

Metrohm Ltd., CH-9101 Herisau, Switzerland

pH/Ion Meter

692

Series 01 ...

Principal keys and settings of 692 pH/Ion Meter

Key functions, configuration

< Key >; display (LCD)	Remarks	Input range (initial values in <i>italics</i>)
<mode>	1. Mode selection. 2. Brings instrument program back to its initial state.	<i>pH, °C, mV, mV/lpol</i>
<select>	Selection of input options for dialog positions followed by a colon (:), e.g. «dialog:», «meas. input:», etc.	
<clear>	Deletes parameter values and variables from the display.	
<quit>	Allows to exit from rolling inquiries, printing, stirring times and certain error messages; leads back to the next higher program level.	
<enter>	Confirms existing parameter settings or enters parameter values that have been keyed in and appear in the display.	
<cal>	Starts calibration.	
<cal. data>	Allows viewing of calibration data.	
<config>	Instrument configuration; dialog positions are independent of mode.	
>auxiliaries		
last digit:	Last digit of display can be switched off.	ON, OFF.
dialog:	Dialog language.	<i>english</i> , deutsch, français, español.
date	Date in YY-MM-DD format.	
time	Time in HH:MM:SS.	24 h format, e.g. 14:07:51
temperature unit:	Selection of temperature unit.	C, F (°C, °F).
run number	Run number.	0...999, OFF.
type of Dosimat:	Selection of Dosimat type.	665, 725.
device label	Designation of 692 pH/Ion Meter for call-up via RS 232C.	8 ASCII characters. (<←>, <→> keys).
program	Designation of installed program version (read only).	

pH measurement

<Key>; display (LCD)	Remarks	Input range (initial values in <i>italics</i>)
<param>	Parameter settings. The dialog positions depend on the mode selected; the following refers to the pH mode .	
>measuring parameters meas. input:	Measuring input.	1, 2, diff. 1: input «pH/ISE 1», 2: input «pH/ISE 2», diff.: differential potentiometry
electr. id:	<select> or enter (<←>, <→>) electrode name.	8 ASCII characters.
drift pH	Drift limit for pH measurement.	0.005...0.05...9.999/pH
[temperature]	Measurement temperature. Appears only if no temperature sensor Pt 100 or Pt 1000 is connected.	-999.9...25.0...999.9
method id	Method name (read only).	
delta measurement:	Display and output of measured value referred to a reference value.	OFF, ON, meas.
stirrer:	Stirrer status.	OFF, ON, control.
<param>	692 pH/Ion Meter in pH mode .	
>calibration parameters [temperature]	Calibration temperature. Appears only if no temperature sensor Pt 100 or Pt 1000 is connected.	0.0...25.0...99.9
drift	Drift limit for pH calibration.	0.1...0.5...9.9 mV/min
report:	Report type.	OFF, short, full.
no. of buffers	Number of buffers for calibration.	1...2...9
buffer type:	Buffer type for calibration.	<i>Metrohm</i> , NIST, DIN, Fisher, Ciba, Ingold, Merck, Beckman, Radiometer, special, own, mixed.
offset U _{as} state:	For electrodes whose U _{as} is outside ± 30 mV.	OFF, ON, meas.

<cal> starts calibration; <cal. data> allows viewing of calibration data.

Ion concentration measurement

Direct concentration measurement with *manual* calibration

<Key>; display (LCD)	Remarks	Input range (required settings in bold face , initial values in <i>italics</i>)
<param>	692 pH/Ion Meter in Conc «c» .mode.	
parameter meas. type:	Selection of procedure for ion concentration measurement.	direct , std. add, smpl. add.
>measuring parameters ion type:	Designation of ion to be analyzed.	Ag(+1), BF ₄ (-1), Br(-1), Ca(+2), Cd(+2), Cl(-1), CN(-1), Cu(+2), F(-1), I(-1), K(+1), Na(+1), NH ₄ (+1), NO ₂ (-1), NO ₃ (-1), Pb(+2), S(-2), SCN(-1), SO ₄ (-2), own. «own»: 7 ASCII characters.
conc. unit:	Selection or concentration unit.	<i>moll</i> , %, ppm, g/l, mg/l, µg/l, mEq/l, own «own»: 5 ASCII characters.
>calculation parameters smpl size V total factor smpl. size unit:	If not needed: <clear> → «OFF ml». Starting volume (sample + ISA or TISAB). Result multiplier. Unit for sample size.	0.001...99 999.9, <i>OFF</i> . 0.1... <i>100.0</i> ...9 999.9 ml. 0...1...10 000 000. <i>ml</i> , g.
>calibration parameters no. of standards addition: conc. 1 conc. 2...	Number of standards for calibration. Selection of addition type. Standard concentrations.	1, 2...19. manual , auto. 0.001... <i>0.01</i> ...100 000 000.

<cal> starts calibration; <cal. data> allows viewing of calibration data.

Direct concentration measurement with *automatic* calibration

<Key>; display (LCD)	Remarks	Input range (required settings in bold face , initial values in <i>italics</i>)
<param>	692 pH/Ion Meter in Conc «c» .mode.	
parameter meas. type:	Selection of procedure for ion concentration measurement.	direct , std. add, smpl. add.
>calibration parameters no. of standards addition: min. conc. max. conc. V init no. of Exchange Units conc. 1 V Exchange Unit 1:	Number of standards for calibration. Selection of addition type. Minimum concentration to be analyzed. Maximum concentration to be analyzed. Initial volume (ISA or TISAB). Depends on concentration range; normally 1 Exchange Unit suffices. Concentration of standard in Exchange Unit 1. Select according to Exchange Unit used.	1, 2...19. manual , auto. 0.001... <i>0.1</i> ...10 000 000. 0.001...1.0... 10 000 000. 0.001... <i>100</i> ...9999.9 ml. 1...5. 0.001... <i>100.0</i> ...10 000 000. 1, 5, <i>10</i> , 20 or 50 ml.

Concentration measurement with manual standard addition

<Key>; display (LCD)	Remarks	Input range (required settings in bold face, initial values in <i>italics</i>)
<param>	692 pH/Ion Meter in Conc «c» .mode.	
parameter meas. type:	Selection of procedure for ion concentration measurement.	<i>direct</i> , std. add , <i>smpl. add.</i>
>standard addition type:	Select addition or subtraction.	add , <i>sub.</i>
conc. std.	Concentration of standard solution.	0.001... <i>1.0</i> ...100 000 000.
report:	Selection of report type.	<i>OFF</i> , <i>short</i> , <i>full</i> .
addition:	Select manual or automatic addition.	manual , <i>auto dos</i> , <i>auto</i> .
no. of additions	Number of standard additions.	1...19.
increment 1	Volume of 1 st increment.	0.001...0.1...99.9. This setting can be modified during standard addition to yield the desired potential increase.
start add with <enter>	692 pH/Ion Meter is ready for manual standard addition.	

Concentration measurement with automatic standard addition «auto»

<Key>; display (LCD)	Remarks	Input range (required settings in bold face, initial values in <i>italics</i>)
<param>	692 pH/Ion Meter in Conc «c» .mode.	
parameter meas. type:	Selection of procedure for ion concentration measurement.	<i>direct</i> , std. add , <i>smpl. add.</i>
>standard addition type:	Select addition or subtraction.	add , <i>sub.</i>
conc. std.	Concentration of standard solution.	0.001... <i>1.0</i> ...100 000 000.
report:	Selection of report type.	<i>OFF</i> , <i>short</i> , <i>full</i> .
addition:	Select manual or automatic addition.	<i>manual</i> , <i>auto dos</i> , auto .
delta U	Potential increase to be obtained per volume increment.	1...6...100 mV.
dos. rate:	Selection of dosing rate.	<i>medium</i> , <i>fast</i> , <i>slow</i> .
no. of additions	Number of standard additions.	1...19.
V Exchange Unit:	Select according to Exchange Unit used.	1, 5, 10, 20 or 50 ml.
start add with <enter>	692 pH/Ion Meter is ready for automatic standard addition.	

692 pH/Ion Meter – Instructions for Use

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1. Introduction

1.1 General

The 692 pH/Ion Meter puts at your disposal a large number of features and selection possibilities. However, the sophisticated user dialog facilitates access to all these options and allows you to adapt the instrument optimally to your requirements.

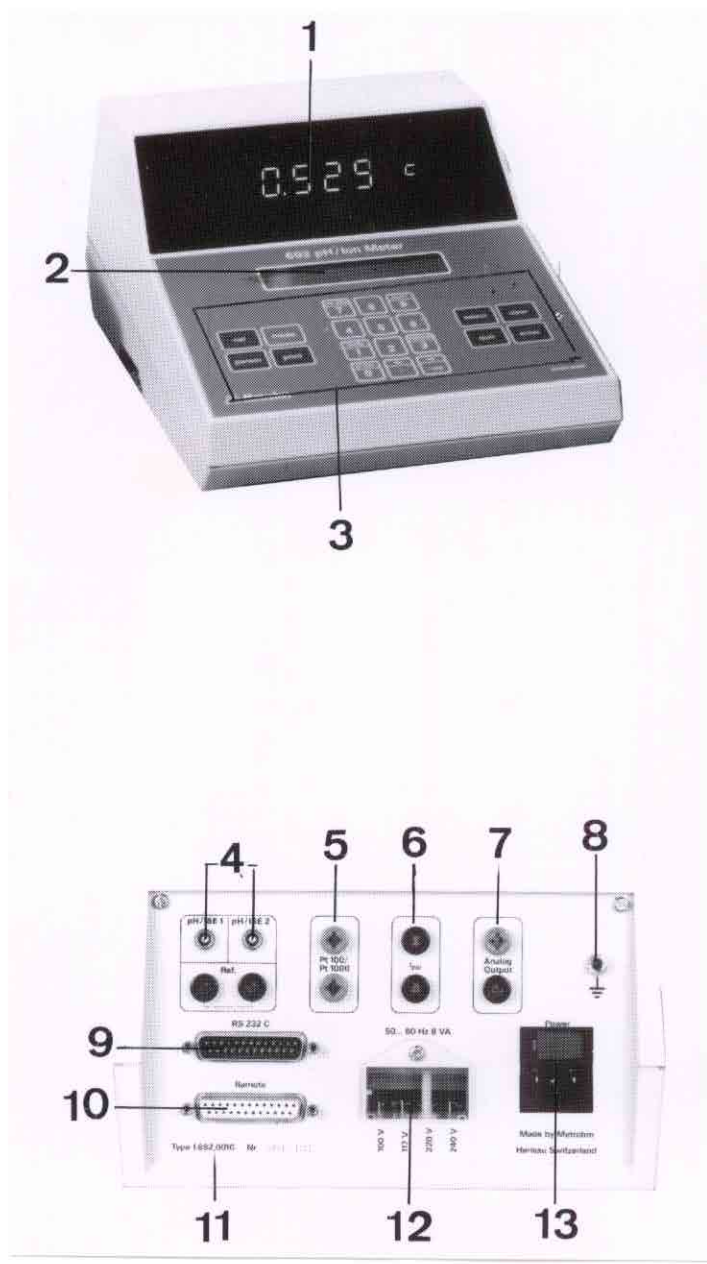
These Instructions for Use will first introduce the 692 pH/Ion Meter and subsequently show you how to prepare the instrument for pH measurement. At the same time, you will acquaint yourself with the dialog structure, which is analogous for all the many uses this instrument can be put to.

The list of contents preceding this page gives an idea of the organization of these Instructions for Use. When looking for a particular detail, the best approach is normally via the index, which is to be found at the end of the document.

The material printed on the green sheets is of interest if you wish to use the built-in RS 232 interface for the remote control of your 692 pH/Ion Meter.

Additional information on pH measurement, on concentration determination and on electrodes can be taken from the following Metrohm documents:

- Application Bulletin No. 188 «pH measurement technique»,
- Leaflet accompanying the Metrosensor pH electrodes,
- Instructions for Use of Metrosensor ion selective electrodes,
- Monograph «Electrodes in potentiometry»,
- Pamphlet «Metrosensor Electrodes»,
- Electrode catalog.



1.2 External features of the 692 pH/Ion Meter

The scope of delivery is not defined by the photographs shown here; refer to Appendix 2.

- ① Main display (gas discharge display) with numerical value, unit and status indicators.
- ② Dialog display (LCD), consisting of two lines of 24 characters each.
- ③ Keypad with number keys and operation keys.

- ④ Two inputs for potentiometric sensors (pH electrodes, ISE's, redox or silver electrodes) with integrated or separate reference electrodes. The two «pH/ISE» inputs and one of the «Ref» inputs can be used for differential potentiometry. See also section 1.3.
- ⑤ Input for Pt 100 or Pt 1000 temperature sensor.
- ⑥ Input for polarized electrodes.
- ⑦ Analog output for connecting a recorder or the pulse controller of a Combi Titrator consisting of pH/Ion meter, Impulsomat, Dosimat and, possibly, printer, recorder or PC.
- ⑧ Earthing socket.

- ⑨ RS 232C interface for connecting a printer or a computer.
- ⑩ Remote control connection (I/O lines) for stirrer, sample changer or robot.
- ⑪ Rating plate with series and manufacturing number.
- ⑫ Voltage selector window.
- ⑬ Power plug and power switch.

1.3 Input options for potentiometric electrodes, i.e. pH electrodes, ion selective electrodes, redox electrodes or silver electrodes

Key: CE Combined electrode (with integrated reference electrode)

SE Separate electrode (without reference electrode)

RE Reference electrode

AE Auxiliary electrode

Ve1 Vessel 1

Ve2 Vessel 2

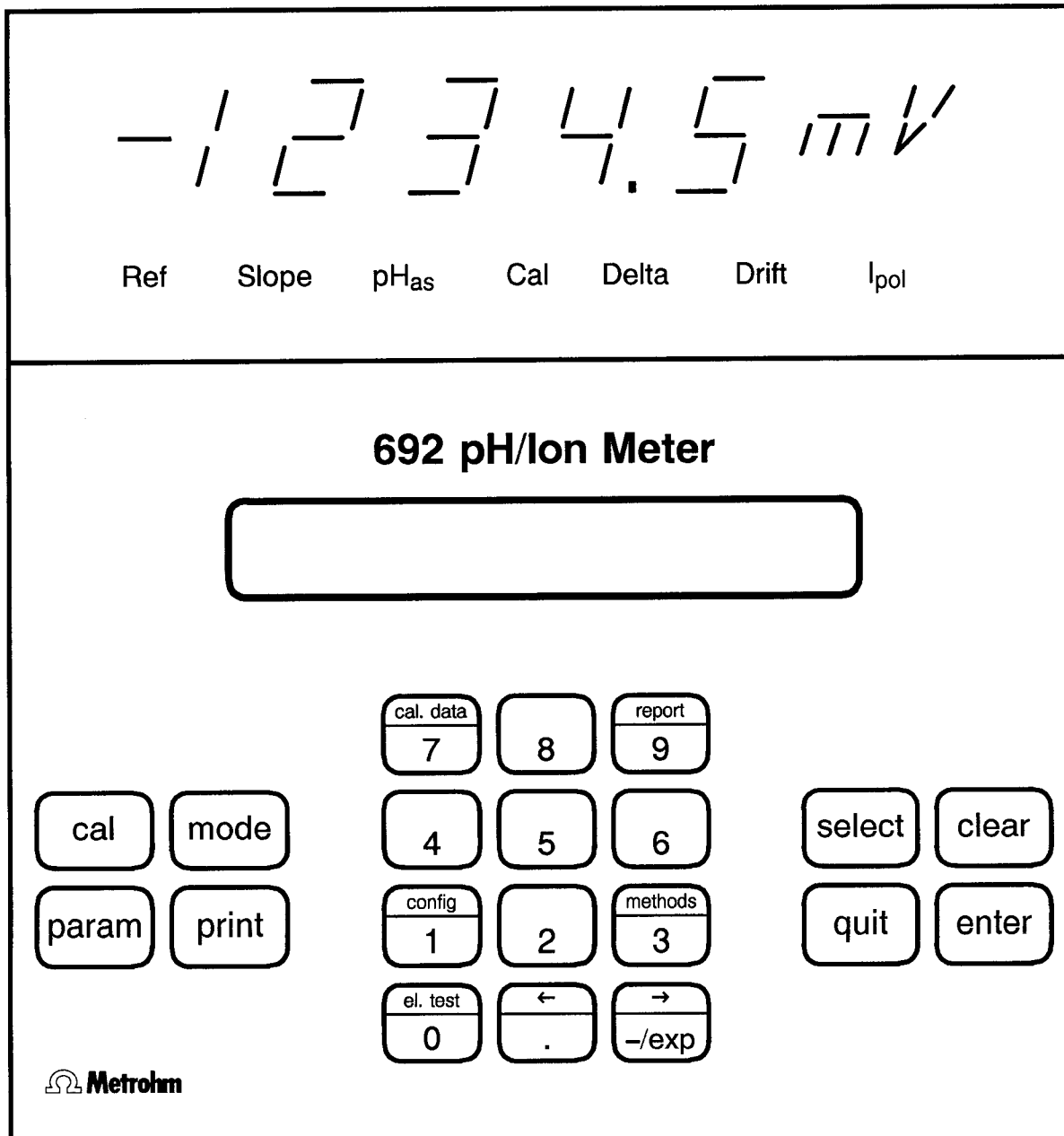
Configuration	Input options offered by the 692 pH/Ion Meter (each line corresponds to one option)		
	pH/ISE 1	pH/ISE 2	Ref.
1 vessel, 1 indicator electrode Use differential potentiometry for measurements in earthed solutions!	CE – SE –	– CE – SE	– – RE RE
1 vessel, 2 indicator electrodes Use differential potentiometry for measurements in earthed solutions!	CE SE SE	SE CE SE	– – RE
2 vessels, 2 indicator electrodes Important: The two solutions must not be earthed and there must be <i>no electrical connection</i> between the two solutions (beware of earth loops)!	CE Ve1 SE Ve1 CE Ve1 SE Ve1	CE Ve2 CE Ve2 SE Ve2 SE Ve2	– RE Ve1 RE Ve2 RE Ve1 + RE Ve2
Differential potentiometry (see also section 6.2.3.)	SE (6.0133.100)	RE (6.0729.100, shielded)	AE (6.0301.100)

Note: The two reference electrode inputs (Ref.) are connected

- with each other and
- with the shields of the pH/ISE 1 and pH/ISE 2 inputs.

The shields of the pH/ISE 1 and pH/ISE 2 inputs, in their turn, are connected **directly to earth**.

1.4 Sketch of main display and keypad



1.5 Some features of instrument operation

1.5.1 Non-volatile working memory

The 692 pH/Ion Meter, upon being switched on, is in exactly the same condition as when last switched off, i.e. mode, parameter settings, configuration and data memory are not affected when the power is switched off.

1.5.2 Basic methods

Ex works, the instrument memory is loaded with the basic methods «Conc», «pH», «T», «U» and «I_{pol}». These contain the initial values of the parameters for the measurement of concentration, pH, temperature (°C), potential (mV) and potential with I_{pol}, respectively. To recall the basic method «pH», e.g., switch on the 692 pH/Ion Meter and press **<methods>**. The display will show:

methods

>recall method

Press **<enter>** to get

>recall method

name: XXXX

Press **<select>** repeatedly until the name «pH» appears in the display and conclude with **<enter>**. The working memory of the 692 pH/Ion Meter now contains the method named «pH».

The basic methods should be kept for reference purposes. Accordingly, any changes made to the basic methods should be stored under a method name that is different from the above mentioned ones.

1.5.3 Instrument dialog

Use the **<mode>** key to switch the 692 pH/Ion Meter to the desired mode. If you are in any dialog position and wish to return to the initial state of the instrument program, press either **<mode>** or **<quit>**.

The instrument dialog is organized in the form of so-called rolling inquiries, which are arranged hierarchically. As an example, let us consider the inquiries accessible in the pH mode via the **<param>** key:

If **<param>** is pressed repeatedly, the following positions appear:

parameter

>measuring parameters
>calibration parameters
>electrode test
>analog output
>limits pH
>limits T
>plot parameters
>measuring parameters

To view or set the measuring parameters, depart from

parameter

>measuring parameters

and press **<enter>**. This leads to

>measuring parameters
meas. input: 1

The colon appearing in the lower line of the LCD display means that there is a selection of settings – in the present case these are «1», «2» and «diff» – that can be viewed by pressing **<select>**. Select «1» and confirm with **<enter>**. This brings to the display the next inquiry position

electr. id:

Here, the names of the pH electrodes (if any) stored with their calibration data can be viewed by pressing <select> or a new electrode name can be entered using the <←>, <→>, <clear> and <quit> keys. Upon pressing <enter>, the next inquiry position is displayed:

drift pH 0.050 /min

This parameter setting can be left as it is or a different value can be keyed in using the number keys and confirmed with <enter>, which brings us to the next positions, namely

temperature XX.X °C This dialog position appears only if no temperature sensor Pt 100 or Pt 1000 is connected. Key in the measuring temperature and press <enter> to get ...

method id pH 04 For example.

This «read only» information tells us that we are working with method «pH 04», e.g. We leave the inquiry by pressing <quit>, which brings us back to

parameter
>measuring parameter

Pressing <quit> another time brings us to the initial state of the program, with, e.g., the following display:

temp. Pt1000 23.6 °C
YY-MM-DD HH:MM:SS

2. Setting up, two-point calibration and pH measurement

2.1 Power connection

The set operating voltage is visible at the rear of the instrument. If the set voltage does not agree with the available power voltage, proceed as follows:

- Disconnect power cable.
- Unscrew plastic cover of voltage selector window.
- Using a small pair of pliers, insert the voltage selection plug at the appropriate voltage.
- Screw on plastic cover.

The power cable supplied with the instrument is three-cored and equipped with a plug with an earthing pin. If a different plug has to be fitted, the yellow/green lead must be connected to the protective earth. If no socket with earthing is available, the instrument must be connected to a perfect earthing conductor via its earthing socket. Each break in the earthing inside or outside the instrument can make it a hazard.

When the instrument is opened or if parts of it are removed, certain components may be live if the instrument is connected to the power line. The power cable must therefore always be unplugged when certain adjustments are made or parts replaced.

2.2 Buffer options

The buffer series listed below are stored in the 692 pH/Ion Meter as functions of temperature. The temperature dependence of each buffer is given in Appendix 3. The 692 pH/Ion Meter offers the possibility to use buffers belonging to various series for the same calibration («buffer type: mixed»). The additional buffers available for this are listed separately.

Buffer series	pH value of buffer											Additional buffers accessible under «buffer type: mixed»
	1	2	3	4	7	9	10	11	12	13		
Metrohm	●			●	●	●					●	
NIST ^{a)}	●			●	●	●					●	
DIN ^{b)}	●		●	●	●	●				●		
Fisher				●	●		●					
Ciba				●	●	●						
Ingold		●		●	●	●			●			
Merck		●		●	●	●				●		1 3 4.66 5 6 6.88 8 9.22 10 11 13
Beckman				●	●		●					
Radiometer				● 4.01	●	● 9.18						1.09 1.68 6.84 7.38 10.01

a) National Institute of Standards and Technology (formerly NBS)

b) Deutsches Institut für Normung (German Standards Association)

Additional possibilities:

- «special» Enter up to 9 single buffer values of your own choice.
- «own» Enter 5 buffer series of your own choice as follows: Key in the buffer values belonging to the temperature indicated in the display (e.g. «pH at 0 °C»); buffer values that are not explicitly known at a given temperature must be estimated by linear interpolation and entered; however, at the lower and upper ends of the table thus produced, pH = 0 may be set for those temperatures where no data is available. The instrument applies linear interpolation to calculate the buffer values as a function of temperature.
- «mixed» Select 5 buffers from the following series: Metrohm, NIST, DIN, Fisher, Ciba, Ingold, Merck, Beckman, Radiometer or «own».

Please note: If the instrument is programmed to work with more than 2 buffers, buffers no. 3 to 9 may be the same as buffers no. 1 or 2. This procedure can be applied if one wishes to give added statistical weight to a given buffer. Of course, in two-point calibration, the same buffer cannot be used twice (error message: «same buffer»).

2.3 Preliminary settings

The 692 pH/Ion Meter is ready for measurement immediately after being switched on.

The following describes how the 692 pH/Ion Meter is prepared for pH measurement by setting the instrument configuration and the parameters and by carrying out a two-point calibration.

The information set in *italics* applies only if a Pt 100 or Pt 1000 temperature sensor is connected; on the other hand, the information put within square brackets [...] does not appear if one of the temperature sensors mentioned is connected.

Use the <select> key to view options, <clear> to delete entries, <quit> to switch to a higher program level and <enter> to confirm options as well as to enter parameters, time, date, etc.

Key	Display (LCD); recommended settings	Available options; remarks
Power on	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	Power switch is above power cable connector.
<mode> → pH	temp. <i>Pt</i> ...: YY-MM-DD XX.X °C HH:MM:SS	pH, °C, mV, mV/I _{pol} , Conc («C»)
<config>	config >auxiliaries	<config> key is combined with number key «1».
<enter>	last digit: ON	ON, OFF (<select> key); OFF→last digit is not displayed.
<enter>	dialog: english	english, deutsch, français, español
<enter>	date YY-MM-DD	
<enter>	time HH:MM:SS	24 h format, e.g. 15:07:51
<enter>	temp. unit: C	C, F (°C, °F)
<enter>	run number OFF	0, 1, 2, 3 ... 999, OFF
<enter>	device label 692 pH/I	8 ASCII characters (← → keys); see chap. 4, <config>, <←> and <→> keys.
<enter>	program XXXXXXXX	Installed program version.

2.4 Two-point calibration

Connect pH electrode to input «pH/ISE 1».

Key	Display (LCD)	Remarks
<cal>	[enter cal.temp. temperature XX.X °C]	Put electrode into buffer 1. [Enter buffer temperature and confirm with <cal> ...]
	<i>measure temperature buffer 1</i>	
[<cal>]	meas U buffer 1	
	change buffer buffer 2	Put electrode into buffer 2 or interrupt by pressing <quit> or <mode>. →One-point calibration.
<cal>	<i>measure temperature buffer 2</i>	
	meas U buffer 2	
	pHas 7.009	Electrode slope, e.g. 0.987, appears for some seconds in the main display.
	temp. Pt ...: XX.X °C YY-MM-DD HH:MM:SS	Instrument switches to pH measurement automatically.

The 692 pH/Ion Meter is now ready for pH measurement.

2.5 Calibration data

The calibration data obtained by linear regression can be viewed as shown below. For additional information see chapter 4, <cal. data> key.

Key	Display (LCD)	Remarks
<cal. data>	cal. data electr. id pH E1 12	<cal. data> on key «7». Electrode designation. See section 2.3: <param> – > measuring parameters – «electr. id:».
<enter>	slope 0.987	Slope = 98.7% (e.g.). Range 0.001 ... 9.999.
<enter>	pH(as) 7.009	Asymmetry pH = 7,009 (e.g.). Range -99.999 ... 99.999.
<enter>	temperature [man] XX.X °C	
<enter>	cal.date YY-MM-DD HH:MM	Date and time of latest calibration. See following page*.
<enter>	measure input 1	Electrode input 1.
<enter>	offset Uas XX.X mV	This information appears only if «offset Uas» has been set; see section 2.6.

Key	Display (LCD)	Remarks
<enter>	buffer type	Metrohm
<enter>	no. of buffers	2 Number of buffers actually used for calibration.
<enter>	cal. table:	original original, delete n, reset cal. See chapter 4, <cal. data> key.
<enter>	temp. Pt ...: YY-MM-DD	XX.X °C HH:MM:SS

- * If more than 2 buffers have been used for calibration, the variance is shown here. It is calculated according to the following formula:

$$\text{Variance} = \text{Sum of all } (U_i \text{ calculated} - U_i \text{ measured})^2 / (N-F);$$

where	U_i (measured)	measured voltage of point i ;
	U_i (calculated)	voltage resulting from regression analysis;
	N	number of points measured;
	F	degrees of freedom for pH calibration (linear correlation): F=2 → variance can only be calculated for more than 2 buffers.

«variance manual» is displayed if calibration data have been entered manually.

2.6 Application of «offset U_{as} »

The automatic buffer recognition of the 692 pH/Ion Meter is based on an asymmetry potential U_{as} of ± 30 mV. Normally, with Ag/AgCl reference systems, this condition is fulfilled. However, if this reference system is replaced by a calomel one, e.g., U_{as} may be outside the above limits. To ensure the functioning of the automatic buffer recognition also in those cases, the deviation has to be compensated as follows:

Key	Display (LCD)	Remarks
	parameter >calibration parameters	Press <enter> repeatedly ...
<enter> ...	>calibration parameters offset U_{as} state	meas meas: measured potential is displayed in the next step. OFF: no offset U_{as} . ON: offset U_{as} can be set.
<enter>	offset U_{as}	XX.X mV Immerse pH electrode into buffer pH=7, wait for a stable reading and press <enter>. Offset U_{as} can also be keyed in manually, its range being -1999.9 ... 1999.9 mV. Offset U_{as} is taken into account by the instrument for the automatic buffer recognition and can be viewed under <cal. data> (see section 2.5).

2.7 Error messages

During pH calibration, the following error messages may appear:

Key	Display (LCD or main display)	Remarks; corrective action
	buffer alloc. impossible	Buffer cannot be recognized. → Replace buffer and press <cal>.
	same buffer	Same buffer used twice or asymmetry potential too large. → Change buffer and press <cal> or enter asymmetry potential U_{as} (see section 2.6).
	buffer not defined	pH value of «own» buffer not defined at given temperature. → Enter missing value in temperature table (<param> – > calibration parameters – buffer type: own – > own buffer X – pH at XX °C).
	1.381 (e.g.) Slope	Cal
	pHas yes: <enter>	6.149 (e.g.) no: <mode>
		Main display.
		LCD.
		Cause: extreme values of calibration data.
<mode>	→ Reject calibration data.
<enter>	→ Accept calibration data.
	<i>delta T > 2 °C</i>	Buffer temperatures differ by more than 2 °C. → Use buffers having the same temperature and press ...
<cal>	<i>meas temperature buffer X</i>	
	1999.9 °C (flashing)	Main display. Temperature sensor has been disconnected during calibration or is defective. → Reconnect or replace temperature sensor.
	<i>meas temperature buffer X</i>	

3. Ion concentration measurement

3.1 General

For information on ion selective electrodes, sample preparation and other methodological features of ion concentration measurement see the Instructions for Use delivered with every MetroSensor ion selective electrode. The Metrohm Monograph «Electrodes in Potentiometry» gives fundamental as well as practical information on ion selective and other potentiometric electrodes.

Details concerning the connection of a stirrer, Dosimat or printer can be taken from section 3.3.

3.1.1 Available techniques

The overview given below informs about the possibilities that are offered by the 692 pH/Ion Meter in the field of ion concentration measurement.

Technique Variant	Corresponding dialog positions of 692 pH/Ion Meter	See section
Direct measurement after calibration	parameter meas. type direct	
Manual calibration	>calibration parameters addition: manual	3.2
Automatic calibration	>calibration parameters addition: auto	3.3
Standard addition (subtraction)	parameter meas. type std. add	
Manual addition	>standard addition type: add (sub) addition: manual	3.5.2
Automatic addition of predetermined volume increments	>standard addition type: add (sub) addition: auto dos	3.5.3
Automatic addition of variable volume increments yielding the predetermined potential changes ΔU	>standard addition type: add (sub) addition: auto	3.5.4
Sample addition (subtraction)	parameter meas. type smp1. add	
Manual addition	>sample addition type: add (sub) addition: manual	3.6
Automatic addition of predetermined volume increments	>sample addition type: add (sub) addition: auto dos	
Automatic addition of variable volume increments yielding the predetermined potential changes ΔU	>sample addition type: add (sub) addition: auto	

3.1.2 Evaluation

The volumes added during calibration or standard addition are taken into account automatically.

The calibration data are fitted to the Nikolsky equation:

$$U_i = E_0 + \text{slope} \times \log(c_i + c_{\text{blank}}),$$

where U_i measured potential,

E_0 constant (= potential at $c_i + c_{\text{blank}} = 1$),

slope slope (potential change per decade),

c_i ion concentration,

c_{blank} blank concentration

(for $c_{\text{blank}} = 0$, there results a linear relationship between U_i and $\log c_i$).

The evaluation of the measured data, U_i and c_i , results in values for E_0 , slope and c_{blank} if at least 3 calibration standards are used. If only 2 calibration standards are used, c_{blank} is set equal to zero and is not displayed; if only 1 calibration standard is used, c_{blank} is set equal to zero and «slope» is either left at the value determined in the previous calibration (if any) or set equal to its theoretical value, e.g., -59.2 mV for monovalent anions, such as F^- , at 25 °C. The calibration data can be viewed under <cal. data> or on the printout; see chapter 4, description of <cal. data> key.

For the evaluation of the addition methods c_{blank} is assumed to be equal to zero, therefore the resulting relationship is always linear.

The following two formulae are applied for result calculation:

Result = $c_i \times \text{factor}$ (with «sample size OFF»);

Result = $c_i \times \text{factor} \times \langle V_{\text{total}} \rangle / \langle \text{sample size} \rangle$ (with «sample size XX»).

3.1.3 Display of results, scientific notation

The 692 pH/Ion Meter displays ion concentrations as shown by the following examples:

Main display	LCD	Floating point notation
58.9 c	58.9 mg/l	58.9 mg/l
2.16 2	2.16E+02 ppm	216 ppm
9.87 -5	9.87E-05 mol/l	0.0000987 mol/l

Ion concentrations may assume both very large or very small values. The 692 pH/Ion Meter allows to enter concentration values in the range $1.0E-30 \dots 1.0E+30$ ($1.0 \times 10^{-30} \dots 1.0 \times 10^{+30}$). For the range $1.0E-5 \dots 1.0E+5$ ($1.0 \times 10^{-5} \dots 1.0 \times 10^{+5}$), the list given below shows the relationship between the scientific (exponential) notation used by the 692 pH/Ion Meter, the standard scientific notation and floating point notation.

