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User Manual

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Specifications

Specifications are subject to change without notice.

Specification	Details
Measurement method	Nephelometric
Regulatory	Meets EPA Method 180.1 ASTM D7315 - Standard Test Method for Determination of Turbidity Above 1 Turbidity Unit (TU) in Static Mode ASTM D6655 - Standard Test Method for Determination of Turbidity Below 5 NTU in Static Mode
Light source	Tungsten filament lamp
Measurement modes	NTU, NEP (Nephelo), EBC, Abs (absorbance), %T (% transmittance), CU (color units) and two user-defined units

Specification	Details
Range	NTU (Ratio on, manual range): 0–0.999, 0–9.99, 0–99.9, 0–10,000 NTU (Ratio on, auto range): 0–10,000 auto decimal NTU (Ratio off): 0–40 Nephelo (Ratio on, manual range): 0–9.99, 0–99.9, 0–67,000 Nephelo (Ratio on, auto range): 0–67,000 auto decimal Nephelo (Ratio off): 0–268 EBC (Ratio on, manual range): 0–0.999, 0–9.99, 0–99.9, 0–2450 EBC (Ratio on, auto range): 0–2450 auto decimal EBC (Ratio off): 0–9.8 Absorbance (manual range): 0–0.999, 0–2.00 Absorbance (auto range): 0–2.00 Transmittance (%): 1.0–100 Color units (at 455 nm): 0–500
Accuracy[1, 2, 3, 4]	Ratio on: ±2% of reading plus 0.01 NTU from 0–1000 NTU, ±5% of reading from 1000–4000 NTU, ±10% of reading from 4000–10,000 NTU Ratio off: ±2% of reading plus 0.01 NTU from 0–40 NTU Absorbance: ±0.005 Abs from 0–1 Abs at 455 nm Transmittance: 0.12% T from 10–100% T at 455 nm Color: ±2 CU from 0–30 (calibrated at 15 CU), ±5 CU from 0–500 CU (calibrated at 500 CU)

1 Turbidity specifications identified using USEPA filter assembly, recently prepared formazin standard and matched 25-mm sample cells.
2 Use of a flow cell is necessary to get color measurement specifications.
3 Intermittent electromagnetic radiation of 3 volts/meter or greater may cause slight accuracy shifts.
4 Reference conditions: 23 ± 2 °C, 50% ± 10% RH noncondensing, 115/230 VAC, 50/60 Hz

Specification	Details
Resolution	Turbidity: 0.001 NTU/EBC Nephelo: 0.01 Absorbance: 0.001 Abs Transmittance: 0.1% T Color: 1 CU
Repeatability	±1% of reading or 0.01 NTU, whichever is greater (under reference conditions)
Response time	Signal averaging off: 6.8 seconds Signal averaging on: 14 seconds (when 10 measurements are used to calculate the average)
Stabilization time	Ratio on: 30 minutes after start-up Ratio off: 60 minutes after start-up
Reading modes	Manual or auto range, signal averaging on and adjustable or off, Ratio on or off
Power requirement	115–230 VAC, 50/60 Hz (automatic power selection) 28 W maximum
Pollution degree/installation category	2; II
Protection Class	1
Operating conditions	Temperature: 0 to 40 °C (32 to 104 °F) Relative humidity: 0–90% at 25 °C, 0–75% at 40 °C, noncondensing Altitude: 2000 m (6560 ft) maximum Indoor use only
Storage conditions	–40 to 60 °C (–40 to 140 °F), instrument only
Printer	Built-in (thermal, 58-mm, up to 28 column)
Interface	RS232C serial interface by way of DB9 subminiature D-shell connector for data output to computer or printer, and data input (command). No handshaking.

Specification	Details
Air purge	Dry nitrogen or instrument grade air (ANSI MC 11.1, 1975) 0.1 scfm at 69 kPa (10 psig); 138 kPa (20 psig) maximum Hose barb connection for $^{1}/_{8}$-inch tubing
Sample cells	Round cells 95 x 25 mm (3.74 x 1 in.) borosilicate glass with rubber-lined screw caps ***Note:*** *Smaller sample cells (less than 25 mm) can be used when a cell adapter is used.*
Sample requirements	25 mm sample cell: 20 mL minimum 0 to 95 °C (32 to 203 °F) ***Note:*** *Refer to Use a cell adapter on page 39 for the minimum sample size when not using a 25 mm sample cell.*
Enclosure	High-impact polycarbonate plastic
Dimensions	30.5 x 40 x 15.6 cm (12.0 x 15.7 x 6.1 in.)
Weight	3.8 kg (8.5 lb)
Certification	CE, cETLus

General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

Safety information

NOTICE

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol, if noted on the instrument, will be included with a danger or caution statement in the manual.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user. ***Note:*** *For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.*

Certification

Canadian Radio Interference-Causing Equipment Regulation, IECS-003, Class A:

Supporting test records reside with the manufacturer.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numèrique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

FCC Part 15, Class "A" Limits

Supporting test records reside with the manufacturer. The device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable

protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Product overview

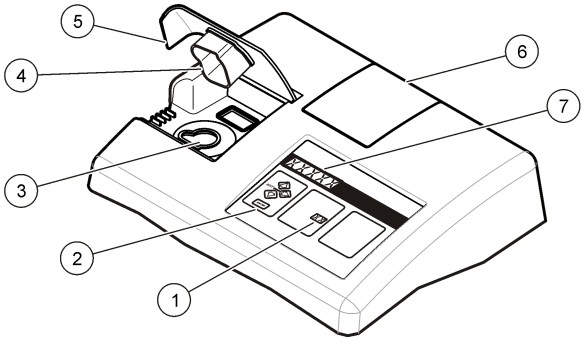
The 2100AN laboratory turbidimeter measures turbidity in NTUs (nephelometric turbidity units), NEPs (nephelos) and EBCs (European Brewing Convention units). NEPs and EBCs are calculated using the conversion factors of 6.7 nephelos per 1.0 NTU and 0.245 EBCs per 1.0 NTU. The 2100AN turbidimeter also measures absorbance, transmittance and color (APHA Pt-Co Method).

In addition, two user-defined measurement units can be specified. Refer to Application specific methods on page 47. The application specific mode of operation uses the nephelometric optical system and the NTU measurement mode.

The turbidimeter has a built-in printer and an RS232 output for connection to a printer, data logger or computer and a recorder output.

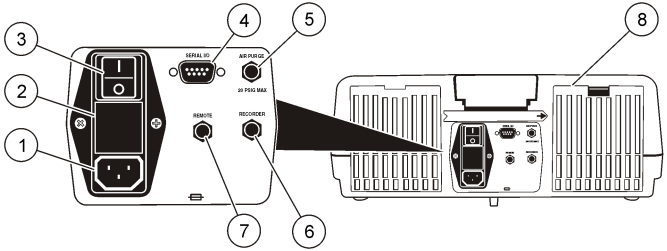
The turbidimeter contains a real-time clock with battery. The clock provides a time-date stamp on all data transmitted to the built-in printer or to external devices by way of the RS232 interface (i.e., measurements and calibration records).

Figure 1 Front overview



1	Mode display: shows the calibration standard number, setup number or sample number	**5**	Cover for the sample cell compartment
2	Keypad	**6**	Printer cover
3	Sample cell holder	**7**	Eight-digit LED display
4	Light shield		

Figure 2 Back overview

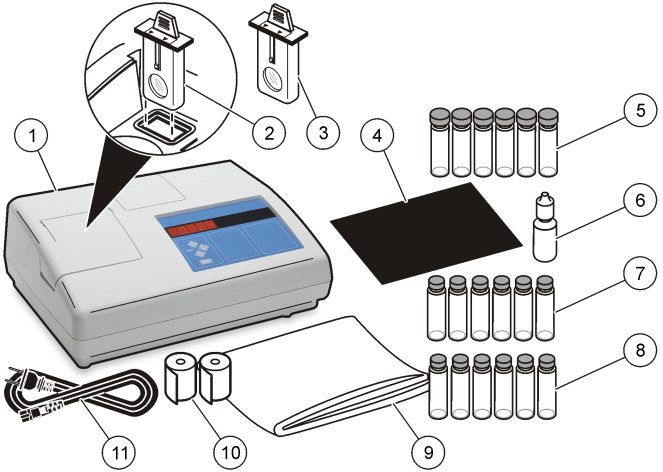


1	Power cord connector	**5**	Air purge fitting
2	Fuse holder	**6**	Recorder output jack for a chart recorder (0 to 1 V output)
3	Power switch	**7**	Remote cable jack for flow valve module connection to the automatic flow cell (low pressure)
4	DB9 connector for RS232 cable	**8**	Lamp access cover

Product components

Refer to Figure 3 to make sure that all components have been received. If any of these items are missing or damaged, contact the manufacturer or a sales representative immediately.

Figure 3 Instrument components



1	2100AN turbidimeter	**7**	StablCal® Calibration kit
2	USEPA filter assembly	**8**	Gelex® secondary turbidity standardization kit[5]
3	455 nm filter assembly	**9**	Dust cover
4	Oiling cloth	**10**	Printer paper roll (2x)[6]
5	Six 1" sample cells (30 mL) with caps	**11**	Power cord
6	Silicone oil		

[5] Supplied with 4700100 only.
[6] Do not remove the plastic wrapper from the paper rolls until the paper is installed.

Installation

DANGER

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

Put paper in the printer

NOTICE

Use only the provided thermal paper. Use of other thermal paper may cause poor print quality and decrease the life of the print-head.

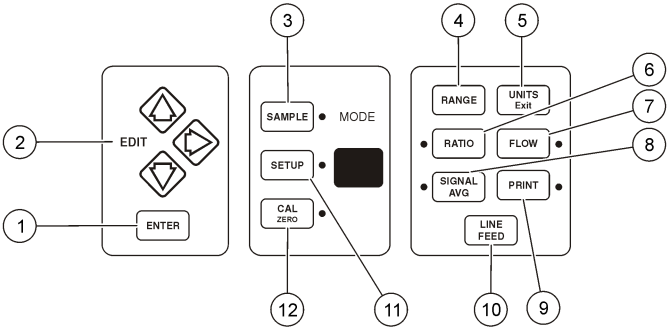
Notes:

- Do not rub the thermal paper with a hard object.
- Do not use chemical paste on thermal paper.
- A red line on the edge of the thermal paper shows when the paper supply is low.

1. Cut the end of the paper with scissors to make an arrow shape.
2. Open the printer cover.
3. Put the point of the thermal paper in the paper entrance slot.
4. Push the paper through until the point of the paper comes out the exit slot.
5. Pull the paper out of the exit slot until the full width of the paper is past the exit slot.
6. Put the paper roll in the printer.
7. Put the thermal paper through the slot in the printer cover, then close the printer cover.

User interface

Figure 4 Keypad



1	ENTER key	**7**	FLOW key
2	EDIT (arrow) keys	**8**	SIGNAL AVG key
3	SAMPLE key	**9**	PRINT key
4	RANGE key	**10**	LINE FEED key
5	UNITS/Exit key	**11**	SETUP key
6	RATIO key	**12**	CAL/Zero key

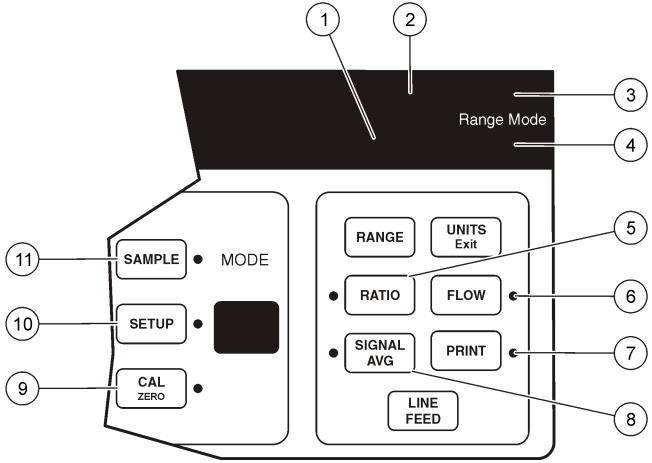
Table 1 Key descriptions

Key	Description
ENTER	Enters the value on the display. Starts the measurement of a calibration standard. Clears data from the buffer.
EDIT	Changes the numbers and/or letters on the display. Steps through the calibration standards. The right arrow key moves the cursor to the previous or next digit.

Table 1 Key descriptions (continued)

Key	Description
SAMPLE	Starts the changing of the sample number shown on the mode display.
RANGE	Selects automatic or manual ranging.
UNITS Exit	Selects the unit of measure. Exits Calibration or Setup mode without saving changes.
RATIO	Turns Ratio on or off.
FLOW	Turns on or off the Flow mode of operation. Used only with the automated flow cell.
SIGNAL AVG	Turns signal averaging on or off.
PRINT	Sends the data that is on the display to a printer or computer. Sends a calibration data report to a printer or computer when in Calibration mode. Sends diagnostic results to a printer or computer if held down when the instrument is turned on. Provides a print of the setup commands when in Setup mode. Turns the print interval feature on or off if the instrument has been configured with a printer interval.
LINE FEED	Moves the printer paper forward one line.
SETUP	Turns on Setup mode and starts the selection of the setup number on the mode display.
CAL Zero	Starts a calibration when in NTU, NEP or EBC mode. Starts analytical zeroing when in CU, %T or Abs mode.

