GE Healthcare

Conductivity Montior

User Manual

Important user information

All users must read this entire manual to fully understand the safe use of Conductivity monitor.

WARNING!

The WARNING! sign highlights instructions that must be followed to avoid personal injury. It is important not to proceed until all stated conditions are met and clearly understood.

CAUTION!

The Caution! sign highlights instructions that must be followed to avoid damage to the product or other equipment. It is important not to proceed until all stated conditions are met and clearly understood.

Note

The Note sign is used to indicate information important for trouble-free and optimal use of the product.

CE Certifying

This product meets the requirements of applicable CE-directives. A copy of the corresponding Declaration of Conformity is available on request.

The **CE** symbol and corresponding declaration of conformity, is valid for the instrument when it is:

– used as a stand-alone unit, or

– connected to other CE-marked GE Healthcare instruments, or

– connected to other products recommended or described in this manual, and

– used in the same state as it was delivered from GE Healthcare except for alterations described in this manual.

WARNING!

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Recycling

This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of equipment.

WARNING!

This is a class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

Contents

1 Introduction

IMPORTANT! Conductivity Monitor is intended for laboratory use only, not for clinical or *in vitro* use, or for diagnostic purposes.

The GE Healthcare Conductivity Monitor, Code No. 18-1500-00, is a high quality, high precision on-line monitor for conductivity measurements and gradient determination in liquid chromatography applications.

The monitor consists of two units, the flow cell and the control unit. The flow cell contains the titanium electrodes used for conductivity measurement as well as a temperature sensor. The small size of the flow cell allows it to be positioned anywhere in the liquid path, provided that the pressure specification for the cell is not exceeded.

The control unit carries the six programming keys for the monitor. An easy to read 32 digit alphanumeric display shows the conductivity measured in Siemens/cm (mS/cm or µS/cm) and the temperature. The display also shows the relative gradient position as a percentage of the maximum set value, as both a percentage figure and graphically.

The monitor has a very large dynamic range from 1 µS/cm to 999.9 mS/cm and is therefore suitable for a wide range of applications, ranging from reversed phase to hydrophobic interaction chromatography. A unique design of the electronics is the microprocessor control of frequency variations within the working range. This gives excellent linearity and eliminates the need for range settings.

WARNING! No service parts inside equipment, it is not allowed to open the instrument by the user or responsible body.

2 Unpacking and Installation

2.1 Unpacking

Carefully unpack the GE Healthcare Conductivity Monitor. Check the contents against the packing list supplied. Inspect for any damage that may have occurred during transit. Report any damage immediately to your local GE Healthcare representative and to the transport company concerned.

- The system should be installed on stable laboratory bench providing a suitable working area.
- To maintain correct ventilation, the system requires an appropriate amount of free space. Do not block the ventilation inlets or outlets on the system.

2.2 Tubing connections

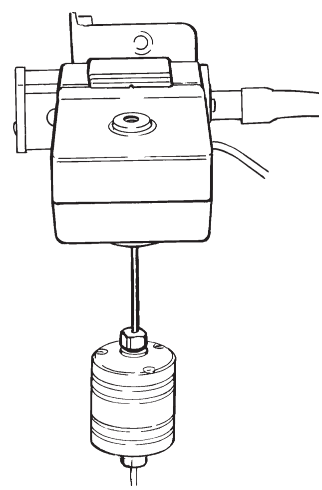


Fig 1. Connection of the gradient monitor flow cell.

Unpack the flow cell. Connect the short pre-flanged ETFE tubing to one end of the conductivity monitor flow cell. Connect the other end of the tubing to the outlet of the UV monitor flow cell or the column. Connect a pre-flanged tubing with an M6 connector (FPLC™ connector) to the conductivity monitor flow cell outlet.

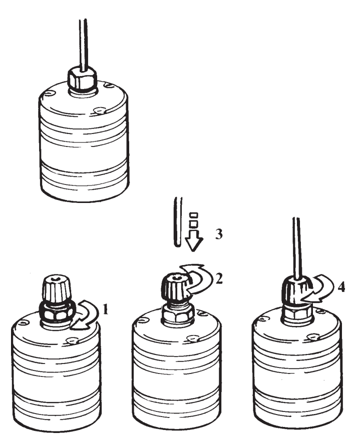


Fig 2. Connection of 1/16” tubing to the flow cell.

If the conductivity monitor flow cell is connected to a UV monitor from another manufacturer, use the 1/16” tubing with a Tubing Connector M6 male to connect the flow cell to the UV monitor flow cell. Connect the M6 connector to the flow cell. Unscrew the top of the M6 connector, push the tubing into the rubber cone, and fasten the top of the connector. Use a suitable ”finger tight” type connector to connect the other end to the UV monitor. Use the same tubing at the outlet of the conductivity flow cell.

Note: *The flow cell does not have a recommended flow direction. However, if it is positioned very close to another system instrument, connection should be such that the end of the flow cell with the screws faces that instrument to minimise influences from its ground potential.*

2.3 Electrical connections

WARNING! Use only mains cables delivered and approved by GE Healthcare.

2.3.1 Connection of the flow cell

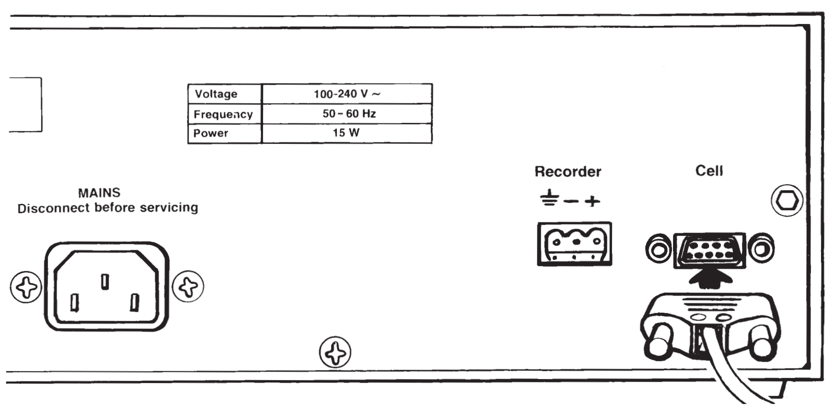


Fig 3. Connection of flow cell.

