Operating manual

DULCOTEST® DT2C
Photometer

A0944

Please carefully read these operating instructions before use! · Do not discard!
The operator shall be liable for any damage caused by installation or operating errors!
Technical changes reserved.

Part number 985619 **Target group: instructed personnel** BA DT 036 02/12 EN

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General non-discriminatory approach

In order to make it easier to read, this document uses the male form in grammatical structures but with an implied neutral sense. It is aimed equally at both men and women. We kindly ask female readers for their understanding in this simplification of the text.

Supplementary information

Please read the supplementary information in its entirety.

The following are highlighted separately in the document:

- Enumerated lists

→ Instructions

  ⇨ Outcome of the instructions

Information

This provides important information relating to the correct operation of the device or is intended to make your work easier.

Safety information

The safety information includes detailed descriptions of the hazardous situation.

Table of contents

1 General information

WARNING!

Danger from hazardous substances!

Possible consequence: Fatal or very serious injuries.

Please ensure when handling hazardous substances that you have read the latest safety data sheets provided by the manufacture of the hazardous substance. The actions required are described in the safety data sheet. Check the safety data sheet regularly and replace, if necessary, as the hazard potential of a substance can be re-evaluated at any time based on new findings.

The system operator is responsible for ensuring that these safety data sheets are available and that they are kept up to date, as well as for producing an associated hazard assessment for the workstations affected.

1.1 Scope of supply

The following components are included as standard:

Description	Quantity
■ Case, blue with blue fasteners – with ProMinent sticker, Dulcotest DT2C photometer, code 1039316 – and danger symbol	1
Foam insert for the case	1
Cover foam for the case	1
■ Photometer DT2C – Chlorine, chlorine dioxide, fluoride – Battery compartment lid with O-ring	1
Screwdriver with clip, red	1
Countersunk screws	4
Batteries, 1.5 V alkali-manganese, type AA	4
Round cuvettes, 10 ml, d = 24 mm, h = 48 mm	6
Lid for round cuvette, 24 mm, grey	6
Sealing rings, grey	6
Syringe, 2 ml	1
Syringe, 10 ml	1
Plastic mixing rod, 10 cm long	1
Cleaning brush	1
Operating instructions for Dulcotest DT2C	1
DPD-1 buffer, 15 ml bottle, blue	1
DPD-1 reagent, 15 ml bottle, green	1
DPD-3 solution, 15 ml bottle, red	1

Description	Quantity
Separately packed:	
SPADNS reagent, 250 ml	1
Calibration standard 1 mg/l fluoride, 30 ml	1

1.2 Instructions for use

- *Request the safety data sheets.*
- *Reagents are intended for chemical analysis and access to them by unauthorised persons must not be permitted.*
- *You must dispose of reagent solutions properly.*
- *Observe the application possibilities, analysis instruction and matrix effects of the methods.*

1. You must thoroughly clean the cuvettes, lids and stirring rod after each analysis to avoid carry-over errors.

   Even slight reagent residue can lead to incorrect measurement results. For cleaning use the supplied brush.

   If the fully reacted water sample is left for any length of time it may produce stubborn coloured deposits, which you can remove using dilute (= 4 %) hydrochloric acid.

2. The outer walls of the cuvettes must be clean and dry before the analysis is carried out. Fingerprints or water droplets on the light-entry surfaces of the cuvette will result in faulty measurements. The cuvette should therefore be wiped clean with a soft paper tissue (paper handkerchief) before carrying out the measurement.

3. The zero correction and the analysis must both be carried out using the same cuvette, as the cuvettes may have slightly varying tolerances.

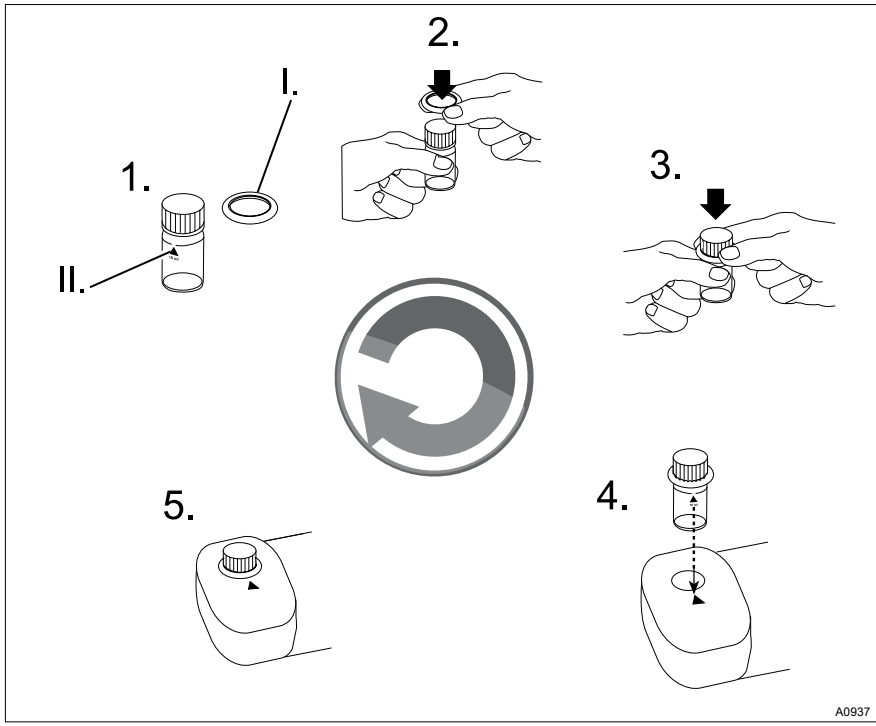

Fig. 1: Cuvette positioning (Ø 24 mm):

I. Seal
II. Marking with the white triangle

4. For the zero correction and test, the cuvette must be positioned in the sample chamber in such a way that the marking with the white triangle (II.) points towards the housing marking.

