filling hose.

NOTICE

– It cannot be avoided that sample drops emerge from the measuring cell when filling with a syringe.
  Put an acid-proof catch basin underneath the filling equipment.
– Inserting the glass tip of the syringe directly into a filling adapter, may result in the fracture of the tip.
  Always use a Viton hose to connect the glass syringe to the inlet adapter as shown in Section 3.5.3 [▶ 13].

7.3.2 Filling automatically with an Xsample

Refer to the documentation of the Xsample for instructions on its installation and use.

7.3.3 Special filling techniques

Refer to the Reference Guide for a discussion of special filling techniques concerning the following kinds of samples:

– bubbling samples
– suspensions and emulsions
– highly viscous samples
– pastes

7.4 Actual measurement procedure

– When you have verified that all measurement settings are correct, and the sample has been filled, tap *MEASURE*.

  The measurement will be performed according to your settings. The progress bar shows the progress of the measurement.

  If the last digits of the density value are grayed out, this means that the set measurement performance is not yet fully met.

  When the measurement is finished, the results are displayed.

  The results together with the camera image (unless deactivated with cell illumination) and a time stamp are automatically saved in the data memory.

  Saved data can be accessed in the data explorer.

– Tap
  – *DONE* to close the results and finish or
  – *REMEASURE* to perform another measurement with the same settings.

7.5 Measuring at low temperatures / under high humidity conditions

If the ambient air is humid, and the measuring temperature is lower than the ambient temperature, condensation may occur inside the measuring cell and in the measuring cell block.

Condensation inside the density measuring cell causes adjustment and measurement errors. Condensation in the measuring cell block damages the electronics and may lead to a failure of the U-view™ function.

The higher the difference between the set measuring temperature and ambient temperature, and the higher the air humidity, the easier condensation occurs. The instrument's condition monitoring will show a warning if the temperature lies below the dew point.

7.5.1 Condensation inside the measuring cell

If U-View™ shows condensed water inside the measuring cell, install a drying cartridge to dry the air from the air pump outlet. When you use the internal air pump for drying the measuring cell, its air will then be dry.

A drying cartridge must be used for a measuring temperature of 20 °C under the following ambient conditions:

Ambient temperature	Relative air humidity
20 °C (68 °F)	>70 %
25 °C (77 °F)	>50 %
30 °C (86 °F)	>38 %

To remove condensation inside the measuring cell

1. Install a drying cartridge, mat. no. 65085 (Section 7.5.2 [▶ 25]).
2. Dry the measuring cell with the internal air pump as usual until you can't see condensed water anymore in U-View™ (Cleaning and drying the measuring cell).

7.5.2 The optional drying cartridge

The drying cartridge, mat. no. 65085, can be used to dry the air from the air pump outlet.

Installing the drying cartridge

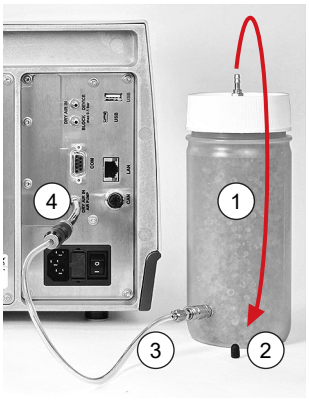


Fig. 10: *Drying cartridge installed*

1 Drying cartridge
2 Remove cap from inlet of drying cartridge
3 Transparent polyurethane hose
4 Black hose, connected to air pump inlet connector

1. Push the fitting on the thin, transparent polyurethane hose (coming with the drying cartridge) into the outlet connector at the bottom of the drying cartridge (3).
2. Push the open end of the transparent hose into the connector on the thicker, black hose (coming with the drying cartridge).
3. Connect the open end of the black hose to the air pump inlet connector "DRY AIR IN / AIR PUMP" at the rear of the instrument (4).
4. Remove the cap from the barbed fitting (inlet) on top of the drying cartridge (2).

NOTICE

- Never connect hoses containing liquids or moist gases to the air pump inlet connector "DRY AIR IN / AIR PUMP" as this may lead to condensation in the density measuring cell and subsequently to measurement and adjustment errors.
- Operate the air pump inlet only at ambient pressure.

To regenerate moist silica gel

The drying cartridge contains silica gel, a non-toxic drying agent. When active, the color of the drying agent is orange. Silica gel having absorbed liquid turns green.

Moist silica gel can be regenerated:

Pour the silica gel into a glass bowl and put it in a laboratory oven for a few hours (or overnight) until its color is orange again.