Scientific notation used by 692 pH/Ion Meter	Standard scientific notation	Floating point notation
1.0E-05	1.0×10^{-5}	0.00001
1.0E-04	1.0×10^{-4}	0.0001
1.0E-03	1.0×10^{-3}	0.001
1.0E-02	1.0×10^{-2}	0.01
1.0E-01	1.0×10^{-1}	0.1
1.0E+00	1.0×10^0	1.
1.0E+01	1.0×10^1	10.
1.0E+02	1.0×10^2	100.
1.0E+03	1.0×10^3	1000.
1.0E+04	1.0×10^4	10 000.
1.0E+05	1.0×10^5	100 000.

3.2 Direct ion concentration measurement with manual calibration

The following describes how the 692 pH/Ion Meter is prepared for ion concentration measurement by setting the instrument configuration and the parameters and by carrying out a calibration with three standard solutions.

The information set in *italics* applies only if a Pt 100 or Pt 1000 temperature sensor is connected; on the other hand, the information put within square brackets [...] does not appear if one of the temperature sensors mentioned is connected.

See section 1.3 about the input options for potentiometric electrodes; section 1.5 gives a summary of instrument operation.

• Configuration

With the exception of

type of Dosimat: **665** (665 or 725 Dosimat can be selected)

the settings accessible via the <config> key do not affect the procedure to be described and can be taken from section 2.3.

• Parameters

Select mode «C», i.e. ion concentration measurement, and set the parameters as described below:

Key	Display (LCD); recommended settings	Available options; remarks
<param >	parameter meas. type: direct	direct, std. add, smpl. add
<enter >	parameter >measuring parameters	
<enter >	>measuring parameters ion type: F(-1)	Ag(+1), BF ₄ (-1), Br(-1), Ca(+2), Cd(+2), Cl(-1), CN(-1), Cu(+2), F(-1), I(-1), K(+1), Na(+1), NH ₄ (+1), NO ₂ (-1), NO ₃ (-1), Pb(+2), S(-2), SCN(-1), SO ₄ (-2), own own: 7 ASCII characters (← → keys).
<enter >	conc. unit: mg/l	mol/l, %, ppm, g/l, mg/l, µg/l, mEq/l, own own: 5 ASCII characters (← → keys).
<enter >	meas. input: 1	1; 2; diff: electrode input 1; 2 or differential potentiometry.
<enter >	electr. id: F Electr	ASCII string (← → keys)
<enter >	drift 1 mV/min	Refers to measurement , not calibration. 0.1...999.9 mV/min; OFF
[<enter >	temperature XX.X °C]	-999.9...999.9 °C; sample temperature
<enter >	method id. XY ...	Read only.
<enter >	delta measurement: OFF	OFF, ON, meas.
<enter >	stirrer: OFF	ON, control, OFF (if «control» is selected, there are some additional steps).
<enter >	parameter >calculation parameters	
<enter >	smpl size XX ml	0.001...99 999.9 ml. If not needed: <clear > → «OFF ml».
<enter >	V total XX.X ml	0.001...9 999.9 ml. Total starting volume made up of sample plus ISA or TISAB, etc.
<enter >	factor 1.0	0...10 000 000 (1E-37...1E+30); result multiplier.
<enter >	smpl size unit: ml	ml, g
<enter >	parameter >calibration parameters	
[<enter >	>calibration parameters temperature XX.X °C]	0.0...99.9 °C; temperature of standards.
<enter >	drift 0.5 mV/min	For calibration ; 0.1...9.9 mV/min.
<enter >	report: OFF	short, full, OFF
<enter >	no. of standards 3	1; 2;...19
<enter >	addition: manual	auto, manual

Key	Display (LCD); recommended settings	Available options; remarks
<enter>	conc. 1 XX.X mg/l	0.001...100 000 000. Enter standard concentr. 1.
<enter>	conc. 2 XX.X mg/l	Enter standard concentr. 2.
<enter>	conc. 3 XX.X mg/l	Enter standard concentr. 3.
<enter>	parameter >analog output	Exit by pressing ...
<quit>	F(-1): XX.XX mg/l temp. Pt ... XX.X °C	Start calibration by pressing ...
<cal>	[enter cal.temp. temperature XX.X °C]	Immerse electrode into standard 1. [Key in calibration temperature and confirm with <cal> ...]
[<cal>]	enter std. conc. conc. 1 XX.X mg/l	Enter standard concentr. 1.
<cal>	<i>measure temperature std. 1</i>	
[<cal>]	meas U std. 1	Main display shows measured potential.
	change std. std. 2	Immerse electrode into standard 2.
<cal>	enter std. conc. conc. 2 XX.X mg/l	Enter standard concentr. 2.
<cal>	<i>measure temperature std. 2</i>	
	meas U std. 2	Main display shows measured potential.
	change std. std. 3	Immerse electrode into standard 3.
<cal>	enter std. conc. conc. 3 XX.X mg/l	Enter standard concentr. 3.
<cal>	<i>measure temperature std. 3</i>	
	meas U std. 3	Main display shows measured potential.
	evaluation *	Evaluation in progress (asterisk flashing).
	E0: XX.X mV Cb: X.XX	E(0) and c(blank). Main display shows calculated slope in mV.
	F(-1) temp. Pt ... XX.X mg/l XX.X °C	The main display shows the numerical value of the measured concentration (without unit). The temperature displayed is either that measured by the Pt 100 or Pt 1000 temperature sensor or the measurement temperature entered under «measuring parameters».

To view the calibration data, press <cal. data>; see also section 3.4 and chapter 4, <cal. data> key.

Depending on the application, more than three standard solutions may be needed. The 692 pH/Ion Meter allows to use up to 19 different standards.

After calibration the 692 pH/Ion Meter is ready for the measurement of ion concentrations; the concentration corresponding to the potential measured appears in the main display (without unit) and in the upper line of the LCD.

The printout and the plotting of measured concentrations and temperatures is described in chapter 4, <print> key.

3.3 Direct ion concentration measurement with automatic calibration

This procedure offers a maximum of comfort; the optimally spaced calibration standards are generated automatically by the Dosimat after the following parameters have been specified: number of calibration standards, the concentration range to be covered (minimum and maximum concentration), the total initial volume, the concentration of the standard solution in the Exchange Unit used and its buret volume. If very large concentration ranges have to be covered, it is possible to use up to 5 Exchange Units with different standard solutions. Maximum one buret volume can be added per Exchange Unit used.

It is assumed that a 665 or 725 Dosimat, a stirrer (622, 649 or 722) or a Titration Stand (727 or 703) are connected. The Dosimat type has to be specified under <config>, see section 3.2.

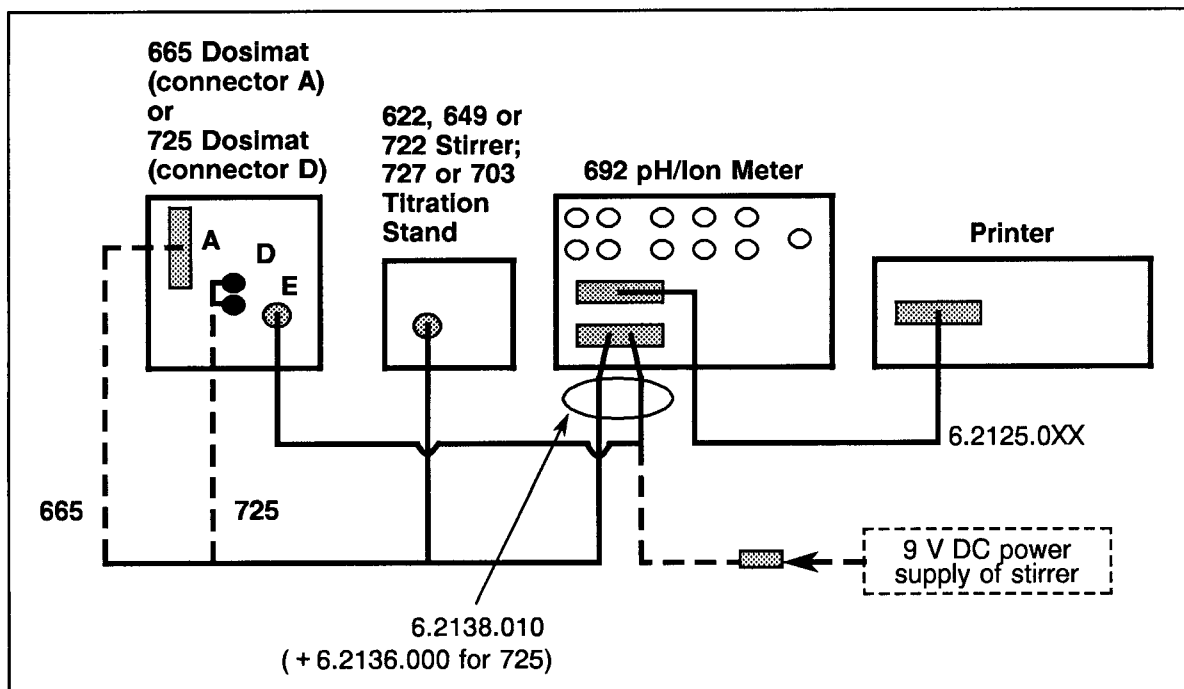


Fig. 3.3: Cable connections between 692 pH/Ion Meter, 665 or 725 Dosimat, stirrer and printer.

The 6.2138.010 cable serves to connect the 665 or 725 Dosimat and/or the stirrer with the 692 pH/Ion Meter; the 725 Dosimat requires the additional 6.2136.000 adapter. To connect the stirrer alone, the 6.2138.000 cable can also be used (see section 5.1).

For the connection of a printer see section 7.1.

Important:

- Switch on the 692 pH/Ion Meter first, then the Dosimat.
- Set Dosimat Mode to «DIS C».

The initial settings can be taken from the preceding section 3.2 with the following exceptions:

Key	Display (LCD); recommended settings	Available options; remarks
	>measuring parameters	
	conc. unit: ppm	
	stirrer: control	OFF, ON, control.
<enter>	prestir pause XX s	0...99 999 s; waiting time before stirring.
<enter>	stir time XX s	0...99 999 s; stirring time.
<enter>	poststir pause XX s	0...99 999 s; waiting time after stirring.
<enter>	parameter	
	>calculation parameters	See section 3.2.
<param>	parameter	
	>calibration parameters	
[<enter>	>calibration parameters	
	temperature XX.X °C]	0.0...99.9 °C; temperature of standards.
<enter>	drift 0.5 mV/min	For calibration ; 0.1...9.9 mV/min.
<enter>	report: full	OFF, short, full. Calibration report on printer.
<enter>	no. of standards 4	1; 2;...19
<enter>	addition: auto	auto, manual
<enter>	min. conc. XXX.X ppm	0.001...10 000 000 (1E-30...1E+30). Minimum concentration to be analyzed.
<enter>	max. conc. XXX.X ppm	0.001...10 000 000 (1E-30...1E+30). Maximum concentration to be analyzed.
<enter>	V init XX.X ml	0.001...9999.9. Total initial volume (ISA or TISAB solution, etc.).
<enter>	no of Exchange Units 1	1, 2...5; depends on concentration range; normally 1 Exchange Unit suffices.
<enter>	conc. 1 XXXX.X ppm	0.01...10 000 000 (1E-30...1E+30). Conc. of standard in Exchange Unit 1.
<enter>	V Exchange Unit 1: XX	1, 5, 10, 20 or 50 ml; in accordance with Exchange Unit used.
<enter>	parameter	
	>analog output	Exit by pressing ...
<quit>	F(-1): XX.XX mg/l temp. Pt ... XX.X °C	Start calibration by pressing ...
<cal>	[enter cal.temp. temperature XX.X °C]	Put electrode into initial solution. [Enter standard temperature and confirm with <cal> ...]
[<cal>]	filling dosimat dV=X µl c=XXXX.X mg/l	Applies to 665; with 725, the message «fill dosimat, max. rate» appears. Set «Δ volume» on Dosimat = dV = X µl and dosing rate «dV/dt» to position 10. With the 665, the procedure continues automatically, with the 725, press <quit> when ready.

Key	Display (LCD); recommended settings	Available options; remarks
	add standard std. 1	
	prestir pause std. 1	XX s Count down of prestir waiting time.
	stirring std. 1	XX s Count down of stirring time.
	poststir pause std. 1	XX s Count down of poststir waiting time.
	<i>measure temperature</i> std. 1	
	meas U std. 1	
	add standard std. 2	
	prestir pause std. 2	Sequence continues as shown above.
	evaluation	* Evaluation in progress (asterisk flashing).
	E0: XX.X mV Cb: X.XX	E(0) and c(blank). Main display shows calculated slope in mV.
	F(-1) temp. Pt ...	XX.X mg/l XX.X °C Main display shows numerical value of measured concentration (without unit).

To view the calibration data, press <cal. data>; see also section 3.4 below and chapter 4, <cal. data> key.

The following pages contain two examples of concentration calibration reports together with the corresponding parameter reports.

Report of automatic concentration calibration carried out using one Exchange Unit (left), with printout of measured value (bottom left) and corresponding parameter report (right) (graphics not strictly representative)

Concentration calibration report and printout of measured value

Parameter report

```

date 92-10-17      time 08:21:41      3
conc. calibration
meas. input:      1
ion type          F(-1)
electr. id       F 5
temperature      21.3 C
cal. date        92-10-17 08:21

      conc/ppm      U/mV      dconc/%*
std. 1      4.99E+01      8.4      0.1
std. 2      9.08E+01     -6.9     -0.1
std. 3      1.65E+02    -22.1    -0.1
std. 4      3.00E+02    -37.3     0.1
    
```

```

variance          0.001
slope             -58,7mV
E(0)             108.1 mV
**
===== ***
    
```

```

date 92-10-17      time 08:30:19
id1 Metrohm Herisau
id2 Appl. 441
#5      263 ppm      22.2 C      F(-1)
      92-10-17      08:30:19
===== ***
    
```

```

date 92-10-17      time 08:26:49
parameter
meas. type:      direct
>measuring parameters
ion type:        F(-1)
conc. unit:      ppm
meas. input:    1
electr. id:      F 5
drift            1.0 mV/min
method id       F Schn
delta measurement: OFF
stirrer:        control
Prestir pause   1 s
stir time       25 s
poststir pause  5 s
>calculation parameters
smp1 size       20.0 ml
V total         40.0 ml
factor          1.0
smp1 size unit: ml
>calibration parameters
drift           0.5 mV/min
report:         full
no. of standards 4
addition:       auto
min. conc.     50.0 ppm
max. conc.     300.0 ppm
V init         50.0 ml
no. of Exchange Units 1
conc. 1        10000.0 ppm
V Exchange Unit 1: 10
>analog output
select:         Conc
state:          OFF
>limits Conc
state:          OFF
>limits T
state:          OFF
>plot parameters
left mar.       5.0E+01 ppm
right mar.      3.0E+02 ppm
left marg. T    20 C
right marg. T   30 C
-----
    
```

* «dconc/%» is calculated as follows:

$$(\text{nominal std. concentration} - \text{calculated concentration}) / \text{nominal std. concentration} \times 100.$$

** c(blank) is not indicated because the relationship is linear (c(blank) = 0).

*** The double dashed line appears at the end of original calibration and measurement reports, the single dashed line at the end of duplicates.

Report of automatic concentration calibration carried out using three Exchange Units (left), with corresponding parameter report (right) (graphics not strictly representative)

Concentration calibration report

Parameter report

```

date 92-10-01   time 13:37:30   7
conc. calibration
meas. input:           1
ion type               F(-1)
electr. id             502.150
temperature             20.4 C
cal. date              92-10-01 13:37

      conc/ppm      U/mV      dconc/%*
std. 1      2.00E-01      145.9      -0.9
std. 2      3.79E-01      130.9       1.3
std. 3      7.15E-01      115.0       0.6
std. 4      1.35E+00       98.8       0.3
sdt. 5      2.56E+00       82.6       0.1
sdt. 6      4.84E+00       66.4       0.0
sdt. 7      9.16E+00       50.0      -0.5
sdt. 8      1.73E+01       33.6     -1.1
sdt. 9      3.27E+01       17.5     -0.6
sdt.10      6.20E+01        1.3     -0.2
sdt.11      1.17E+02      -15.0       0.1
sdt.12      2.22E+02      -31.3     -0.1
sdt.13      4.19E+02      -47.6     -0.1
sdt.14      7.93E+02      -63.8       0.2
std.15      1.50E+03      -79.9       0.9
    
```

```

variance           0.029
slope              -58,8 mV
E(0)              106.7 mV
c(blank)          1.43E-02 ppm
===== **
    
```

```

date 92-10-01   time 13:43:43
parameter
meas. type:           direct
>measuring parameters
ion type:             F(-1)
conc. unit:           ppm
meas. input:         1
electr. id:           502.150
drift                 1.0 mV/min
method id             F MS
delta measurement:    OFF
stirrer:              control
Prestir pause        3 s
stir time             20 s
poststir pause       5 s
>calculation parameters
smp1 size             20.0 ml
V total               40.0 ml
factor                1.0
smp1 size unit:      ml
>calibration parameters
drift                 0.5 mV/min
report:               full
no. of standards     15
addition:             auto
min. conc.            0.2 ppm
max. conc.            1500.0 ppm
V init                40.0 ml
no. of Exchange Units 3
conc. 1               100.0 ppm
V Exchange Unit 1:   5
conc. 2               2000.0 ppm
V Exchange Unit 2:   5
conc. 3               10000.0 ppm
V Exchange Unit 3:   10
>analog output
select:               Conc
state:                OFF
>limits Conc
state:                OFF
>limits T
state:                OFF
>plot parameters
left mar.             0E+00 ppm
right mar.            1.5E+03 ppm
left marg. T          20 C
right marg. T         30 C
    
```

* «dconc/%» is calculated as follows:

$$(\text{nominal std. concentration} - \text{calculated concentration}) / \text{nominal std. concentration} \times 100.$$

** The double dashed line appears at the end of original calibration and measurement reports, the single dashed line at the end of duplicates.

3.4 Calibration data

The current calibration data can be viewed as follows:

Key	Display (LCD)	Remarks
<cal. data>	cal. data ion type: F(-1)	<cal. data> on key «7».
<enter>	electr. id F Electr	Electrode designation.
<enter>	slope -XX.X mV	
<enter>	E(0) XXX.X mV	
<enter>	c(blank) X.XX mg/l	
<enter>	temperature [man] XX.X °C	
<enter>	cal.date YY-MM-DD HH:MM	Date and time of latest calibration.
<enter>	variance X.XXX	See note below*.
<enter>	measure input 1	Electrode input 1.
<enter>	no. of standards X	Number of standards actually used for calibration.
<enter>	cal. table: original	original, delete n, reset cal (see chapter 4, <cal. data> key).
<enter>	F(-1): XX.X mg/l temp. Pt ... XX.X °C	

* The variance is shown here if more than 3 standards [c(blank) ≠ 0, which is normally the case] or more than 2 standards [c(blank) = 0] are used. It is calculated according to the following formula:

$$\text{Variance} = \text{Sum of all } (U_i \text{ calculated} - U_i \text{ measured})^2 / (N-F);$$

where U_i (measured) measured voltage of point i ;
 U_i (calculated) voltage resulting from regression analysis;
 N number of points measured;
 F degrees of freedom:
 $F = 2$ for c(blank) = 0 (linear correlation);
 $F = 3$ for c(blank) ≠ 0 (non-linear correlation).

«variance manual» is displayed if calibration data have been entered manually.

3.5 Ion concentration measurement with standard addition (or subtraction)

3.5.1 General

The standard addition method consists in adding to the sample solution exactly metered volumes of a single standard containing a known concentration of the ion to be determined. The potential is measured in the initial sample solution and after each standard addition. For details on the methodology, see, e.g., the Instructions for Use of the MetroSensor ion selective electrodes.

The initial settings can be taken from sections 3.2. and 3.3 with the exceptions mentioned below. Information on the connection of a stirrer and a Dosimat is given in section 3.3.

For the connection of a printer see section 7.1.

3.5.2 Manual standard addition

With manual standard addition, the 692 pH/Ion Meter allows to gauge the volume increments such that the desired potential increase is obtained each time an addition is made. This feature can be employed to check the suitability of standard solutions to be used for automatic standard addition.

Key	Display (LCD); recommended settings	Available options; remarks
<param >	parameter meas. type	std. add
		direct, std. add, smpl. add
	>measuring parameters conc. unit	ppm
		mol/l, %, ppm, g/l, mg/l, µg/l, mEq/l, own.
	parameter >calculation parameters	
		See section 3.2.
	>standard addition type:	add
		add, sub(tract)
<enter >	conc. std.	XXXX.X ppm
		0.001...100 000 000; concentration of standard solution.
<enter >	report:	full
		short, full, line, OFF
<enter >	addition:	manual
		manual, auto dos, auto. manual: manual addition; auto dos: automatic addition of predetermined volume increments, see section 3.5.3; auto: fully automatic additions resulting in constant potential increments ΔU , see section 3.5.4.
<enter >	no. of additions	3
		1...19 manual standard additions.
<enter >	increment 1	0.1 ml
		0.0...99.9 ml; this and the following settings can be modified during the standard addition.
<enter >	increment 2	0.1 ml
<enter >	increment 3	0.1 ml

Key	Display (LCD); recommended settings	Available options; remarks
<enter>	*** 692 pH/Ion Meter *** start add with <enter>	
<enter>	[enter temp. temperature XX.X °C]	Main display: «Add c». Immerse electrode into initial solution. [Key in sample temperature and confirm with <enter>.]
<enter>	...	The stirrer sequence is performed, see section 3.3.
	add standard increment 1 0.1 ml	Main display shows «mV – Delta», i.e. the voltage change ΔU referred to the initial solution is indicated. Add standard until the desired ΔU (e.g. 15 mV) is reached and enter the corresponding volume as increment 1.
<enter>	...	Stirrer sequence etc. up to increment 3.
	evaluation *	Evaluation in progress (asterisk flashing).
	F(-1) XX.X ppm start add with <enter>	Result. Instrument is ready for next run.

3.5.3 Automatic standard addition «auto dos»

«auto dos» stands for the automatic addition of predetermined volume increments by means of a 665 or 725 Dosimat.

It is assumed that a 665 or 725 Dosimat, a stirrer (622, 649 or 722) or a Titration Stand (727 or 703) are connected. The Dosimat type has to be specified under <config>, see section 3.2.

A sketch of the cable connections is given in section 3.3. The 6.2138.010 cable serves to connect the 665 or 725 Dosimat and/or the stirrer with the 692 pH/Ion Meter; the 725 Dosimat requires the additional 6.2136.000 adapter.

For the connection of a printer see section 7.1.

Important:

- Switch on the 692 pH/Ion Meter first, then the Dosimat.
- Set Dosimat Mode to «DIS C».

The initial settings can be taken from sections 3.2. and 3.3 with the following exceptions:

Key	Display (LCD); recommended settings	Available options; remarks
<param >	parameter meas. type std. add	direct, std. add, smpl. add
	>measuring parameters conc. unit ppm	mol/l, %, ppm, g/l, mg/l, µg/l, mEq/l, own.
	>standard addition type: add	add, sub(tract)
	>standard addition addition: auto dos	manual, auto dos, auto. manual: manual addition; auto dos: automatic addition of predetermined volume increments; auto: fully automatic additions resulting in constant potential increments delta U, see section 3.5.4.
<enter >	dos. rate: medium	fast, slow, medium.
<enter >	no. of additions 3	1...19.
<enter >	V Exchange Unit: XX	1, 5, 10, 20, 50 ml.
<enter >	increment 1 XX.X ml	0.0...99.999 ml. Etc. up to increment 3.
<enter >	F(-1) XX.X ppm start add with <enter >	
<enter >	filling dosimat dV=X µl c=XXXX.X mg/l	Applies to 665; with 725, the message «fill dosimat, max. rate» appears. Set «Δ volume» on Dosimat = dV = X µl and dosing rate «dV/dt» to position 10. With the 665, the procedure continues automatically, with the 725, press <quit > when ready. Main display shows «Add c».
	[enter temp. temperature XX.X °C]	Put electrode into initial solution. [Enter sample temperature and confirm with <enter > ...]
	prestir pause XX s stirring XX s poststir pause XX s	Stirrer sequence, see section 3.3.

Key	Display (LCD); recommended settings	Available options; remarks
<i>measure temperature</i>		
	meas U	Voltage measurement in initial solution.
	add standard increment 1 X.XXX ml	Increment 1 is added.
	prestir pause increment 1 X.XXX ml	Sequence continues as shown above.
	stirring increment 1 X.XXX ml	
	poststir pause increment 1 X.XXX ml	
	meas U increment 1 X.XXX ml	After the measurement, increment 2 is added, etc., up to increment 3.
	evaluation *	Evaluation in progress (asterisk flashing).
	F(-1) XX.X ppm start add with <enter>	Main display shows numerical value of measured concentration (without unit).

3.5.4 Automatic standard addition «auto»

With «auto», the 665 or 725 Dosimat adds volume increments such that the desired potential increase is obtained.

Key	Display (LCD); recommended settings	Available options; remarks
<param >	parameter meas. type std. add	direct, std. add, smpl. add
	>measuring parameters conc. unit ppm	mol/l, %, ppm, g/l, mg/l, µg/l, mEq/l, own.
	>standard addition type: add	add, sub(tract)
	>standard addition addition: auto	manual, auto dos, auto. manual: manual addition; auto dos: automatic addition of predetermined volume increments; auto: fully automatic additions resulting in constant potential increments delta U.
<enter >	delta U 15 mV (e.g.)	1...999 mV; desired potential increase for each increment.

Key	Display (LCD); recommended settings	Available options; remarks
<enter>	dos rate: medium	slow, medium, fast; select «slow» for sluggish electrodes and «fast» for electrodes that adjust very quickly.
<enter>	no. of additions 3	1...19
<enter>	V Exchange Unit XX	1, 5, 10, 20 or 50 ml
<enter>	*** 692 pH/Ion Meter *** start add with <enter>	
<enter>	filling dosimat dV=X µl c=XXXX.X mg/l	Applies to 665; with 725, the message «fill dosimat, max. rate» appears. Set «Δ volume» on Dosimat = dV = X µl and dosing rate «dV/dt» to position 10. With the 665, the procedure continues automatically, with the 725, press <quit> when ready. Main display shows «Add c».
	[enter temp. temperature XX.X °C]	Put electrode into initial solution. [Enter sample temperature and confirm with <enter> ...]
	prestir pause XX s stirring XX s poststir pause XX s	Stirrer sequence, see section 3.3.
	<i>measure temperature</i>	
	meas U	Voltage measurement in initial solution.
	add standard increment 1 X.XXX ml	Increment 1 is added.
	prestir pause increment 1 X.XXX ml	Sequence continues as shown above.
	stirring increment 1 X.XXX ml	
	poststir pause increment 1 X.XXX ml	
	meas U increment 1 X.XXX ml	After the measurement, increment 2 is added, etc., up to increment 3.
	evaluation *	Evaluation in progress (asterisk flashing).
	F(-1) XX.X ppm start add with <enter>	Main display shows numerical value of measured concentration (without unit).

Report of automatic standard addition «auto» (left), with corresponding parameter report (right) (graphics not strictly representative)

Concentration calibration report and printout of measured value

Parameter report

```

date 92-10-01      time 14:41:38      4
addition/subtraction method
meas. type:          std. add
electr. id          F Electr
meas. input         1
temperature         22.1 C
conc. std           10000.0 ppm
V total             40.0 ml
initial voltage     -17.9 mV
smp1 size           20.0 ml
date                92-10-01 14:41

          dV/ml    U/mV    dU/mV
std.incr.1    0.419   -32.9   -15.0
std.incr.2    0.773   -47.9   -15.0
std.incr.3    1.427   -62.6   -14.7
    
```

```

variance          0.000
slope             -59.1 mV
E(0)              106.7 mV
F(-1)             257 ppm*
===== **
    
```

```

date 92-10-01      time 14:47:08
parameter
meas. type:          std. add
>measuring parameters
ion type:            F(-1)
conc. unit:          ppm
meas. input:         1
electr. id:          F Electr
drift                1.0 mV/min
method id            F in TR
delta measurement:   OFF
stirrer:             control
Prestir pause       3 s
stir time            20 s
poststir pause      5 s
>calculation parameters
smp1 size            20.0 ml
V total              40.0 ml
factor               1.0
smp1 size unit:     ml
>standard addition
type:                add
conc. std.           10000.0 ppm
report:              full
addition:            auto
delta U              15 mV
dos. rate:           medium
no. of additions     3
V Exchange Unit:    10
-----
    
```

* The final result is twice the primary result obtained from the evaluation of the data (see parameter report: > calculation parameters – sample size 20.0 ml; V total 40.0 ml). In accordance with this, the primary result estimated from the graph is approximately 257/2 ppm (≈ 102.1).

** The double dashed line appears at the end of original calibration and measurement reports, the single dashed line at the end of duplicates.

3.6 Ion concentration measurement with sample addition (or subtraction)

Also here, addition can be done manually («addition: manual») or automatically («addition: auto dos» or «addition: auto»). The settings listed below refer to manual sample addition. See section 3.5.1 for information on connection possibilities. Automatic addition is analogous to that treated in sections 3.5.3 and 3.5.4.

Key	Display (LCD); recommended settings	Available options; remarks
<param>	parameter meas. type	smp1. add direct, std. add, smp1. add
	>measuring parameters conc. unit	ppm mol/l, %, ppm, g/l, mg/l, µg/l, mEq/l, own.
	parameter >calculation parameters	See section 3.2.
	>sample addition type:	add add, sub(tract)
<enter>	conc. standard XXXX.X ppm	1E-30...1E+30. Concentration of standard solution.
<enter>	report:	full short, full, line, OFF
<enter>	addition:	manual manual, auto dos, auto. manual: manual addition; auto dos: automatic addition of predetermined volume increments, see section 3.5.3; auto: fully automatic additions resulting in constant potential increments delta U, see section 3.5.4.
<enter>	no. of additions	3 1...19 manual sample additions.
<enter>	increment 1	0.1 ml 0.0...99.9 ml; this and the following settings can be modified during the sample addition.
<enter>	increment 2	0.1 ml
<enter>	increment 3	0.1 ml
<enter>	*** 692 pH/Ion Meter *** start add with <enter>	Main display: «Add c».
<enter>	[enter temp. temperature	XX.X °C] Main display: «Add c». Immerse electrode into standard solution. [Key in sample temperature and confirm with <enter>.]
<enter>	...	The stirrer sequence is performed, see section 3.3.

Key	Display (LCD); recommended settings	Available options; remarks
	meas. U	Potential measurement in standard solution.
	add sample increment 1	0.1 ml
		Main display shows «mV – Delta», i.e. the voltage change ΔU referred to the initial solution is indicated. Add sample until the desired ΔU (e.g. 15 mV) is reached and enter the corresponding volume as increment 1.
<enter>	...	Stirrer sequence etc. up to increment 3.
	evaluation	*
	F(-1)	XX.X ppm
	start add with <enter>	Result. Instrument is ready for next run.

3.7 Error messages

The following list contains the Error messages that may occur during calibration and standard addition; the corrective action required is also indicated.

Key	Display (LCD or main display)	Remarks; corrective action
	<i>Err c</i>	Main display. Appears together with the error messages «Check working conditions» and «Evaluation error» that are displayed on the LCD (see below).
	same standard	Same standard used twice. →Change standard.
<cal>	meas U standard X	
	Vadd too great	Volume to be added is larger than buret volume. →Use larger buret, decrease starting volume (V total) or increase standard concentration.
	check working conditions	No change in potential after standard addition. Strongly drifting electrode signal. Sign of slope resulting from standard addition does not correspond to ion type specified. →Check Dosimat and replace standard solution, if necessary. Check electrode. Check ion selected (see section 3.2).
	E0: XX.X mV yes: <enter>	Cb: X.XX no: <mode>
		Extreme values of calibration data. Sign of slope determined by calibration does not correspond to ion type specified.
<mode>	→Reject calibration data.
<enter>	→Accept calibration data.
	evaluation error	Evaluation is not possible. →Check standard solutions. Check parameters.
	<i>delta T > 2 °C</i>	Temperatures of standards differ by more than 2 °C. →Use standards having the same temperature and press ...
<cal>	<i>meas temperature std. X</i>	
	1999.9 °C (flashing)	Main display. Temperature sensor has been disconnected during calibration or is defective. →Reconnect or replace temperature sensor.
	<i>meas temperature std. X</i>	

4. Functions of instrument keys



The <mode> key serves to select the instrument functions. It automatically activates the instrument settings that were valid when the corresponding mode was left after its prior utilization.

- Conc «C» Ion concentration measurement,
- pH pH measurement,
- °C or °F temperature measurement,
- mV voltage (potential) measurement,
- mV I_{pol} voltage (potential) measurement with polarized electrodes.

Moreover, pressing the <mode> key brings the instrument program back to its initial state.

The following sequence illustrates the above.

Key	Display (LCD)	Main display
Power on	F(-1) 1.85E-2 mg/l (e.g.) temp. Pt ... XX.X °C	1.85 -2
<mode>	temp. Pt ...: XX.X °C YY-MM-DD HH:MM:SS	XX.XXX pH
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	XX.X °C
<param>	parameter >measuring parameters	XX.X °C
<param>	parameter >analog output T	XX.X °C
<enter>	>analog output T state: ON	XX.X °C
<enter>	>analog output T 0 mV at XX.X °C	XX.X °C
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	XX.X °C
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	XXX.X mV
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	XXX.X mV I_{pol}
<mode>	F(-1) 1.85E-2 mg/l (e.g.) temp. Pt ... XX.X °C	1.85 -2

cal

Starts pH calibration; is active in the pH and concentration mode only.