5. You must carry out the zero correction and test with the cuvette lid closed. You must provide the cuvette lid with a sealing ring (I.) to prevent the entrance of light into the sample chamber.

6. Formation of bubbles on the inside walls of the cuvette will result in faulty measurements. Should this happen, seal the cuvette with the cuvette lid and tip it back and forth to dissolve/remove the bubbles before carrying out the test.

7. It is important to prevent water getting into the sample chamber because this leads to incorrect measurement results.

8. Dirt in the transparent sample chamber leads to incorrect measurement results. The light entry surfaces should be checked at regular intervals and cleaned as necessary.

   Standard spectacle cleaning cloths and cotton buds are suitable for cleaning.

9. Pronounced differences in temperature between the photometer and the surroundings can lead to incorrect measurements, e.g. due to the formation of condensation in the sample chamber and on the cuvette.

10. Protect the device from direct sunlight.

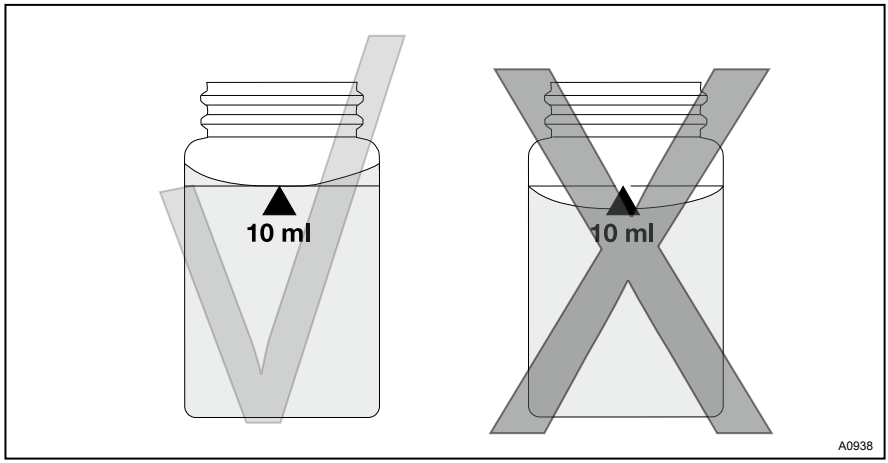

Fig. 2: Correct filling of the cuvette: Left = correct / right = incorrect

11. Fill the cuvette as shown in Fig. 2.

12. Insert the reagent tablets directly from the blister pack into the water sample, without touching them with your fingers.

13. After use immediately close the dropping bottles containing the liquid reagents by closing them with the screw caps of the same colour.

14. You must observe the sequence for the addition of reagents without fail.

1.3 Operations carried out on the device

Battery replacement:

To ensure complete leak-tightness of the photometer, you must insert the gasket (2) and screw on the battery compartment lid (1).

If the battery is removed for more than 1 minute from the device, then when the device is switched on again with new inserted batteries, the date/time program appears automatically.

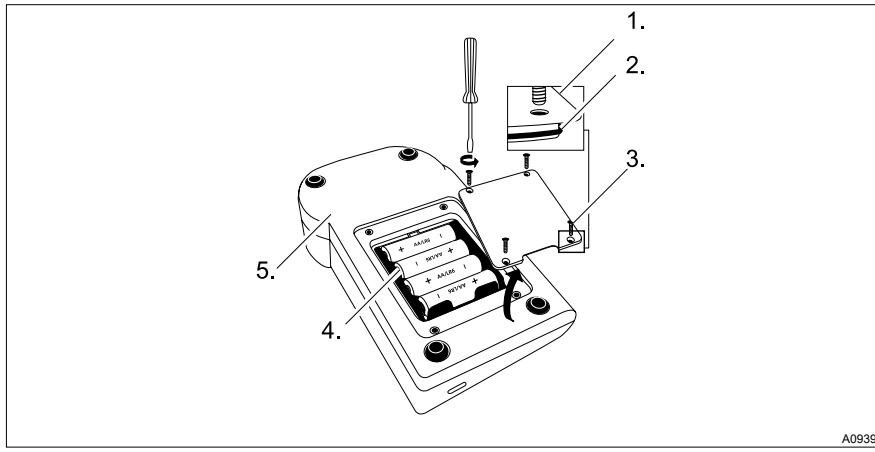

Fig. 3: Battery replacement

1. Battery compartment cover
2. Seal
3. Screw
4. Batteries
5. Rear of the device

2 DT2 commissioning

2.1 Commissioning

Switching on and zero correction

> *Scroll memory (SM)*
>
> *With multi-parameter devices the sequence of the various methods is specified. After switching on the device, the method which was last selected before the device was switched off is automatically displayed. This permits rapid access to a favoured method.*

1. Switch the device on using the *[ON/OFF]* key
   ⇨ The display outputs: The last selected *[METHOD]*.
2. Select the *[METHOD]* using the *[MODE]* key
   ⇨ The display outputs: *[METHOD]*.

Zero correction

3. Fill the cuvette up to the 10-ml marking with the water sample, see Fig. 2
4. Close the cuvette using the cuvette lid
5. Position the cuvette in the sample chamber
   ⇨ Observe the correct positioning of the cuvette.
6. Press the key *[ZERO/TEST]*
   ⇨ *[METHOD]* flashes for approximately 8 seconds.
   [0.0.0] appears in the display.
7. Remove the cuvette from the sample chamber
   ⇨ Zero correction is ended.