NOTICE

Do not use drying temperatures over 130 °C (266 °F). Otherwise the indicator function of the silica gel will be spoiled.

7.5.3 Preventing and removing condensation

If the measuring temperature is more than 5 °C (9 °F) lower than the ambient temperature, a dry air supply for the measuring cell and the measuring cell block must be used in addition to the drying cartridge.

The following specifications of the applied air are required:

- **0.03 bar** (0.435 psi) relative pressure
- max. volumetric flow rate: 80 L/h
- class 5 according to ISO 8573-1
- max. particle size: 40 µm
- max. pressure dew point: 10 °C below measuring temperature
- max. oil content: 25 mg/m³

Measuring cell block and camera

To prevent or remove condensation in the measuring cell block and on the camera:

1. Connect a dry air supply to the "DRY AIR IN / BLOCK" connector. Use a 3x5 mm hose made of suitable material, for example silicone.
2. Continuously flush the measuring cell block with dry air.

Interior of the housing

To prevent or remove condensation in the housing:

1. Connect a dry air supply to the "DRY AIR IN / DEVICE" connector. Use a 3x5 mm hose made of suitable material, for example silicone.
2. Continuously flush the housing's interior with dry air.

NOTICE

Never connect hoses containing liquids or moist gases to the “DRY AIR IN / BLOCK” or “DRY AIR IN / DEVICE” connectors as this may lead to damage of the electronics.

7.6 Measuring sulfuric acid or oleum

WARNING

Sulfuric acid (H_2SO_4) and oleum (fuming sulfuric acid) are highly caustic substances, which may cause irritations and serious injuries to skin, eyes, and mucous membranes

Observe all safety instructions in Section 1 [▸ 5], in particular section “Precautions when measuring sulfuric acid or oleum”.

NOTICE

Oleum samples with 28 to 58 % w/w of free SO_3 may freeze inside components of the measurement system (hoses, sample containers, etc.) at temperatures below 35 °C (95 °F).

– Keep components of the measurement system containing sample at a temperature higher than 35 °C (95 °F) to prevent freezing of the sample.

IMPORTANT: *Observe all hints and warnings in this document concerning the measurement and handling of aggressive samples.*

TIP: *The industry profile Chemicals provides predefined products specific for the measurement of sulfuric acid and oleum.*

The instrument is designed to measure the concentration of pure sulfuric acid and oleum (fuming sulfuric acid) in the ranges of 0 to 100 % w/w H_2SO_4 and 0 to 65 % w/w SO_3.

– Use a measurement setup as described in Section 3.5.3 [▸ 13] with a glass syringe and Viton hoses or use a suitable peristaltic pump for filling.

TIP: *If you measure a series of samples of very similar concentrations, you can displace the previous sample by the new sample. Minimal amount of new sample: approx. 10 mL when filling by syringe.*

– You can use the predefined products *Sulfuric acid & oleum@ 20 °C* and *Sulfuric acid & oleum@ 40 °C*, depending on the concentration of free SO_3 in the sample.

  If the concentration of free SO_3 in all your samples is ≤27 % w/w, then a measuring temperature of 20 °C should be selected. All samples are liquid at this temperature.

  If you regularly have to measure samples with concentrations of free SO_3 >27 % w/w, then a measuring temperature of 40 °C has to be selected. This switches the instrument to full range evaluation (from 0 % w/w H_2SO_4 to 65 % w/w SO_3).

TIP: *Note that measurements at 20 °C take considerably less time than measurements at 40 °C.*

Calculation method

The concentration of sulfuric acid in % w/w is calculated using a function of the density or the sound velocity, depending on the concentration range.

The following table shows for the measuring temperatures 20 °C and 40 °C, in which concentration ranges the density or sound velocity is used for the calculation.

Temperature	Density	Sound velocity
20 °C	0–87 % H_2SO_4 0–27 % free SO_3	87–100 % H_2SO_4
40 °C	0–90 % H_2SO_4 0–47 % free SO_3	90–100 % H_2SO_4 47–65 % free SO_3

The density and sound velocity graphs of sulfuric acid and oleum for the whole concentration range at a measuring temperature of 40 °C are shown in Fig. 11 [▸ 27].