Figure 5 Indicator lights



1 Lamp icon light	**7** PRINT light
2 "CAL?" light	**8** SIGNAL AVG light
3 "Manual" light	**9** CAL/Zero light
4 "Auto" light	**10** SETUP light
5 RATIO light	**11** SAMPLE light
6 FLOW light	

Table 2 Light descriptions

Light	Description
	Illuminated when the instrument light source is on. Flashes when there is not sufficient light for measurement.
CAL?	"CAL?" is shown during a calibration if the calibration data is not within the acceptable range. Flashes when the instrument should be calibrated. ***Note:*** *The CAL? light applies when the USEPA filter and a 25-mm sample cell are used. Ignore the CAL? light if illuminated during calibration when a different filter or a smaller sample cell is used. Push* ***UNITS/Exit*** *to start measurements.*
Manual	"MANUAL" is shown above the Range Mode label when the instrument is in manual ranging mode.
Auto	"AUTO" is shown below the Range Mode label when the instrument is in auto ranging mode.
RATIO	Illuminated when Ratio is on.
FLOW	Illuminated when the Flow mode of operation is selected. Flashes when the flow cycle is done.
PRINT	Illuminated when the printer interval feature is selected. Flashes when a print interval has been selected but is not active.
SIGNAL AVG	Illuminated when signal averaging is on.
CAL Zero	Illuminated when Calibration or Zeroing mode is selected.
SETUP	Illuminated when Setup mode is selected.
SAMPLE	Illuminated when Sample mode is selected.

Startup

Turn the instrument on

1. Put the instrument on a stable, level surface that is free of vibration. Do not put in direct sunlight.
2. Make sure that there is air circulation around the instrument. Keep the back and area below the instrument free of material that could decrease air flow through the vents.
3. Connect the power cord to the power plug on the back of the instrument.
4. Connect the power cord to a power socket with ground contact.
5. Push the power switch on the back of the instrument to turn the instrument on.

Turn the keypad sound off (optional)

By default, the instrument makes an audible sound when a key is pushed. To turn the keypad sound off:

1. Push **SETUP**. The SETUP light turns on.
2. Use the arrow keys to select 00.
3. Push **ENTER**.
4. Use the arrow keys to select the sound option:

Option	Description
BEEP ON	An audible sound is made when a key is pushed.
BEEP OFF	No sound is made when a key is pushed.

5. Push **ENTER**.
6. Push **SETUP**.

Set the date and time

1. Push **SETUP**. The SETUP light turns on.
2. Use the arrow keys to select an option:

Option	Description
05	Sets the hours and minutes (HH-MM).

Option	Description
06	Sets the month and day (MM-DD).
07	Sets the year (YY).

3. Push **ENTER**.
4. Use the arrow keys to change the value.
5. Push **ENTER**.
6. Push **SETUP**.

Show the current time (optional)

1. Push **SETUP**. The SETUP light turns on.
2. Use the arrow keys to select 08.
3. Push **ENTER**. The current time is shown on the display (HH-MM-SS).
4. Push **SETUP**.

Standard operation

Calibrate the turbidimeter with StablCal® Standards

Calibrate the turbidimeter before it is used for the first time using the StablCal® sealed vial standards provided. As an alternative, calibration can be done with recently prepared formazin standards. Refer to Calibrate the turbidimeter with formazin standards on page 42.

Calibrate the turbidimeter at least every 3 months or as specified by the regulating authority when data is used for USEPA reporting.

The instrument is ready for calibration 60 minutes after start-up. Keep the instrument on 24 hours a day if the instrument is used regularly.

Note: *Unknown results may occur if standards other than the recommended calibration points are used. The recommended calibration points (< 0.1, 20, 200, 1000, 4000 and 7500 NTU) provide the best calibration accuracy. Use of standards other than StablCal, or user-prepared formazin, may result in less accurate calibrations. The manufacturer cannot guarantee the performance of the instrument if calibrated with co-polymer styrenedivinylbenzene beads or other suspensions.*

Prepare the StablCal standards

When received and at intervals:

1. Clean the exterior surface of the StablCal vials with laboratory glass cleaning detergent.
2. Rinse the vials with distilled or deionized water.
3. Dry the vials with a lint-free cloth.

Note: *Never shake or invert the < 0.1 NTU standard. If the standard has been mixed or shaken, do not move the vial for 15 minutes or more before using.*

Note: *Do not remove the caps from the sealed vials.*

Make sure that the StablCal standards are at ambient instrument temperature before use (and no greater than 40 °C (104 °F)).

Mix the standards before use:

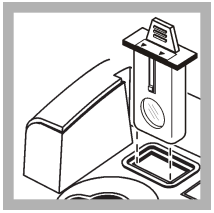
1. Open the case lid. Remove the < 0.1 NTU standard from the plastic case.
2. Leave the other standards in the case. Close the case lid.
3. Shake the case vigorously for at least 10 seconds.
4. Let the standards stand with no movement for 3–5 minutes before use.

Calibration notes

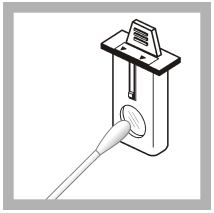
- Make sure that the instrument is in the same ambient conditions as where it is used.
- Make sure that the standards are at the same ambient temperature as the instrument before use.
- Use only the provided silicone oil. This silicone oil has the same refractive index as the vial glass and masks minor glass differences and scratches.
- Store the oiling cloth in a plastic storage bag to keep the cloth clean.
- If power is lost during calibration, the new calibration data is lost and the last calibration data is used. To exit a calibration and not save the new values, push **UNITS/Exit**.
- In Calibration mode, automatic range and signal averaging on are selected. When calibration is completed, all operational modes go back to the last settings.

- All nephelometric (turbidity units of measure) calibrations are done at the same time.
- Ratio-on and Ratio-off calibration data is measured and recorded at the same time.
- The 7500-NTU standard does not have to be measured during calibration if turbidity less than 4000 NTU will be measured. Push **CAL/Zero** after the 4000 NTU standard is measured to complete the calibration procedure.
- Clean the USEPA filter assembly before doing a primary calibration, or at least every 3 months (which is the USEPA-recommended primary calibration interval).

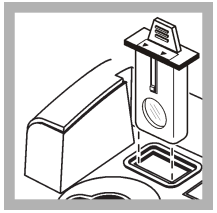
StablCal calibration procedure



1. Remove the filter assembly. Refer to Change the filter assembly on page 50.



2. Clean the lens of the USEPA filter assembly. Refer to Clean the filter assembly on page 50.



3. Hold the tab of the USEPA filter assembly so that the arrows point toward the front of the instrument. Push the filter assembly fully in the housing.

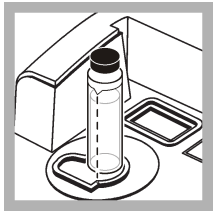
4. Push **CAL/Zero**.

The CAL/Zero light turns on, and the mode display shows "00". The NTU value of the dilution water that was used in the previous calibration is shown on the display.

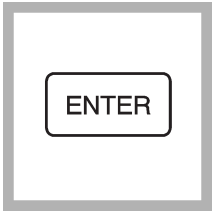
5. Get the < 0.1 NTU vial. Clean the vial with a soft, lint-free cloth to remove water spots and fingerprints. Do not invert the vial.

6. Apply a small bead of silicone oil from the top to the bottom of the vial.

7. Use the oiling cloth to apply the oil equally to the surface of the vial. Remove the excess oil. Make sure that the vial is almost dry.



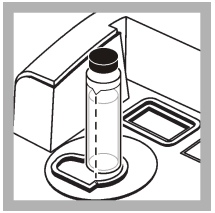
8. Put the vial in the sample cell holder with the triangle on the vial aligned with the reference mark on the sample cell holder. Close the cover.



9. Push **ENTER**.

The instrument display counts down, then measures the standard.

The next expected standard (e.g., 20.00) is shown. The mode display shows "01".



10. Remove the vial from the sample cell holder.

11. Do steps 5–10 for the other StablCal vials (from lowest to highest NTU standard).

The mode display shows "00" after the last vial is measured.

12. Push **CAL/Zero**.

The instrument saves the new calibration data and goes back to Measurement mode.

StablCal standards storage

- Do not move a StablCal standard to a different container for storage. Keep StablCal standards in the plastic case provided with the cover closed.
- Store at 5 to 25 °C (41 to 77 °F).
- For long-term storage (more than one month between use), keep at 5 °C (41 °F).

Using Gelex secondary standards

The Gelex secondary standards are used when a calibration check or an optical system check is done. Refer to Calibration verification on page 18 and Optical system check on page 18.

Gelex notes

- Measure the Gelex secondary standards on the instrument on which they will be used. The measured values can only be used for one instrument due to small differences in glass and instrument optical systems.
- Do not keep a Gelex vial in the instrument for more time than is necessary to complete measurement. The heat from the lamp can change the turbidity value of a Gelex vial.
- Keep the Gelex standards at room temperature. Do not let Gelex standards freeze or become warmer than 50 °C (122 °F). High temperatures may cause Gelex suspensions to divide.
- Make sure that the Gelex standards are at ambient instrument temperature before measurement.

Measure the Gelex stray light standard

Measure the Gelex stray light standard when the instrument is first received. Record the value on the Gelex vial with a permanent marker one time.

1. Clean the stray light standard with a soft, lint-free cloth to remove water spots and fingerprints.

2. Apply a small bead of silicone oil from the top to the bottom of the vial.

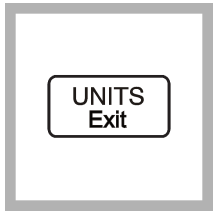
3. Use the oiling cloth to apply the oil equally to the surface of the vial. Remove the excess oil. Make sure that the vial is almost dry.

4. Push **RANGE** to select automatic ranging.

"AUTO" is shown below the Range Mode label on the instrument.

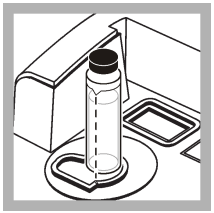
5. Push **SIGNAL AVG** to turn signal averaging off.

The SIGNAL AVG light turns off.

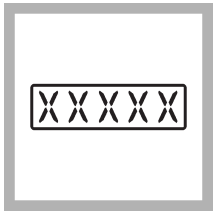


6. Push **UNITS/Exit** to select the NTU measurement mode.

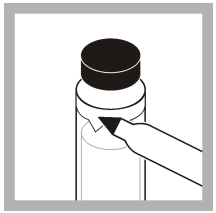
7. Push **RATIO** to turn Ratio mode on.



8. Put the stray light standard in the sample cell holder with the triangle on the vial aligned with the reference mark on the sample cell holder. Close the cover.



9. Read the value when stable. Remove the vial from the instrument.



10. Record the value on the white diamond space on the vial using a permanent marker.

Measure the Gelex secondary turbidity standards

Measure the Gelex secondary turbidity standards each time the instrument is calibrated and record the new values on the Gelex vials with a water soluble marker.

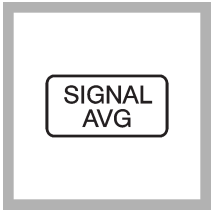
1. Clean the Gelex vials with a soft, lint-free cloth to remove water spots and fingerprints.

2. Apply a small bead of silicone oil from the top to the bottom of the vial.

3. Use the oiling cloth to apply the oil equally to the surface of the vial. Remove the excess oil. Make sure that the vial is almost dry.

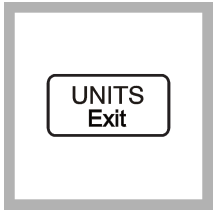
4. Push **RANGE** to select automatic ranging.

"AUTO" is shown below the Range Mode label on the instrument.



5. Push **SIGNAL AVG** to turn signal averaging off.

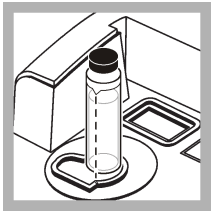
The SIGNAL AVG light turns off.



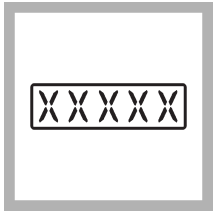
6. Push **UNITS/Exit** to select the NTU measurement mode.

7. Push **RATIO** to select Ratio on or off.

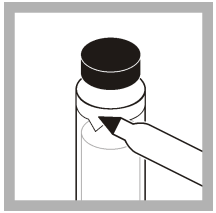
Ratio must be on for Gelex standards greater than 40 NTU. For the 0–2 and 0–20 NTU Gelex standards, select the Ratio function that the instrument will operate in.



8. Put the 0–2 NTU Gelex vial in the sample cell holder with the triangle on the vial aligned with the reference mark on the sample cell holder. Close the cover.



9. Read the value when stable. Remove the vial from the instrument.



10. Record the value on the white diamond space on the vial using a water soluble marker.

Record on the vial if Ratio was on or off when the vial was measured.

11. Do steps 7–10 for the other Gelex vials (but not the stray light standard). Measure from lowest to highest NTU.

Calibration verification

At intervals, measure the Gelex secondary turbidity standard that is closest in value to the turbidity range to be measured. Do the steps in Measure the Gelex secondary turbidity standards on page 17, but do not change the value that is recorded on the vial.

Turn Ratio on if the Gelex vial is greater than 40 NTU. Select the Ratio setting recorded on the Gelex vial for vials less than 40 NTU.

If the measured value is within ±5% of the value recorded on the Gelex vial, calibration is verified. If not, calibrate the instrument.

Note: *The StablCal® primary turbidity standards can also be used to do a calibration check. Prepare the StablCal vials before use. Refer to* Prepare the StablCal standards *on page 13**. Do not use the < 0.1 NTU StablCal vial as it does not have an accurately identified NTU value. The instrument is calibrated if the measured value is within ±5% of the StablCal value.*

Optical system check

At intervals, measure the Gelex stray light standard to inspect the integrity of the optical system. Do the steps in Measure the Gelex stray light standard on page 16, but do not change the value that is recorded on the vial.

If the value measured is similar to the value recorded on the Gelex stray light standard (within ±0.02 NTU), the instrument works correctly. If not, contact Customer Service.

Prepare a sample cell

Use a clean sample cell(s) for sample measurement.

Note: *As an alternative, a flow cell can be used for sample measurement. Refer to* Using a flow cell *on page 34**.*

Clean the sample cell

⚠ CAUTION

Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current material safety data sheets (MSDS) for safety protocols.