Analysis

8. Fill the cuvette up to the 10-ml marking with the water sample, see Fig. 2
9. Add reagents to the water sample
   ⇨ The characteristic colouring develops.
10. Close the cuvette using the cuvette lid
11. Position the cuvette in the sample chamber
12. Press the *[ZERO/TEST]* key, in so doing adhere to any possibly required reaction time, see *‘Switching the countdown function on’ on page 13*
    ⇨ *[METHOD]* flashes for approximately 3 seconds.
    The result is output to the display.

The result is automatically saved.

Repeating the analysis

Press the key *[ZERO/TEST]* again

⇨ The process runs as described here *'Switching on and zero correction' on page 12*.

New zero correction

Press the key *[ZERO/TEST]* for 2 seconds

⇨ The process runs as described here *'Switching on and zero correction' on page 12*.

Switching the countdown function on

NOTICE!

If reaction times are not observed, the result may be incorrect measurement results.

The countdown can only be activated directly prior to a measurement.

The countdown time equals 2 minutes and is non-adjustable.

The currently running countdown can be ended by pressing the key [ZERO/TEST]. The measurement then takes place immediately.

For methods with a reaction time, you can optionally switch on a countdown function:

1. Press the key *[!]* and then keep the key depressed
2. Press the key *[ZERO/TEST]*
3. Release the *[!]* key

⇨ The countdown starts After the countdown has elapsed (2 minutes), measurement takes place automatically

Displaying stored data

The device has a ring buffer for 16 data records.

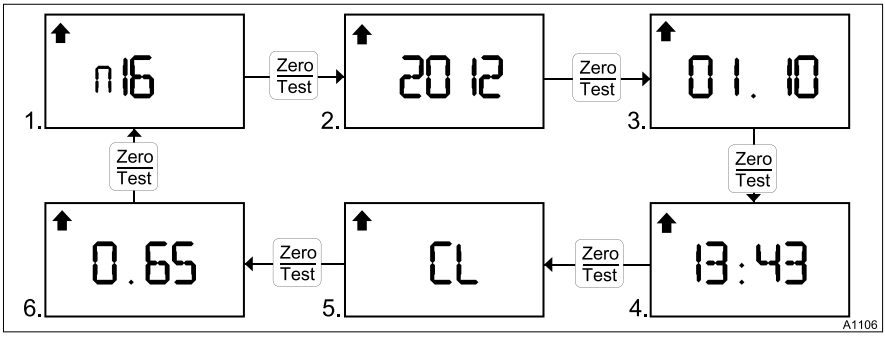

Fig. 4: Displaying stored data

1. Data record (n01 ... n16)
2. Year
3. Month/day
4. Time
5. Measured variable (e.g. chlorine, dependent upon the device version)
6. Value in mg/l

1. With the device switched on press the *[!]* key for more than 4 seconds then release the key again

   ⇨ The display immediately switches to the memory menu.

2. Press the *[MODE]* key to scroll through the 16 data records
3. Press the *[ZERO/TEST]* key to scroll through the values of a data record
4. Press the *[!]* key to return to the *[METHOD]* display

Display background lighting

Press the *[!]* key

⇨ The display's background lighting switches on or off.

During measuring the background lighting switches off automatically.

2.2 Note on the analysis method [fluoride]

Batch number of the SPADNS reagent solution

Before initial commissioning a calibration of the [fluoride] analysis method must be carried out (see [fluoride] calibration mode). [SPADNS] reagent solution from the same batch number must be used for calibration and sample measurement. The device must be recalibrated for each new [SPADNS] batch number.

3 Operating Menu

3.1 Operating menu options

Operating menu selection

1. The device is switched off Press the *[MODE]* key and then keep it depressed
2. Switch the device on using the *[ON/OFF]* key
   ⇨ 3 decimal points appear in the display.
3. Release the *[MODE]* key
4. The [!] key provides you with the following selection of operating menu items.
   - *[diS]* = read out of stored data
   - Setting of date and time
   - User calibration

   ⇨ The selected operating menu item is indicated to you by an arrow in the display.
5. Using key *[!]* select the operating menu item *'Setting of date and time'* (arrow upper right and bottom left in the display)

Setting date and time (24 h format)

Increase the value to be set by pressing the [MODE] key.

Reduce the value to be set by pressing the [ZERO/TEST] key.

By pressing the key [!] you can access the next value to be set.

1. Press the *[MODE]* key
   ⇨ The parameter to be set appears for 2 seconds.
2. Enter the year *[YYYY]*
3. Enter the month *[MM]*
4. Enter the day *[dd]*
5. Enter the hour *[hh]*
6. Enter the minutes *[mm]*

   Enter minutes in 10 minute steps

   Press the *[!]* key

   Enter minutes in 1 minute steps
7. After setting the minutes, press the *[!]* key
   ⇨ *[IS SET]* appears in the display and the device automatically returns to the measuring mode.

3.2 Operating instructions

Display	Meaning
Hi	Measuring range exceeded or turbidity too large.
Lo	Measuring range undershot.
	Change the batteries immediately, further processing not possible.
btLo	Battery voltage for background lighting too low, measurement not possible.
RESULT	In a method which was calibrated by the user, when the result is output in the display an arrow is displayed in the *[Cal]* position.

3.3 Error messages

Display	Meaning
E 27 / E 28 / E 29	Light absorption too great. Cause e.g. dirty optics.
E 10 / E 11	Calibration factor outside the permissible range.
E 20 / E 21	Detector receives too much light.
E 23 / E 24 / E 25	Detector receives too much light.
E 22	The battery power was too low during the measurement. Replace the battery.
E 70	CL: Factory calibration not OK / deleted
E 71	CL: User calibration not OK / deleted
E 72	F: Factory calibration not OK / deleted
E 73	F: User calibration not OK / deleted

4 Analysis method

4.1 Procedure instructions when using liquid reagents

When calculating non-directly determinable parameters from individual measured values error propagation based on the possible tolerances of the individual methods must be considered.