1. Connect the signal cable from the flow cell to the socket ”Cell” on the Control Unit.

2.3.2 Connection of the recorder

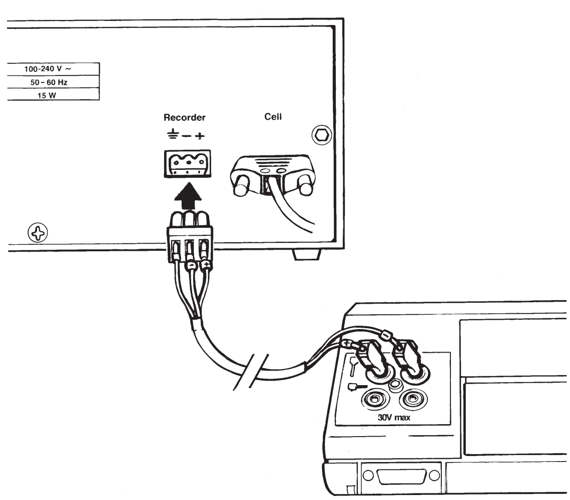


Fig 4. Connection of the recorder.

1. Connect one of the supplied signal cables between the monitor and the recorder. On the recorder end, connect one of the supplied banana plugs to the cable marked + and the other banana plug to the cable marked –. Connect the banana plugs to the corresponding connector on the recorder.

   On the monitor end, connect the supplied green 3 Pole Female Connector to the cable. Make sure that the polarity of the cable connections to the monitor corresponds to those on the recorder. The third lead of the cable should be connected to ground.

2. Set the voltage on the recorder to 1 V.

3. Select the appropriate mains cable and connect it to the mains socket on the control unit.

4. Switch on the power.

2.3.3 Connection of the gradient signal to LCC-501 Plus and to the Recorder.

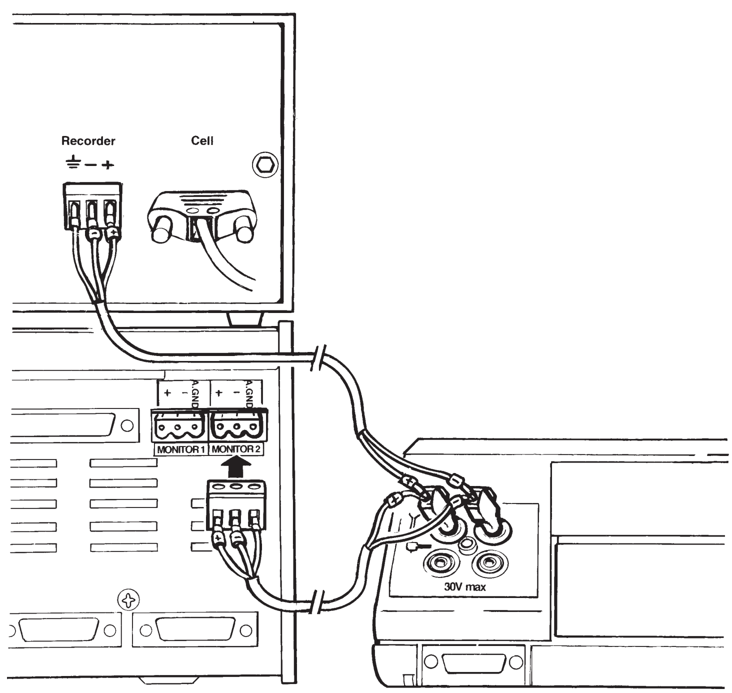


Fig 5. Connection of the gradient signal to LCC-501 Plus and to the recorder.

1. Use the two signal cables supplied to connect the Conductivity Monitor to the recorder and the LCC-501 Plus. Insert the ends marked + from both cables to one banana plug. Insert the ends marked – to the other plug. Connect the banana plugs to the corresponding contacts on the recorder.

2. Connect one signal cable to the Conductivity Monitor using the green 3 Pole Female Connector as described above (see 2.3.2).
3. Use the second supplied 3 Pole Female Connector to connect the other cable to the socket marked Monitor 1 or Monitor 2 on the LCC-501 Plus. Make sure that the end marked + is connected to +, and the end marked – to – on the LCC-501 Plus. Connect the third end to the ”A GND”.
4. Set the monitor range to 1000 mV in the Calibration block in the LCC-501.
5. Select the appropriate mains cable and connect it to the mains socket on the control unit.

3 Getting started

3.1 Setting the scale with buffers

set 100% Press 1 second

set 0% Press 1 second

Fig 6. Setting the scale.

When the conductivity monitor is switched on, it is in Run Mode and will display the measured conductivity. To set the output range to the recorder, the conductivity levels 100% and 0% can easily be set with the high and low conductivity buffers used for the gradient

1. Start the flow in the system with the high conductivity buffer, preferably with the column to be used in the application installed.
2. When the conductivity reading stabilises, press **set 100%** for 1 second.
3. Change to the low conductivity buffer and when the new conductivity level is stable, press **set 0%** for 1 second.

   The monitor is now ready for use.

   The setting of the 100% and 0% levels will remain in the control unit until a new scale is set.
4. Check that the recorder is set to 1 V full scale deflection.

4 General description

4.1 Principle of operation

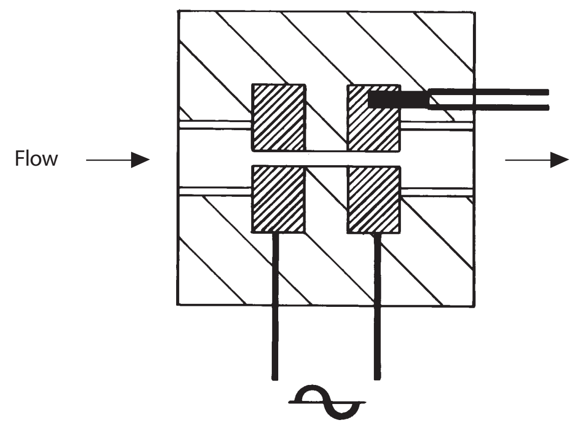


Fig 7. The flow cell.

The flow cell has two cylindrical shaped titanium electrodes positioned in the flow path of the cell. An alternating voltage is applied between the electrodes and the resulting current is measured and used to calculate the conductivity of the eluent. The microprocessor controls the AC frequency and automatically increases it with increasing conductivity between 50 Hz and 50 kHz. This unique design gives maximum linearity and true conductivity values.

The monitor measures conductivity over the complete working range. No range settings are required. However, to obtain a usable output signal to the recorder and to get a relative conductivity value, it is possible to set a 0 to 100% range. This can be done with the buffers used or by selecting any fixed range between 0 µS/cm and 999.9 mS/cm.

The monitor displays the conductivity in µS/cm or mS/cm. The conductivity is automatically calculated by multiplying the measured conductance by the flow cells cell constant. The cell constant is pre-calibrated on delivery but can be measured with a separate calibration procedure.