The concentration (% w/w) of free SO_3 is calculated from the concentration of sulfuric acid according to:

$$c_{SO_3} = \frac{mw_{SO_3} \cdot \left(c_{H_2SO_4} - 100\right)}{mw_{H_2O}}$$

$$c_{SO_3} \approx 4.444 \cdot \left(c_{H_2SO_4} - 100\right)$$

c *concentration [% w/w] (SO_3: free SO_3 / H_2SO_4: sulfuric acid)*

mw *molecular weight*

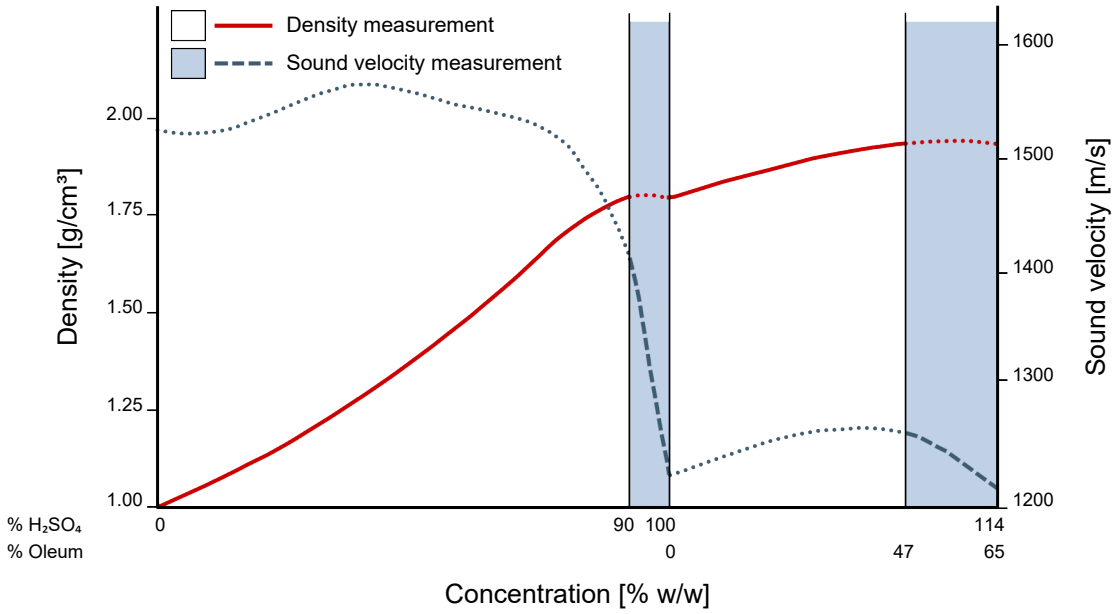


Fig. 11: *Density and sound velocity of sulfuric acid and oleum at 40 °C*

8 Checking, adjusting and calibrating

8.1 Checks

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

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

TIP: *The instrument takes automatically account of the set temperature and, with air checks, the measured air pressure.*

– Use **water checks** or **custom checks** to verify that the instrument is measuring with satisfactory accuracy.

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

  Perform additional water checks or custom checks as required and at your own discretion, for example when you get unexpected results.

– 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 cells have been cleaned and dried.

  Perform additional air checks as required and at your own discretion, for example after the measurement of critical samples that might stick to the measuring cells (e.g., samples containing adhesives, sticky particles, proteins).

TIP: *An air check does not give you any information about the accuracy of sound velocity measurements as the sound velocity of air is not within the instrument's specifications.*

8.1.1 Performing a check

1. Select *Checks* in the menu, then select one of the available checks.
2. Observe all hints on the screen and fill the check medium.
   – For a water check, use freshly degassed ultrapure water.
   – For an air check, clean and dry the measuring cell thoroughly.

   Use the camera image to check that the density measuring cell is clean or that the check medium has been filled bubble-free.
3. Tap *START CHECK*.
4. The summary of the check will show the check results and a recommendation if the check has failed and an adjustment is necessary.

   All results are also saved in the data memory.
5. Tap *DONE* to close the summary.

IMPORTANT: *We advise you to follow the recommendations.*

If the water check has failed

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

– Examine the camera image included in the results to check that the water has been filled bubble-free.
– Check the quality of the water.
– Clean the measuring cell thoroughly.

– If above actions do not help, perform an air/water density adjustment.

8.1.2 Diet concentration check

From time to time (for example at the beginning of a new batch), verify the validity of the slope of the diet adjustment: Perform a diet concentration check using your lab reference method for comparison.

1. Take two fresh samples from the production line.
2. Analyze one sample with the lab reference method.
3. With the other sample, start a product measurement on the instrument (select the product that you want to check).
4. Compare the *Diet concentration* result of the finished measurement with the result of the lab reference analysis.
   – If the results differ by less than acceptable limits (defined by you), you can go on with your regular diet measurements.
   – If the results differ by more, perform a new diet concentration adjustment (refer to Section 8.2.2 [▶ 28]). Use the option *last saved measurement* for an immediate adjustment without new filling and measurement.

