pH Transmitter 2220(X)

Your Representative:

04/03
52 120 666

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CE

Warranty
Defects occurring within 3 years from delivery date shall be remedied free of charge at our plant (carriage and insurance paid by sender).
Accessories: 1 year

Subject to change without notice

Contents

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Package contents and unpacking

Unpack the Transmitter carefully.
Check the shipment for transport damage and completeness.

The package should contain:

- pH Transmitter 2220(X)
- This instruction manual
- Any accessories ordered with the Transmitter (For available accessories, see Chap. 9)

Information on this instruction manual

Warnings and notes

Warning
Warning means that ignoring the given instructions may lead to a malfunction of or damage to the Transmitter and to property damage or personal injuries.

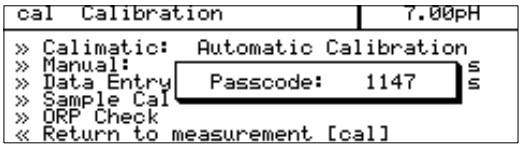
Note
Notes provide important information that should be followed when using the Transmitter.

Typical representations

The keys of the pH Transmitter 2220(X) are shown like this in the text:

meas , **cal** , **maint** , **par** , **diag**

◀ , ▶ , ▲ , ▼ , **enter**



Menus shown in the instruction manual may differ somewhat from the display of your Transmitter. This depends on which options your Transmitter is equipped with.

If the behavior of your Transmitter deviates from the description in this manual, check whether the manual corresponds to the software version of your Transmitter: see Pg 6-4, Device description.

Safety information

Be sure to read and observe the following instructions!

The safety instructions must always be followed for your own safety.
Failure to follow these instructions may result in injuries

The instrument has been designed in accordance with the state of the art and complying with the applicable safety regulations. When operating the instrument, certain conditions may nevertheless lead to danger for the operator or damage to the instrument.

Whenever it is likely that the protection has been impaired, the instrument shall be made inoperative and secured against unintended operation.

The protection is likely to be impaired if, for example:

- the instrument shows visible damage
- the instrument fails to perform the intended measurements
- after prolonged storage at temperatures above 70 ˚C
- after severe transport stress

Before recommissioning the instrument, a professional routine test in accordance with EN 61010-1 must be performed. This test should be carried out by the manufacturer.

Proper use

The pH 2220(X) series consists of 2-wire Transmitters. The Transmitter is supplied with power from the 4 to 20 mA loop current, which also transmits the measured variable.

The pH Transmitter 2220(X) is used for continuous pH and temperature measurement in liquids. The Transmitter is designed for industrial use. The enclosure is protected to IP 65 and allows direct wall mounting on the site.

The instrument shall not be used in a manner not specified by this manual. Any applications not specified in this manual are inadmissible.

pH Transmitter 2220 (non intrinsically safe)

Never use the pH Transmitter 2220 for measurements in hazardous locations.

Assembly/dismantling, installation, operation and maintenance may only be carried out by qualified personnel as defined by the automation industry in compliance with the applicable regulations and this instruction manual. Be sure to observe the specified ambient conditions and installation instructions.

When commissioning, a complete configuration must be carried out.

Manipulations of the instrument other than described in this manual are not permitted.

pH Transmitter 2220X (intrinsically safe)

The pH Transmitter 2220X is approved for operation in hazardous locations. It has been developed and manufactured in compliance with the applicable European guidelines and standards. The Declaration of Conformity confirms the compliance with the applicable European guidelines and standards.

The stipulations of EN 60 079-14:1996 and the following must be observed when installing the instrument in a hazardous location. The pH Transmitter 2220X may only be connected to certified intrinsically safe circuits. The electrical data are listed in the EC-Type-Examination Certificate (see Pg XII).

Before commissioning it must be proved that the intrinsic safety is maintained when connecting the instrument to other equipment, such as supply units including cables and lines.

When commissioning, a complete configuration must be carried out.

Manipulations of the instrument other than described in this manual are not permitted.

Assembly/dismantling, installation, operation and maintenance may only be carried out by qualified personnel as defined by the automation industry in compliance with the applicable regulations and this instruction manual. Be sure to observe the specified ambient conditions and installation instructions.