The calibration is electrode-specific. For further details, see description of <cal data> and <methods> keys below.

The following example describes a two-point calibration, whereby the information set in *italics* applies only if a Pt 100 or Pt 1000 temperature sensor is connected. On the other hand, the information put within square brackets [...] does not appear if one of the temperature sensors mentioned is connected.

Key	Display (LCD)	Remarks
<cal>	[enter cal.temp. temperature XX.X °C]	Put electrode into buffer 1. [Enter buffer temperature and confirm with <cal> ...]
	<i>measure temperature buffer 1</i>	
[<cal>]	meas U buffer 1	
	change buffer buffer 2	Put electrode into buffer 2 or interrupt by pressing <quit> or <mode>. →One-point calibration.
<cal>	<i>measure temperature buffer 2</i>	
	meas U buffer 2	
	pHas 7.009	Electrode slope, e.g. 0.987, appears for some seconds in the main display.
	temp. Pt ...: XX.X °C YY-MM-DD HH:MM:SS	Instrument switches to pH measurement automatically.

param

This key gives access to the parameter settings available for the respective mode. In the sequence shown below, the rolling inquiry «parameter» is shown for the pH mode.

The first line of the two-line LCD is shown only where necessary.

Key	Display (LCD)	Main display
Power on	temp. <i>Pt</i> ...: YY-MM-DD	XX.X °C HH:MM:SS XX.XXX pH
<param>	parameter >measuring parameters	XX.XXX pH
<param>	>calibration parameters	XX.XXX pH
<param>	>electrode test	XX.XXX pH
<param>	>analog output	XX.XXX pH
<param>	>limits pH	XX.XXX pH
<param>	>limits T	XX.XXX pH
<mode>	temp. <i>Pt</i> ...: YY-MM-DD	XX.X °C HH:MM:SS XX.XXX pH
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD	XX.X °C HH:MM:SS
<param>	parameter >measuring parameters	XX.X °C
<param>	>analog output T	XX.X °C
<param>	>limits T	XX.X °C
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD	XX.X °C HH:MM:SS
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD	XXX.X mV HH:MM:SS
<param>	parameter >measuring parameters	XXX.X mV
<param>	>analog output U	XXX.X mV
<param>	>limits U	XXX.X mV
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD	XXX.X mV HH:MM:SS
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD	XXX.X mV <i>I_{pol}</i> HH:MM:SS
<param>	parameter >measuring parameters	XXX.X mV <i>I_{pol}</i>
<param>	>analog output <i>I_{pol}</i>	XXX.X mV <i>I_{pol}</i>
<param>	>limits <i>I_{pol}</i>	XXX.X mV <i>I_{pol}</i>
<mode>	*** 692 pH/Ion Meter *** YY-MM-DD	XXX.X mV <i>I_{pol}</i> HH:MM:SS
<mode>	temp. <i>Pt</i> ...: YY-MM-DD	XX.X °C HH:MM:SS XX.XXX pH



Manual triggering of stirrer sequence (if specified) and printer output.

The following page contains a printout of pH measurements and a plot of direct ion concentration measurements, together with the relevant sections of the corresponding parameter and configuration reports. The «plot» function is available for all those applications of the 692 pH/Ion Meter that feature continuous measurement.

If a Pt 100 or Pt 1000 temperature sensor is connected to the 692 pH/Ion Meter, the temperature will also be printed out or plotted. The scaling of the temperature and pH or concentration axes is performed by setting – under «>plot parameters» – the appropriate values for the left and right margins; see parameter report corresponding to the plotted output, where the left margin is set to 0 ppm and the right margin to 10 ppm.

For a detailed description of the additional settings affecting printout and plotting see the description of the <config> key («>printer» and «>print meas. value») given further below. A description of the stirrer settings is given in section 7.4.1.

The error message «**plot data overflow**» is displayed and printed out if the data output rate from the 692 pH/Ion Meter is higher than the data processing rate of the printer. For this case the following measures are suggested:

- Increase the time interval between measurements (<config> – >print meas. value – time interval).
- Reduce the paper feed rate by increasing «time scale»: <config> – >print meas. value – time scale.
- Reduce «width», switch off «grid» and «frame» (see section 7.1.2); change the >plot parameters «left mar.» and «right mar.» such that the plot is shifted as far as possible towards the left hand margin. The aim of all these measures is to reduce printhead travel and thus increase the printer's processing rate.
- Instead of pH *and* temperature, e.g., plot only pH, i.e. disconnect temperature sensor.

If the above measures are not feasible or not successful, a faster printer should be used.

Examples of printout and plot with excerpts of corresponding reports

Printout

```

date 92-11-30      time 17:01:53
id1 692 pH/Ion Meter
id2 pH & temperature
#1 pH= 5.985      24.0 C
   92-11-30      17:01:53
   ===== *
#2 pH= 6.438      24.1 C
   92-11-30      17:01:33
#3 pH= 6.931      24.3 C
   92-11-30      17:03:131
    
```

Parameter report (excerpt)

```

parameter
>measuring parameters
  meas. input:      1
  electr. id:      pH 233
  drift pH        0.050 /min
  method id      pH print
  delta measurement: OFF
  stirrer:      control
  prestir pause   3 s
  stir time      20 s
  poststir pause  5 s
    
```

Configuration report (excerpt)

```

config
>printer
  character set:   Seiko
  print header:   once
  date & time:    ON
  id1             692 pH/Ion Meter
  id2             pH & temperature
>print meas. value
  print crit:     time
  time interval   40.0 s
  stop time      120 s
  date & time:    ON
    
```

Plot

```

date 92-11-30      time 17:55:58
id1 Fluoride conc.
id2 Direct measuremem.
    
```

Parameter report (excerpt)

```

parameter
>measuring parameters
  ion type:      F(-1)
  conc. unit:    ppm
  meas. input:   1
  electr. id:    FE 3
  drift         1.0 mV/min
  method id     c plot
  delta measurement: OFF
  stirrer:      control
  prestir pause  1 s
  stir time     25 s
  poststir pause 5 s
>plot parameters
  left mar.      0E+00 ppm
  right mar.     1.0E+01 ppm
  left marg. T   20 C
  right marg. T  30 C
    
```

Configuration report (excerpt)

```

config
>printer (analogous to that shown left)
>print meas. value
  print crit:     plot
  time interval   4.0 s
  time scale      30 s/cm
  time scale label: abs
  stop time      120 s
    
```

* The double dashed line appears at the end of original calibration and measurement reports, the single dashed line at the end of duplicates.

clear

Is used to delete parameter values and variables from the display.

select

Whenever the <select> key can be used to view the available options, the corresponding parameter is followed by a colon (:). Selecting the dialog language is one of the many uses of the <select> key:

Key	Display (LCD)
<config>	config >auxiliaries
<enter>	last digit:
<enter>	dialog: english
<select>	dialog: deutsch
<select>	dialog: français
<select>	dialog: español
<select>	dialog: english
<enter>	date YY-MM-DD

quit

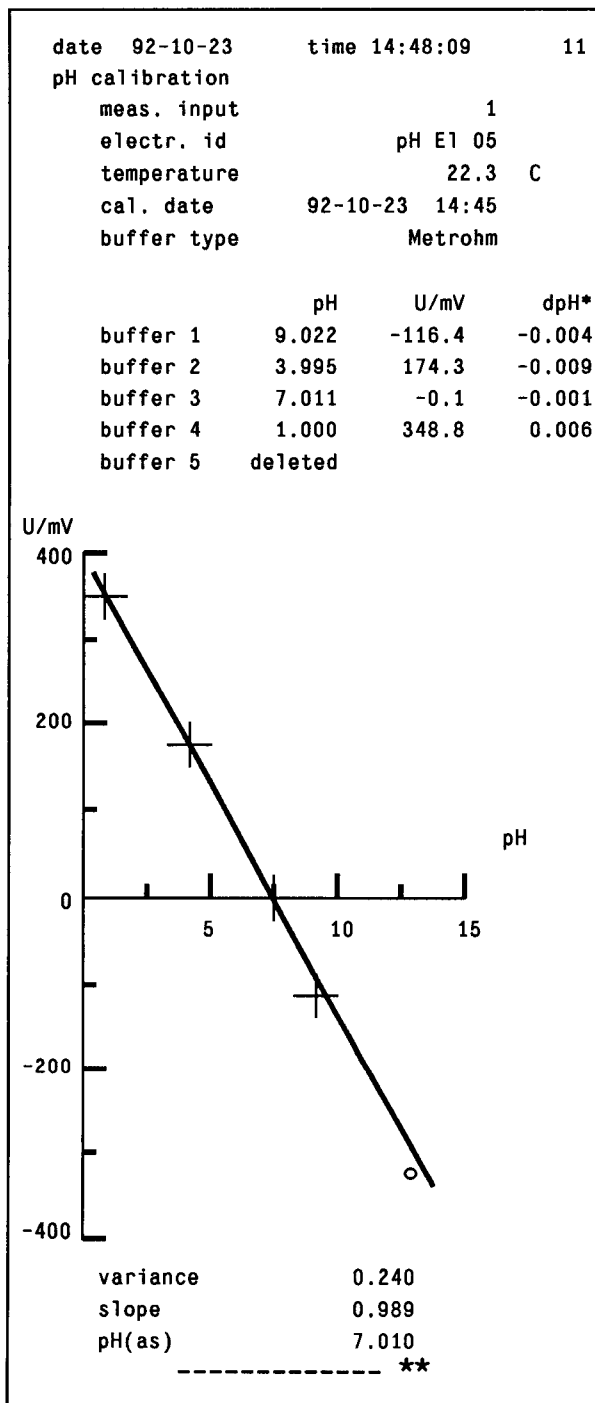
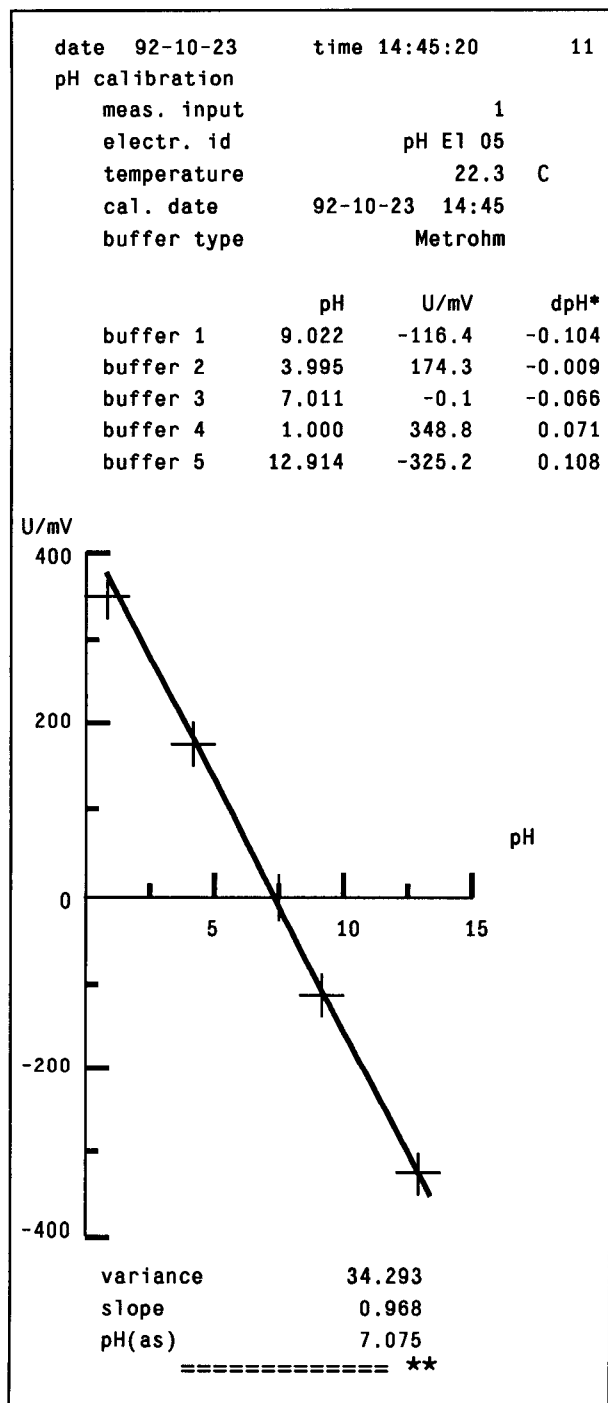
<quit> is used to exit from rolling inquiries, printing, stirring times and certain error messages. <quit> brings you back to the next higher program level, as shown by the following example:

Key	Display (LCD)
	temp. Pt ...: XX.X °C YY-MM-DD HH:MM:SS
<param>	parameter >measuring parameters
<enter>	>measuring parameters meas. input 1
<quit>	parameter >measuring parameters
<quit>	temp. Pt ...: XX.X °C YY-MM-DD HH:MM:SS

pH calibration reports with original data (left) and after deleting one data set (right) (graphics not strictly representative)

Original printout:

Deleting the data measured with buffer 5, pH = 13, yields vastly improved calibration data, which indicates that the buffer in question was faulty.



* «dpH» is the difference

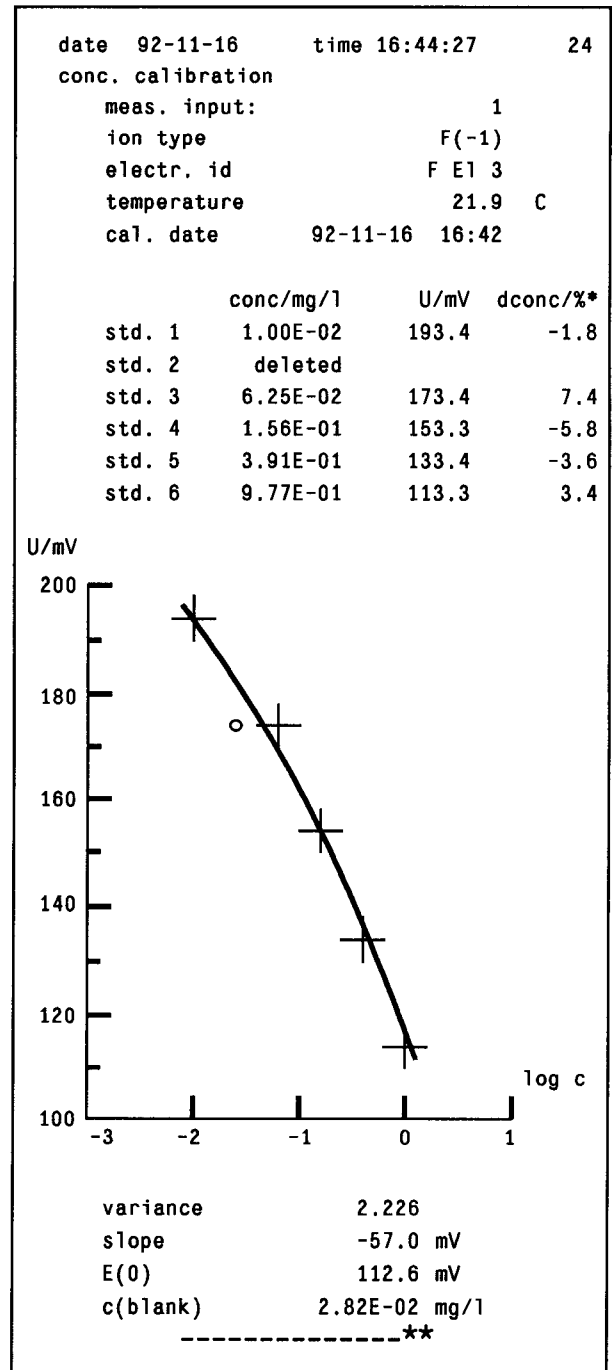
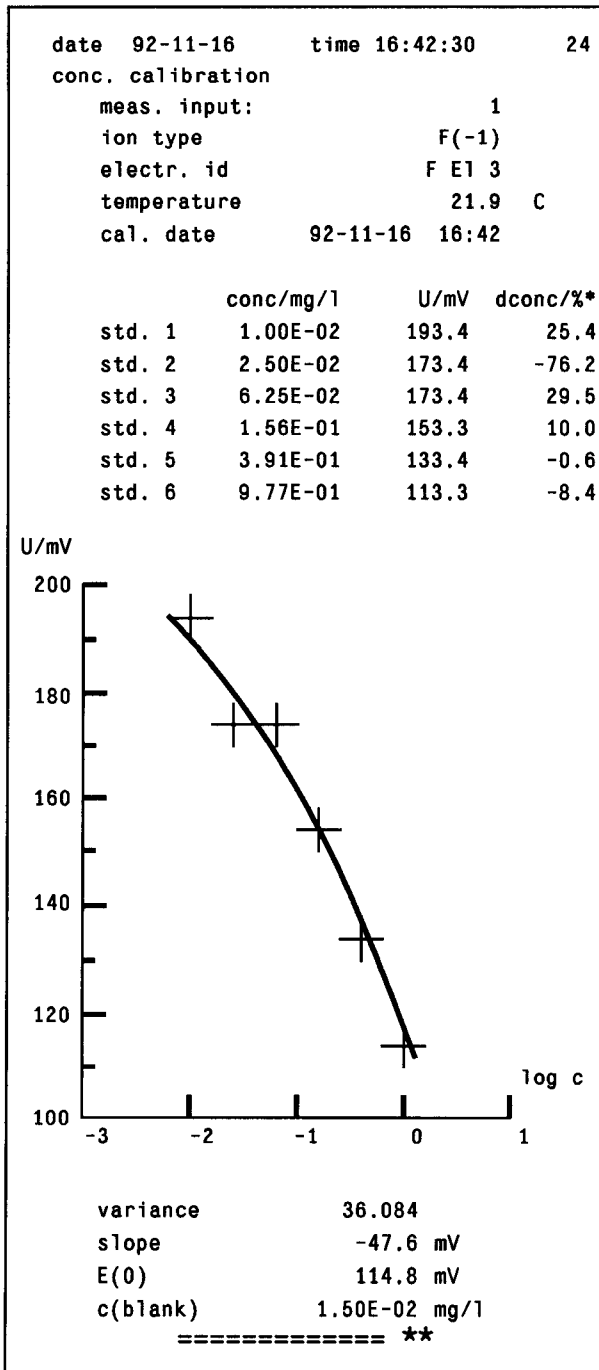
nominal pH value of the buffer – pH value resulting from regression analysis at the potential measured.

** The double dashed line appears at the end of original calibration reports, the single dashed line at the end of duplicates.

Concentration calibration reports with original data (left) and after deleting one data set (right) (graphics not strictly representative)

Original printout:

Deleting the data measured with standard 2, «0.025 mg/L», yields vastly improved calibration data. Explanation: Standard 3 – 0.0625 mg/L – had been used twice!



* «dconc/%» is calculated as follows:

$$(\text{nominal std. concentration} - \text{calculated concentration}) / \text{nominal std. concentration} \times 100.$$

** The double dashed line appears at the end of original calibration reports, the single dashed line at the end of duplicates.

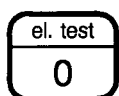


The <config> key gives access to all those settings that concern the configuration of the 692 pH/Ion Meter, which is independent of the mode selected. The following compilation shows all the dialogue positions concerned.

Key	Display (LCD)	Available options; remarks
<config>	config >auxiliaries	<config> key is combined with number key «1».
<enter>	last digit: ON	ON, OFF (<select> key); OFF→last digit is not displayed and the measuring frequency increases from 2.5 to 12.5 per second.
<enter>	dialog: english	english, deutsch, français, español
<enter>	date YY-MM-DD	
<enter>	time HH:MM:SS	24 h format, e.g. 15:07:51
<enter>	temp. unit: C	C, F (°C, °F)
<enter>	run number OFF	0, 1, 2, 3...999, OFF
<enter>	type of Dosimat: 665	665, 725. Specification of Dosimat type to be used for automatic calibration or standard addition in the «Conc» mode.
<enter>	device label 692 pH/I	ASCII string (← → keys); designation for addressing the 692 pH/Ion Meter via the RS 232C interface.
<enter>	program XXXXXXXX	Installed program version.
<enter>	config >printer	
<enter>	character set:	Citizen, IBM, Epson, Seiko
<enter>	print header:	once, always, OFF
<enter>	date & time	ON, OFF
<enter>	id1	ASCII string for first line of print header, 16 characters (← → keys)
<enter>	id2	ASCII string for second line of print header, 16 characters (← → keys)
<enter>	config >print meas. value	
<enter>	print crit:	immediate, time, drift, plot, OFF; see also function of <print> key in this chapter. If «time» or «plot» is selected, additional lines will appear here: see below.

Key	Display (LCD)	Available options; remarks
		<p>immediate: printout occurs either immediately or after the stirrer sequence (if specified; see section 7.4.1) has been performed.</p> <p>time: printout occurs immediately after the stirrer sequence has been performed and subsequently in the specified time intervals until the stop time has elapsed.</p> <p>drift: printout occurs after the stirrer sequence has been performed and after the drift condition (see above) has been met.</p> <p>plot: plotting of measured values.</p> <p>OFF: <print> key is not active.</p>
	print crit: time	
<enter>	time interval XX.X s	0.4, 0.8...99 998 s (27 h 47 min). Time interval between printouts in multiples of 0.4 seconds.
<enter>	stop time XXX s	1...999 999 s (277 h 47 min), OFF. Total duration of recording in seconds. OFF→no time limit.
<enter>	date & time	ON, OFF
	print crit: plot	
<enter>	time interval XX.X s	0.4, 0.8...99 998 s (27 h 47 min). Time interval between plottings in multiples of 0.4 seconds.
	time scale XXX s/cm	5 (\approx 12 cm/s), 10, 30, 60, 120, 180 (0.333 cm/s)...99 960 s/cm (\approx 0.036 cm/h). Scaling of time axis. The reciprocal of the value specified corresponds to the paper feed rate in cm per second. Example: A feed rate of 2 cm/min = 2/60 cm/s is obtained by setting «time scale» to the reciprocal of the latter value, i.e. 60/2 s/cm = 30 s/cm.
		Note: The actual time scale appearing on the graph depends on the printer used; it may therefore differ to some extent from the set value!
<enter>	time scale label:	abs or rel. abs: Time axis is labelled in absolute terms, e.g. 08:24 – 08:25, etc. rel: Time axis is labelled in relative terms, starting with zero, e.g. 0s – 1m00s, etc.
<enter>	stop time XXX s	1...999 999 s (277h 47 min). Total duration of plotting in seconds.

Key	Display (LCD)	Available options; remarks
<enter>	config >RS 232 settings	See also section 7.1.3.
<enter>	baud rate:	9600, 4800, 2400, 1200, 600, 300
<enter>	data bit:	7, 8
<enter>	stop bit:	1, 2
<enter>	parity:	even, none, odd
<enter>	handshake:	HWs, HWf, SWchar, SWline, none
<enter>	RS control:	ON, OFF (refers to external control via RS 232 interface).
<enter>	temp. Pt YY-MM-DD	XX.X °C HH:MM:SS



<el. test> starts the electrode test, which is described in detail in chapter 5.



With <report> you select the type of report to be printed out. The selection offered is independent of the mode. However, only the report types relevant to the current mode can be printed out.

Key	Display (LCD)	Remarks
<report>	report select: user memory	Lists contents of user memory with methods and calibration data sets together with storage capacity, both used up and still available.
<select>	select calib	Calibration report of selected pH electrode.
<select>	select: config	Configuration report of 692 pH/Ion Meter.
<select>	select: param	Parameter report.
<select>	select: el. test	Electrode test report of selected pH electrode.
<select>	select: result	Short result report of standard addition method.
<select>	select: all	All relevant reports (depending on current mode).
<select>	select: user memory	See above.

Examples of the following reports are shown below: user memory, configuration (config) and parameter report. For additional information on the user memory, see description of <methods> key given below.

Examples of reports: user memory, configuration and parameter report

```

date 92-09-22 time 16:59:11
user memory
>methods
  pH          pH          44
  T           T           26
  U           U           24
  Ipo1       Ipo1       36
  Conc F(-1) Conc        40
  pH         pH 05      64
>caldata
  pH          pH E1 05    62
                remaining bytes 4704
                -----

```

```

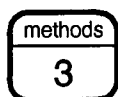
date 92-09-22 time 16:54:27
config
>auxiliaries
  last digit:      ON
  dialog:         english
  date            92-09-22
  time           16:54:27
  temp.unit:      C
  run number      35
  type of Dosimat 665
  device label    692 pH/I
  program         XXXXXXXX
>printer
  character set:   Seiko
  print header:   once
  date&time:      ON
  id1            692 pH/Ion Meter
  id2            pH & temperature
>print meas.value
  print crit:     immediate
  date&time:      ON
>RS232 settings
  baud rate:      9600
  data bit:       8
  stop bit:       1
  parity:         none
  handshake:      HWs
  RS control      OFF
                -----

```

```

date 92-09-22 time 17:03:02
parameter
>measuring parameters
  meas.input      1
  electr.id:     pH/Pt 100
  drift pH       0.050 /min
  method id      22.9.
  delta measurement: OFF
  stirrer:       OFF
>calibration parameters
  drift          0.5 mV/min
  report:        full
  no. of buffers 5
  buffer type:   Metrohm
  offset Uas state: OFF
>electrode test
  report:        full
>analog output
  select:        pH
  state:         ON
  0 mV at       7.000 pH
  1 V range     10.000 pH
>limits pH
  state:         OFF
>limits T
  state:         OFF
>plot parameters
  left mar.     0.0 pH
  right mar.    14.0 pH
  left marg. T  20 C
  right marg. T 30 C
                -----

```



The <methods> key allows the manipulation of methods. A method includes all parameter settings but not the instrument configuration (<config>).

Independent of the instrument mode, the rolling inquiry is made up of the following items:

Key	Display (LCD)	Remarks
<methods>	methods >recall method	
<enter>	>recall method name:	Select name of method to be recalled.
<enter>		
<methods>	methods >recall method	
<methods>	>store method	Store method under its freely chosen name.
<methods>	>delete method	Delete a method.

The organization of the user memory is illustrated by the printouts shown on the following page together with details on the recall and deletion of methods and calibration data.

Reports illustrating the organization of the user memory

```

date 92-09-22 time 16:49:18
user memory
>methods
  pH          pH          44
  T           T           26
  U           U           24
  Ipo1       Ipo1        36
  Conc F(-1) Conc         40
>caldata
                remaining bytes  4830
                -----

```

1. Initial state of user memory, i.e. ex works or after RAM initialization. The «initial methods» pH, T, U, I_{pol} and Conc contain the default settings of each mode. They may be useful for reference purposes and should not be deleted.

```

date 92-09-22 time 16:59:11
user memory
>methods
  pH          pH          44
  T           T           26
  U           U           24
  Ipo1       Ipo1        36
  Conc F(-1) Conc         40
  pH         pH 05        64
>caldata
  pH          pH E1 05     62
                remaining bytes  4704
                -----

```

3. The actual instrument settings (not including the configuration <config>) have been stored as method «pH 05». This method name has been chosen to indicate that the electrode «pH E1 05» is meant to be used with method «pH 05». However, if required, methods and pH electrodes can be combined without any restrictions.

```

date 92-09-22 time 16:54:47
user memory
>methods
  pH          pH          44
  T           T           26
  U           U           24
  Ipo1       Ipo1        36
  Conc F(-1) Conc         40
>caldata
  pH          pH E1 05     62
                remaining bytes  4768
                -----

```

2. User memory after calibration of the pH electrode named «pH E1 05»: Its calibration data are stored under «>caldata».

Recall of methods and calibration data

Whenever a method is recalled from the user memory, the actual instrument settings (except those falling under «configuration») are replaced by those of the recalled method.

To recall calibration data, select the pH electrode in question by the sequence <param> – >measuring parameters – «electr. id:».

Deleting methods and calibration data

After deleting the method «pH 05», the calibration data for the electrode «pH E1 05» remain stored. By selecting «pH E1 05» under «measuring parameters» (see above paragraph) and resetting its calibration data (<cal. data> – cal. table: reset cal), these are eliminated from the method memory. The user memory report now appears in its initial form shown at the top left.



<→> and <←> are used to key in alphanumeric electrode or method designations. The following example shows how a method designation is entered.

Key	Display (LCD)	Remarks
<methods>	methods >recall method	
<methods>	>store method	
<enter>	name XXXXXXXX	
<clear>	name	<p><clear> serves to clear the display only; the corresponding method is not affected in any way.</p> <p>Press <→> or <←> until «p» appears flashing in the leftmost position. Press <enter> and continue by bringing «H» to the second position from left. Press <enter> and make a space (blank) appear in the third position from left. Press <enter> and key in «07». Press <quit> to clear the remaining positions. The display now shows ...</p>
	name pH 07	<p>Press <enter> to store the current instrument settings (except configuration) as method «pH 07».</p> <p>To make corrections, i.e. to move one position to the left on the display, simply use <clear>.</p>

The «Delta» function

The «Delta» function is available for all the modes of the 692 pH/Ion Meter. It allows to display the measured value relative to a reference value that is selectable within wide limits. The relative value appears not only in the display, but is also used for the analog output, the limits function and the RS 232C data interface.

Key	Display (LCD)	Remarks
<param>	parameter >measuring parameters	Press <enter> repeatedly ...
<enter> ...	>measuring parameters delta measurement: meas	OFF, ON, meas. <select> meas; this causes the measured temperature to be offered as the reference value. OFF: no delta measurement. ON: enter reference value.
<enter>	reference 23.6 °C	Measured temperature. Range -999.9...999.9 °C.
<enter>	stirrer: XXXX	Main display shows temperature relative to 23.6 °C and the «Delta» indicator is on. Exit by pressing <quit> twice.

If the reference temperature is set to -273.2 °C, the numerical value displayed (e.g. 298.9 at 25.7 °C) corresponds to the so-called absolute temperature (Kelvin).

By setting «delta measurement: OFF» you return to «normal» temperature measurement and the «Delta» indicator disappears from the main display.

5. pH electrode test

5.1 Equipment required

The pH electrode test offered by the 692 pH/Ion Meter allows you to determine whether your pH electrode is still working properly. The test can be carried out with any buffer set containing the buffers pH = 4, 7 and 9. While we recommend to use Metrohm buffers, NIST, DIN, Ciba, Ingold, Merck and Radiometer buffers can also be used. Buffer sets not containing the required buffers produce the error message «buffers unsuitable» as soon as <el. test> is actuated.

The test requires at least a Stirrer (622, 649 or 722) or a Titration Stand (727 or 703). Stirrer control is either manual or automatic (6.2138.000 or 6.2138.10 connecting cable installed, see also section 3.3). If you wish to print out full or short test reports as well as the corresponding curves (potential-time transients) you require a printer and the corresponding connecting cable. Details on the connection of a printer can be found in section 7.1.

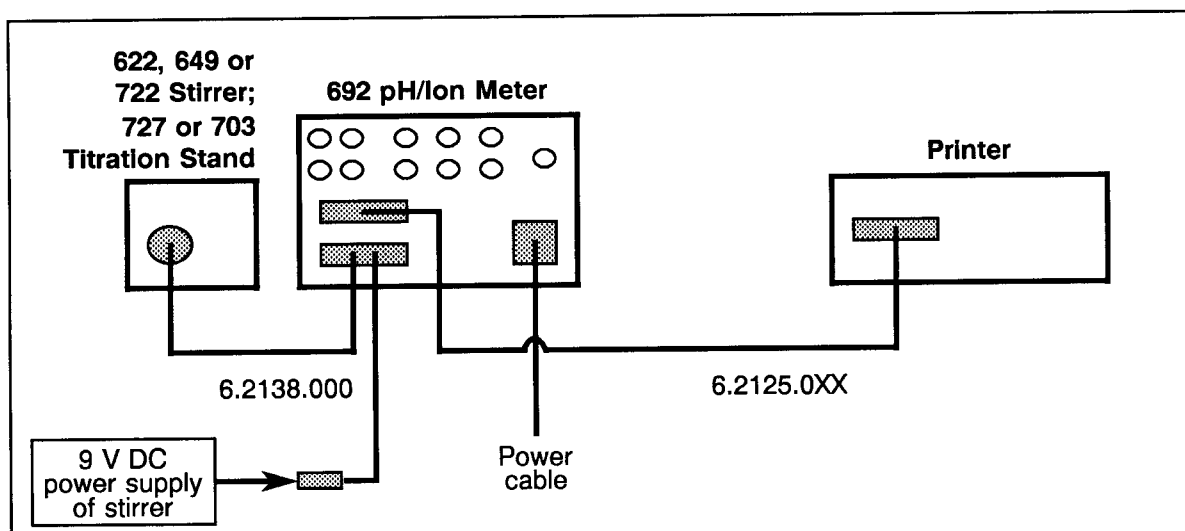


Fig. 5.1: Cable connections for the pH electrode test

5.2 Preliminary settings

Before the test can be started, a number of parameters have to be set. These are listed in the following.