TIP: *The option "last saved measurement" is not available if you combine the diet concentration adjustment with a process water adjustment.*

8.2 Adjustments

Refer to the Reference Guide for comprehensive information on all available adjustments and how to reset the instrument to factory adjustment.

IMPORTANT: ***Atmospheric pressure for adjustments***

The atmospheric pressure that you get from a local weather station is usually not the absolute atmospheric pressure, but a calculated atmospheric pressure value referenced to sea level.

TIP: ***Density adjustments for measurements in a pressurized system***

– *To achieve maximal accuracy, perform the water (or reference liquid) adjustment with the same pressure with which you are going to perform the sample measurements.*
– *Perform the air adjustment, as usual, at ambient pressure.*

8.2.1 Air/water density adjustment

Perform an air/water density adjustment if a water check has failed and corrective actions have not helped.

TIP: *The ThermoBalance™ technology allows for precise measurements over the whole temperature range with only one adjustment at 20 °C.*

Duration: 5 to 10 minutes if the instrument is already clean and dry and equilibrated to 20 °C

Adjustment media: dry air and freshly degassed ultra-pure water

1. Select *Adjustments* in the menu, then select *Air/Water* for density.
2. Enter the parameters for the air adjustment and tap *CONTINUE*.
   – The air humidity is set to 50 % per default.
   – The atmospheric pressure displayed is measured automatically by a built-in sensor.
3. Rinse and clean the measuring cell.

TIP: *If you use undenatured ethanol as the final rinsing liquid, only 3 to 4 minutes drying time are required.*

4. Dry the measuring cell.
   Close U-Dry to start the air pump, open U-Dry to stop the air pump.
5. Tap *CONTINUE*.
   The air adjustment routine is carried out.
6. Fill freshly degassed ultra-pure water into the measuring cell.
   Take care to fill the water without air bubbles.
7. Tap *CONTINUE*.
   The water adjustment routine is carried out.
8. The result of the adjustment is shown.
   Check the recommendation on the screen and apply or reject the adjustment.
   All results are also saved in the data memory.

IMPORTANT: *If you measure diet products, perform a diet process water adjustment after every air/water density adjustment.*

8.2.2 Diet adjustments

(Only relevant for diet products)

The diet concentration is calculated from the density difference between the diet beverage and the process water that has been used for its production. In case of a pressurized measurement system, the CO_2-corrected density values are used.

Diet concentration adjustments bind the calculations to reference values which you have determined separately with your reference laboratory method.

The diet adjustments are stored with the diet products (Section 6.1 [▶ 18]).

Process water adjustment

Interval: To compensate changes of the process water and consequential fluctuations of the diet measurement results, perform the process water adjustment at least **daily**.

TIP: *If your process water results tend to show strong variations (>0.75 % Diet), we recommend to perform process water adjustments more often still.*

A process water adjustment is automatically stored with all currently defined diet products. Therefore, you need not perform the process water adjustment for each diet product.

Adjustment medium: process water taken freshly before the adjustment

1. Select *Products* in the menu, then select a diet product.
2. Check the measurement settings (or edit them), then tap *Create measurement*.

   If available, the diet adjustments stored with the product are shown.
3. Tap *Start* to start the adjustment procedure.
4. Select *Process water* and tap *CONTINUE*.
5. Fill process water and tap *CONTINUE*.
6. The result of the adjustment (density of the process water) is shown.

   Check the recommendation on the screen and apply or reject the adjustment.

Diet concentration adjustment

Interval: For each type of diet beverage that has already a diet concentration adjustment, we recommend checking the diet results in regular intervals (for example at the beginning of a new batch): Check with your reference laboratory method and perform a new concentration adjustment only if the result of the check deviates from the result delivered by the instrument more than you will accept. If you constantly get too large deviations, refer to the appendix “Troubleshooting” in the Reference Guide.

If your production process is very stable, the diet concentration adjustment can be valid for a long time. Sometimes, however, it may be necessary to perform concentration adjustments for every new batch due to production-related reasons.

Adjustment medium: freshly produced diet beverage sample of which the diet concentration has been determined separately with your reference laboratory diet measuring method (for example titration).

IMPORTANT: *You will achieve the best measurement results with the instrument in a pressurized measurement system and if the reference samples for the concentration adjustment are finished product packages from the filling line with the same carbonation level as the samples to be measured.*
If manually produced syrup mixtures or degassed samples are used for the adjustment, the accuracy of the measurements will be lower.