One of the electrodes has a small temperature sensor for measuring the temperature of the eluent in the flow path. Temperature variations influence the conductivity and in some applications, when highly precise conductivity values are required, it is possible to program a temperature compensation factor that recalculates the conductivity to a set reference temperature.

4.2 Control Unit

4.2.1 Front panel

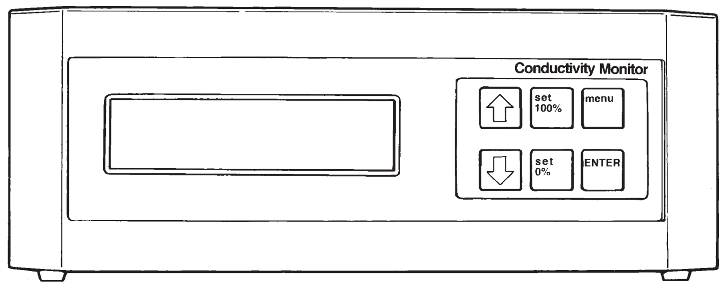


Fig 8. Front panel.

The front panel consists of an alphanumerical LCD display window and a keyboard with six membrane keys.

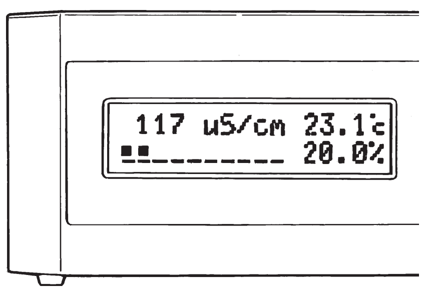


Fig 9. Display.

Display

mS/cm Displays the actual conductivity value in mS/cm or µS/cm.

bar graph Displays the conductivity relative to the set 100% and 0% conductivity levels.

Note: *This value must not be confused with the %B value as conductivity is not directly proportional to %B at high salt concentrations.*

°C Displays the actual buffer temperature in the flow cell.

% Displays the conductivity relative to the set 100% and 0% conductivity levels in percentage.

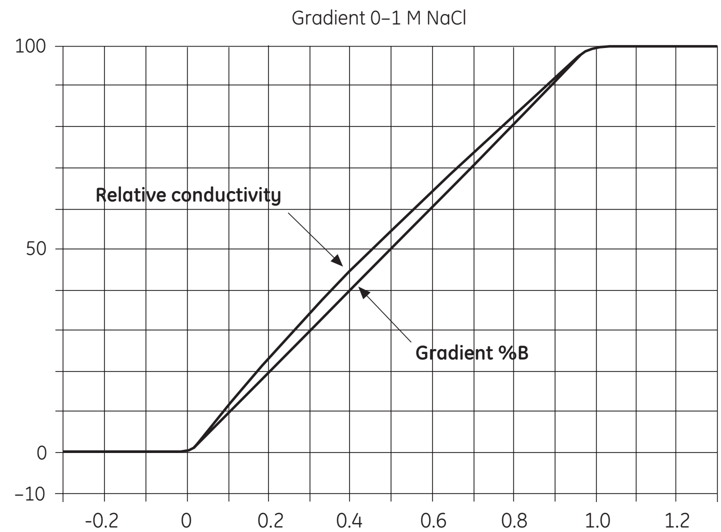


Fig 10. A typical conductivity gradient.

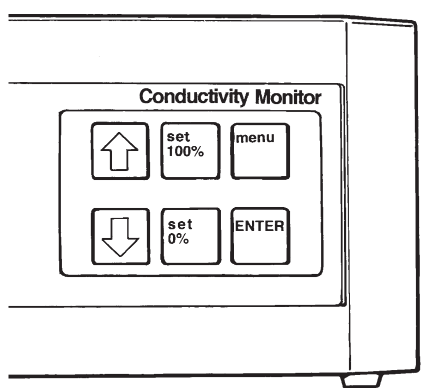
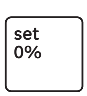
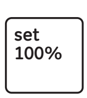


Fig 11. Key board.

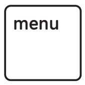
Keyboard



This key sets the 0% conductivity level with the low conductivity buffer. The set 0% key is pressed for 1 second while the low conductivity buffer is pumped through or injected into the flow cell. The voltage output to the recorder is set to 0 V for the measured conductivity.



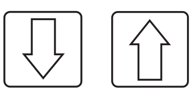
This key sets the 100% conductivity level with the high conductivity buffer. The set 100% key is pressed for 1 second while the high conductivity buffer is pumped through or injected into the flow cell. The voltage output to the recorder is set to 1 V for the measured conductivity.



The menu is used to step between the functions below:

1. Set scale 100%. With this function any fixed conductivity value in µS/cm or mS/cm can be set for the 100% level.
2. Set scale 0%. With this function any fixed conduc-tivity value in µS/cm or mS/cm can be set for the 0% level.
3. Set temperature comp. A temperature compensation factor for the conductivity can be set. This can be necessary for high precision measurements. The temperature compensation factor is expressed in percentage increase of conductivity per °C increase in temperature. If the temperature compensation factor is unknown, a general approximate value of 2% can be set. This is an approximate value for many common salt buffers used in chromatography applications.

   When the temperature compensation is set to 0, it is inactive.
4. Set reference temp. The temperature compensation factor must be related to and adjusted to a set reference temperature in the range 4–40 °C.



The ”arrow down” and ”arrow up” keys are used to selectnumerical values in the menu settings. The keys can be held down for a faster scroll.

The ENTER key is used to enter programmed values and exit to Run Mode.

4.2.2. Rear panel

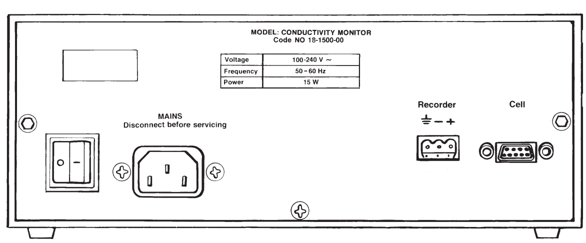


Fig 12. Rear panel.

On/Off	Mains switch.
Mains	Socket for mains cable, 100–240 V ~.
Recorder	3-pole connector for connection of signal cable to recorder using the
supplied	3-Pole Female Connector.
Cell	Connector for connecting the signal cable from the flow cell.

4.3 Flow cell

The flow cell exterior is made of PEEK and the interior between the titanium electrodes of fluoroplastics. Both ends of the flow cell have female M6 fittings. The signal cable which connects to the control unit has a 9 pole DSUB connector.