Key	Display (LCD); required settings	Available options; remarks
Power on	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	Power switch is above power cable connector.
<mode> →pH	temp. Pt: XX.X °C YY-MM-DD HH:MM:SS	pH, °C, mV, mV/I _{pol}
<config>	config >auxiliaries	
<config>	>printer	
<enter>	character set:	Citizen, IBM, Epson, Seiko: see section 7.1.
<enter>	print header:	OFF, once, always

Key	Display (LCD); required settings	Available options; remarks
<enter>	date & time:	ON, OFF. Appears only if «print header» is set to «once» or «always».
<enter>	id1	XXXXXX ASCII string of 16 characters (← → keys).
<enter>	id2	XXXXXX ASCII string of 16 characters (← → keys).
<enter>	>print meas. value	
<config>	>RS 232 settings	
<enter>	baud rate:	Baud rate to be set and additional RS 232 settings: see section 7.1. Press <quit> twice and continue with ...
<param>	parameter >measuring parameters	
	measuring input	1 1, 2, diff.
<enter>	electr. id:	XXXX Press <enter> until «stirrer» is displayed:
<enter> ...	stirrer:	control ON, control, OFF; <select> control.
<enter>	prestir pause	XX s Waiting and stirring times are not effective for the electrode test. Switch to calibration parameters by pressing <quit> and ...
<param>	parameter >calibration parameters	Here the buffer set can be specified; see sections 5.1 and 2.3.
<param>	parameter >electrode test	
[<enter>	temperature	XX.X °C] If no temperature sensor is connected.
<enter>	report:	short → short report, full → full report including response curves, OFF → no report (if no printer is connected).
<enter>	parameter >analog output	Exit by pressing <quit>.

5.3 Procedure

Briefly, the test runs as follows: First, the electrode is immersed in buffer pH = 9 and its signal (potential) is monitored during 3 min under stirring and then 1 min in the absence of stirring. Subsequently, the same measurements are performed in buffers pH = 4 and pH = 7.

In order to get realistic response times, the electrode must not be immersed in the respective buffer before the start of the measurement. The stirring should be vigorous and the electrode tip located reasonably close to the stirrer.

The information set in *italics* applies only if a Pt 100 or Pt 1000 temperature sensor is connected; on the other hand, the information put within square brackets [...] does not appear if one of the temperature sensors mentioned is connected.

Key	Display (LCD)	Remarks
Power on	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	Power switch is above power cable connector.
<mode> → pH	temp. Pt ...: YY-MM-DD XX.X °C HH:MM:SS	pH, °C, mV, mV/I _{pol}
<el. test>	[enter temp. temperature XX.X °C]	
[<enter>]	buffer pH 9.00 press <enter> to start	Immerse electrode into Metrohm buffer pH = 9 and immediately press ...
<enter>	buffer pH 9.00 time to go XXX s	Count down 239 → 1 s. At 60 s, the stirrer is switched off automatically or – if it is not connected as shown in Fig. 5.1 – the prompts «switch stirrer on» and «switch stirrer off» appear before the start of the count down or at 60 s, respectively.
	<i>meas temperature</i>	
	buffer pH 4.00 press <enter> to start	Immerse electrode into Metrohm buffer pH = 4 and immediately press ...
<enter>	buffer pH 4.00 time to go XXX s	Count down 239 → 1 s. At 60 s, stirrer is switched off automatically or manually.
	<i>meas temperature</i>	
	buffer pH 7.00 press <enter> to start	Immerse electrode into Metrohm buffer pH = 7 and immediately press ...
<enter>	buffer pH 7.00 time to go XXX s	Count down 239 → 1 s. At 60 s, stirrer is switched off automatically or manually.
	<i>meas temperature</i>	
	Electrode test excellent electrode (e.g.)	Classification criteria and further possible messages see below.

If no printer is connected to the RS 232C interface, the following error message may appear:

***RS error 42

In this case, press <quit>, repeat the sequence shown at the end of paragraph 5.2 and set

```
>electrode test
report:                OFF
```

5.4 Results

5.4.1 Partial reproduction of a full electrode test report (transients not to scale)

```

date 92-09-22 time 08:29:18 3
Electrode test
meas. input 1
temperature man. 25.0 C
date 92-09-22 08:10

buffer pH 9.00 at 25.0 C

time/min U/mV drift/mV/min
1 (stirred) -123.2 0.1
2 (stirred) -123.1 0.3
3 (stirred) -123.3 0.2
4 -124.3 0.0

response time t(1mV) 5 s
dU (unstirred-stirred) -1.0 mV
    
```

```

buffer pH 4.00 at 25.0 C

time/min U/mV drift/mV/min
1 (stirred) 166.7 0.0
2 (stirred) 166.8 0.0
3 (stirred) 166.8 0.2
4 166.5 0.2

response time t(1mV) 12 s
dU (unstirred-stirred) -0.2 mV
    
```

```

buffer pH 7.00 at 25.0 C

time/min U/mV drift/mV/min
1 (stirred) -7.4 0.1
2 (stirred) -7.3 0.2
3 (stirred) -7.4 0.2
4 -7.7 0.2

response time t(1mV) 4 s
dU (unstirred-stirred) -0.3 mV
    
```

```

results buffers 4.00/7.00

time/min pHas Uas/mV slope
1 (st) 6.872 -7.4 0.981
2 (st) 6.874 -7.3 0.981
3 (st) 6.872 -7.4 0.981
4 6.867 -7.7 0.981

results buffers 7.00/9.00

time/min pHas Uas/mV slope
1 (st) 6.872 -7.4 0.979
2 (st) 6.874 -7.3 0.979
3 (st) 6.872 -7.4 0.980
4 6.868 -7.7 0.986

results buffers 9.00/4.00

time/min pHas Uas/mV slope
1 (st) 6.874 -7.3 0.980
2 (st) 6.876 -7.2 0.980
3 (st) 6.874 -7.3 0.981
4 6.862 -8.0 0.983

time/min sum of drifts in 3 buffers
1 (stirred) 0.2 mV/min
2 (stirred) 0.5 mV/min
3 (stirred) 0.6 mV/min
4 0.4 mV/min

conclusion
good electrode
===== *
    
```

* The double dashed line appears at the end of original reports, the single dashed line at the end of duplicates.

5.4.2 Classification of pH electrodes

Test results	Electrode classification
Slopes after 3 min: $0.97 \leq \text{slope} \leq 1.01$ Sum of absolute drift values (3 min): $\text{drift} \leq 1.0 \text{ mV/min}$ Sum of absolute values of differences $U(3 \text{ min, stirred}) - U(4 \text{ min, unstirred})$: $dU \leq 1.0 \text{ mV}$ Response time $t(1\text{mV})$, i.e. time after which the potential is within 1 mV of the value reached after 3 min: $t(1\text{mV}) \leq 30 \text{ s}$	→ «excellent electrode»
$0.96 \leq \text{slope} \leq 1.02$ $\text{drift} \leq 2.0 \text{ mV/min}$ $dU \leq 2.5 \text{ mV}$ $t(1\text{mV}) \leq 45 \text{ s}$	→ «good electrode»
$0.95 \leq \text{slope} \leq 1.03$ $\text{drift} \leq 3.0 \text{ mV/min}$ $dU \leq 4.0 \text{ mV}$ $t(1\text{mV}) \leq 60 \text{ s}$	→ «electrode passing»
$\text{slope} < 0.95 \text{ or } \text{slope} > 1.03$ $\text{drift} > 3.0 \text{ mV/min}$ $dU > 4.0 \text{ mV}$ $t(1\text{mV}) > 60 \text{ s}$ Average of calculated asymmetry potentials (3 min, absolute value): $U_{\text{as}} > 30.0 \text{ mV}$	→ «bad electrode»

5.4.3 Messages that may appear during and after the electrode test

Procedure and numerical tests	Message displayed if answer is «yes»
Measurement in buffer pH = 9.	
Absolute value of drift measured in pH = 9 after 3 min > 1 mV/min?	«serious problem»
U(4 min) < 10 mV AND sum of absolute drift values between 1 min ... 4 min < 12 mV/min?	«short circuit»
Measurement in buffer pH = 4.	
Measurement in buffer pH = 7.	
Calculation of slopes, drift values, absolute values of U(3 min, stirred) – U(4 min, unstirred) = dU.	
Sum of absolute drift values after 3 min in buffers 9, 4 and 7 > 3 mV/min?	«bad electrode system»
2 slopes do not fulfil $0.95 < \text{slope} < 1.03$ AND 1 slope fulfils $0.95 < \text{slope} < 1.03$?	«wrong buffer»
1 of the dU values > 4 mV?	«bad diaphragm»
0.95 < slope < 1.03 AND $U_{as} > 30$ mV?	«reference not matching»
All slopes do not fulfil $0.95 < \text{slope} < 1.03$?	«partial short circuit»
1 response time $t(1 \text{ mV}) > 60$ s?	«glass membrane»

5.5 Corrective action

5.5.1 Recommendations

The pH electrode test may result in electrode classifications or messages that require corrective action. The steps to be taken are explained in section 5.5.2 below. See also the leaflet that accompanies each Metrosensor pH electrode and the Metrohm Monograph «Electrodes in Potentiometry».

Under certain conditions such as very low humidity, plastic flooring and synthetic clothing, the pH electrode may suffer from discharges of static electricity. This leads to strongly drifting electrode signals and correspondingly bad results of the pH electrode test. These problems may be avoided if the operator is wearing an ESD arm bracelet.

Message	Recommended measures
«electrode passing»	Clean diaphragm.
«bad electrode»	Clean diaphragm and/or regenerate glass membrane. Check reference system.
«serious problem»	Clean diaphragm and/or regenerate glass membrane.
«short circuit»	Replace electrode (electrical short or crack in glass membrane).
«bad electrode system»	Clean diaphragm and/or regenerate glass membrane.
«wrong buffer»	Repeat test with correct buffers.
«bad diaphragm»	Clean diaphragm.
«reference not matching»	Repeat with appropriate reference system (Ag/AgCl/ c(KCl) = 3 mol/L or calomel) or replace (contaminated) reference electrolyte.
«partial short circuit»	Check temperature sensor or set correct temperature; if this does not help, replace electrode.
«glass membrane»	Regenerate glass membrane.

5.5.2 Care and maintenance of pH glass electrodes

General

Always make sure that

- the combined electrode is filled with the correct reference electrolyte, i.e. $c(\text{KCl}) = 3 \text{ mol/L}$,
- the reference electrolyte compartment is filled to the top with clean electrolyte,
- the filling hole is open during measurement (and closed during storage),
- there are no air bubbles in the internal or in the reference electrolyte,
- the cable connections are dry and clean.

Caution: Ultrasonic cleaning may damage the electrodes.

Storage

- Combined glass electrodes should be stored in the reference electrolyte, $c(\text{KCl}) = 3 \text{ mol/L}$. If a combined electrode is stored in water, AgCl will precipitate within the diaphragm!
- Separate glass electrodes should be stored in distilled water.

Cleaning of the diaphragm

- After measurements in media of low chloride concentration (precipitated AgCl in the diaphragm, which has a darkish brown colour): Place electrode overnight in concentrated ammonia solution, rinse with water and renew the reference electrolyte.
- After measurements in protein containing media: Immerse electrode for several hours in a solution of 5% pepsin in $c(\text{HCl}) = 0.1 \text{ mol/L}$, the best effect being obtained at 38 °C. Then soak thoroughly.
- After measurements in sulphide-containing media (Ag_2S in the diaphragm, which assumes a dark colour): Place electrode for several hours in freshly prepared, slightly acidic 7% thiourea solution. Then rinse with water and renew the reference electrolyte.
- If the electrode is contaminated with organic compounds: Place electrode for approximately 5 min in chromosulphuric acid at 80 °C, then rinse thoroughly with water and renew reference electrolyte.
- If the above measures do not help: Carefully file down diaphragm with a diamond nail file. The outflowing electrolyte should be visible as a dark ring.

Care of the glass membrane

- When performing measurements in non-aqueous media, soak electrode in water between the measurements.
- Regeneration of the glass membrane: Immerse the glass membrane either for 1 min in a 10% solution of ammonium hydrogenfluoride (NH_4HF_2) or for a few seconds in 40% HF. *Attention: HF is poisonous and affects the skin! Do not use glass vessels!* After the etching, rinse for approximately 10 seconds in a solution $\text{H}_2\text{O} : \text{HCl} = 1 : 1$. Rinse electrode in water and allow to stand for 24 h in the storage solution.

6. Measuring temperature and potential

6.1 Measuring temperature

Whenever a Pt 100 or Pt 1000 temperature sensor is connected to the inputs marked «Pt 100/Pt 1000» of the 692 pH/Ion Meter, the temperature can be measured either alone (°C mode) or simultaneously with the pH value (pH mode) or the concentration (Conc mode). In the pH mode, the temperature appears on the LCD display and serves to correct the pH value for the effect of temperature.

The procedure given below prepares the 692 pH/Ion Meter for straightforward temperature measurement; see chapter 4 on delta measurement, section 7.4.1 on stirrer control, section 7.3.1 on the analogue output and section 7.4.3 on limits. A plot of the temperature together with the fluoride concentration is shown in chapter 4, <print> key.

Key	Display (LCD); recommended settings	Available options; remarks
Power on	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	Power switch is above power cable connector.
<mode> → °C	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	pH, °C, mV, mV/I _{pol} , Conc. Main display shows temperature.
<config>	config >auxiliaries	<config> key is combined with number key «1».
<enter>	last digit: ON	ON, OFF (<select> key); OFF→last digit is not displayed.
<enter>	dialog: english	english, deutsch, français, español
<enter>	date YY-MM-DD	
<enter>	time HH:MM:SS	24 h format, e.g. 15:07:51
<enter>	temp. unit: C	C, F (°C, °F)
<enter>	run number OFF	0, 1, 2, 3 ... 999, OFF
<enter>	device label pH 713	ASCII string (← → keys)
<enter>	program XXXXXXXX	Installed program version.
<enter>	config >printer	Exit by pressing ...
<quit>	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	Switch to parameter settings by pressing...
<param>	parameter >measuring parameters	
<enter>	electr. id Pt 1000	ASCII string (← → keys), 8 characters; electrode designation.
<enter>	drift 1 °C/min	0.5 ... 999.9 °C/min; OFF
<enter>	method id T 03	Name of current method; see chapter 4, <methods> key.

Key	Display (LCD); recommended settings	Available options; remarks
<enter>	delta measurement: OFF	OFF, ON, meas. See chapter 4.
<enter>	stirrer: OFF	OFF, ON, control. See section 7.4.1.
<enter>	parameter >analog output T	See section 7.3.1. Exit by pressing ...
<quit>	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	

6.2 Measuring potential

6.2.1 Measuring redox potential

Redox potential (voltage) measurements can be carried out with a combined noble metal electrode or with a separate metal electrode plus a reference electrode. The inputs «pH/ISE 1» or «pH/ISE 2» are used, see also section 1.3.

The 6.2306.020 redox standard serves to check the proper functioning of redox electrodes. The procedure is explained in the leaflet accompanying the Metrohm metal electrodes.

Of course, the signal of pH, ion selective or silver electrodes can also be monitored in the «mV» mode.

The procedure given below prepares the 692 pH/Ion Meter for straightforward potential measurement; see chapter 4 on delta measurement, section 7.4.1 on stirrer control, section 7.3.1 on the analogue output and section 7.4.3 on limits. The configuration settings, accessible via the <config> key, are not mentioned below; see, e.g., the preceding section 6.1. The plotting of the potential is prepared in the same way as that of concentration or temperature, see chapter 4, <print> key.

Key	Display (LCD); recommended settings	Available options; remarks
Power on	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	Power switch is above power cable connector.
<mode> →mV	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	pH, °C, mV, mV/I _{pol} , Conc. Main display shows potential in mV.
<param>	parameter >measuring parameters	
<enter>	meas. input: 1	1, 2, diff: electrode input 1, 2 or differential potentiometry. For details on differential potentiometry see sections 6.2.3 and 1.3.
<enter>	electr. id Pt 415	ASCII string (← → keys), 8 characters; electrode designation.
<enter>	drift 1.0 mV/min	0.5 ... 999.9 mV/min, OFF.
<enter>	method id U 05	Name of current method; see chapter 4, <methods> key.
<enter>	delta measurement: OFF	OFF, ON, meas. See chapter 4.

Key	Display (LCD); recommended settings	Available options; remarks
<enter>	stirrer: OFF	OFF, ON, control. See section 7.4.1.
<enter>	parameter >analog output U	See section 7.3.1. Exit by pressing ...
<quit>	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	

6.2.2 Measuring potential with polarized electrodes

Double metal electrodes are used for these measurements; the input to be used is marked «I_{pol}».

The procedure given below prepares the 692 pH/Ion Meter for straightforward potential measurement with polarized electrodes; see chapter 4 on delta measurement, section 7.4.1 on stirrer control, section 7.3.1 on the analogue output and section 7.4.3 on limits. The configuration settings, accessible via the <config> key, are not mentioned below; see, e.g., the preceding section 6.1. Here too, the potential can be plotted in a similar way as done with concentrations or temperatures, see chapter 4, <print> key.

Key	Display (LCD); recommended settings	Available options; remarks
Power on	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	Power switch is above power cable connector.
<mode> →mV/I _{pol}	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	pH, °C, mV, mV/I _{pol} . Main display shows the potential in mV and the indicator «I _{pol} » is on.
<param>	parameter >measuring parameters	
<enter>	electr. id Pt 308	ASCII string (← → keys), 8 characters; electrode designation.
<enter>	drift 1.0 mV/min	0.5 ... 999.9 mV/min, OFF.
<enter>	I(pol) 10 µA	-127 ... 127 µA. The initial value is 1 µA; for many applications the recommended setting is I _{pol} = 10 µA.
<enter>	method id Ipol 4	Name of current method; see chapter 4, <methods> key.
<enter>	delta measurement: OFF	OFF, ON, meas. See chapter 4.
<enter>	stirrer: OFF	OFF, ON, control. See section 7.4.1.
<enter>	parameter >analog output Ipol	See section 7.3.1. Exit by pressing ...
<quit>	*** 692 pH/Ion Meter *** YY-MM-DD HH:MM:SS	

6.2.3 Differential potentiometry

In potentiometric measurements in media of low conductivity, e.g. in organic solvents, high-impedance electrode assemblies such as pH electrodes record noise voltages which arise from stray electrostatic and electromagnetic fields. Particularly high field strengths occur through friction at insulators such as plastic floors, synthetic clothing, etc.; i.e. conditions which can appear in every normal laboratory environment. These disturbing voltages are superimposed on the measurement signal and when titration curves are recorded can lead to «ghost end points», which make an automatic evaluation virtually impossible.

Earthing of the solution will discharge the static electricity but is not recommended because it can give rise to earth loops via earthed peripheral units such as balances and computers.

Problems of this type can be solved by measurement using a differential amplifier. Here, the indicator and reference electrode are each connected to a high-impedance measuring input. It is important to ensure that both electrodes have identical shielding and are thus symmetrical with regard to the recording of noise signals. An auxiliary electrode provides the electrical connection between the reference point of the amplifier circuit and the measurement solution.

The 692 pH/Ion Meter is prepared for differential potentiometric measurements in the «pH», «Conc» or «mV» modes as follows: <param> – >measuring parameters – <enter> – meas. input: (1, 2, diff.) – <select> diff. – <enter>.

Electrodes recommended for differential potentiometry

Measuring Input	Manual determinations	Determinations with sample changer
pH/ISE 1	6.0133.100 pH glass electrode	6.0104.100 pH glass electrode
pH/ISE 2	6.0729.100 shielded Ag/AgCl reference electrode	6.0729.110 shielded Ag/AgCl reference electrode
Ref. (use only one reference input)	6.0301.100 auxiliary electrode	6.0302.110 auxiliary electrode

Practical tip: Glass electrodes should be preconditioned in the solvent used for ca. 1 hour.

7. Connection possibilities

7.1 Connecting a printer to the RS 232 interface

Data transfer is possible only if the printers are set to «on line».

7.1.1 Connecting cables

RS 232C – Seiko DPU 411-11B(E/U), DPU 411-20B(E/U)	6.2125.020
RS 232C – Epson P-40, EX-800, LQ-850/1050	6.2125.040 (EX, LQ: without serial interface #8148)
RS 232C – Citizen iDP-560RS, Epson FX, LX, LQ, Kodak Diconix 180 Si	6.2125.050 (FX, LX, LQ with serial interface #8148)

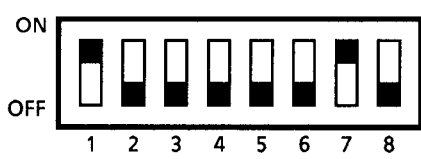
7.1.2 Graphics settings and plot parameters

The initial values of the parameters «width» and «length» – 0.8 and 1.0, respectively – will normally produce graphics outputs that fit onto the printer strip. To change these parameters, proceed as follows:

Key	Display (LCD)	Remarks
Power on & <config>	*** 692 pH/Ion Meter *** >input assign	Press <config> during power up until «>input assign» appears.
<config>	>temp. measurement	
<config>	>graphics	
<enter>	grid: ON	ON, OFF
<enter>	frame: ON	ON, OFF
<enter>	width 0.8	0.4...1.0 (1.0 $\hat{=}$ maximum width).
<enter>	length 1.0	0.4...1.0 (1.0 $\hat{=}$ maximum length).
<enter>	temp. Pt ...: XX.X °C YY-MM-DD HH:MM:SS	

Citizen IDP-560-RS: DIP switch and jumper positions

Set printer to on line with <SEL>



ON
OFF

1 2 3 4 5 6 7 8

Jumper

CN 7 5 4 3 2 1

closed

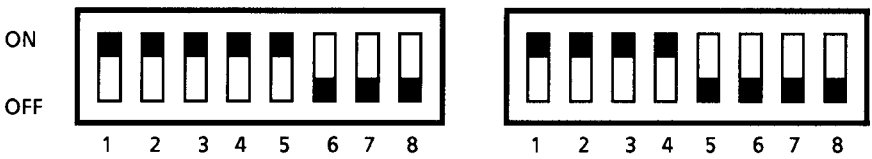
Jumper 1 & 2: Character code	
USA	J1: open J2: open
England	J1: closed J2: closed
France	J1: closed J2: open
Germany	J1: open J2: closed

Configuration 692
 <config>
 >printer
 character set: Citizen

>RS 232 settings
 baud rate: 9600
 data bit: 8
 stop bit: 1
 parity: none
 handshake: HWs

Epson LQ-850/1050: DIP switch positions on the printer (without #8148 interface board)

With this printer, the parameters «width» and «length» have both to be set to 0.7. The procedure is explained in section 7.1.2.



ON
OFF

1 2 3 4 5 6 7 8

SW1

1 2 3 4 5 6 7 8

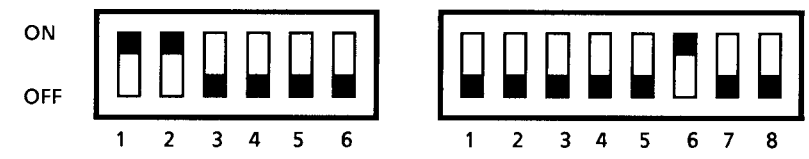
SW2

Configuration 692
 <config>
 >printer
 character set: Epson

>RS 232 settings
 baud rate: 9600
 data bit: 8
 stop bit: 1
 parity: none
 handshake: HWs

Epson FX-/LX-/LQ-: DIP switch positions on the #8148 interface board of the printer

With this printer, the parameters «width» and «length» have both to be set to 0.7. The procedure is explained in section 7.1.2.



ON
OFF

1 2 3 4 5 6

SW2

1 2 3 4 5 6 7 8

SW1

Configuration 692
 <config>
 >printer
 character set: Epson

>RS 232 settings
 baud rate: 9600
 data bit: 8
 stop bit: 1
 parity: none
 handshake: HWs

Kodak Diconix 180 si

The settings on the Kodak Diconix 180 si are performed by means of a dialogue-guided set up procedure.

Configuration 692

<config>

>printer

character set: Epson

>RS 232 settings

baud rate: 9600

data bit: 8

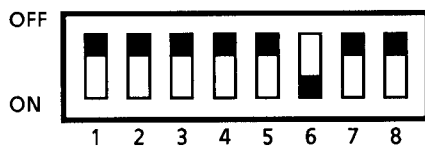
stop bit: 1

parity: none

handshake: HWs

Epson P-40

The Epson P-40 printer is markedly slower than the other printers mentioned here. To get graphics that fit onto the printer strip, the parameters «width» and «length» must both be set to 0.4 with «character set: Epson». For English-language printouts, «character set: Seiko» may be used; in this case, «width» and «length» must both be set to 0.7 using the procedure shown in section 7.1.2.



Configuration 692

<config>

>printer

charact. set: s. above

>RS 232 settings

baud rate: 9600

data bit: 8

stop bit: 1

parity: none

handshake: HWs

7.2 Connecting a computer to the RS 232 interface

The computer is connected to the 692 pH/Ion Meter as follows:

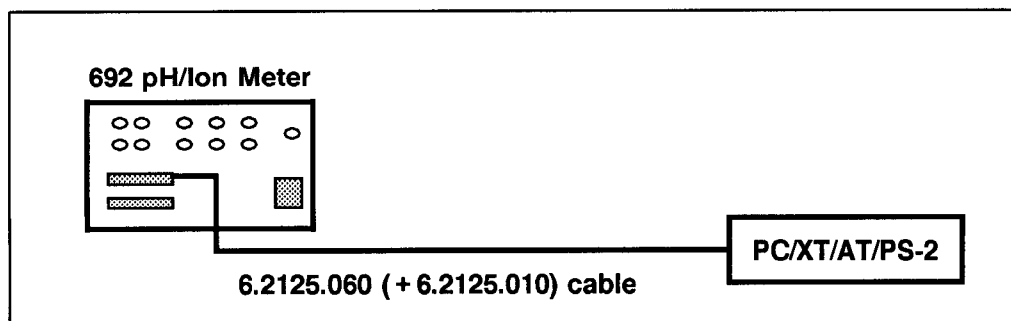


Fig. 7.2: Connection between 692 pH/Ion Meter and computer

For the connection of IBM® AT computers and compatibles that are fitted with a 9-pin connector, the 6.2125.010 adapter cable is required.

The RS 232 settings to be performed on the 692 pH/Ion Meter depend on the control program of the computer.

6.6008.010 PC program VESUV for the acquisition of measuring data on a PC. User dialogue configurable in English or German. Data from up to 8 Metrohm instruments can be received, stored as ASCII text files and printed out.

7.3. Applications of the analog output

7.3.1 Connecting a recorder

The Metrohm 586 Labograph can be connected to the 692 pH/Ion Meter as follows:

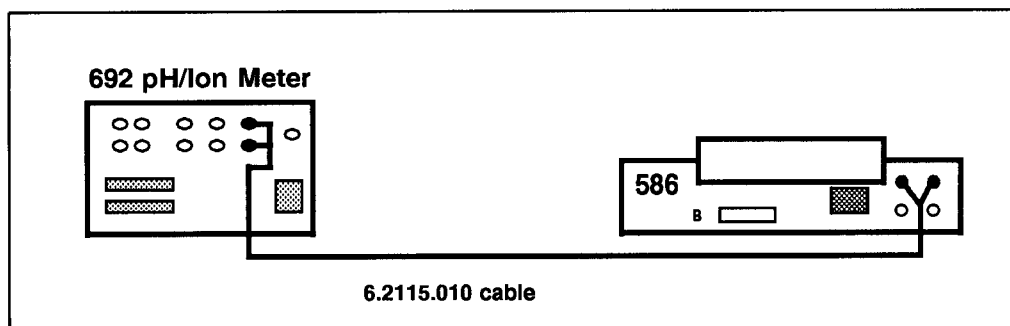


Fig. 7.3.1.1: Connection between 692 pH/Ion Meter and 586 Labograph

Other makes of laboratory recorders can be connected in place of the 586 Labograph.

In the pH and concentration modes, either the primary measured value (pH/concentration) or the temperature can be brought to the analog output of the 692 pH/Ion Meter. Assuming that we want to record pH values in the range pH = 3...7, the recorder can be «calibrated» from the 692 pH/Ion Meter as follows:

Key	Display (LCD)	Remarks
		Press <param> repeatedly ...
<param> ...	parameter >analog output	
<enter>	select:	pH pH, T
<enter>	state:	PRESET OFF, ON, PRESET. <select> PRESET to «calibrate» the recorder. OFF: 0 mV across analog output. ON: voltage across analog output according to settings.
<enter>	0 mV at	5.000 pH -19.999...19.999. Key in 5, i.e. the centre of the pH range to be recorded.
<enter>	1 V range	4 pH -19.999...19.999. Key in 4.
<enter>	preset	XX.XXX pH Key in 5 and press <enter> . Set recorder to 0 V and adjust recorder pen to the exact centre of the full scale range. Set recorder to 1 V (1000 mV) full scale. Key in 3 and press <enter> . The recorder pen will shift to the lower limit of the full scale range. Key in 7 and press <enter> . The recorder pen will shift to the upper limit of the full scale range. Enter values between 3 and 7 and observe the reaction of the recorder pen.
		Conclude the «calibration» by pressing ...

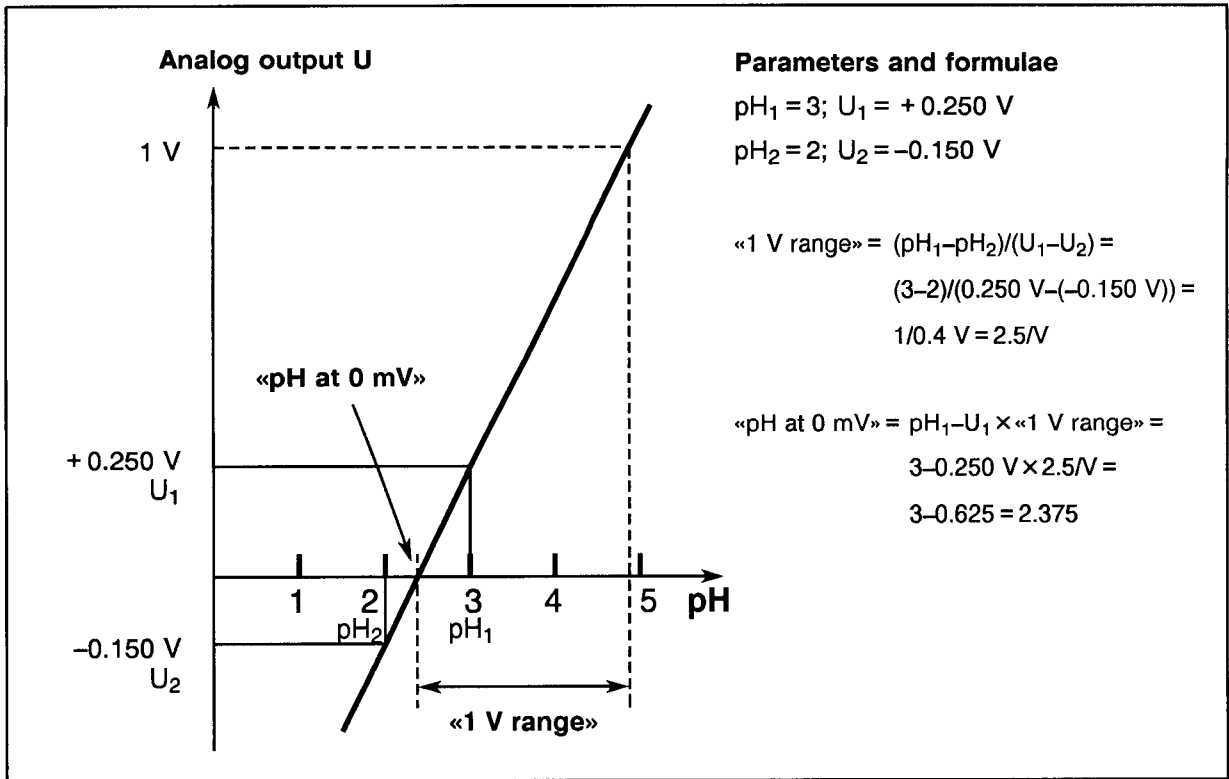
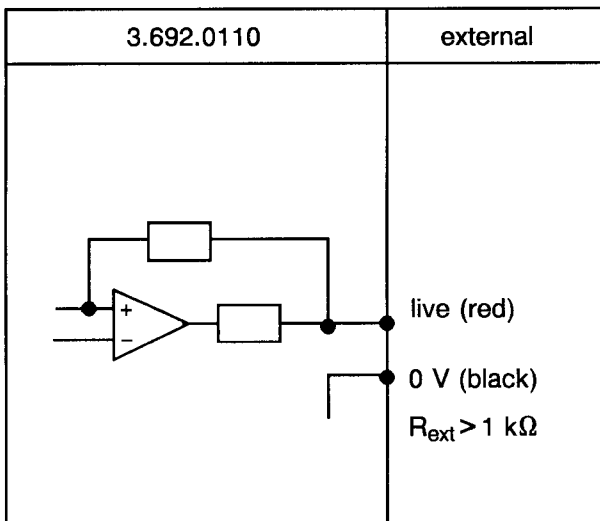


Fig. 7.3.1.2: Example of analog output voltage as a function of pH



Voltage range of analog output: -2000...2000 mV.
 Resolution: 1 mV (12 bit).

Fig. 7.3.1.3: Analog output circuit of 692 pH/Ion Meter

7.3.2 Expansion of the 692 pH/Ion Meter to a Combi Titrator

Fig. 7.3.2.1 shows one possible set of cable connections between 692 pH/Ion Meter, 665 Dosimat and 614 Impulsomat. Depending on the application, cables different from those shown in Fig. 7.3.2.1 will be needed. This becomes clear from Fig. 7.3.2.2, which illustrates the Combi Titrator concept and shows the equipment needed for the different options. The printer shown in Fig. 7.3.2.2 is the Seiko DPU-411. To connect alternative printers to the RS 232 interface of the 665 Dosimat, the following cables are needed:

6.2124.070 cable for the connection 665 – Citizen iDP 560 RS, Epson LX ..., LQ ..., FX ... and Kodak Diconix;

6.2124.040 cable for the connection 665 – Epson P-40 or P-80.

