ION450

Ion Analyser

Reference Manual

D21M079

D21M079 • Printed by Radiometer Analytical SAS • 2008-07D

Contents

Contents 3
Introduction 11
Read me! 12
Practical examples 15
Programming electrodes 17
Programming methods 23
Programming ION sequences 27
Programming SAC sequences 29
Programming tips 32
Glossary 33
Accept a result 35
Acceptance criteria 35
Acceptation 36
Access routine mode 36
Active electrode unknown in "method ID" 36
Add method menu 37
Address 37
Alarm: Locked 37
Alarm: Unlocked 37
Alphanumeric characters 38
Applied signal (AC/DC) 38
Archives data lost - Cal. Data lost - Methods kept 38
Archiving 39
Assistant function 39
Autochaining 40
Auxiliary input 41
Auxiliary output 42
Aux. on for 42
Bar code reader connection 42
Beaker detection 43
Beaker detection minimum height 44
Beaker menu 45
Beakers: [F;L] 45
Beep 46
C0 (Detection limit) 46
Cable capacity 47

Cable resistance 48
Calibrate conductivity cells 49
Calibrate ISE electrodes 49
Calibrate pH electrodes 49
Calibration = Manual 50
Calibration curve of an ISE electrode 51
Calibration delay elapsed 51
Calibration parameters 51
Calibration request/Calibration 51
Calibration request = Fixed 52
Calibration request = Free 53
Calibration stack 53
Calibration results parameters 53
Catalogue list 53
Cell constant (parameter) 54
Cell constant (definition) 55
Cell grounding 55
Cell window 56
Change electrode name 56
Change method name 56
Change sequence name 56
Check command 57
Check electrodes 57
Communication failure (SAC error) 58
Concentration x 58
Concentration unit 58
Conductivity cell 58
Conductivity cell calibration 58
Conductivity measurement method 59
Configuration menu 60
Connections 60
Connect electrodes 60
Contrast 60
Controlled by TTL IN 60
Copy electrode 61
Copy method 62
Coupled method 62
Create electrode 63
Create method 64
Current value 64
Curve 64

Curves data lost - Cal. Data kept - Methods kept 64
Customise 65
Date entry 65
Default parameters 65
Delete electrode 66
Delete method 66
Demand: Locked 66
Demand: Unlocked 67
Detailed 68
Detection limit (C0) 68
Direct ISE measurement method - definition 69
Direct ISE measurement method - notes 70
Direct ISE measurement method - programmation 70
Direct measurements 70
Disconnect electrodes 71
Display contrast 71
Display measurement 72
Dyn. rinse 73
Dynamic rinses 74
E0 standard potential 74
EC socket 75
EC/pH measurement method - definition 76
EC/pH measurement method - programmation 77
Edit electrode menu 78
Edit method menu 79
Edit sequence menu 80
Electrode calibration (Fixed mode, conductivity cell) 81
Electrode calibration (Free mode, conductivity cell) 82
Electrode calibration (ISE) 83
Electrode calibration (Fixed mode, pH electrode) 84
Electrode calibration (Free mode, pH electrode) 85
Electrode calibration (SAC sequence) 86
Electrode calibration not required 87
Electrode calibration parameters 87
Electrode calibration stack 88
Electrode connection 89
Electrode connection - Important 90
Electrode function 90
Electrode icons 91
Electrode ID 91
Electrode library 92

Electrode not calibrated *92*
Electrode system *92*
Electrode type *93*
Electrode window *94*
Empty sequence *94*
ERR#32 (SAC error) *94*
Error - Error messages *95*
Fixed (calibration mode) *95*
Format (printouts) *96*
Free (calibration mode) *96*
Function *96*
Fuses *97*
GLP-Archives menu *98*
Ground conflict *98*
Help *98*
High (result indicator) *98*
Icons *99*
ID *99*
Input address conflict *99*
Insert method menu *100*
Insufficient number of beakers *100*
ION cell external Gnd *100*
ISE calibration results parameters *100*
ISE calibration solutions *101*
Iso pH *101*
Keyboard connection *102*
Keyboard connection - Important *103*
Language *103*
Linear (temperature correction) *103*
Low (result indicator) *103*
Main window *104*
Mains frequency *104*
Maintenance *105*
Manual (calibration mode) *105*
Max. stab reached *106*
Max. stab time *106*
Measurement *106*
Measurement method *107*
Method *107*
Method library *108*
Method parameters menu *108*

Method results menu *109*
Method wrong type *109*
Min. cell cst - Max. cell cst *109*
Min. pH0(25) - Max. pH0(25) *110*
Min. sensitivity - Max. sensitivity *110*
Min. Temp. - Max. Temp. *110*
Minimum value - Maximum value *111*
Missing beaker (SAC error) *112*
Mode *112*
Molar weight *112*
Nat. water (temperature correction) *113*
Nb lines per page (printouts) *113*
No stirrer (SAC error) *113*
None (temperature correction) *113*
Notification message *114*
Number of buffers *114*
Number of cycles *114*
Number of decimals *114*
Number of digits *115*
Number of dynamic rinses *115*
Number of solutions *115*
Number of static rinses *116*
Number of tests *116*
OK (result indicator) *116*
Others list *117*
Parameters menu *117*
PC cable - A95X501 ..... *117*
PC connection *117*
PC keyboard *117*
Periodicity *118*
Periodicity for QC samples *118*
pH0(25) *118*
pH buffer *118*
pH int *119*
Potential versus SHE *120*
Preprogrammed list *121*
Printer *121*
Printer cables - A95P201, A95X506 ..... *122*
Printer connection *123*
Print in table *123*
Printouts *124*

Printouts detailed *124*
Printouts menu *125*
Printouts setup *125*
Printouts title *125*
Programming method *126*
Programming sequence *127*
QC (result indicator) *128*
QC analysis required *128*
QC data menu *128*
QC ID *128*
QC not required *128*
QC periodicity elapsed *129*
QC sample *129*
QC sample (Yes/No) *129*
Ref. electrode conflict *129*
Reference Temp. *129*
Reject a result *129*
Remove method from a sequence *130*
Replace electrodes *130*
Reset memory *130*
Reset to factory settings *130*
Result accepted (Yes/No) *131*
Result indicators *132*
Result unit *132*
Results *133*
Results factor (Yes/No) *134*
Results menu *134*
Rinse aux. output *135*
Rinse time *135*
Routine mode *135*
Run window *136*
Run window (continued) *137*
Running a method *138*
Running a SAC sequence *139*
Running an ION sequence *140*
SAC80/SAC90/SAC850/SAC950 ..... *140*
SAC arm obstructed (SAC error) *140*
SAC ext. cell GND *140*
SAC Method *140*
SAC option missing (SAC error) *141*
SAC Sequence *141*

SAC switch Off/On (SAC error) 141
Same buffer change buffer 141
Sample changer 142
Sample changer cable - A95A202 (SAC80/SAC90) 143
Sample changer cable - A95X501 (SAC850/SAC950) 143
Sample ID 144
Sample preparation no. 144
Sample stack 145
Select electrode 146
Select method 146
Select sequence 146
Sensitivity 147
Sequence/SAC sequence 148
Sequence/Sample stack menu 149
Sequence end in Park (Yes/No) 149
Serial number (of an electrode) 149
Setup menu 150
Skip empty position 150
Software version 150
Solution menu 151
Stability 152
Standard (conductivity standard) 153
Standard potential 154
Standard solution (conductivity measurements) 154
Standard solution (ISE measurements) 154
Static rinses 154
Static rinse time 154
Statistics 154
Stirring 155
Stop analysis 156
Supervisor code 157
Supervisor mode 158
T°C minimum/maximum value 158
Temp. coef. 158
Temp. correction None/Linear/Nat. water 159
Temp. limit exceeded 160
Temperature Probe/ Fixed at 25°C/Entered 160
Temperature sensor ID 161
The sequence is empty 161
Time max (result indicator) 161
Title 161

Tray missing (SAC error) *161*
TTL 5 V OUT/TTL 12 V OUT (sockets) *162*
TTL IN (sockets) *162*
Turntable blocked (SAC error) *163*
Type of method *163*
User ID (Yes/No) *163*
User list *163*
User's rights *164*
Valency *164*
Working mode *165*
Wrong buffer *165*
Wrong type (SAC error) *165*
Zero pH *165*
Appendixes **167**
Appendix 1: Preprogrammed methods *169*
Appendix 2: General information *171*
Appendix 3: Result calculations *173*
Appendix 4: Technical specifications *183*

Introduction

The ION450 Ion Analyser is dedicated for routine use. It offers two distinct user levels:

- ***Supervisor***

  Dedicated for operators who wish to edit their methods to fit their specific needs. They can also assign a password to protect the programmed data from eventual changes.

- ***Routine***

  Dedicated for operators wishing to use the routine functions to guide them step by step through the analyses.

The ION450 can store up to 50 methods and 30 electrodes. In addition 30 electrodes have been pre-defined to help you save time setting up your application.

Thanks to the preprogrammed applications, the Ion Analyser is ready for use as soon as it has been installed. *Refer to "Appendix 1: Preprogrammed methods", page 169.*.

The ION450 also allows you to automatically sequence and repeat measurements.

The purpose of the ION450 Reference Manual is to give detailed information on the Ion Analyser and the data displayed during operations. The information is listed in alphabetical order for quick access and cross-references are listed in italics.

In addition to this handbook, a general User's Guide (part no. D21M075) is available giving descriptions and overviews of the ION450 menus and operating concepts to guide you through programming and running of the analyses.

Read me!

An important feature of this instrument interface is that it controls the presence of different elements necessary to run the defined application for a selected method/sequence, before the method/sequence is run.

Working in Supervisor mode

A Supervisor has access to all the libraries for *creation* purposes.

When programming the instrument in **"SUPERVISOR"** mode, it is recommended to work in stages. These stages *must* be carried out in the order described below:

A.To program method

1. Define your electrode(s)

Identify electrodes (including temperature sensors) to be used for the analysis:

Electrodes can be created from the following lists:

Catalogue, *see "Catalogue list", page 53.*

Other, *see "Others list", page 117.*

Copy from, *see "Copy electrode", page 61.*

When creating the electrode, define if electrode calibration is required (or not), if yes specify the "periodicity" of the calibrations and the pH, ISE or conductivity standards to be used.
Refer to "Calibrate pH electrodes", page 49.
Refer to "Calibrate ISE electrodes", page 49.
Refer to "Calibrate conductivity cells", page 49.

2. Create new method or Edit a pre-programmed one

Create the method to be used for the analyses. Enter the parameters required to calculate the results, *see "Programming methods", page 23.*

When you have finished programming, select the method/sequence or pre-programmed application, *see "Select method", page 146.* or *see "Select sequence", page 146.*

If your methods are to be performed in a sequence, program the sample stack, *see "Sample stack", page 145.*

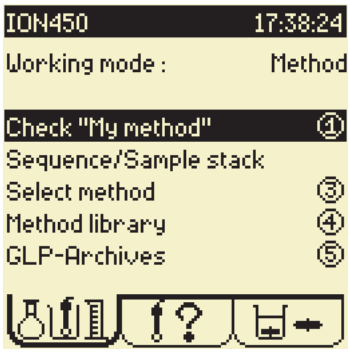
3. Check icons

The following icons indicate the exact state of your working system:

	***Sunny icon***: Everything is OK. Run the method or sequence.
	***Cloudy icon***: Electrode calibration is required within 12 or 24 hours.
	***Stormy icon***: Electrode calibration date elapsed or electrodes not installed.
	***Question mark***: Programming error.

Refer to "Electrode icons", page 91.

A Sunny icon is needed in order to run the selected method.
*If a Cloudy/Stormy/Question mark icon is displayed in the Electrode window press **1** to activate the "Check" command. The ION450 will automatically guide you through the operations required to solve the errors encountered.*



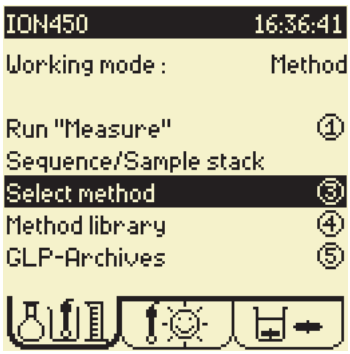
B.Running methods

To run a method or sequence, *see "Working in Routine mode", page 14.*

Working in Routine mode

A.Access methods

A Routine operator has access to all the methods “Select method” and programmed parameters “Display method” for *checking* purposes



B.Running methods

When working in **“ROUTINE”** mode, it is necessary to install your measurement system according to the selected method or sequence, prior to running a method or sequence.

1. Select the method or sequence

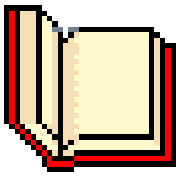
Refer to "Select method", page 146.
Refer to "Select sequence", page 146.

2. Check icons

Refer to "Check icons", page 13.

Depending on the icon displayed, the ION450 will automatically guide you through the steps necessary to run the analysis, see below:

a. **Connect the electrode(s)**
   Connect/install electrodes and temperature sensors, *Refer to "Electrode connection", page 89.*
b. **Calibrate electrode(s)**
   Now, run the calibration.
   Refer to "Calibrate pH electrodes", page 49.
   Refer to "Calibrate ISE electrodes", page 49.
   Refer to "Calibrate conductivity cells", page 49.
c. **Run the method or the sequence**
   Refer to "Running a method", page 138.
   Refer to "Running a SAC sequence", page 139.
   Refer to "Running an ION sequence", page 140.



Practical examples

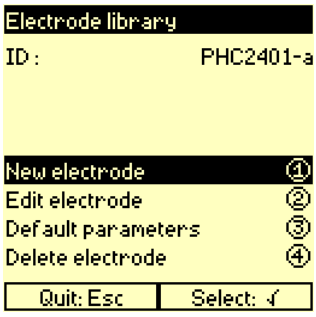
Programming electrodes

pH electrodes

1.

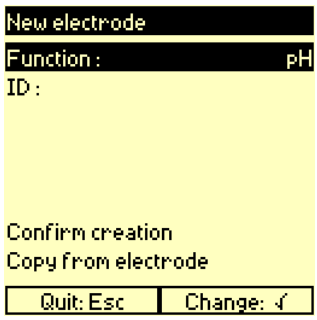
Press **4**.

2.



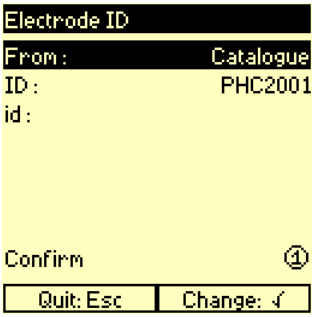
Press **1**.

3.



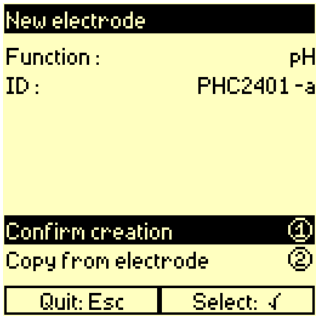
Select function and ID.

4.



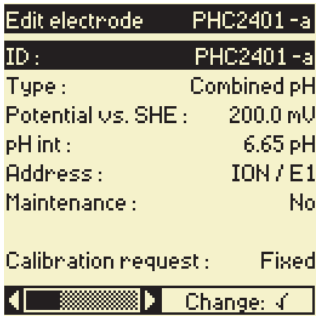
Select ID from Catalogue or Others list.
Press **1** to confirm.

5.



Press 1 to confirm the creation of the new electrode.

6.



For a combined or a simple or reference electrode, enter the potential (in mV) of the reference versus the Standard Hydrogen Electrode (SHE).
For a combined or a simple electrode if you have selected the Others list, enter the internal pH of the electrode.
Enter the electrode address.
If you want a message to be displayed once a week concerning this electrode, select Maintenance = Yes and enter the message.
Select Fixed or Free if a calibration is required, *go to step 7*.
Select No, for no calibration, press **Esc** to leave the menu. Programming is completed.

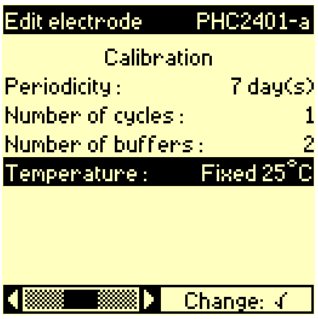
Calibration request = Fixed

Calibration with automatic recognition of the buffer among a list of predefined values. The buffer values are entered during method edition.

Calibration request = Free

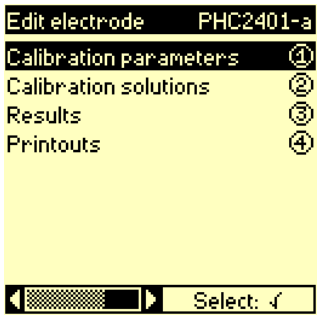
The buffer values are entered FREEly by the user. Use this option to calibrate pH electrode with buffers that do not belong to the predefined list.

7.



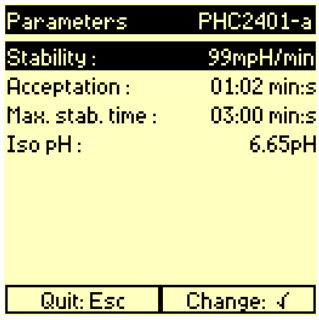
Enter the calibration parameters.

8.



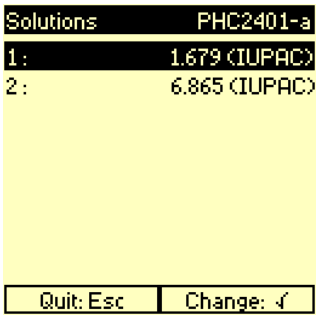
Press **1**.

9.



Enter the electrode calibration parameters.
For a Fixed calibration, press **Esc** then **2**. *Go to step 10.*
For a Free calibration, press **Esc** then **3**. *Skip to step 11.*

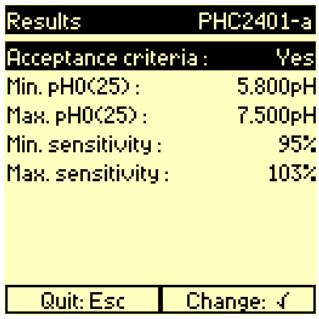
10.



Fixed calibration only.

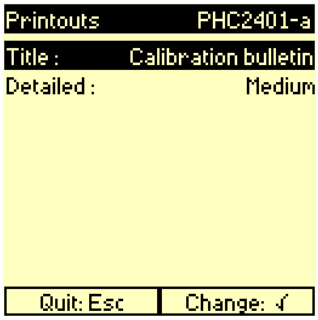
Select the buffer solutions used. Press **Esc** then **3**.

11.



Enter the results parameters. Press **Esc** then **4**.

12.



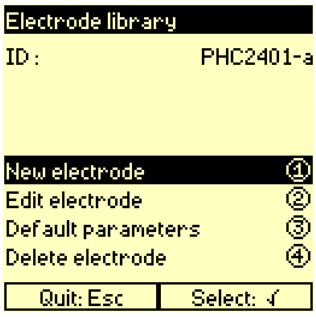
Enter the printouts parameters. Press **Esc** twice. Electrode programming is completed.

ISE electrodes

1.

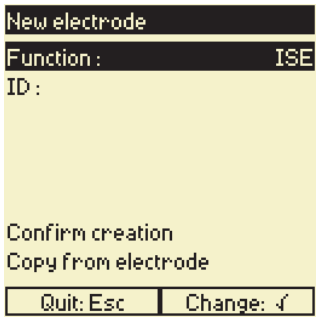
Press **4**.

2.



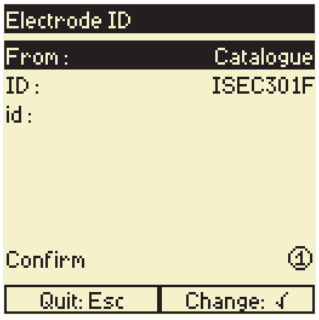
Press **1**.

3.



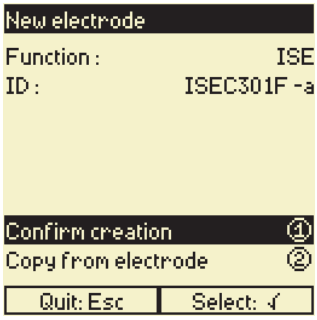
Select function and ID.

4.



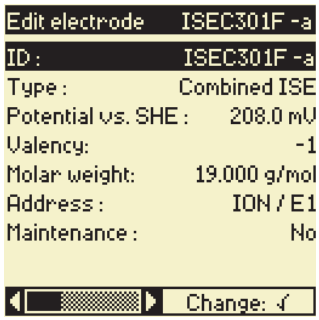
Select ID from Catalogue or Others list.
Press **1** to confirm.

5.



Press 1 to confirm the creation of the new electrode.

6.

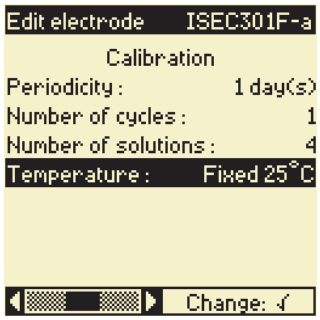


For a combined or a simple or reference electrode, enter the potential (in mV) of the reference versus the Standard Hydrogen Electrode (SHE).
If you have selected the Others list, select the valency and enter the molar weight of the ion under study.
Enter the electrode address.
If you want a message to be displayed once a week concerning this electrode, select Maintenance = Yes and enter the message.
Press the **Left** or **Down arrow** key.
Select Manual if a calibration is required then *go to step 7*.
Select No, for no calibration, press **Esc** to leave the menu. Programming is completed.

Calibration = Manual

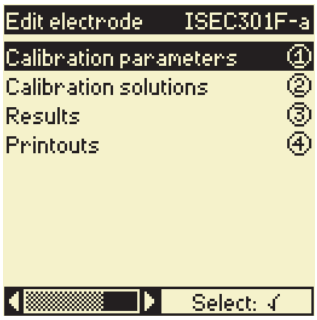
Calibration using 1 to 9 standards of known concentration.The standard concentrations are entered during method edition. This method requires 1 to 9 calibration beakers.

7.



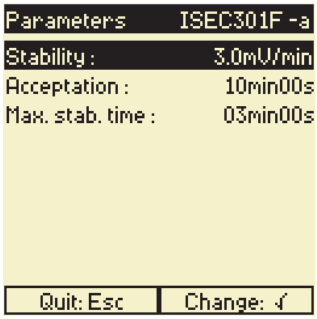
Enter the calibration parameters.

8.



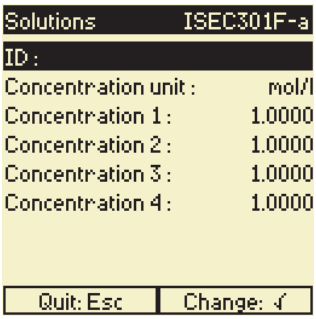
Press **1**.

9.



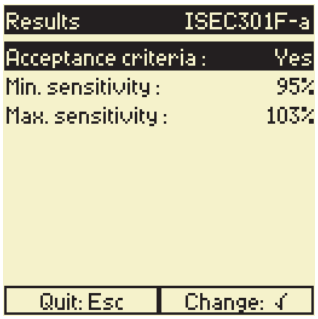
Enter the electrode calibration parameters.
Press **Esc** then **2**.

10.



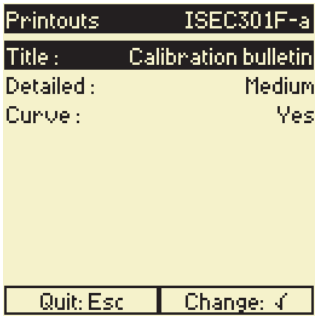
Enter the standard solution ID and standard concentrations.
Press **Esc** then **3**.

11.



Enter the results parameters.
Press **Esc** then **4**.

12.



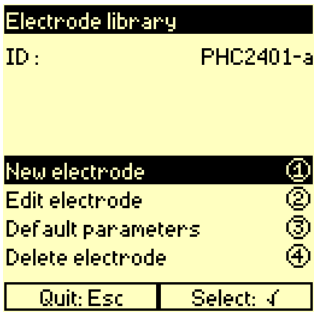
Enter the printouts parameters.
Press **Esc** twice. Electrode programming is completed.

Conductivity cells

1.

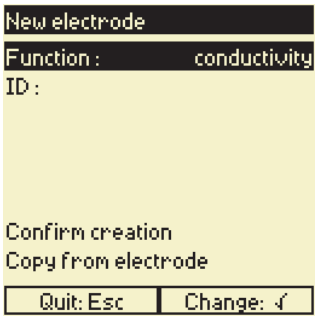
Press **4**.

2.



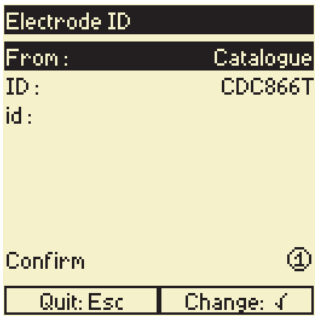
Press **1**.

3.



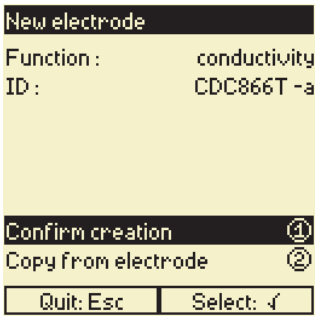
Select function and ID.

4.



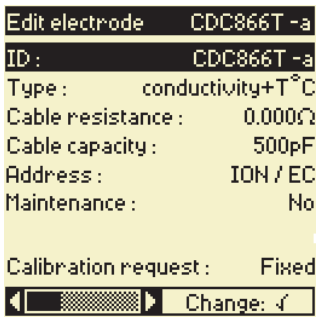
Select ID from Catalogue or Others list.
Press **1** to confirm.

5.



Press 1 to confirm the creation of the new electrode.

6.



If you have selected the Others list, enter the cable resistance and capacitance.
If you want a message to be displayed once a week concerning this electrode, select Maintenance = Yes and enter the message.
Select Fixed or Free if a calibration is required, *go to step 7*.
Select No, for no calibration, press **Esc** to leave the menu. Programming is completed.

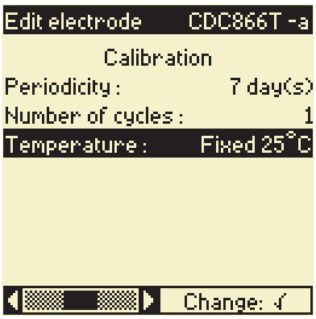
Calibration request = Free

Use the Free calibration mode when you use a standard that does not belong to the Catalogue list and you know the conductance of this standard at a given temperature. During a Free calibration run and after stabilisation of the measurement, you will adjust the cell constant in order to display the correct conductance value.

Calibration request = Fixed

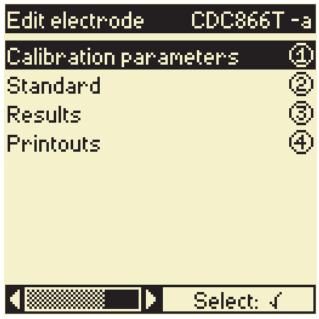
With the Fixed mode when you use a standard that belongs to the Catalogue list, the cell constant is determined as the ratio of the conductivity (known by the instrument) divided by the measured conductance.

7.



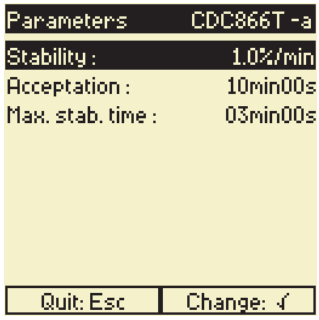
Enter the calibration parameters.

8.



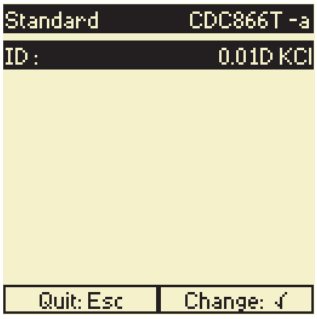
Press **1**.

9.



Enter the electrode calibration parameters.
For a Fixed calibration, press **Esc** then **2**. *Go to step 10.*
For a Free calibration, press **Esc** then **3**. *Skip to step 11.*

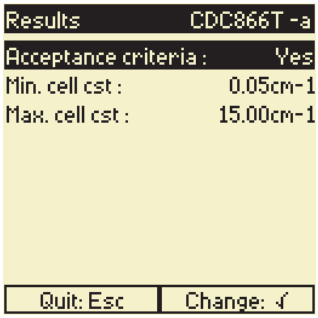
10.



Fixed calibration only.

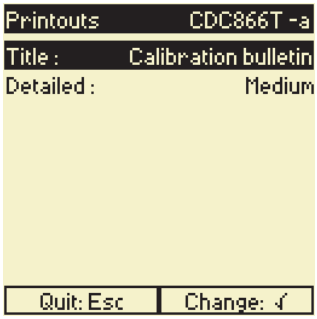
Select the standard solution used. Press **Esc** then **3**.

11.



Enter the results parameters. Press **Esc** then **4**.

12.

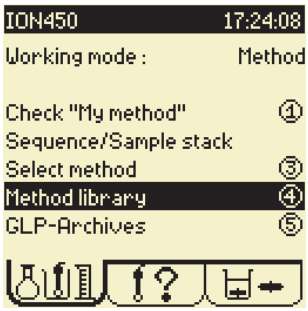


Enter the printouts parameters. Press **Esc** twice. Electrode programming is completed.

Programming methods

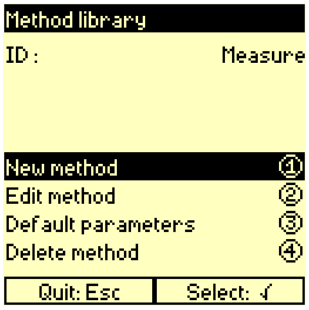
Creating and editing a method

1.



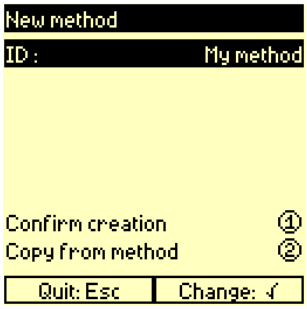
Press **4**.

2.



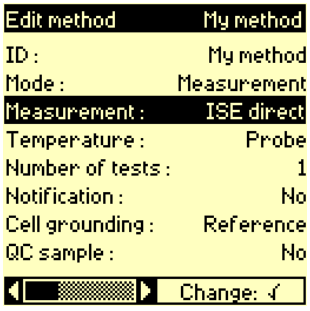
Press **1**.