5 Operation

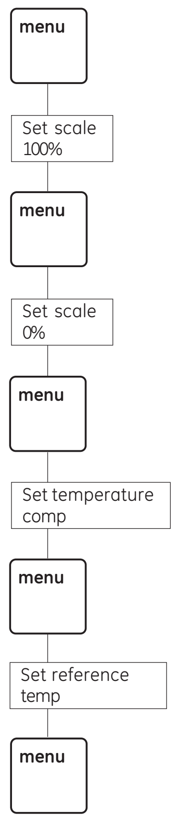


Fig 13. Menu overview.

5.1 Menu

With the **menu** key, more advanced functions can be programmed, such as setting the conductivity to any range independent of the buffers and temperature compensation of the conductivity to a reference temperature. The **menu** key is also used to step between the functions.

5.2 Fixed scale setting

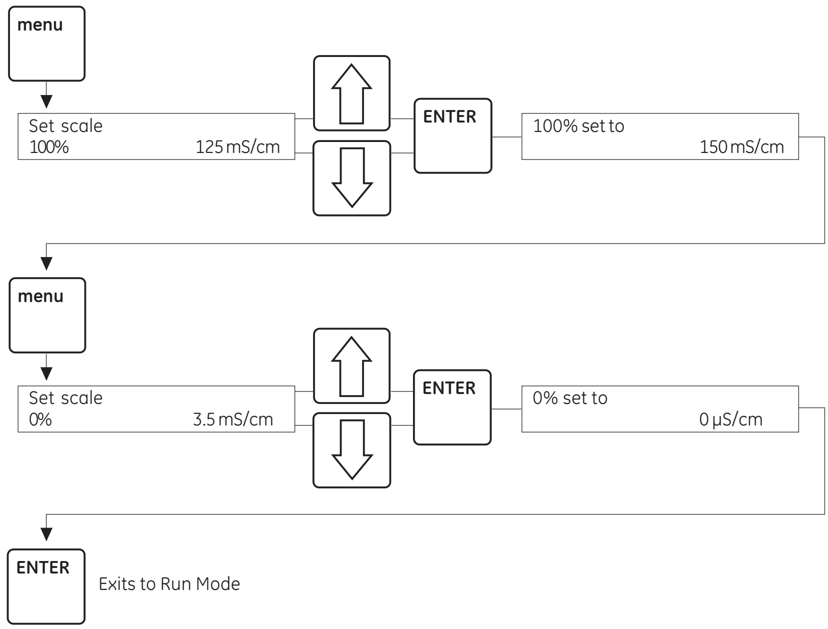


Fig 14. Fixed scale setting.

The 100% and 0% conductivity values can be set to any value of your choice, e.g. to extend the recorder full scale deflection and baseline to be slightly over and under the conductivity of the buffers. In addition it might be easier to read the conductivity values for specific peaks in a chromatogram if the scale is in tens or hundreds of mS/cm or µS/cm.

In this example the conductivity scale is changed from a previously set 100% value of 125 mS/cm to a new value of 150 mS/cm. The 0% value is changed from 3.5 mS/cm to 0 µS/cm.

1. Press menu, the previously set 100% value is displayed.
2. Use ⇧ and ⇩ keys to set the conductivity value to 150 mS/cm.
3. Press ENTER to accept the value. 100% set to 150 mS/cm is displayed.
4. Press menu again to set the 0% value.
5. Set the value for 0% to 0 µS/cm using the ⇧ and ⇩ .
6. Press ENTER to accept the setting. 0% set to 0 µS/cm is displayed.
7. Press ENTER again to exit to Run Mode.

5.3 Temperature compensation

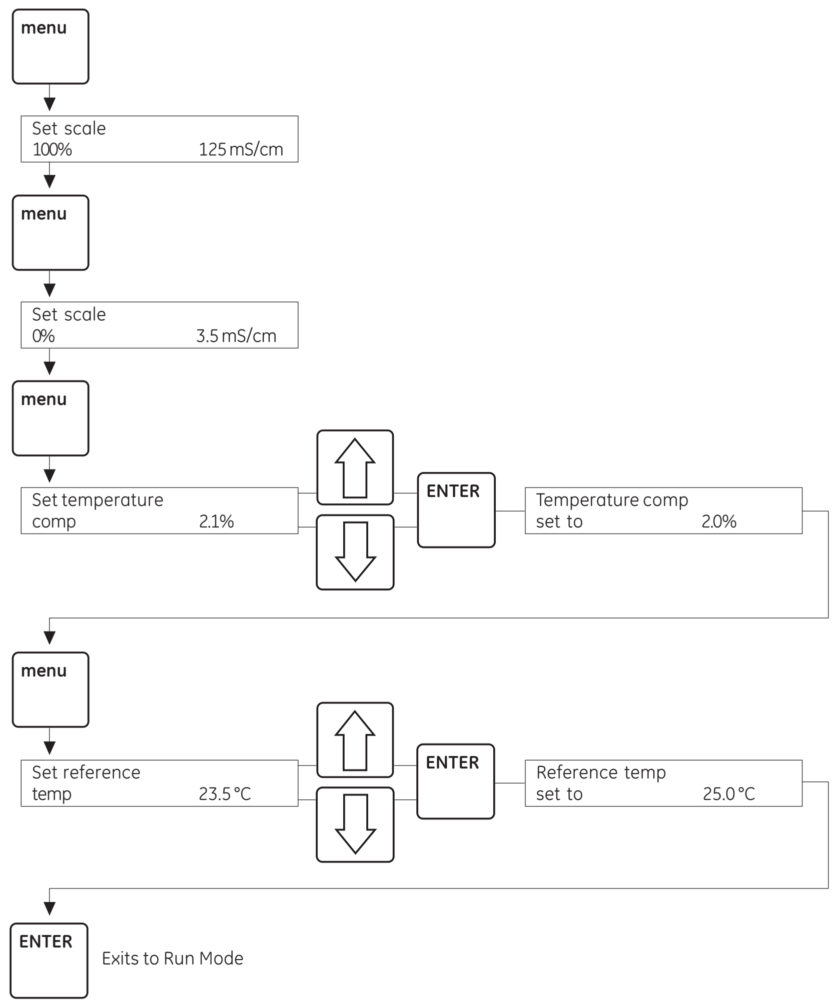


Fig 15. Temperature compensation setting.

Temperature variations may influence conductivity. If high accuracy in the specific conductivity is required, a temperature compensation factor can be programmed together with a reference temperature. All conductivity values will then automatically be converted to the set reference temperature. If the temperature coefficient is unknown a recommended average temperature compensation factor of 2% (conductivity increase in percentage per °C) can be used for most common salts used in liquid chromatography applications.

When the temperature compensation is set to 0, this function is inactive.