NOTICE

Do not air dry the sample cells. Always store the sample cells with caps on to prevent the cells from drying. For storage, fill the sample cell with distilled or demineralized water.

1. Clean the internal and external surfaces of the sample cell and cap with a laboratory glass cleaning detergent.
2. Fully rinse the sample cell many times with distilled or deionized water.
3. Clean the internal and external surfaces of the sample cell and cap with 1:1 hydrochloric acid.
4. Fully rinse the sample cell many times with distilled or deionized water.

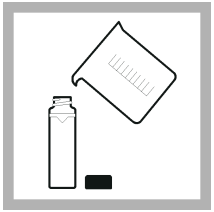
   Note: *If the sample cell will be used to measure low range turbidity samples or dilution water, rinse with dilution water (not distilled or deionized water). Refer to* Prepare dilution water *on page 24.*
5. Dry the external surface of the sample cell with a soft, lint-free cloth.
6. Fill the sample cell with distilled or deionized water.

   Note: *If the sample cell will be used to measure low range turbidity samples or dilution water, fill the sample cell with dilution water (not distilled or deionized water).*
7. Immediately put the cap on the sample cell.

   Note: *Hold the sample cell by the top only to minimize dirt and fingerprints.*

Indexing a single sample cell

When measuring very low turbidity samples, use a single indexed sample cell or a flow cell for all measurements to get precise and repeatable measurements. As an alternative, optically matched sample cells can be used. Refer to Matching sample cells on page 22. Matched sample cells do not provide as good of accuracy and precision as a single indexed sample cell that is used for every measurement or a flow cell.



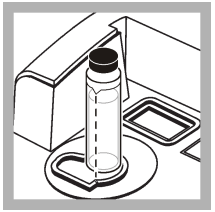
1. Rinse a clean, empty sample cell two times with dilution water and drain to waste. Fill the sample cell to the line (about 30 mL) with dilution water and immediately put the cap on the sample cell. Refer to Prepare dilution water on page 24.

Let the sample cell sit for at least five minutes to degas.

2. Clean the sample cell with a soft, lint-free cloth to remove water spots and fingerprints.

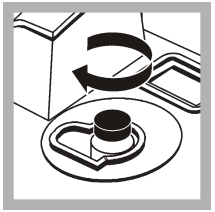
3. Apply a small bead of silicone oil from the top to the bottom of the sample cell.

4. Use the oiling cloth provided to apply the oil equally to the surface of the sample cell. Remove the excess oil. Make sure that the sample cell is almost dry.



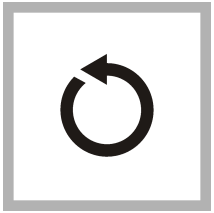
5. Put the sample cell in the sample cell holder. Close the cover.

Record the value when stable.

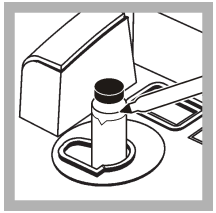


6. Remove the sample cell, turn it about $^{1}/_{8}$ of a turn and put it in the sample cell holder again. Close the cover.

Record the value when stable.



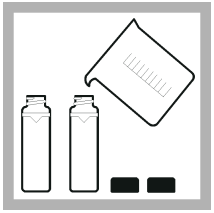
7. Repeat step 6 until the lowest value is shown on the display.



8. Put an orientation mark on the marking band near the top of the sample cell where the lowest value is shown.

Matching sample cells

To decrease the effects that optical differences among sample cells can have on turbidity, transmittance, color or absorbance measurements, measure samples in matched sample cells. It may not be possible to match all sample cells due to the differences in glass.



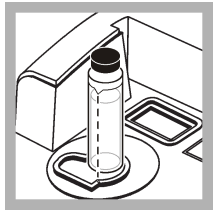
1. Rinse two or more clean, empty sample cells two times with dilution water and drain to waste. Fill the sample cells to the line (about 30 mL) with filtered dilution water and immediately put the cap on the sample cell. Refer to Prepare dilution water on page 24.

Let the sample cell sit for at least five minutes to degas.

2. Clean the sample cells with a soft, lint-free cloth to remove water spots and fingerprints. Do not invert the sample cell.

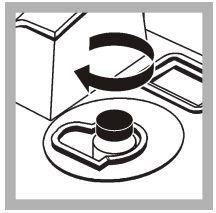
3. Apply a small bead of silicone oil from the top to the bottom of the sample cells.

4. Use the oiling cloth provided to apply the oil equally to the surface of the sample cells. Remove the excess oil. Make sure that the sample cells are almost dry.



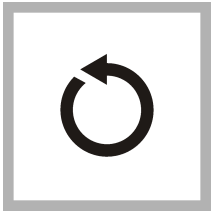
5. Put the first sample cell in the sample cell holder. Close the cover.

Record the value when stable.

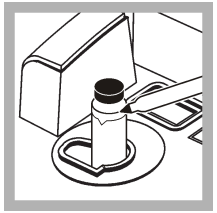


6. Remove the sample cell, turn it about $^{1}/_{8}$ of a turn and put it in the sample cell holder again. Close the cover.

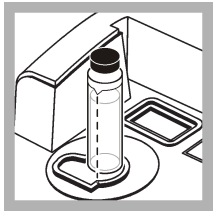
Record the value when stable.



7. Repeat step 6 until the lowest value is shown on the display.

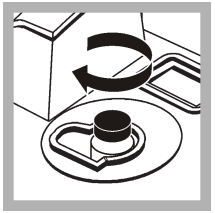


8. Record the value. Put an orientation mark on the marking band near the top of the sample cell.



9. Put the second sample cell in the sample cell holder. Close the cover.

Record the value when stable.

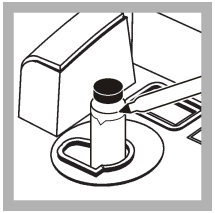


10. Remove the sample cell, turn it about $^{1}/_{8}$ of a turn and put it in the sample cell holder again. Close the cover.

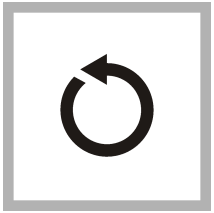
Record the value when stable.

11. Repeat step 10 until the value matches the first sample cell value within ±0.005 NTU.

Note: *Match sample cells to within ±0.002 absorbance units when indexing sample cells in the Absorbance mode for use with transmittance or absorbance measurements.*



12. Put an orientation mark on the marking band near the top of the sample cell where the lowest value is shown.



13. Do steps 9–12 again as necessary to match the other sample cells prepared in steps 1–4.

Prepare dilution water

Dilution water is used when indexing a sample cell or matching sample cells and to prepare formazin standards.

1. Collect at least 1000 mL of high-quality, low-turbidity water (i.e., distilled, demineralized or deionized water or filtered tap water).
2. Measure the turbidity of the water using the turbidimeter. Refer to Turbidity measurement on page 26.
3. If the turbidity of the water is greater than 0.5 NTU, filter the water using the sample filtration and degassing kit. Refer to the user instructions provided with the sample filtration and degassing kit.

Prepare the sample

Proper sampling techniques are important to get accurate measurements.

Prepare a representative sample

A representative sample accurately reflects the true condition of the water source from which the sample was taken.

To prepare a representative sample:

- Gently but fully mix every sample before collecting aliquots (sample portions). Mix by gentle inversion only. Do not shake.
- When collecting a sample from a water tap in a distribution system or treatment plant, turn the water on for at least five minutes, then collect the sample.
- When collecting a sample from a body of water (e.g., a stream or storage tank), collect at least one liter (1 quart) and fully mix before taking an aliquot for measurement. If the quality of the sample source is not constant, collect samples at many locations at different depths as necessary. Then, mix the samples together to prepare one sample for measurement.

Remove air bubbles from the sample

If readings are not stable, air bubbles may be the cause. Remove air or other gases from the sample before measurement even if no bubbles can be seen.

The methods typically used for degassing are:

- Let the sample stand for several minutes
- Apply a vacuum
- Use an ultrasonic bath
- Apply heat

Let the samples stand for several minutes, then gently invert two or three times before measurement.

In some cases, more than one method may be necessary to remove bubbles (e.g., the use of heat with an ultrasonic bath may be necessary in some severe conditions). Use care with these methods as sample turbidity can be changed if these methods are not used correctly.

Apply a vacuum

Apply a vacuum with any available, clean, oil-free vacuum source, such as the sample degassing kit, or an electric or hand-operated pump equivalent to those in Accessories on page 56. The vacuum lowers the atmospheric pressure above the sample letting trapped gas bubbles exit.

Vacuum works well with samples that are not viscous, such as water, and do not contain volatile components. Application of vacuum to viscous, volatile samples (i.e., paint resins) may cause volatile components to come out of solution, and increase the bubbles.

Use an ultrasonic bath

An ultrasonic bath removes gas bubbles from most samples, especially viscous liquids. The time necessary to remove bubbles may be a few seconds to a minute or more.

To identify the time necessary for ultrasonic treatment:

1. Apply ultrasound to the sample for a short period of time, then measure turbidity. Record the value and the treatment time.
2. Do step 1 again until there is no change in the turbidity of the sample.

Note: *In some instances, the use of ultrasound may divide gas bubbles and make them more difficult to remove.*

To use an ultrasonic bath:

1. Fill a clean sample cell with sample. Do not put the cap on the sample cell.
2. Put $^{1}/_{2}$ to $^{2}/_{3}$ of the sample cell into the ultrasonic bath and let it stand until visible bubbles are removed.
3. Remove the sample cell from the ultrasonic bath and put the cap on.
4. Fully dry the sample cell.

Apply heat

⚠ CAUTION

Make sure that the cap on the sample cell is loose. Increasing the temperature of a tightly-capped sample cell may cause an explosion. More caution should be taken when increasing the temperature of volatile compounds.

If possible, do not use heat to accelerate degassing. Heat may change the properties of the suspended particles and cause volatile components to come out of the solution.

Gentle heat may be used to remove bubbles from very viscous samples when used with vacuum or ultrasound. If applying heat to the sample is necessary, do so only as much as is necessary to complete degassing. Before measurement, decrease the temperature of the sample to the initial temperature, then gently invert the sample.

Prevent condensation on a sample cell

Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. This condensation or fogging of the sample cell interferes with turbidity measurement.

To prevent condensation:

- Make sure that the outside of the sample cell is dry before measurement.
- Use the air purge system as necessary. Refer to Using the air purge system on page 34.
- If condensation occurs while using the air purge system, warm the sample slightly. Let the sample sit at room temperature or partially put the sample into a warm water bath for a short time. Gently invert the sample cell before measurement.

Note: *Warming may change the sample turbidity. Measure the sample without warming when possible.*

Measure over-range samples

The nephelometric method of turbidity measurement depends on light scattering from suspended particles. If turbidity is very high, significant amounts of light may be absorbed by the particles, and little light is available for scattering. This results in a negative interference causing the measured turbidity to be lower than the actual turbidity. This condition is called “going blind”.

Methods used to prevent the instrument from going blind include:

- Turn Ratio on. Ratio on mode decreases the effects of light absorbing particles, color, absorbance and high turbidity interferences.
- Sample dilution. Refer to Sample dilution on page 25.

When too much light is absorbed by the sample, the lamp icon on the instrument display flashes.

Sample dilution

Use filtered sample, deionized water or distilled water for sample dilution. Measure sample dilutions soon after they are prepared.

To prepare filtered sample, use the sample filtration and degassing kit. Refer to the user instructions provided with the sample filtration and degassing kit.

If the filters in the sample filtration and degassing kit plug quickly, use a standard 47 mm filtration apparatus shown in Figure 6 with a membrane filter or use a glass-fiber filter. Refer to Accessories on page 56.

After dilution and measurement, calculate the actual turbidity as follows:

1. Calculate the total volume:

   Total volume = sample + dilution water

   Example: 20 mL of sample and 80 mL of dilution water

   Total volume = 20 mL + 80 mL = 100 mL
2. Calculate the dilution factor:

   Dilution factor = total volume ÷ sample volume

Example: Dilution factor = 100 ÷ 20 = 5

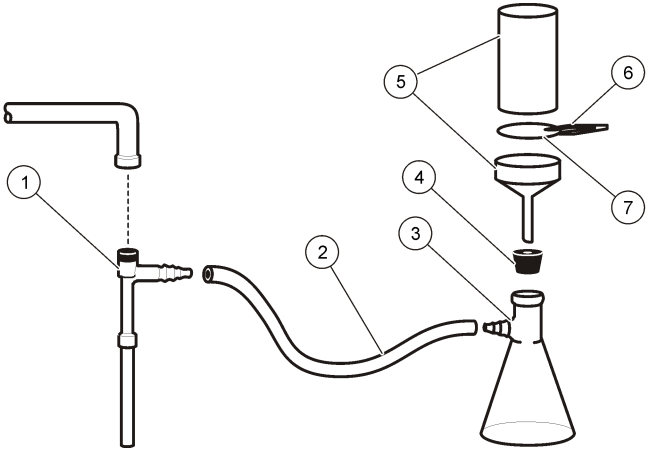
3. Calculate the actual turbidity:

   Actual turbidity = measured value × dilution factor

   Example: Measured value = 2450 NTU

   Actual turbidity = 2450 × 5 = 12,250 NTU

Figure 6 Prepare filtered sample using membrane or glass-fiber filter



1 Filter pump	**4** Stopper	**7** Filter
2 Hose	**5** Filter holder	
3 Filter flask	**6** Tweezers	

Turbidity measurement

⚠ WARNING

Potential explosion and fire hazard. This instrument is for measuring water based samples. Do not measure solvent or combustible based samples.

For accurate turbidity readings use clean sample cells and remove air bubbles. Refer to Clean the sample cell on page 19 and Remove air bubbles from the sample on page 24.