1. Cleaning the cuvettes Many domestic cleaning agents contain reducing substances. Use of these substances leads to false low readings when measuring chlorine/bromine/chlorine dioxide/ozone. To exclude this measurement error, the glassware must not cause any chlorine loss. Therefore the cuvettes must be stored in a sodium hypochlorite solution (0.1 g/l) for one hour and then thoroughly rinsed with deionised water.
2. For the relevant specification of free chlorine and total chlorine use a separate set of cuvettes for each determination (see EN ISO 7393-2, section. 5.3).

Label the cuvettes set on the top and bottom so that inadvertent interchanging of the cuvettes is not possible.

3. When preparing water samples you must avoid the outgassing of chlorine/bromine/chlorine dioxide/ozone, e.g. by pipetting and shaking. This applies particularly for the dissolved gases chlorine dioxide and ozone, especially at temperatures > 30 °C. You must carry out the analysis immediately after taking the water sample.
4. The DPD colour development takes place at a pH-value of 6.2 to 6.5. Therefore the reagents contain a buffer for pH value adjustment. You must ensure strongly alkaline or acidic water samples come within a pH range between 6 and 7 (using 0.5 mol/l sulphuric acid solution or 1 mol/l sodium hydroxide solution).
5. Concentrations above
   - 4 mg/l chlorine when using liquid reagents
   - 7.6 mg/l chlorine dioxide when using liquid reagents

⇨ may lead to results within the measuring range down to 0 mg/l. In this case, you must dilute the water sample with water free from oxidizing agent and repeat the measurement (plausibility test).

6. Any turbidity that occurs during the colour reaction leads to exaggerated results. You can prevent this error by pre-diluting the sample with oxidizing agent-free water.

7. After use immediately close the dropping bottles containing the liquid reagents using the respective screw caps of the matching colour. Store the reagent set at + 6 °C to + 10 °C.

8. The DPD method used responds to many oxidising media, hence you must ensure that the selected oxidising agent is present on its own. Mixtures, e.g. of chlorine and chlorine dioxide only yield total values. These total values must then be differentiated using additional steps. To differentiate between chlorine and chlorine dioxide, see *[Chlorine with liquid reagent method, section d.]*. To differentiate between chlorine and ozone, see *[Chlorine with liquid reagent method, section e.]*.

9. In water containing bromide and iodide (primarily seawater), the free and, as the case may be, bound halogens formed by chlorination are stated as chlorine.

   A steady increase in the measured value of a water sample therefore indicates that alongside the selected oxidising agent (e.g. chlorine) a further oxidising agent (e.g. bromide or iodide) is present. This additional oxidising agent (e.g. bromide or iodide) may due to certain circumstances (many times higher concentration, equilibria, higher temperature) bleed through into the measurement. By working quickly and reading off the measurement immediately, the resulting error can be minimised.

   ⇨ These interference effects are also known to occur with these systems {combined chlorine ⇛ free chlorine} and {chloride ⇛ chlorine dioxide}.

4.2 Quantitative determination using liquid reagents

Chlorine with liquid reagents 0.01 ... 4.0 mg/l

Use the *[MODE]* key to select *[Cl]*.

a) Free chlorine

1. Take your cuvette set 1
2. In a 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see *'Switching on and zero correction' on page 12*
3. Remove the cuvette from the sample chamber and empty the cuvette completely
4. Hold the dropping bottle upright and by slow pressing, add equal sized drops into the cuvette:
   - 6 drops ➡ DPD 1 buffer solution
   - 2 drops ➡ DPD 1 reagent solution

   Fill the cuvette up to the 10 ml marking with the water sample
5. Close the cuvette using the cuvette lid
6. Mix the contents of the cuvette by tipping it back and forth
7. Position the cuvette in the sample chamber
   ⇨ Observe the correct positioning of the cuvette.
8. Press the key *[ZERO/TEST]*
   ⇨ *[METHOD]* flashes for approximately 3 seconds.

   The result in mg/l of free chlorine appears in the display.

b) Total chlorine

1. Take your cuvette set 2
2. In a 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see *'Switching on and zero correction' on page 12*
3. Remove the cuvette from the sample chamber and empty the cuvette completely
4. Hold the dropping bottle upright and by slow pressing, add equal sized drops into the cuvette:
   - 6 drops ➡ DPD 1 buffer solution
   - 2 drops ➡ DPD 1 reagent solution
   - 3 drops ➡ DPD 3 solution

   Fill the cuvette up to the 10 ml marking with the water sample
5. Close the cuvette with the cuvette lid and mix the contents by tipping back and forth
6. Place the cuvette in the sample chamber
   ⇨ Observe the correct positioning of the cuvette.

7. Switch the countdown on, see ‘ *Switching the countdown function on’ on page 13*. To do this, press the *[!]* and *[ZERO/TEST]* key

   ⇨ Wait for the 2 minutes reaction time to elapse

8. The METHOD symbol flashes for approximately 3 seconds

   ⇨ The result in mg/l of total chlorine appears in the display.

c) combined chlorine

Combined chlorine = total chlorine minus free chlorine

Calculate the combined chlorine

d) Chlorine together with chlorine dioxide

1. Fill a cuvette with a 10 ml water sample
2. Insert a *[GLYCINE]* tablet directly from the foil into the water sample and crush the *[GLYCINE]* tablet with a stirring rod
3. Close the cuvette with the cuvette lid and mix the contents by tipping back and forth until the tablet has dissolved
4. In a second 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see ‘ *Switching on and zero correction’ on page 12*
5. Remove the cuvette from the sample chamber for the zero correction and empty the cuvette out
6. Hold the dropping bottle upright and by slow pressing, add equal sized drops into the cuvette:
   - 6 drops ➡ DPD 1 buffer solution
   - 2 drops ➡ DPD 1 reagent solution
7. Pour the contents of the first cuvette (*[GLYCINE]* solution) into the prepared cuvette
8. Close the cuvette with the cuvette lid and mix the contents by tipping back and forth
9. Place the cuvette in the sample chamber

   ⇨ Observe the correct positioning of the cuvette.
10. Press the key *[ZERO/TEST]*

    ⇨ *[METHOD]* flashes for approximately 3 seconds.