In the example below the temperature compensation factor is changed from a previously set value of 2.1% to a new value of 2.0%. The reference temperature is changed from 23.5 °C to 25.0 °C.

1. Press [menu] three times until the Set temperature comp. menu is displayed.
2. Set the value of the temperature compensation factor to 2.0% using the [⇧] and [⇩] keys.
3. Press [ENTER] to accept the value. Temperature comp set to 2.0% is displayed.
4. Press [menu] to set the temperature to which the conductivity values should be corrected. Set reference temp. 23.5 °C. is displayed. Use the [⇧] and [⇩] keys to set the temperature to 25.0 °C.
5. Press [ENTER] to accept the temperature.
6. Press [ENTER] again to exit to Run Mode.

5.4 Summary of commands in menu

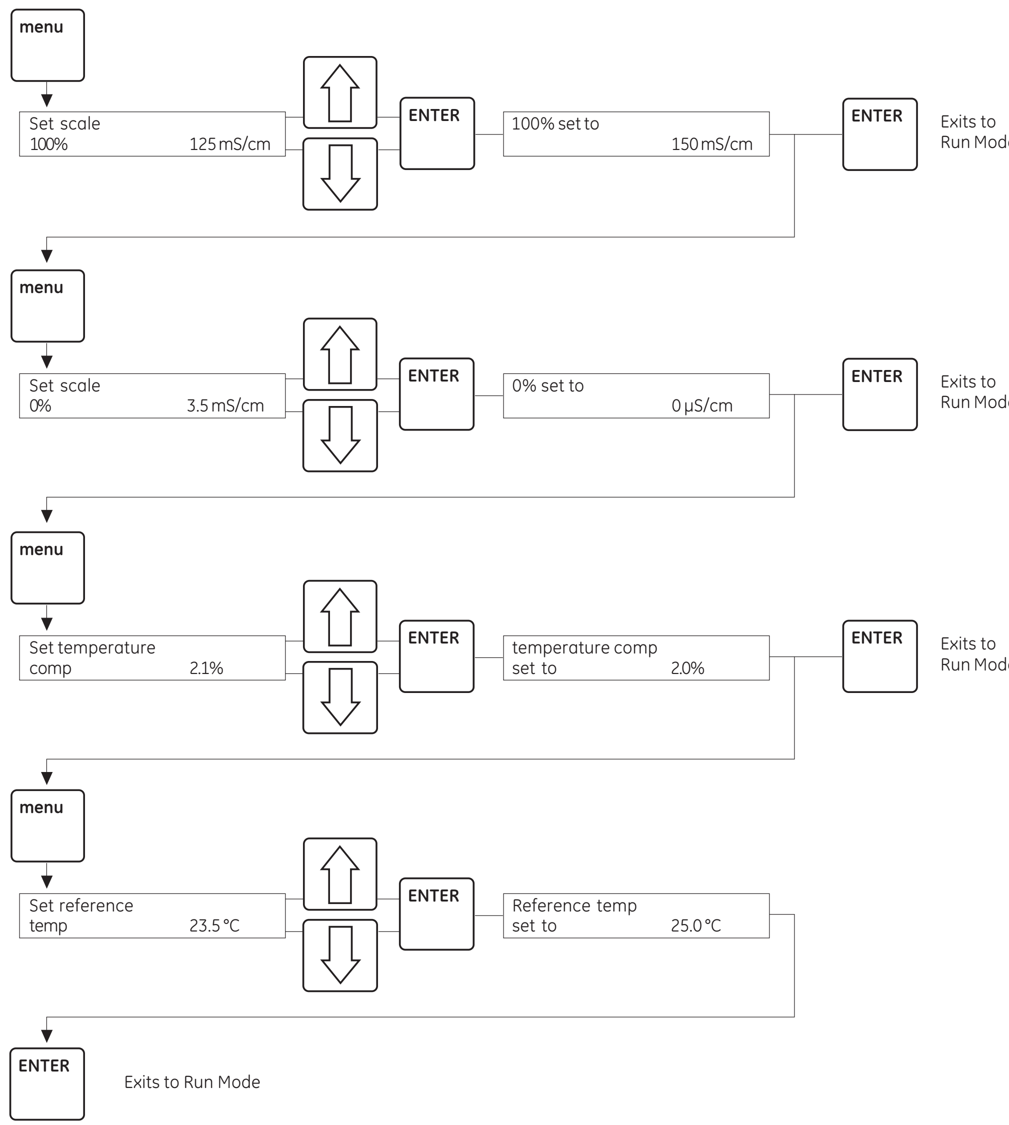


Fig 16. Summary of commands.

6 Maintenance

The Conductivity Monitor requires very little maintenance if precautions are taken to protect the flow cell.

WARNING! When using hazardous chemicals, make sure that the entire system has been flushed thoroughly with bacteriostatic solution, e.g. NaOH, and distilled water before service and maintenance.

Note: *When the flow cell is not in use, rinse the cell with de-ionised water, do not leave buffers to dry in the cell. When the monitor is stored for a longer period of time, fill it with 20% ethanol.*

If you suspect contamination clean the flow with 1 M NaOH as described below.

6.1 Recycling

This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of equipment.

6.2 Instrument housing

Wipe the instrument regularly with a damp cloth. Let the instrument dry completely before use.

6.3 Cleaning the flow cell

If the conductivity measurement results are not comparable to previous results, the electrodes in the flow cell may be contaminated and require cleaning.

To clean the flow cell;

Normally this is done by pumping 15 ml of 1 M NaOH at 1 ml/min through the flow cell. Check that your pumps are resistant to 1 M NaOH. If not fill the flow cell using a syringe and leave it for 15 minutes.

Rinse thoroughly with 50 ml de-ionised water.

If the flow cell is totally blocked, the blockage can be broken using a thin needle or a piece of string with a diameter less than 0.8 mm.

6.4 Calibration mode

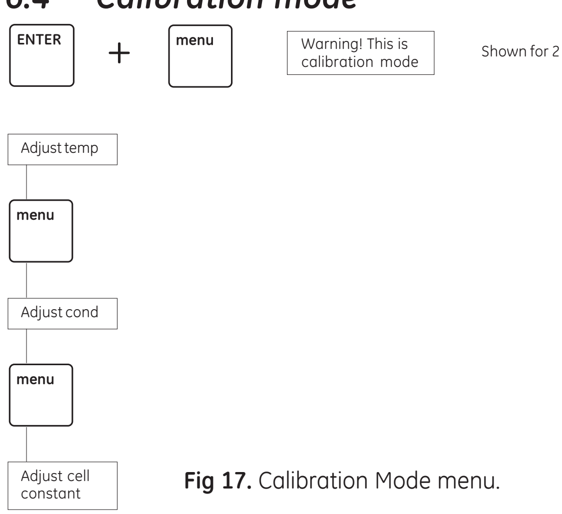


Fig 17. Calibration Mode menu.