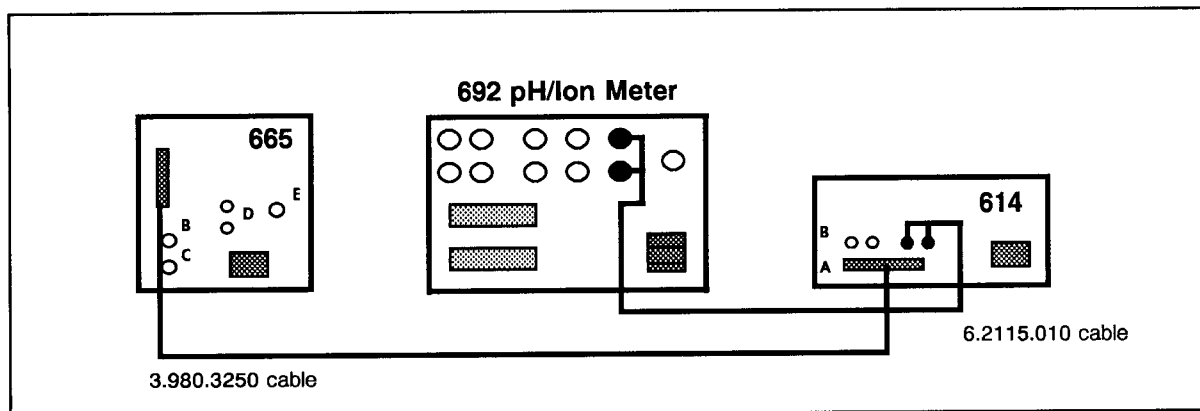


Fig. 7.3.2.1: Cable connections between 692 pH/Ion Meter, 665 Dosimat and 614 Impulsomat.

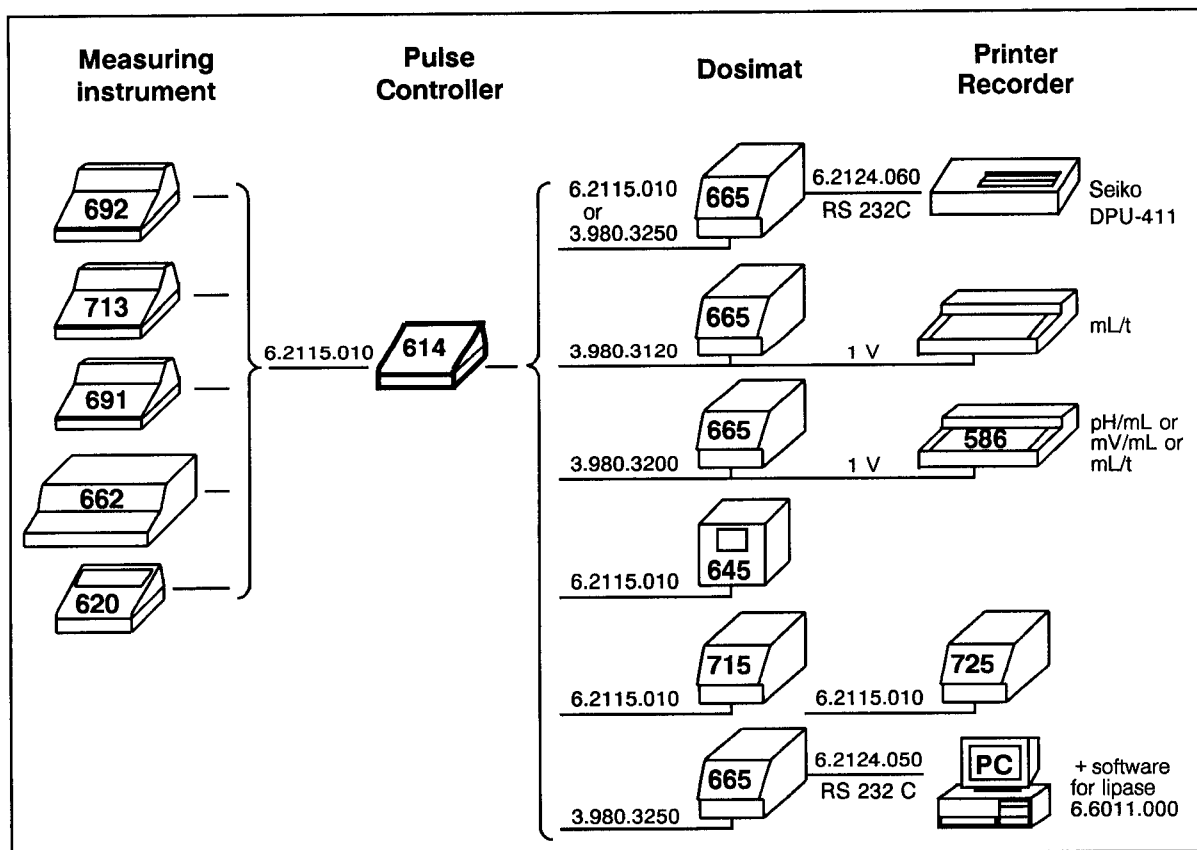


Fig. 7.3.2.2: The Combi Titrator concept

7.4 Applications of the «Remote» I/O lines

7.4.1 Stirrer control via the «Remote» I/O lines

The operation of the 622, 649 and 722 Stirrers and of the 727 Titration Stand can be controlled by the 692 pH/Ion Meter via the optional 6.2138.000 or 6.2138.010 cable. The set-up is shown in section 3.3.

The following steps serve to set the stirring parameters on the 692 pH/Ion Meter:

Key	Display (LCD)	Available options, remarks
<param >	parameter >measuring parameters	
	measuring input	1 1, 2, diff.
<enter >	electr. id: XXXX	Press <enter > until «stirrer» is displayed:
<enter > ...	stirrer: control	ON, control, OFF
<enter >	prestir pause XX s	0...99 999 s. Waiting time before stirring starts, in seconds.
<enter >	stir time XX s	0...99 999 s. Stirring time in seconds.
<enter >	poststir pause XX s	0...99 999 s. Waiting time after stirring, in seconds.

During calibrations or when the <print > key is actuated, the stirrer sequence thus specified will be executed before the measured value is taken over, considering the criteria specified as follows:

	config >print meas. value	
<enter >	print crit: drift (e.g.)	immediate, time, drift, OFF (see chapter 4, <config > key): <select > and confirm with <enter > .

7.4.2 Connecting a sample changer to the «Remote» I/O lines

The «Remote» socket allows not only the connection of a sample changer but also additional control functions. For the pin assignment of the «Remote» socket see Appendix 5.

Figs. 7.4.2.1 and 7.4.2.2 show two possible sample changer connections.

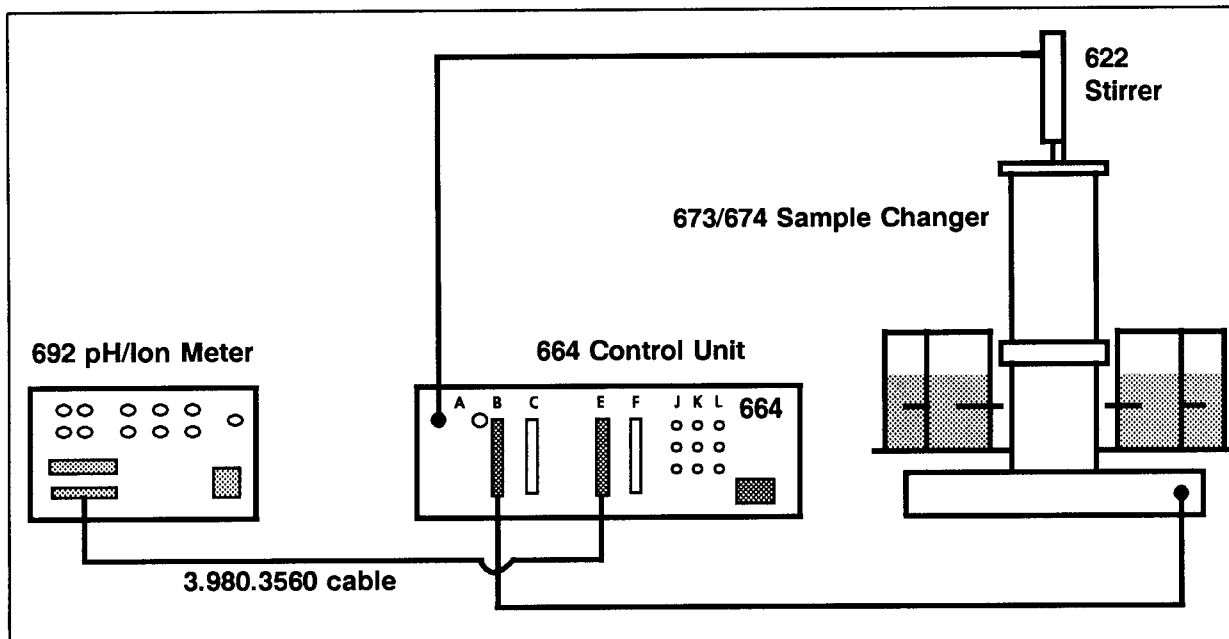


Fig. 7.4.2.1: Connection of a sample changer with the 3.980.3560 cable for pH or concentration measurements.

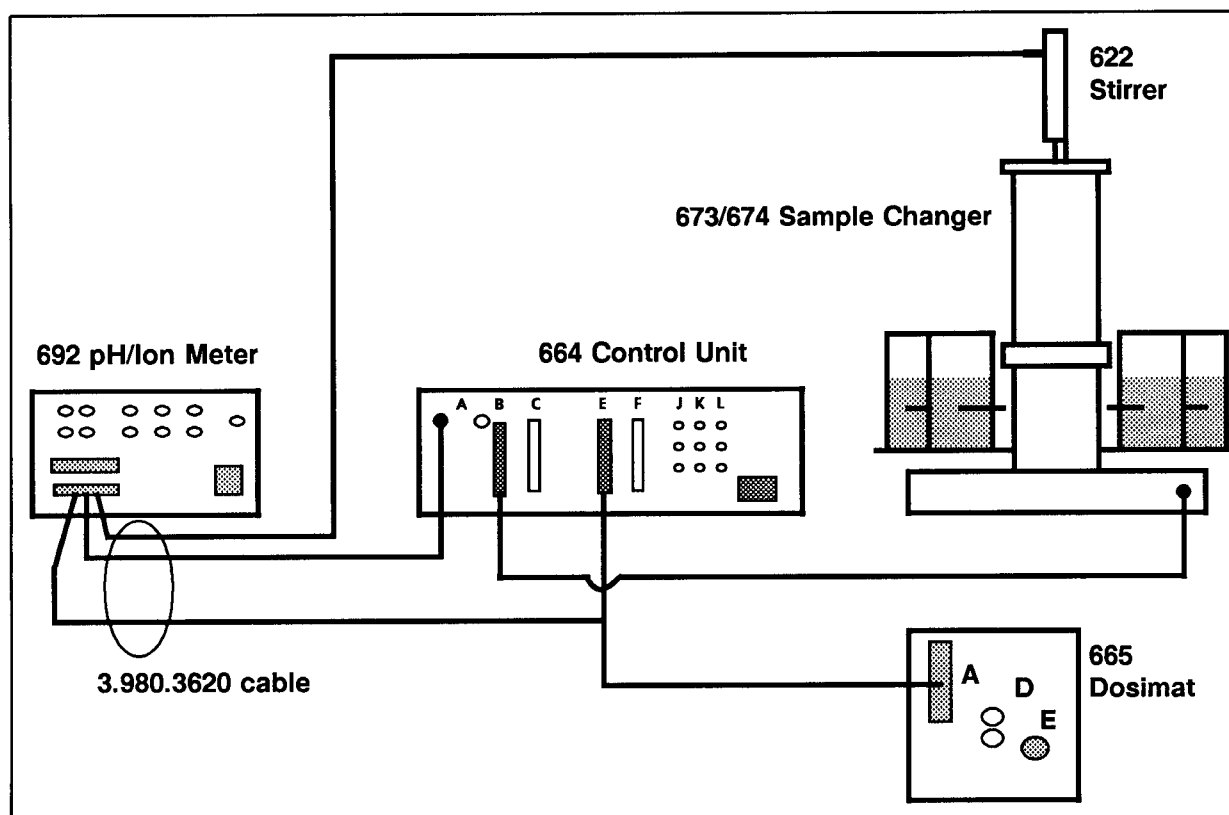


Fig. 7.4.2.2: Connection of a sample changer with the 3.980.3620 cable for the determination of concentrations by the standard addition technique. Stirrer control jointly by 692 pH/Ion Meter (switch) and 664 Control Unit (switched power).

7.4.3 The «Limits» function

The «Limits» function opens up a large number of applications of the «Remote» outputs. The pin assignment of the «Remote» socket is shown in Appendix 5.

Assuming that we wish to keep the the pH value within the range 7 to 9 by control via the «Remote» socket, the settings are performed as follows:

Key	Display (LCD)	Available options, remarks
<param>	parameter >measuring parameters	Press <param> repeatedly ...
<param> ...	parameter >limits pH	
<enter>	state:	ON ON, OFF; <select> ON.
<enter>	u.limit	9 pH -19.999...19.999; key in 9 for the upper limit (pH = 9.000).
<enter>	u. hyst.	0.020 pH -19.999...19.999; 0.020 = default value of upper hysteresis.
<enter>	l. limit	7 pH -19.999...19.999; key in 7 (pH = 7.000).
<enter>	l. hyst.	0.020 pH -19.999...19.999; 0.020 = default value.
<enter>	parameter >limits T	Exit by pressing <quit>.

Figs 7.4.3.1 and 7.4.3.2 schematically show the functioning of «Limits».

When measured values are plotted on a printer using the «plot» function (see chapter 4, <print> key), any limits defined as shown above will be clearly marked on the plot.

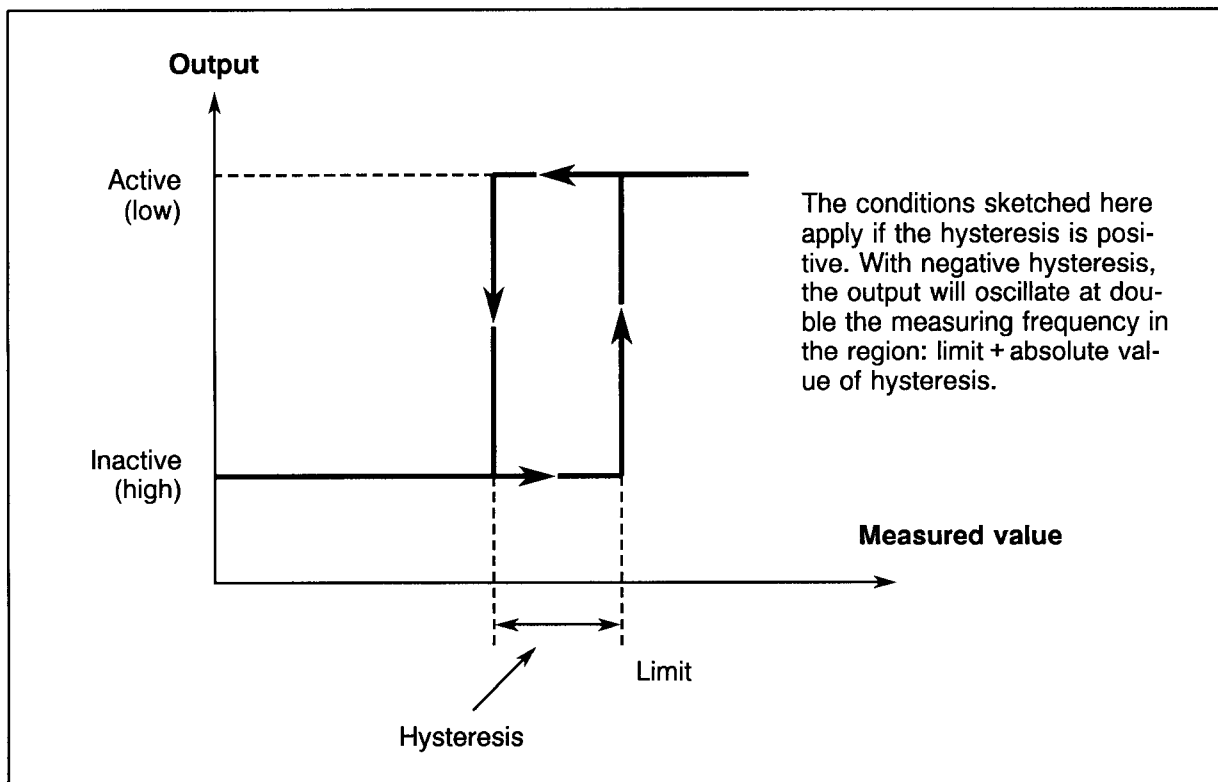


Fig. 7.4.3.1: Schematic of «Limits» function.

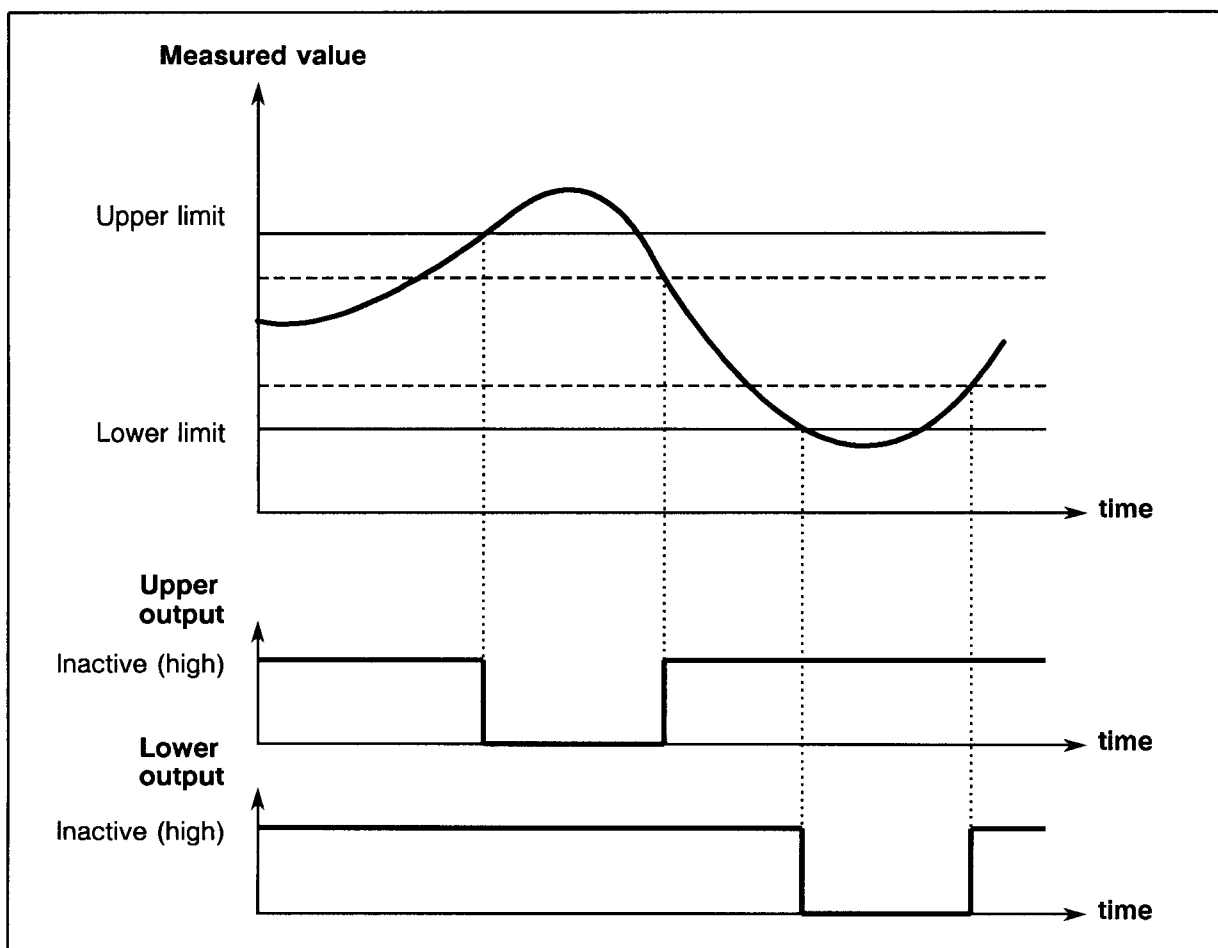


Fig. 7.4.3.2: «Remote» outputs obtained as a function of the measured value when applying the «Limits» function.

8. Operation via RS 232C interface

8.1 General rules

The 692 pH/Ion Meter has an extensive remote control facility that allows full control of the titrator via the RS232 interface, i.e. the titrator can receive data from an external controller or it can send data to an external controller. C_R and L_F are used as terminators for the data transfer. The 692 pH/Ion Meter sends $2 \times C_R$ and L_F as termination of a **data block**, to differentiate between a **data line** which has C_R and L_F as terminator. (After \$Q the last data line is terminated by $C_R L_F$ and the data block is marked in addition by $C_R C_R L_F$, i.e., an empty line is sent.)

The controller terminates its commands with C_R and L_F . If the controller sends more than one command per line, a semicolon (;) is used as separator between the commands.

The commands are grouped logically and are easy to understand. Thus, e.g., for the selection of the pH mode the command

&Mode.Select "pH"

must be sent, but only the boldface characters need be inputted, thus

&M.S "pH"

All quantities of the 692 pH/Ion Meter are collected in groups. For example, the entries for the configuration are in the group

&Config

The "Config" group contains subgroups, e.g. for the setting of the RS interface parameters (RS Settings)

&Config.RSSet

This subgroup in turn contains the individual inquiries for the settings, e.g. the inquiry regarding the baud rate

&Config.RSSet.Baud

or regarding the setting of the parity

&Config.RSSet.Parity

The commands have a hierarchical structure (tree structure). The quantities that appear in this tree are called **objects** in what follows. The baud rate is an object that is called up with the command

&Config.RSSet.Baud

If one is at the desired location in the tree, the value of the appropriate object can be queried, e.g. in the case of the inquiry regarding the baud rate:

&Config.RSSet.Baud \$Q (Q for Query)

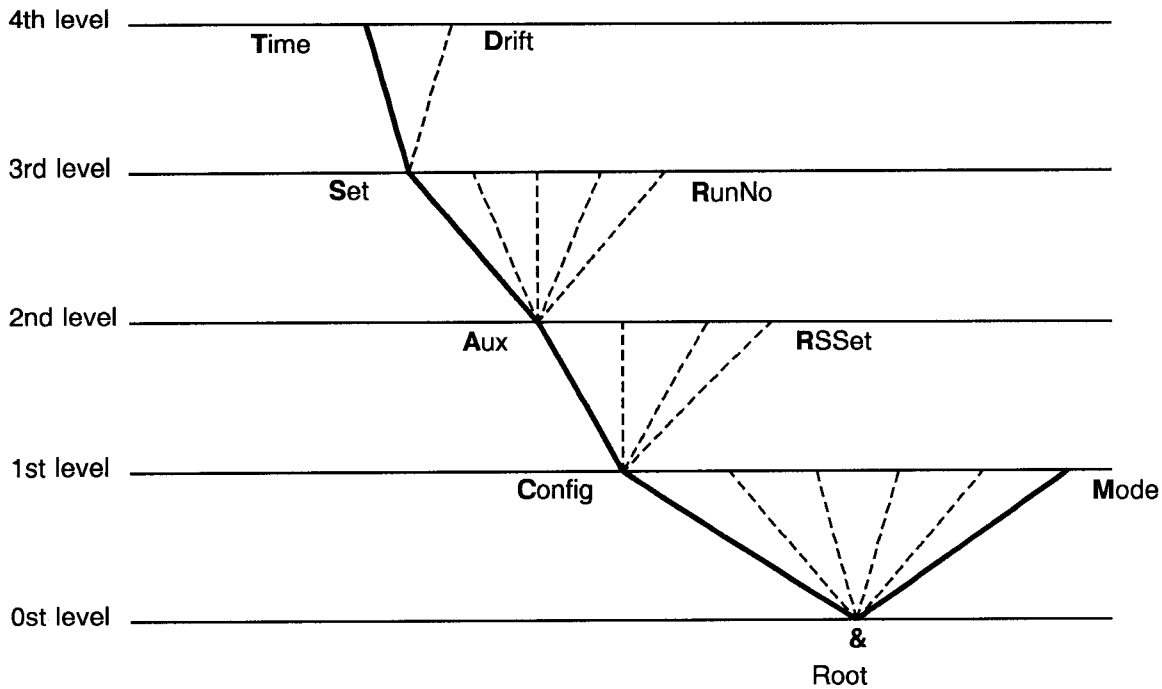
\$Q triggers the output of the value from the 692 pH/Ion Meter. Entries that are introduced with the character dollar (\$) trigger something. They are thus called **triggers** in what follows.

Values of objects cannot only be requested, they can also be modified. Values are always entered in quotation marks ("), e.g.

&Config.RSSet.Baud "9600"

8.2 Call up of objects

All objects of the 692 pH/Ion Meter are grouped hierarchically. They have a tree structure. A section of this tree is shown below:



Rules

Examples

- The root of the tree is marked by &.
- For the call up of an object the nodes (levels) of the tree are marked with a point (.).
- The call up of the objects requires as many letters as necessary to ensure unequivocal assignment of the object. If the call is not unequivocal, the first object in the series is recognised.
- Upper- or lowercase letters can be used
- An object can be assigned a value. Each value is marked at the beginning and end with quotation marks ("). A value can contain up to 24 characters. Numeric values can include up to 6 digits, a negative sign and a decimal point. Numbers with more than 6 digits will not be accepted; more than 4 decimal places are rounded off. With numbers < 1, it is necessary to enter leading zeros.
- If a new object is not called up, the old object remains current.
- New objects can also be addressed relative to old objects:
A preceding point moves one node **forwards** in the tree.
More than one preceding point moves one node **backwards** in the tree. n nodes backwards require n + 1 preceding points.
- If a jump is to be made back to the root, a preceding & is entered.

Call up of time:
&Config.Aux.Set.Time
 or **&C.A.S.T**

&C.A.S.T or **&c.a.s.t**

Entry of "14:37" for the time
&C.A.S.T "14:37"

Correct entries of numbers:
"-31.2273"
"0.1"
 incorrect entries:
"1,5" or **" +3"** or **".1"**

Entry of a different time:
"14:42"

From the root to the 'Aux' node:
&C.A
 Forwards from the 'Aux' node to 'Set': **.S**

Jump from 'Set' onto the 'Aux' node and selection of a new object at this node, 'RunNo': **..R**
 Jump from the object 'RunNo' via the 'Aux' node to the 'Config' node and to the new node 'RSet': **...R**

Change from the 'RSet' node via the root into the 'Mode' node: **&M**

8.3 Triggers

Triggers initiate an action at the 692 pH/Ion Meter, e.g. starting of a procedure or sending of data. Triggers are marked with the introducer: **\$**

The following triggers are possible:

\$G	Start:	Starts operations, e.g. start of the calibration or setting of the RS232 interface parameters
\$S	Stop:	Stops operations, e.g. calibration
\$D	Detailed Info:	Used for inquiry of the detailed status
\$Q	Query:	Used for inquiry of all information from the current node in the tree upwards up to and including the values
\$Q.P	Path:	Used for inquiry of the path from the root of the tree up to the current node
\$U	qUit:	Used to abort the data flow of the 692 pH/Ion Meter, e.g. after \$Q

The triggers **\$G** and **\$S** and are linked to objects, see section 8.2.

The other triggers, however, can be used at any time and at any location on the object tree.

Examples:

Inquiry of the value of the baud rate: **&Config.RSSet.Baud \$Q**

Inquiry of all values of the node 'RSSet': **&Config.RSSet \$Q**

Inquiry of the path of the node 'RSSet': **&Config.RSSet \$Q.P**

Start of pH calibration: **&Mode.pH.Cal \$G**

Inquiry of the detailed status: **\$D**

8.4 Status conditions and error messages

There is only one status message per inquiry (**\$D**).

The main process is the foreground measurement. The measurement of the main process does not need to be started. The instrument is ready. The global condition is then **\$R**. The stirrer macro is started in the measure mode as well. Its global condition is **\$G**.

Besides the above main processes, there are others: pH calibration, electrode test. Their status messages only appear if these processes run in the foreground. As soon as they are concluded, the status condition of the main process is active again.

8.4.1 Status conditions

Status conditions of the global **\$G**

The status **\$G** appears if a process has been started actively.

\$G.Mode.pH .Stirrer:	Waiting for the stirring times to elapse during meas.
.Cal.Inac:	At beginning of calibration.
.Stirrer:	Calibrating, waiting for stirring times to elapse.
.Req.Temp1:	Requesting temperature.
.Meas.TempX:	Temperature measurement in buffer X.
.Meas.BufX:	Calibrating, measuring buffer X.
.Req.BufX:	Requesting pH of buffer X.
.Data:	Display of data, data output.
.EITest .Inac:	At beginning of electrode test.
.Req.TempX:	Requesting X th temperature.
.Meas.BufX:	Performing X th measurement.
.Req.BufX:	Waiting for X th buffer.
.Meas.IncX:	Measuring X th increment.
.Data:	Data output.

\$G.Mode.U.Stirrer:	Waiting for the stirring times to elapse during measurement.
\$G.Mode.T.Stirrer:	Waiting for the stirring times to elapse during measurement.
\$G.Mode.Ipol.Stirrer:	Waiting for the stirring times to elapse during measurement.
\$G.Mode.Conc.Add.Inac:	At beginning of standard addition.
.Stirrer:	Waiting for the stirring times to elapse.
.Req.Temp0:	Requesting temperature.
.Meas.Temp0:	Measuring temperature.
.Meas.Inc0:	Measuring initial solution.
.Req.IncX:	Requesting X th increment.
.Add.IncX:	X th increment is being added.
.Data:	Data output.
.Direct.Stirrer:	Waiting for the stirring times to elapse during meas.
.Cal.Inac:	At beginning of calibration.
.Stirrer:	Waiting for the stirring times to elapse during calibration.
.Req.Temp1:	Requesting temperature during calibration.
.Meas.Temp1:	Temperature measurement during calibration.
.Meas.StdX:	Measuring X th standard.
.Req.StdX:	Requesting X th standard.
.Add.StdX:	Standard is being added.
.Data:	Data output.

Status conditions of the global \$R

The process has been concluded in the normal way or has not yet been actively started.

\$R.Mode.pH.Drift:	Measuring in pH mode, drift criterium not met.
.DriftOK:	Drift criterium met.
\$R.Mode.U.Drift:	Measuring in U mode, drift criterium not met.
.DriftOK:	Drift criterium met.
\$R.Mode.T.Drift:	Measuring in T mode, drift criterium not met.
.DriftOK:	Drift criterium met.
\$R.Mode.Ipol.Drift:	Measuring in I _{pol} mode, drift criterium not met.
.DriftOK:	Drift criterium met.
\$R.Mode.Conc.Drift:	Direct measurement in Conc mode, drift crit. not met.
.DriftOk:	Drift criterium met.
\$R.Mode.Conc.Add.Inac:	Add sequence finished in Conc mode.

Status conditions of the global \$\$

The process has been stopped arbitrarily because of an error that produces \$\$... The condition from which the process has been stopped is indicated. Example:

\$\$Mode.Conc.Add.Inac:	Stopped at very beginning.
.Stirrer:	Stopped when waiting for stirring times to elapse.
\$\$Mode.XX.Drift(Ok)	Measurement stopped via RS 232.

8.4.2 Error messages

Error messages are sent upon status inquiry at the end of the status message, after the separating semicolon «;». Example: \$R.Mode.lpol;E22.

Some errors interrupt the running process; the corresponding messages are marked by an asterisk «*».

The error numbers are valid for all Metrohm instruments whose software is arranged in a tree structure. Accordingly, the error numbers for a given instrument have gaps between them. If you connect several Metrohm instruments to your computer, you are able to set up a table containing the error numbers and their meaning.

Error	How to exit
E21 Check electrode, short circuit.	Rectify fault or change mode.
E22 Check electrode, break (for polarized electrodes).	Rectify fault or change mode.
E26 Manual stop.	\$G, \$S or mode change.
E28 Wrong object call up.	Correct path.
E29 Wrong value.	Correct value or new path.
E30 Wrong trigger.	Correct trigger or new path.
E31 Command not possible in active status.	Repeat command in inactive status.
RS receive errors	
E36 Parity.	< quit > and ensure settings are the same on both devices.
E37 Stop Bit.	< quit > and ensure settings are the same on both devices.
E38 Overrun error. At least 1 character could not be read.	< quit > .
E39 The internal receive buffer of the 692 pH/Ion Meter is full.	< quit > .
RS send errors	
E40 DSR = OFF. No proper handshake for more than 1 second.	< quit > . Is receiver switched on and ready?
E41 DCD = ON. No proper handshake for more than 1 second.	< quit > . Is receiver switched on and ready?
E42 CTS = OFF. No proper handshake for more than 1 second.	< quit > . Is receiver switched on and ready?
E43 Transmission from the 692 pH/Ion Meter has been interrupted by XOFF for at least 3 seconds.	Send XON or < quit > .
E44 The RS 232 interface parameters are no longer the same for both devices.	Reset.
E45 The receive buffer of the 692 pH/Ion Meter contains an incomplete command (L _F missing). Sending from the 692 is therefore blocked.	Send L _F or < quit > .
E120* Overage.	Rectify fault or change mode. In running process: \$G.
E135* Check temperature sensor.	Rectify fault or change mode.
E136* Same buffer, standard.	\$S or \$G.
E137 XXX bytes missing (during method storage).	New command.
E138* Buffer not defined.	\$S or \$G.
E139* Buffer alloc. impossible.	\$S or \$G.
E140* Delta T > 2 °C.	\$S or \$G.
E141* Cal. data out of limits.	\$S or \$G.
E142* El. test failed.	\$S or mode change.
E143* AddV too small.	\$S or mode change.
E144* AddV too great.	\$S or mode change.
E145* Check working conditions.	\$S or mode change.
E146 Evaluation error in conc.	\$G or mode change.
E148* Buffer not valid for el. test.	\$S or mode change.