1. For final beverages, take two diet drink packages having come consecutively from the filling line.
   – Use one package to measure the diet concentration with your reference laboratory method.
   – Use the second package to perform the diet concentration adjustment.
2. Select *Products* in the menu, then select the specific diet product.
3. Check the measurement settings (or edit them), then tap *Create measurement*.

   If available, the diet adjustments stored with the product are shown.
4. Tap *Start* to start the adjustment procedure.
5. Select *Concentration* and tap *CONTINUE*.
6. If a stored measurement with the product is available, you can choose to perform the adjustment calculation with the *last saved measurement* or to perform a *new filling and measurement* first.

   Tap *CONTINUE*.
7. If your choice has been *New filling and measurement*:
   – Fill the diet sample and tap *CONTINUE*.

   If your choice has been *Last saved measurement*:
   – Tap *CONTINUE*.

   The result of the last measurement with the diet product will be used for the adjustment.
8. Enter the reference value determined with the reference laboratory method.

   Tap *CONTINUE*.
9. The result of the adjustment is shown.

   Check the recommendation on the screen and apply or reject the adjustment.

   If you apply the adjustment, a new diet slope will be calculated using the concentration adjustment value and the last process water value.

8.2.3 Viewing the adjustment history

You can access and manage adjustment reports, like all saved data, in the data explorer:

– Select *Data explorer* in the menu, then select the data category *Adjustments*.

  You will see a list of adjustments performed.

Alternatively, there is a shortcut from the adjustments spot to the data explorer:

– Select *Adjustments* in the menu, then tap below any of the defined adjustments.

  You will see the adjustment history already filtered for the specific adjustment.

9 Upkeep and cleaning

9.1 Cleaning and drying the measuring cells

Employ a regular and effective cleaning routine and store the instrument under the recommended conditions.

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 measure a sample that is not miscible with the previous sample
- before you want to measure using a minimum sample amount
- before you measure a sample that could chemically react with the previous sample
- immediately after you have measured a sample that could solidify or harden in the measuring cell

Cleaning liquids

Employ two cleaning liquids in a row:

- Cleaning liquid 1 dissolves and removes sample residues in the measuring cells. It has to be a good solvent for all sample components.

  Recommended cleaning liquid 1 for aqueous samples / beverages: water
- Cleaning liquid 2 removes cleaning liquid 1 and is easily evaporated by a stream of dry air so that drying of the cells is accelerated. Cleaning liquid 2 has to be a good solvent for cleaning liquid 1.

  Recommended cleaning liquid 2 for aqueous samples / beverages: non-denatured ethanol

Find more recommendations in the appendix of the Reference Guide.

If you are uncertain about a suitable cleaning liquid, perform preliminary tests on a glass plate (for example a microscopic slide):

- Put some drops of sample on the glass surface and try to remove it by rinsing with different liquids.
- Only if the sample can be removed completely by rinsing (**not wiping**) with a suitable cleaning liquid, it should be filled into the density measuring cell.

Cleaning procedure

WARNING

Risk of injuries and fire by liquids leaking

Before you fill any sample or cleaning liquid, in particular hazardous or flammable chemicals, into the instrument:

- Strictly follow all safety instructions concerning the use of chemicals and the use of flammable chemicals (refer to Section 1 [▸ 5]).
- Make sure that all wetted parts are resistant to the filled-in liquid (refer to the appendix). Consider also the wetted parts of installed options.

NOTICE

Risk of damaging the measuring cell

Do not use any mechanical action for cleaning the measuring cell.

IMPORTANT: *Observe all safety instructions for filling sample that are applicable for cleaning liquids.*

For a description of the cleaning and drying procedure with an optional Xsample, refer to the manual of the Xsample.

WARNING

Risk of serious injuries and damage of goods when cleaning after measurements of sulfuric acid or oleum

Cleaning the measuring cell after the measurement of **sulfuric acid** or **oleum** samples requires special precautions.

- For details refer to Section 9.2 [▸ 31].

1. Select *Cleaning* in the menu.
2. Rinse the measuring cell with cleaning liquid 1 (minimum 5 mL).

   If your sample is viscous or contains particles, use more cleaning liquid.
3. Empty the measuring cell (by filling air).
4. Rinse the measuring cell with cleaning liquid 2 (minimum 5 mL).
5. Empty the measuring cell.
6. Continue with the drying procedure.

Drying procedure

IMPORTANT: *Consider to install a drying cartridge if the instrument's condition monitoring shows a warning.*

Fig. 12: *Drying the measuring cells*

1. Close U-Dry – the air pump starts automatically.

   Without U-Dry: Connect the air pump hose with Luer cone directly to the sample inlet adapter. On the *Cleaning* screen, tap ▶ to start the air pump.