6.5 Calibration of the temperature sensor

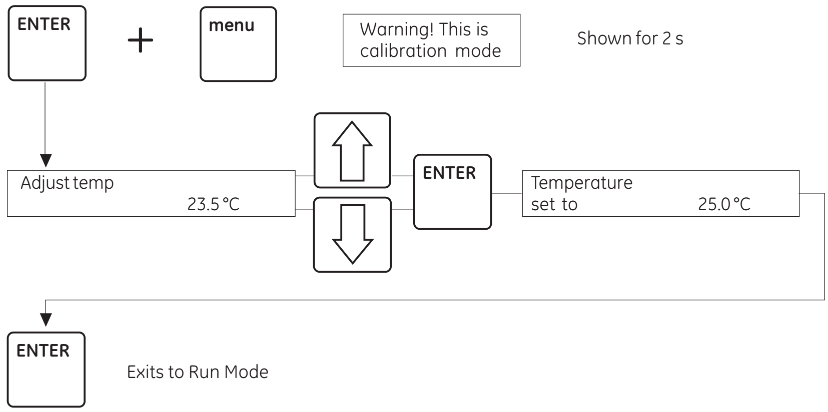
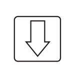


Fig 18. Calibration of the temperature sensor.

The cell constant and the temperature sensor can be calibrated in the monitor calibration mode. New monitors are factory calibrated and it is not recommended to change these values.

Calibration of the temperature sensor is only necessary if the monitor is used to determine absolute conductivity with high accuracy.

In the example below the temperature is adjusted from 23.5 °C to the measured temperature of 25.0 °C.

1. Place the flow cell together with a precision thermometer inside a box or beaker to ensure that they are not exposed to draft. Leave them for 15 minutes to let the temperature stabilise.
2. Read the temperature on the thermometer.
3. Press ENTER and menu simultaneously for 2 seconds to enter the Calibration Mode.
4. The display shows Adjust temp. 23.5 °C. Use the  and  keys to set the temperature on the control unit to 25.0 °C, the temperature shown on the thermometer.
5. Press ENTER to accept the setting.
6. Press ENTER again to exit the Calibration Mode.

6.6 *Calibration of the cell constant*

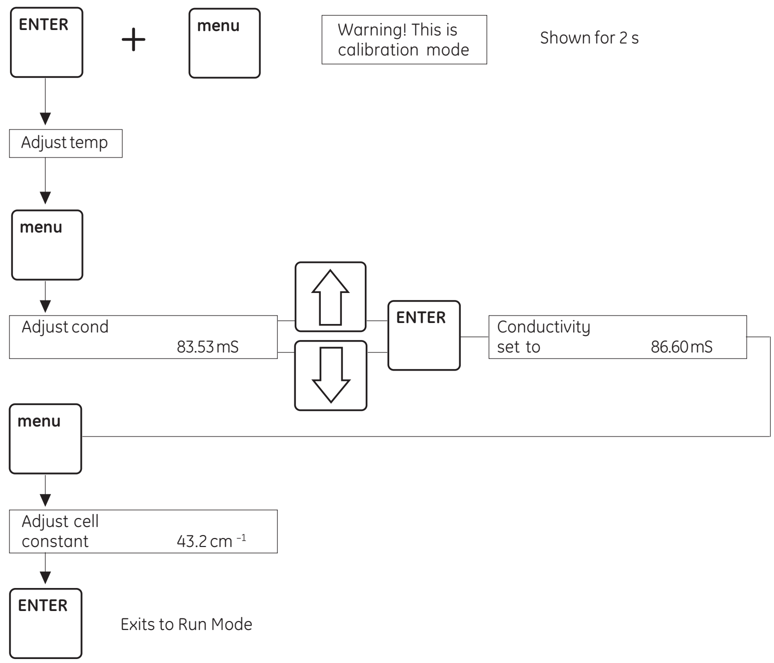


Fig 19. Calibration of cell constant.

Normally it is not necessary to calibrate the flow cell as it is pre-calibrated on delivery. Calibration of the flow cell is only necessary when the monitor is to be used to determine specific conductivity with high accuracy.

In the example below the cell constant is changed by setting the conductivity value of a calibration buffer to the theoretical value at an exact temperature. The conductivity is changed from the measured value of 83.53 mS/cm to the theoretical value of 86.60 mS/cm.

1. Prepare a calibration solution of 1.0 M NaCl, 58.44 g/l.
2. Fill the flow cell with the calibration solution, either via a syringe or by pumping at least 15 ml through the cell.
3. Stop the flow and wait 15 minutes, until the temperature is constant in the range 20–30 °C.
4. Check the displayed temperature of the solution. Read the conductivity value displayed and compare it with the theoretical value from the graph below, at the temperature of calibration solution. If the displayed value and the theoretical value correspond, no further action is required. If the values differ proceed as outlined below.
5. Press ENTER and menu simultaneously for 2 seconds to enter the Calibration Mode.
6. Press menu again until the display shows adjust cond 83.53 mS/cm. Use the ⇧ and ⇩ keys to enter the theoretical conductivity value of 86.60 mS/cm. The new cell constant is automatically calculated.

7. Press ENTER to accept the value. Conductivity set to 86.60 mS/cm will be displayed.
8. Press menu again and the new cell constant value will be displayed in the menu Adjust cell constant.

   Note: *Do not change this value.*

9. Press menu to exit to Run mode.

Note: *The displayed value will differ from the set value, if the temperature compensation, TC, is activated.*