3.



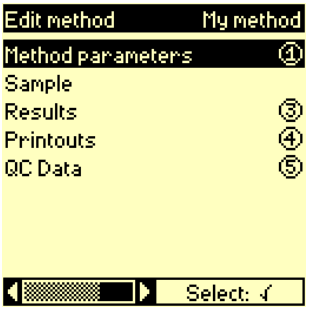
Enter ID.
Press **1** to confirm.

4.



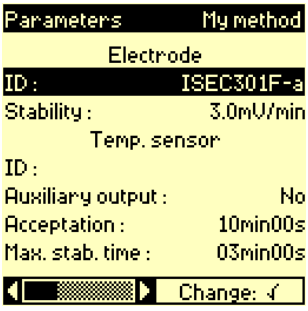
Enter method parameters.
Specify the Mode, *see "Mode", page 112.*

5.



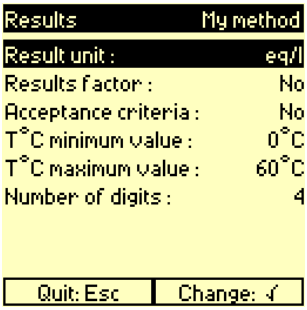
Press **1**.

6.



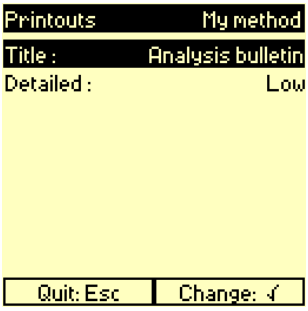
Press ✓ and select the electrode(s) and temperature sensor from the lists.
Enter the other method parameters.
Press **Esc** then **3**.

7.



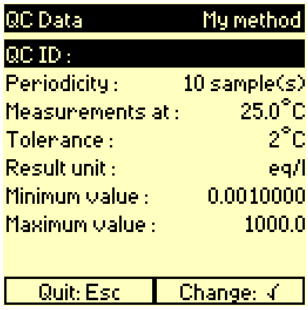
Enter the results parameters. Press **Esc** then **4**.

8.



Enter the printouts parameters. If a QC sample has been defined in step 4, press **Esc** then **5**.

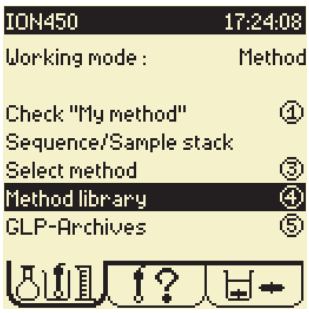
9.



Enter the QC data. Press **Esc** twice. Method programming is completed.

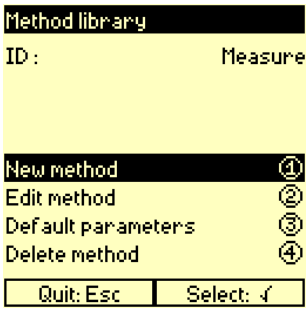
For a Coupled method

1.



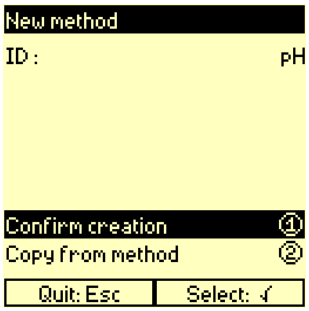
Press **4**.

2



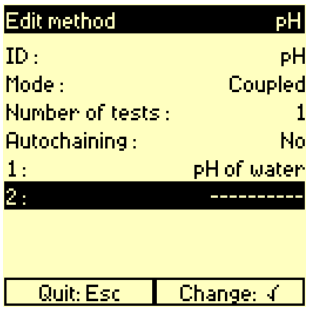
Press **1**.

3.



Enter the Method ID and press **1** to confirm.

4.

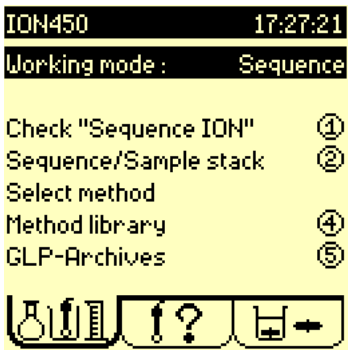


Select *Mode = Coupled*.
Enter the method to be linked.
Press **Esc** twice.
Method programming is completed.

Programming ION sequences

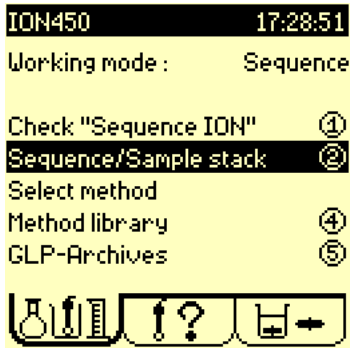
An ION sequence is a sequence of methods with manual change of the beakers. No sample changer is used.

1.



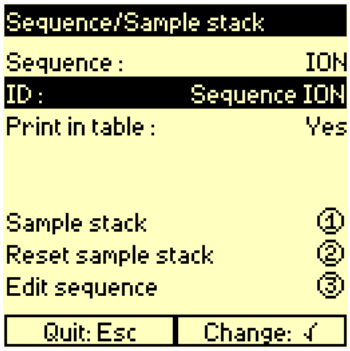
Select ***Sequence***.

2



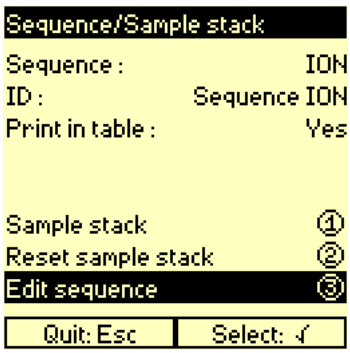
Press **2**.

3.



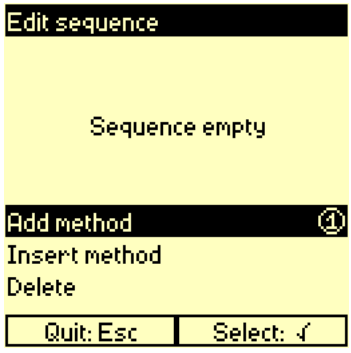
Enter a name for the sequence.

4.



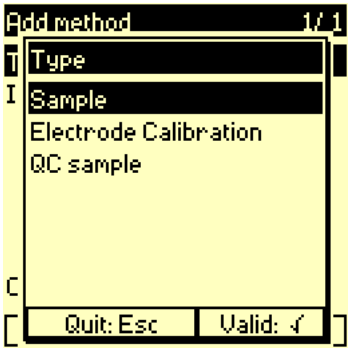
Press **3**.

5.



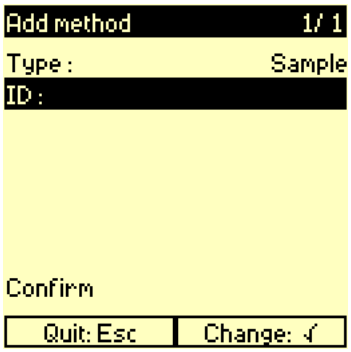
Press **1** to add a method.

6.



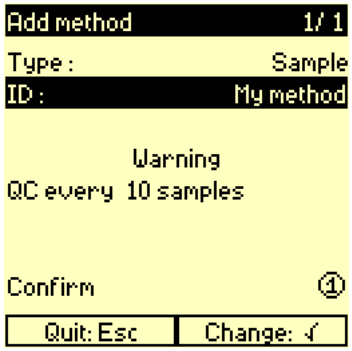
Select the type of method.

7.



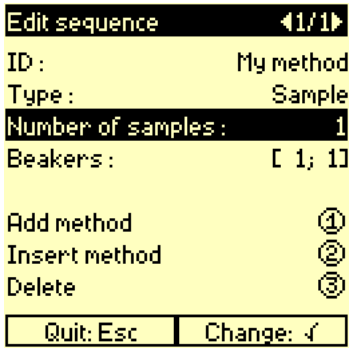
Select a method in the list of available methods.

8.



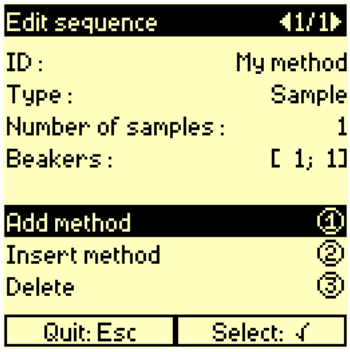
Press **1** to add the method to the sequence.

9.



If Sample has been selected in step 6, enter the number of samples (number of times you wish to repeat the method in the sequence).

10.

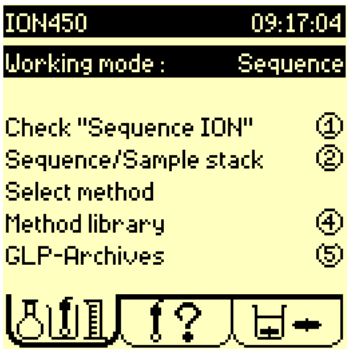


Press **1** to add a second method to the sequence.
Repeat steps 6 to 9.
Up to 10 methods can be chained in a sequence.
After having added the last method, press **Esc** twice.
Sequence programming is completed.

Programming SAC sequences

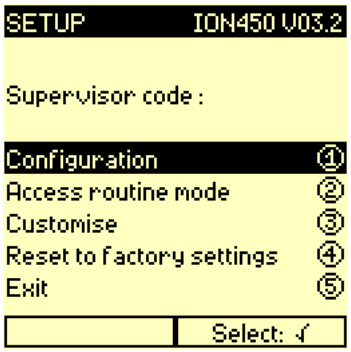
A SAC sequence is a sequence of methods with automatic change of the beakers. A sample changer (SAC80, SAC90, SAC850 or SAC950) is used.

1.



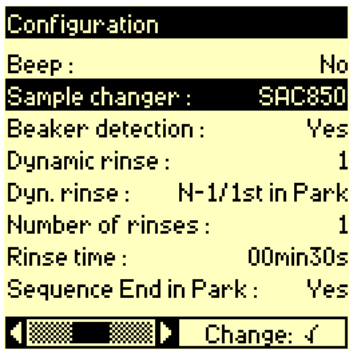
Press **Stop** for 3 seconds to enter the Setup menu.

2



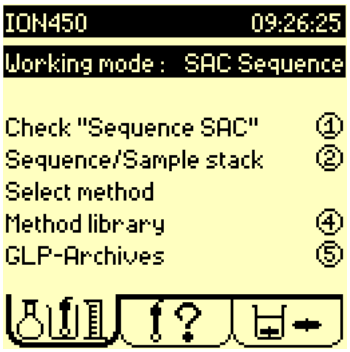
Press **1**.

3.



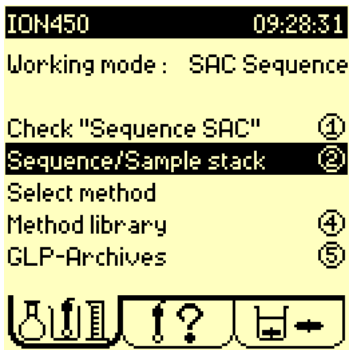
Select a Sample Changer (SAC80, SAC90, SAC850 or SAC950). Enter the parameters of the sample changer selected (number of rinses, rinse time, etc.).
Press **Esc** then **5** (Exit) to quit the Setup menu.

4.



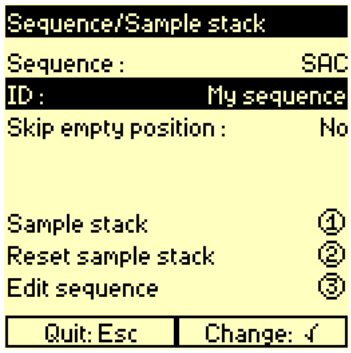
Select ***SAC Sequence***.

5.



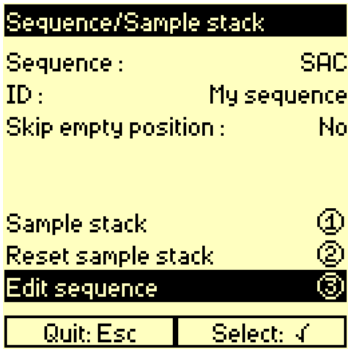
Press **2**.

6.



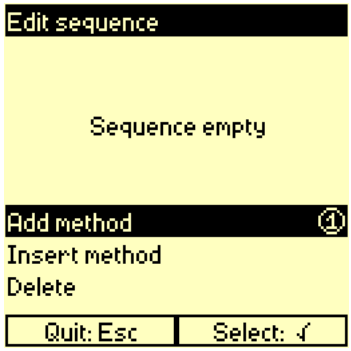
Enter a name for the sequence.

7.



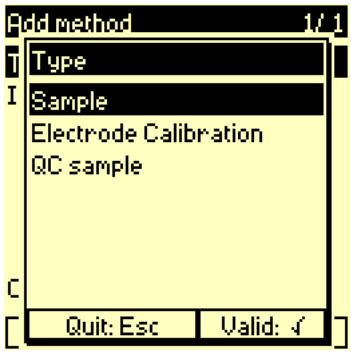
Press **3**.

8.



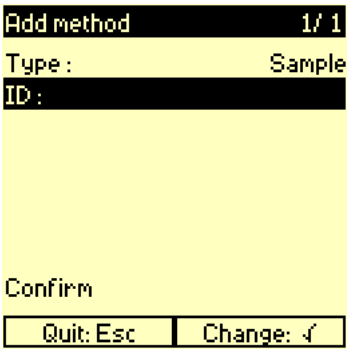
Press **1** to add a method.

9.



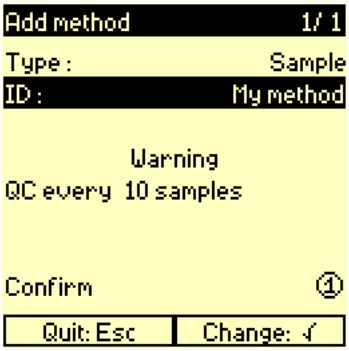
Select the type of method.

10.



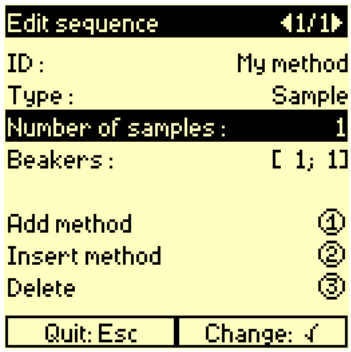
Select a method in the list of available methods.

11.



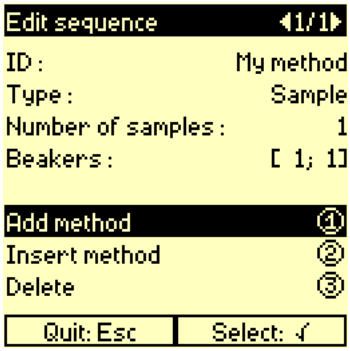
Press **1** to add the method to the sequence.

12.



If Sample has been selected in step 9, enter the number of samples (number of times you wish to repeat the method in the sequence).
If a SAC850 or SAC950 has been selected in step 3, enter the sample preparation number.

13.



Press **1** to add a second method to the sequence.
Repeat steps 9 to 12.
Up to 10 methods can be chained in a sequence.
After having added the last method, press **Esc** twice.
Sequence programming is completed.

Programming tips

- Do not forget to declare electrode(s) when programming your method parameters
- If a Sample Changer is used, do not forget to declare one in the Configuration menu.
- If a printer is used, do not forget to declare one in the Configuration menu.

If no sun icon appears after the method has been selected, check the following points:

1. Install electrode(s) for selected method, *see "Check electrodes", page 57.*
2. If required, calibrate electrode.
   Refer to "Calibrate pH electrodes", page 49..
   Refer to "Calibrate ISE electrodes", page 49..
   Refer to "Calibrate conductivity cells", page 49.

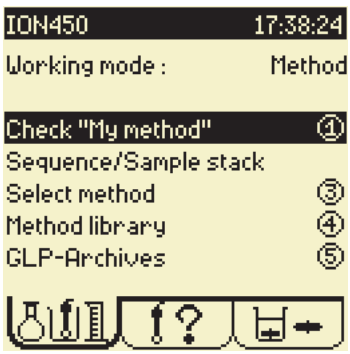
If a Sunny icon appears:
Everything is OK. A sunny icon is required to run the selected method.

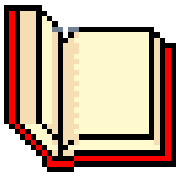
If a Cloudy icon appears:
An electrode calibration should be performed within 24 hours.
This is a simple warning, it will not stop you from running the analysis.

If a Stormy icon appears:
Electrode required in the selected method is not installed. Electrode required in the selected method has not been calibrated.

If a Question mark icon appears:
It is a programming error, electrode is not defined in the selected method. Revise the method programming.

*When a Stormy or a Question mark icon appears, press **1** "Check" . The ION450 will automatically guide you through the operations necessary to solve the errors encountered.*





Glossary

Accept a result

Refer to "Result accepted (Yes/No)", page 131.

Acceptance criteria

Acceptance criteria = Yes

Enables the user to enter preset minimum and maximum values for measurement results. If the result lies outside these values an alarm message appears and the results are rejected by the instrument. The Supervisor is the only person allowed to accept a result that has been rejected by the instrument, *see "Result accepted (Yes/No)", page 131*.
Therefore, acceptance limits can be set on:

- the conductivity cell constant,
  see "Min. cell cst - Max. cell cst", page 109.
- the result value such as a pH, a potential, a concentration,
  see "Minimum value - Maximum value", page 111.
- the response slope of a pH or an ISE electrode,
  see "Min. sensitivity - Max. sensitivity", page 110.
- the pH0 of a pH electrode,
  see "Min. pH0(25) - Max. pH0(25)", page 110.

Acceptance criteria = No

The Supervisor or Routine user is free to accept/reject the results.

Enter in:

Edit method > Results
Edit method > QC data
Edit electrode > Results

Irrespective of the Yes or No option selected for the Acceptance criteria parameter:

•Acceptance limits must be set for the sample or the standard measured temperature,
see "Min. Temp. - Max. Temp.", page 110,
see "T°C minimum/maximum value", page 158.

•A minimum limit is set by the instrument for the concentration measured by an ISE Direct measurement method. This limit is the C_0 concentration,
see "Minimum value - Maximum value", page 111.

•A maximum limit is set by the instrument for the concentration measured by an ISE Direct method. This limit is set to 10^{30}, *see "Minimum value - Maximum value", page 111*.

Acceptation

Result acceptance time limit.
When the time entered for the `Acceptation` has elapsed the measurement will be accepted whether stable or not.

*For the signal to be accepted once the Acceptation has elapsed, the **Max. Stab. time** must be greater than the **Acceptation time**.*

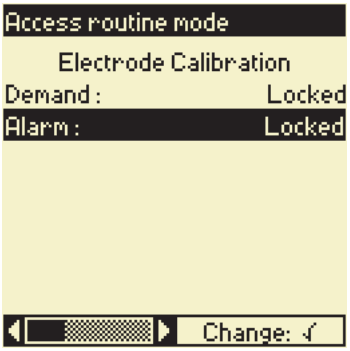
Enter in:
Edit method > Parameters menu
Edit electrode > Calibration parameters menu

Range available:
0 to 59:59 min:s

Access routine mode

Press **Stop** for 3 seconds from the Main window then press **2.**

These rules can be set by the Supervisor to allow the routine user access to certain operations.



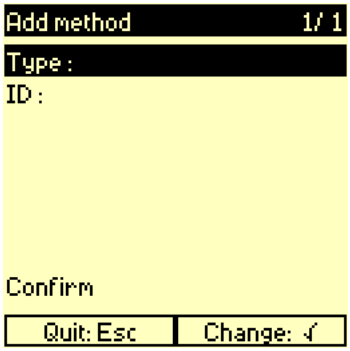
Enter in:
Setup menu > Access routine mode

Active electrode unknown in "method ID"

The method in use, has at least one electrode which has not been defined. Press ✓ and declare the electrode in the Electrode ID field of the Method parameters screen.

Add method menu

Use this menu to set the ID and type of method to be added to a sequence.



In the title bar, x/y (eg. 1/1) indicates the position "x" of the method in the sequence and "y" the total number of methods in the sequence.

When a sequence is created <1/1> is displayed.

To access:

Press **1** in the Edit sequence menu.

Address

The position where the electrode is placed during operation:

The electrode address is defined using the format “ION/x” where “x” corresponds to the socket.

For example ION/E1, indicates that the electrode is connected to E1 socket on the ION450.

Refer to "Electrode connection", page 89.

Alarm: Locked

The user cannot bypass an electrode and/or QC sample analysis if the last result obtained lies outside the acceptance range.

Enter in:

Setup menu > Access routine mode

Alarm: Unlocked

Enables the user to bypass an electrode and/or QC sample analysis when the last result obtained lies outside the acceptance range.

Enter in:

Setup menu > Access routine mode

Alphanumeric characters

The following alphanumeric characters can be obtained using the ION450s Keypad:

Keys	Characters
7	7, A, B, C, a, b, c, @
8	8, D, E, F, d, e, f
9	9, G, H, I, g, h, i
4	4, J, K, L, j, k, l
5	5, M, N, O, m, n, o, µ
6	6, P, Q, R, p, q, r
1	1, S, T, U, s, t, u
2	2, V, W, v, w
3	3, X, Y, Z, x, y, z
0	0, -, +, *, ^, =, #, <, >, . space, /, (,), [,], |, ?, !, %, °

Table 1: Entering alphanumeric characters

Applied signal (AC/DC)

Specifies the current type (alternative AC or direct DC) to be sent to the **Pt-Pt** socket on the Ion Analyser. The AC signal frequency is 1.67 Hz. This option is available if `mV(i>0)` has been selected for `Measurement` in the Edit method menu.

Enter in:
Method parameters menu

Archives data lost - Cal. Data lost - Methods kept

Instrument internal failure. Only the method parameters have been kept.

Archiving

Archiving = Yes (default setting)
All measurements (sample and electrode calibrations) are saved in the archives. You can view these measurements as follows:

- Sample results: enter Main window and press **5**
- Electrode calibration results: enter Electrode window and press **6**

Refer to "GLP-Archives menu", page 98.

Archiving = No
No measurements are saved in the archives. The instrument saves only the last electrode calibration.

*When you set **Archiving** from **No** to **Yes**, you must recalibrate your electrodes!*

Enter in:
Setup menu > Configuration menu

Assistant function

Embedded instructions on the ION450 display to guide the user step-by-step through electrode installations. These instructions appear at the start of a run method if the working system has not been correctly installed.

By default this option is set to Yes. It is recommended to use the default setting at all times!

If the setting is set to No, the ION450 *considers* that the working system is correctly installed at the start of a run method.
However, this may not be the case, the user must know the status of the working system at all times!

Enter in:
Setup menu > Configuration menu

Autochaining

This option is valid for a Coupled method which is not part of a sequence.

Autochaining = No

At the end of each method run, you must confirm the result in order to perform the next method. If a Notification message has been selected, a message is displayed between each method of the Coupled method.

Autochaining = Yes

At the end of each method run, The methods are chained automatically in the Coupled method. If a Notification message has been selected, a message is displayed upon starting the first method (no message is displayed after).

Refer to "Notification message", page 114.

Enter in:

Edit method menu (for a Coupled method)

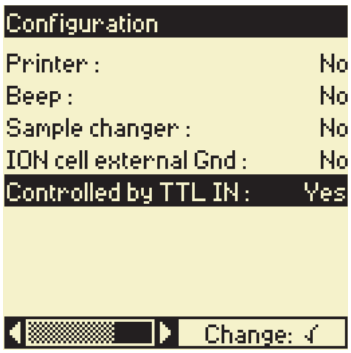
Auxiliary input

The auxiliary input socket can be connected to an external device unit used to send an analysis start command to the ION450. The analysis is a sequence of methods with manual change of the sample beakers (Working mode = Sequence, *see "Working mode", page 165*).

The external device unit is to be connected to the red and black **IN** banana sockets of the ION450. The red banana socket receives the TTL 0 ± 5 V auxiliary signal and the black banana socket is connected to the instrument electrical zero.

Proceed as follows to trigger a sequence of methods by an auxiliary signal input:

- In the Configuration menu, select `Controlled by TTL IN = Yes`.



- Connect the auxiliary control unit to red and black **IN** banana sockets of the ION450.
- Run the sequence. The ION450 displays a waiting for auxiliary signal message. The sequence is started as soon as the auxiliary signal is received.

Spécifications of the auxiliary input signal

Refer to "TTL IN (sockets)", page 162.

Auxiliary output

The auxiliary outputs are used to control external equipment such as valves or pumps during analyses. This signal is sent between the red and black banana sockets **5V OUT** or **12V OUT** of the ION450.

Auxiliary output (5 V, 12 V, No)

Activate to 5 V or 12 V or disable the auxiliary signal.
Specifications of the auxiliary ouput signal:
see "TTL 5 V OUT/TTL 12 V OUT (sockets)", page 162.

Aux. on for

Time during which the auxiliary signal is set to 5 V or 12 V.

Enter in:
Method parameters menu

Range available:
Aux. on for: 0 to 99:59 min:s

An auxiliary output can be activated:

*•at the measurement start (duration set by **Aux. on for**)*

*•or during the whole measurement including measurement stabilisation delay. In this case, select a 5 V or 12 V auxiliary output and set **Aux. on for = 0**.*

Aux. on for

Refer to "Auxiliary output", page 42.

Bar code reader connection

Connect a bar code reader to the ION450 via the 6-pin mini DIN port situated on the right hand side of the instrument.

Beaker detection

On a SAC850 or SAC950, a Beaker detection module (ultrasonic transducer) makes it possible to detect beakers containing liquid sample with a height higher than the minimum detection limit (10 mm), *see "Beaker detection minimum height", page 44*.

In all other cases, the beaker positions are not detected, that is to say:

a. empty positions (positions not occupied by beakers),
b. empty beakers or beakers considered as empty (i.e. beakers with heights of liquid less than the minimum detection limit),
c. beakers containing solid or powder samples.

In case of a position not detected, you can ask the ION450 to jump the position (analysis not performed on that position): tick both options `Beaker detection` and `Skip empty position`. *Refer to "Skip empty position", page 150*

Case of a SAC950 sample changer with the Beaker cover module already installed

On a SAC950 with the Beaker cover module installed, the Beaker detection module is also able to detect all beakers covered by appropriate metal lids (the sample changer User's Guide, chapter 7 "Accessories" gives a list of the metal lids part numbers). By this way, you can detect beakers with heights of liquid less than the minimum detection limit) or beakers containing solid or powder samples.
You have just to tick the option `Beaker detection`.

The option Beaker detection

If you tick the option `Beaker detection`, then you can ask the ION450 to jump or not the positions which will be not detected (depending on your selection for the option `Skip empty position`).

If you clear the `Beaker detection` option, the ultrasonic transducer is disabled. All the positions between the first and the last beaker of the sample stack (including the static rinse and park beakers) will be regarded as occupied by a beaker.
Thus, place beakers on all these positions. In this case, the `Skip empty position` option is not available (option is greyed).

Enter in:

Setup menu > Configuration
If `Sample changer` = `SAC850` or `SAC950`

Beaker detection minimum height

The table below reports the minimum height of liquid that must be present in the beaker in order to detect the beaker as not empty, *see also "Beaker detection", page 43*.

Beaker type diameter x height (mm)	Detection minimum height	Part no.
400 ml tall form 70 x 131	10 mm (40 ml)	
250 ml low form 70 x 95	10 mm (40 ml)	
250 ml tall form 60 x 120	10 mm (30 ml)	
125 ml, Gosselin, PP, 54 x 73	10 mm (25 ml)	X31T087 (pack of 50)
180 ml, Gosselin, PP, 54 x 103	10 mm (25 ml)	X31V005 (pack of 50)
150 ml tall form 60 x 80	10 mm (30 ml)	
150 ml low form 62 x 81	10 mm (30 ml)	
40-100 ml, PP 60 x 80	10 mm (30 ml)	904-490 (pack of 50)
100 ml tall form 48 x 80	10 mm (20 ml)	
50 ml low form 42 x 60	10 mm (15 ml)	904-489 (pack of 50)
22-45 ml, PP 44 x 70	10 mm (15 ml)	904-489 (pack of 50)
8-25 ml, PP 44 x 70	10 mm (15 ml)	904-488 (pack of 50)

Beaker menu

Use this menu to prepare a sample or calibration stack. This menu defines individual data for all the samples or standards used in the sequence.

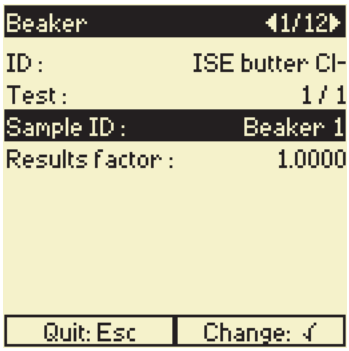


Figure 1: Beaker menu (for a sample stack)

To access (for a sample stack):

1. Select Working mode = Sequence or SAC Sequence in the Main window.
2. Press **2** Sequence/Sample stack.
3. Press **1** Sample stack.

The sequence must have been edited in the Edit sequence menu beforehand. Refer to "Edit sequence menu", page 80.

To access (for an electrode calibration stack):

1. Select Working mode = SAC Sequence in the Main window.
2. In the Electrode window, press **1** Calibrate electrodes.
3. Press **2** Calibration sequence.

The electrode calibration method must have been edited beforehand. Refer to "Edit electrode menu", page 78.

Refer to "Sample stack", page 145.
Refer to "Electrode calibration stack", page 88.

Beakers: [F;L]

The beakers information is displayed in the Edit sequence menu of a sequence.

It indicates the **F**irst and **L**ast positions occupied by the beakers in the sequence.

Beep

If Yes has been selected, three beeps will sound when a result is obtained.

Enter in:
Setup menu > Configuration

C_0 (Detection limit)

Refer to "Direct ISE measurement method - definition", page 69.

Cable capacity

A cable of a given length has a given capacity. When the measured conductance is low (below 4 µS), the cable capacity is not negligible and must be taken into account.

Enter the cable capacity when:

- measuring low conductances (below 4 µS),
- the cable capacity of the conductivity cell is greater than 350 pF.