2. Wait until the measuring cell is dry (stable density reading).

   The time needed depends on the vapor pressure of your cleaning liquid 2 and the temperature of the measuring cell (ethanol at 20 °C: approx. 5 minutes, acetone at 20 °C: approx. 3 minutes).

3. Open U-Dry – the air pump stops.

   You can also set the air pump to turn off automatically:

   – Tap ⚙ to open the air pump settings.
   – Switch *Turn off when density is stable* or *Turn off after timeout* on/off according to your requirements.
   – Tap *Save*.

   Without U-Dry: Tap ■ to stop the air pump. Disconnect the air pump hose from the sample inlet adapter.

⚠ WARNING

Risk of injuries and fire by liquids leaking

If liquids get into the air pump system, they may destroy the pump diaphragm and leak from the instrument.

– Disconnect the air pump hose before you start filling liquids.

9.2 Cleaning and drying the measuring cells after measurements of sulfuric acid / oleum

⚠ WARNING

Risk of serious injuries due to strong exothermic reactions

Mixing oleum or concentrated sulfuric acid with water or organic solvent will cause a very strong exothermic reaction. An exothermic reaction inside the measuring cells may destroy them.

– Strictly follow all safety instructions concerning the use of sulfuric acid or oleum (refer to Section 1 [▶ 5]).
– Never flush out oleum or concentrated sulfuric acid with water.
– Ensure that samples of strongly differing concentrations do not come into contact with each other.
  Use only 98 % w/w H_2SO_4 to remove oleum, remove 98 % w/w H_2SO_4 only with 70 % w/w H_2SO_4, and remove 70 % w/w H_2SO_4 with 40 % w/w H_2SO_4. Only then water may be used to rinse the measuring cells.
– Always use separate waste containers for sulfuric acid waste and ethanol (or other solvent) waste.
– Always place the waste vessel below the level of the filling adapter to prevent a sample backflow from the waste vessel into the instrument.

NOTICE

– Sample residues on the injection adapters will cause corrosion and inaccurate results.
  Leave the injection adapters mounted during cleaning so that they are cleaned together with the measuring cells.
– If air humidity is high or the ambient temperature is very low, condensation could build up in the measuring cells. When sulfuric acid or oleum is filled, this condensation may cause an exothermic reaction, which may destroy the measuring cells.
  Install a drying cartridge, mat. no. 65085, to completely dry the air from the air pump when drying the measuring cells.

Cleaning and drying procedure using a syringe

WARNING

Risk of serious injuries due to sample leaking from corroded syringes

Syringes made of polypropylene / polyethylene are not resistant to oleum and concentrated sulfuric acid.

– Use only glass syringes with Teflon-sealed plungers for oleum and for H_2SO_4 with concentrations higher than 95 % w/w.

Refer to Fig. 9 [▸ 13].

1. Fill the syringe with sulfuric acid of the proper concentration:
   – 98 % w/w H_2SO_4 to remove oleum
   – 70 % w/w H_2SO_4 to remove 98 % w/w H_2SO_4
   – 40 % w/w H_2SO_4 to remove 70 % w/w H_2SO_4
2. Connect the syringe to the Viton filling hose and slowly inject the liquid into the measuring cells.

   Leave the syringe connected to the filling hose.
3. Remove the liquid from the measuring cells by slowly pulling back the plunger of the syringe.
4. Disconnect the syringe and drain its contents into the sulfuric acid waste container.
5. Repeat steps 1 to 4 with sulfuric acid of decreasing concentrations until it is safe to rinse with water (concentration of H_2SO_4 ≤40 % w/w).
6. Rinse with at least 30 mL of ultra-pure water by the same method as above (steps 1 to 4).
7. Exchange the sulfuric acid waste container with an ethanol waste container.
8. Rinse with at least 20 mL of 96 % ethanol.
9. Connect the air pump hose with the adapter Luer cone to the Viton filling hose.
10. Select *Cleaning* in the menu.
11. On the *Cleaning* screen, tap ▶ to start the air pump.
12. Wait until the measuring cells are dry (stable density reading).

    The time needed depends on the vapor pressure of your cleaning liquid 2 and the temperature of the measuring cells (ethanol at 20 °C: approx. 5 minutes, acetone at 20 °C: approx. 3 minutes).
13. Tap *STOP* ■ to stop the air pump.