Measurement notes

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. For accurate and repeatable measurements:

Instrument

- Make sure that the instrument is on a level, stationary surface that is free of vibration during the measurement.
- The USEPA filter assembly is required for turbidity measurements reported for United States Environmental Protection Agency (USEPA), National Primary Drinking Water Regulations (NPDWR) or National Pollutant Discharge Elimination System (NPDES) permits.
- Turn the instrument on 30 minutes (Ratio on) or 60 minutes (Ratio off) before measurement. Keep the instrument on 24 hours a day if the instrument is used regularly.
- Always close the sample compartment lid during measurement, calibration and storage.
- Remove the sample cell from the instrument and turn off the instrument if the instrument is stored for an extended time period (more than a month).
- Keep the sample compartment lid closed to keep dust and dirt out.

Sample cells

- Always cap the sample cell to prevent spillage of the sample into the instrument.
- Always use clean sample cells in good condition. Dirty, scratched or damaged cells can result in readings that are not accurate.
- Make sure that cold samples do not “fog” the sample cell. Refer to Prevent condensation on a sample cell on page 25.
- Store sample cells filled with distilled or deionized water and cap tightly.
- For the best accuracy, use a single sample cell for every measurement or a flow cell.

Note: *As an alternative, matched sample cells may be used for measurements but do not provide as good of accuracy or precision as a single indexed sample cell or flow cell. When using matched sample cells, align the orientation mark on the sample cell with the reference mark on the sample cell holder.*

Measurement

- Measure samples immediately to prevent temperature changes and settling. Before a measurement is taken, always make sure that the sample is homogeneous throughout.
- Avoid sample dilution when possible.
- Avoid instrument operation in direct sunlight.

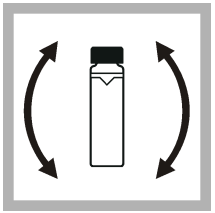
Turbidity measurement procedure

1. Rinse a clean, empty sample cell two times with the solution to be measured and drain to waste. Fill to the line (about 30 mL) with sample and immediately put the cap on the sample cell.

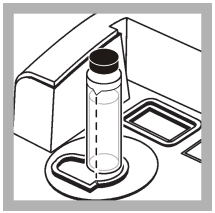
2. Clean the sample cells with a soft, lint-free cloth to remove water spots and fingerprints.

3. Apply a small bead of silicone oil from the top to the bottom of the sample cells.

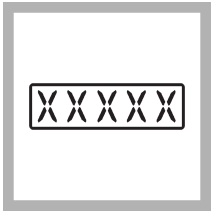
4. Use the oiling cloth provided to apply the oil equally to the surface of the sample cells. Remove the excess oil. Make sure that the sample cells are almost dry.



5. Gently and slowly invert the sample cell to fully mix the sample. Be careful not to add air bubbles.



6. Put the sample cell in the sample cell holder with the triangle on the sample cell aligned with the reference mark on the sample cell holder. Close the cover.



7. Read and record the value when stable.

Note: *To print or send (via RS232) a measurement record, push* ***PRINT****.*

Absorbance and transmittance measurement

Measurement notes

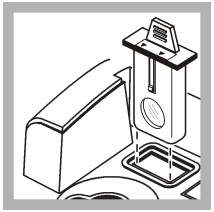
For the best accuracy and reproducibility:

- Set the zero reference point before measurement. Set the zero reference point again when a measurement is not taken for several hours as shown in Absorbance and transmittance measurement procedure on page 29.
- Color, transmittance and absorbance measurements use the same zero reference point. Color, absorbance and transmittance can be measured on a single sample after setting a zero reference point in one of the three modes.
- Use a flow cell for measurements. A flow cell is necessary to get the accuracy and reproducibilty specifications shown in Specifications on page 5.

  If a flow cell is not used, use a single indexed sample cell or match sample cells. Sample cells should be matched using the Transmittance or Absorbance modes. Refer to Matching sample cells on page 22.
- Refer to Measurement notes on page 26 for more measurement notes.

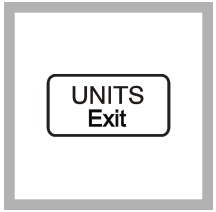
Absorbance and transmittance measurement procedure

Note: *To measure samples with negative absorbance, set the analytical zero using the sample with the greatest absorbance, and measure the sample with the least absorbance. Report the reading as negative absorbance.*

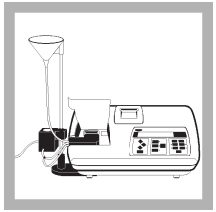


1. Put a clean filter assembly in the instrument. Refer to Change the filter assembly on page 50.

Note: *The minimum wavelength for absorbance and transmittance measurement is 420 nm.*



2. Push **UNITS/Exit** until "%T" or "ABS" is shown on the display.



3. Using the manual flow cell kit, install the flow cell. Refer to Using a flow cell on page 34.

Note: *The sample cell cover does not close when the flow cell is installed.*

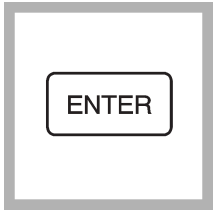
4. Slowly put 250 mL of 100 %T or zero absorbance reference solution down the interior edge of the inlet reservoir.

Put the sample down the interior edge of the reservoir to prevent air bubbles in the sample.

5. Push **CAL/Zero**.

The display shows "100 %T" or zero.

Note:
The instrument starts analytical zeroing for color, transmittance, and absorbance modes at the same time.

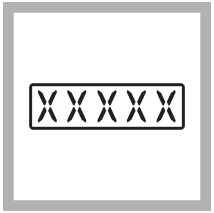


6. Push **ENTER**.

The instrument display counts down from 30 to 0.

Note: *If the value shown is not 100 %T, 0.000 A, or if dashes flash, do steps 5 and 6 again.*

7. Slowly put 250 mL of the sample in the inlet reservoir.



8. After the sample flow stops and the display stabilizes, read and record the value.

Note: *To print or send (via RS232) a measurement record, push* ***PRINT****.*

Color measurement

Measurement notes

For the best accuracy and reproducibility:

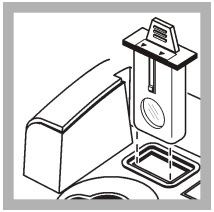
- Calibrate the instrument for color measurement using a blank solution (deionized water) and a known standard (15 or 500 CU) as shown in Color measurement and calibration procedure on page 31.

  15 CU standard—Use for calibration when low-color concentrations are to be measured. To make a 15 CU standard, add deionized water to 15 mL of the 500 CU standard from Hach until 500 mL. A flow cell must be used to do a calibration with a 15 CU standard.

  500 CU standard—Use for calibration when color concentrations greater than 30 CU are to be measured. Use the 500 CU standard from Hach for the 500 CU standard.
- Set the zero reference point before measurement when a measurement is not taken for several hours as shown in Color measurement and calibration procedure on page 31.
- Color, transmittance and absorbance measurements use the same zero reference point. Color, transmittance and absorbance can be measured on a single sample after setting a zero reference point in one of the three modes.
- Use a flow cell for measurements. A flow cell is necessary to get the accuracy and reproducibilty specifications shown in Specifications on page 5. Use of a Flow Cell is especially important when low-level color is measured.

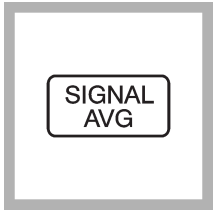
  If a flow cell is not used, match sample cells using the Transmittance or Absorbance modes. Refer to Matching sample cells on page 22.
- Refer to Measurement notes on page 26 for more measurement notes.

Color measurement and calibration procedure

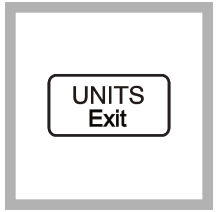


1. Make sure that the 455 nm filter assembly is installed in the instrument.

2. Push **RANGE** to select manual or automatic ranging. Refer to Manual or automatic ranging on page 33.



3. Push **SIGNAL AVG** to set signal averaging on or off. Refer to Signal averaging on or off on page 33.

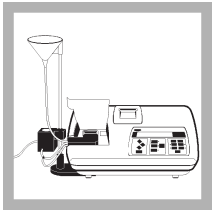


4. Push **UNITS/Exit** until "CU" is shown on the display.

5. Push **CAL/Zero**.

The display shows "ZERO" CU.

Note:
The instrument starts analytical zeroing for Color, Transmittance, and Absorbance modes at the same time.

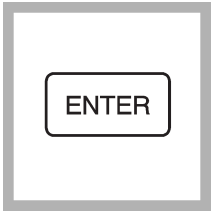


6. Using the manual flow cell kit, install the flow cell. Refer to Using a flow cell on page 34.

Note: *The sample cell cover does not close when the flow cell is installed.*

7. Slowly put 250 mL of deionized water down the interior edge of the inlet reservoir.

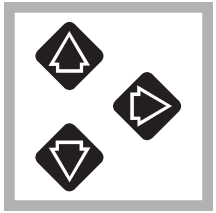
Put the CU standard down the interior edge of the reservoir to prevent air bubbles in the sample.



8. Push **ENTER**.

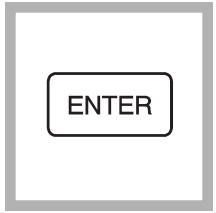
The instrument display counts down from 30 to 0, and then measures the deionized water and sets the zero reference point.

Note: *To make measurements using the current calibration, go to step 12.*



9. Use the arrow keys to change the display to show the value of the CU standard to be used for calibration.

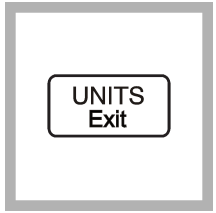
10. Slowly put 250 mL of the CU standard in the inlet reservoir.



11. Push **ENTER**.

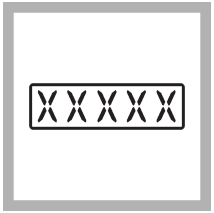
The instrument display counts down from 30 to 0, and then measures the CU standard and sets the calibration point. Then, the measured value is shown.

The calibration is complete, go to step 13.



12. Push **UNITS/Exit** to go back to Measurement mode.

13. Slowly put 250 mL of the sample in the inlet reservoir.



14. After the sample flow stops and the display stabilizes, read and record the value.

Note: *To print or send (via RS232) a measurement record, push **PRINT**.*

Measurement techniques

Measurements may be made with different operation mode settings and optional accessories.

Calibrate the instrument whenever the sample cell pathlength is changed.

Manual or automatic ranging

The manufacturer recommends that ranging be set to automatic for most measurements.

The setting can be changed at any time during sample measurement.

Push **RANGE** repeatedly to step the instrument from automatic ranging to manual ranging and then scroll through the manual range settings.

"MANUAL" is shown above the Range Mode label on the instrument when manual ranging is selected. "AUTO" is shown below the Range Mode label on the instrument when automatic ranging is selected.

Notes:

- When manual ranging is selected, the display flashes all 9s when the sample being measured is greater than the selected range. The display flashes all 0s when the sample measured is less than the selected range.
- When automatic ranging is selected, the display flashes 9s when the sample is greater than the maximum range of the instrument. The display flashes 9s when Ratio is off and the measurement is greater than 40 NTUs (268 nephelos or 9.8 EBCs). Turn Ratio on to increase the range. Refer to Measure over-range samples on page 25.
- When automatic ranging is selected, the display flashes all 0s when the measurement is less than the range of the instrument or a negative value. Calibrate the instrument. When measuring color, absorbance or transmittance, set the zero reference point again.

Signal averaging on or off

Signal averaging corrects for reading fluctuations that are caused by random drifting particles in the sample. When signal averaging is on, an average reading is calculated every 3 seconds and shown on the display.

The manufacturer recommends that signal averaging be on for most measurements.

Push **SIGNAL AVG** to turn signal averaging on or off. The SIGNAL AVG light turns on when signal averaging is on.

Push **ENTER** when signal averaging is on to erase data in the signal averaging buffer and provide an immediate update on the display as necessary. This is especially useful when measuring samples with large differences in turbidity.

To change the number of measurements that are used to calculate the average reading (default=10):

1. Push **SETUP**. The SETUP light turns on.
2. Select 09 using the arrow keys.
3. Push **ENTER**.
4. Use the arrow keys to select the number of measurements—1 to 15.

   Note: *If a number greater than 15 is selected, 15 measurements will be used.*
5. Push **ENTER**.
6. Push **SETUP**.

Ratio on or off

Ratio on provides very good linearity, calibration stability and a wide measurement range. Ratio on helps correct for interference when color is present in the sample that absorbs at the wavelength of incident light.

The manufacturer recommends that Ratio on be used for most measurements. Ratio must be on to measure samples greater than 40 NTUs (268 nephelos or 9.8 EBCs).

Ratio can be turned on for NTU, EBC, NEP and ASC -1- and -2- measurements.

Push **RATIO** to turn Ratio on or off. The Ratio light is on when Ratio is on.

Notes:

- If the sample being measured is greater than 40 NTU (or equivalent) and Ratio is off, the display will show 9s and the RATIO light will flash. Push **RATIO** to turn Ratio on and remove the over-range condition.
- Measurements with Ratio on and measurements with Ratio off are almost the same for turbidity measurements that are less than 40 NTU

if interferences caused by color or light absorbing particles are not present.

Using the air purge system

The air purge system is used to keep condensation off the external surface of the sample cell when cold samples are measured.

The air purge system pushes dry air through the optical compartment to keep the outside the sample cell dry. The connection is made at the air purge fitting on the back of the instrument Figure 2 on page 9.

Use dry nitrogen or instrument grade air (ANSI MC 11.1, 1975) at no greater than 138 kPa (20 psig). The manufacturer recommends an air consumption rate of 3 to 10 SCFH (standard cubic feet/hour).

