OPERATING MANUAL

ECO 521 / ECO 522 / ECO 523

Handheld Conductivity Meter / EC-Meter

B-H87.0.0X.DK2-4.1

senseca

Table of contents

1 About this documentation

1.1 Foreword

Read this document carefully and familiarize yourself with the operation of the device before you use it.
Keep this document ready to hand and in the immediate vicinity of the device so that it is available to the personnel/user for reference at all times in case of doubt.

The user must have carefully read and understood the operating manual before beginning any work.

1.2 Legal notices

The liability and warranty of the manufacturer for damages and consequential damages are voided with misuse, disregarding this document, disregarding safety notices, assignment of inadequately qualified technical personnel and arbitrary modifications of the device.

This document is entrusted to the recipient for personal use only. Any impermissible transfer, duplication, translation into other languages or excerpts from this operating manual are prohibited.

The manufacturer assumes no liability for print errors.

1.3 Further information

Software version of the device:

- V1.5 or later

For the exact product name, refer to the type plate on the rear side of the device.

Note

For information about the software version, press and hold the ON button to switch on the device for longer than 5 seconds. The series is shown in the main display and the software version of the device is shown in the secondary display.

2 Safety

2.1 Explanation of safety symbols

Danger!

This symbol warns of imminent danger, which can result in death, severe bodily injury, or severe property damage in case of non-observance.

Caution!

This symbol warns of potential dangers or harmful situations, which can cause damage to the device or to the environment in case of non-observance.

Note

Blue underlining indicates processes, which can have a direct influence on operation or can trigger an unforeseen reaction in case of non-observance.

2.2 Foreseeable misuse

The fault-free function and operational safety of the device can only be guaranteed if applicable safety precautions and the device-specific safety instructions for this document are observed.

If these notices are disregarded, personal injury or death, as well as property damage can occur.

Danger: Incorrect area of application!

In order to prevent erratic behavior of the device, personal injury or property damage, the device must be used exclusively as described under intended use.

- Do not use in safety / Emergency Stop devices!
- The device is not suitable for use in explosion-prone areas!
- The device must not be used for diagnostic or other medical purposes on patients!
- The pro device duct is not intended to come into direct contact with food. For measurement in foods, samples must be taken and discarded after the measurement!
- Not suitable for use with requirements on functional safety, e.g. SIL!

2.3 Safety instructions

Caution

Measuring cell must never come into contact with water-repellent materials such as oil or silicone.

- Empty batteries and batteries of inferior quality can leak more easily, which can destroy the device. Please also observe the instructions in the chapter “Operation and maintenance”.

Note

This device does not belong in children's hands!

2.4 Intended use

The device is designed for measuring the conductivity in liquids.
The measuring cell is connected permanently.

The range of application depends on the different measuring cells of the type:

ECO 521	2-pole titanium measuring cell, with a wide range of applications e.g. fish farming, hydroponics, measurement of surface water and drinking water.
ECO 522	2-pole graphite measuring cell, with a wide range of applications e.g. fish husbandry, measurement of surface water and drinking water
ECO 523	2-pole stainless steel measuring cell for low conductivities <100µS e.g. pure and purest water, boiler water, osmosis and filter technology

2.5 Qualified personnel

For commissioning, operation and maintenance, the relevant personnel must have adequate knowledge of the measuring process and the significance of the measurements. The instructions in this document must be understood, observed and followed.

In order to avoid any risks arising from interpretation of the measurements in the concrete application, the user must have additional expertise. The user is solely liable for damages/danger resulting from misinterpretation due to inadequate expertise.

3 The device at a glance

LCD Display

Front view

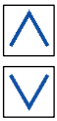
3.1 Display elements

	Battery indicator	Evaluation of the battery status
	Unit display	Display of units or type of mode, min/max/hold
	Main display	Measurement of the current conductivity value or value for min/max/hold
	Auxiliary display	Corresponding temperature value for the value shown in the main display. If applicable, alternating with the temperature compensation.