The cable capacity is normally specified by the manufacturer. Cable capacities of a few Radiometer Analytical conductivity cells are given below :

Conductivity cell	Cable capacity (pF)
CDC511T	500
CDC861T	500
CDC565	440
CDC749	170
CDC267-9 with cable A94L136	70
CDC267-9 with cable A94L336	200
CDC241-9 with cable A94L136	70
CDC241-9 with cable A94L336	200
XE100 with cable A94L136	70
XE100 with cable A94L336	200

Figure 2: Cable capacities of Radiometer Analytical conductivity cells

If you create a conductivity cell from the Catalogue list, the cable capacity is automatically assigned to the conductivity cell created (and cannot be modified).

Enter in:

When creating an electrode with the Conductivity function and the option `From = Other`.
Refer to "Create electrode", page 63.

Available limits:

0 to 1999 pF

Cable resistance

A cable has a given length, therefore a given resistance. When the measured resistance is low (below 50 Ω), the cable resistance is not negligible and must be taken into account.

Enter the cable resistance when:

- measuring low resistances (below 50 Ω) or high conductances (above 20 mS).
- using a 2 or 3-pole conductivity cell.

The cable resistance is normally specified by the manufacturer. Cable resistances of a few Radiometer Analytical conductivity cells are given below:

Conductiivity cell	Cable resistance (Ω)
CDC511T	0
CDC861T	0
CDC565	0
CDC749	0.180
CDC267-9 with cable A94L136	0.145
CDC267-9 with cable A94L336	0.350
CDC241-9 with cable A94L136	0.145
CDC241-9 with cable A94L336	0.350
XE100 with cable A94L136	0.145
XE100 with cable A94L336	0.350

Figure 3: Cable resistances of Radiometer Analytical conductivity cells

If you create a conductivity cell from the Catalogue list, the cable resistance is automatically assigned to the conductivity cell created (and cannot be modified).

Enter 0 for the cable resistance of a 4-pole conductivity cell (whatever the conductivity cell used).

Enter in:

When creating an electrode with the Conductivity function and the option `From = Other`.
Refer to "Create electrode", page 63.

Available limits:

0.000 to 9.999 Ω

Calibrate conductivity cells	*Refer to "Electrode calibration (Fixed mode, conductivity cell)", page 81*. *Refer to "Electrode calibration (Free mode, conductivity cell)", page 82*.
Calibrate ISE electrodes	*Refer to "Electrode calibration (ISE)", page 83*.
Calibrate pH electrodes	*Refer to "Electrode calibration (Fixed mode, pH electrode)", page 84*. *Refer to "Electrode calibration (Free mode, pH electrode)", page 85*.

Calibration = Manual

Available if Electrode type = ISE single, ISE combined (w/o temperature sensor),

In this ISE electrode calibration mode, 1 to 9 standard of known concentration are to be prepared. The user enters each standard concentration in the Edit electrode > Solution menu.

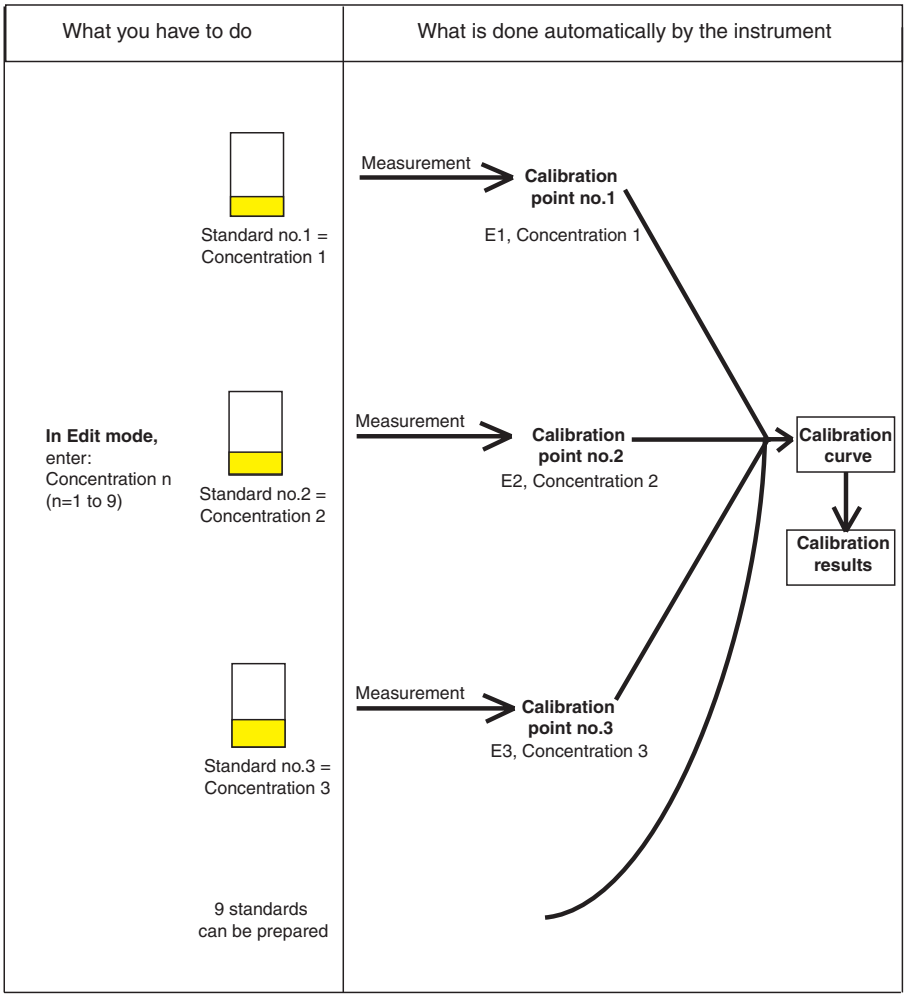


Figure 4: ISE electrode calibration in Manual mode

Calibration curve of an ISE electrode

This is the E = f (pC = -log C) curve obtained at the end of a calibration cycle performed on an ISE electrode.

Displaying the calibration curve:

Refer to "Electrode calibration (ISE)", page 83.

Printing the calibration curve:

The curve is printed out automatically at the end of each calibration cycle if asked for in the Printouts menu of the calibration method, *see "Printouts setup", page 125*.

Calibration delay elapsed

This message appears at analysis start. A new electrode calibration is required. The delay Periodicity entered in the Edit electrode screen has elapsed, *see "Periodicity", page 118*.

Press ✓ and perform a calibration.

Calibration parameters

For an electrode calibration method, *see "Electrode calibration parameters", page 87*.

Calibration request/ Calibration

Available if Electrode type =

- *pH single, pH combined (w/o temperature sensor),*
- *ISE single, ISE combined (w/o temperature sensor),*
- *Conductivity (w/o temperature sensor).*

Select the option `Calibration request = Fixed` or `Free` to calibrate a pH electrode or a conductivity cell.
Select the option `Calibration = Manual` to calibrate an ISE electrode.
The corresponding calibration parameters and standards will be displayed.

Enter in:
Edit electrode menu

Refer to "Calibration request = Fixed", page 52.
Refer to "Calibration request = Free", page 53.
Refer to "Calibration = Manual", page 50.

Calibration request = Fixed

Available if Electrode type = pH single, pH combined (w/o temperature sensor), conductivity (w/o temperature sensor).

In this calibration mode, the electrode is calibrated with standards that belong to a list of predefined values.

Moreover, for a pH electrode, the buffers/standards are automatically recognised.

The user selects the buffer/standard values during method edition. Use this mode if you intend to calibrate the electrode using buffers/ standards of the ION450 predefined list.

pH Buffer (value at 25°C)	Radiometer Analytical part no.
IUPAC - 1.679 pH	S11M001 (500 ml)
IUPAC - 4.005 pH	S11M002 (500 ml)
IUPAC - 6.865 pH	S11M003 (500 ml)
IUPAC - 7.000 pH	S11M004 (500 ml)
IUPAC - 7.413 pH	S11M005 (500 ml)
IUPAC - 9.180 pH	S11M006 (500 ml)
IUPAC - 10.012 pH	S11M007 (500 ml)
IUPAC - 12.454 pH	S11M008 (500 ml)
pH 4	S11M012 (500 ml)
pH 7	S11M013 (500 ml)
pH 10	S11M014 (500 ml)

Table 2: pH buffers of the ION450 predefined list

Conductivity standard	Radiometer Analytical part no.
1 D KCl	S51M001 (500 ml)
0.1 D KCl	S51M002 (500 ml)
0.01 D KCl	S51M003 (500 ml)
0.1 M KCl	C20C250 (500 ml)
0.01 M KCl	C20C270 (500 ml)
0.001 M KCl	C20C280 (500 ml)
0.05 % NaCl	S51M004 (500 ml)
25 µS/cm NaCl	S51M013 (250 ml)

Table 3: Conductivity standards of the ION450 predefined list

See also: *"Calibration request = Free": see page 53.*

Calibration request = Free

Available if Electrode type = pH single, pH combined (w/o temperature sensor), conductivity (w/o temperature sensor).

In this calibration mode, the buffer/standard values are entered FREEly by the user. Use this option to calibrate pH electrode or conductivity cells with buffers/standards that do not belong to the instrument predefined list. You must accurately know the pH/conductivity of the buffer/standard at given temperatures.

When running a calibration in Free mode and after stabilisation of the measurement, the user enters the pH buffer/standard conductivity value at the temperature measured in the buffer/standard.

See also: *"Calibration request = Fixed": see page 52.*

Calibration stack

For an electrode calibration method, *see "Electrode calibration stack", page 88*.

Calibration results parameters

Refer to "Results menu", page 134.

Catalogue list

List of Radiometer Analytical names of electrodes. This list cannot be modified.

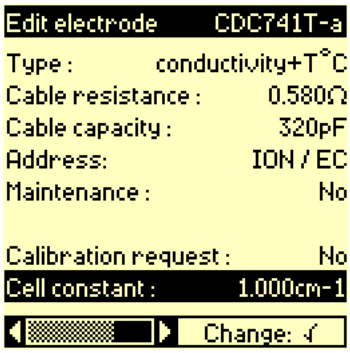
Cell constant (parameter)

Enter the cell constant value. The cell constant is a specification of the conductivity cell and is normally provided by the cell manufacturer.

If you do not know the cell constant value or if you want to check its value, select `Calibration request = Fixed` *or* `Free`*, edit and run a calibration method.*
It is recommended to periodically check the constant value by performing a cell calibration.
Refer to "Electrode calibration (Fixed mode, conductivity cell)", page 81.
Refer to "Electrode calibration (Free mode, conductivity cell)", page 82.
Refer to "Cell constant (definition)", page 55.

Access:

Edit Electrode menu (for a Conductivity type of electrode with `Calibration request = No`)



Range available:

0.050 to 15.000 cm^{-1} (by steps of 0.001 cm^{-1})

Cell constant (definition)

The ION450 calculates and displays the κ conductivity based on a **G** measured conductance and the **K** cell constant of the conductivity cell used.

$$\kappa \text{ (in S.cm}^{-1}\text{)} = K \times G \text{ (in S)}$$

The **K** constant (expressed in cm^{-1}) is a characteristics of the conductivity cell depending on the cell geometry.

To measure conductivities, you must know the cell constant value. With the ION450, you can directly enter **K** in the Edit electrode menu (*see "Cell constant (parameter)", page 54*) or determine **K** by calibrating the conductivity cell (*see "Electrode calibration (Fixed mode, conductivity cell)", page 81* or *see "Electrode calibration (Free mode, conductivity cell)", page 82*).

Cell grounding

Defines the grounding of the measuring cell. Select one of the following options:

Reference

Grounding is ensured by a reference electrode - *general use*.

Metal

Grounding is ensured by a metal electrode connected to the **GND** socket on the ION450. Use this option in case of high resistive solutions in order to avoid measuring background noise at the electrodes.

Others

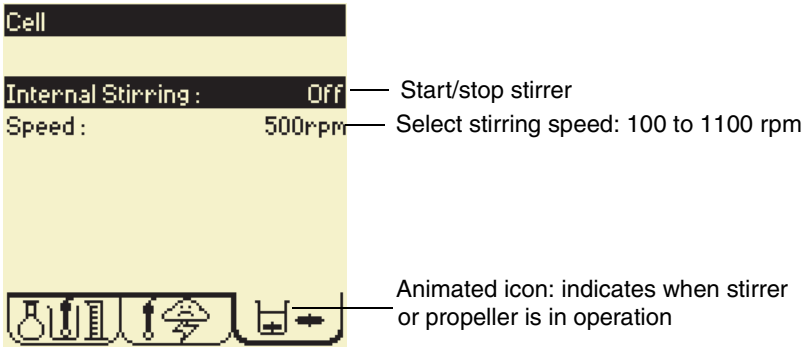
Grounding is not ensured by the reference electrode and is defined outside the method.

Enter in:

Edit method menu

Cell window

Use **LEFT/RIGHT** arrow keys to access.
This window controls the stirring function of the measurement cell.



An external stirrer (propeller) can be connected to a ION450.

Refer to "Stirring", page 155.

Change electrode name

1. Display the Electrode window.
2. Press **4** then **2**.
3. In the ID field, enter the new name for the electrode (16 characters maximum).

Change method name

1. Display the Main window.
2. Press **4** then **2**.
3. In the ID field, enter the new name (16 characters maximum).

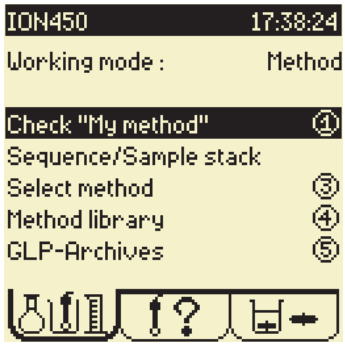
Change sequence name

1. Select Sequence in the Main window.
2. Press **2**.
3. In the Sequence/Sample stack menu, select ID.
4. Enter the new name (16 characters maximum).

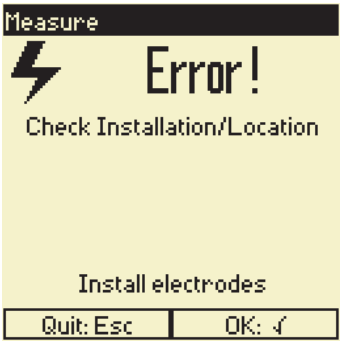
Check command

If a Stormy or a Question mark icon appears in the Electrode windows, press **1** to run the “Check” command. The ION450 will automatically guide you through the operations required to solve the problems encountered.

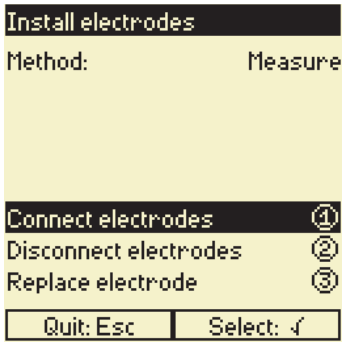
For example:



Press **1**



Press ✓



Press **1** to start the Electrode Installation procedure.

Check electrodes

Press **3** in the Electrode window to display the parameters of the current electrode used in the system. For example, electrode ID and address.

Communication failure (SAC error)

The data transmission between the sample changer and the ION450 cannot be performed properly.

Check the cable connections and make sure that the sample changer is switched on and connected to the ION450 via the RS232 serial cable.

Press the ION450 key ✓ or **Stop** and restart the sequence. It is not possible to continue the sequence from the point it stopped.

Concentration x

Concentration of the measured species present in the standard no. x (x=1 to 9). These x standards are used to calibrate an ISE electrode.

Enter in:

Edit electrode > Solution (for an ISE electrode)

Range available:

10^{-10} to 10^{10} (unit = `Concentration unit`)

Refer to "Solution menu", page 151.

Concentration unit

Standard concentration unit used for an ISE electrode calibration.

Enter in:

Edit electrode > Solution (for an ISE electrode)

Range available:

eq/l, meq/l, mol/l, mmol/l, g/l, mg/l, mg/ml, µg/ml, % or ppm

Refer to "Solution menu", page 151.

Conductivity cell

Refer to "EC socket", page 75.

Conductivity cell calibration

Refer to "Electrode calibration (Fixed mode, conductivity cell)", page 81.

Refer to "Electrode calibration (Free mode, conductivity cell)", page 82.

Conductivity measurement method

Measurement method using a conductivity cell connected to the ION450 **EC** socket.

You enter the cell constant of the conductivity cell or detemine it by calibrating the conductivity cell using a standard solution of known conductivity against temperature.
Refer to "Cell constant (definition)", page 55.

The ION450 measures the **G** conductance of the sample then calculates the κ conductivity using the **K** cell constant and the following equation :

$$\kappa \text{ (in S.cm}^{-1}\text{)} = K \times G \text{ (in S)}$$

The conductivity determined at the sample temperature can be corrected back to:

- a reference temperature of your choice (enter the reference temperature and a variation coefficient expressed in %/°C),
- 25 °C by using a correction table based on the variations of the conductivity against temperature for a natural water.

How to define a conductivity measurement method?

1. In the Main window, press **4** then **2** Edit method.
2. For `Mode`, select `Measurement`.
3. For `Measurement`, select `Conductivity`.
4. Edit the other parameters of this measurement method.

How to calibrate a conductivity cell?

Refer to "Cell constant (parameter)", page 54.
Refer to "Electrode calibration (Fixed mode, conductivity cell)", page 81.
Refer to "Electrode calibration (Free mode, conductivity cell)", page 82.

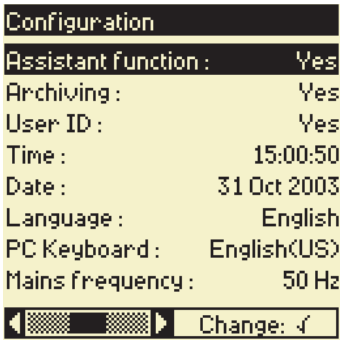
How to run a conductivity measurement method?

Refer to "Running a method", page 138.

Configuration menu

Press **Stop** 3 seconds in the Main window then press **1**.

Contains the configuration parameters for the instrument. .



Refer to "Setup menu", page 150.

Connections

Bar code reader: *Refer to "Bar code reader connection", page 42.*

Electrodes: *Refer to "Electrode connection", page 89.*

PC keyboard: *Refer to "Keyboard connection", page 102.*

PC: *Refer to "PC connection", page 117.*

Printer: *Refer to "Printer connection", page 123.*

Sample changer: *Refer to "Sample changer", page 142.*

Connect electrodes

Refer to "Electrode connection", page 89.

Contrast

The contrast of the display can be adjusted in the Main window.

- press **0** to increase the contrast
- press **7** to decrease the contrast

Controlled by TTL IN

Refer to "Auxiliary input", page 41.

Copy electrode

This procedure is used to create an electrode by copying an existing one.

1. Enter the `Electrodes` window.
2. Press **4** then **1**.
3. In the `Function` field, select the function according to the electrode type then press ✓, *see "Electrode type", page 93*.
4. Press ✓ .
5. Select `From = Catalogue`.
6. In the `ID` field, select an electrode name from the Catalogue list.
7. In the `id` field, you can identify the electrode by assigning a second id name. This electrode will be called "ID id".
8. Press **1** to confirm then **2** Copy from electrode.
9. In the `Library` field, select the Preprogrammed or User list.
10. In the ID field, select the electrode to be copied from the list of available electrodes.
11. Press **1** to confirm. The electrode is created and saved in the User list.

If you selected the option Preprogrammed, the list is limited to electrodes of the same type as the "copied" electrode.

If you selected User, the list is limited to electrodes having the same function (pH, mV (i=0), mV (i>0), ISE, Conductivity, T°C, Reference or Ground) as the "copied" electrode.

It is not necessary to select `Catalogue` *to create an electrode using the copy function. An electrode ID created from* `Other` *can also use the copy function.*

Copy method

This procedure is used to create a method by copying an existing one.

1. Switch to Main window.
2. Select Method.
3. Press **4** then **1**.
4. Press **3** in New method menu.
5. Enter a method name.
6. Press **2** Copy from method.
7. In the `Library` field, select the Preprogrammed or User list.
8. In the ID field, select the method to be copied from the list of available methods.
9. Press **1** to confirm. The method is created and saved in the User list.

Coupled method

A Coupled method is a combination of methods performed in the same beaker. When using a coupled method, the instrument runs all these methods on the same sample.

If you wish to run a series of methods in different beakers, it is necessary to program a Sequence instead of a Coupled method.

Example: Combination of method 1 and method 2.

The number of test portions (for example 3) is entered during programming. The method is then repeated in the number of beakers specified.

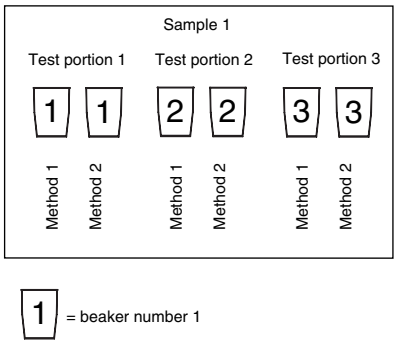


Figure 5: Coupled method with three tests

Create electrode

1. Enter the Electrode window.
2. Press **4** then **1**.
3. Select the electrode function, *see "Electrode type", page 93*.
4. Press ✓ in the ID field.
5. Select `From = Other`.

The option `From = Catalogue` *allows you to create an electrode from a list of Radiometer Analytical electrodes.*

6. Enter the electrode name (up to 16 alphanumeric characters).
7. In the Confirm creation screen:

- For pH, mV or ISE function electrodes only: select the electrode type.
  Refer to "Electrode type", page 93.
- For combined pH or single pH electrodes; enter the internal pH (pH int) of the electrode.
  Refer to "pH int", page 119.
- For combined pH, Metal/Redox or ISE electrodes or for a Conductivity electrode; select if the electrode has a built-in temperature sensor or not.
- For reference electrodes or combined pH, Metal/Redox, ISE electrodes; enter the potential of the reference (in mV) versus the Standard Hydrogen Electrode.
  Refer to "Potential versus SHE", page 120.
- For ISE electrodes only; enter the ion valency and molar weight (in g/mol).
  Refer to "Valency", page 164.
- For conductivity cells only; enter the cable resistance (in Ω) and capacitance (in pF).
  Refer to "Cable resistance", page 48.
  Refer to "Cable capacity", page 47.

8. Press **1** to create the electrode. The Edit electrode menu is displayed. Enter the electrode definition parameters.

Create method

1. Enter the Main window.
2. Select Method.
3. Press **4** then **1**.
4. Press ✓ in the New method screen.
5. Enter a method name (up to 17 alphanumerical characters).
6. Press **1** to create the method. Go to Edit method screen and enter the method parameters.
   Refer to "Programming method", page 126.

Current value

This is the current sent to the **Pt-Pt** socket on the ION450. This parameter is available if `mV(i>0)` has been selected for `Measurement` in the Edit method menu.

Enter in:
Method parameters menu

Range available:
-1000 to +1000 µA in steps of 1 µA

Curve

Select if you want to print the E = f (pC = -log C) calibration curve at the end of each ISE electrode calibration cycle.

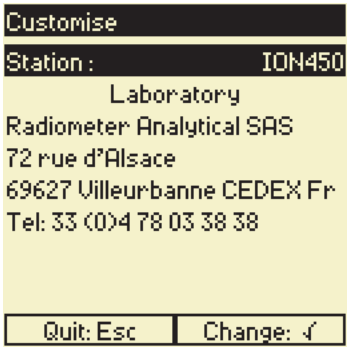
Enter in:
Edit electrode > Printouts (ISE electrodes)

Curves data lost - Cal. Data kept - Methods kept

The last curve data acquisition is lost. Generally, this error occurs when the instrument is switched off while an analysis is in progress.

Customise

A name (max. 16 alphanumeric characters) can be assigned to the ION450. This name will be displayed in the title bar of the Main window.



If required, a maximum of 4 lines (32 characters) is available to enter personal information, or your company's address. This information will appear as a header at the start of the report printout.

Enter in:

Setup window > Customise

Date entry

Enter current date in following format: dd:mm:yyyy.
Use the **Up/Down** arrow keys to jump to the month.

Enter in:

Setup menu > Configuration

Default parameters

Reset the parameters programmed in the method or electrode. Use this command to reset the preprogrammed methods or electrodes to the ION450's default values.

Proceed as follows:

1. Display the Main or Electrode window.
2. Press **4**.
3. Select the method or electrode ID.
4. Press **3** Default parameters.
5. Press ✓ to confirm the reset.

Delete electrode

1. Select the electrode to be deleted.
2. Press **4**.
3. Press ✓ to confirm or **ESC** to leave the menu with deleting.

It is not possible to delete an electrode which is used in another method or sequence. Modify the method or sequence, e.g. change electrode iD or remove the electrode, before deleting.

Delete method

1. Select the method to be deleted.
2. Press **4**.
3. Press ✓ to confirm or **ESC** to leave the menu with deleting.

It is not possible to delete a method which is part of a method sequence or coupled method. Remove the method from the sequence or from the coupled method before deleting.

Demand: Locked

Electrode calibration

The routine user is not allowed to bypass an electrode calibration demand before continuing measurements. It means that the electrode calibration periodicity has(have) been elapsed.

QC sample analysis

If a QC sample periodicity has been reached, the next run of the method must be performed on a QC sample.

Sequence edition

The routine user is not allowed to create, edit or delete sequence of methods.

Enter in:

Setup menu > Access routine mode

Demand: Unlocked

Electrode calibration

The routine user is allowed to bypass an electrode calibration demand and continue measurements. This happens when the electrode calibration periodicity has elapsed.

QC sample analysis

If a QC sample periodicity has been reached, the routine user is able to run the method without having to use a QC sample.

Sequence edition

The routine user is allowed to create, edit or delete sequence of methods.

Enter in:

Setup menu > Access routine mode

Detailed

This parameter sets level of details of report printouts.

Detailed = Low

- The header only comprises the analysis name, time and date and the instrument serial number. These data are printed on the same line.
- Electrode calibration method: results are printed.

Detailed = Medium

This is the printout level selected by default.

- The header comprises the analysis name, time and date, the instrument serial number and the laboratory coordinates.
- Electrode calibration method: results are printed.

Detailed = High

This is the printout level selected by default.

- The header comprises the analysis name, time and date, the instrument serial number and the laboratory coordinates.
- Electrode data, electrode serial number, electrode calibration data and results are printed.
- The buffer or standard data (name and batch number, potential value) are printed.

Enter in:

Edit method > Printouts

Edit electrode > Printouts

Detection limit (C_0)

Refer to "Direct ISE measurement method - definition", page 69.

Direct ISE measurement method - definition

Measurement method using a selective electrode (ISE) of the ion you want to determine the concentration.

In a Direct ISE measurement method, you must calibrate the ISE electrode using 1 to 9 standard solutions of known concentration. *Refer to "Electrode calibration (ISE)", page 83*.

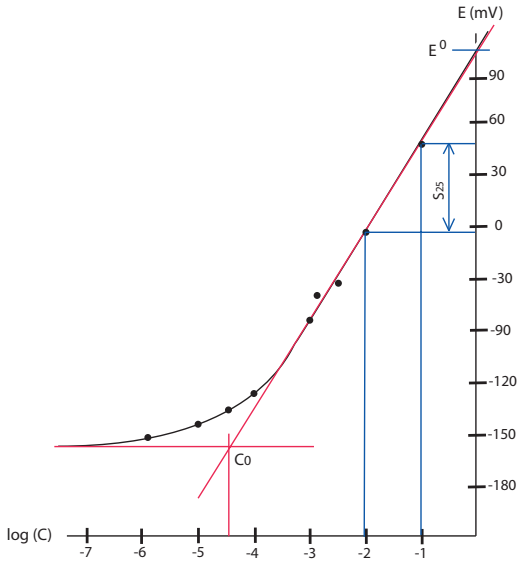
If a calibration with 3 to 9 standards is carried out, E^0, S and C_0 are determined by non linear regression using the following equation:

$$E = E^0 + S_{25} \times T/T_{25} (-\log (C+C_0)) \text{ where:}$$

- E = potential measured in the sample,
- E^0 = electrode standard potential,
- S_{25} = electrode response slope (sensitivity) at 25°C,
- T = temperature of the solution in K,
- T_{25} = 298.16 K,
- C = concentration of sample,
- C_0 = detection limit concentration. It is the “experimental detection limit of the electrode regarding the species under study“.

If a 1-point calibration is performed, only E^0 is calculated. The ION450 takes the S_{25} sensitivity from the last calibration done or takes the theoretical value which depends on the ion valency (for example: -59.16 mV for a positive monovalent ion). C_0 is equal to 0.

If a 2-point calibration is performed, E^0 and S_{25} are calculated using the same equation as above but with C_0 = 0. It is recommended to perform a 2-point calibration in the linear response zone of the ISE electrodre.



Refer to "Direct ISE measurement method - notes", page 70.

Direct ISE measurement method - notes

The accuracy of the measurements using a Direct ISE method depends on the following elements:

- The concentrations of the standards used for a 2-point calibration must lie on either side of the samples to be measured.
- For calibration using more than 2 standards, one of the standard concentration must lie in the non-linear response zone of the ISE electrode.
- If you want to measure low concentrations (values situated in the non-linear response zone), run a 2 or 3-point calibration in the non-linear response zone of the electrode.
- It is recommended to measure sample concentrations above the C_0 limit.
- A high value found for C_0 may undergo false measurements (check your standards and electrode).
- A similar ionic strength must be found in both standards and samples (add a supporting electrolyte in the standards and samples).
- The samples must not contain a significant amount of interfering ions.
- Use the same temperature for your standards and samples (thermostate the solutions).

How to edit a Direct ISE measurement method?
see "Direct ISE measurement method - programmation", page 70.

How to run a Direct ISE measurement method?
Refer to "Running a method", page 138.

What is a Direct ISE measurement method?
see "Direct ISE measurement method - definition", page 69.

Direct ISE measurement method - programmation

Proceed as follows to edit a Direct ISE measurement method:

1. From the Main window, press **4** then **2** Edit method.
2. For `Mode`, select `Measurement`.
3. For `Measurement`, select ISE `Direct`.
4. Define the other parameters of this measurement method.

What is a Direct ISE measurement method?
see "Direct ISE measurement method - definition", page 69.

How to run a Direct ISE measurement method?
Refer to "Running a method", page 138.

Direct measurements

Refer to "Display measurement", page 72.

Disconnect electrodes

Disconnect all connected electrodes.