Mettler-Toledo GmbH
Process Analytics

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Bank	Credit Suisse First Boston, Zürich (Acc.-No. 0835-370501-21)

Declaration of conformity
Konformitätserklärung
Déclaration de conformité

CE

We/Wir/Nous	Mettler-Toledo GmbH, Process Analytics Im Hackacker 15 8902 Urdorf Switzerland
	declare under our sole responsibility that the product, erklären in alleiniger Verantwortung, dass dieses Produkt, déclarons sous notre seule responsabilité que le produit,
Description Beschreibung/Description	pH2220X
	to which this declaration relates is in conformity with the following standard(s) or other normative document(s). auf welches sich diese Erklärung bezieht, mit der/den folgenden Norm(en) oder Richtlinie(n) übereinstimmt. auquel se réfère cette déclaration est conforme à la (aux) norme(s) ou au(x) document(s) normatif(s).
Explosion Protection Explosionsschutzrichtlinie Protection contre les explosions	94/9/EG
Standard/ Norm/ Standard	EN 50 014: 1997 + A1 + A2 EN 50 020: 1994
EMC Directive/EMV-Richtlinie Directive concernant la CEM	89/336/EWG SR 734.5, VEMV
Standard/ Norm/ Standard	DIN EN 61326 / VDE 0843 Teil 20: 1998-01 DIN EN 61326 / A1 / VDE 0843 Teil 20 / A1: 1999-05
Place and Date of issue Ausstellungsort / - Datum Lieu et date d'émission	Urdorf, 13.12.2001

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Artikel Nr. 52960197 KE

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METTLER TOLEDO

Version b

Sitz der Gesellschaft Mettler-Toledo GmbH, Im Langacher, CH-8606 Greifensee

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

(1) EC-TYPE-EXAMINATION CERTIFICATE

(Translation)

(2) Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres - **Directive 94/9/EC**

(3) EC-type-examination Certificate Number:

PTB 00 ATEX 2191

(4) Equipment: pH-Transmitter type 2220X Opt. ...

(5) Manufacturer: Mettler Toledo AG

(6) Address: Im Hackacker 15, Ch-8902 Urdorf

(7) This equipment and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The Physikalisch-Technische Bundesanstalt, notified body No. 0102 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive.

The examination and test results are recorded in the confidential report PTB Ex 00-20252.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 50014:1997 + A1 + A2 **EN 50020:1994**

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-type-examination Certificate relates only to the design and construction of the specified equipment in accordance with Directive 94/9/EC. Further requirements of this Directive apply to the manufacture and supply of this equipment.

(12) The marking of the equipment shall include the following:

II 2 (1) G EEx ib [ia] IIC T6

Zertifizierungsstelle Explosionsschutz
By order:

Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, January 24, 2001

sheet 1/3

(13) # SCHEDULE

(14) ## EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2191

(15) Description of equipment

The pH-transmitter type 2220X Opt. ... is used preferably for detecting and processing electrochemical quantities and is equipped with an input for the pH- resp. ORP-measurement and an input for the measurement of temperature.

The application occurs within the hazardous area.

The maximum permissible ambient temperature is 50 °C.

Electrical data

Loop measuring circuit..... (KL 9, 10)	type of protection Intrinsic Safety EEx ib IIC only for connection to a certified intrinsically safe circuit maximum values: U_i = 30 V I_i = 100 mA P_i = 0.8 W C_i = 22 nF L_i negligibly low
Output circuit 2 ..... (KL 11, 12)	type of protection Intrinsic Safety EEx ib IIC only for connection to a certified intrinsically safe circuit maximum values: U_i = 30 V I_i = 100 mA P_i = 0.8 W C_i = 48 nF L_i negligibly low
pH-measuring circuit..... (KL 1, 3, 4, 5)	type of protection Intrinsic Safety EEx ia IIC maximum values: U_o = 10 V I_o = 11 mA P_o = 15 mW R = 456 Ω linear characteristic C_0 = 440 nF L_0 = 5 mH

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

SCHEDULE TO EC-TYPE-EXAMINATION CERTIFICATE PTB 00 ATEX 2191

	C_i = 50 nF L_i negligibly low
Temperature measuring circuit ..... (KL 6, 7, 8)	type of protection Intrinsic Safety EEx ia IIC maximum values: U_o = 10 V I_o = 3 mA P_o = 4 mW R = 1.6 kΩ linear characteristic C_0 = 475 nF L_0 = 1.8mH C_i = 50 nF L_i negligibly low
PA	only for connection to the equipotential bonding system

The loop measuring circuit is safely electrically isolated from the other intrinsically safe circuits up to a voltage of 60 V.

The output circuit 2 is safely electrically isolated from the pH- and from the temperature measuring circuit up to a voltage of 60 V.

The pH-measuring circuit and the temperature measuring circuit are electrically interconnected.