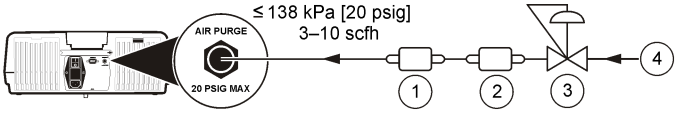
When the sample temperature is about or less than 2 °C (35 °F), use a desiccant dryer and particle filter to make sure that the dew point of the air purge is less than the sample temperature. The air dryer contains silica gel desiccant that turns pink. Replace the desiccant when it turns pink.

If only shop air is available, use a coalescing filter with an automatic drain and a dryer and particle filter to get instrument quality air. Use a coalescing filter that typically operates for greater than 2000 hours. Replace the particle filter when the air dryer is replaced.

Figure 7 and Figure 8 show the methods for connecting the two types of air supply to the instrument.

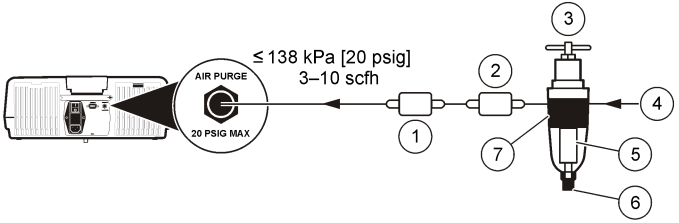
Note: *The dryer and filter are not necessary if dry nitrogen is used.*

Figure 7 Instrument quality air



1 Particle filter (Balston DFU 9933-05-BQ or equivalent)	**3** Pressure regulator
2 Air dryer (Balston DAU 9933-05-101 or equivalent)	**4** Instrument air

Figure 8 Standard shop air



1 Particle filter	**5** Filter (Balston 100-12-BX or equivalent)
2 Air dryer	**6** Auto drain (Balston 20-105 or equivalent)
3 Coalescing filter/regulator (0–30 psig)	**7** Filter housing (Balston FR-920-30 or equivalent)
4 Shop air	

Using a flow cell

⚠ CAUTION

Do not use a flow cell with flammable samples or those that contain hydrocarbons, solvents, concentrated acids or concentrated bases that may damage wetted parts of the cells. Conduct tests before use of flow cells if sample compatibility is not known.

Note: *Do not use a high pressure flow cell kit with this instrument.*

Use a flow cell to increase the speed, accuracy and reproducibility of measurement. The manufacturer especially recommends using a flow cell for low turbidity measurements.

A flow cell must be used to get the accuracy and reproducibility values in Specifications on page 5 for color, absorbance or transmittance.

Install a flow cell

1. Fully clean and assemble the flow cell, tubing and stand. Refer to Clean a flow cell assembly on page 35 and the user instructions provided with the flow cell.
2. Fill the flow cell and tubing with water and make sure that there are no leaks or air bubbles.

   Note: *Air bubbles collect in areas that are not cleaned fully.*
3. Clean the exterior surface of the flow cell with a soft, lint-free cloth to remove water spots and fingerprints.
4. Apply a small bead of silicone oil from the top to the bottom of the flow cell.

   Note: *Use only the provided silicone oil. This silicone oil has the same refractive index as the flow cell glass and masks minor glass scratches.*
5. Use the oiling cloth provided to apply the oil equally to the surface of the flow cell. Remove the excess oil. Make sure that the flow cell is almost dry.

   Note: *Put the oiling cloth in a plastic storage bag to keep the cloth clean.*
6. Install the flow cell in the sample cell compartment.
7. Push the inlet and outlet tubes in the slots on the top of the instrument enclosure so the sample cell cover can be installed. Refer to the user instructions.
8. Put the flow-cell light cover over the flow cell.

   Note: *The standard sample cell cover of the instrument does not close when the flow cell is installed.*

Clean a flow cell assembly

1. Disassemble the flow cell assembly.
2. Clean the inside and outside of the glass parts with a laboratory glass cleaning detergent. Follow with multiple rinses with distilled or demineralized water.

   Note: *All tubing, flow cells, and caps in the flow cell assembly can also be steam sterilized.*
3. If measuring low turbidity samples, clean the inside and outside of the glass parts with 1:1 hydrochloric acid and rinse multiple times with dilution water.
4. Fill the sample cell with distilled or demineralized water and immediately put the caps on the sample cell.
5. Clean the inside and outside of the plastic parts and tubing with laboratory detergent and warm water.

   Note: *At intervals, replace the tubing as contaminants, including microbiological growths, are difficult to remove from the inside surface of the tubing.*
6. Air dry the parts after cleaning.

Flow cell maintenance

- Keep all parts of the flow cell assembly clean.
- At intervals, replace all the tubing to make sure that the system is clean. Keep the tubing as short as possible to minimize air locking and lag time of sample flow. Locate the instrument as close to the drain as possible.

Flow cell operation

- Do not use the flow cell for samples that contain large particles that may collect and stop the sample from flowing.
- Slowly put the sample down the interior edge of the inlet reservoir to prevent mixing of the sample, which can cause air bubbles. Air bubbles create a false positive interference in a turbidity measurement.
- If bubbles collect in the flow cell, gently tap the flow cell on a soft surface to remove the bubbles. If bubbles continue to collect in the flow cell, put the glass flow cell in liquid detergent for 24 hours and then rinse fully.
- When measuring many samples of different turbidity, measure the samples in order of the cleanest (lowest turbidity) to the dirtiest (highest turbidity) to prevent contamination from one sample to the next.
- Do not use greater than the recommended maximum sample pressure of 34 kPa (5 psig).
- Keep the drain tubing below the center line of the instrument. If the whole 152 cm (60 in.) length of drain tubing is used, make sure that the end of the drain tubing is at least 46 cm (18 in.) below the center line of the instrument.

Flow cell storage

- Install the reservoir cover when the system is not in use to prevent contamination of the system by airborne particles.
- For short-term storage (a few hours), flush the system with distilled or deionized water and leave the flow cell full of the flush water to minimize air locks and build up of residue on the parts.
- For long-term storage, disassemble, fully clean and air dry all parts.

Using a manual flow cell

To set the flow rate, increase the height of the collection drain assembly on the support rod to decrease the flow rate. Make sure that the bottom of the collection drain assembly is no lower than 7.5 cm (3 in.) above the support stand base.

To flush the flow cell, lower the collection drain assembly to the support stand base to flush the flow cell.

Using an automated flow cell

Change the position of the valve-control switch on the flow valve module to control the flow manually. The valve-control switch has three positions:

- Continuous Open—The flow valve is open.
- Closed—The flow valve is closed.
- Momentary Open—The flow valve is open while the switch is pushed down and held to the Momentary Open position. When the switch is released, the switch goes back to the Closed position and the flow valve closes.

Set the valve-control switch to the Closed position for automated operation of the flow valve module. In automated operation, the instrument controls the flow.

Select static or dynamic mode

In automated operation, the instrument can make flowing (dynamic) or not flowing (static) sample measurements.

Static mode:

1. The flow valve opens for the selected fill time. Refer to Select the fill time on page 36. The flow cell fills and removes the previous sample from the system.
2. The flow valve closes when the fill time interval ends. The last portion of sample flowing through the flow cell is held so that sample volume measurements can be made for the selected measurement time. Refer to Select the measurement time on page 37.
   A measurement is completed and the display is updated about once every second.
3. The readings on the display of the instrument are sent at the selected print time interval to the internal printer (and/or through the RS232 output to an external printer or computer). Refer to Configure the printer output on page 41.
4. At the end of the selected measurement time, the final reading is held on the display and sent to the internal printer (and/or through the RS232 output to an external printer or computer). The FLOW light flashes.

Dynamic mode:

1. The flow valve opens for the selected fill time. Refer to Select the fill time on page 36. The flow cell fills and removes the previous sample from the system.
2. The flow valve stays open when the fill time period ends.
3. Measurements are made on the dynamic (flowing) sample stream as it moves through the flow cell for the selected measurement time. Refer to Select the measurement time on page 37.
   A measurement is completed and the display is updated about once every second.
4. The readings on the display of the instrument are sent at the selected print time interval to the internal printer (and/or through the RS232 output to an external printer or computer). Refer to Configure the printer output on page 41.
5. After the selected measurement time, the flow valve closes and the final reading is held on the display. The final reading is sent to the internal printer (and/or through the RS232 output to an external printer or computer). The FLOW light flashes.

Select the fill time

The fill time is the time interval that the flow valve stays open so that sample flows through the flow cell before measurements are taken.

Set the fill time from 0 seconds to 99 minutes and 99 seconds.

A fill time setting of 0 seconds causes the instrument to start measurement immediately.

Use the flow cell specifications in Table 3 to calculate the correct fill time. Make sure that the fill time includes time to fill the system and to fully remove the previous sample from the system.

Table 3 Automated flow cell specifications

Specification	Details
System flow rate	250 mL/minute
System volume (from the discharge of the inlet reservoir to the outlet of the flow cell, not including the 350 mL inlet reservoir)	30 mL (fill time = 8 seconds)
Purge volume	120 mL (fill time = 30 seconds) minimum Recommended to fully remove the previous sample from the system.[7]

Select the measurement time

The measurement time is the time interval that the instrument measures the sample.

A measurement is completed and the display is updated about once every second.

Set the measurement time from 0 to 99 minutes and 99 seconds (minimum=15 seconds).

A measurement time of 0 provides continuous measurement until FLOW is pushed.

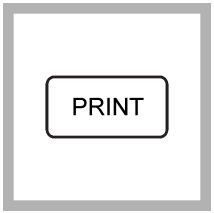
Note: *A measurement time of 0 is not recommended for static mode because particles in the sample may settle over time. The measured turbidity may be lower than the actual turbidity.*

Measurement notes

Before measurement, select the printer to use and the print time interval. Refer to Configure the printer output on page 41.

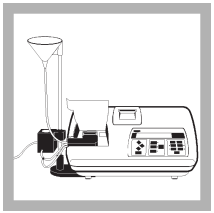
[7] A shorter fill time may be used when the same sample is being measured again and again.

Static or dynamic measurement procedure



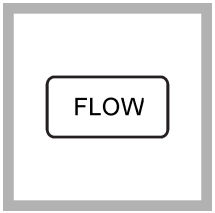
1. Push **PRINT** to turn the print interval feature on.

The PRINT light turns on.



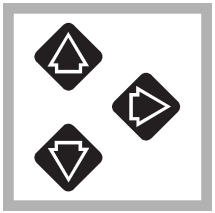
2. Install the automated flow cell. Refer to Install a flow cell on page 35.

Note: *The sample cell cover does not close when the flow cell is installed.*

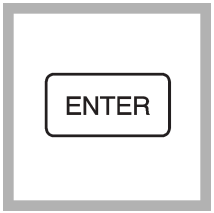


3. Push **FLOW**.

The FLOW light turns on.

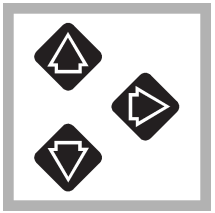


4. Push the up and down arrow keys to select **STAT** (static) or **DYN** (dynamic).

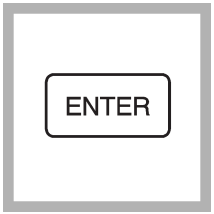


5. Push **ENTER**.

The display shows "MM-SS FIL" (or an actual fill time if a fill time has been selected previously).

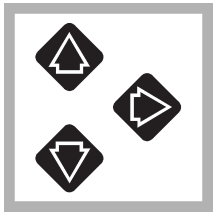


6. Push the arrow keys to select the fill time.

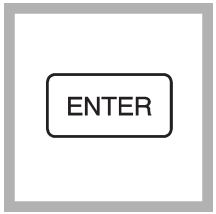


7. Push **ENTER**.

The display shows "MM-SS MEA" (or an actual measurement time if a measurement time has been selected previously).



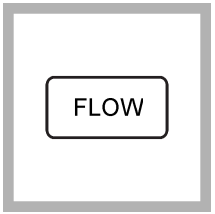
8. Push the arrow keys to select the measurement time.



9. Push **ENTER** to open the flow valve and start the fill time interval.

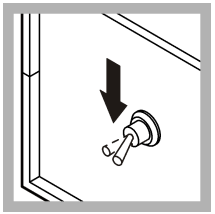
To do the measurement again without the fill time interval, push **ENTER**.

To do the measurement again with the fill time interval, push **FLOW** two times, then push **ENTER**.



10. When measurements are complete, push **FLOW**.

The FLOW light turns off.



11. Push and hold the valve-control switch to the Momentary Open position to drain the flow cell.

Use a cell adapter

Many different test tubes, sample cells and ampules can be used to measure samples when a cell adapter is used. Use a cell adapter when the test tube, sample cell or ampule is less than 25 mm. Refer to Accessories on page 56 for the available cell adapters.

Use only test tubes and sample cells that are free of significant scratches. Clean and apply silicone oil to all sample cells, test tubes and ampules used with the cell adapters. Refer to Clean the sample cell on page 19.

Note: *Performance specifications may be different than shown in* Specifications *on page 5 when test tubes, sample cells or ampules less than 25 mm are used.*

Use a cell adapter when:

- Only a small quantity of sample is available.
- The sample to be measured is in an ampule that cannot be opened.

Refer to Table 4 for minimum sample sizes.

Table 4 Minimum sample sizes

Test tube size	Sample
12 mm	2.5 mL
13 mm	3.5 mL
16 mm	5 mL
19 mm	7 mL

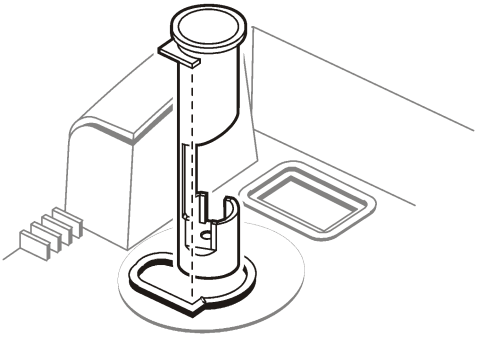
Install a cell adapter

Note: *Use the application specific calibration (ASC) ability of the instrument to provide direct reading of results with cell adapters installed. If the ASC ability is not used, a new calibration curve must be developed each time a cell adapter is used.*

1. Align the tab on the cell adapter toward the front of the instrument (Figure 9).
2. Put the cell adapter in the sample cell holder.
3. Calibrate the instrument each time the sample cell diameter is changed. Calibrate using sample cells of the same path length as the sample cell that will be used to measure samples.