Proceed as follows:

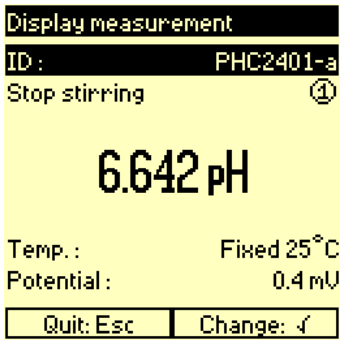
1. Press **2** in the Electrode window.
2. Press **2** Disconnect electrodes.
3. Disconnect electrode from rear panel.
4. Press ✓ to confirm.
5. Repeat steps 3 and 4 for all other electrodes to be disconnected.

Display contrast

Refer to "Contrast", page 60.

Display measurement

Press **5** in the Electrode window.



The signal measured of a connected electrode in the current system is displayed. If several electrodes are connected, select the electrode at the `ID` line.

Depending on the type of electrode connected, the display shows:

- pH and corresponding potential difference in mV (pH electrodes)
- potential difference in mV (metal/redox or non-calibrated ISE electrodes)
- concentration in the electrode calibration unit (calibrated ISE electrodes)
- temperature in °C (temperature sensors)
- conductivity measured in mS/cm at sample temperature (conductivity cells). If the conductivity is not calibrated, the instrument displays a conductivity with a cell constant value equal to 1 cm^{-1}. The sample temperature is measured or is equal to 25 °C. There is no temperature correction performed.
  To get accurate measurements, it is therefore recommended to calibrate the conductivity cell at a given temperature and thermostat the sample to that temperature before running the measurement.

Press **1** to apply or stop stirring.

Press **Esc** to stop measurements.

Dyn. rinse

You have the choice between rinsing dynamically the electrodes :

- `N-1/st in Park`: in previous (just analysed) beaker except 1st and calibration beakers in park,
- `N-1/st in Rinse 2`: in previous (just analysed) beaker except 1st and calibration beakers in R2 (static rinse beaker no.2),
- `In Park`: in park (all dynamic rinses performed in the park beaker).

For the first dynamic rinse of sample changer cycle run, we have the choice between rinsing dynamically the electrodes in the Park beaker or in the R2 beaker (static rinse beaker no.2). If R2 is selected, it means that only 1 beaker remains available for static rinses (static rinse beaker no.1 (R1)).

Refer to "Number of static rinses", page 116.

At the end of a dynamic rinse, the electrodes are left above a nearly emptied rinse beaker. The beaker contains a little solvent which has been used to rinse the end of the electrodes and the addition tips.
Refer to "Dynamic rinses", page 74.

Dynamic rinses can not occur in calibration beakers. When an electrode or a reagent calibration beaker is found in the sequence, the dynamic rinse which follows the measurement will occur in the Park or Rinse 2 beaker depending on the option selected for `Dyn. rinse`*.*

Static rinse beakers and Park beakers: Refer to User's Guide of the SAC850/950 sample changer (part no. D21T085).

Enter in:

Setup menu > Configuration

Range available:

N-1/1st in Park, N-1/1st in Rinse 2 or In Park.
If `Sample changer` = `SAC850` or `SAC950`

Dynamic rinses

Dynamic rinses are performed by a SAC850 or SAC950 Sample Changers if the Dynamic rinsing module is installed on the sample changer.

A Dynamic rinse performed in a Park or Rinse beaker consists of the following operations:

1. The electrode are positioned above the Park or Rinse beaker.
2. The electrodes are dipped into the beaker. The beaker is emptied to a waste in the same time. At the end, the electrodes are located in the emptied beaker at their downmost position.
3. The electrodes are washed with rinse solution (usually demineralised water) then start to move up under rinsing. At the end, the electrodes are located above a beaker filled with rinse solution and some remaining impurities.
4. Steps **2** and **3** can be repeated up to 8 times as up to 9 dynamic rinses can be programmed. Steps **2** and **3** are performed under stirring.

A Dynamic rinse performed in a Sample beaker consists of the following operations:

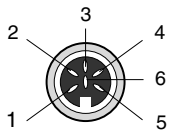
1. The electrodes are dipped into the Sample beaker. The beaker is emptied to a waste in the same time. At the end, the electrodes are located in the emptied beaker at their downmost position.
2. The electrodes move up and are washed in the same time with rinse solution (usually demineralised water). At the end, the electrodes are located above a beaker filled with rinse solution and some remaining impurities.
3. The sample beaker is emptied to a waste.
4. A last rinsing of the electrodes and delivery tips is carried out. At the end, the electrodes are located above a nearly emptied beaker containing a little solvent that was used to flush the electrodes and delivery tips.
5. Steps **1** to **3** can be repeated up to 8 times as up to 9 dynamic rinses can be programmed. Steps **1** to **3** are performed under stirring.

E0 standard potential

Refer to "Direct ISE measurement method - definition", page 69.

EC socket

6-pin DIN socket for connection of the conductivity cell with 2, 3 or 4 poles and a temperature sensor.



Pin layout:
Pin 1 : pole no.1
Pin 2 : pole no.2
Pin 3 : pole no.3
Pin 4 : pole n°4, also connected to pin no. 5
Pin 5 : 0 V (ground)
Pin 6 : temperature sensor

Potential imposed between poles 2 and 3: ±200 mV constant for all conductance ranges.

The current passing through poles 1 and 4 is measured. The potential between poles 1 and 4 cannot exceed 3 V in absolute value.

The following Radiometer Analytical conductivity cells can be connected to the **EC** socket:

Conductivity cell	Number of poles	Built-in temperature sensor	Connection to ION450
CDC566T **(*)**	4	Yes	Direct connection
CDC866T **(*)**	4	Yes	Direct connection
CDC641T **(*)**	2	Yes	Direct connection
CDC511T	4	Yes	Direct connection
CDC741T **(*)**	2	Yes	Direct connection
CDC861T	4	Yes	Direct connection
CDC565	4	No	Direct connection
CDC749	2	No	Direct connection
CDC745-9 **(*)**	2	No	Via A94L136 cable
CDC267-9	2	No	Via A94L136 cable
CDC241-9	2	No	Via A94L136 cable
XE100	2	No	Via A94L136 cable

Figure 6: Radiometer Analytical conductivity cells

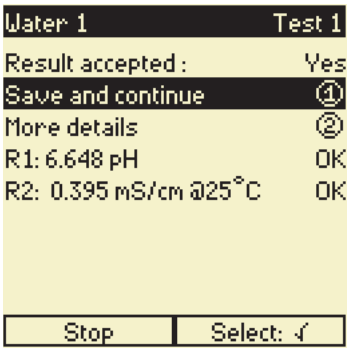
(*) *This conductivity cell is present in the ION450 electrode library (Catalogue list)*

Conductivity cell with 2, 3 or 4 poles?
see the “Conductivity theory and practice“ guide, part no. D61M002.

EC/pH measurement method - definition

Using this method, conductivity and pH are measured simultaneously in a same sample. This method uses a conductivity cell and a pH combined electrode (or a separate pH and reference electrode).

Method parameters are those of a conductivity and a pH measurement. Some parameters are common to the 2 types of measurements such as the Acceptation time and the Maximum stabilisation time. When both pH and the conductivity measurements are stable, the ION450 displays the 2 results as R1 and R2.

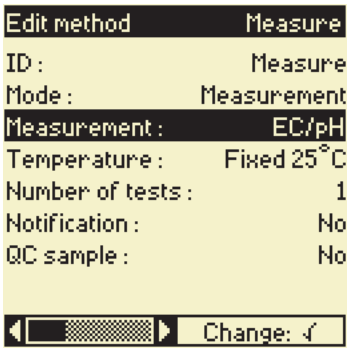


Refer to "EC/pH measurement method - programmation", page 77.

EC/pH measurement method - programmation

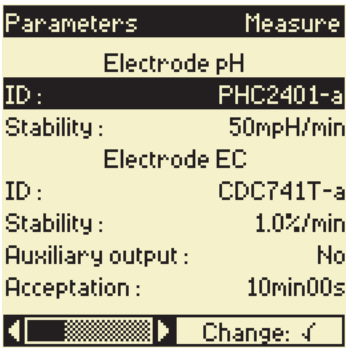
Proceed as follows to edit an EC/pH measurement method:

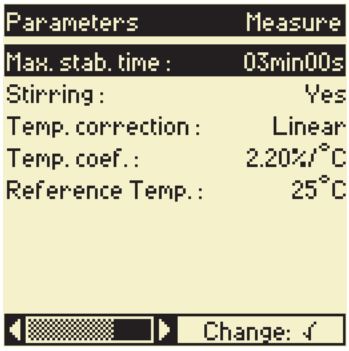
1. From the Main window, press **4** then **2** Edit method.



For Mode, select Measurement.
For Measurement, select EC/pH.

2. Press the Right arrow key, press **1**.





Select a pH electrode and enter a pH measurement stability criterion.
Select a Conductivity cell and enter a conductivity measurement stability criterion.
Some parameters are common to both pH and Conductivity measurements (Acceptation, Max. Stab time, Auxiliary output, Stirring).
Temp. correction , Temp. coef. and Reference Temp. parameters deal with conductivity measurements.

3. Press the **Esc** key, press **3** and edit the Results parameters.
4. Press the **Esc** key, press **4** and edit the Printouts parameters.

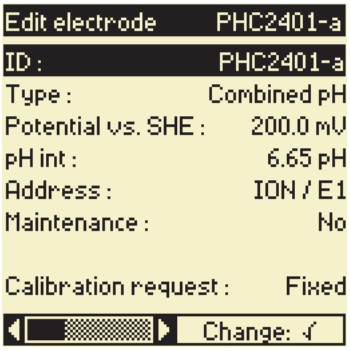
What is an EC/pH measurement method?
Refer to "EC/pH measurement method - definition", page 76.

Edit electrode menu

In this menu, you can rename the electrode (line `ID`), revise electrode data, decide if you want to calibrate the electrode (line `Calibration request`) and enter the electrode calibration data if relevant.

To access:

1. Press **4** in the Electrode window.
2. Press **2** Edit electrode.



if an electrode calibration is requested, the following menus are accessible using the arrow keys:

Calibration parameters.
Refer to "Electrode calibration parameters", page 87.

Calibration solutions.
Refer to "Solution menu", page 151.

Results.
Refer to "Results menu", page 134.

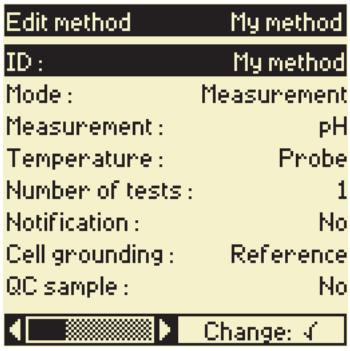
Printouts.
Refer to "Printouts menu", page 125.

Edit method menu

In this menu, you can rename the method (line `ID`), revise and enter method data.

To access:

1. Press **4** in the Main window.
2. Press **2** Edit electrode.



The following menus are accessible using the arrow keys:

Method parameters.
Refer to "Method parameters menu", page 108.

Results.
Refer to "Results menu", page 134.

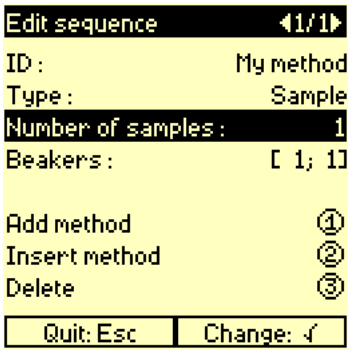
Printouts.
Refer to "Printouts menu", page 125.

QC Data
Refer to "QC data menu", page 128.

Edit sequence menu

Use this menu to program a sequence (add, insert, remove a method from a sequence or delete the sequence). You can also specify the number of times a method must be repeated within the sequence (parameter `Number of samples`).

At the line Beakers: [F;L], the instrument displays the positions **F** and **L** occupied by the first and last beakers In the sequence.



In the title bar, “x/y” (1/1) indicates the position "x" occupied by the method in the sequence and "y" the total number of methods listed in the sequence.

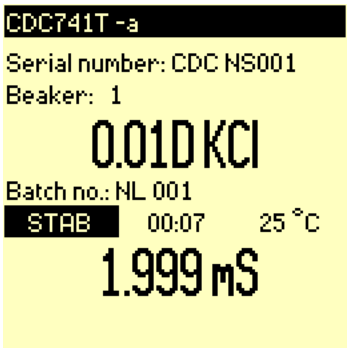
The ID and type of the selected method can not be modified at this level. They are defined in the `Add method` or `Insert method` menu.

To access:

1. Select Sequence or SAC Sequence for `Working mode` in the Main window,
2. Press **2** Sequence/Sample stack,
3. Enter a name for the sequence,
4. Press **3** Edit sequence.

Electrode calibration (Fixed mode, conductivity cell)

1. Select the method which uses the conductivity cell to be calibrated.
2. Connect the electrode system,
   see "Electrode connection", page 89.
3. Press **1** Calibrate electrodes in the Electrode window.
4. Select the conductivity cell from the list.
5. Press **1** to Run, and follow the messages on the display.
   Measurements start in beaker no.1.



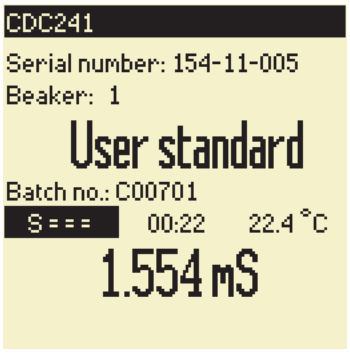
The ION450 displays the conductance measured. The displayed temperature is the temperature measured, entered or is equal to 25°C according to the calibration method programmed.

If you are not using a temperature probe and want to get accurate measurements, it is recommended to thermostat your standard beakers at the temperature you have entered (or at 25°C).
Pay attention to the temperature range of the standard used:
see "Standard (conductivity standard)", page 153.

6. After stabilisation or at the end of the maximum stabilisation time, the ION450 calculates the standard conductivity at the measured or entered temperature. Then, the instrument calculates and displays the cell constant.
7. Accept or reject the result then start a new calibration cycle (new beaker of the same standard) or end the calibration.
   Refer to "Result accepted (Yes/No)", page 131.
8. The cell constant (mean of all cycle results accepted) is saved with the electrode.
   To consult the calibration results, *see "GLP-Archives menu", page 98*.

Electrode calibration (Free mode, conductivity cell)

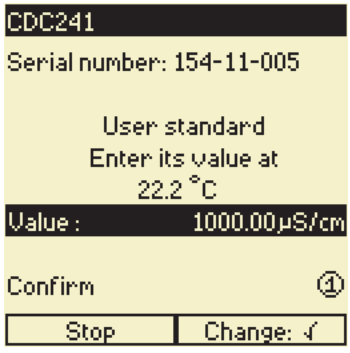
1. Select the method which uses the conductivity cell to be calibrated.
2. Connect the electrode system,
   see "Electrode connection", page 89.
3. Press **1** Calibrate electrodes in the Electrode window.
4. Select the conductivity cell from the list.
5. Press **1** to Run, and follow the messages on the display.
   Measurements start in the user standard.



The ION450 displays the conductance measured. The displayed temperature is the temperature measured, entered or is equal to 25°C according to the calibration method programmed.
Note:
An ID can be assigned to the standard. In this case, the standard ID entered replaces the name "User standard".

If you are not using a temperature probe and want to get accurate measurements, it is recommended to thermostat your standard beakers at the temperature you have entered (or at 25°C).

6. After stabilisation in the user standard.



Press ✓ and enter the conductivity value of your standard at the temperature displayed.
Press 1 to confirm.

7. The ION450 calculates and displays the cell constant.
   Accept or reject the result then start a new calibration cycle (new beaker of the same standard) or end the calibration.
   Refer to "Result accepted (Yes/No)", page 131.
8. The cell constant (mean of all cycle results accepted) is saved with the electrode.
   To consult the calibration results, *see "GLP-Archives menu", page 98*.

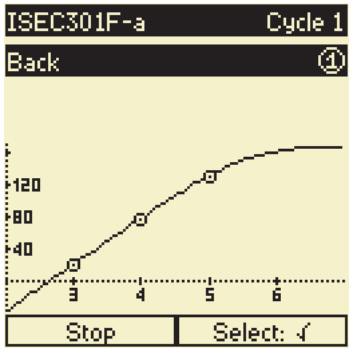
Electrode calibration (ISE)

Preparation of the calibration standards:
see "Calibration = Manual", page 50.

1. Select the method which uses the electrode to be calibrated.
2. Connect the electrode system, *see "Electrode connection", page 89*.
3. Press **1** Calibrate electrodes in the Electrode window.
4. Select the electrode from the list.
5. Press **1** to Run, and follow the messages on the display.

The ION450 displays the potential measured. The displayed temperature is the temperature measured, entered or is equal to 25°C according to the calibration method programmed.

For a 3 to 9-point calibration, the E^0 standard potential, S_{25} sensitivity at 25°C and C_0 detection limit concentration are calculated at the end of the calibration.
For a 2-point calibration, E^0 and S_{25} are calculated. $C_0 = 0$.
For a 1-point calibration, only E^0 is calculated, S_{25} comes from the last multi-point calibration performed or is equal to the default value (59.16 mV/pC for a monovalent ion). $C_0 = 0$.



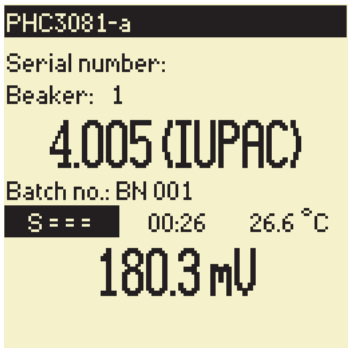
At the end of a calibration cycle, you can display the E (mV) = f (pC = -log C) calibration curve. The calibration points are marked (here 3). To display the curve of a calibration cycle, press **2** More details then **4** Curve from the result data display.

The calibration results are saved with the electrode.
To consult the calibration results, *see "GLP-Archives menu", page 98*.

It is recommended to maintain all your standards at the same temperature. Then the temperature entered at the start of a calibration cycle is valid for all your standards.

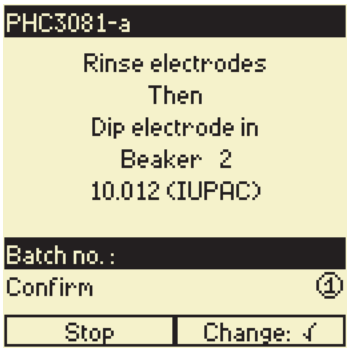
Electrode calibration (Fixed mode, pH electrode)

1. Select the method which uses the electrode to be calibrated.
2. Connect the electrode system, *see "Electrode connection", page 89*.
3. Press **1** Calibrate electrodes in the Electrode window.
4. Select the electrode from the list.
5. Press **1** to Run, and follow the messages on the display. Measurements start in buffer no.1.



The ION450 displays the potential measured. The displayed temperature is the temperature measured, entered or is equal to 25°C according to the calibration method programmed.

6. After stabilisation of the measurement in buffer no.1:



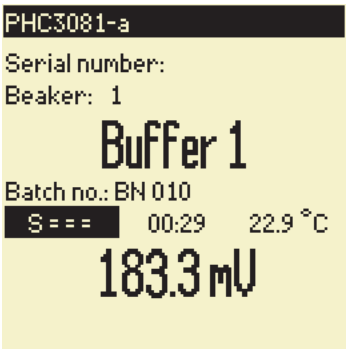
The ION450 has recognised buffer no.1. Enter the batch number for buffer no.2 and dip the electrodes in buffer no.2. Measurements start in buffer no.2 and so on.
A pH calibration can be performed over 1 to 5 buffers.

The electrode zero pH and sensitivity are calculated at the end of a multi-point calibration. For a 1-point calibration, only the zero pH is calculated, the slope comes from the last calibration performed or is equal to the default value (59.16 mV/pH unit). The calibration results are saved with the electrode.
To consult the calibration results, *see "GLP-Archives menu", page 98*.

It is recommended to maintain all your buffers at the same temperature. Then the temperature entered at the start of a calibration cycle is valid for all your buffers.

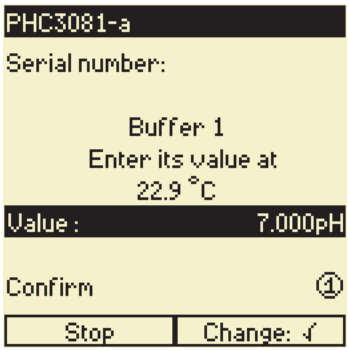
Electrode calibration (Free mode, pH electrode)

1. Select the method which uses the electrode to be calibrated.
2. Connect the electrode system, *see "Electrode connection", page 89*.
3. Press **1** Calibrate electrodes in the Electrode window.
4. Select the electrode from the list.
5. Press **1** to Run, and follow the messages on the display. Measurements start in buffer no.1.



The ION450 displays the potential measured. The displayed temperature is the temperature measured, entered or is equal to 25°C according to the calibration method programmed.
Note:
An ID can be assigned to the pH buffers. In this case, the buffer ID entered replaces the name "Buffer n".

6. After stabilisation of the measurement in buffer no.1:



Press ✓ and enter the pH value of your buffer at the temperature displayed.
Press 1 to confirm.
The calibration goes on with buffer no.2. Enter the batch number for buffer no.2 and dip the electrodes in buffer no.2. Measurements start in buffer no.2 and so on.
A pH calibration can be performed over 1 to 5 buffers.

The electrode zero pH and sensitivity are calculated at the end of a multi-point calibration. For a 1-point calibration, only the zero pH is calculated, the slope comes from the last calibration performed or is equal to the default value (59.16 mV/pH unit). The calibration results are saved with the electrode.
To consult the calibration results, *see "GLP-Archives menu", page 98*.

It is recommended to maintain all your buffers at the same temperature. Then the temperature entered at the start of a calibration cycle is valid for all your buffers.

Electrode calibration (SAC sequence)

In a calibration sequence, the standard solution beakers are handled automatically using a sample changer. A SAC80, SAC90, SAC850 or SAC950 Sample Changer must be connected and declared in the Configuration menu.

1. Select the SAC Sequence option in the Main window. This SAC Sequence must use the electrode to be calibrated.
2. If a Question mark "?" is present in the Electrode tab, it means that the sequence needs to be programmed - an electrode is missing. Review programming in Supervisor mode. *Refer to "Programming sequence", page 127*.
3. Install the sample changer and connect it to the **SAC** socket of the ION450 using the cable, part no. A95A202 or A95X501.
   Refer to the User's Guide of the sample changer (part no.: D21T002 for a SAC90, D21T013 for a SAC80, D21T085 for a SAC850 or SAC950).
   Refer to "Sample changer", page 142.
4. Connect the electrode system, *see "Electrode connection", page 89*.
5. Press **1** Calibrate electrodes in the Electrode window.
6. Select the electrode from the list of the electrode system.
7. Press **2** Calibration sequence.
8. Prepare the electrode calibration stack, *see "Electrode calibration stack", page 88*.
9. Press **Esc** then **1** to run the calibration sequence. Follow the messages on the display.
10. The sample changer cycle is initiated.
    - 1 to 9 dynamic rinses (if programmed with a SAC850/SAC950)
    - 1 to 3 static rinses (if programmed).
    - Electrodes are dipped into the first standard solution.
    Measurement starts.
    - Between each standards (beakers), 1 to 9 dynamic rinses (if programmed with a SAC850/SAC950) then 1 to 3 static rinses are performed (if programmed to do so).
11. At the end, the ION450 displays the calibration results. The calibration results are saved with the electrode.
    To consult the calibration results, *see "GLP-Archives menu", page 98*.

When running a calibration sequence with a SAC80 Sample Changer, do not use the STOP key of the SAC80.

Electrode calibration not required

Message appears at the start of a sequence, if a method sequence has been programmed with an electrode calibration. The electrode used has been programmed without calibration `Calibration request = No`.

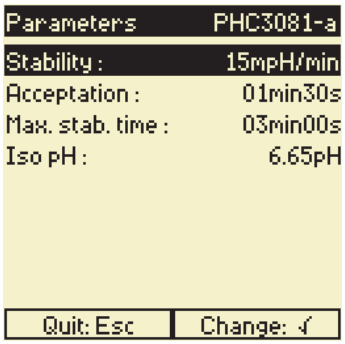
Go to Sequence/Sample stack, `Edit sequence` menu and remove the electrode calibration method.

Electrode calibration parameters

This menu contains the general parameters concerning the electrode calibration method (measurement stabilisation criteria in particular).

To access:

1. From the Electrode window, press **4**.
2. Select the electrode to be edited.
3. Press **2** Edit electrode and check that the `Calibration request = Fixed` or `Free` option (pH electrode) or `Calibration = Manual` option (ISE electrode) has been selected.
4. Edit the electrode calibration general parameters.
5. Use the **LEFT/RIGHT** arrow keys to move to the last Edit electrode display.
6. Press **1** Calibration parameters.

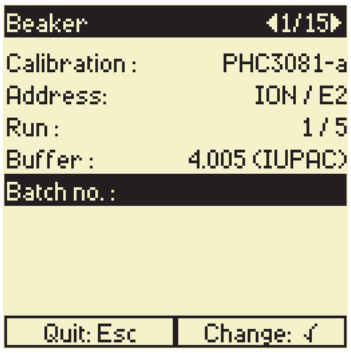


Refer to "Calibration = Manual", page 50.
Refer to "Calibration request = Fixed", page 52.
Refer to "Calibration request = Free", page 53.

Electrode calibration stack

The electrode calibration stack defines individual data for each buffer solution beakers present in an electrode calibration sequence.

1. Declare a sample changer (SAC80, SAC90, SAC850 or SAC950) in the Setup > Configuration menu.
   Refer to "Configuration menu", page 60.
2. In the Main window, select SAC Sequence or SAC method for the working mode. This SAC sequence or SAC method must use the electrode you want to calibrate. Edit the sequence or the method if relevant, *see "Programming sequence", page 127*.
3. Enter the Electrode window.
4. Press **1** Calibrate electrodes and select the electrode to calibrate.
5. Press **2** Calibration sequence.



<1/15> means the first beaker over 15 programmed in the sequence. Use the **LEFT/ RIGHT** arrows to review the other beakers in the sequence.

Run 1/5 means that this beaker deals with the first cycle over 5 programmed in the sequence.

Enter the batch number of each buffer solution.

Beakers are numbered in that order:
Cycle 1, Buffer 1 - Cycle 1, Buffer 2 ..... Cycle 1, Buffer n (n=1 to 5)
Cycle 2, Buffer 1 - Cycle 2, Buffer 2 .....Cycle 2, Buffer n
.....
Cycle m (m=1 to 9), Buffer 1 - Cycle m, Buffer 2 .....Cycle m, Buffer n
n and m are entered in the Edit electrode menu. The buffer solutions are selected in the Solutions menu.

Label the beakers indicating the running number in the sequence, for example: 1/15, 2/15 etc.... and the name of the buffer solution.
Place the beakers in the numbered position on the sample changer.
If rinses are programmed, position the corresponding rinse beakers at the right places.
Refer to "Number of static rinses", page 116.
Refer to "Dynamic rinses", page 74.
*You can print the calibration stack by pressing **Print** from the calibration menu.*

6. Press **Esc** then run the sequence by pressing **1** Run calibration.

Electrode connection

Proceed as follows to connect/install electrodes and temperature sensors:

1. In the Electrode window, press **2** then **1** Connect electrode.
2. Enter serial number
3. Connect electrodes to the rear panel socket of the ION450. See figure and table below. For example: pHC2001 to address ION/E1. *Refer to "Address", page 37*.
4. Install electrodes on the ION450 or sample changer holder.
5. Press **1** to confirm.

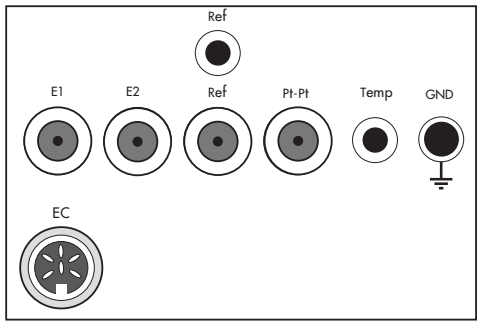


Figure 7: Electrode sockets

Socket	Type of electrode
REF	Single reference
TEMP	Temperature
GND	Ground metal for cell grounding only
Pt-Pt	Double metal
E1/E2	Indicating (pH, Metal/Redox, ISE) single or combined
EC	Conductivity cell w/o temperature sensor

Table 4: Connecting electrodes

If the current method in use requires an electrode different to the one already connected, the ION450 will prompt you to disconnect the electrode before connecting the new one, see "Disconnect electrodes", page 71.

Refer to "Electrode connection - Important", page 90.

Electrode connection - Important

In order to simplify user operations when performing several types of daily analyses, the instrument allows the connection of electrodes that do not belong to the electrode system, provided that the electrodes are compatible. In this way, the user will have a minimum of operations to perform. It involves that all connected electrodes must be immersed in the solution.

1st case

When you change from a method using a double platinum electrode or a conductivity cell to a method using a pH electrode for example, the instrument prompts you to check the double platinum electrode or the conductivity cell connection then asks you to connect the pH electrode. The instrument allows the presence of a double platinum electrode or a conductivity cell even though these electrodes are not used in the operating system. However, the instrument switches to differential measurement mode using the reference of the pH electrode disconnected from the ground. This is because it is the double platinum electrode or the conductivity cell that provides the connection to the instrument ground. It involves that the double platinum electrode or the conductivity cell must be immersed in the solution.

2nd case

You edit a method using the differential mode (Cell grounding = Metal) with, for example, a pH and a metal electrode. After several tests, you decide to change the method programmation and clear the differential mode (Cell grounding = Reference). In this case, the instrument does not prompt you to disconnect the metal electrode and thus, continues to use the differential measurement mode. It involves that the metal electrode must be immersed in the solution.

If you no longer want to use the differential mode due to your work schedule or the your installed electrodes, you just have to perform a complete electrode uninstallation procedure (select Install electrodes > Disconnect electrodes then Connect electrodes). By doing this, the electrodes in the system will only be installed.

Refer to "Disconnect electrodes", page 71.

Electrode function

Refer to "Function", page 96.

Electrode icons

Select to access Electrode window.

Indicates the state of the electrode system.

Sunny icon:
The calibration has been performed on all the electrodes present in the system and/or all the electrodes have been installed.

Cloudy icon:
The electrode calibration of one of the electrodes present in the system should be performed within 24 hours.
Note: when the Periodicity is set to 1 day, this icon will appear to indicate that a calibration must be performed within 12 hours.

Stormy icon:
The calibration date has elapsed for one of the electrodes present in the system.
If acceptance limits have been set for the calibration: at least one calibration result lies outside the programmed acceptance limits.
At least one of the electrodes present in the system has not been installed.