    You can also set the air pump to turn off automatically:
    – Tap ⚙ to open the air pump settings.
    – Switch *Turn off when density is stable* or *Turn off after timeout* on/off according to your requirements.
    – Tap *Save*.
14. Disconnect the air pump hose from the filling hose.

WARNING

Risk of injuries and fire by liquids leaking

If liquids get into the air pump system, they may destroy the pump diaphragm and leak from the instrument.

– Disconnect the air pump hose before you start filling liquids.

9.3 Cleaning the instrument housing, U-Dry, and the touchscreen

WARNING

Before using any cleaning agents for the instrument's surface parts:

– Strictly follow all safety instructions concerning the use of chemicals and the use of flammable chemicals (refer to Section 1 [▸ 5]).
– Make sure that all surface parts are resistant (refer to section "Wetted parts" in the appendix). 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's surface parts. Never use:

– highly nonpolar solvents (like toluene, hexane, solvent naphtha)
– strong acids or bases (like nitric acid, sulfuric acid, hydrochloric acid, caustic soda)
– strong mechanical action (steel brush)

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

If necessary unmount U-Dry for cleaning.

9.4 Storing the instrument

Clean and dry the measuring cell before you store the instrument for **more than one day**. Otherwise algae may grow on the glass surface, which are difficult to remove.

If you store the instrument for **less than one day**, the measuring cell can be filled with ultra-pure water or stay filled with the last cleaning liquid used. If you have filled by syringe, leave the syringe mounted in the filling position to keep the liquid from running out.

9.5 Transporting the instrument

CAUTION

Risk of squeezing your fingers

Do not hold the instrument by its bottom to avoid squeezing your fingers when you put down the instrument.

- Empty the measuring cell and all hoses before you move or lift the instrument.
- To carry the instrument, put one hand into the recessed grip below the front and grasp the metal ledge on the rear with the other hand.
- Carry the instrument in front of you and keep it close to your body.

10 Maintenance and repair

10.1 Maintenance performed by an authorized Anton Paar representative

The product does not require a periodic maintenance by an authorized Anton Paar representative to retain warranty coverage.

To fulfill requirements of regulatory authorities e.g. FDA 21 CFR 211.67, PIC/S 023-2 (5.5), Anton Paar offers services for compliant preventive maintenance and requalification for qualified Anton Paar products in case of software update, repair, and location change.[1]

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.

10.2 Repair performed by an authorized Anton Paar representative

In case your product needs repair, contact your local Anton Paar representative, who will take care of the necessary steps. If your product 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.
Do not return products that are contaminated by radioactive materials, infectious agents or other substances that cause health hazards.

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

[1] For detailed information, please refer to general terms of delivery (GTD) on the Anton Paar website (https://www.anton-paar.com).

Appendix A Technical data

Appendix A.1 Specifications

Density	
Measuring range	0 g/cm³ to 3 g/cm³
Repeatability s.d.[a]	0.000001 g/cm³
Reproducibility s.d.[a]	0.000005 g/cm³
Accuracy[b]	0.000005 g/cm³
Resolution	0.000001 g/cm³
Sound velocity	
Measuring range	1000 m/s to 2000 m/s
Repeatability s.d.[a]	0.1 m/s
Reproducibility s.d.[a]	0.5 m/s
Resolution	0.01 m/s
Temperature	
Measuring range[c]	0 °C to 100 °C (32 °F to 212 °F)
Repeatability s.d.	0.001 °C (0.0018 °F)
Accuracy	0.01 °C (0.018 °F)
Measuring time per sample[d]	typically 0.5 to 6 minutes
Sample volume	3.5 mL
Accuracy and convenience features	ambient air pressure sensor | full range viscosity correction | reference oscillator | automatic bubble detection | camera image of the density measuring cell | dew point warning (condition monitoring)

[a] *According to ISO 5725*

[b] *Under ideal conditions and for low densities/viscosities*

[c] *Cooling down more than 15 °C (27 °F) below ambient temperature only with CK models of the instrument*

[d] *Depending on sample properties and measurement performance setting*

Table 7: Additional specifications for industry profile *Beverages*

Diet	
Measuring range	0 to 200 % Diet 0 to 200 mL NaOH 0 to 200 g/L TA 0 to 600 mg/100 mL H_3PO_4
Repeatability s.d.[ab]	0.5 % Diet
Sugar / extract	
Measuring range	0 to 80 °Brix actual/fresh/inverted
Repeatability s.d.[bc]	<0.01 °Brix actual 0.02 °Brix fresh/inverted