8.5 Remote control commands

8.5.1 Definition of «macros»

These «macros» will no longer be listed in detail later on.
Default settings are marked by **bold** type.

Delta measurement

«.Delta» means

.Delta	\$G	Acquire actual measured value
.Status	ON/meas/OFF	Switch on/off or offer measured value
.Reference	Depends on meas. value	Either measured or fixed value

Limits

«.Limit macro» means

.Status	ON/OFF	Switch on/off. If «OFF», the lines are available.
.UpperLim	Depends on meas. value	Upper limit
.UHysteresis	Depends on meas. value	Hysteresis for upper limit
.LowerLim	Depends on meas. value	Lower limit
.LHysteresis	Depends on meas. value	Hysteresis for lower limit

Analog output

«.Analog output macro» means

.Status	ON, OFF, preset	
.Zero	Depends on meas. value	Measured value for 0 mV analog signal
.Range	Depends on meas. value	Range for 2 V analog signal
.PresetValue	Depends on meas. value	Setting of a fixed value

Stirrer

«.Stirrer» means

.Status	ON, control, OFF	This macro is started by «print» or &Config.PrintMeasVal \$G. ON: continuous stirring; OFF: no stirring; control: intervals
.PreStirTime	0 ... 99999	Waiting time before stirring starts, in seconds
.StirTime	0 ... 99999	Stirring time in seconds
.PostStirTime	0 ... 99999	Waiting time after stirring, in seconds

8.5.2 Instrument tree structure

«Macros» as defined in the preceding section.

Command	Input options Default values are marked by bold type .	Meaning
&Mode		
.Select	pH , T, U, Ipol	Loading of mode
.pH		
.Cal	\$G, \$S	Start or stop mode Cal
.EITest	\$G, \$S	Start or stop Electrode Test
.MeasPara		
.MeasInput	1, 2, diff	
.ElectrodeId	8 ASCII	Electrode identification
.Drift	0.005... 0.05 ...9.999	pH drift limit in 1/min
.Temperature	-999.9... 25.0 ...999.9	Measuring temperature
.MethodId	Read only	Method name
«.Delta»		Macro
«.Stirrer»		Macro
.CalPara		
.CalTemp	0.0... 25.0 ...99.9	Calibration temperature
.Drift	0.1... 0.5 ...9.9	Drift in mV/min
.Report	full, short, OFF	Calibration report
.Buffer		
.Number	1... 2 ...9	Number of buffers for calibration
.Type	Metrohm , NIST, DIN, Fisher, Merck, Ciba, Ingold, Beckman, Radiometer, special, own, mixed	Selection of buffer set
.Special		Special buffers
.1		1 st special buffer
.Val	0... ± 19.999	pH value
:		
.n		
.Own		Definition of own buffers
.1		1 st buffer
.1		Temperature no. 1; 0 °C
.Val	0... ± 19.999	pH value at 0 °C
.2		Temperature no. 2; 5 °C
:		
.20		Temperature no. 20; 95 °C
.2		2 nd buffer
:		
.5		Maximum 5 buffers
.Mixed		Mix of buffers
.1		1 st buffer
.Select	Met X, NIST X, DIN X, Fis X, Mer X, Cib X, Ing X, e.g. Met 9 = Metrohm buffer pH = 9. Bec X, Rad X, own X	Selection of buffer, X = buffer designation;
:		
.5		Maximum 5 buffers
.UOffset	\$G	Acquisition of measured value
.Status	ON, meas, OFF	Status of UOffset. meas = preparation for measured value
.Value	0... ± 1999.9	Measuring or fixed value.
.EITestPara		Parameters for electrode test
.Temperature	0... 25.0 ...99.9	Temperature
.Report	full, short OFF	Report

.AnalogOutput		
.Select	pH, T	Assignment
.pH		
	«.Analog output macro»	
.T		
	«.Analog output macro»	
.LimitspH		
	«.Limit macro»	
.LimitsT		
	«.Limit macro»	
.PlotPara		Parameters for live plot on printer. Start with <print>, abort with <quit>.
.LeftMargin	-19.9...0...19.9	Left margin of pH scale.
.RightMargin	-19.9...14...19.9	Right margin of pH scale.
.TLeftMargin	-999...20...999	Left margin of T scale (secondary meas. value).
.TRightMargin	-999...30...999	Right margin of T scale (secondary meas. value).
.U		
.MeasPara		
.MeasInput	1, 2, diff	
.Electrodeld	8 ASCII	
.Drift	0.5...1...999.9, OFF	Drift limit in mV/min
.Methodld	Read only	Method name
«.Delta»		Macro
«.Stirrer»		Macro
.AnalogOutput		
	«.Analog output macro»	
.Limits		
	«.Limit macro»	
.PlotPara		Parameters for live plot on printer. Start with <print>, abort with <quit>.
.LeftMargin	-1999.9...-1000...1999.9	Left margin of voltage scale.
.RightMargin	-1999.9...1000...1999.9	Right margin of voltage scale.
.T		
.MeasPara		
.Electrodeld	8 ASCII	
.Drift	0.5...1...999.9, OFF	Drift limit in °C/min or °F/min
.Methodld	Read only	Method name
«.Delta»		Macro
«.Stirrer»		Macro
.AnalogOutput		
	«.Analog output macro»	
.Limits		
	«.Limit macro»	
.PlotPara		Parameters for live plot on printer. Start with <print>, abort with <quit>.
.LeftMargin	-999.9...0...999.9	Left margin of temperature scale.
.RightMargin	-999.9...100...999.9	Right margin of temperature scale.
.Ipol		
.MeasPara		
.Electrodeld	8 ASCII	
.Drift	0.5...1...999.9, OFF	Drift limit in mV/min
.Current	-127...1...127	Polarization current
.Methodld	Read only	Method name
«.Delta»		Macro
«.Stirrer»		Macro
.AnalogOutput		
	«.Analog output macro»	
.Limits		
	«.Limit macro»	
.PlotPara		Parameters for live plot on printer. Start with <print>, abort with <quit>.
.LeftMargin	-1999.9...-1000...1999.9	Left margin of voltage scale.
.RightMargin	-1999.9...1000...1999.9	Right margin of voltage scale.

.Conc		
.MeasType	direct, std dos, smpl dos	Selection of technique.
.MeasPara		Measuring parameters.
.Ion		
Select	Ag(+1), BF ₄ (-1), Br(-1), Ca(+2), Cd(+2), Cl(-1), CN(-1), Cu(+2), F(-1), I(-1), K(+1), Na(+1), NH ₄ (+1), NO ₂ (-1), NO ₃ (-1), Pb(+2), S(-2), SCN(-1), SO ₄ (-2), own	Ion type.
.Own		
.Name	7 ASCII.	
.Charge	-9...1...9	Charge of ion.
.Unit		Unit for concentration.
.Select	mol/l, %, ppm, g/l, mg/l, µg/l, mEq/l, own	Unit selection.
.Own	5 ASCII	String for «own» unit.
.MeasInput	1, 2, diff	
.ElectrodeId	8 ASCII	
.Drift	0.1...1...999.9, OFF	Drift limit in mV/min.
.Temperature	-999.9...25.0...999.9	Measurement temperature.
.MethodId	Read only	Method name.
«.Delta»		Macro, only for «direct».
«.Stirrer»		Macro
.CalcPara		Calculation parameters.
.SmplSize	0.001...99 99.9, OFF	Sample size.
.VTotal	0.001...100...9 999.9	Total starting volume.
.Factor	1E-37...1...1E+30	Result multiplier («conc» × factor).
.SmplUnit	ml, g	Unit for sample size.
.Direct		
.Cal	\$G, \$S	Start or stop calibration.
.CalPara		Calibration.
.CalTemp	0...25...99.9	Calibration temperature.
.Drift	0.1...0.5...9.9	Drift limit in mV/min.
.Report	short, full, OFF	Calibration report.
.NumberStd	1...2...19	Number of calibration standards.
.Type	manual, auto	manual handling; EOD after each measurement. auto: standards generated by Dosimat; EOD at end of calibration.
.Manual		With manual calibration:
.1		Concentration of
.Conc	1E-30...0.01...1E+30	1 st standard.
:		
.Auto		With automatic calibration:
.CMin	1E-30...0.1...1E+30	Concentration range to
.CMax	1E-30...1.0...1E+30	be covered.
.VInit	0.001...100...9 999.9	Total initial volume (ISA or TISAB, etc.)
.NoExUnit	1...5	Number of Exchange Units.
.1		
.Conc	1E-30...100...1E+30	Concentration of standard in Exchange Unit 1.
.ExV	1, 5, 10, 20, 50	Buret volume of Exchange Unit 1.
:		
.5		
.AnalogOutput		
.Select	Conc, T	
.conc		Default setting.
«.Analog output macro»		
.T		
«.Analog output macro»		
.LimitsConc		
«.Limit macro»		
.LimitsT		
«.Limit macro»		

.PlotPara		Parameters for live plot on printer. Start with <print>, abort with <quit>.
.LeftMargin	-1E-30...0...1E30	Left margin of concentration scale.
.RightMargin	-1E-30...1E30	Right margin of concentration scale.
.TLeftMargin	-999...20...999	Left margin of T scale (secondary meas. value).
.TRightMargin	-999...30...999	Right margin of T scale (secondary meas. value).
.StdAdd	\$G, \$\$	Standard addition:
.Type	add, sub	Addition or subtraction.
.Conc	1E-30...1...1E + 30	Concentration of standard solution.
.Report	OFF, short, full, line	Selection of report type.
.Add	manual, auto dos, auto	manual: sequence with stops, no pulses via I/O. auto dos: set increments are added, no stops. auto: I/O pulses used to reach set «delta U». No stops, no queries of increments.
.DeltaU	1...6...999	For «auto» additions.
.DosRate	slow, medium, fast	Addition rate.
.NumberAdd	1...19	Number of additions.
.Bur	1, 5, 10, 20, 50	Buret volume of Exchange Unit.
.Increment		Size of increment.
.1		1st increment.
.Val	0...99.999	Volume in ml.
.n		Up to number of increments.
.SmplAdd	\$G, \$\$	Sample addition:
.Type	add, sub	Addition or subtraction.
.Conc	1E-30...1...1E + 30	Concentration of standard solution.
.Report	OFF, short, full, line	Selection of report type.
.Add	manual, auto dos, auto	See above.
.DeltaU	1...6...999	For «auto» additions.
.DosRate	slow, medium, fast	Addition rate.
.NumberAdd	1...19	Number of additions.
.Bur	1, 5, 10, 20, 50	Buret volume of Exchange Unit.
.Increment		Size of increment.
.1		1st increment.
.Val	0...99.999	Volume in ml.
&UserMeth		User methods
.FreeMemory	Read only	Memory still available
.Recall	\$G	Move method to foreground
.Name	n ASCII	Method name
.Store	\$G	Store method
.Name	n ASCII	Method name
.Delete	\$G	Delete method
.Name	n ASCII	Method name
.DeleteAll	\$G	Delete all methods
&Config		User methods
.Aux		
.LastDigit	ON, OFF	Last digit of display
.Language	english, deutsch, francais, español	Language selection for manual operation; remote control language: english only
.Set	\$G	Sets date and time
.Date	XX-XX-XX	Format: YY-MM-DD
.Time	XX:XX:XX	HH-MM-SS; 24 h format
.TempUnit	C, F	Temperature unit °C or °F
.RunNo	0...999, OFF	Current run number
.Dosimat	665, 725	Dosimat type
.DevName	8 ASCII	Instrument name
.Prog	Read only	Program version

.Printer		
.CharSet	Epson, Seiko, IBM , Citizen	Selection of character set
.PrintHead	once , always, OFF	Print header once, always, never
.DateTime	ON , OFF	Date and time for print header
.Id1	16 ASCII	Additional identifier for print header
.Id2	16 ASCII	Additional identifier for print header
.PrintMeasVal	\$G, \$S	Send/print (same as <print> key)
.PrintCrit	plot, OFF, immediate , time, drift	«plot» can be aborted via RS 232 by \$U.
.Time		
.Interval	0.08... 4 ...99999	Time interval for sending, in seconds
.StopTime	1...999999, OFF	When elapsed, an EOD is sent
.Plot		
.Interval	0.4... 4 ...99 998	Interval in seconds.
.TimeScale	5, 10, 30, 60 ...99 960	Time scale in seconds/cm.
.TLabel	abs, rel	abs: clock time in HH:MM.
.StopTime	1...999 999, OFF	Total duration in seconds; when elapsed, an EOD is output.
.DateTime	ON , OFF	Date and time for measured value
.RSSet		
.Baud	Value	\$G sets RS 232 parameters
.Data bit	7, 8	Baud rate, default value 9600
.Stop bit	1, 2	Data length
.Parity	even, odd, none	Stop bits
.Handsh	HWf, HWs, SWchar, SWline, none	Parity
(.RSControl		Handshake
		This node is not visible during RS 232 operation)

&Info		
.Report		
.Select	\$G, \$S user memory, calib, config, param, el. test, all	\$G sends formatted reports Selection of report type
.pHCalData		
.ElectrodeId	Read only	pH calibration data Electrode identification
.Slope	0.001...1...9.999	Slope
.pHas	0...7...99.999	Asymmetry pH
.CalTemp	Read only	Calibration temperature
.DateTime	Read only	Date and time of calibration
.Variance	Read only	Statistics parameter
.MeasInput	Read only	Measuring input
.BufferType	Read only	Buffer set
.NoBuffer	Read only	Number of buffers used for calibration
.CalTab		
.Select	original, delete n, reset cal	Buffer table
.DeleteN	1...9	Delete measurement with buffer N
.MeasData		
.1		Query for measured values Buffer 1
.pH	Read only	Nominal pH value
.U	Read only	Measured potential
.dpH	Read only	Deviation resulting from regression analysis
.2		Buffer 2
:		

.EITestData		Electrode Test Data
.Electrodeld	Read only	Electrode identification
.Temp	Read only	Temperature
.DateTime	Read only	Date and time of test
.MeasInput	Read only	Measuring input
.Message	Read only	Result of electrode test
.ConcCalData		Calibration data for «Conc» mode.
.IonType	Read only	Ion type.
.Electrodeld	Read only	Electrode identification.
.Slope	Value	See section 3.1. Manual entry:
.E0	Value	See section 3.1. Calibration table
.CBlank	Value	See section 3.1. is deleted.
.CalTemp	Read only	Calibration temperature.
.DateTime	Read only	Date and time of calibration.
.Variance	Read only	See section 3.4.
.MeasInput	Read only	Electrode input.
.NoStd	Read only	Number of calibration standards.
.CalTab		Calibration table.
.Select	original , delete n, reset cal	
.DeleteN		Delete N th measurement.
.MeasData		Query of measured data.
.1		Standard 1.
.conc	Read only	Nominal concentration.
.U	Read only	Corresponding voltage.
.dconc	Read only	Deviation from calibration curve.
.2		Standard 2.
:		
.AddData		Data of «conc» mode, «add» technique.
.IonType	Read only	Ion type.
.MeasType	Read only	
.Electrodeld	Read only	Electrode identification.
.Slope	Read only	See section 3.1.
.E0	Read only	See section 3.1.
.Conc	Read only	Concentration.
.VTotal	Read only	Total starting volume.
.StdConc	Read only	Concentration of standard added.
.Temp	Read only	Temperature.
.DateTime	Read only	Date and time.
.Analyte	Read only	Voltage measured in initial solution.
.Variance	Read only	See section 3.4.
.MeasInput	Read only	Electrode input.
.Factor	Read only	Result multiplier («conc» × factor).
.SmplSize	Read only	Sample size.
.MeasData		Query of measured data.
.1		Standard 1.
.AddV	Read only	Volume added.
.U	Read only	Corresponding voltage.
.2		Standard 2.
:		
.ActualInfo		
.Inputs		
.Status	Read only	Status query in byte form
.Change	Read only	Change of line since Clear, in byte form. Example: 1 0 0 0 1 0 0 0 7 6 5 4 3 2 1 0 Decimal output: "136"
.Clear	\$G	Clears Change byte
.Outputs		
.Status	Read only	Status query in byte form
.Change	Read only	Change of line since Clear
.Clear	\$G	Clears Change byte

.MeasValue		Measured value
.Primary	Read only	Primary measured value
.Secondary	Read only	Secondary measured value
.Display		SQ sends whole display
.Value	Numerical value	Main display; measured value
.Unit	Unit	Main display; unit
.Ind		Indicators in byte form
		7 6 5 4 3 2 1
		Ref Slpe pH _{as} Cal D1ta Drft Ip1
		Output: decimal
.L1	24 ASCII	LCD Line 1
.L2	24 ASCII	LCD Line 2
.Assembly		
.CycleTime	Read only	Measuring cycle in seconds

&Assembly

.Meas		Measurement
.Status	ON, OFF	Switch measurement on or off
.Outputs		Assignment of Output lines of Remote socket
.SmplX	ON, OFF	Sample Changer assignment; with OFF, I/O inputs are inactive
.AutoEOD	ON, OFF	Automatic output of EOD signal at the end of a determination → forward pulse for Sample Changer
.SetLines	\$G	Set lines
.L1	active, inactive, pulse, OFF	
:		
.L8	24 ASCII	
.ResetLines	\$G	Switch off all lines

&Setup

.IdReport	ON, OFF	Report identification on/off With printer: No report id's
.Keycode	ON, OFF	Sends the code of actuated keys #XX
.Trace	ON, OFF	Instrument sends path and value upon changes &XXX"XXX"
.Lock		
.Keyboard	ON, OFF	Lock all keys
.Config	ON, OFF	Lock <config> key
.Parameter	ON, OFF	Lock <param> key
.Cal	ON, OFF	Lock <Cal> key
.UserMeth		
.Recall	ON, OFF	Lock recall function of <methods>
.Store	ON, OFF	Lock store function of <methods>
.Delete	ON, OFF	Lock delete function of <methods>
.CalData	ON, OFF	Lock <cal. data> key
.Mode	ON, OFF	Lock <mode> key
.ElTest	ON, OFF	Lock <el. test> key
.Display	ON, OFF	Display is no longer served by 692's program

.AutolInfo		Automatic message upon status change
.Message		Definition of message
		Full message: Space!DevName"nodes involved"Date Time; e.g., !692pHM".G;.E;.!"
		92-09-24 16:33:09
.DateTime		ON, OFF
		Date and time of occurrence
.P		ON, OFF
		PowerOn if line power is on
.G		ON, OFF
		Procedure has been started
.R		ON, OFF
		Ready
.S		ON, OFF
		Instrument has been stopped
.E		ON, OFF
		Error
.Re		ON, OFF
		Instrument in "request" mode
.D		ON, OFF
		DriftOk if drift condition ok
.I		ON, OFF
		Input: change upon inputs
.O		ON, OFF
		Output: change upon outputs
.InputAssign		Assignment of I/O line inputs
.pH		0...1...15
		Mode pH
.T		0...2...15
		Mode T
.U		0...3...15
		Mode U
.Ipol		0...4...15
		Mode Ipol
.pHcal		0...5...15
		Start pH calibration
.EITest		0...6...15
		Start electrode test
.Conc		0...8...15
		«conc» mode.
.ConcCal		0...9...15
		Start concentration calibration.
.Enter		0...15
		<enter> key
.TMeas		
.Cycles		3...9...9999, OFF
		Temperature measurement in pH and conc mode: every n th cycle
.Graphics		
.Grid		ON, OFF
		Grid across graph
.Frame		ON, OFF
		Frame around graph
.Recorder		
.Right		0.4...0.8...1
		Recording width
.Feed		0.4...1.0
		Recording length
.&Diagnose		Entry into diagnostic program
		stops measurement
.Init		\$G
		Set default values
.Select		Value
		Value: ActMode, Modes, Setup, Config, Assembly, All
.RamTest		\$G
		Starts RAM test
.PolarizerTest		\$G
		Starts polarizer test
.PlasmaTest		\$G, \$\$
		Plasma test
.LcdTest		\$G, \$\$
		LCD test
.IoTest		\$G, \$\$
		Input/output test
.RSTest		\$G, \$\$
		RS 232 interface test
.KeyTest		\$G, \$\$
		Key test
.SimulateKey		0...23
		Simulates pressing of key
.Adjust		\$G, \$\$
		Sets adjustment data
.Report		ON, OFF
		Adjustment report
.PowerOn		\$G
		Simulation of power on

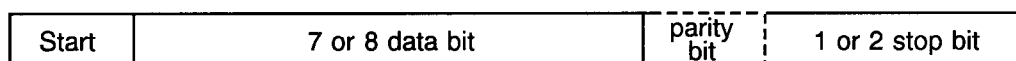
8.6 Characteristics of the RS 232C interface

8.6.1 Data transfer protocol

The 692 pH/Ion Meter is configured as DTE (Data Terminal Equipment).

The RS232 interface has the following technical specifications:

Data interface in accordance with the RS 232C standard	
Baud rates:	300, 600, 1200, 2400, 4800, 9600
Handshake:	software or hardware handshake (see section 8.6.2)
Data bit:	7 or 8 bit
Parity:	even, odd or none
Stop bit:	1 or 2
Max. line length:	80 characters + C _R L _F
Control characters:	C _R (ASCII DEC 13) L _F (ASCII DEC 10) XON (ASCII DEC 17) XOFF (ASCII DEC 19)
Cable length:	max. ca. 15 m



For interconnections of the 692 pH/Ion Meter with non-Metrohm units, only a shielded data cable may be used. The cable shielding must be faultlessly earthed at both units (pay attention to current loops; always use star-head earthing). Only connectors with adequate shielding may be used.

8.6.2 Handshake

Software handshake, SWChar

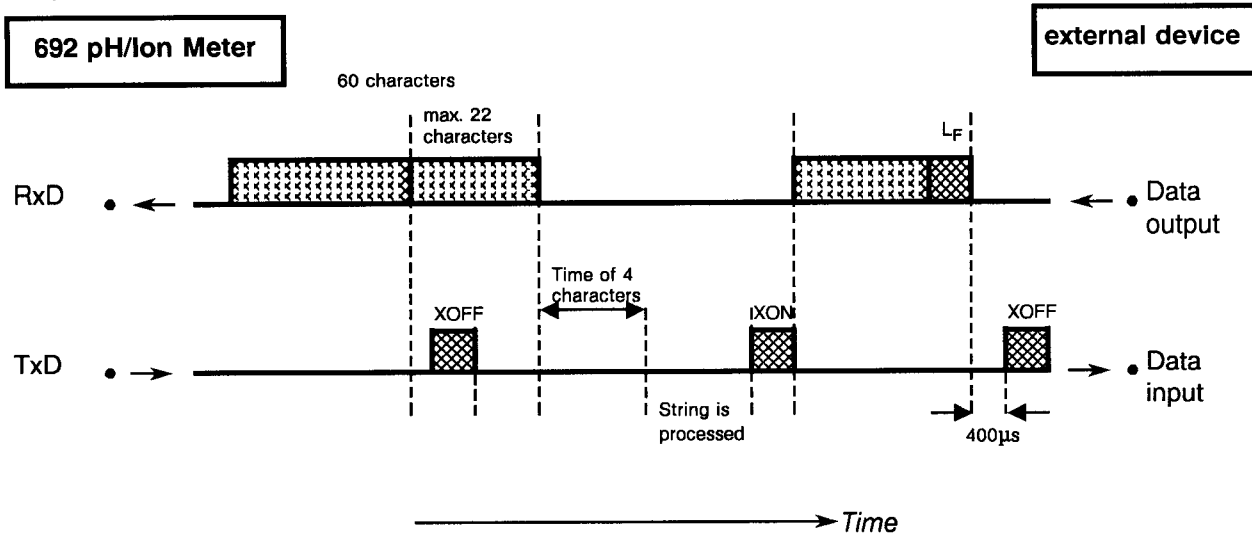
Handshake inputs at the 692 pH/Ion Meter (CTS, DSR, DCD) are not checked.
Handshake outputs (DTR, RTS) are set by the 692 pH/Ion Meter.

As soon as a L_F is recognised, the 692 pH/Ion Meter sends XOFF. It can then receive 6 extra characters and store them.

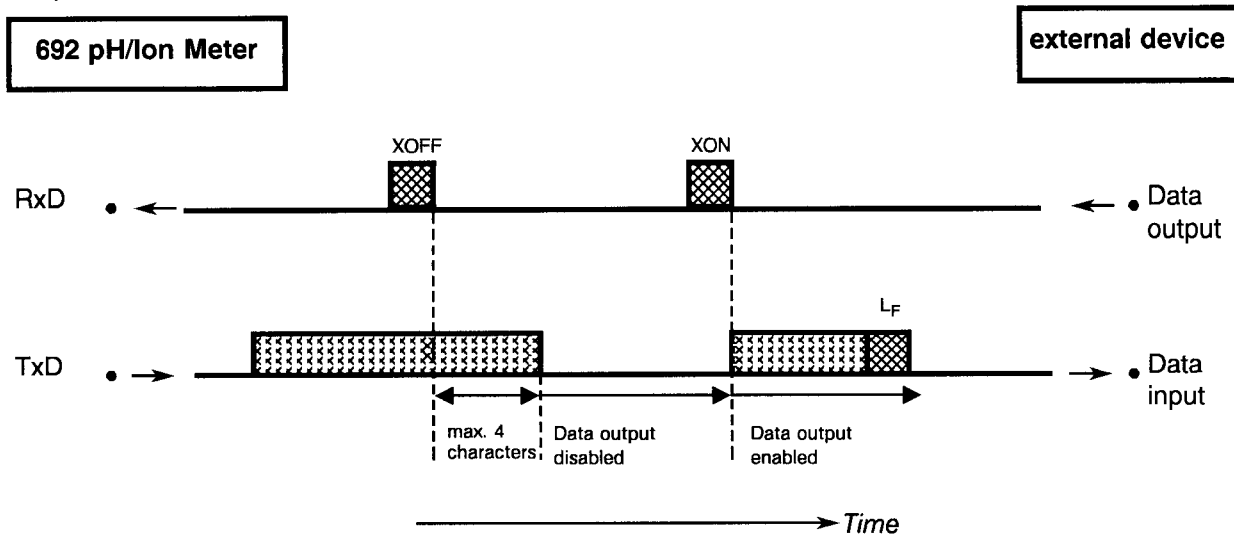
However, the 692 pH/Ion Meter also sends XOFF if its input buffer contains 60 characters. After this, it can receive maximum 22 extra characters (incl. L_F).

If the transmission is interrupted for the time of 4 characters after the 692 pH/Ion Meter has sent XOFF, the string received earlier is processed even if no L_F has been sent.

692 pH/Ion Meter as **receiver**:



692 pH/Ion Meter as **sender**:

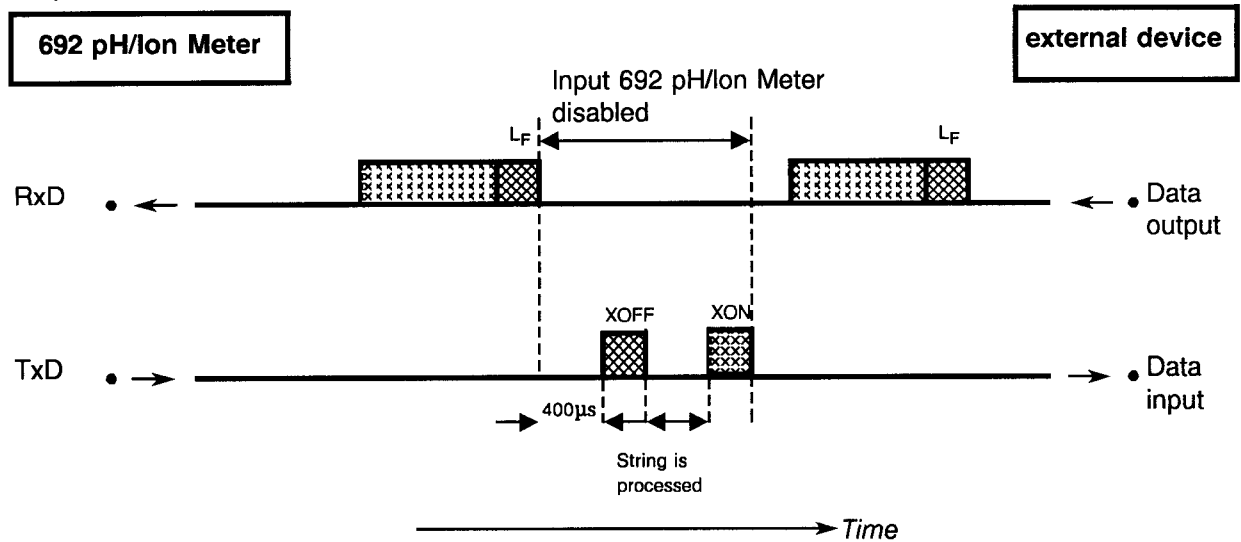


Software-Handshake, SWline

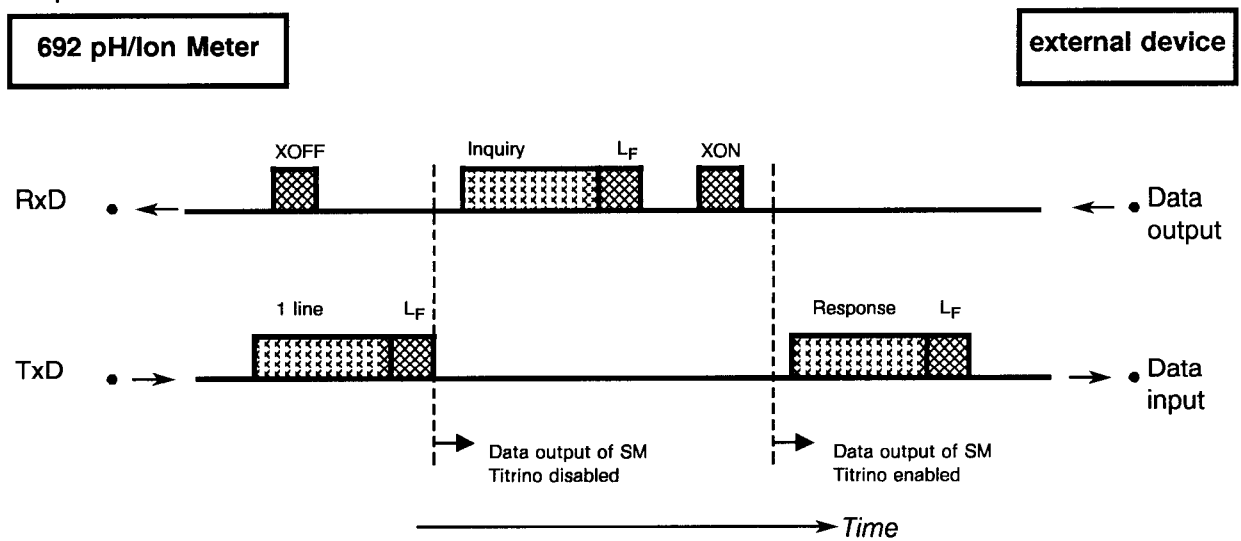
Handshake inputs at the 692 pH/Ion Meter (CTS, DSR, DCD) are not checked.
Handshake outputs (DTR, RTS) are set by the 692 pH/Ion Meter.

The 692 pH/Ion Meter is equipped with an input buffer that can accommodate a string of up to 80 characters + C_{RLF} . As soon as an L_F is recognised, the 692 pH/Ion Meter sends XOFF. After this, it can receive maximum 6 extra characters and store them. The string sent previously is now processed by the 692 pH/Ion Meter. Afterwards, the 692 pH/Ion Meter sends XON and is again ready to receive.

692 pH/Ion Meter as receiver:



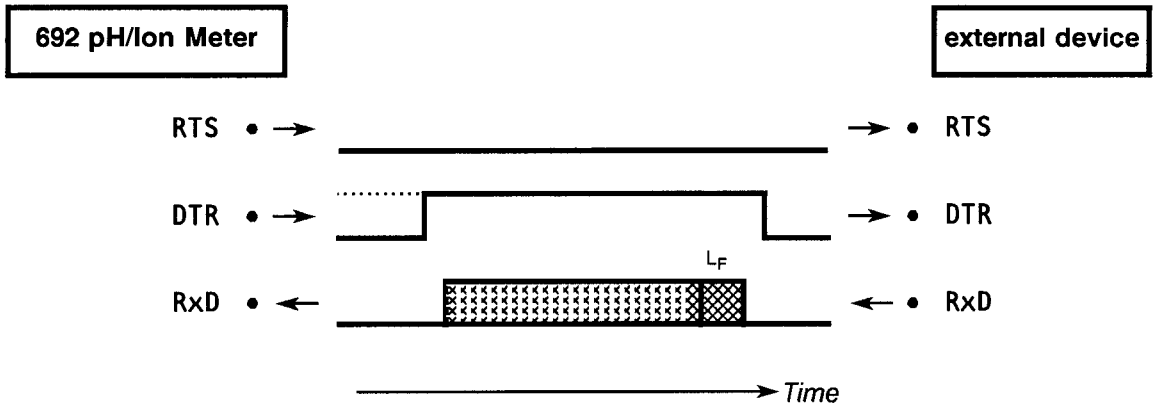
692 pH/Ion Meter as sender:



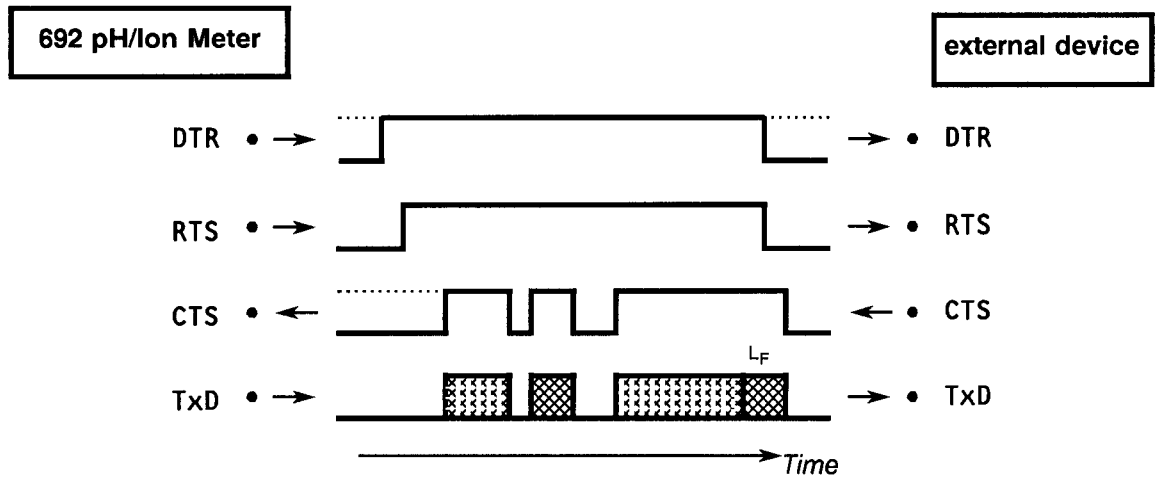
The transmission of the 692 pH/Ion Meter can be stopped by the external device with XOFF. After receipt of XOFF, the 692 pH/Ion Meter completes transmission of the line already started. If the data output is disabled for more than 3 s by XOFF, E43 appears in the display.