Question mark:
The electrode system has not been programmed correctly. Enter Supervisor mode and Check the electrode parameters in the Method parameters menu. If a temperature sensor has been defined in the Electrode menu, use the same sensor in method.

*Press **1** in the Main window, the instrument will indicate the possible errors and prompt you to correct them.*

Electrode ID

Name assigned to the electrode (max. 16 alphanumeric characters).

Enter in:
Electrode window > Edit electrode

Electrode library

To access, press **4** in Electrode window.

The electrode library comprises the following menus and commands:

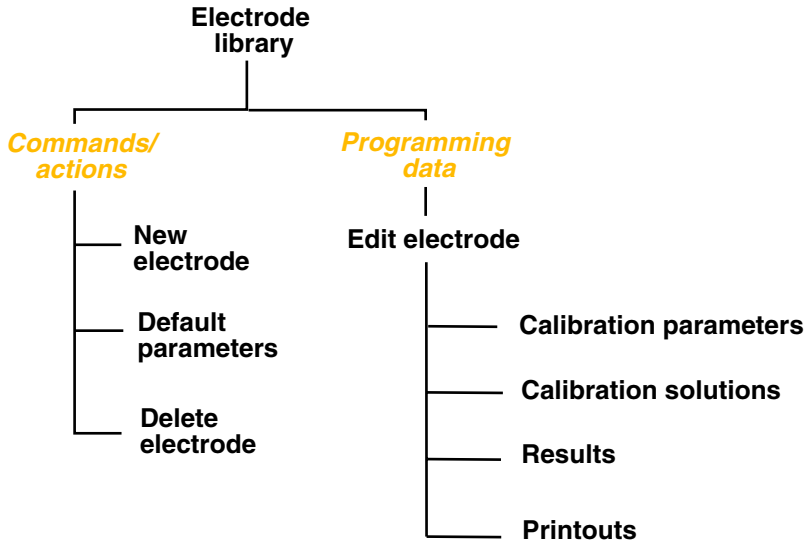


Figure 8: Electrode library overview

Electrode not calibrated

The electrode has not been calibrated and there is no electrode data stored in the archives. Press ✓ and calibrate the electrode.

Electrode system

An electrode system comprises all the electrodes necessary to run a method or a sequence of methods.

A method, consists of an indicating electrode, a reference electrode and, if required a temperature sensor.

A sequence, can consist of several indicating electrodes.

When a method/sequence is run, the instrument prompts you to connect or disconnect the electrodes that will be required to run this method/sequence.

Electrode type

The electrode type is displayed with respect to the function selected (*see "Function", page 96*). The electrode type is defined when a new electrode is created.
Refer to "Create electrode", page 63.
The different electrode types are listed below:

Type	Function
Single pH	pH
Combined pH (w/o temperature sensor)	pH
Single metal/redox	mV (i=0)
Combined metal/redox (w/o temperature sensor)	mV (i=0)
Single ISE	ISE or mV (i=0)
Combined ISE (w/o temp. sensor)	ISE or mV (i=0)
Reference	Reference
Temperature sensor	T°C
Ground metal	Ground
Double metal	mV (i >0)
Conductivity: conductivity cell with 2, 3 or 4 poles (w/o temp. sensor)	Conductivity

Table 5: Electrode functions and types

If Combined pH is defined, the ION450 prompts you to specify if it has a built-in temperature sensor.

If a Single electrode is defined, the ION450 prompts you to define a reference electrode.

Electrode window

This window contains all the information and operations concerning the electrodes.

To access:

Use **LEFT/RIGHT** arrow keys.

Empty sequence

Involves removing the methods present in the sequence.

Proceed as follows:

1. Select the sequence to be emptied.
2. Press **3** twice.
3. Press **2**, then ✓ to confirm or press **Esc** to leave the screen without emptying the sequence.

Refer to "Remove method from a sequence", page 130.

ERR#32 (SAC error)

Refer to "SAC switch Off/On (SAC error)", page 141.

Error - Error messages

See also "Check command", page 57.

ION450 errors:

"Active electrode unknown in "method ID"": see page 36.
"Archives data lost - Cal. Data lost - Methods kept": see page 38.
"Calibration delay elapsed": see page 51.
"Curves data lost - Cal. Data kept - Methods kept": see page 64.
"Electrode calibration not required": see page 87.
"Electrode not calibrated": see page 92.
"Ground conflict": see page 98.
"Input address conflict": see page 99.
"Insufficient number of beakers": see page 100.
"Max. stab reached": see page 106.
"Method wrong type": see page 109.
"QC analysis required": see page 128.
"QC not required": see page 128.
"QC periodicity elapsed": see page 129.
"Ref. electrode conflict": see page 129.
"Reset memory": see page 130.
"Same buffer change buffer": see page 141.
"Temp. limit exceeded": see page 160.
"The sequence is empty": see page 161.
"Wrong buffer": see page 165.

SAC errors:

"Communication failure (SAC error)": see page 58.
"ERR#32 (SAC error)": see page 94.
"Missing beaker (SAC error)": see page 112.
"No stirrer (SAC error)": see page 113.
"SAC arm obstructed (SAC error)": see page 140.
"SAC option missing (SAC error)": see page 141.
"SAC switch Off/On (SAC error)": see page 141.
"Tray missing (SAC error)": see page 161.
"Turntable blocked (SAC error)": see page 163.
"Wrong type (SAC error)": see page 165.

Fixed (calibration mode)

Refer to "Electrode calibration (Fixed mode, conductivity cell)", page 81.
Refer to "Electrode calibration (Fixed mode, pH electrode)", page 84.

Format (printouts)

Format = Listing

The whole report is printed in one operation.

Format = Page by page

The printer waits until a preset number of lines have been collected then prints one page (this number is set by the `Nb line per page` parameter), *see "Nb lines per page (printouts)", page 113*.

*The printing format applies for automatic printouts (at the end of a test) or manual printouts (by pressing key **Print**).*

Access:

Setup Menu > Configuration

Refer to "Printouts", page 124.

Free (calibration mode)

Refer to "Electrode calibration (Free mode, conductivity cell)", page 82.
Refer to "Electrode calibration (Free mode, pH electrode)", page 85.

Function

Select the electrode function relative to the electrode in use.
The possible electrode functions are:

- pH,
- ISE,
- mV (i = 0),
- mV (i>0),
- T°C,
- Reference,
- Ground,
- Conductivity.

Refer to "Electrode type", page 93.

Fuses

For continued protection replace the fuse with one of a high interrupting capacity, same type and rating:

2 x fuses, slow blow, 1.0 A (5 x 20 mm), part no. 450-020.

To replace the fuses:

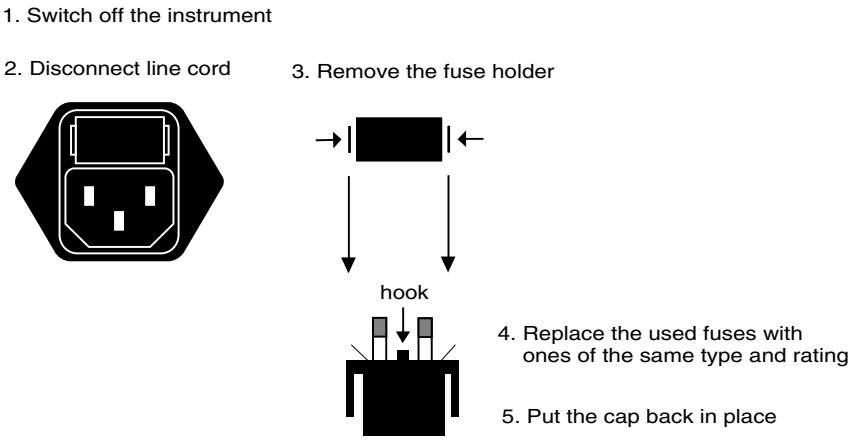


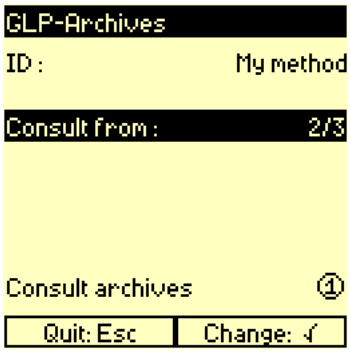
Figure 9: Fuse replacement

GLP-Archives menu

The GLP-Archives (Good Laboratory Practice) command is available in the Main and Electrode windows provided that **Yes** has been entered for **Archiving** in the Setup > Configuration menu (*see "Archiving", page 39*):

To access:

- Sample results: enter Main window and press **5**
- Electrode calibration results: enter Electrode window and press **6**



Press ✓ and enter the result number from where you want to start visualising results, e.g. result no. 2 over 3.

Press 1 to consult archives
Press 2 to consult the Global variables

Storage capacity:

Last 200 sample results.

Last 100 electrode calibration results.

When the GLP-Archives is full and a new result arrives, the oldest result stored will be the first one removed.

Ground conflict

Ground conflict: External grounding defined in Setup/Configuration and a metal electrode or a conductivity cell.

An external grounding is defined for the measurement system cell in the Configuration screen and a Ground metal, Double metal or Conductivity type electrode is used by the method.

When a metal electrode or a conductivity cell is used, select `ION cell external Gnd` = `No` in the Configuration menu.

Help

Refer to "Check command", page 57.

High (result indicator)

Refer to "Result indicators", page 132.

Icons

	Everything is OK. Run the method or sequence.
	Action required within 12 or 24 hours (for a calibration).
	Electrode calibration date elapsed. An electrode has not been installed.
	Programming error.
	Animated icon, indicates when a run method is in progress.
	Animated icon, indicates when stirring is in progress.

Refer to "Electrode icons", page 91.

ID

Refer to "Electrode ID", page 91.
Refer to "QC ID", page 128.
Refer to "Sample ID", page 144.
Refer to "Temperature sensor ID", page 161.
Refer to "User ID (Yes/No)", page 163.

Input address conflict

Two electrodes have been defined at the same address.

Enter the Edit electrode menu and modify the address of one of the electrodes.

Insert method menu

Use this menu to set the ID and the type of method to be inserted before or between two methods in a sequence. This menu is the same as Add method, *see "Add method menu", page 37*.

To access:

Press **2** in the Edit sequence menu.

The sequence must contain at least one method.

Insufficient number of beakers

This message will appear when the number of beakers defined in the method sequence is greater than 126.

ION cell external Gnd

Specify in the Configuration menu if the grounding of the measuring cell takes place using an external connection to the measurement system.

This is the case when the solution is grounded via a metal shield or via a conductivity cell connected to a conductivity meter.

The following configurations will be therefore not possible:

- connecting a metal electrode to the **GND** socket of the measurement system,
- connecting a conductivity socket to the **EC** socket of the measurement system.
- connecting a double platinum electrode to the **Pt-Pt** socket of the measurement system.

If `ION cell external Gnd = Yes` and a reference electrode is connected to the **Ref.** socket of the measurement system, grounding will take place by an external link and not by the **Ref.** socket.

If `ION cell external Gnd` = No, grounding of the cell will be determined in the method by the measurement type (pH or mV) and the parameter Cell grounding (Reference/Metallic/Other).

Refer to "Cell grounding", page 55.

ISE calibration results parameters

Refer to "Results menu", page 134.

ISE calibration solutions

Refer to "Solution menu", page 151.

Iso pH

pH at which the electrode potential is no longer temperature dependant. The Iso pH is an electrode characteristic supplied with every Radiometer Analytical electrode.

Values are normally between 6.3 and 7.3 pH

Enter in:

Edit Electrode > Calibration parameters menu

Range available:

0.00 to 14.00 pH

Keyboard connection

Connect an external mini-keyboard to the ION450 via the 6-pin mini DIN port situated on the left hand side of the instrument.
Keyboard type: PCT or compatible with a 6-pin mini DIN connector.
A Notebook Keyboard Mask, part no. X31T108 indicating the keyboard functions is available for use with the mini keyboards.
Refer to "Keyboard connection - Important", page 103.

Keyboard functions

In combination with the ION450 (ION) the keys of the PC keyboard perform predefined functions. Refer to the table below.

PC keyboard	ION450 keys	ION450 operation
<Print screen>	Print	Printout data
<Esc>	Esc	Leave menus
<Pause>	Stop	Stop analysis
<Del>	Del	Deletion of a character.
Enter	Check mark	Confirmation of an entry
<Up arrow>	Up arrow	Menu lines can be scrolled
<Down arrow>	Down arrow	Menu lines can be scrolled
<Left arrow>	Left arrow	Select a window
<Right arrow>	Right arrow	Select a window
Home	-	Go to Main screen
<F1>	-	Run analysis
<F3>	-	Calibrate electrode
<F4>	-	Select method or Edit sample stack
<F6>	-	Install electrode system
<F8>	-	Direct measurement
<F10>	-	Select stirring speed-Cell menu
<F11>	-	GLP - Archives (Sample)
<F12>	Stop 3 s	Enter Setup menu

Figure 10: Keyboard functions

Keyboard connection - Important

To make sure that the ION450 complies with the requirements of the EMC Directive 89/336/EEC, the PC keyboard connected to the instrument's PS2/DIN socket must be fitted with a ferrite. This ferrite is placed as close as possible to the PS2/DIN keyboard cable plug.

All the mini keyboards supplied by Radiometer Analytical are fitted with a ferrite. This ferrite must not be removed!

If you intend to use the ION450 with a keyboard that is not supplied by Radiometer Analytical, you must make sure that the ferrite is positionned next to the PS2/DIN keyboard cable plug.

Note: the absence of the ferrite on the PC keyboard cable will not in any way impede the correct operation of the ION450.

Language

Select from English, French, German, Danish, Spanish, Italian or Swedish.

Enter in:

Setup menu > Configuration

Linear (temperature correction)

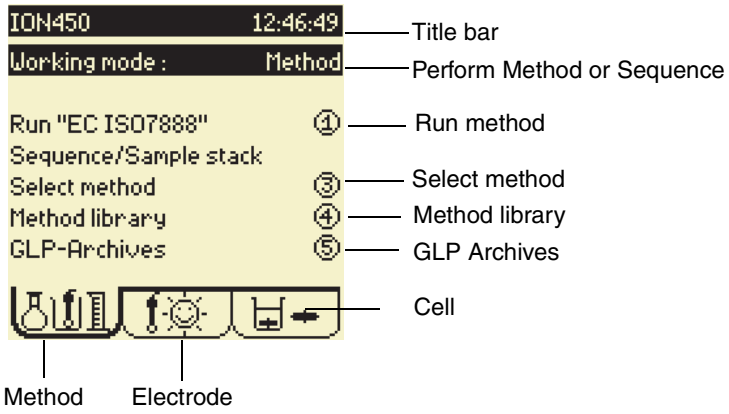
Refer to "Temp. correction None/Linear/Nat. water", page 159.

Low (result indicator)

Refer to "Result indicators", page 132.

Main window

First window to appear when the instrument is switched on:



To navigate in the window use:

- **RIGHT** and **LEFT** arrow keys, to move between the Method, Electrode and Cell windows
- **UP** and **DOWN** arrow keys allow you to select a line.
- Press ✓ to select an option (or use the corresponding numerical key).
- Press **ESC** to leave the menus without applying changes.

Mains frequency

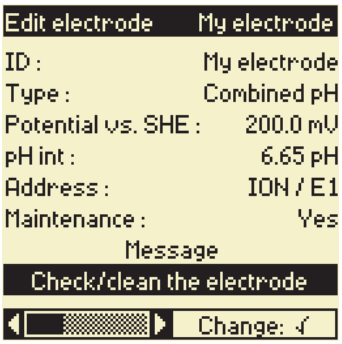
Specify the mains supply frequency (50 or 60 Hz). This selection will optimise the signal/background noise ration for your measurements.

Enter in:

Setup menu > Configuration

Maintenance

If you want a message to be displayed once a week upon starting a method, a sequence of methods or an electrode calibration with a particular electrode, select `Maintenance = Yes` and enter the message (3 lines of 32 characters maximum). This message can remind you to check or to clean an electrode.



With the electrode parameters entered above, the ION450 will display the following message when you run a method using this electrode:

Name of the electrode.

Message entered in the Edit electrode menu.

Perform the required operation and click ✓. The instrument displays the Main window. If you restart the method, the message is not displayed. The instrument will display this message again if you repeat a method using this electrode 7 days at the earliest.

Enter in:

Edit electrode menu

Manual (calibration mode)

Refer to "Calibration = Manual", page 50.

Max. stab reached

Unstable measurement. Stability has not been reached before the preset Max. Stab time.

Resume the test or end the analysis.

Max. stab time

If the stability criterion has not been fullfiled during the time entered for the Maximum stabilisation time an error message will appear. Check your electrode before repeating the measurement.

In the case of an EC/pH measurement method, stability is reached when both pH and conductivity measurement stability criteria have been fulfilled.

Enter in:

Edit method > Parameters menu
Edit electrode > Calibration parameters menu

Range available:

0 to 59:59 min:s

Measurement

Measurement type for the method.

Enter in:

Edit method menu.

Range available:

pH measurement (pH), zero-current potential measurement (mV), imposed current potential measurement (mV(i>0)).

For Measurement methods (Mode = Measurement : *see "Mode", page 112*), 3 other options are available : ISE Direct, Conductivity and EC/pH (pH and conductivity measurements are performed simultaneously in the same beaker).

If you select mV(i>0)*, connect the double platinum electrode to the* ***Pt-Pt*** *socket on the rear panel. One of the electrode's poles is connected to the ground, so it is necessary to select* `ION ext. cell Gnd = No` *in the Setup window.*

If you select Conductivity*, connect the conductivity cell to the* ***EC*** *socket on the rear panel. One of the* ***EC*** *socket pin is connected to the ground, so it is necessary to select* `ION ext. cell Gnd = No` *in the Setup window.*

Measurement method

For this method, one result is obtained after satisfaction of a user-selectable stability criterion or at the end of a preset delay.

Several measurement types are available:

- pH,
- mV,
- mV (i>0)
- Direct ISE measurements,
  see "Direct ISE measurement method - definition", page 69,
- Conductivity,
  see "Conductivity measurement method", page 59,
- EC/pH
  see "EC/pH measurement method - definition", page 76.

Method

A method, groups the parameters necessary to perform a sample analysis. The following groups of parameters exist:

Edit method parameters

Result parameters

Printout parameters

QC parameters

An electrode calibration method is defined and saved with the electrode. Call the method up using the electrode name.

The method modes available on a ION450 are:

- Measurement (pH, mV, mV(i<0), ISE Direct, Conductivity, EC/pH),
- Coupled.

*The electrode installed in the working system must also be defined as part of the method. Go to **Method parameters menu** and define the electrode used.*

Refer to "Programming method", page 126.

Method library

To access, press **4** in the Main window.

The method library comprises the following menus and commands:

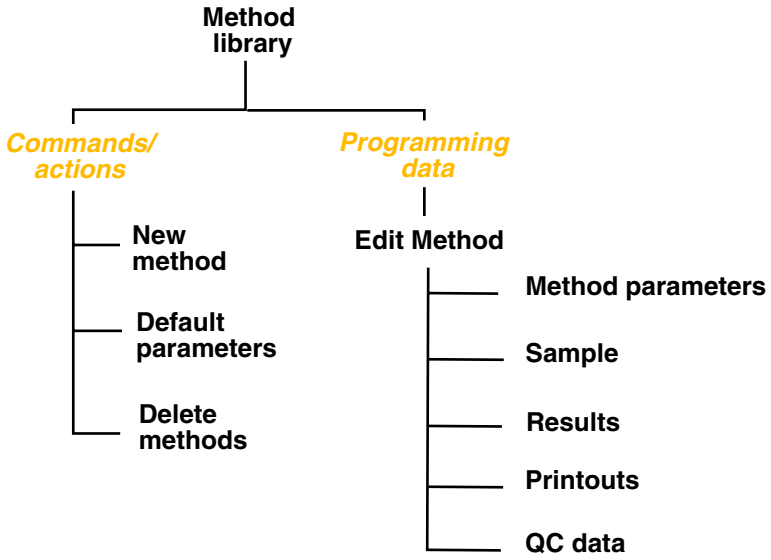


Figure 11: Method library overview

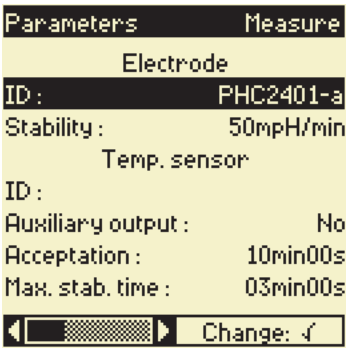
Method parameters menu

This menu contains the general parameters concerning the electrode used by the method. The method parameters necessary to run the analysis are also programmed.

Do not forget to select the electrode and temperature sensor created in this menu!

To access:

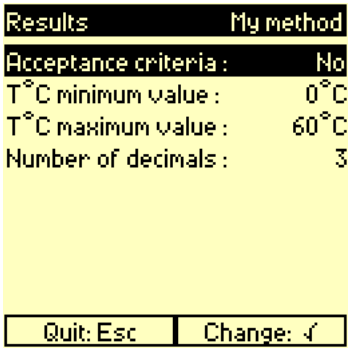
1. Press **4** in the Main window.
2. Press **2** Edit method.
3. Use arrow keys to move to last display.
4. Press **1**.



Method results menu

To access:

1. Press **4** in the Main window.
2. Press **2** Edit method.
3. Use arrow keys to move to last display.
4. Press **3** Results.



Method wrong type

This message appears at the start of a coupled method if it contains a Coupled method.

A Coupled method cannot be part of a Coupled method.

Min. cell cst - Max. cell cst

Acceptance range for the cell constant.
If the cell constant lies outside the defined range, the conductivity cell calibration must be repeated.

Enter in:

Edit electrode > Result menu (Conductivity type electrodes)

Range available:

Min. cell cst = 0.05 cm^{-1} to Max. cell cst
Max. cell cst = Min. cell cst to 15.00 cm^{-1}

Min. pH0(25) - Max. pH0(25)

Acceptance range for the zero pH.
If the zero pH lies outside the defined range, the pH calibration must be repeated.

Enter in:
Edit electrode > Result menu

Range available:
Min. pH0(25) = -9.000 pH to Max. pH0(25)
Max. pH0(25) = MIn. pH0(25) to 23.000 pH

Min. sensitivity - Max. sensitivity

Acceptance range for the electrode sensitivity. If the sensitivity lies outside the defined range, the calibration must be repeated.

Enter in:
Edit electrode > Result menu

Range available:
Min. sensitivity = 80% to Max. sensitivity
Max. sensitivity = Min. sensitivity to 110%

Min. Temp. - Max. Temp.

Acceptance range for the temperature measured in the standard solution. If the temperature lies outside the defined range the calibration is stopped.

Enter in:
Edit electrode > Result menu

Range available:
Min. Temp. = -9°C to + Max. Temp.
Max. Temp = Min. Temp. to +99°C

Minimum value - Maximum value

If the acceptance criteria option has been set to Yes, enter the acceptance range for the result. If the result lies outside these limits, a "High" or "Low" warning message appears and the result is rejected by the instrument.

Enter in:

Edit method > Results menu (Acceptance criteria = Yes)
Edit method > QC data menu

Range available:

Minimum value = 0.0 to Maximum value

Maximum value = Minimum value to 10^{10}

Unit:

Sample method: `Result unit`

In a Direct ISE measurement method, the instrument rejects all results that is higher than 10^{30} ("High" is displayed) even if you do not enter acceptation limits for the result.
In the same way, in a Direct ISE measurement method, the instrument rejects all results that is lower than the C_0 concentration ("Low" is displayed) .

Select Acceptance criteria = No in the Results menu of the method if you do not want to enter acceptance limits for the result, *see "Acceptance criteria", page 35.*

Missing beaker (SAC error)

Beaker not detected. Solve the problem and restart the sequence from the beaker it stopped (key **1** Resume analysis).

Warning!

Do not change the turntable before restarting the sequence from the beaker it stopped (key **1**) or before restarting the sequence from the next beaker (key **2**). The sample changer identifies a turntable only when a new sequence is initialized (equivalent to a keystroke on **3** `End of sequence` followed by **1** `Run sequence`).

Causes:

1. There is no beaker at the dedicated position and/or there is not enough liquid in the beaker and the beaker cannot be detected.
   Refer to "Beaker detection minimum height", page 44.
   Add solution in the beaker or desactivate the beaker automatic detection by clearing the option "Beaker detection" in TitraMaster 85 (refer to TitraMaster 85 on-line help, topics "Editing an application - Configuration").
2. Using a level, check that the sample changer is installed on a flat and horizontal bench surface.
3. If points **1** and **2** have failed, adjust the beaker detector position (refer to the User's Guide of the sample changer, chapter 6 "Maintenance").

Mode

This is the type of method used.

Enter in:

Edit method menu

Range available:

Measurement or Coupled.

Molar weight

This parameter is available when you create an ISE electrode with the From = Other option.
Refer to "Create electrode", page 63.

Range available:

0.001 to 1000 g/mol.

Nat. water (temperature correction)

Refer to "Temp. correction None/Linear/Nat. water", page 159.

Nb lines per page (printouts)

When printing page by page (*see "Format (printouts)", page 96*), this parameter sets the maximum number of lines for one printed page.

Access:

Setup Menu > Configuration

Range available:

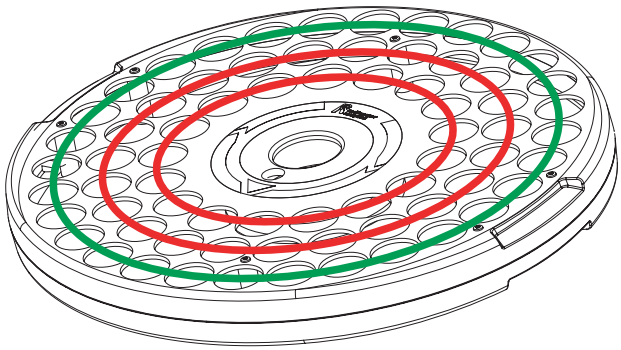
26 to 255

No stirrer (SAC error)

SAC950 Sample changer error: there is no magnetic stirring possible for the beaker position mentionned.

When using a 2 or 3-radii turntable with a SAC950, you must use a propeller stirrer to stir the solutions that are placed on the smallest row (2-radii turntable) or on the 2 smallest rows (3-radii turntable).

Green positions : magnetic and propeller stirring possible
Red positions : propeller stirring only



Connect a propeller stirrer to the sample changer. *Refer to the Sample Changer User's Guide, part no. D21T085.*
You can also edit a sample stack in order to use a 1-radius turntable or to use only the largest row of a mutil-radii turntable. In this case, the magnetic stirring is possible. *Refer to "Sample stack", page 145*.

None (temperature correction)

Refer to "Temp. correction None/Linear/Nat. water", page 159.

Notification message

Select `Notification = Yes` if you want to a message to be displayed on starting a measurement method. Type the message (3 lines of 1 to 32 alphanumerical characters).

Enter in:
Edit method menu

Number of buffers

Available if Calibration request = Fixed or Free

Number of pH standards to be used for the calibration. Work with at least two standards to calculate the electrode sensitivity. If one standard is used only the zero pH is calculated.

Enter in:
Edit electrode menu

Range available:
1 to 5
Refer to "pH buffer", page 118.

Number of cycles

Available if Calibration request = Fixed or Free (pH electrode or conductivity cell). Available if Calibration = Manual (ISE electrode)

Number of times the calibration is to be repeated, i.e. the number of beakers to be prepared for each pH, conductivity or ISE standard.

Enter in:
Edit electrode menu

Range available:
1 to 9

Number of decimals

Number of decimals (0 to 3) to be displayed and printed for the result.

Enter in:
Edit method > Results (for a pH measurement method)

Number of digits

Number of significant digits (1 to 5) to be displayed and printed for the result calculated.

Example: If Number of digits = 4:

- 1456.1 is displayed “1456”
- 12.124 is displayed “12.12”
- 0.15872 is displayed “0.1587” (the first significant digit is “1”)
- 0.4 is displayed “0.4000” (the first significant digit is “4”)

Enter in:
Edit method > Results (for ISE measurement methods)

Number of dynamic rinses

If a SAC850 or SAC950 Sample Changer is in use, enter the desired number of dynamic rinses to be carried out before each beaker analysis of a SAC sequence, *see also "Dynamic rinses", page 74*.

Enter in:
Setup menu > Configuration

Range available:
0 to 9

Number of solutions

Available for an ISE electrode if Calibration = Manual

Number of ISE standards to be used for the ISE electrode calibration.
Work with at least 3 standards to calculate the electrode C_0 concentration which represents the experimental detection limit of the ISE electrode regarding the ion under study.
Work with at least two standards to calculate the electrode sensitivity. If only one standard is used, only the E^0 electrode standard potential will be calculated.
Refer to "Direct ISE measurement method - definition", page 69.

Enter in:
Edit electrode menu (ISE electrode)

Range available:
1 to 9.

Number of static rinses

If a Sample Changer is in use, enter the desired number of static rinses to be carried out before each sample run of a SAC sequence.

During a static rinse, the electrodes are dipped for a time (selectable between 0 and 30:59 min:s, *see "Rinse time", page 135*) into a beaker filled up with a rinse or conditioning solution.

These rinse beakers are located:

- on the 1, 2 or 3 last positions of the SAC80 turntable,
- on the RINSE 1, RINSE 2 or RINSE 3 dedicated rinse positions of a SAC90 tray,
- on the last 1 or 2 available positions of the SAC850 tray,
- on the 1 or 2 dedicated rinse positions of the SAC950 reconditionning beakers extension.

Enter in:

Setup menu > Configuration

Range available:

- 0, 1, 2 for a SAC850 or SAC950.
  If you have allowed the dynamic rinses to occur in previous beaker except 1st in Rinse 2, then only one beaker will remain available for static rinses (Rinse1 beaker). *Refer to "Dyn. rinse", page 73*.
- 0, 1, 2 or 3 for a SAC80/SAC90

Refer to User's Guide of the sample changer used (part no.: D21T002 for a SAC90, D21T013 for a SAC80, D21T085 for a SAC850 or SAC950).

Number of tests

This is the number of times you wish to repeat the method on the same sample. The method will be repeated in a new beaker. If the method is part of a coupled method the number entered here will not be taken into account. It will be the number of tests entered in the Coupled method parameters that will be used.

Enter in:

Edit method menu.

Range available:

1 to 99.

OK (result indicator)

Refer to "Result indicators", page 132.

Others list

Choice enabling you to enter electrodes other than those from Radiometer Analytical.