Degree of inversion	
Measuring range	0 to 100 %
Repeatability s.d.[b]	1 %

[a] *Determined according to ISO 5725*

[b] *Under optimal conditions and with ideal samples*

[c] *Valid up to 60 °Brix and at 20 °C*

Table 8: Typical accuracy of conversion for concentration measurement of aqueous solutions

Sulfuric acid	
0–100 % w/w H_2SO_4	±0.02 % w/w H_2SO_4
0–28 % w/w free SO_3	±0.04 % w/w H_2SO_4
28–65 % w/w free SO_3	±0.1 % w/w free SO_3
Acetic acid	
0–100 % w/w acetic acid	±0.7 % w/w

NOTE: *Only valid for uncontaminated samples*

Appendix A.2 Instrument data and operating conditions

Data memory	– audit trail entries: up to 50,000 – measurement data: up to 10,000 (with camera image) – check results: up to 500 – adjustment results: up to 300 – products: up to 400 – custom quantities: up to 50 – images: up to 50 – users and roles: not limited, tested with up to 1000 users and 100 roles
Display	10.1” TFT WXGA (1280x800 px); PCAP touchscreen
Controls	touchscreen, optional keyboard, mouse, and barcode reader
Interfaces	4x USB 2.0 (type A)[a], 1x USB OTG (Micro-A), 1x RS-232, 1x Ethernet (100 Mbit), 1x CAN Bus
RS-232C printer settings	Baud rate: 9600; Parity: none; Stop bit: 1; Data bits: 8
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)
Operating pressure sample	max. 8 bar (116 psi) relative pressure
Pressure range	0–50 °C (32–122 °F): max. 8 bar (116 psi) relative pressure[b] >50 °C (>122 °F): max. 4 bar (58 psi) relative pressure
Pressure drying air	max. 0.1 bar (1.45 psi) relative pressure
Pollution degree	2
Overvoltage category	II
Voltage	100 to 240 V~, 50/60 Hz, fluctuation ±10 %
Power consumption	190 VA (incl. Xsample and external measuring modules)[c]

Power inlet	according to IEC/EN 60320-1/C14, protection class I
Fuses	ceramic tube fuses 5x20 mm; IEC60127-2; AC 250 V; T 5 AH
Dimensions (L x W x H)	526 mm x 347 mm x 230 mm (20.7 in x 13.7 in x 9 in)
Weight	DMA 6002 Sound Velocity: 22.62 kg (49.87 lbs) DMA 6002 Sound Velocity CK: 23.04 kg (50.79 lbs)

[a] *USB memory devices have to be formatted with FAT32 or exFAT file system*

[b] *For the measuring cell together with the injection adapters DMA/CarboQC, mat. no. 159537, in the specified temperature range*

[c] *In the stand-alone configuration (no Xsample or external measuring modules) the power consumption will not exceed 85 VA*

Appendix A.3 Wetted parts and housing surface materials

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

Instrument

Material	Part
Borosilicate glass	density measuring cell
HTL 5 CR	solder (sound velocity cell)
Stainless steel DIN 1.4539 / UNS N08904	sound velocity cell

Standard accessories

Material	Part
HDPE (high-density polyethylene)	waste vessel
PEEK (polyether ether ketone)	U-Dry, syringe holder
Polypropylene / polyethylene	syringe 5 mL Luer
PTFE (polytetrafluoroethylene)	connection tube density/ sound, injection adapters, male Luer plug, adapter Luer cone, U-Dry Luer cone, standard filling and waste hose
Silicone	hose
Tefzel	adapter UNF ¼” Luer male, adapter Luer ¼” UNF

Instrument housing surface materials

Front, top, sides, bottom cover	Durotect PUR Plus 2K texture paint
Back	aluminum
Extension slot cover plate	ABS (acrylonitrile butadiene styrene) + PC (polycarbonate)

Appendix B Declaration of conformity

Docusign Envelope ID: CD7D394A-8851-42E2-9177-1E18358D14BF

EU Declaration of Conformity

(original)

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

Product designation:	**DMA 6002 SOUND VELOCITY, DENSITY AND SOUND VELOCITY METER** **DMA 6002 CK SOUND VELOCITY, DENSITY AND SOUND VELOCITY METER**
Model:	**DMA 6002 SOUND VELOCITY, DMA 6002 SOUND VELOCITY CK**
Material number:	325384, 325765

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

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

Applied harmonised standard:

- EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019
- EN IEC 61010-2-010:2020

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

Applied harmonised standard:

- EN 61326-1:2013

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

Place and date of issue: Graz, 24.6.2025

Signed by:
17130DDD5260426...
Steffen Riemer
Executive Director
Business Unit Measurement

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

I51IB003EN-B

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