Hardware handshake, HWs

692 pH/Ion Meter as receiver:



692 pH/Ion Meter as sender:

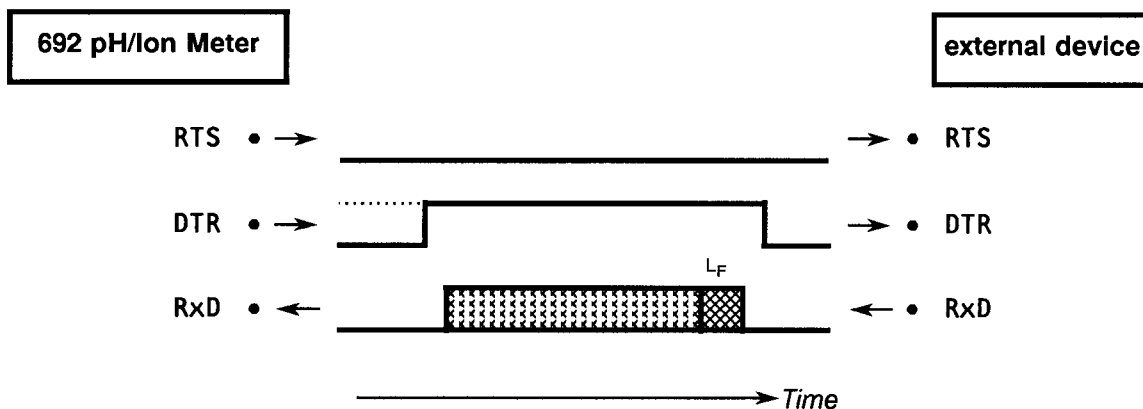


The data flow can be interrupted by deactivation of the CTS line.

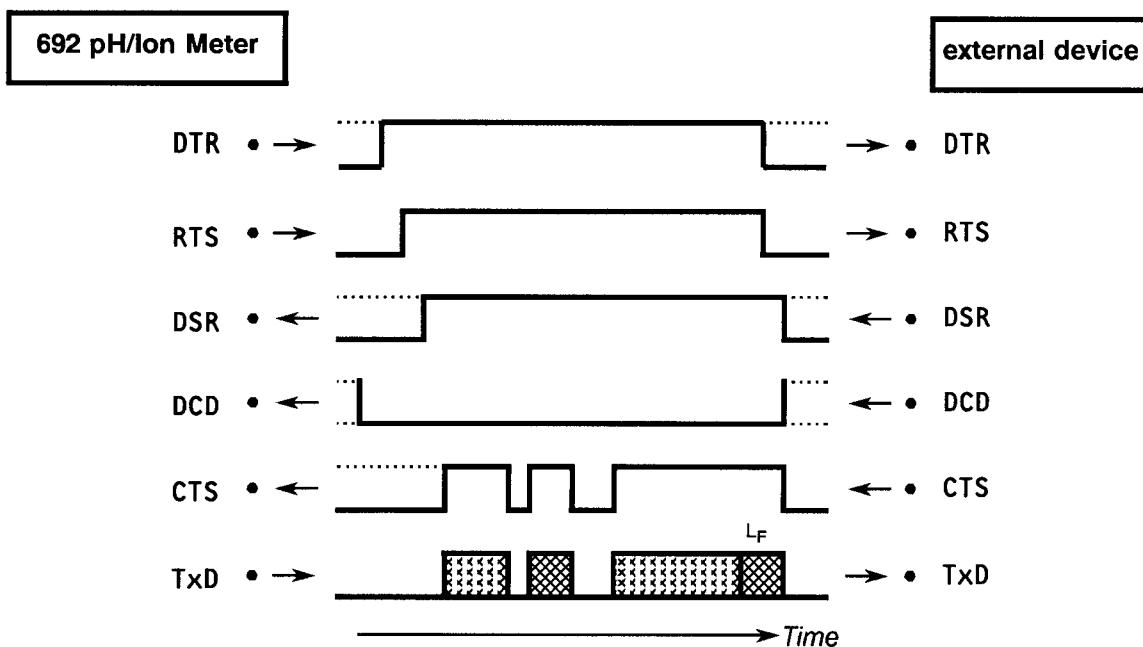
Hardware handshake, HWf

All handshake inputs are checked at the 692 pH/Ion Meter, handshake outputs are set.

692 pH/Ion Meter as receiver:

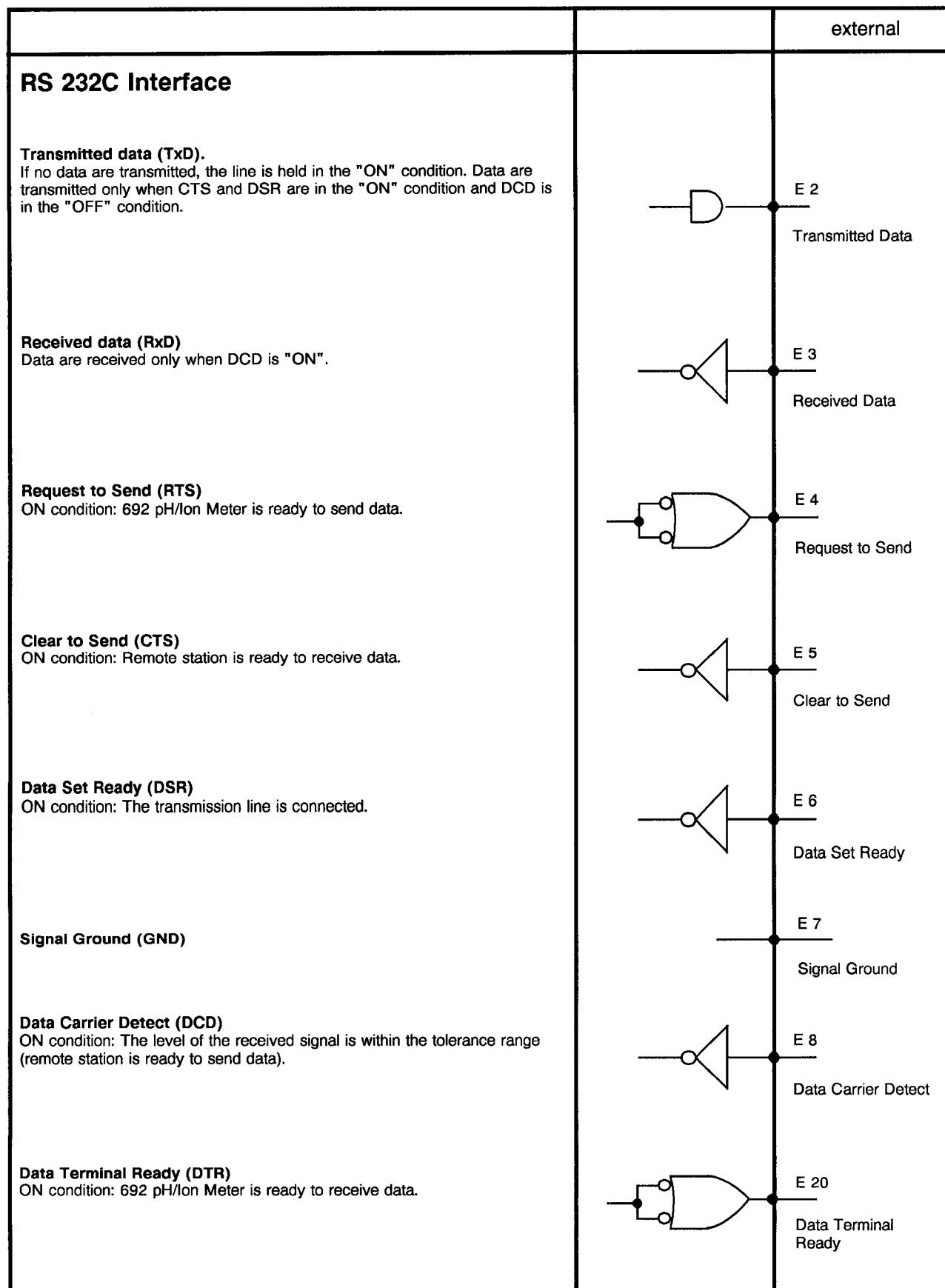


692 pH/Ion Meter as sender:



The data flow can be interrupted by deactivation of the CTS line.

8.6.3 Pin assignment



8.7 Troubleshooting

Problem	Questions for corrective action
No characters can be received on a connected printer.	<ul style="list-style-type: none"> - Are the instruments and the connection cables plugged in properly? - Is the printer set to «on-line»? - Are baud rate, data bit and parity settings the same for both devices? - Is the handshake set properly? <p>If everything appears to be in order, try to print out a report using the <report> key. If this report is printed out correctly, check whether a report is specified at all for the corresponding procedure (calibration, electrode test).</p>
No data transmission occurs and the display of the 692 pH/Ion Meter shows an error message.	<ul style="list-style-type: none"> - RS error 40-42: Transmission error. Is the cable used properly wired and connected? Is the printer switched on and set to «on-line»? - RS error 43: Data output of the 692 pH/Ion Meter disabled for longer than 3 s by XOFF. - RS error 36-39: Receive error. Are the settings of the RS 232 data transmission parameters the same for both devices?
The received characters are garbled.	<ul style="list-style-type: none"> - Are the data bit and the parity settings the same for both devices? - Is the baud rate setting the same for both devices? - Has the correct printer been selected? - Data transfer has been interrupted on the hardware side during the printout of a curve. Re-establish connections and switch printer off/on.
Printout of curve is not ok. Other reports are printed correctly.	<p>Handshake is necessary for the printout of a curve.</p> <ul style="list-style-type: none"> - Is your cable correctly wired? (The DTR of the printer has to be connected to the CTS of the 692 pH/Ion Meter.) - Set «HWs» for the handshake at the 692 pH/Ion Meter. Configure the printer such that its DTR is set (normally with DIP switches).

Appendix

A 1. Technical specifications

Sensor-related effects not considered.

Modes available		Measuring frequency	
Conc	Ion concentration	With last digit on	2.5 Hz (cycles/s)
pH	pH value	With last digit off	12.5 Hz (cycles/s)
°C, °F	Temperature	Temperature in the pH mode	
mV	Voltage	Every n th cycle is a temperature measurement	n = 3 ... 9 ... 9999, OFF (9 = default value)
mV _{I_{pol}}	Voltage of polarized electrodes	Setting of n	Power on & < config > – > temp. measurement – temp. meas n.
Sensor inputs		Measuring error	
2 high-impedance inputs for pH, ion selective or redox electrodes.		Absolute (at adjustment temperature)	
1 input for reference electrode, consisting of 2 banana sockets that are connected with each other and with the shields of the 2 high-impedance inputs (if the 2 sensors are in the same solution, use 1 reference electrode only). These inputs can be used for differential potentiometric measurements.		Conc	± 150 µV ≅ ± 0.6% of reading for monovalent ions
1 input for polarized electrodes.		pH	± 0.003 ± 1 digit
1 input for temperature sensors Pt 100 or Pt 1000.		Temperature	± 0.1 °C ± 1 digit in the –130 ... 500 °C range
Measuring ranges		Voltage	± 0.2 mV ± 1 digit
Conc	1.0E–38...1.0E + 38	Voltage with I _{pol}	± 0.2 mV ± 1 digit
Range of main display	9.99E–19...9.99E + 19	As a function of the operating temperature	
pH	–19.999 ... 19.999	Conc	± 55 µV/K ≅ ± 0.2% of reading/K for monovalent ions
Temperature	–170.0 ... 500 °C (–274.0 ... 932.0 °F)	pH	± 0.004% of (reading–7)/K ± offset deviation
Voltage	–1999.9 ... 1999.9 mV	Temperature	± 0.03 °C/K
Voltage with I _{pol}	–1999.9 ... 1999.9 mV	Voltage	± 0.004% of reading/K ± offset deviation
Resolution		Voltage with I _{pol}	± 0.004% of reading/K
Conc	50 µV ≅ 0.2% of reading for monovalent ions	Common mode error (differential potentiometry)	
pH	0.001	Common mode rejection DC	> 55 dB
Temperature	0.1 °C (0.1 °F)		
Voltage	0.1 mV		
Voltage with I _{pol}	0.1 mV		

Measuring amplifier (inputs pH/ISE 1 and pH/ISE 2)		RS 232 interface	
		Purpose	Connection of a printer for the printing out of reports and the live plotting of measured values.
Input resistance	> 10 ¹³ Ω		
Offset current	< 3 × 10 ⁻¹³ A		
Deviation of offset voltage as a function of the operating temperature	< 15 μV/K		Connection of a computer; the 692 pH/Ion Meter can be controlled entirely via the computer keyboard.
Polarizer current			
I _{pol}	-127 ... 127 μA	«Remote» I/O lines	
Resolution	1 μA	Purpose	Connection of a Dosimat for automatic concentration calibration or standard addition; connection of sample changer or laboratory robot.
Error	± 1.5% of selected value ± 0.7 μA		
Concentration measurement			
Direct measurement after manual or automatic calibration with up to 19 standards. Calibration data is fitted to Nikolsky equation.		Input lines	Start, Enter, Sample Ready.
Manual or automatic standard addition with up to 19 standards. Linear fit of data (C _{blank} = 0 in Nikolsky equation).		Output lines	Basic state, End of measurement, Error, Activate, lines to be set via RS 232 control.
Manual or automatic sample addition with up to 19 additions. Linear fit of data (C _{blank} = 0 in Nikolsky equation).		Analog output	
		Output signal	-2000 ... 2000 mV (see section 7.3.1)
pH measurement		Signal type	According to current mode; in the pH and Conc mode, pH/Conc or T can be selected.
Compensation of temperature effect within the 0 ... 100 °C range.			
pH calibration			
Number of buffers	1, 2 ... 9	Resolution	1 mV (12 bit)
Buffer recognition	Automatic.	Output signal error	
Buffer series stored as functions of temperature	Metrohm, NIST, DIN, Fisher, Ciba, Ingold, Merck, Beckman, Radiometer.	Absolute (at adjustment temp.)	± 1.5 mV
		As a function of the operating temperature	± 0.005% of selected output/K ± 50 μV/K
«Mixed» buffer sets	5 buffer series can be selected from those mentioned above.		
«Own» buffer sets	5 buffer series can be entered as a function of temperature.		
«Special» buffers (no automatic recognition)	9 single buffer values can be entered.		

continued ...

The above specifications apply under the following conditions:

Adjustment interval	1 year
Adjustment temperature	23 ± 2 °C
Operating temperature	5 ... 50 °C
Relative humidity	5 ... 85%
Temperature during transport and storage	-20 ... 70 °C
Measuring frequency	2.5 Hz (cycles/s)

Dimensions

Width

Without stand rod	205 mm
With stand rod	235 mm

Height

Without stand rod	120 mm
With stand rod	315 mm

Depth

240 mm

Weight, including standard accessories

3.3 kg

Displays

Main display

Type	Gas discharge display.
Character height	15 mm

Dialog display

Type	LCD, 2 lines of 24 characters each.
Character height	5 mm

Materials

Housing	Light metal alloy, stove-enamelled.
Keypad	Chemically resistant plastic film (polyester).

Safety specifications

Designed and tested in accordance with IEC publication 348, safety class I. This manual contains information and warnings that have to be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

Power connection

Voltage	100, 117, 220 (230), 240 V ± 10% (switchable)
Frequency	50 ... 60 Hz (cycles/s)
Power consumption	8 VA
Fuse	Thermal fuse

A 2. Scope of delivery; options

Scope of delivery

- 2.692.0010** 692 pH/Ion Meter,
including the following accessories:
- 1 × 6.2001.030 Base plate for stand rod
 - 1 × 6.2013.010 Clamping ring
 - 1 × 6.2016.050 Stand rod
 - 1 × 6.2021.020 Electrode holder
 - 1 × Power cable with cable plug to customer's specifications:
 - 6.2122.020 Plug type SEV 12 (Switzerland ...), socket type IEC 320/C13
 - 6.2122.040 Plug type CEE(7), VII (Germany ...), socket type IEC 320/C13
 - 6.2122.070 Plug type NEMA/ASA (USA ...), socket type CEE(22) V
 - 1 × 6.2723.270 Dust cover
 - 1 × 8.692.1003 Instructions for Use for 692 pH/Ion Meter

Options

For more detailed information on electrodes, see the Electrode Catalogue and the Monograph «Electrodes in Potentiometry», which you can obtain free of charge from your Metrohm agency.

649 Stirrer for operation with Dosimat 665 or 725

- 2.649.0010** 649 Magnetic Swing-out Stirrer without base plate and without stand rod; power is supplied by Dosimat.

649 Stirrer for operation without Dosimat

- 2.649.0024** 649 Magnetic Swing-out Stirrer without base plate and without stand rod; including power adapter 220...240 V, with Euro plug.
- 2.649.0021** 649 Magnetic Swing-out Stirrer without base plate and without stand rod; including power adapter 100...120 V, with US plug.

727 Titration Stand for operation with Dosimat 665 or 725

- 2.727.0010** 727 Titration Stand with rinsing pump and rinsing head
- 2.722.0010** 722 Rod Stirrer with controller and stirrer propeller; without power adapter
- 2.727.0100** 727 Titration Stand with built-in magnetic stirrer, rinsing pump and rinsing head; without power adapter

727 Titration Stand for operation without Dosimat, power voltage 220 V, Euro plug

- 2.727.0014** 727 Titration Stand with rinsing pump and rinsing head, power adapter 220 V, Euro plug; without stirrer
- 2.722.0010** 722 Rod Stirrer with controller and stirrer propeller, without power adapter
- 2.727.0104** 727 Titration Stand with built-in magnetic stirrer, rinsing pump and rinsing head; with power adapter 220 V, Euro plug

727 Titration Stand for operation without Dosimat, power voltage 110 V, US plug

- 2.727.0011** 727 Titration Stand with rinsing pump and rinsing head, power adapter 110 V, US plug; without stirrer
- 2.722.0010** 722 Rod Stirrer with controller and stirrer propeller, without power adapter
- 2.727.0101** 727 Titration Stand with built-in magnetic stirrer, rinsing pump and rinsing head; with power adapter 110 V, US plug

Dosimats

- 2.665.0010** 665 Dosimat, without Exchange Unit
- 6.2124.000 Keypad for 665 Dosimat
- 2.725.0010** 725 Dosimat including keypad, without Exchange Unit

Exchange Units with ceramic stopcock and light protection

- 6.3012.153 Exchange Unit with 1 L reagent bottle made of brown glass, micro outlet valve, burette volume 5 mL
- 6.3012.213 Exchange Unit with 1 L reagent bottle made of brown glass, micro outlet valve, burette volume 10 mL
- 6.3012.223 Exchange Unit with 1 L reagent bottle made of brown glass, micro outlet valve, burette volume 20 mL
- 6.3011.253 Exchange Unit with 1 L reagent bottle made of brown glass, burette volume 50 mL

Electrode cables, sleeves, adapters

- 6.2021.020 Electrode holder for stand rod of 10 mm diameter; for up to 4 electrodes and 2 burette tips
- 6.1236.040 SGJ sleeve made of silicone rubber for electrodes without SGJ 14/15
- 6.2104.020 Cable for pH electrodes, ion-selective electrodes, combined silver and noble-metal electrodes fitted with a plug-in head; length 1 m, with plug F ($\varnothing \approx 5$ mm)
- 6.2106.020 Cable for reference electrodes; length 1 m, plug B (banana plug 4 mm)
- 6.2104.080 Cable for 6.1110.100 Pt 1000 resistance thermometer (length 1 m, 2 plug B)
- 6.2104.000 Adapter for the attachment of electrodes with E plug (DIN 19 262) to the 692 pH/Ion Meter
- 6.2103.090 Adapter for the attachment of electrodes with BNC plug to the 692 pH/Ion Meter

pH electrodes, metal electrodes, Pt 100 and Pt 1000 temperature sensor (selection)

- 6.0233.100 Combined pH electrode with plug-in head and SGJ; with low-resistance membrane glass, with fewer diaphragm problems and short response time on temperature change
- 6.0238.000 Combined pH electrode with built-in Pt 1000 temperature sensor, SGJ and fixed cable (1 m) with plug F and 2 × plug B
- 6.0218.010 Combined pH electrode with built-in Pt 100 temperature sensor, SGJ and fixed cable (1 m) with plug F and 2 × plug B
- 6.0415.100 Combined platinum cap electrode with plug-in head and SGJ
- 6.0308.100 Double platinum wire electrode (each 0.8 × 6 mm) with plug-in head and SGJ
- 6.1103.000 Pt 100 resistance thermometer with SGJ and fixed cable (length 1 m, 2 × plug B)
- 6.1110.100 Pt 1000 resistance thermometer with plug-in head and adjustable SGJ sleeve

Ion selective electrodes (selection)

- 6.0726.100 Ag/AgCl reference electrode for the ISE listed below (except NH₃ electrode), with plug-in head and SGJ; sleeve diaphragm; exchangeable bridge electrolyte
- 6.0733.100 Ag/AgCl reference electrode for the ISE listed below (except NH₃ electrode), with plug-in head and SGJ; comparable with calomel electrode, but without mercury and with fewer diaphragm problems

Ion-selective electrodes with crystal membrane; with adjustable SGJ sleeve:

- 6.0502.150 F⁻
- 6.0502.140 Cu²⁺
- 6.0502.180 Ag⁺/S²⁻

Ion-selective electrodes with polymer membrane; with adjustable SGJ sleeve:

- 6.0504.100 Ca²⁺
- 6.0504.120 NO₃⁻
- 6.0504.110 K⁺
- 6.0504.130 BF₄⁻

- 6.0501.100 Na⁺-selective electrode with glass membrane and glass shaft with SGJ

- 6.0506.010 Ammonia electrode (incl. reference electrode) with glass membrane and plastic foil; with fixed cable (length 1 m, plug E)

Buffers and electrolytes (selection)

- 6.2305.010 3 × 50 mL concentrate pH = 4; to be diluted to 250 mL
- 6.2305.020 3 × 50 mL concentrate pH = 7; to be diluted to 250 mL
- 6.2305.030 3 × 50 mL concentrate pH = 9; to be diluted to 250 mL
- 6.2306.020 250 mL ready-to-use redox standard solution; can also be used as buffer pH = 7
- 6.2313.000 1000 mL electrolyte solution c(KCl) = 3 mol/L; for Ag/AgCl reference systems

Connecting cables

- 6.2125.020 Connecting cable 692 – Seiko printer DPU-411-11BX (X = U (USA), E (Europe) or J (Japan))
- 6.2125.050 Connecting cable 692 – printers with 25-pin connector (DB 25), e.g. Citizen iDP 560 RS, Epson FX, LX, LQ or Kodak Diconix 180 si
- 6.2125.040 Connecting cable 692 – Epson printer with 6-pin circular connector (DIN 45 322; 60 °)
- 6.2138.010 Connecting cable 692 – 665 (725) Dosimat and 622, 649 or 722 Stirrer or 727 Titration Stand
- 6.2136.000 Adapter to connect 62138.0010 cable to 725 Dosimat
- 6.2138.000 Connecting cable 692 – 622, 649 or 722 Stirrer or 727 Titration Stand
- 6.2125.060 Connecting cable 692 – IBM® PC/XT/PS-2 and compatibles
- 6.2125.010 Adapter cable RS 232C 25-pin – 9-pin for IBM® AT and compatibles fitted with a 9-pin connector
- 6.2115.010 Connecting cable 692 – 614 Impulsomat
- 3.980.3560 Connecting cable 692 – 664 Control Unit for Sample Changer
- 3.980.3620 Connecting cable 692 – 664 Control Unit/665 Dosimat/Stirrer

VESUV

- 6.6008.010 PC program VESUV for the acquisition of measuring data on a PC. User dialogue configurable in English or German. Data from up to 8 Metrohm instruments can be received, stored as ASCII text files and printed out.

A 3. Buffer sets stored in the 692 pH/Ion Meter

Of the buffer sets cited below, only those with **bold** headings are directly accessible. However, those with light-faced heading can be used for composing mixed buffer sets.

The buffer designations appearing below are identical to those in the dialog of the 692 pH/Ion Meter; they may, in some cases, differ from the actual buffer designations.

The calibration at temperatures where the respective buffer value is not listed («→» in the tables) should be avoided (error message: «buffer alloc. impossible»).

Temp. °C	Metrohm buffers «Met»					NIST ^{a)} buffers «NIST»				
	pH 1.00 ± 0.02	pH 4.00 ± 0.02	pH 7.00 ± 0.02	pH 9.00 ± 0.02	pH 13.00 ± 0.03	pH 1	pH 4	pH 7	pH 9	pH 13
0	–	3.99	7.11	9.27	–	–	4.010	6.984	9.464	13.423
5	–	3.99	7.08	9.18	–	1.668	4.004	6.951	9.395	13.207
10	0.99	3.99	7.06	9.13	13.38	1.670	4.000	6.923	9.332	13.003
15	0.99	3.99	7.04	9.08	13.18	1.672	3.999	6.900	9.276	12.810
20	1.00	3.99	7.02	9.04	13.00	1.675	4.001	6.881	9.225	12.627
25	1.00	4.00	7.00	9.00	12.81	1.679	4.006	6.865	9.180	12.454
30	1.00	4.00	6.99	8.96	12.62	1.683	4.012	6.853	9.139	12.289
35	1.00	4.01	6.98	8.93	12.46	1.688	4.021	6.844	9.102	12.133
40	1.00	4.02	6.98	8.90	12.30	1.694	4.031	6.838	9.068	11.984
45	1.01	4.03	6.97	8.87	12.14	1.700	4.043	6.834	9.038	11.841
50	1.01	4.04	6.97	8.84	11.98	1.707	4.057	6.833	9.011	11.705
55	1.01	4.06	6.97	8.81	11.84	1.715	4.071	6.834	8.985	11.574
60	1.01	4.07	6.97	8.79	11.70	1.723	4.087	6.836	8.962	11.449
65	1.01	4.09	6.98	8.76	11.57	1.732	4.108	6.840	8.941	–
70	1.01	4.11	6.98	8.74	11.45	1.743	4.126	6.845	8.921	–
75	1.02	4.13	6.99	8.73	11.32	1.754	4.145	6.852	8.902	–
80	1.02	4.15	7.00	8.71	11.20	1.766	4.164	6.859	8.885	–
85	1.02	4.18	7.00	8.70	11.09	1.778	4.185	6.867	8.867	–
90	1.02	4.20	7.01	8.68	10.98	1.792	4.205	6.877	8.850	–
95	–	4.23	7.02	8.67	–	1.806	4.227	6.886	8.833	–

a) NIST = National Institute of Standards and Technology (formerly NBS)

Temp. °C	DIN ^{b)} buffers «DIN»						Fisher buffers «Fis»		
	pH 1	pH 3	pH 4	pH 7	pH 9	pH 12	pH 4	pH 7	pH 10
0	1.08	–	4.67	6.89	9.48	–	4.01	7.13	10.34
5	1.08	–	4.66	6.86	9.43	–	3.99	7.10	10.26
10	1.09	3.10	4.66	6.84	9.37	13.37	4.00	7.07	10.19
15	1.09	3.08	4.65	6.82	9.32	13.15	3.99	7.05	10.12
20	1.09	3.07	4.65	6.80	9.27	12.96	4.00	7.02	10.06
25	1.09	3.06	4.65	6.79	9.23	12.75	4.00	7.00	10.00
30	1.10	3.05	4.65	6.78	9.18	12.61	4.01	6.99	9.94
35	1.10	3.05	4.66	6.77	9.13	12.44	4.02	6.98	9.90
40	1.10	3.04	4.66	6.76	9.09	12.29	4.03	6.97	9.85
45	1.10	3.04	4.67	6.76	9.04	12.13	4.04	6.97	9.81
50	1.11	3.04	4.68	6.76	9.00	11.98	4.06	6.97	9.78
55	1.11	3.04	4.69	6.76	8.97	11.84	4.07	6.97	9.74
60	1.11	3.04	4.70	6.76	8.92	11.69	4.09	6.98	9.70
65	1.11	3.04	4.71	6.76	8.90	11.56	4.11	6.99	9.68
70	1.11	3.04	4.72	6.76	8.88	11.43	4.13	7.00	9.65
75	1.12	3.04	4.74	6.77	8.86	11.30	4.14	7.02	9.63
80	1.12	3.05	4.75	6.78	8.85	11.19	4.16	7.03	9.62
85	1.12	3.06	4.77	6.79	8.83	11.08	4.18	7.06	9.61
90	1.13	3.07	4.79	6.80	8.82	10.99	4.21	7.08	9.60
95	–	–	–	–	–	–	4.23	7.11	9.60

b) DIN = Deutsches Institut für Normung (German Standards Association)

Temp. °C	Ciba buffers «Cib»			Ingold buffers «Ing»				
	pH 4	pH 7	pH 9	pH 2	pH 4	pH 7	pH 9	pH 11
0	4.01	7.11	9.20	2.03	4.01	7.12	9.52	11.90
5	4.00	7.08	9.15	2.02	4.01	7.09	9.45	11.72
10	4.00	7.05	9.10	2.01	4.00	7.06	9.38	11.54
15	4.00	7.02	9.05	2.00	4.00	7.04	9.32	11.36
20	4.00	7.00	9.00	2.00	4.00	7.02	9.26	11.18
25	4.01	6.98	8.96	2.00	4.01	7.00	9.21	11.00
30	4.01	6.97	8.91	1.99	4.01	6.99	9.16	10.82
35	4.02	6.96	8.88	1.99	4.02	6.98	9.11	10.64
40	4.03	6.95	8.84	1.98	4.03	6.97	9.06	10.46
45	4.04	6.94	8.80	1.98	4.04	6.97	9.03	10.28
50	4.06	6.94	8.77	1.98	4.06	6.97	8.99	10.10
55	4.07	6.93	8.74	1.98	4.08	6.98	8.96	-
60	4.09	6.93	8.71	1.98	4.10	6.98	8.93	-
65	4.11	6.93	8.69	1.98	4.13	6.99	8.90	-
70	4.13	6.94	8.67	1.99	4.16	7.00	8.88	-
75	4.14	6.94	8.65	1.99	4.19	7.02	8.85	-
80	4.16	6.95	8.63	2.00	4.22	7.04	8.83	-
85	4.18	6.96	8.61	2.00	4.26	7.06	8.81	-
90	4.21	6.97	8.60	2.00	4.30	7.09	8.79	-
95	4.23	6.98	8.59	-	4.35	7.12	8.77	-

Temp. °C	Merck buffers (1) «Mer»									
	pH 1	pH 2	pH 3	pH 4	pH 4.66	pH 5	pH 6	pH 6.88	pH 7	pH 8
0	0.96	2.01	3.05	4.05	4.68	5.06	6.04	6.98	7.13	8.15
5	0.99	2.01	3.05	4.04	4.68	5.05	6.02	6.95	7.07	8.10
10	0.99	2.01	3.03	4.02	4.67	5.02	6.01	6.92	7.05	8.07
15	0.99	2.00	3.01	4.01	4.67	5.01	6.00	6.90	7.02	8.04
20	1.00	2.00	3.00	4.00	4.66	5.00	6.00	6.88	7.00	8.00
25	1.01	2.00	3.00	4.01	4.66	5.00	6.02	6.86	6.98	7.96
30	1.01	2.00	3.00	4.01	4.66	5.00	6.03	6.86	6.98	7.94
35	1.01	2.00	3.00	4.01	4.66	5.00	6.03	6.85	6.96	7.92
40	1.01	2.00	2.98	4.01	4.67	5.00	6.04	6.84	6.95	7.90
45	1.01	2.00	2.975	4.00	4.675	5.005	6.05	6.84	6.95	7.875
50	1.01	2.00	2.97	4.00	4.68	5.01	6.06	6.84	6.95	7.85
55	1.015	2.00	2.97	4.00	-	5.025	6.08	6.84	6.95	7.84
60	1.02	2.00	2.97	4.00	-	5.04	6.10	6.84	6.96	7.83
65	1.02	2.00	2.97	4.00	-	5.045	6.11	6.84	6.96	7.815
70	1.02	2.01	2.97	4.00	-	5.05	6.12	6.84	6.96	7.80
75	1.02	2.01	2.97	4.00	-	5.075	6.145	6.85	6.96	7.79
80	1.02	2.01	2.97	4.00	-	5.10	6.17	6.86	6.97	7.78
85	1.02	2.01	2.965	4.00	-	5.12	6.205	6.87	6.98	7.765
90	1.02	2.01	2.96	4.00	-	5.14	6.24	6.88	7.00	7.75
95	-	-	-	4.00	-	-	-	-	7.02	-

continued...