Parameters menu

For a sample method, *see "Method parameters menu", page 108*.

For an electrode calibration method,
see "Electrode calibration parameters", page 87.

PC cable - A95X501

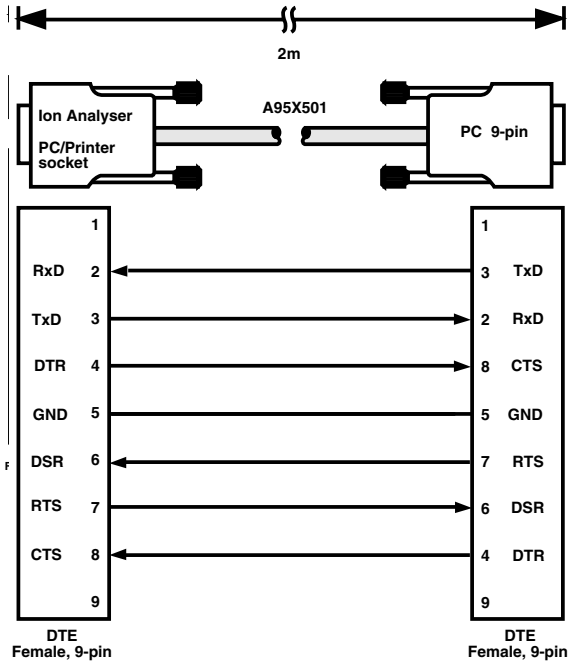


Figure 12: PC cable, A95X501

PC connection

Connect the PC serial port to the **PC/Printer** socket of the ION450 using the cable, part no. A95X501.

Refer to "PC cable - A95X501", page 117.

PC keyboard

Specify the PC keyboard in use. For example, English (US) for a Qwerty keyboard.

Enter in:

Setup menu > Configuration

Range available:

English (US), French, German, Spanish, Italian, Danish, Swedish.

Periodicity

Available if Calibration request = Fixed or Free (pH electrode or conductivity cell). Available if Calibration = Manual (ISE electrode)

Maximum period of time between two calibrations. If the period of time is exceeded, measurements can no longer be performed using this electrode. A new calibration is required except if `Alarm : Unlocked` has been set in the Setup > Access Routine mode menu.

Enter in:

Edit electrode menu

Range available:

1 to 999 days

Periodicity for QC samples

This is the number of samples to be placed between two successive QC samples. When this number is reached, a QC analysis must be run using this method except if `Alarm : Unlocked` has been set in the Setup > Access Routine mode menu.

Enter in:

QC data menu

Range available:

1 to 999 samples

pH0(25)

This is the pH of the solution at 25°C at which the measured electrode potential is equal to zero. The potential developed depends on both electrodes; the reference and the glass. These potentials may vary to bring about an electrode drift. This drift can be compensated by frequent calibrations.

Normally the following ranges are used by default (6.850 pH and 7.200 pH)

Enter in:

Edit electrode > Results

Range available:

pH(0)25 min. = -9.000 pH to pH0(25) max.

pH0(25) max. = pH0(25) min. to 23.000 pH

pH buffer

Refer to "Solution menu", page 151.

pH int

This parameter is available when creating a single or a combined pH electrode with the option `From = Other`.
Refer to "Create electrode", page 63.

This is the internal pH of a single or combined pH electrode.
The pH int is used for the buffer recognition.
The table below gives the pH int of Radiometer Analytical pH electrodes:

Electrode	pH int
PHG301, PHG311, XG100, XG200, XG250	6.06 pH
PHG201, PHG311	6.65 pH
PHC2001, PHC2011, PHC2085,PHC2401, PHC2501, PHC2601, PHC3001, PHC3011, PHC3081, PHC3185, XC100, XC111, XC120, XC161	6,65 pH
PHC4000	6.80 pH

Table 6: pH int of Radiometer Analytical electrodes

Range available:
0.00 to 14.00 pH

Potential versus SHE

This parameter is available when creating a reference or a combined electrode with the option `From = Other`.
Refer to "Create electrode", page 63.

This parameter enables you to calibrate electrodes with automatic buffer checking using any kind of reference electrodes (for example with a mercurous sulphate electrode Hg/Hg2SO4 (Sat. K2SO4)). You just need to know the potential of the reference electrode versus the Standard Hydrogen Electrode.

This potential is taken into account in the buffer recognition algorithm and for pH calculation when no calibration is performed. When you create a reference or a combined electrode with the option `From = Catalogue`, the instrument calculates pH using the potential versus SHE stored in memory for the reference electrode selected. In this case, potential versus SHE cannot be changed.
The table below gives the potential at 25°C versus the SHE (E SHE) of a few "reference elements/filling solution" couples.

Reference element and filling solution	E SHE (mV)	Radiometer Analytical Reference electrodes
Hg/Hg_2Cl_2 – Sat. KCl SCE: Saturated Calomel Electrode	+244	pHC4000, pHC4001, pHC4006, XC601, REF401, REF421, REF451, XR100, XR110, XR130, XR150, MC408PtREF401, REF421, PHC4000
Hg/Hg_2Cl_2 – 1M LiCl	+280	REF921
Hg/Hg_2SO_4 - Saturated K_2SO_4	+651	REF601, REF621, XR200, XR230, MC602Pt, MC6091Ag
Hg/Hg_2SO_4 - 1 M H_2SO_4	+616	
Hg/HgO - 0.1 M KOH	+174	XR400, XR430, XR440
Ag/AgCl - Saturated KCl	+199	XR300, XR820, XC100, XC111, XC120, XC161, XC200, XC250
Ag/AgCl - 3 M KCl	+208	pHC3001, pHC3005, pHC3006, pHC3011, pHC3081, pHC3185, REF321, REF361, MC3051Pt, ISEC301F
Ag/AgCl - 1 M KCl	+235	
Ag/AgCl - 0.6 M KCl (sea water)	+250	
Red Rod - Saturated KCl	+199	pHC2001, pHC2002, pHC2003, pHC2005, pHC2011, pHC2015, pHC2051, pHC2085, pHC2401, pHC2441, pHC2501, pHC2601, pHC2701, REF200, REF201, REF251, REF261, MC2095Sb,MC201Au-8

Table 7: Reference electrode potentials versus SHE

Range available:
0.0 mV to +1000.0 mV

Preprogrammed list

Ready-to use list of methods and electrodes which have been programmed in the ION450 during manufacturing. This list cannot be deleted nor modified.

These lists can be used to create methods or electrodes or using the copy command, and store them in the user list.

Printer

Declare a printer:
Refer to "Printouts setup", page 125.

Connect a printer:
Refer to "Printer connection", page 123.

Printouts parameters:
Refer to "Printouts menu", page 125.
Refer to "Printouts title", page 125.
Refer to "Printouts detailed", page 124.

Contents of a printout:
Refer to "Printouts", page 124.

Printer cables - A95P201, A95X506

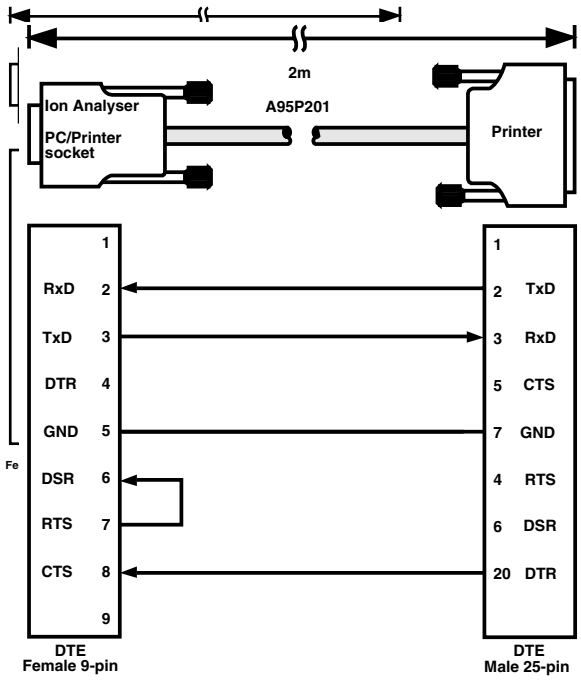


Figure 13: Printer cable, A95P201

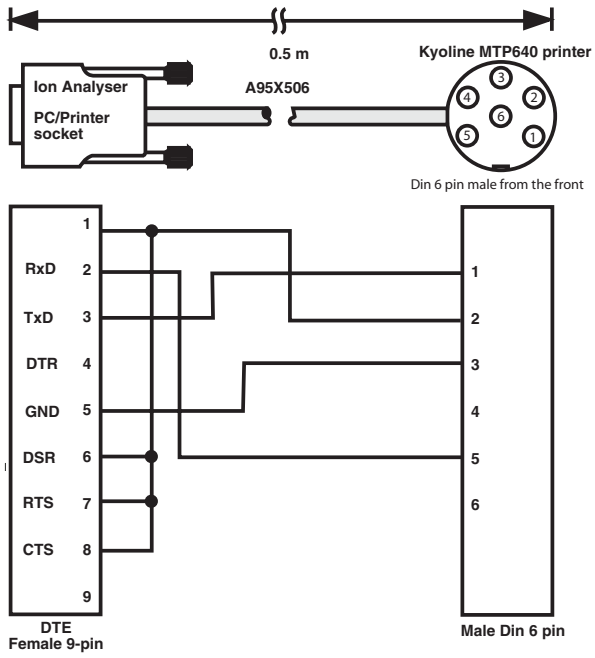


Figure 14: Printer cable, A95X506

Printer connection

Connect the printer to the **PC/Printer** socket on the rear panel using the cable, 9-25 pin, part no. A95P201.

The printer must have the following characteristics for connection to the ION450.

- 80 characters,
- RS232C interface,
- 9600 baud, no parity, 8 data bits, 1 stop bit,
- Flux control via the DTR line (pin 20 on the 25-pin plug),
- Printout of tables,
- IBM fonts; character sets.

To connect the Kyoline MTP640 Thermal Pocket Printer, part no. A70P020 (230 V), A70P021 (115 V), use the cable 5-9 pin, part no. A95X506.
For use with an ION450, the dip-switch of the Kyoline MTP640 Thermal Pocket Printer should be set as follows:

SW no.	1	2	3	4	5	6	7	8
Setting	On	On	Off	Off	On	Off	On	Off

Table 8: Dip switch setting of the Kyoline MTP640 Thermal Pocket Printer

Refer to "Printer cables - A95P201, A95X506", page 122.

Print in table

If you have defined a printer in the Setup > Configuration menu, select for `Print in table` if you want to print all the sequence results in a table (one line per method) or to print the results method by method (one frame per method).

Refer to "Programming sequence", page 127.

Access:

Menu Sequence/Sample stack

Printouts

Printouts can be initiated automatically at the end of a test or manually by pressing key **Print** from the following data screens:

- Main window: list of available methods.
- Electrode window: list of available electrodes.
- Edit method menu: list of method parameters.
- Edit electrode menu: list of electrode parameters.
- GLP - Archives (methods) menu: sample results.
- GLP - Archives (electrodes) menu: electrode calibration results.
- Sequence/Sample stack menu: sample stack of the sequence (for each beaker: method type and ID, beaker number and ID).
- Beaker menu (while preparing an electrode calibration stack): calibration stack (for each beaker: buffer ID and batch number, beaker number).

Automatic printouts

They contain the following information:

- **Header**: information entered in the Setup > Customise menu with the instrument serial number and the date and time of analysis.
- **Title of report**: entered in Printouts menu, during method with the method name (ID).
- **Analysis ID**: User ID and Sample ID entered at the start of the analysis.
- **Footnote**: appears automatically at the end of printouts.
- **Calibration data (if relevant)**: electrode used to perform the measurement.
- **The calibration curve E = f(pC) of an ISE electrode** (if programmed in the Printouts menu of the calibration method).
- **Measurement results**: obtained at the end of the analysis and an analysis counting number.

In automatic mode, the printout format depend on the High/Medium/Low option selected for the Detailed parameter. *Refer to "Detailed", page 68.*

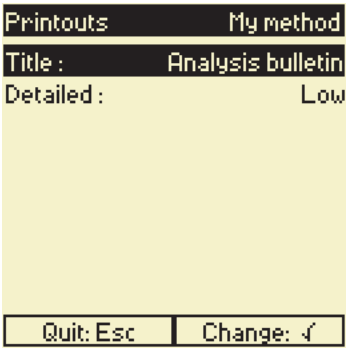
Printouts detailed

Refer to "Detailed", page 68.

Printouts menu

To access:

- **Method**: Method library > Edit method > Printouts (key **4)**.
- **Electrode**: Electrode library > Edit electrode > Printouts (key **4**).



Printouts setup

Perform the following, before printing:

1. Connect the printer to the ION450.
2. Enter the Setup menu (**Stop**, 3 seconds from the Main window).
3. Press **1** Configuration.
4. Select `Printer = 80 columns`.
5. Select the printout format (Listing or Page by Page).
   Refer to "Format (printouts)", page 96.
6. Press **Esc** then **3** to customise the printouts, e.g. enter instrument name.
7. In the Edit method > Printouts and Edit electrode > Printouts menus, define the contents of the printouts. The Detailed = High/Medium/Low option set the amount of information that will be printed automatically at the end of each test.
   Refer to "Detailed", page 68.
8. In the Edit electrode > Printouts menu of an ISE electrode calibration method, select whether you want to print or not the calibration curve (E = f(pC = -log C)). This curve will be printed automaticaly at the end of each calibration cycle.
   Refer to "Calibration curve of an ISE electrode", page 51.

Printouts title

Title of the report printout (1 to 23 characters).

Enter in:

Edit method > Printouts

Edit electrode > Printouts

Programming method

1. Check or create the electrode(s) to be used by the method.
2. Finally, create the method, which will consequently use the electrode(s) created in the first step of programming.
3. In the Main window, select `Working mode` = `Method` or `SAC Method`, whether you want to run a single method without Sample Changer or a single method to be used with a Sample Changer.

Only the Supervisor is allowed to program the methods. Once you have finished programming, make sure that NO question mark "?" is displayed in the Electrode tab!

*If "?" is displayed in the Electrode tabs, press **1** in the Main window to check the method. The instrument indicates the possible errors and prompts you to correct them, until "**?**" disappears.*

Refer to "Programming methods", page 23.

Programming sequence

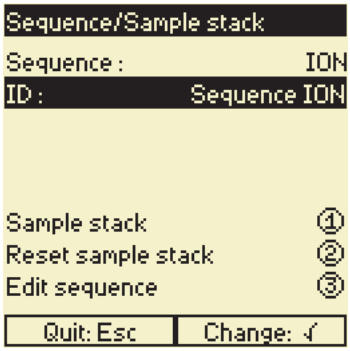
1. Start by programming each method that will be used in the sequence, *see "Programming method", page 126*.
2. *If you are using a Sample Changer only:*
   In the Configuration menu, declare the model of sample changer used (SAC80, SAC90, SAC850 or SAC950). Depending on the model of sample changer used, enter the sample changer configuration parameters. *Refer to "Sample changer", page 142*.
3. In the Main window, select:

- `Working mode = SAC Sequence`, for automatic sample handling using a sample changer.

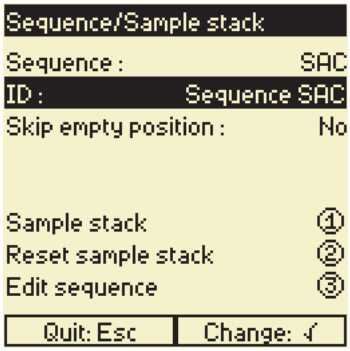
or

- `Working mode = Sequence` for manual sample handling.

4. Press **2** in the Main window.



In Sequence mode



In SAC Sequence mode

5. At the line `ID`, enter a name for the sequence.
6. In a SAC Sequence, for `Skip empty position`, select whether you want or not the sample changer to skip to the next beaker if an empty position is found. If you answer No, 3 options are offered if an empty position is found: restart the analysis in the same beaker, skip to the next beaker or end the analysis.
   Refer to "Skip empty position", page 150.
7. If you have defined a printer in the Setup > Configuration menu, select for `Print in table`, if you want to print all the sequence results in a table (one line per method) or to print the results method by method (one frame per method).
8. Press **3** Edit sequence then edit the sequence.
   see "Edit sequence menu", page 80.
9. Press **1** Sample stack then edit the sample stack, *see "Sample stack", page 145*.

Refer to "Programming ION sequences", page 27.
Refer to "Programming SAC sequences", page 29.

QC (result indicator)

Refer to "Result indicators", page 132.

QC analysis required

This message is displayed at the start of a method requiring a QC sample.

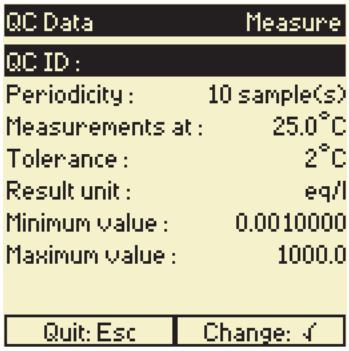
Press ✓ and run a QC analysis.

QC data menu

This menu is available for all measurement methods.

To access:

1. Enter the Main window.
2. Select or create a method.
3. Select `QC sample = Yes` in the Edit method menu.
4. Use the **LEFT/RIGHT** arrow keys to move to the last Edit method display.
5. Press **5** QC data.



QC ID

Enter the name of the QC sample (16 alphanumeric characters). This name is called up when you run a QC sample analysis.

QC not required

Message appears at the start of a sequence, that originally included a method programmed with a QC sample.

The method to has now been reprogrammed without QC sample.

Go to Sequence/Sample stack, Edit sequence screen and remove the QC sample from the sequence.

QC periodicity elapsed

This message is displayed at the start of a method requiring a QC sample. The Periodicity, entered in the QC Data screen of the method has elapsed. For example, if Periodicity = 10 samples, then a QC sample must be performed every 10 samples.

Press ✓ and run a QC analysis.

QC sample

Quality control (QC) samples are used as a means of studying the variation within and between batches of a particular analysis. A typical QC sample will be stable, homogenous, typical in composition to the types of sample normally examined. The concentration of a QC sample is known accurately and its composition is as close as possible to one of the samples to be analysed.

Quality control samples can be used for all measurement methods.

QC sample (Yes/No)

Select Yes for QC sample if you wish to perform measurements on QC samples.

The QC sample ID, the periodicity of QC samples and the minimum and maximum acceptance limits for the control test are entered in the QC data menu.

If the QC test fails, the method can be locked, so that it is impossible to run the method while the QC sample results lie outside the preset limits.

Enter in:

Edit method menu

Ref. electrode conflict

Two reference electrodes are being used in the same beaker.

Change one of the reference electrodes in the electrode system.

Reference Temp.

Refer to "Temp. correction None/Linear/Nat. water", page 159.

Reject a result

Refer to "Result accepted (Yes/No)", page 131.

Remove method from a sequence

1. Select the sequence.
2. Press **3** Edit sequence.
3. Select the method to be removed using the **LEFT/RIGHT** arrow keys.
4. Press **3**.
5. Press **1** Remove method.

The method is removed from the sequence but is not deleted.

Replace electrodes

Use this procedure to replace an electrode with another one of the same type and ID.

Proceed as follows:

1. Select the method/sequence using the electrode.
2. Press **2** in the Electrode window.
3. Press **3** Replace electrode.
4. Select the electrode to be replaced. The ID list contains all the electrodes connected.
5. Disconnect electrode and press ✓ to confirm.
6. Connect the new electrode at the address indicated.
7. Enter the serial number and confirm.

Reset memory

An internal error has occurred. Press ✓. The ION450 resets the parameters to default settings. The method and electrode lists are reset to the preprogrammed list. All the results are lost.

Reset to factory settings

Use this command to restore the method and electrode menus to factory settings. The method and electrode user lists are reset to the preprogrammed lists.

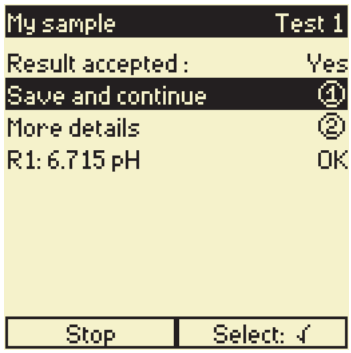
A reset to factory settings is equivalent to a memory reset and all the results and user entered methods are deleted.

Press **4** in the Setup menu and confirm the reset.

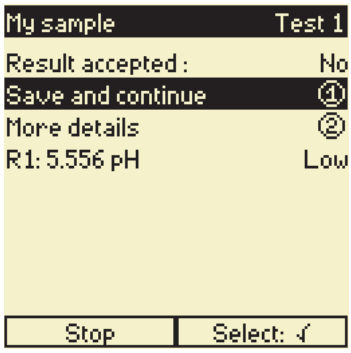
Result accepted (Yes/No)

A result is automatically accepted by the instrument if it lies within the minimum/maximum acceptation limits set. The user can then decide to keep the result or reject it.

A result will be automatically rejected by the instrument if it lies outside these limits. The user (at the Supervisor level only) can then decide to accept the result or to reject it.



Result accepted by the instrument.



Result rejected by the instrument.

To accept a result accepted by the instrument:

At the end of the run, press **1** Save and continue.

To reject a result accepted by the instrument:

At the end of the run, press **2** More info and select `Accept result: No`. Press **1** Back then **1** again Save and continue.

To accept a result rejected by the instrument (Supervisor only):

At the end of the run, press **2** More info and select `Accept result: Yes`. Press **1** Back then **1** again Save and continue.

To reject a result rejected by the instrument:

At the end of the run, press **1** Save and continue.

A rejected result is stored in the GLP-Archives but is not used for mean and standard deviation calculations.

Result indicators

Appear with the result at the end of a run.

- OK: accepted by the instrument (result lies within the acceptance limits).
- Low: alarm, rejected by the instrument (result lies below the acceptance limit or below the C_o blank concentration in the case of an ISE Direct measurement method).
- High: alarm, rejected by the instrument (result lies above the acceptance limit or above 10^{30} in the case of an ISE Direct measurement method).
- Time max: the measurement has been accepted at the end of the Acceptance delay.
- QC: the user has bypassed a QC sample analysis demand.

You can reject a result that was accepted by the instrument. You can accept a result that was rejected by the instrument (Supervisor users only).
Refer to "Result accepted (Yes/No)", page 131.

Result unit

Unit used for the result.

Enter in:

Edit method > Results (ISE Direct measurement method)

Range available:

eq/l, meq/l, mol/l, mmol/l, g/l, mg/l, mg/ml, µg/ml, % (m/v) or ppm (m/v)

Warning!
In an ISE Direct method, the ppm and % units are expressed in weight/volume.
Nevertheless, if the standard solution has been prepared in % or ppm (weight/weight), the % or ppm result will be in weight/weight.
You can also use the Results factor to convert in % or ppm (weight/weight) a result obtained in % or ppm (weight/volume).
Refer to "Results factor (Yes/No)", page 134.

Results

The following results are displayed automatically at the end of a run.

pH calibration

Mean of zero pH (pH0(25))

Mean of sensitivity

ISE calibration

Mean of E0

Mean of sensitivity

Mean of Co detection limit concentration

Conductivity cell calibration

Mean of cell constant

Measurement method

Measurement

Mean ± standard deviation

Results can be accepted or rejected at the end of each test performed, *see "Result accepted (Yes/No)", page 131*.

Results factor (Yes/No)

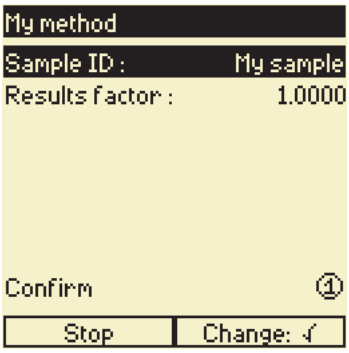
This multiplying factor is applied to the method result.

Access:

Edit method > Results (ISE direct measurement method)

Proceed as follows to multiply the method result by a factor:

- In the method Results menu, select `Results factor = Yes`.
- Run the method:



Enter the results factor (from 0.001 to 10 000) then press **1** to start the method.

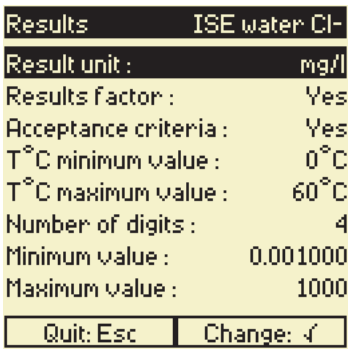
There is no results factor for an electrode calibration method.

Results menu

This menu displays the result identification parameters and acceptance criteria required to run a sample method or an electrode calibration.

To access:

- **Method**: Method library > Edit method > Results (key **3)**.
- **Electrodes**: Electrode library > Edit electrode > Results (key **3**).



The Results menu for an ISE direct measurement method

Rinse aux. output

Option available when sample changer in use.

This command will set the auxiliary signal on during a programmed rinse.

Enter in:

Setup > Configuration menu

Range available:

No, 5 V, or 12 V

Rinse time

When a Sample Changer is in use enter the time (in minutes and seconds) the electrodes should be immersed in each static rinse beaker. *Refer to "Number of static rinses", page 116*.

Enter in:

Setup menu > Configuration (if `Sample changer` = `SAC80`, `SAC90`, `SAC850` or `SAC950`)

Range available:

00:00 to 30:59 min:s

Routine mode

In **“ROUTINE”** mode the user is able to select and run methods. Clear-text messages and icons present on the large graphic display guide the user at every step. However, the routine user cannot create or modify methods or electrodes.

Refer to "User’s rights", page 164.

Run window

Follow the measurements on this window when an analysis is in progress. The displayed information depends on the type of method which is running.

Enter in:

Run an analysis. *Refer to "Running a method", page 138*.

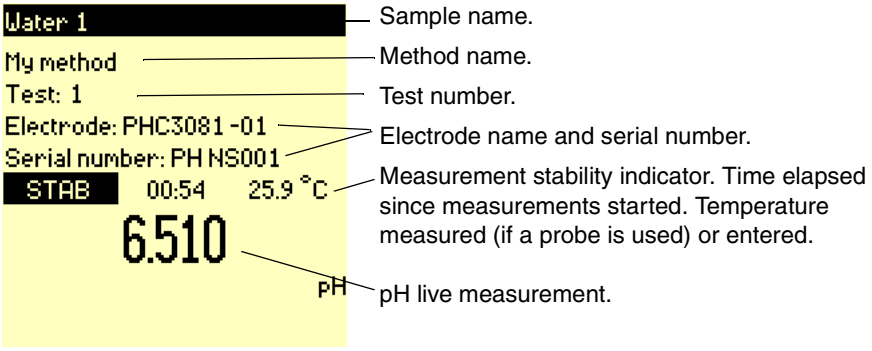


Figure 15: Run window of a Measurement method (pH)

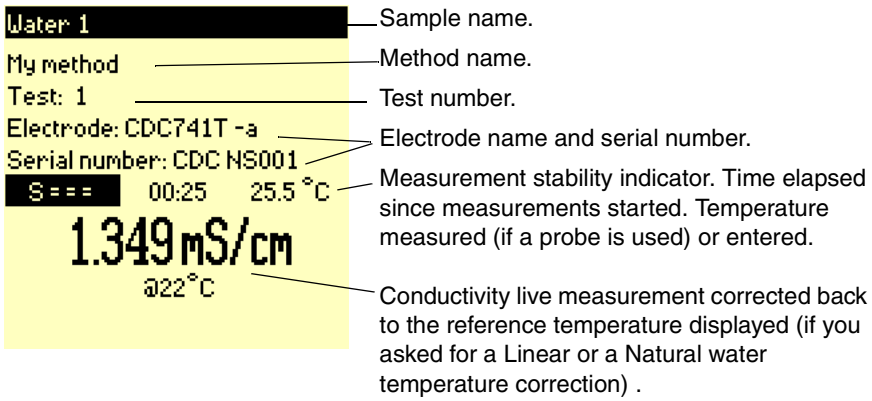


Figure 16: Run window of a Measurement method (Conductivity)

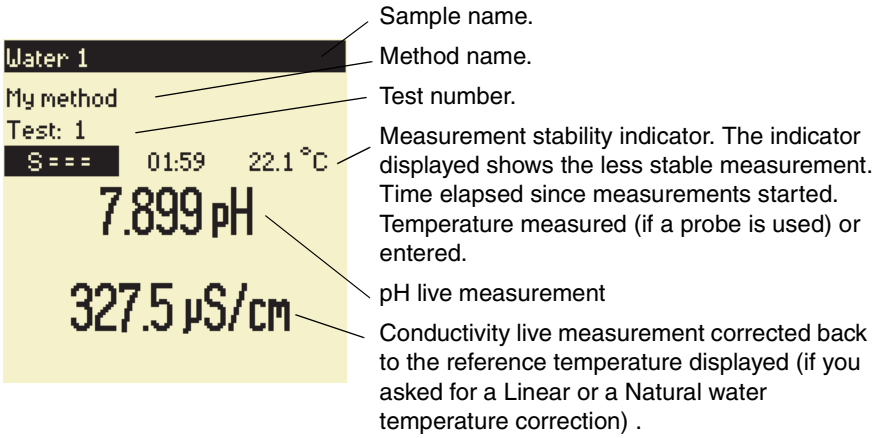


Figure 17: Run window of a Measurement method (EC/pH)

Refer to "Run window (continued)", page 137.

Run window (continued)

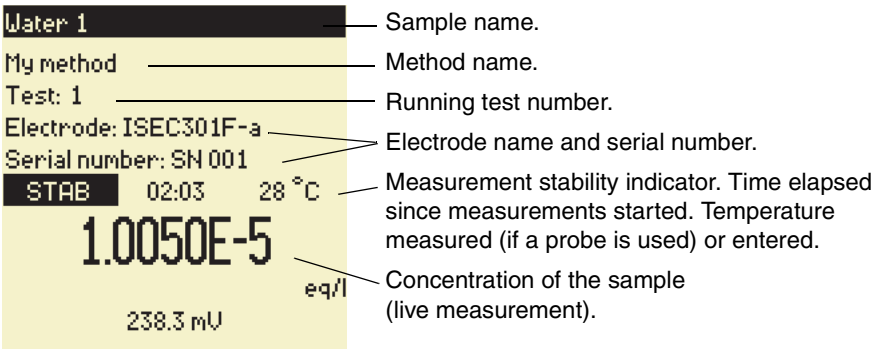


Figure 18: Run window of a Measurement method (ISE Direct)

Running a method

1. Select method.
   Refer to "Select method", page 146.
2. If a Question mark "?" is present in the Electrode tab, it means that the method needs to be programmed - an electrode is missing. Review programming in Supervisor mode. *Refer to "Programming method", page 126*.