   Note: *If test tubes are taller than the cover for the sample cell compartment, use the tall light shield provided with the cell adapter.*

Figure 9 Install a cell adapter



Remove a cell adapter

1. Carefully pull the cell adapter up until it is half out of the sample cell holder.
2. Slowly turn the cell adapter 90 degrees counter-clockwise.
3. Pull the cell adapter up to remove it.

NOTICE

Do not force the cell adapter out of the instrument as serious damage can occur.

Using the optional filter assemblies

The USEPA filter assembly is used for turbidity measurements. The 455-nm interference filter assembly is used for color measurements.

The 850-nm interference filter assembly can be used to make the instrument meet ISO 7027 specifications.

Use the optional filter assemblies in Accessories on page 56 as necessary to select different wavelengths of light to measure samples.

Calibrate the instrument when the filter assembly is changed.

Application development using alternate wavelengths

It may not be possible to complete measurements in all units of measure for a particular application using the optional filter assemblies (especially turbidity measurements).

For example, the NTU unit of measure may not be the correct unit to use at a 560-nm wavelength for a particular sample. But, the measurement could be completed in Absorbance (ABS) or Transmittance (%T) modes.

The problem that will occur most often when using the turbidity units of measure with the optional filter assemblies is that there will not be sufficient light. Use cell adapters and smaller sample cells to provide a shorter light path. Refer to Use a cell adapter on page 39.

The correct selection of the measurement unit, wavelength and light path length of the sample cell corrects many low-light conditions that occur when applications are made using different wavelengths.

1. Prepare a series of standards solutions that agree with the range to be measured.
2. Select the filter assembly that gives the correct wavelength and install it in the instrument.
3. Select the correct unit of measure.
4. Measure the standards, and record the readings in a graph.
5. If a low-light condition occurs, do step 4 again using a cell adapter and a smaller sample cell.

Connect to a printer or computer

Use the serial interface (RS232) connector on the back of the instrument to transmit data from the instrument to an external printer or a serial communication port on a computer. Refer to Figure 2 on page 9.

To connect a serial printer to the instrument, use a printer cable assembly that is terminated with a standard 25-pin D connector. A serial-to-parallel converter can be used to print to a parallel printer. Data is transmitted to a printer as a 39-character string plus the line feed and carriage return.

To connect a computer to the instrument, use a serial communication cable with a DB9 connector.

Note: *Use of the specified cable or equivalent is mandatory for CE compliance (a shielded cable assembly must be used).*

Configure the printer output

1. Push **SETUP**. The SETUP light turns on.
2. Use the arrow keys to select the printer option:

Option	Description
01	Sets the printer speed—FAST PRT or SLOW PRT (2.5 second delay).
02	Sets the printer to use—INTERNAL, EXTERNAL (RS232 connection) or BOTH.
03	Sets the print time interval for automatic prints of the reading on the display in minutes and seconds (mm-ss)—00-15 to 99-99 (disable=00-00). ***Note:*** *To turn the print interval feature on or off, push **PRINT**.*
04	Sets the printer contrast—0 (darkest print) to 7 (lightest print).

3. Push **ENTER**.
4. Use the arrow keys to change the value.
5. Push **ENTER**.
6. Push **SETUP**.

Configure the RS232 connection

1. Push **SETUP**. The SETUP light turns on.
2. Use the arrow keys to select an option:

Option	Description
10	Sets the baud rate (default=1200).
11	Sets the character length (default=8).
12	Sets the stop bit (default=1).
13	Sets the parity select (default=NONE).

3. Push **ENTER**.
4. Use the arrow keys to change the value.
5. Push **ENTER**.
6. Push **SETUP**.

Computer (RS232) commands

A communication program (i.e., such as Window Terminal or ProComm Plus) is recommended for computer operation of the instrument. Configure the communication program to the RS232 connection settings. Refer to Configure the RS232 connection on page 41.

Table 5 shows the RS232 command set for the instrument.

Table 5 RS232 command set

Command	Description
VAL	Gets the current measurement with the measurement units.
LST	Gets the calibration standards and coefficients.
DAT	Gets the current date. To change the date, enter **DAT=MM/DD/YY** (MM=month, DD=day, YY=year), then push **Enter**.
TIM	Gets the current time in 24-hour format. To change the time, enter **TIM=HH:MM** (HH=hour, MM=minutes), then push **Enter**.

Table 5 RS232 command set (continued)

Command	Description
RMN	Gets the recorder minimum value. To change the recorder minimum value, enter **RMN=XXXXX** (XXXXX=a number, minimum value=0), then push **Enter**.
RMX	Gets the recorder maximum value. To change the recorder maximum value, enter **RMX=XXXXX** (XXXXX=a number, maximum value=10,000), then push **Enter**.
RTN	Gets the recorder trim minimum value. To change the recorder minimum value, enter **RTN=XXXXX** (XXXXX=a number, minimum value=200), then push **Enter**.
RTX	Gets the recorder trim maximum value. To change the recorder maximum value, enter **RTX=XXXX** (XXXX=a number, maximum value=4800), then push **Enter**.
SAV	Gets the signal average buffer size. To change the signal average buffer size, enter **SAV=XX** (XX=a number, maximum value=15, default=10), then push **Enter**.

Connect to a data recorder

Note: *Use a twisted-pair, shielded recorder cable. Use of non-shielded recorder cable may result in radio wave emission levels greater than is allowed under the compliance regulations listed.*

Note: *Connect the shield of the recorder cable to the recording device chassis ground terminal to decrease the effects of unwanted interferences.*

Connect a ¼–inch recorder phone plug to the recorder output jack on the back of the instrument. Refer to Figure 2 on page 9. For the best performance, use a twisted-pair, shielded recorder cable that is no more than 1.8 m (6 ft) in length with a load impedance greater than 10 kohms.

Configure the data recorder output

Note: *The recorder minimum and maximum values are selected independently for each measurement mode. When the measurement mode changes, the previous settings are automatically used.*

1. Push **SETUP**. The SETUP light turns on.
2. Use the arrow keys to select an option:

Option	Description
14	Sets the minimum value of the recorder output for the current measurements units.
15	Sets the the maximum value of the recorder output for the current measurement units.
16	Moves the recorder minimum output to calibrate the recorder.
17	Moves the recorder full-scale output to calibrate the recorder.
18	Sets the recorder to zero scale.
19	Sets the recorder to half scale.
20	Sets the recorder to full scale.

3. Push **ENTER**.
4. If option 14 or 15 was selected, move the decimal point to the correct location using the right arrow key, then push **ENTER**.
5. Use the arrow keys to change the value.
6. Push **ENTER**.
7. Push **SETUP**.

Advanced operation

Calibrate the turbidimeter with formazin standards

The instrument may be calibrated using prepared formazin standards made from 4000-NTU formazin stock solution. Refer to Accessories on page 56.

Note: *Use recently prepared formazin standards to get the accuracy specifications for turbidity in* *Specifications on page 5*.

Prepare formazin standards

For the best accuracy and long-term data comparability, use formazin stock solution from Hach to make formazin standards.

Note: *As an alternative, a 4000-NTU formazin stock solution that is prepared by the user may be used to make formazin standards. Refer to* Making 4000-NTU formazin stock solution *on page 46.*

Prepare formazin standards immediately before calibration in an environment that is at the same ambient temperature as the instrument. Discard after use.

Refer to Table 6 for the procedures to make the recommended calibration standards.

Table 6 Formazin standard preparation

Standard	Step 1	Step 2	Step 3
20 NTU	Add 100 mL of dilution water to a clean 200-mL Class A volumetric flask. Refer to Prepare dilution water on page 24.	With a TenSette® Pipet, add 1.00 mL of well-mixed 4000-NTU formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
200 NTU	Add 50 mL of dilution water to a clean 100-mL class A volumetric flask.	With a TenSette[8] Pipet, add 5.00 mL of well-mixed 4000-NTU formazin stock solution to the 100-mL flask.	Dilute to the mark with dilution water. Stopper and mix.

Table 6 Formazin standard preparation (continued)

Standard	Step 1	Step 2	Step 3
1000 NTU	Add 50 mL of dilution water to a clean 100-mL class A volumetric flask.	With a TenSette[8] Pipet, add 25.00 mL of well-mixed 4000-NTU formazin stock solution to the 100-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
4000 NTU	Rinse a clean sample cell two times with well-mixed 4000-NTU formazin stock solution. Put about 30 mL of 4000-NTU formazin stock solution in the sample cell. No dilution is necessary.	—	—
7500 NTU	The 7500-NTU formazin standard is provided in an ampule and is ready for use. Refer to Accessories on page 56. Do not open the ampule or use the contents as dilution stock. The 7500-NTU formazin standard is stable for up to one year.	—	—

Calibration notes

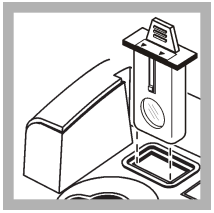
- Make sure that the instrument is in the same ambient conditions as where it is used.
- Make sure that the standards are at the same ambient temperature as the instrument before use.

[8] A class A volumetric pipet may be used in place of a TenSette Pipet.

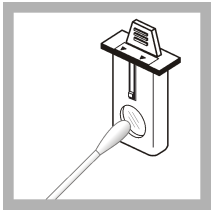
- Use only the provided silicone oil. This silicone oil has the same refractive index as the vial glass and masks minor glass differences and scratches.
- Store the oiling cloth in a plastic storage bag to keep the cloth clean.
- If power is lost during calibration, the new calibration data is lost and the last calibration data is used. To exit a calibration and not save the new values, push **UNITS/Exit**.
- In Calibration mode, automatic range and signal averaging on are selected. When calibration is completed, all operational modes go back to the last settings.
- All nephelometric (turbidity units of measure) calibrations are done at the same time.
- Ratio-on and Ratio-off calibration data is measured and recorded at the same time.
- The 7500-NTU standard does not have to be measured during calibration if turbidity less than 4000 NTU will be measured. Push **CAL/Zero** after the 4000 NTU standard is measured to complete the calibration procedure.
- Clean the USEPA filter assembly before doing a primary calibration, or at least every 3 months (which is the USEPA-recommended primary calibration interval).

Formazin calibration procedure

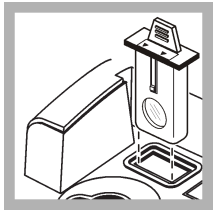
For the best accuracy, use four matched sample cells or the same sample cell for all measurements during calibration. Refer to Matching sample cells on page 22.



1. Remove the filter assembly. Refer to Change the filter assembly on page 50.



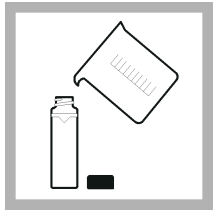
2. Clean and inspect the lens of the USEPA filter assembly. Refer to Clean the filter assembly on page 50.



3. Hold the tab of the USEPA filter assembly so that the arrows point toward the front of the instrument. Push the filter assembly fully into the housing.

4. Push **CAL/Zero**.

The CAL/Zero light turns on, and the mode display shows "00" . The NTU value of the dilution water used in the previous calibration is shown.

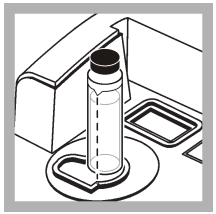


5. Rinse a clean sample cell two times with dilution water. Fill the sample cell to the line (about 30 mL) with dilution water and immediately put the cap on the sample cell. Use the same dilution water that was used to prepare the formazin standards.

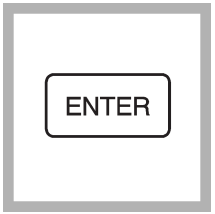
6. Clean the sample cell with a soft, lint-free cloth to remove water spots and fingerprints. Do not invert the sample cell.

7. Apply a small bead of silicone oil from the top to the bottom of the sample cell.

8. Use the oiling cloth provided to apply the oil equally to the surface of the sample cell. Remove the excess oil. Make sure that the sample cell is almost dry.



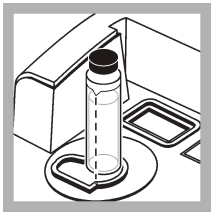
9. Put the sample cell in the sample cell holder with the triangle on the sample cell aligned with the reference mark on the sample cell holder. Close the cover.



10. Push **ENTER**.

The instrument display counts down from 60 to 0, and then measures the standard.

The instrument shows the next expected standard (e.g., 20.00). The mode display shows "01".



11. Remove the sample cell from the sample cell holder.

12. Do steps 5–11 for the other formazin standards (from lowest to highest NTU standard). Mix each formazin standard well and rinse the sample cell two times with formazin standard before the sample cell is filled.

The mode display shows "00" after the last sample cell is measured.

13. Push **CAL/Zero**.

The instrument saves the new calibration data and goes back to Measurement mode.

Making 4000-NTU formazin stock solution

⚠ WARNING

Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current material safety data sheets (MSDS) for safety protocols.

Note: *Making formazin stock solution from raw materials is not recommended. Preparation of formazin stock solution is temperature and technique sensitive. Use Hach formazin stock solution to get the best instrument performance and analytical standard accuracy.*

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($(NH_2)_2$–$H_4H_2SO_4$) in about 400 mL of demineralized water.
2. Dissolve 50.000 grams of reagent grade hexamethylenetetramine in about 400 mL of demineralized water.
3. Quantitatively, put the two solutions in a 1-liter volumetric flask, and dilute to volume with demineralized water. Mix fully.
4. Let the solution stand for 48 hours at 25 ± 1 °C (77 ± 1 °F).