Appendix 3: Buffer sets stored in the 692 pH/Ion Meter

Temp. °C	Merck buffers (2) «Mer»						Beckman buffers «Bec»		
	pH 9	pH 9.22	pH 10	pH 11	pH 12	pH 13	pH 4 (red)	pH 7 (green)	pH 10 (blue)
0	9.24	9.46	10.26	11.45	12.58	13.80	4.00	7.12	10.32
5	9.16	9.40	10.17	11.32	12.41	13.59	4.00	7.09	10.25
10	9.11	9.33	10.11	11.20	12.26	13.37	4.00	7.06	10.18
15	9.05	9.28	10.05	11.10	12.10	13.18	4.00	7.04	10.12
20	9.00	9.22	10.00	11.00	12.00	13.00	4.00	7.02	10.06
25	8.95	9.18	9.94	10.90	11.88	12.83	4.00	7.00	10.01
30	8.91	9.14	9.89	10.81	11.72	12.67	4.01	6.99	9.97
35	8.88	9.10	9.84	10.72	11.67	12.59	4.02	6.985	9.93
40	8.85	9.07	9.82	10.64	11.54	12.41	4.03	6.98	9.89
45	8.82	9.04	9.78	10.56	11.435	12.28	4.045	6.975	9.86
50	8.79	9.01	9.74	10.48	11.33	12.15	4.06	6.97	9.83
55	8.76	8.985	9.705	10.465	11.185	11.95	4.075	6.975	-
60	8.73	8.96	9.67	10.45	11.04	11.75	4.09	6.98	-
65	8.715	8.945	9.645	10.32	10.97	11.68	4.105	6.985	-
70	8.70	8.93	9.62	10.19	10.90	11.61	4.12	6.99	-
75	8.68	8.91	9.585	10.125	10.80	11.50	4.14	6.995	-
80	8.66	8.89	9.55	10.06	10.70	11.39	4.16	7.00	-
85	8.65	8.87	9.52	9.995	10.59	11.27	4.175	7.01	-
90	8.64	8.85	9.49	9.93	10.48	11.15	4.19	7.02	-
95	-	-	-	-	-	-	4.21	7.03	-

Temp. °C	Radiometer buffers «Rad»							
	pH 1.09	pH 1.68	pH 4.01	pH 6.84	pH 7.00	pH 7.38	pH 9.18	pH 10.01
0	1.082	1.666	4.000	6.984	7.118	7.534	9.464	10.317
5	1.085	1.668	3.998	6.951	7.087	7.500	9.395	10.245
10	1.087	1.670	3.997	6.923	7.059	7.472	9.332	10.179
15	1.089	1.672	3.998	6.900	7.036	7.448	9.276	10.118
20	1.091	1.675	4.001	6.881	7.016	7.429	9.225	10.062
25	1.094	1.679	4.005	6.865	7.000	7.413	9.180	10.012
30	1.096	1.683	4.011	6.853	6.987	7.400	9.139	9.966
35	1.098	1.688	4.018	6.844	6.977	7.389	9.102	9.925
40	1.101	1.694	4.027	6.838	6.970	7.380	9.068	9.889
45	1.103	1.700	4.038	6.834	6.965	7.373	9.038	9.856
50	1.106	1.707	4.050	6.833	6.964	7.367	9.011	9.828
55	1.108	1.715	4.064	6.834	6.965	7.361	8.985	9.813
60	1.111	1.723	4.080	6.836	6.968	-	8.962	9.782
65	1.113	1.732	4.097	6.840	6.974	-	8.941	9.765
70	1.116	1.743	4.116	6.845	6.982	-	8.921	9.751
75	1.119	1.754	4.137	6.852	6.992	-	8.900	9.739
80	1.121	1.765	4.159	6.859	7.004	-	8.885	9.731
85	1.124	1.778	4.183	6.867	7.018	-	8.867	9.726
90	1.127	1.792	4.210	6.877	7.034	-	8.850	9.724
95	-	-	4.240	6.886	-	-	-	-

A 4. Diagnosis

The 692 pH/Ion Meter is a very precise and reliable instrument. Thanks to its rugged construction it is virtually impossible for external mechanical or electrical influences to have an adverse effect on its functions.

Although the occasional fault in the instrument cannot be excluded completely, it is certainly much more likely that malfunctions are caused by wrong operation or handling or through improper connections and operation with non-Metrohm instruments.

It is thus advisable in each case to isolate the fault with the rapid and easy to perform diagnostic tests. The customer thus need not call METROHM service until there is a true fault in the instrument. In addition, with the aid of the numbering in the diagnostic program he can provide the service engineer with much more accurate information.

In inquiries always quote the manufacturing (section 1.2) and program number (see <config>, section 2.3) and specify possible error displays.

Procedure

- The diagnostic steps must be performed in sequence and compared with the reactions of the 692 pH/Ion Meter (indented). In the "yes" case, continue with the next instruction.
- If the instrument does not show the expected reaction ("no" case), the appropriate diagnostic step must be repeated to exclude an operating error. With repeated wrong reactions, however, there is a strong possibility that a malfunction exists.
- The diagnostic steps marked with a triangle (≥) allow re-entry into the test routine for repetition if the following display appears:

```
diagnose
>XXXXXXXX
```

- Selection of the diagnosis program with key <9>.

If the instrument is in a subprogram of the diagnostic routine: Press the <quit> key.

If need be, switch the power off then on again after a few seconds. At the same time press key "9" until the above display appears.

- If the <quit> key is pressed during the display of 'diagnose >XXXXXXXX', the instrument jumps back into the user program.
- Error display: An error is shown in the display as follows:

```
***error XX
      |
      v
error number
```

Equipment required:

- voltage calibrator, e.g. Metrohm pH Simulator 642¹
- Resistor switch-box, class 0.1% (or resistor 14.3 k 0.1 %)

Necessary only if external functions should also be checked:

- 3.496.8510 Test Plug (at 'Remote' connector)
- 3.496.8480 Test Plug (at 'RS 232' connector)
- 3.496.5070 cable

¹ If no suitable voltage calibrator is available: Use any stable voltage source and connect a precise DVM in parallel.

➤ 1. **Prepare instrument for diagnosis**

Power off

Remove all external connections (cables at rear, except power cable)

Switch on and immediately press key <9>, holding it down until power-up test pattern disappears. The LCD display then shows:

```
diagnose
>RAM Initialization
```

➤ 2. **Plasma display test**

Press <9> repeatedly until

```
diagnose
>Plasma Display Test
```

Press <enter>

On pressing the <enter> key, characters will be generated for visually checking the display, see Fig. A 4.1.

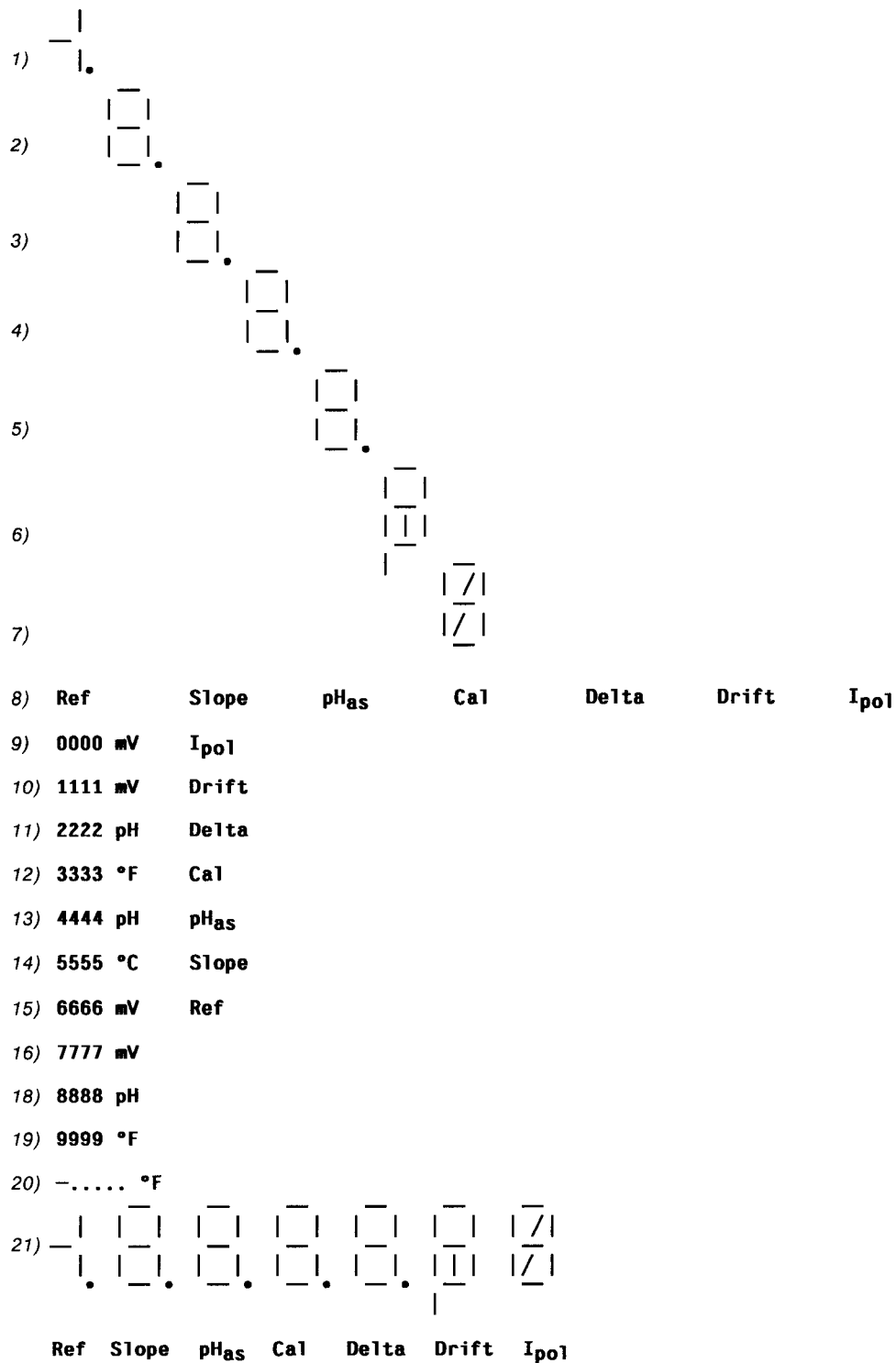


Fig. A 4.1 Sequence of display test

The test sequence can be stopped and started again by pressing key <5>.



➤ 3. LCD display test

If necessary, press <9> repeatedly until



Press <enter>

On pressing the <enter> key, characters will be generated on both lines for visually checking the display.

Test sequence:

- Each pixel on the display is activated.
- Display is cleared, first marked with '#', then with 'H' and finally with 'I'.
- The full character set is shown in a continuous string (0, 1, ..., 9, A, B, ..., Y, Z).
- The test sequence can be stopped and started again by pressing key <5>.
- To quit the test, press the <mode> key.

```
diagnose
>Input/Output Test
```

➤ 4. **Keyboard test**

Press <9> repeatedly until

```
diagnose
>Key Test
```

Press <enter>

```
>Key Test
```

Pressing any key will cause the matrix code according to Fig. A 4.2 to appear on the display (0 - 22). Check the code displayed.

```
>Key Test
code: XX
```

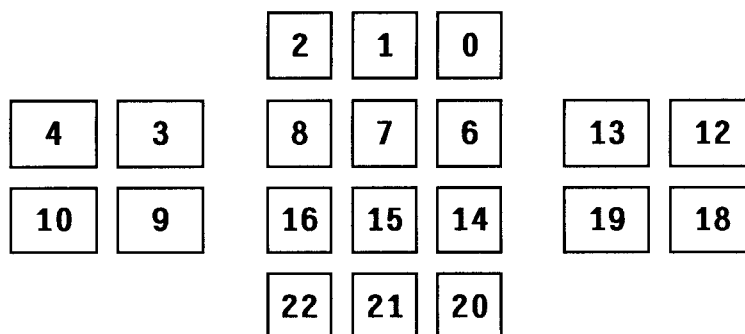


Fig. A 4.2 Keyboard with key numbers

To quit the test, press the <mode> key twice.

```
diagnose
>Instrument Adjustment
```

➤ 5. **Polarizer test**

Press <9> repeatedly until

```
diagnose
>Polarizer Test
```

Press <enter>

```
>Polarizer Test
dummy resistor 14.3k ?
```

Use 2 short lab cables to connect resistance decade (or suitable resistor 14.3 k/0.1 %) to socket 'lpol'.
Set decade to 14.3 k.

Press <enter>

```
>Polarizer Test
polarizer testing * — blinks
```

The plasma display shows mV values measured while testing.

The test runs automatically. If everything is OK, after about 16 s there appears:

```
>Polarizer Test
polarizer ok
```

If not, an error message appears. (If no decade is connected, 'Error 100' appears.)

Remove cables and resistance decade.

Press <enter>

```
diagnose
>Plasma Display Test
```

➤ 6. External inputs and outputs

*This test is useful only when the 692 pH/Ion Meter is used together with other equipment connected to the 'Remote' socket. Also, this test requires a test connector 3.496.8510 normally used for repairs/servicing. However, the customer can obtain this connector under the above number.
For the sake of completeness, the procedure is described here.
(If diagnosis of the external inputs and outputs is not required, continue from 7.)*

Connector 3.496.8510

PIN	PIN	PIN	PIN
1 ——— 24	5 ——— 21		
2 ——— 12	9 ——— 18		
3 ——— 23	10 ——— 17		
4 ——— 22	11 ——— 16		

Fig. A 4.3 Pin allocation in connector 3.496.8510

Press <9> repeatedly until

```
diagnose
>Input/Output Test
```

Press <enter>

```
>Input/Output Test
io connector ?
```

Insert connector 3.496.8510 in 'Remote' socket. (Do not switch off instrument, check connector is the right way round.)

Press <enter>

The test runs automatically. If everything is OK, there appears:

```
>Input/Output Test
io test ok
```

If not, an error message appears. (If no test connector is in place, 'Error 50' appears.)

Remove test connector.

Press <enter>

```
diagnose
>RS-232 Test
```

➤ 7. RS 232 test

This test is useful only when the 692 pH/Ion Meter is used together with other equipment connected to the 'RS 232' socket. Also, this test requires a test connector 3.496.8480 normally used for repairs/servicing. However, the customer can obtain this connector under the above number.

For the sake of completeness, the procedure is described here.

(If diagnosis of the RS 232 interface is not required, continue from 8.)

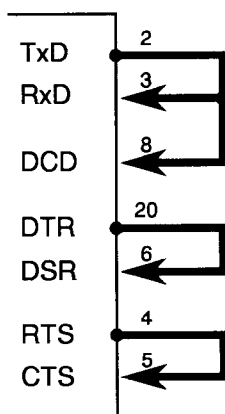


Fig. A 4.4 Connections in connector 3.496.8480

Press <9> repeatedly until

```
diagnose
>RS-232 Test
```

Press <enter>

```
>RS-232 Test
rs connector ?
```

Insert connector 3.496.8480 in socket 'RS 232 C'.
(Do not switch off instrument, check connector is the right way round.)

Press <enter>

```
>RS-232 Test
rs testing
```

The test runs automatically. If everything is OK, there appears

```
>RS-232 Test
rs test ok
```

If not, an error message appears. (If no test connector is in place, 'Error 68' appears.)

Remove test connector.

Press <enter>

```
diagnose
>Key Test
```

➤ 8. **RAM test** *(not to be confused with RAM initialisation)*

Non-destructive RAM test of the whole range.

Press <9> repeatedly until

```
diagnose
>RAM Test
```

Press <enter>

```
>RAM Test
ram test ok
```

<quit> twice

The previously selected mode in the instrument program appears.

➤ 9. **Check instrument calibration**

Connect DVM to analog output.

In case that another language is selected, but English is desired, see section 2.3.

9.1 **Potential measurement, check Input 1**

Press <mode> (as often as needed) until the display shows the mV range (mV without lpol).

Press <param>, <enter>, <select> (<select> as often as needed) until

```
>measuring parameters
meas. input:      1
```

Press <enter>

```
>measuring parameters
electr.id
```

- Using a screened, highly insulated cable, connect a voltage calibrator (mV source, pH simulator *(set to 'low impedance')* etc.] of class 0.1 mV, or an inexact source with parallel precision voltmeter (0.1 mV), to measuring input pH/ISE on the 692. Set a voltage < 2000 mV (e.g. 1900 mV) and compare readings. Wait till 'drift' disappears! (Tolerance ± 1 mV)
- Compare DVM reading (Tolerance ± 2 mV)
- Check resistance:
(if source device allows) set source to 'high impedance' ($R_i = 1000 \text{ M}\Omega$) and compare indicated value with previous reading. Wait till 'drift' disappears! The value must not differ by more than 10 digit.

9.2 **Potential measurement, check Input 2**

Detach voltage source from measuring input 1 and connect to measuring input 2.

Press <quit>, <enter>

```
>measuring parameters
meas. input:      1
```

Press <select>

```
>measuring parameters
meas. input:      2
```

Press <enter>

```
>measuring parameters
electr.id
```

Compare the readings from the same measurements (high and low impedance) as in section 9.1.

9.3 Potential measurement, check derivative response

Short-circuit measuring input 1 with cable 3.496.5070.

Press <quit>, <enter>

```
>measuring parameters
meas. input:      2
```

Press <select>

```
>measuring parameters
meas. input:      diff.
```

Press <enter>

```
>measuring parameters
electr.id
```

Same readings as in 9.2, but opposite sign.

Detach calibrator, DVM and cable 3.496.5070.

9.4 Check temperature measurement

Press <mode> (as often as needed) until '°C' appears.

(Selection of temperature unit see section 2.3.)

Connect Pt 100 or Pt 1000 simulator (or appropriate resistors of 100 Ω or 1 kΩ/0.1 %) to socket 'Pt 100/Pt 1000', and read off the temperature (100 Ω and 1000 Ω are each equivalent to 0°C, Tolerance ±1°C).

Detach temperature simulator (or resistor).

End of diagnosis

➤ 10. Put things back as they were

Re-connect the peripherals which were detached when diagnosis began, then do a quick function test that includes them.

➤ 11. Initialise RAM

It can happen on rare occasions that severe noise signals (e.g. power spikes, lightning, etc.) can upset the processor functions and so result in a system crash. After a system crash, the RAM has to be initialised. Although the instrument's default data are preserved, RAM initialisation should be done only when necessary, as the stored user data (electrode calibration data, chosen buffers, configurations, etc.) are then erased.

Execute step 1 of diagnosis procedure.

```
diagnose
>RAM Initialization
```

Press <enter>

```
>RAM Initialization
Select:          ACTMODE
```

Press <select> repeatedly until

```
>RAM Initialization
Select:          ALL
```

Press <enter>

```
diagnose
>RAM Test
```

Press <enter>

```
>RAM Test
ram test ok
```

Press <quit> twice

The unit returns to the previously selected mode.

The data lost from the user memory must then be inputted again.

Execute step 10.

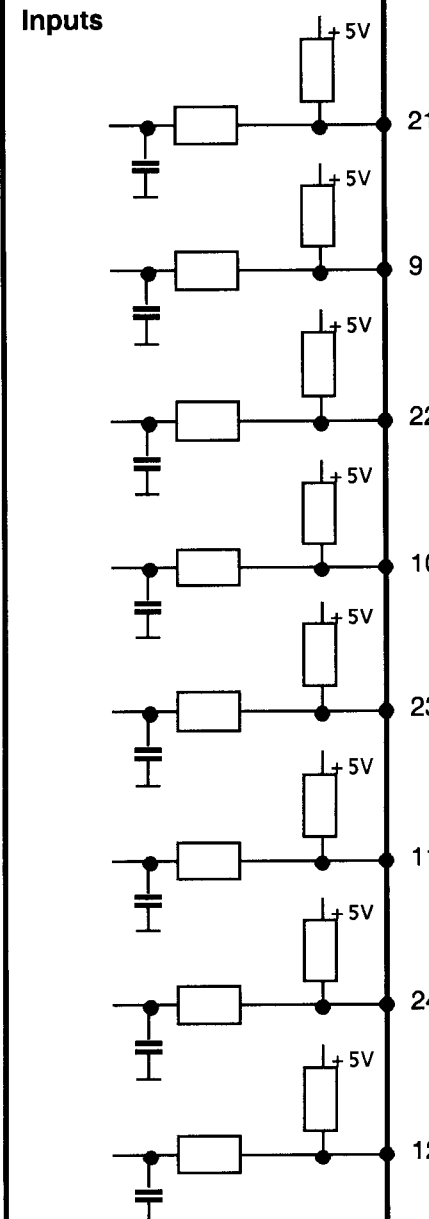
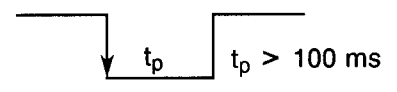
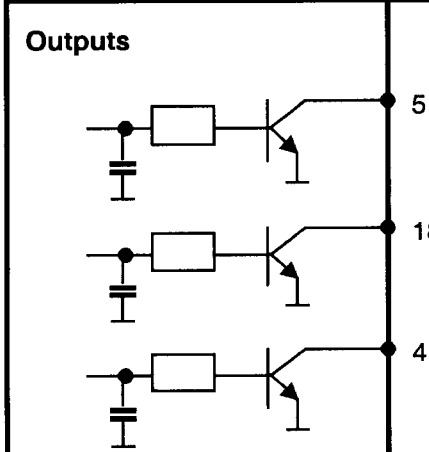
If the display shows 'system error 3', you can leave the instrument program with <quit>. The adjustment default values are then loaded automatically. This means that the instrument can still measure, but there may be a slight loss of accuracy. Metrohm Service can restore the optimum set-up. The error message 'system error 3' appears every time the instrument is switched on, until these adjustments have been made.

Problems and their possible causes

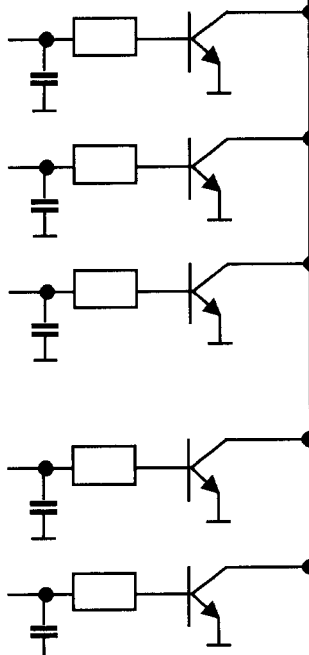
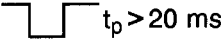
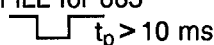
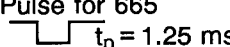
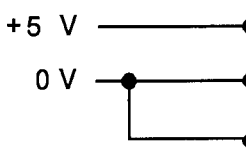
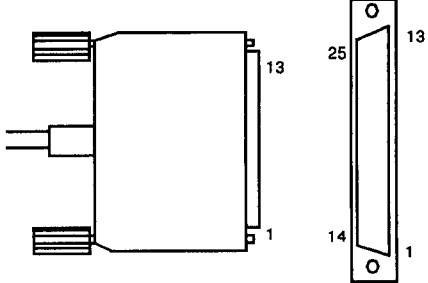
If your diagnosing keeps going wrong at the same point, the table below may help. If it doesn't, you will have get in touch with a Metrohm service centre.

Problem	Remedy
<ul style="list-style-type: none"> - No response from keyboard. Keying in commands has no effect. Instrument does nothing when key is pressed. - Plasma display does not function. - LCD display does not function. 	<p>Do step 1 of diagnosis routine, go into initialisation program with <enter>, select 'SETUP' procedure with <select> and start it with <enter>. If this is completed successfully, the display shows '>RAM Test'. Then work through the diagnosis routine again.</p>
<p>RS 232 interface does not work.</p>	<p>Do step 1 of diagnosis routine, go into initialisation program with <enter>, select 'CONFIG' procedure with <select> and start it with <enter>. If this is completed successfully, the display shows '>RAM Test'. Then work through the diagnosis routine again.</p>

A 5. Pin assignment of the «Remote» socket

	external	Function
Inputs 	21	<p>Printout of result and output of advance pulse for sample changer.</p> <p>Print </p> <p>20 } 21 } Remote control of mode. 22 } Active = (L) 23 } > 100 ms } Functions: See Table at end of this section.</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p><i>All inputs can be queried and surveyed via the RS 232C data interface.</i></p> </div> <p>Ready Ready signal from 665 Dosimat when using addition technique.</p>
	9	
	22	
	10	
	23	
	11	
	24	
	12	
Outputs 	5	Ready Instrument is measuring and all procedures have been terminated.
	18	<p>Primary measuring value Upper limit; if above = (L)</p> <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <p>All outputs: $V_{CE0} = 40\text{ V}$ $I_C = 20\text{ mA}$</p> </div>
	4	Lower limit; if below = (L)

continued ...

<p>Outputs</p> 		<p>Sample changer program</p> <p>Advance pulse Measuring value ok = </p> <p>Stirrer control</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><i>All outputs can be set via the RS 232C data interface.</i></p> </div> <p>Error: active with instrument errors</p> <p><i>Addition techniques with auto add ON</i></p> <p>FILL for 665 </p> <p>Pulse for 665 </p> <div style="border-left: 1px solid black; padding-left: 10px; margin-left: 10px;"> <p><i>All other operating conditions</i> Sec. meas. value: Upper limit; if above = (L)</p> <p>Lower limit; if below = (L)</p> </div>
<p>Voltage</p> 		<p>$I \leq 40 \text{ mA}$ $R_i \approx 12 \Omega$</p> <p>0 V: active = (L) 5 V: inactive</p>
		<p>Contact arrangement at socket (male) for connector "Remote" (female)</p>  <p style="text-align: center; font-size: small;">View from solder side of connector</p> <p>Ordering numbers: K.210.9060 (shell) and K.210.0002</p>
<p>No liability whatsoever will be accepted for damage caused by improper interconnection of instruments.</p>		

continued ...

Functions of «Remote» input lines

Function	Decimal	Pin			
		23	22	21	20
Inactive	0	H	H	H	H
Mode pH	1	H	H	H	L
Mode T/°C	2	H	H	L	H
Mode U/mV	3	H	H	L	L
Mode I _{po} /mV	4	H	L	H	H
pH cal	5	H	L	H	L
el. test	6	H	L	L	H
Mode Conc	8	L	H	H	H
Conc cal	9	L	H	H	L
enter	15	L	L	L	L

The assignment of the input lines can be selected applying the following sequence:

Power on & <config>

*** 692 pH/Ion Meter ***

>input assign

<enter>

>input assign

pH 1 1...15. Select pin assignment. **Caution:** Avoid double assignments!

<enter>

T 2

⋮

Sample changer operation

The sample changer is operated via the six following inputs and outputs:

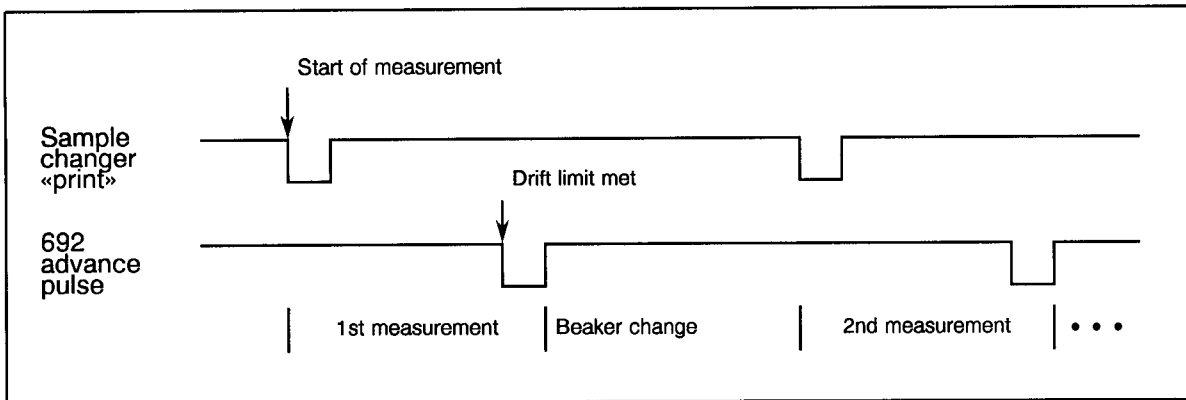
- print Starts measurement (pH, T, U, I_{po}, direct concentration or addition procedure) or continues a calibration.
- 20 Mode selection and
- 21 sequences can be assigned freely
- 22 («input assign», see above). However
- 23 double assignments must be avoided!
- Advance pulse output (17).

Sample changer sequence «measurement»

Communication via «print» and «advance pulse» with the 3.980.3560 cable (see section 7.4.2).

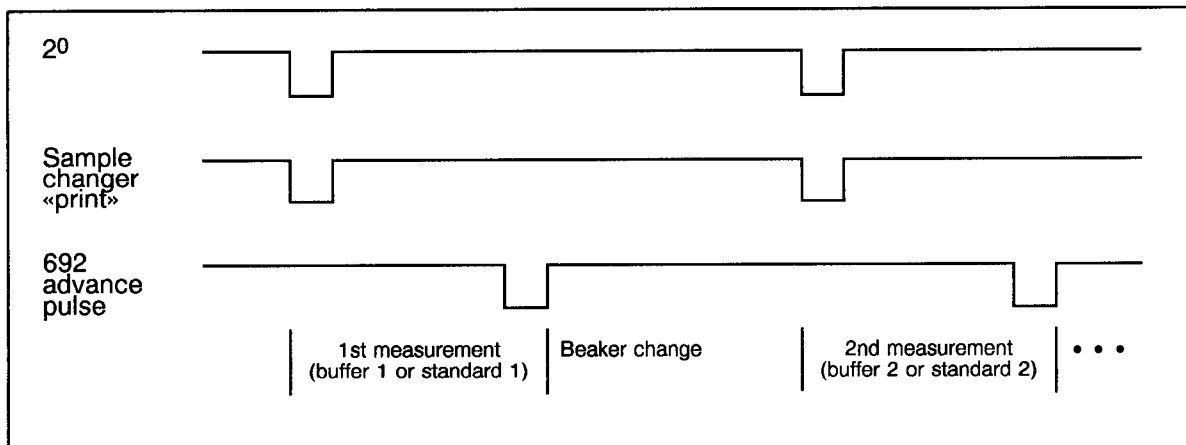
For all direct measurements the print criterion has to be set to «drift».

The 3.980.3620 cable allows to perform the addition techniques with 665 Dosimat and 622 Stirrer controlled by the 692 pH/Ion Meter (see section 7.4.2).



Sample changer sequence «calibration pH/Conc»

Communication via «20», «print» and «advance pulse» with the 3.980.3560 cable; the functional assignment has been programmed in «input assign» (see above). The measuring sequence is determined by the 692 pH/Ion Meter's calibration routines.



A 6. Warranty

The warranty regarding our products is limited to rectification free of charge in our workshops of defects that can be proved to be due to material, design or manufacturing faults which appear within 12 months from the day of delivery. Transport costs are chargeable to the purchaser.

For day and night operation, the warranty is valid for 6 months.

Glass breakage in the case of electrodes or other glass parts is not covered by the warranty. Checks which are not a result of material or manufacturing faults are also charged during the warranty period. For parts of outside manufacture insofar as these constitute an appreciable part of our instrument, the warranty stipulations of the manufacturer in question apply.

With regard to the guarantee of accuracy, the technical specifications in the Instructions for Use are authoritative.

Concerning defects in material, construction or design as well as the absence of guaranteed features, the purchaser has no rights or claims except those mentioned above.

If damage of the packaging is evident on receipt of a consignment or if the goods show signs of transport damage after unpacking, the carrier must be informed immediately and a written damage report demanded. Lack of an official damage report releases METROHM from any liability to pay compensation.

If any instruments and parts have to be returned, the original packaging should be used if at all possible. This applies above all to instruments, electrodes, burette cylinders and PTFE pistons. Before embedment in wood shavings or similar material, the parts must be packed in a dustproof package (for instruments, use of a plastic bag is imperative). If open assemblies are enclosed in the scope of delivery that are sensitive to electromagnetic voltages (e.g. data interfaces etc.) these must be returned in the associated original protective packaging (e.g. conductive protective bag). (Exception: assemblies with built-in voltage source belong in a non-conductive protective packaging.) For damage which arises as a result of non-compliance with these instructions, no warranty responsibility whatsoever will be accepted by METROHM.



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EC Declaration of Conformity

The METROHM AG company, Herisau, Switzerland hereby certifies, that the instrument:

692 pH/Ion Meter

meets the requirements of EC Directives 89/336/EWG and 73/23/EWG.

Source of the specifications:

- | | |
|------------|--|
| EN 50081-1 | Electromagnetic compatibility, basic specification
Emitted Interference |
| EN 50082-2 | Electromagnetic compatibility, basic specification
Interference Immunity |
| EN 61010 | Safety requirements for electrical laboratory measurement
and control equipment |

Description of the instrument:

pH Meter for measurement of pH, voltage, and temperature.
Ion Meter for direct measurements and standard addition.

Herisau, December 6, 1995

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