3.2 Operating elements

On / Off button

Press briefly	Switch on the device Activate / deactivate lighting
Long press	Switch off the device Reject changes in a menu



Up / Down button

Press briefly	▶ Display of the min/max value Change value of the selected parameter
Long press	▶ Reset the min/max value of the current measurement
Both simultaneously	▶ Rotate display, overhead display

Function button

Press briefly	▶ Freeze measurement (Hold) Call up next parameter
Long press, 2s	▶ Start menu “configuration”, ConF appears in the display

Operating status ▶ device is in measured value display

device is in a menu

4 Operation

4.1 Opening the configuration menu

1 Press the *Function key* for 2 seconds to open the *Configuration* menu.

2 ConF appears in the display. Release the Function key.

Parameter	Values	Meaning
OK	∧ ∨	
inP	**Measuring unit**	
	Cond	conductivity
	rES	specific resistance (ECO 521 only)
	EC	EC (~ mS/cm) (ECO 521 only)
	CF	CF (~ 10 x EC) (ECO 521 only)
	SAL	salt content / salinity (ECO 522 only)
	tdS	total dissolved solids (ECO 521, ECO 522 only)
ctdS	**Factor for TDS** (ECO 521 and ECO 522 only)	
	0.40 .. 1.00	Conversion factor for TDS measurement commonly used: 0.500 or 0.700
tcor	**Temperature compensation**	
	oFF	Do not compensate conductivity measurement
	nLF	Non-linear function for natural water in accordance with EN 27888 (ISO 7888) Ground water, surface water or drinking water
	nAcl	Compensation of weak NaCl solutions only in pure and ultrapure water (ECO 523 only)
	Lin	Linear temperature compensation (ECO 523 only)
tLin	**Compensation coefficient** (ECO 523 only)	
	0.300 .. 3.000	Temperature compensation coefficient in %/K
trEF	**Reference temperature for temperature compensation**	
	25 °C	Reference temperature 25 °C or 77 °F
	20 °C	Reference temperature 20 °C or 68 °F

Parameter	Values	Meaning
PoFF	**Shut-off time**	
	oFF	No automatic shut-off
	15, 30, 60, 120, 240	Automatic shut-off after a selected time in minutes, during which no buttons have been pressed
Li tE	**Backlight**	
	oFF	Backlight deactivated
	15, 30, 60, 120, 240	Automatic shut-off of the backlight after a selected time in seconds, during which no buttons have been pressed
	on	No automatic shut off of the backlight
Uni t	**Temperature display unit**	
	°C	Temperature display in °C
	°F	Temperature display in °F
Ini t	**Factory settings**	
	no	Use current configuration
	YES	Reset device to factory settings. After confirming with the function-button, the display shows: Ini t donE

4.2 Adjustment of the measuring input

With the conductivity slope correction, the conductivity value can be readjusted. The temperature input can be adjusted with the zero point correction and the gradient correction. If an adjustment is made, you change the pre-adjusted factory settings.
This is signaled with the display text t.oF, t.SL or SCL when switching on.

1 Switch the device off.
2 Hold the down button and press the *On/Off button* briefly to switch on the device and open the **Adjustment** menu.
3 The display shows the first parameter. Release the *down button*.

Parameter	Values	Meaning
OK	∧ ∨	
t.oF	**Zero point correction of the temperature**	
	0.00	No zero point correction
	-5.00 … 5.00	Zero point correction in °C. (at °F -9.00 .. +9.00)
t.SL	**Gradient correction of the temperature**	
	0.00	No gradient correction
	-5.00 … 5.00	Gradient correction in %
SCL	**Gradient correction for the conductivity value**	
	1.000	No gradient correction
	0.800 … 1.200	Multiplier for the gradient correction

Formula used by device:
Temperature = °C: Display = (measured value - t.oF) * (1 + t.SL / 100)
Temperature = °F: Display = (meas. value - 32 °F - t.oF) * (1 + t.SL / 100) + 32 °F

▶ Gradient correction conductivity.: Displayed value = measured value / SCL

5 Measurement Basics

5.1 Conductivity principles

Conductivity γ

Conductivity describes the capability of a material to conduct electrical current. It is also the inverse of specific resistance. The conductance is the inverse of the measured resistance R.