(16) Test report PTB Ex 00-20252

(17) Special conditions for safe use

none

(18) Essential health and safety requirements

met by the standards mentioned above

Zertifizierungsstelle Explosionsschutz
By order:

Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, January 24, 2001

1 Assembly, installation, and maintenance

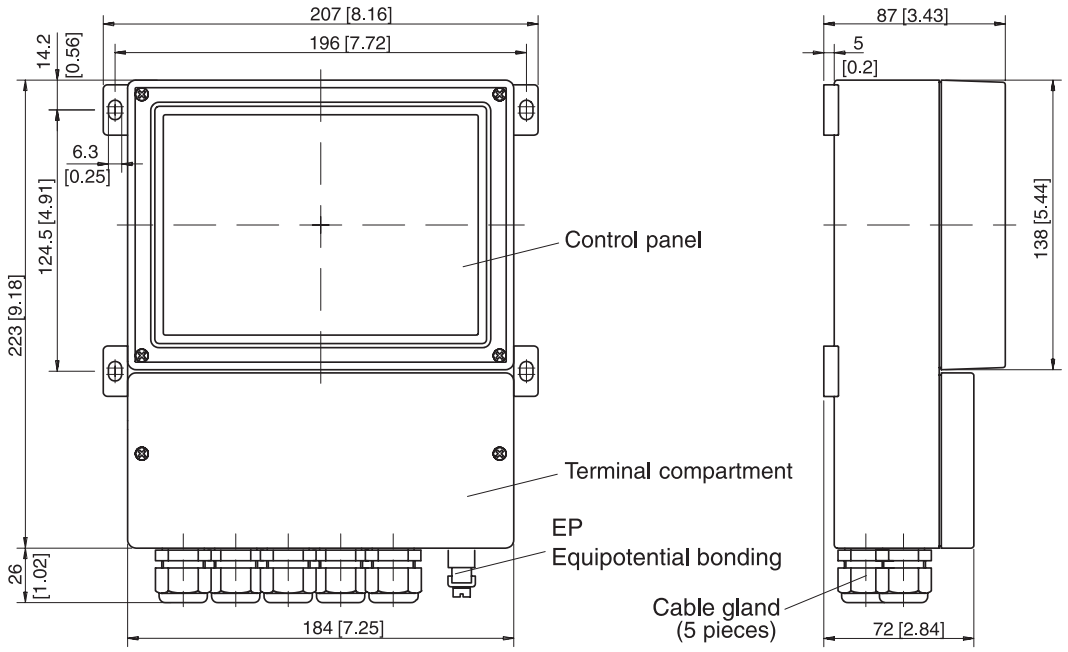
Assembly

- The weatherproof enclosure allows direct wall mounting. See dimension drawing, Fig. 1-1.

- With the ZU 0136 mounting plate and the ZU 0125 bracket kit, the Transmitter can also be mounted on a post or pipe.
  See dimension drawing, Fig. 1-2.

- The ZU 0157 protective hood provides additional protection against direct weather exposure and mechanical damage.
  See dimension drawing, Fig. 1-2.
  For mounting the protective hood, you require the ZU 0136 mounting plate.

- The ZU 0158 protective case provides optimum protection against dust, moisture, and mechanical damage.
  See dimension drawing, Fig. 1-3.
  With the ZU 0220 bracket kit, the protective case can also be mounted on a post or pipe.



Note: All dimensions in mm [inches].

Fig. 1-1 Dimension drawing pH Transmitter 2220(X)