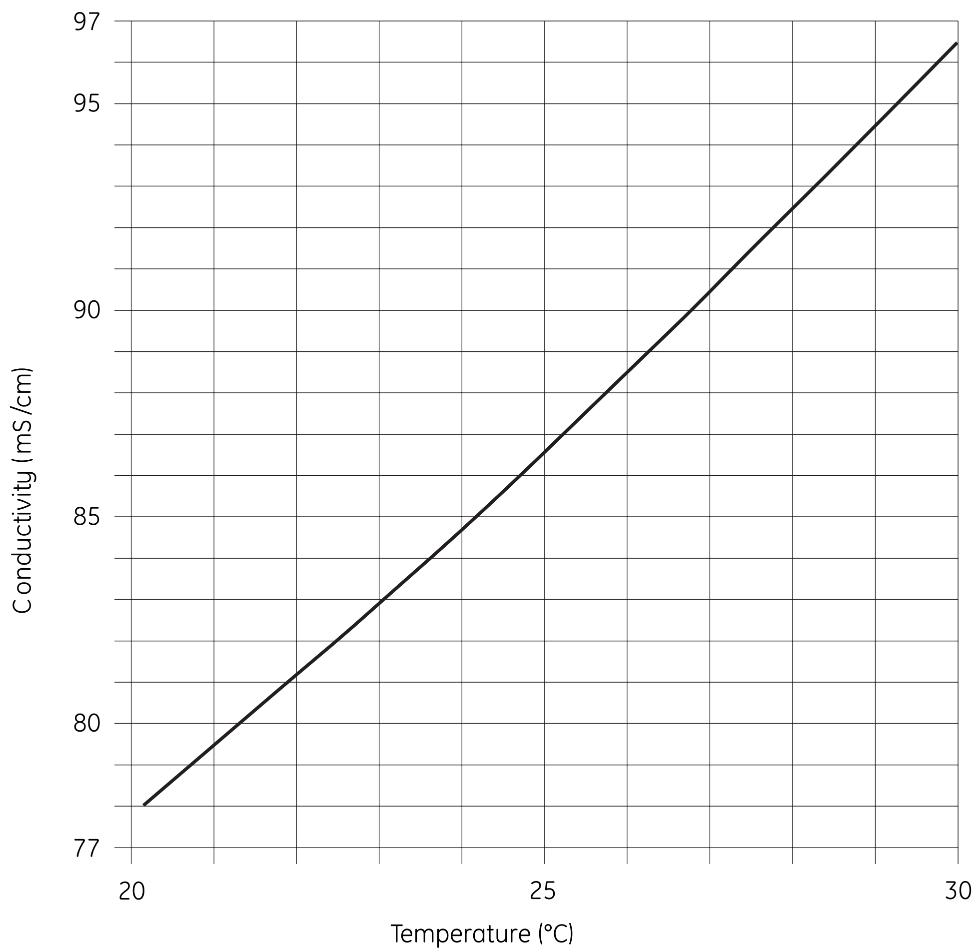


Fig 20. Conductivity of 1 M NaCl at 20–30 °C.

6.7 Replacing the flow cell

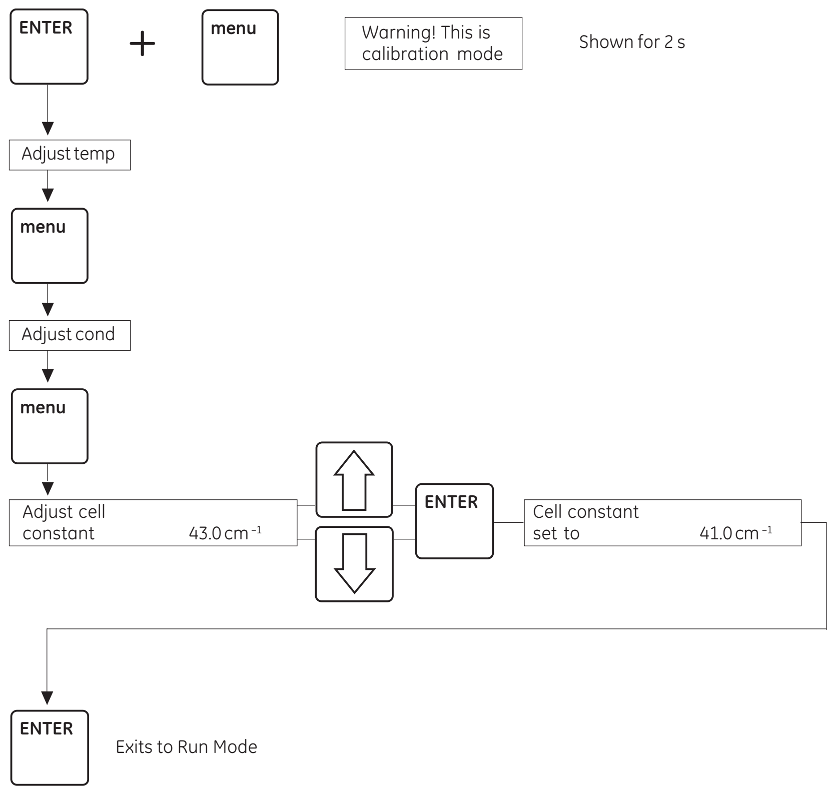


Fig 21. Changing the cell constant.

If the flow cell is replaced with a new flow cell, the monitor must be calibrated with the new cell constant value. The new cell constant is written on the package.

In the example below the cell constant is changed from 43.0 cm^{-1} to 41.0 cm^{-1}.

1. Press ENTER and menu simultaneously for 2 seconds to enter the Calibration Mode.
2. Press menu twice until Adjust cell constant 43.0 cm^{-1} is shown in the display. Use the ⇧ and ⇩ keys to set the cell constant to 41.0 cm^{-1}.
3. Press ENTER to accept the value.
4. Press ENTER again to exit to Run Mode.