Formula: γ = l / (R*A)

- l = length of the material
- A = cross section
- R = measured resistance
- Unit [γ] = Siemens / meter = S / m

▶ Normally, the values for liquids are specified in µS/cm or in mS/cm

5.2 General information about conductivity measuring

During the measurement, the conductivity measuring cell must be dipped at least in so far, that at least 30 mm (ECO 523: 25 mm) beginning from the top of the measuring cell, is located in the medium. The maximum immersion depth for continuous operation should not exceed 110 mm (ECO 523: 70 mm)

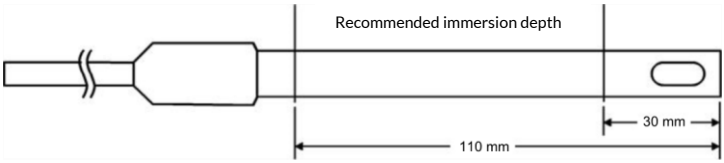


Illustration: Measuring cell ECO 522

The measuring cell can either be stored dry or in water. After dry storage wetting time will be prolonged slightly. If changing over from one liquid to another with conductivities varying widely make sure to properly rinse and shake dry measuring cell.

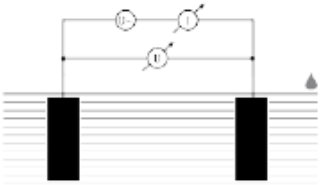
If conductivity measured is much higher or lower than expected this may be due to the electrode being soiled with non-conducting or conducting foreign materials. Measuring cell has to be cleaned with a watery soap solution. When measuring media with low conductivities the electrode has to be stirred sufficiently.

Caution!

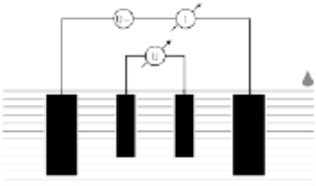
Measuring cell must never come into contact with water-repellent materials such as oil or silicone.

5.2.1 General Design Electrodes / Measuring cell

There are basically two different types of measuring cells: 2-pole and 4-pole measuring cells. Control and/or evaluation take place in a similar manner; the 4-pole measuring cells can compensate well for polarization effects and contamination to a certain degree with the more elaborate measuring processes.



2-pole measuring cell



4-pole measuring cell

The device series is equipped with a permanently connected 2-pole measuring cell.

5.2.2 Calibration / adjustment of the measuring cell

Note

In harsh applications and due to ageing processes, the cell constant of measuring cells changes, which leads to incorrect measured values.

Depending on the application and precision requirement, the overall precision of the display device and measuring cell measuring chain should be checked regularly. Special testing and calibration solutions, such as GKL 100, 101 and 102 are available for this purpose.

In normal application conditions, semi-annual testing is recommended – please refer to 4.2 “Adjustment of the measuring input“.

5.3 Total dissolved solids/TDS measurement (only available at ECO 521 and ECO 522)

The total dissolved solids measurement - TDS measurement - determines the total dissolved solids, which also called evaporation residue, based on the conductivity and a conversion factor CtdS of the total dissolved solids. Well-suited to conduct simple concentration measurements of salt solutions. The display shows mg/l.

Display value TDS = conductivity [in µs/cm, with nLF = 25°C] * CtdS

With selection of TDS, the necessary temperature compensation is selected automatically. Menu settings for temperature compensation are ignored.