Calibrate the turbidimeter with user-selected formazin standards

The instrument may be calibrated using user-selected values of formazin standards.

Calibration with user-selected values of formazin standards is done using the same method that is used to calibrate the instrument with recommended formazin standards with two differences:

- The prepared formazin standards used are user-selected standards and not the recommended standards. Refer to Prepare formazin standards – user selected on page 46.
- The calibration points that are shown on the display must be changed as they occur so they agree with the turbidity of the user-defined standards. Refer to Change the calibration points on page 46.

Note: *Unknown performance may occur if standards other than the recommended calibration points are used. The recommended calibration points (< 0.1, 20, 200, 1000, 4000 and 7500 NTU) provide the best calibration accuracy. Refer to Application note 128, Calibration Methods for Low-Level Turbidity Measurement.*

Prepare formazin standards – user selected

User-selected values of formazin standards are prepared using the same method that is used to prepare the recommended formazin standards. Refer to Prepare formazin standards on page 43.

Prepare user-selected values of formazin standards to span the entire range of the instrument. Four standards are necessary. Suggested standards are in the range of:

- 10–30 NTU
- 180–220 NTU
- 900–1000 NTU
- 4000 NTU

Formazin standards greater than 80 NTU must have a difference of at least 60 NTU.

Change the calibration points

When using user-selected values of formazin standards during calibration, change the calibration points that are shown on the display as they occur. Change the calibration points so that they agree with the turbidity of the user-defined values.

For example: A 25-NTU standard is put in the sample cell holder instead of the recommended 20-NTU standard during calibration. Change the "20.000" on the display to "25.000" before pushing ENTER to start the measurement.

To change the value on the display during calibration:

1. Push the right arrow key. The decimal point flashes.
2. Push the right arrow key to move the cursor to the next position.
3. Push **ENTER** to accept the new cursor position.
4. Use the up and down arrow keys to change the number on the display.
5. Do steps 2–4 again if necessary to change the other digit.
6. Push **ENTER** to save the change and start the measurement.

Special research applications

The instrument has special features and operations for special research applications.

Application specific methods

Use the application specific calibration (ASC) measurement modes to measure turbidity with direct readout in units other than NTU, NEP, or EBC. The unit of measurement, initially referred to as ASC -1- and -2- can be changed by choosing alpha numeric characters during method entry.

ASC methods are made by measuring specific known standards in the NTU mode. Then, data pairs (NTU versus know standard) are entered in the instrument memory. Refer to Program new ASC data on page 48. After entry, the instrument display shows direct reading measurements in the custom unit of measure.

For example: An application for monitoring oil in water can be assigned a unit of OIW. Up to eight calibration points can be stored for the application specific calibration.

A complete understanding of the sample being measured is necessary to make application specific measurements. For successful development of custom applications:

- Use a homogeneous sample.
- Determine the effect of temperature on the sample. Provide a means to control temperature if measurements change significantly with temperature.
- Use a well-defined sample. That is, know all the variables in the sample that affect absorbance or scatter light.

  For example: To measure oil in water, suspended oil must be the primary variable that causes light to scatter or absorb. If other variables in the sample matrix also affect the scattered light detection, there is no way to see a difference between changes in concentration of suspended oil and changes in other sample variables.

Application specific calibration

Nephelometric analysis can result in a calibration curve that is not linear. This instrument can store two application specific caibration (ASC) curves with up to eight data pairs in each.

This instrument uses point-to-point interpolation between entered standards for the ASC calibrations. A series of small, straight lines similar to the nonlinear curve is made.

Before using ASC measurement modes:

- At a minimum, ASC curves must contain linear portions because the instrument calculates only point-to-point curves. The instrument measurements do not use linear regression (least-squares-best-fit) analysis.
- Proper calibration of the instrument for turbidity measurement is necessary. The ASC is based on turbidity units in NTU as the independent variable and the user-defined standards as the dependent variable.
- The sample must be studied before measurement to identify the appropriate cell adapter (when necessary) and filter assembly to use.
- Prepare a series of standards for the ASC unit. Select and install the appropriate cell adapter (when necessary) and filter assembly. Measure the turbidity of the standards in NTUs. Record the results, and plot the prepared standards vs. their corresponding turbidity in NTUs. Refer to Table 7 as an example.
- Always measure the NTU value of the known standard in the same size sample cell to be used for the ASC unit measurement.

Table 7 Standards

Point number	NTU	Concentration (mg/L)
1	0.000	0
2	0.318	10
3	0.542	20
4	0.663	30
5	0.709	40

Either ASC can be changed at any time, so recalibration is not necessary.

The sample is under-range if the display flashes 0s.

If the display flashes 0s when measuring color, absorbance or transmittance, set the analytical reference point again and measure again. Also, make sure that the expected reading is positive when measuring absorbance.

Initial ASC entry

Up to eight standards can be entered in either of the two application specific calibrations (ASCs). Enter standards in order of increasing turbidity.

A record of either ASC can be made on the printer for later analysis. Refer to Make a print of ASC data points on page 48.

In Table 7 on page 47, a calibration that is not linear is made from five standards of known mg/L concentrations. Corresponding NTU values are identified by measuring the known standards with the instrument.

Note: *Make sure that the instrument is calibrated before making NTU measurements.*

Program new ASC data

1. Push **UNITS/Exit** until the correct ASC unit name is shown on the display (ASC -1- or -2-).
2. Push **CAL/Zero** to enter the ASC calibration mode.

   The left digit flashes.
3. Use the arrow keys to enter a three-digit calibration name.

   Note: *The name cannot be one of the units already used NTU, NEP, EBC, %T, A, CU, -1- or -2-).*
4. Push **ENTER**.

   The mode display flashes "01" for data point 1. The blank spaces before of the NTU units ("----- NTU") show that no value is assigned to the data point.
5. Push the right arrow key to change the value of the data point.

   The display shows "0.0000" with the decimal flashing.
6. Push **ENTER** to accept the decimal point position.

   The left digit of the display flashes.
7. Use the arrow keys to change the number on the display to the correct NTU value. Refer to Table 7 on page 47 as an example.
8. Push **ENTER** to accept the NTU value.

   The display shows "0.0000 MGL" with the decimal point flashing.
9. Push the right arrow key one time to move the flashing decimal point one position to the right.
10. Push **ENTER** to accept the decimal point position.

    The left digit of the display flashes.
11. Use the arrow keys to change the number on the display to the correct mg/L (MGL) value for the data point . Refer to Table 7 on page 47 as an example.
12. Push **ENTER** to accept the MGL value.

    The mode display flashes the next data point (e.g., "02" for data point 2).
13. Do steps 5–12 again until NTU and MGL values are entered for data points 1–5.

    Note: *Push **UNITS/Exit** at any time to exit and not save the ASC calibration values.*
14. Push **CAL/Zero** to save the new ASC calibration.

    "ERR13" is shown on the display if the NTU values are not entered in ascending order or only one point has been entered. Push **ENTER** to clear the error message and inspect the NTU values entered with the up and down arrow keys. Refer to Change an ASC unit name or one ASC data point on page 49.

Make a print of ASC data points

To make a print of application specific calibration (ASC) data points:

1. Push **UNITS/Exit** until the correct ASC name is shown on the display.
2. Push **CAL/Zero** to enter ASC calibration mode.
   The display flashes "EDIT?".
3. Push **PRINT** to make a print of the ASC data points.

Note: A print of a graph of the ASC points is also made if the internal printer is enabled.

4. Push **UNITS/Exit** to return to measurement mode.

Change an ASC unit name or one ASC data point

Any ASC unit name or data point can be changed.

*Note: Push **UNITS/Exit** at any time during this procedure to go back to Measurement mode and not save changes.*

1. Push **UNITS/Exit** until the correct ASC name is shown on the display.
2. Push **CAL/Zero** to enter ASC calibration mode.

   The display flashes "EDIT?".
3. Push **ENTER**.

   The left digit flashes.
4. To change the unit name, use the arrow keys to change the unit name on the display.
5. Push **ENTER**.

   The mode display flashes "01" for data point 1. The NTU value that is assigned to data point 1 is shown on the display.
6. To change an NTU value for a data point:

   a. Push the up arrow key until the correct data point is shown on the mode display (e.g., "04" for data point 4).
   b. Push the right arrow key to change the NTU value of the data point.

      The display shows the current NTU value with the decimal point flashing.
   c. Push **ENTER** to accept the decimal point location.

      The left digit flashes.
   d. Use the arrow keys to change the NTU value on the display.
   e. Push **ENTER** to accept the NTU value.

      The display shows the MGL value assigned to the data point with the decimal point flashing.
7. Push **ENTER** to accept the decimal point location.

   The left digit flashes.
8. Push **ENTER** to accept the MGL value shown on the display.

   The mode display flashes the next data point (e.g., "05" for data point 5).
9. Push **CAL/Zero** to save the changed ASC calibration.

   "ERR13" is shown on the display if the NTU values are not entered in ascending order or only one point has been entered. Push **ENTER** to clear the error message and inspect the NTU values entered with the up and down arrow keys.

Delete one ASC data point

Any ASC data point can be deleted individually.

1. Push **UNITS/Exit** until the correct ASC name is shown on the display.
2. Push **CAL/Zero** to enter ASC calibration mode.

   The display flashes "EDIT?".
3. Push **ENTER**.

   The left digit flashes.
4. Push **ENTER** to accept the unit name.

   The mode display flashes "01" for data point 1. The NTU value that is assigned to data point 1 is shown on the display.
5. Push the up arrow key until the correct data point is shown on the mode display (e.g., "04" for data point 4).
6. Push the right arrow key to change the data point.
7. Push **ENTER** to accept the decimal point.

   The left digit flashes.
8. Push the up and down arrow keys until an "X" is shown on the display.
9. Push **ENTER** to delete the data point.

   The display of "----- NTU" shows that the data point value is deleted.
10. Push **CAL/Zero** to save the changed ASC calibration.

    Note: The deleted data point is replaced by blanks and is not used in the calibration curve calculation.

Delete all the ASC data points

Either of the ASC calibration curves can be deleted and the ASC unit name changed back to the factory default.

1. Push **UNITS/Exit** until the correct ASC name is shown on the display.
2. Push **CAL/Zero** to enter ASC calibration mode.

   The display flashes "EDIT?".
3. Push the up or down arrow key until "DEL?" flashes on the display.
4. Push **ENTER** to delete all the ASC data points and change the ASC unit name back to the factory default.

Maintenance

⚠ DANGER

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

Clean the instrument

Keep the instrument clean to get continuous and accurate operation.

NOTICE

Never use cleaning agents such as turpentine, acetone or similar products to clean the instrument including the keypad.

1. Turn the instrument off and disconnect the power cord.
2. Clean the surface of the instrument with a soft, moist cloth and a weak soap solution.
3. Dry the surface of the instrument with a lint-free cloth.

Change the filter assembly

NOTICE

The filter assembly is fragile and must be handled with care to prevent damage.

1. Hold the tab of the filter assembly and pull straight up and out of the instrument.
2. Store the filter assembly in a clean container.
3. Before installation, clean the lens of the filter assembly. Refer to Clean the filter assembly on page 50.
4. Hold the tab of the filter assembly with the arrows pointing toward the front of the instrument.
5. Push the filter assembly fully into the housing.

Clean the filter assembly

Note: *Be careful not to push the lens out of the filter assembly.*

1. Clean both sides of the lens of the filter assembly with glass cleaner, lens cleaner or isopropyl alcohol, and a cotton-tipped swab or lens tissue.
2. Inspect the filter glass for scratches or other damage.
3. If a cloudy circle is seen around the edge of the filter, the filter material is delaminating. Replace the filter assembly.

Replace the lamp

⚠ CAUTION

Wear protective eye wear when the lamp is turned on and the lamp cover is removed.

⚠ CAUTION

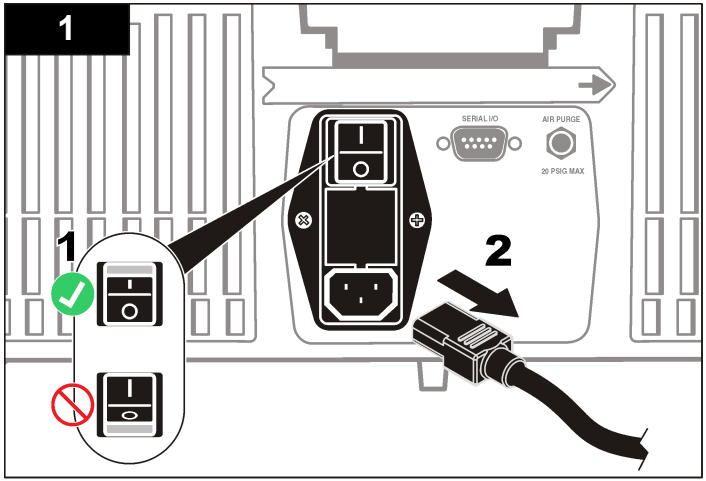
Burn hazard. The lamp must be cool before removal from the instrument.