6.8 Summary of commands in Calibration Mode

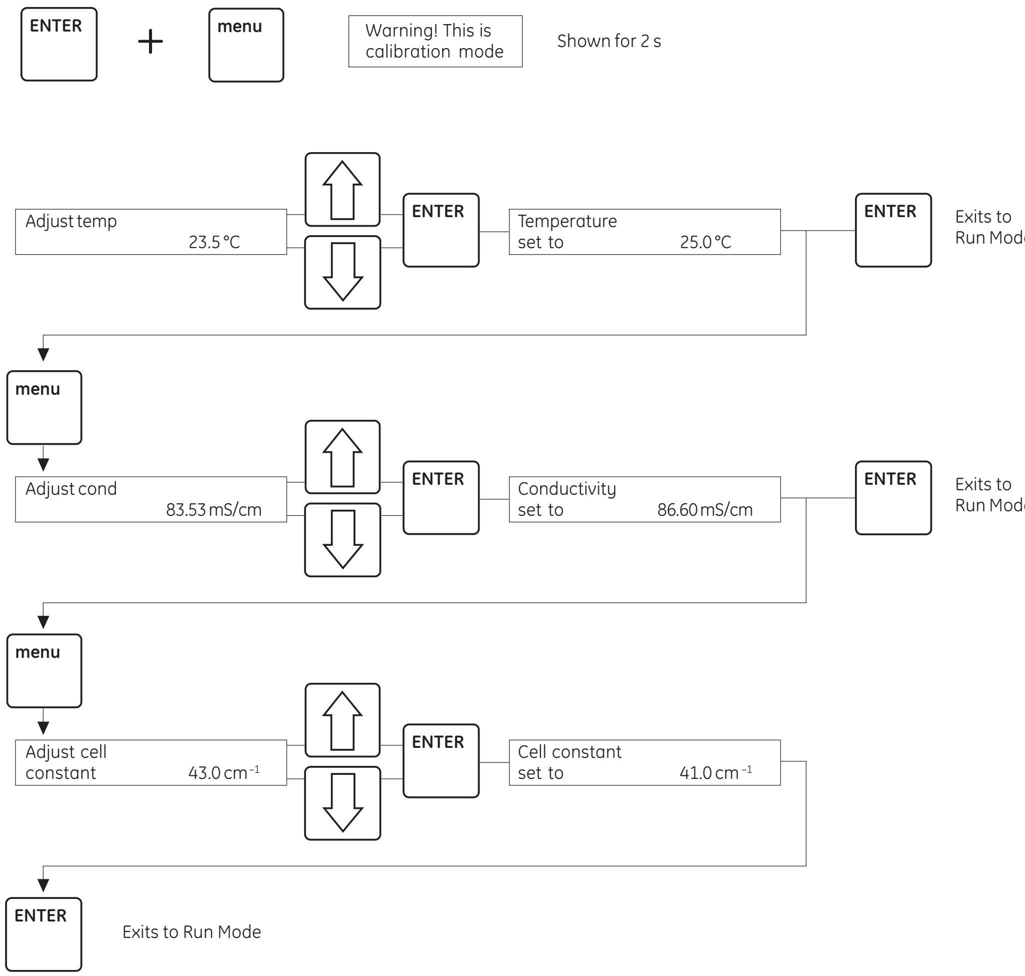


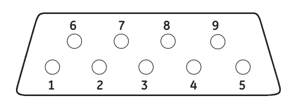
Fig 22. Summary of commands.

7 Trouble Shooting

7.1 Recycling

This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of equipment.

Problem	Possible cause	Remedy
Baseline drift or noisy signal flow cell	Air in flow cell	Use a flow restrictor after the conductivity monitor Check for leaking tubing connections
	Dirty flow cell	Clean flow cell according to procedure described in Maintenance 6.1
	Column not equilibrated or dirty	Equilibrate and/or regenerate column
	Insufficient mixing	Check mixer operation
The gradient profile is larger or smaller than expected	Chart recorder input voltage set incorrectly	Check chart recorder settings 1 V
The absolute conductivity value is wrong	The electrical grounding of the electrode is influenced by another instrument	Turn the flow cell so the end with the screws is facing the other instrument
	Temperature compensation is on	Set the temperature compensation factor to 0
Ghost peaks appear in the gradient profile	Charged sample detected (e.g. protein)	None required
	Air bubbles passing through flow cell	Use a flow restrictor after the conductivity monitor flow cell. Check for loose tubing connections
Chart recorder not responding	Chart recorder is not connected properly	Check electrical connections
	Full scale of recorder set too high	Set recorder range to 1V
	Recorder is off scale	Readjust pen position
	100% set too high	Check the 100% level
	Flow cell not conected inline	Check flow cell tubing connections
Conductivity measurements with the same buffer appear to decrease over time	Dirty flow cell	Clean flow cell according to procedure described in section 6.1
	Room temperature has decreased	Use a temperature compensation factor

Problem	Possible cause	Remedy
The monitor does not respond to conductivity change	Power not switched on Faulty flow cell or control unit	Check To diagnose if it is the flow cell or the control unit which is causing the problem, follow the procedure below 1. Disconnect the flow cell signal cable from the control unit. The display should show 0 µS/cm. 2. Connect the test wire supplied with the monitor between pin 3 and 4 on the Cell connector on the control unit. The display should show 999.9 mS/cm.  3. Connect the test wire between pins 4 and 7. The conductivity value displayed should be the same as the cell constant value in mS/cm ±2%. The value of the cell constant can be found in the Monitor Calibration Mode, see section 6.4. 4. Connect the test wire between pins 4 and 8. The display should show the cell constant value × 3.83 µS/cm, ±2%. If any of the above steps fail to display the correct value the fault is most likely to be found within the control unit. Please contact a GE Healthcare service engineer. If correct values are displayed above, the flow cell is most likely to be causing the problem. Try to clean the flow cell according to the instructions in section 6.1. If cleaning does not help the flow cell must be replaced.
No power	Faulty power connection	Check power cable
	Unit not switched on	Check power on/off switch on rear panel

8 Technical Specifications

Operating mode	Auto range conductivity in mS/cm or μS/cm
Sensitivity range	1 μS/cm–999.9 mS/cm
Accuracy	±2 % full scale calibrated range or ±5 μS/cm whichever is greater in the range 1μS/cm–300 mS/cm
Noise	±0.5% full scale calibrated range
Flow rate range	0–100 ml/min
Analogue output	0–1 V
Power supply	100–240 V, 50–60 Hz
Environment	+4 to +40 °C, 20–95% relative humidity, 84–106 kPa (840–1060 mbar) atmospheric pressure
Power consumption	15 W
Dimensions (w x d x h)	245 x 150 x 100 mm
Weight	2.3 kg
Flow cell	
Type	Flow through
Cell constant	50 cm^{-1}, nominal
Internal volume	14 μl
Maximum operating pressure	5 MPa, 50 bar, 750 psi
Cable length	1.5 m
Wetted parts	Fluoroplastics, titanium
Fittings	M-6 (6 mm metric)
Compliance with standards	The declaration of conformity is valid for the instrument only if it is: • used in laboratory locations • used in the same state as it was delivered from GE Healthcare except for alterations described in the User Manual • connected to other CE labelled GE Healthcare modules or other products as recommended.
Safety standards	This product meets the requirement of the Low Voltage Directive (LVD) 73/23/EEC through the following harmonized standards: • EN 61010-1 • IEC 61010-1 • CAN/CSA-C22.2 No. 61010-1 • UL61010-1

EMC standards	This device meets the requirements of the EMC Directive 89/336/EEC through the following harmonized standards: • EN 61326 (emission and immunity) • EN 55011, GR 2, Class A (emission) • This device complies with part 15 of the FCC rules (emission). Operation is subject to the following two conditions: 1 This device may not cause harmful interference. 2 This device must accept any interference received, including interference that may cause undesired operation.

9 Accessories and Spare Parts

Designation	Code No.
Electrical connector kit	19-1515-25
Tubing connector/M6 male	18-1017-98
Capillary tubing, ETFE O.D. 1/16”	18-3194-01
Conductivity Flow Cell	18-1114-43
Signal event marker cable	19-6006-01
Tubing, O.D. 1.8 mm, I.D. 0.8 mm, L 87 mm, (pre-flanged with M6 connector)	19-1515-35

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