The following approximations apply:

CtdS	
0.50	Monovalent salts with 2 ion types = NaCl, KCl or similar
0.50	Natural water of surface water, drinking water
0.65 bis 0.70	Salt concentration of aqueous fertilizer solutions

Note

These are guideline values for estimates, but are not suitable for precise measurements. The conversion factor for the respective type of solution and the examined concentration range must be determined for precise measurements. This can take place with calibration to known comparison solutions or with actual evaporation of a certain amount of liquid with measured conductivity and subsequent weight of the total dissolved solids.

5.4 Salt content / salinity measurement (only available at ECO 522)

In SAL measuring mode, the salinity, which is the salt content of sea water, is determined. The basis for this is the International Oceanographic Tables, IOT. Standard salt water has a salinity of 35 ‰, 35 g of salt per 1 kg of sea water. The display in % [g/kg] normally does not show units. The designation PSU, Practical Salinity Unit, is also commonly used; the display value is identical. The salinity measurement has temperature compensation, which means the temperature is considered for the display and has a major influence on the display value; any menu settings regarding temperature compensation are ignored.

Note

The salt composition of different seas is not identical. Depending on the location, weather, seasons, etc., there are considerable deviations from the 35 ‰ according to the IOT. The salt composition can also influence the relationship of the salinity display and the actual amount of salt present.

Corresponding tables are available for many salts in salt water aquarium applications. Salt weight to salinity according to the IOT or conductivity. In consideration of these tables, very precise salinity measurements can be conducted.

5.5 Temperature compensation

The conductivity of aqueous solutions is temperature-dependent. The temperature dependency varies greatly according to the type of solution. With temperature compensation, the solution is calculated back to a uniform temperature in order to compare it independently of the temperature. The normal operating temperature for this is 25 °C. However, it can also be adjusted to 20 °C.

5.5.1 NLF temperature compensation according to EN 27888

For most applications, such as fish husbandry applications and measurement of surface water and drinking water, non-linear temperature compensation for natural water NLF is sufficiently accurate in accordance with EN 27888.

- The normal operating temperature is 25 °C.
- The recommended application range of NLF compensation is between 60 µS/cm and 1000 µS/cm.

5.5.2 Linear temperature compensation LIN (only available at ECO 523)

If the function of the temperature compensation is not known exactly, a linear temperature compensation is normally adjusted in the device.

Open the Configuration menu and select the parameter TCOR. Configuration parameter LIN and TLIN correspond to TKlin.

Put simply, this means that the temperature dependency is approximately the same over the considered concentration range of the solution.

Temperature coefficients of 2.0 %/K are most common.

Formula $LFT_{ref} = LF_{TX} / ((1 + TK_{lin} / 100\%) * (TX - T_{ref}))$

A temperature coefficient can be determined, for example, with measurement of a solution at 2 temperatures, T1 and T2, with temperature compensation switched off.

Formula $TKlin = ((LF_{T1} - LF_{T2}) * 100\%) / ((T1 - T2) * LF_{T1})$

TK_{lin} = value is entered in the Configuration menu in parameter TLIN.

- LF_{T1} = conductivity at temperature 1
- LF_{T2} = conductivity at temperature 2

5.5.3 Compensation of weak NaCl solutions (only available at ECO 523)

Compensation of weak NaCl according to EN 60746-3 solutions in pure and ultrapure water.

6 Operation and maintenance

6.1 Operating and maintenance notices

Note

- The device and conductivity measuring cell must be handled with care and used in accordance with the technical data. Do not throw or strike.
- If the device is stored at a temperature above 50 °C, or is not used for an extended period of time, the batteries must be removed. Leaks from the batteries are avoided as a result.

The device is calibrated at the factory with the permanently connected conductivity measuring cell. The highest system precision can be achieved in this manner. If desired, a gradient correction can be carried out for the device in order to further optimize the accuracy in a narrow range. This is only necessary for normal use. See Adjustment of the measuring input.