    The display value *[G]* = chlorine dioxide reappears in the display.
11. Remove the cuvette from the sample chamber
12. Thoroughly clean the cuvette and the cuvette lid

13. Hold the dropping bottle upright and by slow pressing, add equal sized drops into the cuvette:
    - 6 drops ➡ DPD 1 buffer solution
    - 2 drops ➡ DPD 1 reagent solution

    Fill the cuvette up to the 10 ml marking with the water sample
14. Close the cuvette using the cuvette lid
15. Mix the contents of the cuvette by tipping it back and forth
16. Position the cuvette in the sample chamber
    ⇨ Observe the correct positioning of the cuvette
17. Press the key *[ZERO/TEST]*
    ⇨ *[METHOD]* flashes for approximately 3 seconds.

    The display value *[A]* = sum of free chlorine plus chlorine dioxide appears in the display.
18. Remove the cuvette from the sample chamber
19. Hold the dropping bottle upright and by slow pressing, add equal sized drops into the cuvette:
    - 3 drops ➡ DPD 3 solution
20. Close the cuvette using the cuvette lid
21. Mix the contents of the cuvette by tipping it back and forth
22. Position the cuvette in the sample chamber
    ⇨ Observe the correct positioning of the cuvette
23. Switch the countdown on, see *‘Switching the countdown function on’ on page 13*. To do this, press the *[!]* and *[ZERO/TEST]* key
    ⇨ Wait for the 2 minutes reaction time to elapse
24. *[METHOD]* flashes for approximately 3 seconds.
    ⇨ The display value *[C]* = sum of free chlorine plus combined chlorine plus chlorine dioxide appears in the display.
25. Calculation:
    - Chlorine dioxide (mg/l) = display value *[G]* x 1.9
    - Free chlorine (mg/l) = display value *[A]* minus display value *[G]*
    - Combined chlorine (mg/l) = display value *[C]* minus display value *[A]*

Chlorine dioxide with liquid reagents 0.02 ... 7.6 mg/l

Use the *[MODE]* key to select *[CdO]*.

1. In a 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see *'Switching on and zero correction' on page 12*
2. Remove the cuvette from the sample chamber and empty the cuvette completely
3. Hold the dropping bottle upright and by slow pressing, add equal sized drops into the cuvette:
   - 6 drops ➡ DPD 1 buffer solution
   - 2 drops ➡ DPD 1 reagent solution

   Fill the cuvette up to the 10 ml marking with the water sample
4. Close the cuvette using the cuvette lid
5. Mix the contents of the cuvette by tipping it back and forth
6. Position the cuvette in the sample chamber

   ⇨ Observe the correct positioning of the cuvette.
7. Press the key *[ZERO/TEST]*

   ⇨ *[METHOD]* flashes for approximately 3 seconds.

   The result in mg/l of chlorine dioxide appears in the display.
8.

Measuring tolerances when determining the chlorine dioxide content:

- *0 ... 1.9 mg/l: ± 0.1 mg/l*
- *> 1.9 ... 3.8 mg/l: ± 0.2 mg/l*
- *> 3.8 ... 5.7 mg/l: ± 0.4 mg/l*
- *> 5.7 ... 7.6 mg/l: ± 0.6 mg/l*

Fluoride with liquid reagents 0.05 ... 2.0 mg/l F^-

1. In a 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see *'Switching on and zero correction' on page 12*
2. Pour precisely 2 ml of *[SPADNS]* reagent solution into the cuvette with the 10 ml water sample
   ⇨ The cuvette is then full to the brim.
3. Close the cuvette using the cuvette lid
4. Mix the contents of the cuvette by tipping it back and forth
5. Position the cuvette in the sample chamber
   ⇨ Observe the correct positioning of the cuvette
6. Press the key *[ZERO/TEST]*
   ⇨ *[METHOD]* flashes for approximately 3 seconds

   The result in mg/l of fluoride appears in the display.

   Measured tolerances: ± 5 % (of the upper range value).

Remarks

Remarks:

- *[SPADNS] reagent solution from the same batch number must be used for calibration and sample measurement. You must carry out calibration of the device for each new [SPADNS] reagent solution batch number (see Standard Methods 20th, 1998, APHA, AWWA, WEF 4500 F D., S. 4-82).*
- *During calibration and measurement you must carry out the zero correction and test with the same cuvette, as the cuvettes have slightly varying tolerances.*
- *The calibration solution and the water samples to be measured must have the same temperature (± 1 °C).*
- *The analysis result depends on use of the exact sample and reagent volumes. You must only meter the sample and reagent volumes using a 10 ml or 2 ml bulb pipette (class A).*
- *Above 1.4 mg/l fluoride, the accuracy reduces. Although the results for most applications are sufficiently accurate, improved accuracy can be achieved if you dilute the sample prior to use in a 1:1 ratio and multiply the result by 2.*

– *[SPADNS] reagent solution contains arsenite. Chlorine concentrations up to 5 mg/l are not harmful.*
– *You must distil seawater and waste water samples.*

4.3 Procedure instructions when using tablets

When calculating non-directly determinable parameters from individual measured values error propagation based on the possible tolerances of the individual methods must be considered.