   If you have a problem running the analysis, the ION450 will guide you through the necessary operations so that you are able to run the analysis in no time at all.
3. Connect/calibrate the electrode(s).
   Refer to "Electrode connection", page 89.

   To calibrate a pH electrode
   see "Electrode calibration (Fixed mode, pH electrode)", page 84,
   see "Electrode calibration (Free mode, pH electrode)", page 85.

   To calibrate an ion selective electrode (ISE),
   see "Electrode calibration (ISE)", page 83.

   To calibrate a conductivity cell,
   see "Electrode calibration (Fixed mode, conductivity cell)", page 81,
   see "Electrode calibration (Free mode, conductivity cell)", page 82.

   To run a calibration sequence (pH or ISE electrode, conductivity cell),
   see "Electrode calibration (SAC sequence)", page 86.
4. When a Sunny icon is visible in the Electrode tab, press **1** in the Main window to run the method.
   Refer to "Electrode icons", page 91.
5. If prompted to do so, enter the User's name (ID) and press **1**.
6. Enter the Sample name (ID) and press **1**.
7. Dip the electrodes into the sample beaker and press **1** to continue.

For the following steps:
Refer to "Run window", page 136.

Running a SAC sequence

1. Select SAC sequence, *see "Select sequence", page 146*.
2. If a Question mark "?" is present in the Electrode tab, it means that the sequence needs to be programmed - an electrode is missing. Review programming in Supervisor mode.
   If necessary, edit the sequence, *see "Programming sequence", page 127*.
3. Install the sample changer and connect it to the **SAC** socket of the ION450 using the cable, part no. A95A202 or A95X501.
   Refer to the User's Guide of the sample changer (part no.: D21T002 for a SAC90, D21T013 for a SAC80 or D21T085 for a SAC850/SAC950).
4. Connect/check the electrode(s).
   Refer to "Electrode connection", page 89.
5. Prepare the sample stack. *Refer to "Sample stack", page 145*.
6. Press **1** in the Main window to run the sequence from the first beaker of the sample stack.
7. If prompted to do so, enter the User's name (ID) and press **1**.
8. The sample changer cycle is initiated.
   - 1 to 9 dynamic rinses (if programmed with a SAC850/SAC950)
   - 1 to 3 static rinses (if programmed).
   - Electrodes are dipped into the first beaker. Measurement starts.
   - Between each sample tests (beakers), 1 to 9 dynamic rinses (if programmed with a SAC850/SAC950) then 1 to 3 static rinses are performed (if programmed to do so).
9. At the end, the ION450 displays the mean result and standard deviation calculated for all accepted tests.

When running a sequence with a SAC80 Sample Changer, do not use the STOP key of the SAC80.

See also "Electrode calibration (SAC sequence)", page 86.

Running an ION sequence

1. Select sequence, *see "Select sequence", page 146*.
2. If a Question mark "?" is present in the Electrode tab, it means that the method needs to be programmed - an electrode is missing. Review programming in Supervisor mode.
3. Connect/calibrate the electrode(s).
Refer to "Electrode connection", page 89.
4. Prepare the sample stack.
Refer to "Sample stack", page 145.
5. When a Sunny icon is visible in the Electrode tab, press **1** in the Main window to run the sequence from the first beaker of the sample stack.

If you have a problem running the analysis, the ION450 will guide you through the necessary operations so that you are able to run the analysis in no time at all.

For the following steps:

Refer to "Run window", page 136.

SAC80/SAC90/ SAC850/SAC950

Define and connect a sample changer:
Refer to "Sample changer", page 142.

Edit a sequence with a sample changer:
Refer to "Programming sequence", page 127.

Select a sequence with a sample changer:
Refer to "Select sequence", page 146.

Run a sequence with sample changer:
Refer to "Running a SAC sequence", page 139.

SAC arm obstructed (SAC error)

The arm has been blocked and or cannot function properly. Remove the obstruction and press `Resume analysis` (key **1**) to continue the sequence from the point it stopped.

SAC ext. cell GND

If a Sample Changer is in use, specify if the grounding of the measuring cell takes place using an external connection to the SAC80 or SAC90. This is the case when a solution is grounded using a metal shield or via a conductivity cell connected to a conductivity meter.

SAC Method

Refer to "Working mode", page 165.

SAC option missing (SAC error)

Sample changer error: The SAC option addressed is missing and not installed on the sample changer.

Examples:

- Dynamic rinses are programmed in the sequence and no dynamic rinse module is installed and the sample changer.
  Review the Setup > Configuration parameters and/or install missing pump (in particular, check the electrical connection between the pump and the sample changer).
- A reagent addition is programmed in the sample preparation and no peristaltic pump is installed on the sample changer.
  Review the Edit sequence parameters, parameter Sample preparation no. and/or install missing peristaltic pump (in particular, check the electrical connection between the pump and the sample changer).
  For TitraMaster 85 users only, check and, if necessary, edit the sample preparation routine.
  Refer to "Sample preparation no.", page 144.

SAC Sequence

Refer to "Working mode", page 165.
Refer to "Sequence/SAC sequence", page 148.

SAC switch Off/ On (SAC error)

Either the data transmission between sample changer and the ION450 cannot be performed properly, in which case you should check the cable connections, or the measurement stopped due to a movement error.

End the sequence by pressing key **Stop** on the sample changer keypad or key **Stop** of the ION450, and check that nothing is obstructing sample changer movements.

Same buffer change buffer

This message appears at the start of an pH electrode calibration in *Fixed* mode (*see "Calibration request = Fixed", page 52*). The same buffer has been programmed for 2 successive steps in the calibration procedure.

Press ✓ and change one of the buffer values in the Solutions menu of the electrode calibration method.

This message can also appear during a pH electrode calibration in *Free* mode (*see "Calibration request = Free", page 53*) if the difference of potential measured between 2 successive calibration beaker does not exceed 10 mV. Chek the buffers and start a new calibration cycle or end the analysis.

Sample changer

To automate your entire analysis procedure (up to 126 samples in one go), the SAC80, SAC90, SAC850 or SAC950 sample changers can be connected to the **SAC** socket of the ION450 using the cable, part no. A95A202 (SAC80/SAC90) or A95X501 (SAC850/SAC950).
Refer to "Sample changer cable - A95A202 (SAC80/SAC90)", page 143.
Refer to "Sample changer cable - A95X501 (SAC850/SAC950)", page 143.

When using a sample changer, you have to indicate to the ION450 which model is used.

Enter in:
Setup menu > Configuration

Range available:
SAC80, SAC90, SAC850, SAC950, No

Depending on the sample changer used, you have to enter other configuration parameters:

- **For a SAC80 or SAC90:**
  Number of rinses, *see "Number of static rinses", page 116*,
  Duration of a rinse, *see "Rinse time", page 135*.
- **For a SAC850 or SAC950:**
  Automatic detection of beakers, *see "Beaker detection", page 43*,
  Number of rinses, *see "Number of static rinses", page 116*,
  Duration of a rinse, *see "Rinse time", page 135*.
  Number of dynamic rinses, *see "Dynamic rinses", page 74*,
  Location of dynamic rinses, *see "Dyn. rinse", page 73*,
  Sequence end in Park, *see "Sequence end in Park (Yes/No)", page 149*.

See also:
Edit a sequence with a sample changer:
Refer to "Programming sequence", page 127.

Select a sequence with a sample changer:
Refer to "Select sequence", page 146.

Run a sequence with sample changer:
Refer to "Running a SAC sequence", page 139.

Sample changer cable - A95A202 (SAC80/SAC90)

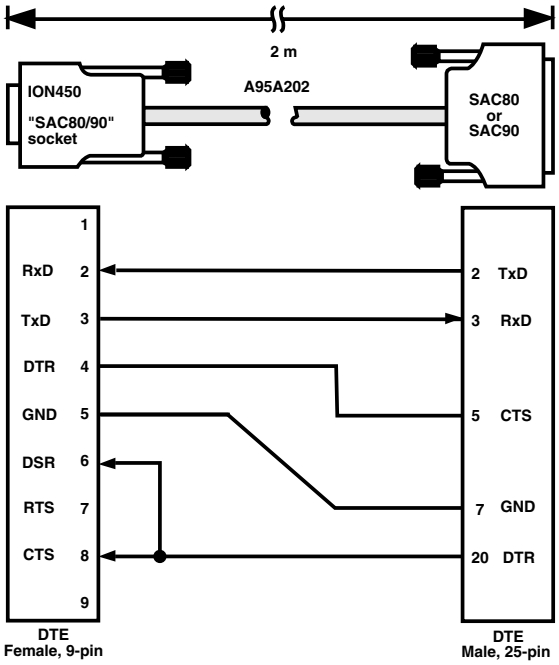


Figure 19: SAC80/SAC90 Sample changer cable, A95A202

Sample changer cable - A95X501 (SAC850/ SAC950)

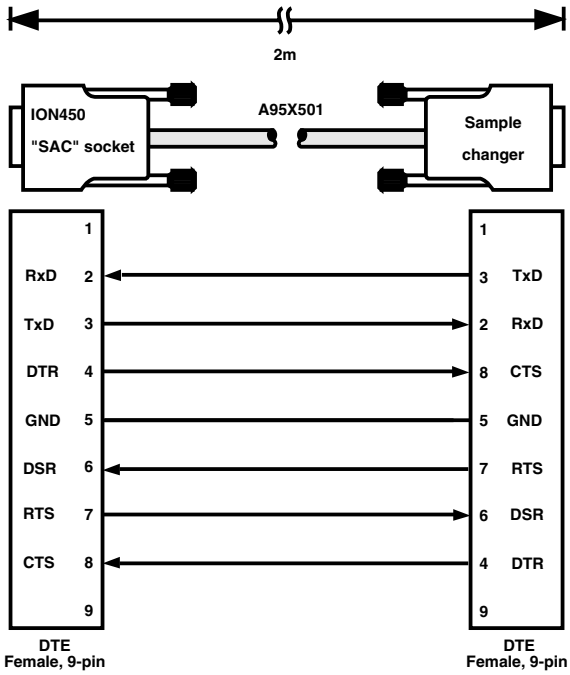


Figure 20: SAC850/SAC950 Sample changer cable, A95X501

Sample ID

The Sample ID is entered during a run procedure.

Range available:

16 characters

Sample preparation no.

The Sample preparation routine gathers all the information required by a SAC850 or SAC950 Sample Changer to prepare each sample beakers of the sequence (sample dilution by adding a solvent, stirring delay, sample degassing, set the sample to a given temperature, start a dynamic rinse, etc.).
One Sample preparation routine is defined per method executed.
A SAC850 or SAC950 can run up to 10 different sample preparations in a given sequence.
Sample preparation routines are created and edited from a PC and TitraMaster 85 PC software. They are loaded in the ION450 memory on connecting the instrument to TitraMaster 85.
On running a sequence, the ION450 sends to the sample changer all sample preparations to be runned for the sequence (one preparation per method).

Enter in:

Edit sequence menu (with a SAC850 or SAC950)

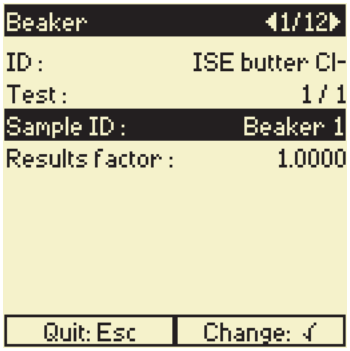
Range available:

0 to 10
0 means no sample preparation selected.

Sample stack

The sample stack gathers individual data for all the samples present in a sequence.

1. Perform steps **1** to **8** of the "Programming sequence" procedure. *Refer to "Programming sequence", page 127*.
2. In the Main window, press **2** Sequence/Sample stack.
3. If required enter a new sequence ID.
4. Press **1** to enter the sample stack.
5. Enter sample data.



<1/12> means the first beaker over 12 programmed in the sequence.
Use the **LEFT/RIGHT** arrow keys to review the other beakers in the sequence.
The data displayed will depend on the type of method selected.

Label the beakers indicating the number of beakers in the sequence, for example: 1/12, 2/12 etc.... the sample ID and the number of times the method is to be performed in the beaker.

Place the beakers in the numbered position on the sample changer. If static rinses and/or dynamic rinses are programmed, position the corresponding rinse beakers at the right places.
Refer to "Number of static rinses", page 116.
Refer to "Dynamic rinses", page 74.

*You can print the sample stack by pressing **Print** from the Sequence/Sample stack screen (screen displayed at step 2 of the operating procedure above).*

Select electrode

Routine user

Is able to select an electrode to check the parameters and/or start a calibration.

1. Select the method/sequence using the electrode.
2. Press **1** to start a calibration or **3** to check the electrode parameters. In both cases, the electrodes available will be those specified in the actual working method or sequence.

Supervisor

From the Electrode window.

1. Press **4**.
2. In the ID field, select the electrode from the User list.

Select method

To select a single method:

1. Select `Working mode = Method` in the Main window.
2. Press **3**.
3. In the ID field, select the method from the User list.

To select a method to be run using a sample changer:

1. Select `Working mode = SAC Method` in the Main window. If this option is not available, enter the Setup menu > Configuration and define a sample changer.
2. Press **3**.
3. In the ID field, select the method from the User list.

Select sequence

To select a Sequence (sample changer not in use):

1. Select `Working mode = Sequence` in the Main window.
2. Press **2** Sequence/Sample stack.

To select a Sequence to be run using a sample changer:

1. Select `Working mode = SAC Sequence` in the Main window. If this option is not available, enter the Setup menu > Configuration and define a sample changer.
2. Press **2** Sequence/Sample stack.

Refer to "Sequence/SAC sequence", page 148.

Sensitivity

Measure of the electrode condition. For ideal electrode chains the sensitivity is 100%. However, it is generally lower. It is expressed as a percentage of the theoretical slope (59.16 mV/pH) of the curve at 25°C and is determined during a calibration on at least 2 points.

Sequence/SAC sequence

Two sequences are available: Sequence or SAC Sequence. The sequences are empty and must be programmed.

Unlike Coupled methods, sequences also allow you to link electrode calibration methods.

A sequence is a chain of up to 10 methods that will be carried out in different beakers and in a defined order given by the operator.

Sequence: The beakers are changed manually.

SAC Sequence: The beakers are changed automatically using a SAC80, SAC90, SAC850 or SAC950 Sample Changer.

Example:

Method 1 performed on 2 samples using 4 test portions (2 x 4 beakers),

Method 2 performed on 1 sample with 3 test portions (1 x 3 beakers).

Thus 11 beaker system will run as follows:

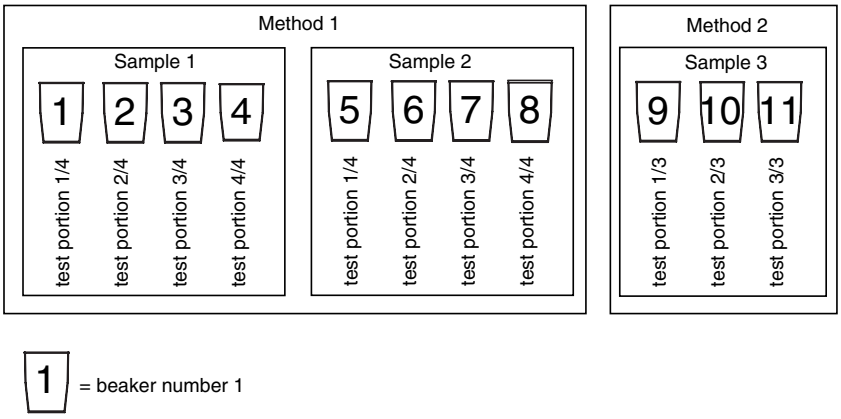


Figure 21: Sequence of methods

The number of samples is entered in the Edit sequence menu and the number of test portions in the Edit method screen.

SAC Sequence and pH electrode/conductivity cell calibration in Free mode.
In this case, the measurement system will wait for the user to enter the buffer (or standard) value before going ahead automatically with the next beaker.

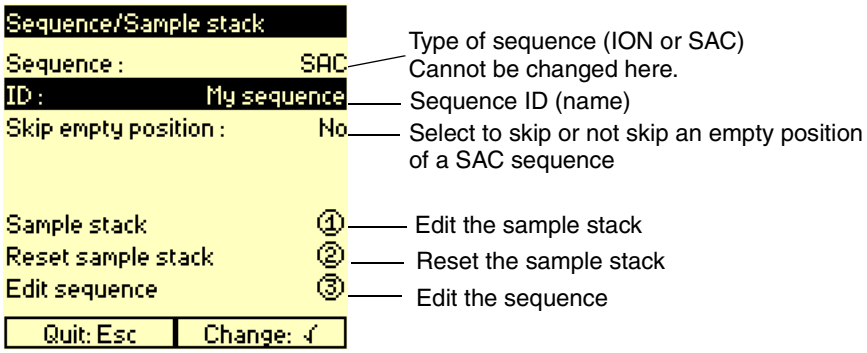
Refer to "Working mode", page 165.
Refer to "Select sequence", page 146.
Refer to "Programming sequence", page 127.
Refer to "Running an ION sequence", page 140.
Refer to "Running a SAC sequence", page 139.

Sequence/ Sample stack menu

In this menu, you can edit a sequence and the sample stack associated.

To access:

1. In the Main window, select `Sequence` or `SAC/sequence` for `Working mode`.
2. Press **2** Sequence/Sample stack.



Refer to "Edit sequence menu", page 80.
Refer to "Sample stack", page 145.
Refer to "Skip empty position", page 150.
Refer to "Sequence/SAC sequence", page 148.

Sequence end in Park (Yes/No)

At the end of a sample changer sequence, you can dip the electrodes into the Park beaker filled with a conditioning solution or you can left the electrodes above the Park beaker (electrodes are stored dry in this case).

Enter in:

Setup menu > Configuration (if `Sample changer` = `SAC850` or `SAC950`)

Serial number (of an electrode)

The serial number is entered when connecting or replacing an electrode.

Enter in:

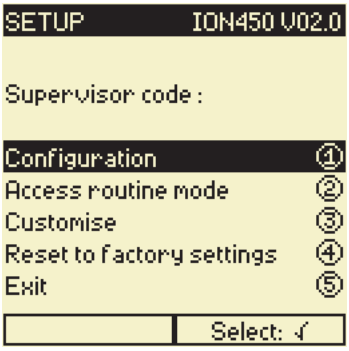
Electrode window > Install electrodes > Connect electrodes
Electrode window > Install electrodes > Replace electrode

Format:

10 characters

Setup menu

Press **Stop** 3 seconds or press key **F12** in the Main window. The title bar indicates the instruments name and the software version.



Skip empty position

Parameter of a SAC Sequence for sample beaker positions only. Does not apply to electrode calibration beaker positions.
Does not apply if a SAC850 or SAC950 sample changer is used with the `Beaker detection` option cleared (deselected),
see "Beaker detection", page 43.
Selects whether you want or not the sample changer (SAC80, SAC90, SAC850 or SAC950) to skip to the next beaker position if an empty position **(*)** is found. If No is answered, 3 possibilities are offered if an empty position is found: restart the analysis in the same beaker, skip to the next beaker or end the analysis.

Enter in:

Press **2** Sequence/Sample stack from the Main window.
Refer to "Programming sequence", page 127.

(*) Empty position:
An empty position means no beaker present at the position.
When you are using a SAC850 or SAC950, an empty position also means a beaker with less liquid than the minimum detection limit or a beaker with a solid or a powder sample.
Refer to "Beaker detection minimum height", page 44.

Software version

The software version is displayed in the title bar of the Setup menu. The version is also displayed for a few seconds while switching on the instrument.

Solution menu

This menu is available for:

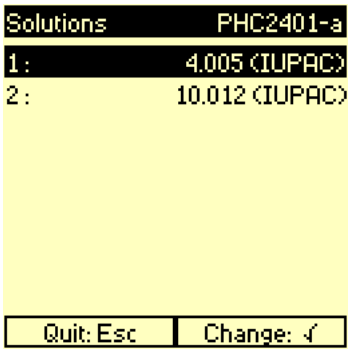
- pH electrodes that are edited with the `Calibration request = Fixed` option.
- ISE electrodes that are edited with the `Calibration = Manual` option.

Refer to "Calibration request = Fixed", page 52.
Refer to "Calibration request = Free", page 53.
Refer to "Calibration = Manual", page 50.

To access:

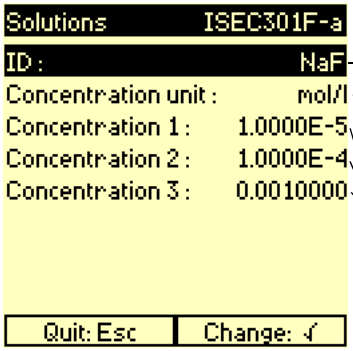
1. From the Electrode window, press **4**.
2. Select the electrode to be edited.
3. Press **2** Edit electrode and check that the `Calibration request = Fixed` (pH electrodes) or `Calibration = Manual` (ISE electrodes) option is selected.
4. Use the **LEFT/RIGHT** arrow keys to move to the last Edit electrode display.
5. Press **2** Calibration solutions.

For a pH electrode calibration



Select the pH standard solutions to be used for the calibration. The pH values are given at 25°C. The following values are available: IUPAC pH standards (pH 1.679, 4.005, 6.865, 7.000, 7.413, 9.180, 10.012 or 12.454) or 4-7-10 Series (pH 4, 7 or 10).

For an ISE electrode calibration



Enter the name of the standard used (16 characters maximum).

Select the standard concentration unit. Available units: eq/l, meq/l, mol/l, mmol/l, g/l, mg/l, mg/ml, µg/ml, % or ppm.

Enter the concentration of each standard with the unit selected above.

Available limits: 10^{-10} to 10^{10}.

Stability

The stability criterion is used to control the stability of the electrode signal. Selecting a low value will bring about, accurate but long measurements.

Enter a stability which is close to the default value (50 mpH/min, 3.0 mV/min or 1.0 %/min).
A zero stability criteria will have no effect on the stability test performed, the reading will be taken into account when the `Acceptation` time is exceeded.

Enter in:

Edit method > Parameters menu
Edit electrode > Calibration parameters menu

Range available:

0 to 99 mpH/min or 0 to 99.9 mV/min or 0 to 99.9 %/min

Standard (conductivity standard)

Selection of the conductivity standard used to calibrate the conductivity cell. 8 standards are available:

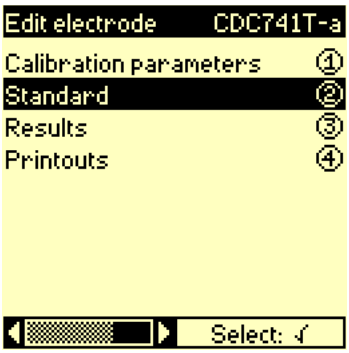
Conductivity standard	Temperature range	Radiometer Analytical part no.
1 D KCl	0 to 27 °C	S51M001 (500 ml)
0.1 D KCl	0 to 50 °C	S51M002 (500 ml)
0.01 D KCl	0 to 50 °C	S51M003 (500 ml)
0.1 M KCl	0 to 36 °C	C20C250 (500 ml)
0.01 M KCl	0 to 34 °C	C20C270 (500 ml)
0.001 M KCl	0 to 30 °C	C20C280 (500 ml)
0.05 % NaCl	0 to 99.9 °C	S51M004 (500 ml)
25 µS/cm NaCl	0 to 100 °C	S51M013 (250 ml)

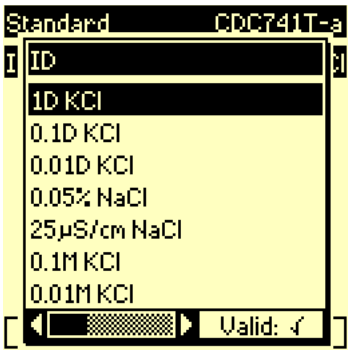
Figure 22: Conductivity standards available in the ION450

The ION450 determines the cell constant from the conductivity values of the standard which are saved versus temperature.

Access:

1. From the Electrode window, press **4**.
2. Select the Conductivity type electrode to be edited.
3. Press **2** Edit electrode and check that the `Calibration request = Fixed` option has been selected.
4. Use the **LEFT/RIGHT** arrow keys to move to the last display.
5. Press **2** Standard line.
6. At the ID line, select the standard used for the calibration of the conductivity cell.





Standard potential *Refer to "Direct ISE measurement method - definition", page 69*.

Standard solution (conductivity measurements) *Refer to "Standard (conductivity standard)", page 153*.

Standard solution (ISE measurements) *Refer to "Solution menu", page 151*.

Static rinses *Refer to "Number of static rinses", page 116*.

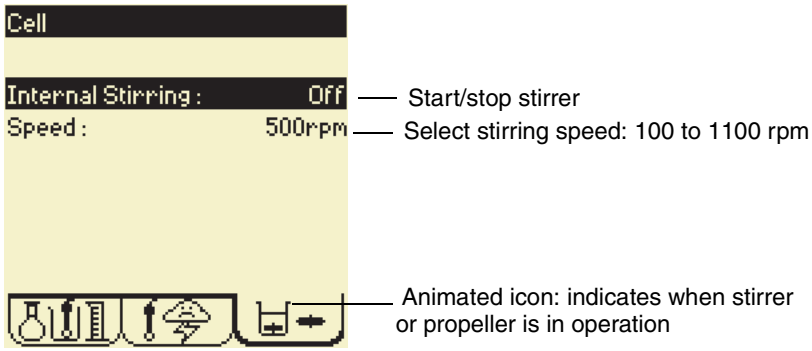
Static rinse time *Refer to "Rinse time", page 135*.

Statistics When several tests are performed on the same sample, the mean and standard deviations are calculated from the accepted tests.

Stirring

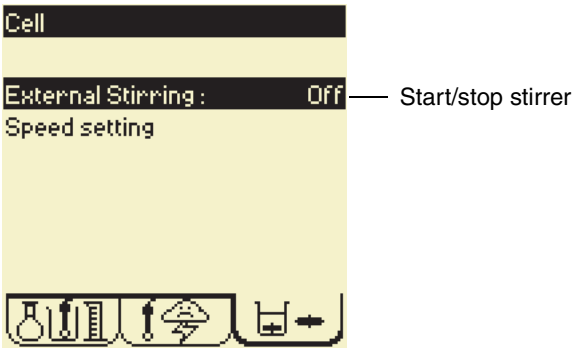
Internal stirrer, e.g. magnetic

Display the Cell window..

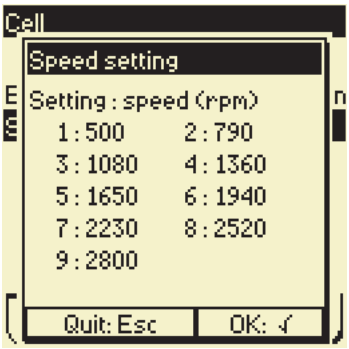


External stirrer, e.g. propeller

1. Connect the Stirring Propeller, part no. 847-731, to the **Propeller** socket.
2. Display the Cell window.



3. Select `External stirring = On` and adjust stirring by turning the stirrer propeller knob or select `Speed setting` then choose a stirring speed from the table.

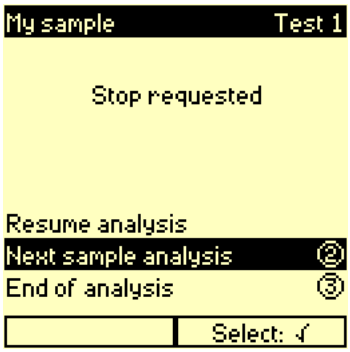


4. To stop stirring, select `External stirring = Off`.

SAC850 and SAC950 stirrer: the stirring speed is adjusted using the TitraMaster 85 PC software.

Stop analysis

The **Stop** key enables you to stop a test and display the following screen:



Press **2** to start a new test in the same, or different sample or end the analysis.
Press **3** to end the measurements. The active test is not saved

The **Del** key enables to stop an analysis and calculate the results. The result of an interrupted test is saved with a "Man. stop" note.

When you end the analysis on a sample and several tests have been accepted, a mean and standard deviation is calculated for the result and stored in the archives.

*When you end the analysis and have not performed the number of tests required for one sample, you have the choice between starting a new test on that sample (key **1**) or ending the analysis (key **2**).*

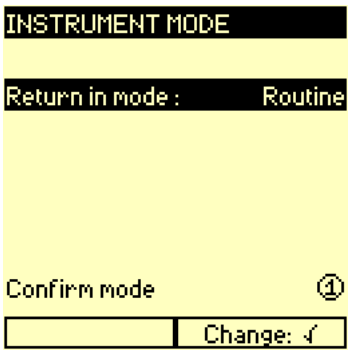
Supervisor code

Enter a Supervisor code to differentiate between the 2 operator modes - Routine and Supervisor.

This code will protect your parameters from any unwanted changes.

DO NOT FORGET this code! it will be asked for each time you try and enter the SETUP mode during Routine use. If you forget the code, you are unable to gain access to the Supervisor mode, and will be obliged to work in Routine mode.

When you exit the `Setup` menu after entering a code, you have the choice to remain in Supervisor mode or return to Routine mode.



If you select Supervisor, the instrument will remain in this mode until the instrument is switched off. If you select Routine, the instrument will switch to Routine mode.

If no code is entered, all users will have free access to all parameters.

Enter in:

Setup menu

Range available:

1 to 10 alphanumerical characters

Refer to "User's rights", page 164.

Supervisor mode

In **SUPERVISOR** mode, you can create, select, edit, delete sequence of methods and electrodes.

To select the Supervisor mode, a supervisor code is required.

Proceed as follows:

- Press **Stop** for 3 seconds in the Main window.
- Enter the Supervisor code.
- Press **5** Exit
- Select Return in mode = Supervisor.

Refer to "User's rights", page 164.

T°C minimum/ maximum value

If the temperature measured lies outside these limits a warning message will be displayed.

Enter in:

Edit method > Results (for a measurement method using a temperature sensor).

Range available:

T°C minimum value: -9 °C to T°C maximum value.

T°C maximum value: T°C minimum value to 100 °C.

Temp. coef.

Refer to "Temp. correction None/Linear/Nat. water", page 159.

Temp. correction None/Linear/ Nat. water

None

The ION450 displays the sample conductivity at the sample temperature. No correction is performed.

Linear

The ION450 measures the sample conductivity and sample temperature and then converts it to the reference temperature using a temperature linear compensation function and displays the conductivity at the reference temperature.