6.2 Battery

6.2.1 Battery indicator

- If the empty frame in the battery display blinks, the batteries are depleted and must be replaced. However, the device will still operate for a certain length of time.
- If the BAT display text appears in the main display, the battery voltage is no longer adequate for operation of the device. The battery is fully depleted.

6.2.2 Changing battery

Danger! Danger of explosion!

Using damaged or unsuitable batteries can generate heat, which can cause the batteries to crack and possibly explode!

- Only use high-quality and suitable alkaline batteries!

Caution! Damage!

If the batteries have different charge levels, leaks and thus damage to the device can occur.

- Only use high-quality and suitable alkaline batteries!
- Do not use different types of batteries!

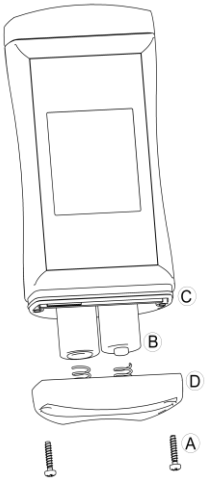
▶ Remove depleted batteries immediately and dispose of them at a suitable collection point.

Note

Unnecessary unscrewing endangers the protection against moisture and should therefore be avoided.

▶ Read the following handling instructions before replacing batteries and follow them step by step.

▶ If disregarded, the device could be damaged or the protection from moisture could be diminished.



1. Unscrews the Phillips screws (A)and remove the cover.
2. Carefully replace the two Mignon AA batteries (B). Ensure that the polarity is correct! It must be possible to insert the batteries in the correct position without using force.
3. The O-ring (C) must be undamaged, clean and positioned at the intended depth.
4. Fit the cover (D) on evenly. The O-ring must remain at the intended depth!
5. Tighten the Phillips screws (A).

7 Error and system messages

Display	Meaning	Possible causes	Remedy
----	Range switches or measured value unstable Impurities or air bubbles Measured value far outside of the measuring range	• Controlling instable • Contamination or air bubbles on cell • Measurement outside permissible range • Measuring cell defect	▶ Wait for the transient effect of the controller ▶ clean contamination / bubbles ▶ Keep measurement within the permissible range ▶ Send in for repair
SEnS Erro	Sensor cable defect Sensor or probe defect Measuring range exceeded/undercut	• Cable breakage • Sensor or probe defect • Measurement outside permissible range	▶ Send in for repair ▶ Send in for repair ▶ Stay within allowable measurement range
No display, unclear characters or no response when buttons are pressed	Battery depleted System error Device is defective	• Battery depleted • Error in the device	▶ Replace battery ▶ Send in for repair
bAt	Battery depleted	• Battery depleted	▶ Replace battery
Err.1	Measuring range exceeded	• Measurement too high • Measuring cell defect	▶ Stay within allowable measurement range ▶ Check the measuring cell / send in for repair
Err.2	Measuring range is undercut	• Measurement too low • Measuring cell defect	▶ Stay within allowable measurement range ▶ Check the measuring cell / send in for repair
SYS Err	System error	• Error in the device	▶ Switch device on/off ▶ Replace batteries ▶ Send in for repair

8 Technical data

ECO 521		
Measuring range	Conductivity	0 .. 5000 µS/cm
	Spec. resistance	-
	EC	0 .. 5.000 EC (corresponds to m/cm)
	CF	0.00 .. 50.00 CF (corresponds to 10 x EC)
	Salinity	-
	TDS	0 .. 2000 mg/l
	Temperature	-5.0 .. +80.0 °C (23.0 .. +176.0 °F).
Accuracy	Conductivity	typ. ± 1 % v. MW ± 0.5 % FS (0 .. 2000 µS/cm)
	Temperature	± 0.3 °C