1. Cleaning the cuvettes Many domestic cleaning agents contain reducing substances. Use of these substances leads to false low readings when measuring chlorine/bromine/chlorine dioxide/ozone. To exclude this measurement error, the glassware must not cause any chlorine loss. Therefore the cuvettes must be stored in a sodium hypochlorite solution (0.1 g/l) for one hour and then thoroughly rinsed with deionised water.Volle.
2. For the relevant specification of free chlorine and total chlorine use a separate set of cuvettes for each determination (see EN ISO 7393-2, section. 5.3).
3. When preparing water samples you must avoid the outgassing of chlorine/chlorine dioxide, e.g. by pipetting and shaking. This applies particularly for the dis-

solved gases chlorine dioxide and ozone, especially at temperatures > 30 °C. You must carry out the analysis immediately after taking the sample.

4. The DPD colour development takes place at a pH-value of 6.2 to 6.5. Therefore the reagents contain a buffer for pH value adjustment. You must ensure strongly alkaline or acidic water samples come within a pH range between 6 and 7 (using 0.5 mol/l sulphuric acid solution or 1 mol/l sodium hydroxide solution).

5. Concentrations above

   - 10 mg/l chlorine when using tablets
   - 19 mg/l chlorine dioxide when using tablets

   ⇨ may lead to results within the measuring range down to 0 mg/l. In this case, you must dilute the water sample with water free from oxidizing agent and repeat the measurement (plausibility test).

6. Turbidity (causes incorrect measurements): For water samples with High Calcium content* and/or high conductivity* when using the *[DPD no. 1 tablet]* the result can be the rendering turbid of the water sample and consequently incorrect measurements. In this case, you must use the alternative reagent tablet *[DPD no. 1 High Calcium]*. If the turbidity only appears after the addition of the *[DPD No. 3]* tablet, you can prevent this by use of the *[DPD no. 1 High Calcium]* and the *[DPD no. 3 High Calcium]* tablet. The *[DPD No. 1 High Calcium]* tablet should only be used in conjunction with the *[DPD No. 3 High Calcium]*.

   ⇨ * exact values cannot be specified, as the formation of turbidity depends on the type and composition of the water sample.

7. The DPD method used responds to many oxidising media, hence you must ensure that the selected oxidising agent is present on its own. Mixtures, e.g. of chlorine and chlorine dioxide only yield total values. These total values must then be differentiated using additional steps. To differentiate between chlorine and chlorine dioxide, see *[Chlorine with tablet method, section D "Chlorine together with chlorine dioxide"]* To differentiate between chlorine and ozone, see *[Chlorine with tablet method]*

8. In water containing bromide and iodide, the free and, as the case may be, bound halogens formed by chlorination are stated as chlorine. A steady increase in the measured value of a water

sample therefore indicates that alongside the selected oxidising agent a further oxidising agent is present. This oxidising agent may due to certain circumstances (many times higher concentration, equilibria, higher temperature) bleed through into the measurement. By working quickly and reading off the measurement immediately, the resulting error can be minimised.

⇨ These interference effects are also known to occur with these systems {combined chlorine ⇛ free chlorine} and {chloride ⇛ chlorine dioxide}.

4.4 Quantitative determination using tablets

Chlorine with tablets 0.01 ... 6.0 mg/l

Use the *[MODE]* key to select *[Cl]*.

a) Free chlorine

1. Take your cuvette set 1
2. In a 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see ↬ *'Switching on and zero correction' on page 12*
3. Remove the cuvette from the sample chamber and empty the cuvette down to the last few drops
4. Insert a *[DPD No. 1]* tablet directly from the foil into the water sample and crush the *[DPD No. 1]* tablet with a stirring rod
5. Fill the cuvette up to the 10 ml marking with the water sample
6. Close the cuvette with the cuvette lid and mix the contents by tipping back and forth until the tablet has dissolved
7. Position the cuvette in the sample chamber
   ⇨ Observe the correct positioning of the cuvette.
8. Press the key *[ZERO/TEST]*
   ⇨ *[METHOD]* flashes for approximately 3 seconds.

The result in mg/l of free chlorine appears in the display.

b) Total chlorine

1. Take your cuvette set 2
2. In a 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see *'Switching on and zero correction' on page 12*
3. Remove the cuvette from the sample chamber and empty the cuvette down to the last few drops
4. Insert a *[DPD No. 1]* tablet directly from the foil into the water sample and crush the *[DPD No. 1]* tablet with a stirring rod
5. Insert a *[DPD No. 3]* tablet directly from the foil into the water sample and crush the *[DPD No. 3]* tablet with a stirring rod
6. Fill the cuvette up to the 10 ml marking with the water sample
7. Close the cuvette with the cuvette lid and mix the contents by tipping back and forth until the tablets have dissolved
8. Place the cuvette in the sample chamber
   ⇨ Observe the correct positioning of the cuvette.
9. Switch the countdown on, see *'Switching the countdown function on' on page 13*. To do this, press the *[!]* and *[ZERO/TEST]* key
   ⇨ Wait for the 2 minutes reaction time to elapse
10. The METHOD symbol flashes for approximately 3 seconds
    ⇨ The result in mg/l of total chlorine appears in the display.

c) combined chlorine

Combined chlorine = total chlorine minus free chlorine

Calculate the combined chlorine

d) Chlorine together with chlorine dioxide

1. Fill a cuvette with a 10 ml water sample
2. Insert a *[GLYCINE]* tablet directly from the foil into the water sample and crush the *[GLYCINE]* tablet with a stirring rod
3. Close the cuvette with the cuvette lid and mix the contents by tipping back and forth until the tablet has dissolved

4. In a second 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see ↳ *'Switching on and zero correction' on page 12*
5. Remove the cuvette from the sample chamber for the zero correction and empty the cuvette out
6. Insert a *[DPD No. 1]* tablet directly from the foil into the water sample and crush the *[DPD No. 1]* tablet with a stirring rod
7. Pour the contents of the first cuvette (*[GLYCINE]* solution) into the prepared cuvette
8. Close the cuvette with the cuvette lid and mix the contents by tipping back and forth until the tablet has dissolved
9. Place the cuvette in the sample chamber

   ⇨ Observe the correct positioning of the cuvette.
10. Press the key *[ZERO/TEST]*

    ⇨ *[METHOD]* flashes for approximately 3 seconds.