Enter the Reference temperature and a Temperature coefficient expressed in % of conductivity variation per °C.

You can determine experimentally the Temperature coefficient: see the "Conductivity theory and practice" guide, part no. D61M002.

Nat. water

The ION450 measures the sample conductivity and sample temperature and then converts it to 25 °C using a temperature non-linear compensation function based on natural waters according to ISO/DIN7888. Then, the conductivity is displayed at 25°C.

Select in:

Edit Method > Method parameters (for a conductivity measurement method)

Range available:

Reference Temp.: 0 to 99°C in steps of 1°C
Temp. coef.: 0.00 to 9.99 %/°C in steps of 0.01 %/°C

As conductivities vary versus temperature, it is recommended for high accuracy measurement:

•to use a temperature sensor or a conductivity cell with built-in temperature sensor.

•to thermostate samples, so that the same temperature is used for the calibrating and measuring.

Temp. limit exceeded

When calibrating a conductivity cell in the Fixed mode, the temperature measured in your standard is out of the range.

Conductivity standard	Temperature range
1 D KCl	0 to 27 °C
0.1 D KCl	0 to 50 °C
0.01 D KCl	0 to 50 °C
0.1 M KCl	0 to 36 °C
0.01 M KCl	0 to 34 °C
0.001 M KCl	0 to 30 °C
0.05 % NaCl	0 to 99.9 °C
25 µS/cm NaCl	0 to 100 °C

Adjust the temperature of the standard and repeat the calibration.

Refer to "Electrode calibration (Fixed mode, conductivity cell)", page 81.

Temperature Probe/ Fixed at 25°C/Entered

Probe

The sample or standard temperature can be measured using a temperature sensor connected to the **Temp** socket of the ION450. Select a temperature sensor in the Method parameters menu.

Fixed at 25°C

If measurements are to be performed at a constant temperature of 25°C.
Note:
No temperature correction is available for conductivity measurements.

Entered

If the temperature is to be entered manually.

Select in:
Edit method menu

Edit electrode menu if Calibrate request = Fixed, Free or Calibrate = Manual

Temperature sensor ID

Name of the temperature sensor or name of the electrode with a built-in temperature sensor.

Enter in:

Edit Electrode > Calibration parameters

Edit Method > Method parameters

Range available:

16 characters

The sequence is empty

You are trying to run or complete a sample stack/sequence experiment which contains no programmed methods.

Go to Sequence/Sample stack, Edit sequence screen and check the sequence.

Time max (result indicator)

Refer to "Result indicators", page 132.

Title

Enter the title of the calibration report sheet (max. 23 alphanumeric characters).

Enter in:

Edit method > Printouts

Edit electrode > Printouts

Tray missing (SAC error)

On starting a sequence, the sample changer cannot read the RFID tag of the turntable. Check that a turntable is correctly mounted on the sample changer.

Check the model of turntable used and refer to the User's Guide of the sample changer, chapter 6 "Accessories".

In particular, note that a SAC850 turntable can be used on a SAC950 but a SAC950 turntable cannot be used on a SAC850.

Solve the problem then restart the sequence.

TTL 5 V OUT/ TTL 12 V OUT (sockets)

Red and black banana sockets (diameter = 2 mm).

The red banana sockets send a TTL 0 ± 5 V or 0 ±12 V.

The black banana sockets are connected to the electrical zero of the instrument.

This auxiliary signal is programmed in the Method parameter menu, *see "Auxiliary output", page 42*.

Specifications (potential difference is given in absolute value)

Output signal

Level 0: 0 to 0.4 V

Level 1: higher than 2.4 V and equal to or less than 5 V (or 12 V)

Output impedance: 1 KOhm at level 0 and 2 kOhm at level 1

A TTL 0-level does not mean a 0 V output. The voltage difference varies from 0 to ±400 mV.

TTL IN (sockets)

Red and black banana sockets (diameter = 2 mm).

The auxiliary input socket can be connected to an external device unit used to send an analysis start command . The red banana socket receives a signal TTL 0 ±5 V and the black banana socket is connected to the instrument electrical zero.

Specifications (potential difference is given in absolute value)

Input signal

Level 0: 0 to 0.8 V

Level 1: higher than 2 V and equal to or less than 5 V

Input impedance: 10 KOhm

The auxiliary input signal is programmed in the Configuration menu, *see "Auxiliary input", page 41*.

A TTL 0-level does not mean a 0 V output. The voltage difference varies from 0 to ±400 mV.

Turntable blocked (SAC error)

The turntable has been blocked or forced and or cannot function properly.
Remove the obstruction and press `Resume analysis` (key **1**) to continue the sequence from the point it stopped.

Warning!

Do not change the turntable before restarting the sequence from the beaker it stopped (key **1**) or before restarting the sequence from the next beaker (key **2**). The sample changer identifies a turntable only when a new sequence is initialized (equivalent to a keystroke on **3** `End of sequence` followed by **1** `Run sequence`).

Type of method

The type of method is selected in the Add method menu while editing a sequence. The following types are available:

- Sample only methods,
- Electrode calibration methods,
- QC sample methods (Yes has been selected for QC sample in the Edit method menu).

User ID (Yes/No)

If specified, User ID will be asked for each time an analysis is run.

Enter in:
Setup menu > Configuration menu

User list

List of user defined methods and electrodes. The list is initialised to the preprogrammed methods and electrodes.

User's rights

The Supervisor and Routine modes set the user's rights as shown in the table below:

	Supervisor	Routine
Create, edit sequence. Remove all methods from a sequence. Delete a sequence	Yes	Yes (if the Supervisor gives the right to), *see "Demand: Unlocked", page 67*.
Create method, electrode	Yes	No
Copy method, electrode	Yes	No
Program sequence, method, electrode	Yes	No
Delete method, electrode	Yes	No
Reset method, electrode parameters	Yes	No
Reset parameters to factory settings	Yes	No
Select sequence, method, electrode	Yes	Yes
Check method, electrode parameters	Yes	Yes
Connect/replace/disconnect electrodes	Yes	Yes
Run sequence, method, electrode calibrations	Yes	Yes
Consult results	Yes	Yes

Figure 23: User's rights

Valency

This parameter is available when creating an ISE electrode with the option `From = Other`.
Refer to "Create electrode", page 63.

Select the valency of the ion under study.

For example: Valency = -1 for a fluoride (F^-) ion selective electrode.

Range available:

+1, +2, -1 or -2.

Working mode

Select the way in which you want to work.

Method: to run a single method.

Sequence: to create or run a sequence of methods. Beakers are manually changed between two method runs.

SAC Method: to run a single method to be performed using a sample changer.

SAC Sequence: to create a sequence of methods to be performed using a sample changer.

Note: the working mode selected will have no effect on the type of method you wish to create.

Define the sample changer in the Configuration menu before selecting SAC Method or SAC Sequence.

Enter in:
Main window

Wrong buffer

While running an electrode calibration, the buffer analysed has not been identifed by the instrument.

End the calibration cycle. Check the buffer then start a new calibration cycle.

Wrong type (SAC error)

Sample changer error: the sample changer connected does not correspond to the one programmed in the Setup > Configuration menu.

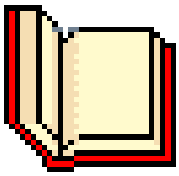
Example:
A SAC850 is connected to the ION450, **SAC** socket and you have declared a SAC950 in the Setup > Configuration menu.

Review the Setup > Configuration parameters and/or connect the correct model of Sample Changer to the SAC socket of the ION450.
Refer to the Sample Changer User's Guide, part no. D21T085.

Zero pH

This is the pH value (pH_0) at which the potential is zero. The zero pH is calculated after a one-point calibration.

Refer to "pH0(25)", page 118.



Appendixes

Appendix 1: Preprogrammed methods

Method name	Type	Electrodes
Measure - *Mesure*	Mesure pH	PHC2401-a
EC ISO7888	Measurement conductivity	CDC741T-a
EC-pH	Coupled “EC ISO7888”+ “pH of water“	PHC3081-a CDC741T
ISE water Cl-	Measurement Direct ISE	ISE25CL water REF601-a T201-a
ISE butter Cl-	Measurement Direct ISE	ISE25CL butter REF601-a T201-a
Nitrates in food	Measurement Direct ISE	ISE25NO3-a REF251 NO3 T201-a
pH of water	Measurement pH	PHC3081-a

Appendix 2: General information

Cleaning

The ION450 requires minimum maintenance. The exterior surface can be cleaned with tepid water and wiped dry with a soft cloth. Never use another solvent unless you have first consulted your Radiometer Analytical representative.

Transporting the ION450

Always use the packaging supplied by the manufacturer.

Remove the metal rod before transporting the ION450. Never pick-up or carry the instrument by the metal rod.

Servicing

The ION450 has been developed for connection to a grounded mains supply. The peripherals that are likely to be connected to the ION450 must conform to the relative safety standards.

DO NOT ATTEMPT TO SERVICE THIS PRODUCT YOURSELF. For servicing, please contact your Radiometer Analytical service representative at the address given below:

RADIOMETER ANALYTICAL SAS

72, rue d'Alsace

69627 Villeurbanne CEDEX - France

Tel.: +33 (0) 4 78 03 38 38

Fax: +33 (0) 4 78 03 38 27

E-mail: radiometer@nalytical.com

or your local service representative:

International Standards

EMC Directive (89/336/EEC)

The ION450 complies with following standards:

Class A equipment for laboratory use, according to the product standard EN 61326-1.

EN 61000-4-2 level 2 & level 3

EN 61000-4-3 level 1

EN 61000-4-4 level 2

EN 61000-4-5 level 2

EN 61000-4-6 level 1

EN 61000-4-11

EN 61000-3-2, class A

EN 61000-3-3

EN 55011, class A

Low Voltage Directive (73/23/EEC)

The ION450 complies with the following standard:

Reference standard: EN 61010-1.

Standard applied:

Standard for Electrical Equipment for Laboratory use: UL 61010A - 1

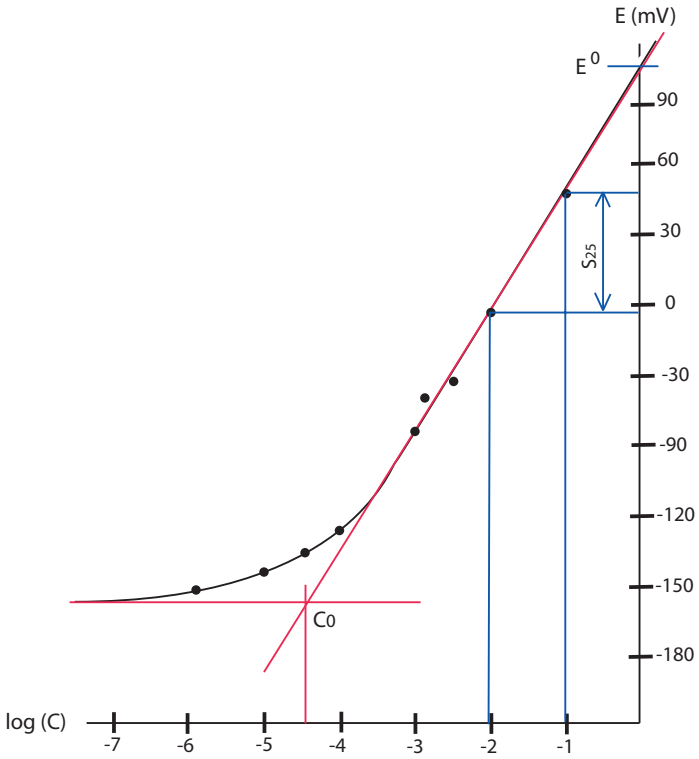
Standard for Safety Requirements for Electrical Equipment for measurement, Control and Laboratory use: CAN / CSA C22 2 N° 1010.1 - 92.

Appendix 3: Result calculations

1. ISE measurements - Direct ISE method

In Direct ISE measurements, the ion selective electrode (ISE) must be calibrated using 1 to 9 standard solutions.

For an ion selective electrode, the measured electrode potential E can be plotted versus the logarithm of concentration:



$$E = E^0 - S_{25} \times \frac{T}{T_{25}} \times \log(C + C_0)$$

Where:

- E = measured potential of the solution,
- E^0 = electrode standard potential,
- S_{25} = response slope of the line E = f(log C) at 25°C in mV/pC,
- C = ion concentration in the solution,
- C_0 = concentration (also called “experimental detection limit of the ISE electrode regarding the species under study“).

Once the E^0, S_{25} and C_0 values are known, the ION450 displays the C_{smp} concentration measured in the sample at the T_{smp} sample temperature using the following Nernst equation:

$$C_{smp} = 10^{-\frac{E-E^0}{S_{25}} \times \frac{T_{25}}{T_{smp}}} - C_0$$

While running direct ISE measurements, the temperature cannot vary by more than **5°C** over the whole batch of samples (if this condition is not fulfilled, a warning message is displayed with the indication dT>5 and the result is rejected). Moreover, the temperature should be as closer as possible to the calibration temperature to get more accurate measurements. The result is converted as follows according to the result and standard unit selected:

Result unit = standard unit x c

where c is the conversion factor.

c conversion factor values

This **c** factor takes the following values according to the result and standard unit selected. The sample quantity is always expressed in volume units. Available result and standard units: eq/l, meq/l, mol/l, mmol/l, mg/l, µg/ml, g/l, mg/ml, ppm, %.

Result unit	**Standard solution unit**						
	eq/l	**meq/l**	**mol/l**	**mmol/l**	**mg/l or µg/ml ppm**	**g/l or mg/ml**	**% (w/v)**
eq/l	1	0.001	V	0.001*V	0.001*V/Ms	V/Ms	10*V/Ms
meq/l	1000	1	1000*V	V	V/Ms	1000*V/Ms	10000*V/Ms
mol/l	1/V	0.001/V	1	0.001	0.001/Ms	1/Ms	10/Ms
mmol/l	1000/V	1/V	1000	1	1/Ms	1000/Ms	10000/Ms
mg/l or µg/ml or ppm	M_S*1000/V	M_S/V	1000*M_S	M_S	1	1000	10000
g/l or mg/ml	M_S/V	0.001*M_S/V	M_S	0.001*M_S	0.001	1	10
% (w/v)	M_S* 0.1/V	0.0001*M_S/V	0.1*M_S	0.0001*M_S	0.0001	0.1	1

Table 9: c conversion factors

Where:
Ms = standard molar weight (g/mol).
V = valency: equal to 1 or 2.

According to the result unit selected, the ION450 may require the molar weight of the analysed species. When you create an ISE electrode, you are prompted to enter the molar weight of the element. This molar weight cannot be changed as it is the case for the ion valency.

A Results factor can be defined in a direct ISE method. This factor can be set to the dilution factor and solve the dilution factor problem in a case of a direct ISE method.

In a Direct ISE method, the ppm and % units are expressed in weight/volume or in weight/weight with a density of the solution equal to 1.

2. Conductivity measurements

To determine a conductivity value, the ION450 performs the following operations in this order:

1. Measurement of the G_S conductance (value displayed live).
2. Cable correction (cable resistance and cable capacity correction): G_m corrected conductance value.
3. The cell constant is used to calculate the κ conductivity at the T sample temperaure (measured or entered).
4. Temperature correction: conductivity recalculated at the T_{ref} reference temperature or at 25°C depending on the method programmation.

2.1 Cable correction

The cable correction takes into account the cable resistance and the cable capacity.

1. Cable resistance

The influence of the cable resistance on the G_m measured conductance is as follows:

$$G_m = \frac{G_S}{1 + (R \times G_S)}$$

Where:
G_s= conductance of solution (S)
R= cable resistance (Ω)

The cable resistance is entered upon creating a 2 or 3 pole conductivity cell. Enter a cable resistance of 0 for a 4-pole conductivity cell. This value cannot be changed afterwards. *Refer to "Create electrode", page 63.*

2. Cable capacity

The cable capacity influences the measurements of very low conductance. The ION450 performs a cable capacity correction when low conductance are measured (< 4 µS).
The equation used by the ION450 enables an accurate measurement correction to be obtained for cable capacities up to 1000 pF.
The cable capacity is entered upon creating the electrode. This value cannot be changed afterwards. *Refer to "Create electrode", page 63.*

2.2 Cell constant correction

The ION450 calculates and displays the κ conductivity of a solution on the basis of the G_m conductance measured (after cable resistance and capacity correction) and the K cell constant of the conductivity cell used.

$$\kappa \text{ (in S.cm}^{-1}\text{)} = K \times G_m \text{ (in S)}$$

The K constant (expressed in cm^{-1}) is a specification of the conductivity cell which depends on the cell geometry. To measure conductivities, you must know K. With the ION450, you can directly enter the K value in the Edit electrode menu (*see "Cell constant (parameter)", page 54*) or determine K by calibrating the conductivity cell (*see "Electrode calibration (Fixed mode, conductivity cell)", page 81* or *see "Electrode calibration (Free mode, conductivity cell)", page 82*).

2.3 Temperature correction

Two types of temperature correction are available using the ION450:

- The linear correction,
- The non-linear correction of "Natural water" type.

The linear correction

Conductivities are corrected to a reference temperature using a temperature coefficient (θ), a reference temperature and the following equation:

$$\kappa_{Tref} = \frac{100}{100 + \theta \times (T - T_{ref})} \times \kappa_T$$

Where:

- T_{ref}= reference temperature in °C
- T= sample temperature in °C
- κ_{Tref}= conductivity at T_{ref}
- κ_T= conductivity at T
- θ = temperature coefficient of the sample in %/°C

With the ION450, the reference temperature can be entered between 0 and 99°C (resolution: 1°C) and the temperature coefficient between 0.00 and 9.99 %/°C (resolution: 0.01 %/°C). These 2 parameters are available in the Edit method > Parameters menu,
see "Temp. correction None/Linear/Nat. water", page 159.

"Natural water" type correction

The conductivity κ_T measured at the sample temperature T is corrected to 25°C to give κ_{25} using the following equation:

$$\kappa_{25} = f_{25}(T) \times \kappa_T$$

f_{25} (T) is the temperature correction factor used for the conversion of conductivity values of natural water from T to 25°C.
f_{25} (T) is calculated from a 4-degree polynomial equation. This equation fits (deviation < 0.1%) the conductivity variations against temperature for a natural water stated by ISO/DIN 7888.

$$f25 = a0 + a1 \times T + a2 \times T^2 + a3 \times T^3 + a4 \times T^4$$

Where :
a0 = 1.917442
a1 = -0.06165928
a2 = 1.493149 x 10^{-3}
a3 = -2.453671 x 10^{-5}
a4 = 1.898527 x 10^{-7}

The available range for T is 0 to 35.9°C and the factor f_{25} (T) varies from 0.808 to 1.918.
A "Natural water" type of temperature correction can be selected in the Edit method > Parameters menu, *see "Temp. correction None/Linear/Nat. water", page 159*.

3. Conductivity cell calibration

This is a 1-point calibration. A conductance and a temperature measurement is performed on a standard solution that has been defined in the Edit electrode menu of the conductivity cell, *see "Standard (conductivity standard)", page 153*.

The calibration result is the conductivity cell constant K expressed in cm^{-1}.

3.1 KCl Demal standards

Concentrations used are:1 D, 0.1 D and 0.01 D (D = Demal).
These standards are prepared by dissolving an amount of dried KCl in 1000 g of demineralised water (correction for air buoyancy must be applied to the weighing):

Standards	Amount of KCl (g/1000 g of water)
KCl 1 D	71.1352
KCl 0.1 D	7.41913
KCl 0.01 D	0.745263

The conductivity of the demineralised water used must not exceed 2 µS/cm.
The OIML "International Organisation of legal Metrology" Recommendation No. 56, June 1980" gives the conductivity values for these standards (in mS/cm):

Standards/Temperature	0°C	18°C	25°C
KCl 1 D	65.14	97.81	111.31
KCl 0.1 D	7.134	11.163	12.852
KCl 0.01 D	0.7733	1.2201	1.4083

Measurements have been repeated more recently by the NIST for the 0.1D and 0.01D standards. The following results have been published (Journal of Solution Chemistry, Vol.20, No.4, 1991; Y.C. Wu and W.F. Koch):

Standards/Temperature	0°C	18°C	25°C
KCl 0.1 D	7.1346	11.162	12.852
KCl 0.01 D	0.77309	1.2203	1.4086

NIST measurements cover the temperature range of 0 to 50°C. The κ_T conductivity (in mS/cm) expressed as a function of T temperature is as follows:

$$\kappa_T = a0 + a1 \times T + a2 \times T^2 + a3 \times T^3$$

The ai coefficients are:

Standards/ai coef.	a0	a1	a2	a3
KCl 1 D (T = 0 to 27°C)	65.14	1.7065	7.066×10^{-3}	-5.805×10^{-5}
KCl 0.1 D (T = 0 to 50°C)	7.13465	0.208431	9.55158×10^{-4}	-5.77358×10^{-6}
KCl 0.01 D (T = 0 to 50°C)	0.773093	2.30993×10^{-2}	1.07177×10^{-4}	-5.74159×10^{-7}

3.2 KCl Molar standards

The conductivity of these standards as a function of temperature is given by Kolraugh 1940, Handbook of Chemistry p. 1211.

A 1M KCl (solution A) is prepared by dissolving 74.59g of KCl in water and diluting to 1 l at 18°C. The specific gravity of such a solution is 1.0449 at 18°C.

The 0.1M KCl (solution B) is obtained by diluting solution A 10 times.

The 0.01M KCl (solution C) is obtained by diluting solution B 10 times.

Most significant conductivity values of solutions B and C as a function of temperature are reproduced in the table below from Kolraugh table :

Temperature (°C)	0.1M KCl standard (µS/cm)	0.01M KCl standard (µS/cm)
0	7 150	776
5	8 200	896
10	9 330	1 020
15	10 480	1 147
18	11 190	1 225
20	11 670	1 278
21	11 910	1 305
22	12 150	1 332
23	12 390	1 359
24	12 640	1 386
25	12 880	1 413
30	14 120	1 552
34	15 130	1 667
36	15 640	

A polynomial has been fitted to these values for both standards, giving conductivity C_y as a function of temperature:

$$C_y = a0 + a1 \times T_m + a2 \times T_m^{\ 2} + a3 \times T_m^{\ 3}$$

C_y: µS/cm

T_m: °C

a_i coefficients:

	a0	a1	a2	a3
KCl 0.1 M (T_m = 0 to 36°C)	7 150	+209.3	$+9.44\ 10^{-1}$	-5.77358×10^{-3}
KCl 0.01 M (T_m = 0 to 34°C)	776	+23.62	$+7.5\ 10^{-2}$	0

3.3 KCl 0.001 M standard

Standard is prepared using demineralised water, the conductivity of this water is known in advance.

	KCl amount per 1000g of solution (g)	Conductivity at 25°C (µS/cm)
0.001M KCl	0.0746	146.9

The equivalent polynomial giving conductivity as a function of temperature is given by the linear equation (issued from the ASTM D1125 (1995) standard):

$$C_y = a0 + a1 \times T_m$$

C_y: µS/cm
T_m: °C in the range 0°C - 30°C

a_0 coefficient = 77.79
a_1 coefficient = 2.7696

3.4 NaCl 25µS/cm standard

Standard is prepared using demineralised water, the conductivity of this water is known in advance.

	NaCl amount per 1000g of solution (g)	Conductivity at 25°C (µS/cm)
NaCl 25 µS/cm	0.0116886	25

The equivalent polynomial giving conductivity as a function of temperature follows table B.2 of the CEI 60746-3 :2002 standard (NF EN 60746-3 french version):

$$C_Y = a0 + a1 \times T_m + a2 \times T_m^{\,2} + a3 \times T_m^{\,3} + a4 \times T_m^{\,4}$$

C_y: µS/cm
T_m: °C in the range 0°C - 100°C

The ai coefficients are:

Standards/ai coef.	a0	a1	a2	a3	a4
NaCl 25 µS/cm (Tm = 0 to 100°C)	13.3095	0.422280	1.873349×10^{-3}	-2.35999×10^{-6}	-3.545746×10^{-8}

3.5 NaCl 0.05% standard (w/w)

With this standard, the measurements obtained with the ION450 fit the tables published in October 1960 by G.F. Hewitt, Atomic Energy Research Establishment, Harwell, U.K.

The κ_T conductivity (in µS/cm) is given a function of T temperature by the equation stated by IEC draft 1980 **(*)**:

$$\kappa_T = 87332 \times \left[1 + b_T \times (T - 18)\right]$$

Where:

$$b_T = a0 + a1 \times T + a2 \times T^2 + a3 \times T^3 + a4 \times T^4$$

With:

a0 = 2.11798 10^{-2}

a1 = 7.86011 10^{-5}

a2 = 1.54398 10^{-7}

a3 = -6.26350 10^{-9}

a4 = 2.27949 10^{-11}

Temperature range: 0 to 140°C.

(*) "International Electrochemical Commission", January 1980, "Sub-Committee 66 /WG2".
and :
G. F. Hewit
Chemical Engineering Division
U.K.A.E.A. Research Group
Atomic Energy Research Establishment
Harwell
October 1960.

4. Standard deviation calculation

For every result obtained on several aliquots, a mean value is calculated with which a standard deviation is associated.

Definitions:

R_i = Result of test i

$$SR_n = \sum_1^n R_i$$

$$SR2_n = \sum_1^n R_i^2$$

Mean result:

$$R = \frac{SR_n}{N}$$

Standard deviation on the mean value σ_μ:

- Number of tests N = 2 to 5 : estimation of the Q variance for a small number of tests.

$$\sigma_\mu^2 = \frac{\left(\frac{R_{max} - R_{min}}{Q}\right)^2}{N}$$

with R_{max} = maximum value of the R_i and R_{min} = minimum value of the R_i :

N	Q
2	1.128
3	1.693
4	2.059
5	2.326

- Number of tests N > 5

$$\sigma_\mu^2 = \frac{SR2_n - \frac{SR_n^2}{N}}{(N-1)\times N}$$

Result is expressed with the mean value R and the standard deviation σ_μ on the mean value:

$$Result = R \pm \sigma_\mu$$

Appendix 4: Technical specifications

Potentiometric Methods

pH electrode calibration: up to 5 points using IUPAC standards or 4-7-10 Series buffers with error recognition on buffer used.

Possibility to work with user defined buffer values using the Free buffer mode.

pH with temperature-compensated reading: probe, entered or fixed at 25°C.

Direct pH/mV measurements with recording on stable reading.

Sequencing of up to 10 methods including electrode calibrations.

Coupling of 2 to 6 methods in one beaker, including direct ISE and EC measurements.

Conductivity Methods (EC)

Direct conductivity measurements with recording on stable reading.

Conductivity with temperature-corrected display: none, natural water (ISO 7888), linear.

Conductivity cell cable resistance compensation.

Conductivity cell calibration: manual cell constant entry or automatic determination using 1, 0.1, 0.01 Demal KCl standards, NaCl 0.05%, NaCl 25 µS/cm at 25°C low conductivity standard, 1, 0.1 and 0.01 M KCl standard.

Possibility to work with user defined standard values using the Free buffer mode.

Ion Selective Methods (ISE)

ISE measurements using direct measurements with recording on stable reading.

Calibration with up to 9 points.

Curves fitted using non-linear regression with C_0 detection limit determination according to IUPAC.

Curve plotting: mV = f(pC) for ISE calibration.

Measuring ranges	Resolution
-9 to 23 pH	0.001 pH
±2000 mV	0.1 mV
4 µS to 400 mS	1/4000 of the range
-10°C to +100°C	0.1°C

Printout

Automatic. GLP compliant.

Selectable: no, 80 columns, continuous, page to page.

3 levels of detail.

Laser or dot matrix printer.

Results

QC check on results with visual warning.

Statistical calculations.

Units

All standard units for samples/results.
Conductivity: µS/cm or mS/cm.
User-defined result units.

Storage capacity

Global password protection for programming access.

Non-volatile memory

User programmable:	50 methods.
Libraries for 30 electrodes:	more than 30 electrodes pre-identified with ID and type to help programming.

Storage of 200 results. Results storage can be disabled.

Stored parameters characterised by own ID, location and calibration data.

Embedded operating procedures for electrode exchange.

Automatic electrode and QC prompt.

Sample list

Up to 126 data with alphanumeric ID.

QC sample definition.

Electrode stand - stirring

Magnetic stirrer, 22 reproducible speeds (0 to 1100 rpm) in 50 rpm steps.

Propeller connection.

Beaker volume: 5 to 400 ml.

Inputs/outputs

2 indicator electrode inputs.

1 reference electrode input.

1 ground input for differential measurements.

1 imposed current input, ±1 mA ±1 µA.

1 temperature input.

2/4-pole conductivity cell input.

0-5 V and 0-12 V TTL output.

0-5 V TTL input.

Serial connections for printer/PC and additional Ion analyser.

Serial connection for sample changer fitted with 10 to 126-position tray.

PS/2 port for PC keyboard and/or barcode reader.

Languages

English, German, Danish, French, Italian, Spanish, Swedish.

General specifications

Casing:	Fully splashproof KYDEX® T (PVC/acrylic). Graphic 128x128 dot LCD and alphanumeric keypad.
Dimensions (H x W x D):	260 x 200 x 400 mm.
Weight:	2.5 kg.
Power requirements:	47.5 – 63 Hz 115/230 Vac +15 -18%.
Environmental operating conditions:	5 to 40°C temperature. 20 to 80% relative humidity.

Secondary fuses

Secondary fuses are mounted on the printed circuit board. If necessary contact a Radiometer Analytical representative for replacement of the fuses, as the instrument casing must be opened.

International standards

Refer to "International Standards", page 172.

CE marking: Complies with EMC directive 89/336/EEC

Complies with LV directive 73/23/EEC

cETLus certification issued by ITS/SEMKO

UL standard 61010A-1

CSA standard C22 2 No.1010.1-92

Burette specifications according to ISO 8655-3

Burette stand	Nominal volume	Maximum permissible systematic errors		Maximum permissible random errors	
Type	ml	± %	± µl (a)	± % (b)	± µl (c)
B501	< 1	0.6	6	0.1	1
B505	5	0.3	15	0.1	5
B510	10	0.2	20	0.07	7
B525	25	0.2	50	0.07	17.5
B550	50	0.2	100	0.055	25

(a) Expressed as the deviation of the mean of a tenfold measurement from the nominal volume or from the selected volume (see ISO 8655-6:—, 8.4).
(b) Expressed as the coefficient of variation of a tenfold measurement (see ISO 8655-6:—, 8.5).
(c) Expressed as the repeatability standard deviation of a tenfold measurement (see ISO 8655-6:—, 8.5).