ECO 522		
Measuring range	Conductivity	0 .. 2000 µS/cm 0.00 .. 20.00 mS/cm 0.0 .. 100.0 mS/cm
	Spec. resistance	-
	EC	-
	CF	-
	Salinity	0.0 .. 50.0 g/kg
	TDS	0 .. 2000 mg/l
	Temperature	-5.0 .. +105.0 °C (23.0 .. +221.0 °F) Note: the conductivity measuring cells can be exposed temporarily to temperatures of up to 100 °C and permanently to temperatures of up to 80 °C.
Accuracy	Conductivity	± 0.5 % of measured value ± 0.5 % FS
	Temperature	± 0.3 °C

ECO 523		
Measuring range	Conductivity	0.000 .. 2.000 µS/cm 0.00 .. 20.00 µS/cm 0.0 .. 100.0 µS/cm
	Specific resistance	10.0 .. 200.0 kΩ/cm 0.010 .. 2.000 MΩ/cm 0.01 .. 20.00 MΩ/cm
	EC	-
	CF	-
	Salinity	-
	TDS	-
	Temperature	-5.0 .. +105.0 °C (23.0 .. +221.0 °F) Note: the conductivity measuring cells can be exposed temporarily to temperatures of up to 100 °C and permanently to temperatures of up to 80 °C.
Accuracy	Conductivity	Typ. ± 1 % of measured value ± 0.5 % FS
	Temperature	± 0.3 °C

Measuring cell	**ECO 521**	**ECO 522**	**ECO 523**
Electrodes	titanium	graphite	stainless steel
Shaft	plastic, Ø12 x 120 mm	PPO (Noryl), Ø12 x 120 mm	stainless steel; Ø12 x 75 mm
Wetted parts	Titan, plastic	graphite, PPO (Noryl), st. steel 1.4435	stainless steel 1.4404, 1.4435), PEEK
Pressure resistance	1 bar	6 bar (@ 25°C)	1 bar
Dimensions *(without cable)*	Ø16 x 155 mm	Ø16.8 x 160 mm	~Ø20 x 195 mm

Measuring cycle		approx. 10 measurements per second (Updating of the display approx. 2 times per second)
Display		3- line segment LCD, additional symbols, illuminated (adjustable white, permanent illumination)
Standard functions		Min/Max/Hold
Adjustment		Offset and gradient correction for temperature, Gradient correction - conductivity
Housing		Break-proof ABS housing
	Protection rating	IP65 / IP67
	Dimensions L*W*H	108 * 54 * 28 mm, without measuring cell or kink protection
	Weight	165 g incl. battery and measuring cell (ECO 521) 180 g incl. battery and measuring cell (ECO 522) 210 g incl. battery and measuring cell (ECO 523)
Nominal temperature		25 °C
Operating conditions		-20 to 50 °C; 0 to 95 %RH (temporarily condensing)
Storage temperature		-20 to 70 °C
Current supply		2 * AA batteries (mignon)
	Current requirement	approx. 2.2 mA, approx. 3.5 mA with lighting
	battery life	Service life > 1000 hours with alkaline batteries (without backlighting)
	Battery indicator	4-stage battery status indicator, Replacement indicator for depleted batteries: "BAT"
	Auto-power-OFF function	The device switches off automatically if this is activated
Directives and standards		The devices conform to the following Directives of the Council for the harmonization of legal regulations of the Member States: • 2014/30/EU EMC Directive • 2011/65/EU RoHS Applied harmonized standards: • EN IEC 61326-1:2021 Emission limits: Class B Immunity according to Table 1 Additional errors: < 1 % FS • EN IEC 63000:2018 The device is intended for mobile use and/or stationary operation in the scope of the specified operating conditions without further limitations.

9 Disposal

Separation by material and recycling of device components and packaging must take place at the time of disposal. The valid regional statutory regulations and directives applicable at the time must be observed.

Note

The device must not be disposed of with household waste. Return it to us, freight prepaid. We will then arrange for the proper and environmentally friendly disposal.

Private end users in Germany have the possibility of dropping off the device at the municipal collection center.

Batteries must be removed beforehand!

Please dispose of empty batteries at the collection points intended for this purpose

10 Service

If you have any questions, please do not hesitate to contact us.

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