    The display value *[G]* (chlorine dioxide) reappears in the display.
11. Remove the cuvette from the sample chamber
12. Thoroughly clean the cuvette and the cuvette lid
13. Fill a cuvette with a few drops of a water sample
14. Insert a *[DPD No. 1]* tablet directly from the foil into the water sample and crush the *[DPD No. 1]* tablet with a stirring rod
15. Fill the cuvette up to the 10 ml marking with the water sample
16. Close the cuvette using the cuvette lid
17. Mix the contents of the cuvette by tipping it back and forth, until the tablet has dissolved
18. Position the cuvette in the sample chamber

    ⇨ Observe the correct positioning of the cuvette.
19. Press the key *[ZERO/TEST]*

    ⇨ *[METHOD]* flashes for approximately 3 seconds.

    The display value *[A]* (sum of free chlorine plus chlorine dioxide) appears in the display.
20. Remove the cuvette from the sample chamber
21. Insert a *[DPD No. 3]* tablet directly from the foil into the same water sample and crush the *[DPD No. 3]* tablet with a stirring rod
22. Close the cuvette using the cuvette lid

23. Mix the contents of the cuvette by tipping it back and forth, until the tablet has dissolved

24. Position the cuvette in the sample chamber

    ⇨ Observe the correct positioning of the cuvette.

25. Switch the countdown on, see ↳ *'Switching the countdown function on' on page 13*. To do this, press the *[!]* and *[ZERO/TEST]* key

    ⇨ Wait for the 2 minutes reaction time to elapse

26. The METHOD symbol flashes for approximately 3 seconds

    ⇨ The display value *[C]* (sum of free chlorine plus combined chlorine plus chlorine dioxide) appears in the display.

27. Calculation:

    - Chlorine dioxide (mg/l) = display value *[G]* x 1.9
    - Free chlorine (mg/l) = display value *[A]* minus display value *[G]*
    - Combined chlorine (mg/l) = display value *[C]* minus display value *[A]*

Chlorine dioxide with tablet 0.02 ... 11 mg/l

Use the *[MODE]* key to select *[CdO]*.

1. In a 24 mm cuvette add a 10 ml water sample and carry out a zero correction, see ↳ *'Switching on and zero correction' on page 12*

2. Remove the cuvette from the sample chamber and empty the cuvette down to the last few drops of the water sample

3. Insert a *[DPD No. 1]* tablet directly from the foil into the water sample and crush the tablet with a stirring rod

4. Fill the cuvette up to the 10 ml marking with the water sample

5. Close the cuvette using the cuvette lid

6. Mix the contents of the cuvette by tipping it back and forth, until the tablet has dissolved

7. Position the cuvette in the sample chamber

   ⇨ Observe the correct positioning of the cuvette.

8. Press the key *[ZERO/TEST]*

   ⇨ *[METHOD]* flashes for approximately 3 seconds.

   The result in mg/l of chlorine dioxide appears in the display.

9.

Measuring tolerances when determining the chlorine dioxide content:

- *0 ... 1.9 mg/l: ± 0.1 mg/l*
- *> 1.9 ... 3.8 mg/l: ± 0.2 mg/l*
- *> 3.8 ... 5.7 mg/l: ± 0.4 mg/l*
- *> 5.7 ... 7.6 mg/l: ± 0.6 mg/l*
- *> 7.6 ... 11 mg/l: ± 0.8 mg/l*

5 Calibration

Chlorine range (Cl) calibration

User calibration

! NOTICE!

A separate calibration of the measuring ranges bromine, chlorine dioxide or ozone is not possible. The chlorine measuring range calibration (Cl) is relied on.

User calibration (display in calibration mode) = *[cCAL]*

Factory calibration (display in calibration mode) = *[cCAL]*

1. Confirm the selection by pressing the *[MODE]* key

   ⇨ The display toggles between *[CAL / METHOD]*

2. Select the method to be calibrated using the *[MODE]* key
3. Fill the cuvette up to the 10-ml marking with standard solution, without adding reagents
4. Close the cuvette using the cuvette lid
5. Position the cuvette in the sample chamber

   ⇨ Observe the correct positioning of the cuvette

6. Press the key *[ZERO/TEST]*

   ⇨ *[METHOD]* flashes for approximately 8 seconds.

   The confirmation of the zero correction *[0.0.0]* alternates with *[CAL]*.

7. Remove the cuvette from the sample chamber and empty the cuvette completely
8. Thoroughly clean the cuvette and the cuvette lid
9. Fill the cuvette up to the 10-ml marking with a standard solution of known concentration and introduce the reagents as described under ↳ *'Chlorine with liquid reagents 0.01 ... 4.0 mg/l' on page 20* or ↳ *'a) Free chlorine' on page 27*
10. Close the cuvette using the cuvette lid
11. Position the cuvette in the sample chamber

    ⇨ Observe the correct positioning of the cuvette.

12. Press the key *[ZERO/TEST]*

    ⇨ *[METHOD]* flashes for approximately 3 seconds.

    The confirmation of the result alternates with *[CAL]*.

13. If the result matches the value of the standard used, (within the tolerance under consideration) you can quit calibration mode by pressing the *[ON/OFF]* key

Changing the displayed value:

Pressing the [MODE] key 1 x increases the displayed result by 1 digit.