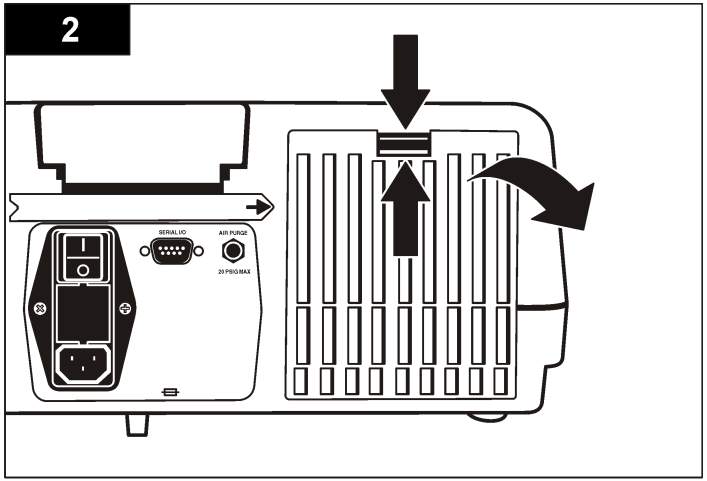
Notes:

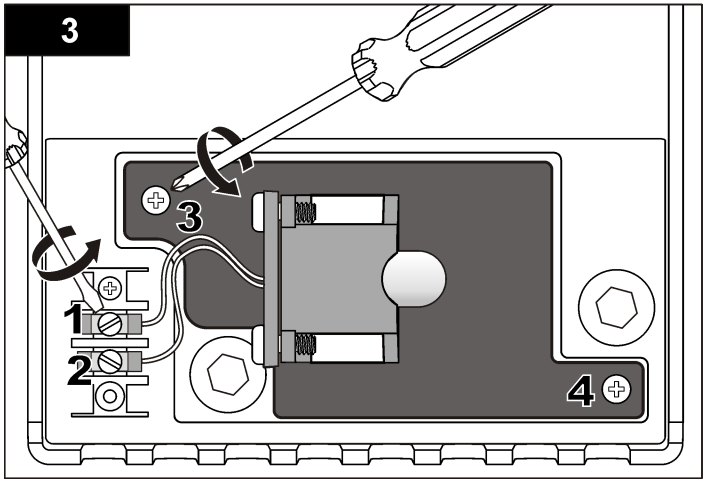
- Replace the lamp with the same size, style and electrical rating (4708900). Refer to Replacement parts and accessories on page 55.
- Do not touch the lamp as oil from skin will damage the lamp. Clean the lamp with alcohol as necessary.
- Either lamp lead can be put in either terminal block position.
- Turn the instrument on 30 minutes (Ratio on) or 60 minutes (Ratio off) before measurement or calibration.
- Calibrate the instrument after the lamp is replaced.

To remove the lamp, refer to the illustrated steps.

To install the lamp, do the illustrated steps in the opposite direction.


1
SERIAL I/O
AIR PURGE
20 PSIG MAX
1
2


2
SERIAL I/O
AIR PURGE
20 PSIG MAX


3
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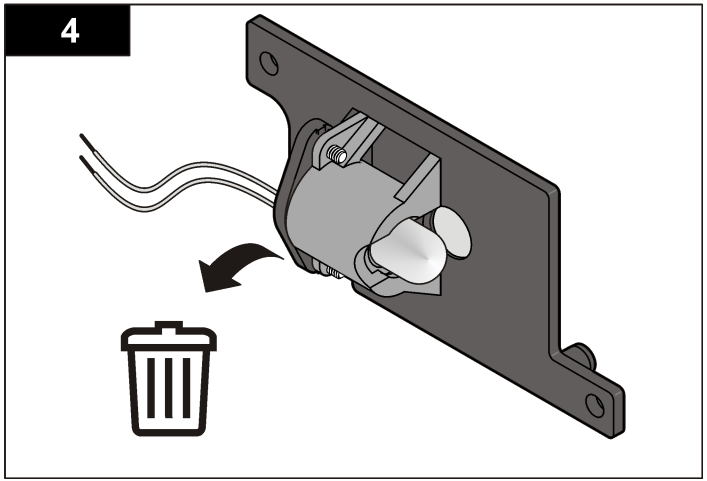

4

Replace a fuse

⚠ DANGER

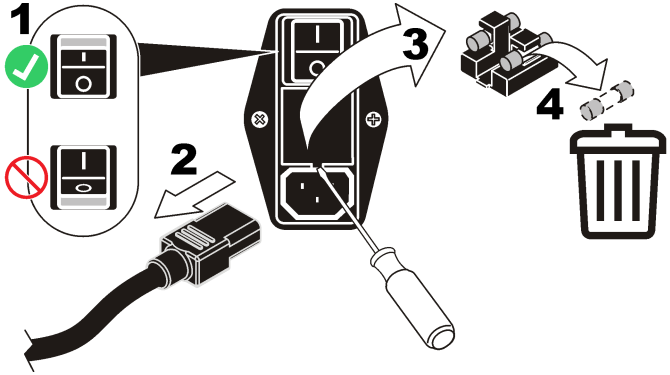
Fire hazard. Use the same type and current rating to replace fuses.

Replacement parts:

- Fuse for 115 V operation, time-delay, 250 V, 1.6 A (3030700), or
- Fuse for 230 V operation, time-delay, 250 V, 1.6 A (3030600)

To replace a fuse, refer to the illustrated steps in Figure 10.

Figure 10 Replace a fuse



Troubleshooting

Refer to the tables in this section for error codes, diagnostic codes, common problem messages or symptoms, possible causes and corrective actions.

Error codes

Table 8 lists the error codes shown for different conditions. Error codes identify instrument malfunction or operator error.

The instrument continues operation in an error condition.

Push **ENTER** to clear an error code from the display.

Note: *Any calibration being calculated when an error occurs, is discarded. The old calibration is kept.*

Table 8 Error codes

Error	Description	Solution
ERR01	The turbidity of the dilution water is greater than 0.5 NTU.	Start the calibration again with lower turbidity dilution water. ***Note:*** *Ignore ERR01 when the sample cell diameter is less than 25 mm. Push **UNITS/Exit** to go back to measurement mode.*
ERR02	• Two calibration standards have the same value. • The difference between two calibration standards is less than 60.0 NTU. • The turbidity of Standard 1 is too low (less than 10 NTU).	**1.** Inspect the preparation of standards. **2.** Do the calibration again. ***Note:*** *Ignore ERR02 when the sample cell diameter is less than 25 mm. Push **UNITS/Exit** to go back to measurement mode.*

Table 8 Error codes (continued)

Error	Description	Solution
ERR03	Low light error	**1.** Put the sample in the instrument again. **2.** Make sure that the lamp icon light is on. **3.** Make sure that an object is not in the light path. **4.** Do sample dilution if necessary. ***Note:*** *If this error occurs when a filter assembly other than the USEPA filter assembly is installed, the filter assembly should not be used for turbidity measurements.*
ERR04	Memory malfunction	**1.** Turn the instrument off and then back on. **2.** Contact Technical Support if the error occurs again.
ERR05	A/D is over the range	**1.** Make sure that the light shield is closed. **2.** Contact Customer Service if necessary.
ERR06	A/D is under the range	**1.** Make sure that no object is in the light path. **2.** Contact Customer Service if necessary.
ERR07	Light leak	**1.** Make sure that the cover for the sample cell compartment is closed. **2.** Turn the instrument off and then back on.
ERR09	Printer time out error or paper in the internal printer can not move	**1.** Gently pull up on the paper in the internal printer to remove the obstruction. **2.** Make sure that the external printer is connected correctly. **3.** Make sure that the external printer is selected (online).

Table 8 Error codes (continued)

Error	Description	Solution
ERR10	System voltage out of range	**1.** Turn the instrument off and then back on. **2.** Contact Customer Service if the error occurs again.
ERR11	System loop test error	**1.** Turn the instrument off and then back on. **2.** Contact Customer Service if the error occurs again.
ERR12	ASC units name error	Enter an application specific calibration (ASC) unit name that is not one of the default units (i.e., NTU or EBC).
ERR14	Invalid time error	The time must be between 00-00 and 23-59.
ERR15	Invalid date error	The date must be between 01-00 and 12-31.

Diagnostic codes

Table 9 lists the diagnostic codes that are used to get information about instrument operation when instrument operation is in doubt.

To do a diagnostic test:

1. Push **SETUP**.
2. Use the arrow keys to enter a diagnostic code.
3. Push **ENTER** to show the diagnostic value.
4. Push **UNITS/Exit** to go back to Measurement mode.

Note: *To print a diagnostic report, hold down **PRINT**, then turn the instrument on.*

Table 9 Diagnostic codes

Code	Display	Description
21	"PRINT TST"	Printer test
22	Test results are shown.	Display test

Table 9 Diagnostic codes (continued)

Code	Display	Description
23	Test results are shown.	Keyboard test
24	Test results are shown.	Memory test

Delete calibration data

To delete any calibration data entered by the user:

1. Turn off the instrument.
2. Push and hold **CAL/Zero**.
3. Turn on the instrument.
   The CAL? light flashes. The instrument starts in Calibration mode.
4. Calibrate the instrument before use.

Flashing 9s

When manual ranging is selected, the display will flash all 9s when the sample being measured is greater than the selected range.

When automatic ranging is selected, the display will flash 9s when the sample is greater than the maximum range of the instrument. The display will also flash 9s if Ratio is off and the measurement is greater than 40 NTUs (268 nephelos or 9.8 EBCs). Turn Ratio on. Refer to Measure over-range samples on page 25.

Flashing 0s

When manual ranging is selected, the display will flash all 0s when the sample measured is less than the selected range.

When automatic ranging is selected, the display will flash all 0s when the measurement is less than the range of the instrument or a negative value. Calibrate the instrument.

- When measuring color, absorbance or transmittance, set the zero reference point again.
- When measuring absorbance, make sure that the reading is positive. To measure samples with negative absorbance, set the analytical zero using the sample with the greatest absorbance and read the sample with the least absorbance. Record the reading as negative absorbance.

Replacement parts and accessories

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Replacement parts

Description	Quantity	Item no.
Calibration kit, StablCal®, sealed sample cells (<0.1, 20, 200, 1000, 4000 and 7500 NTU)	1	2659505
Cover, sample cell compartment	1	4702500
Cover, lamp access	1	4703200
Cover, printer	1	4705400
Dust cover	1	4703000
Filter assembly, USEPA	1	3031200
Filter assembly, 455 nm	1	1999800
Fuse for 115 V operation, time-delay, 250 V, 1.6 A, UL/CSA approved	1	3030700
Fuse for 230 V operation, time-delay, 250 V, 1.6 A, IEC type, VDE approved	1	3030600
Gelex® secondary turbidity standardization kit (stray light standard and 0–2, 0–20, 0–200, 200-4000, and 4,000–10,000 NTU)	1	2589200
Lamp replacement kit	1	4708900
Oiling cloth	1	4707600
Power cord, North America, 115 VAC, UL/CSA approved	1	1801000

Replacement parts (continued)

Description	Quantity	Item no.
Power cord, European, 230 VAC, VDE approved	1	4683600
Printer paper, thermal	5	4709000
Sample cells, 30mL, 1 in. round glass	6	2084900
Silicone oil	1	126936

Accessories

Description	Quantity	Item no.
Color standard solution, 500 platinum cobalt (Pt-Co) color units (CU)	1000 mL	141453
Calibration kit, StablCal®, 100 mL each (<0.1, 20, 200, 1000, 4000 and 7500 NTU)	1	2659510
Calibration kit, StablCal®, 500 mL each (<0.1, 20, 200, 1000, 4000 and 7500 NTU)	1	2659500
Cable, computer, DB-9 to DB-9	1	4950200
Cell adapter, 12–13 mm	1	3033400
Cell adapter, 16 mm	1	3033500
Cell adapter, 19 mm	1	3033600
Filter assembly, empty (accepts a 25.4 mm (1 in.) diameter and 6.35 mm (0.25 in.) thick filter)	1	3039800
Filter assembly, 500 nm	1	3036700
Filter assembly, 560 nm	1	3037100
Filter assembly, 600 nm	1	5432200
Filter assembly, 610 nm	1	3037300

Accessories (continued)

Description	Quantity	Item no.
Filter assembly, 810 nm	1	3037600
Filter assembly, 860 nm (specified by ISO 7027 for turbidity measurement)	1	1999900
Filter disks	10	2323810
Filter, membrane (without pad)	200	1353001
Filter paper, glass fiber, quantitative, 47 mm	100	253000
Flow cell kit, automated, 115 V, low pressure	1	4745000
Flow cell kit, automated, 230 V, low pressure	1	4745002
Flow cell kit, manual, low pressure	1	4744900
Flow cell, glass (included with the manual and automated flow cell kit)	1	4709500
Flow valve module kit, 120 VAC, for the automated flow cell (includes the flow valve module and power supply)	1	4744500
Flow valve module kit, 230 VAC, for the automated flow cell (includes the flow valve module and power supply)	1	4744502
Formazin stock solution, 4000 NTU	100 mL	246142
Formazin stock solution, 4000 NTU	500 mL	246149
Formazin high-range turbidity standard, 7500 NTU ampule	1	2584202
Pump, vacuum, hand-operated	1	1428300

Accessories (continued)

Description	Quantity	Item no.
Pump, vacuum/pressure, 115V, 60 Hz, 1.2 cfm	1	2424800
Pump, vacuum/pressure, 220V, 50 Hz, 1.2 cfm	1	2824802
Sample degassing kit	1	4397500
Sample degassing and filtration kit	1	4397510
0.1 NTU, StablCal™ low-level turbidity verification standards (not for instrument calibration)	100 mL	2723342
0.3 NTU, StablCal™ low-level turbidity verification standards (not for instrument calibration)	100 mL	2697942
0.5 NTU, StablCal™ low-level turbidity verification standards (not for instrument calibration)	100 mL	2698042
TenSette® Pipet, 1.0-10.0 mL,	1	1970010
TenSette® Pipet Tips	250	2199725
Tubing, tygon, ¼-inch OD x $^{1}/_{16}$ inch wide, for the manual or automated flow cell	1 ft	4134400
Tubing, tygon, $^{3}/_{8}$-inch OD x $^{1}/_{16}$ inch wide, for the automated flow cell	1 ft	518137
Tubing, tygon, ½-inch OD x $^{1}/_{16}$ inch wide, for the manual flow cell	1 ft	518637
Ultrasonic bath	1	2489500
Volumetric flask, 100 mL, Class A	1	1457442
Volumetric flask, 200 mL, Class A	1	1457445

Optional reagents

Description	Quantity	Item no.
Hexamethylenetetramine	500 g	187834
Hydrazine sulfate	100 g	74226

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