Pressing the [ZERO/TEST] key 1 x reduces the displayed result by 1 digit.

1. Repeatedly press the keys until the displayed result matches the value of the standard used
2. Press the key *[ON/OFF]*
   ⇨ The new correction factor is calculated and saved in the user calibration level.

   The confirmation of the calibration appears in the display for 3 seconds.

Fluoride range calibration

User calibration

Calibration takes place with: 0 mg/l and 1 mg/l F^- standard and a clean cuvette.

1. Confirm the selection by pressing the *[MODE]* key
   ⇨ The display toggles between *[CAL / F]*.
2. Fill the cuvette up to the 10 ml marking with demineralised water
3. Close the cuvette using the cuvette lid
4. Position the cuvette in the sample chamber
   ⇨ Observe the correct positioning of the cuvette
5. Press the key *[ZERO/TEST]*
   ⇨ *[METHOD]* flashes for approximately 8 seconds.

   The confirmation of the zero correction *[0.0.0]* alternates with *[CAL]*.
6. Add precisely 2 ml of *[SPADNS]* reagent solution to the cuvette in addition to the 10 ml of demineralised water
7. Close the cuvette using the cuvette lid

8. Mix the contents of the cuvette by tipping it back and forth
9. Position the cuvette in the sample chamber
   ⇨ Observe the correct positioning of the cuvette.
10. Press the key *[ZERO/TEST]*
    ⇨ *[METHOD]* flashes for approximately 3 seconds.
    [F0] appears in the display.
11. Remove the cuvette from the sample chamber and thoroughly clean the cuvette and cuvette lid
12. Fill the cuvette with 10 ml of standard fluoride (concentration 1 mg/l F)
13. Close the cuvette using the cuvette lid
14. Mix the contents of the cuvette by tipping it back and forth
15. Position the cuvette in the sample chamber
    ⇨ Observe the correct positioning of the cuvette.
16. Press the key *[ZERO/TEST]*
    ⇨ *[METHOD]* flashes for approximately 3 seconds.
    [F1] appears in the display.
17. By pressing the key *[ON/OFF]* you can save the new calibration
    ⇨ The confirmation of the calibration appears in the display for 3 seconds.

Return to the factory calibration

A return from the user calibration to the factory calibration is only possible for all methods simultaneously.

In a method which was calibrated by the user, when the result is output in the display an arrow is displayed in the [Cal] position.

To return the device tot he factory calibration, proceed as follows:

1. The device is switched off. Simultaneously press the *[MODE]* and *[ZERO/TEST]* keys
2. Switch the device on using the *[ON/OFF]* key
   ⇨ After approximately 1 second release the *[MODE]* and *[ZERO/TEST]* keys.
3. The display toggles between: *[SEL]* and *[CAL]*
   ⇨ The device is in the as-supplied (factory) condition (*[SEL]* stands for select).
4. or
5. The display toggles between: *[SEL]* and *[CAL]*

⇨ The device operates with a calibration carried out by the user. If the user calibration is to be retained, switch the device off using the *[ON/OFF]* key.

6. By pressing the *[MODE]* key you can simultaneously activate the factory calibration for all methods.

7. The display toggles between *[SEL]* and *[CAL]*

8. Switch the device off using the *[ON/OFF]* key

6 Technical data

Device	Two wavelengths, automatic wavelength selection, colorimeter with direct measured value display
Optics	LEDs, interference filter (IF) and photo sensor at the transparent sample chamber Wavelength specifications of the interference filter: ■ 530 nm Δλ = 5 nm ■ 560 nm Δλ = 5 nm
Wavelength trueness	± 1 nm
Photometric accuracy*	3 % FS (**F**ull **S**cale) (T = 20 °C ... 25 °C)
Photometric resolution	0.01 A (**A**bsorption units)
Power supply	4 batteries (AA/LR 6)
Operating time	Approx. 53 h operating time or 15,000 measurements in continuous operation with background lighting switched off
Auto-OFF	Automatic device switch-off 10 minutes after the last key was pressed
Display	Backlit LCD (upon pressing of a key)
Memory	Internal ring buffer for 16 data records
Time	Real time clock and date
Calibration	Fabrication and user calibration. Return to the factory calibration is possible.
Dimensions	190 x 110 x 55 mm (L x W x H)
Weight	Basic device approx. 455 g (with batteries)
***measured with standard solutions**	

Ambient conditions	Temperature: 5 ... 40 °C Relative humidity: 30 ... 90 % (non-condensing)
Water-tight	analogous to IP 68 (1 hour at 0.1m); buoyant device
***measured with standard solutions**	

The specified device accuracy is only obtained when using the original reagent system.

7 Consumables and spare parts

Consumables

Material	Part number
DPD-1 buffer, 15 ml	1002857
DPD-1 reagent, 15 ml	1002858
DPD-3 solution, 15 ml	1002859
[SPADNS] reagent, 250 ml to determine the fluoride level	1010381
DPD reagents set, content 15 ml each: ■ 3 x DPD-1 buffer ■ 1 x DPD-1 reagent ■ 2 x DPD-3 solution	1007567
Calibration standard fluoride 1 mg/l, for calibration of the photometer	1010382

Spare parts

Material	Part number
3 pieces round cuvettes with lid (replacement cuvettes) for: ■ DPD determination	1007566
3 pieces replacement cuvettes for fluoride determination	1010396

8 Standards complied with and conformity declaration

Declaration of Conformity

You can find the EC Declaration of Conformity as a download under *http://www.prominent.de/Service/Download-Service.aspx*

Standards complied with

EC EMC Directive (2004/108/EC)

EN 61326 - 1

9 Index

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