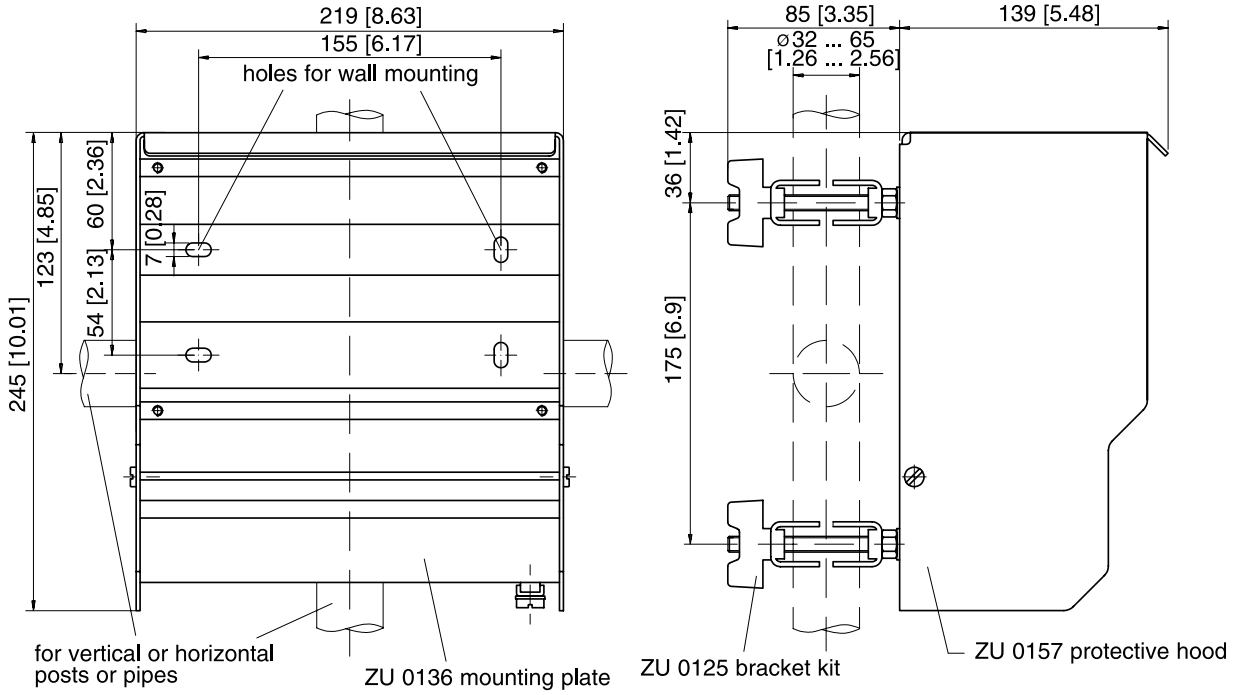
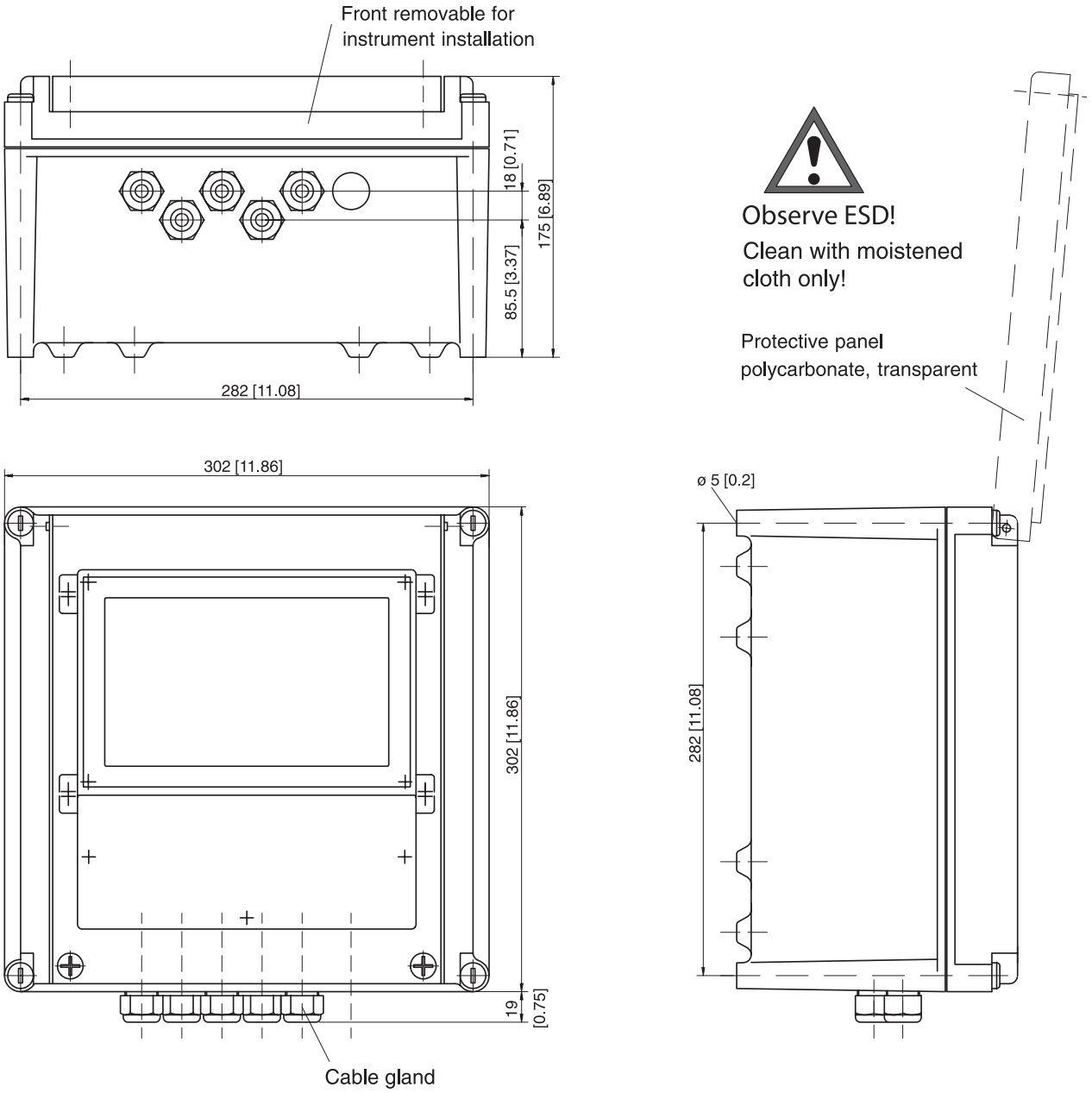
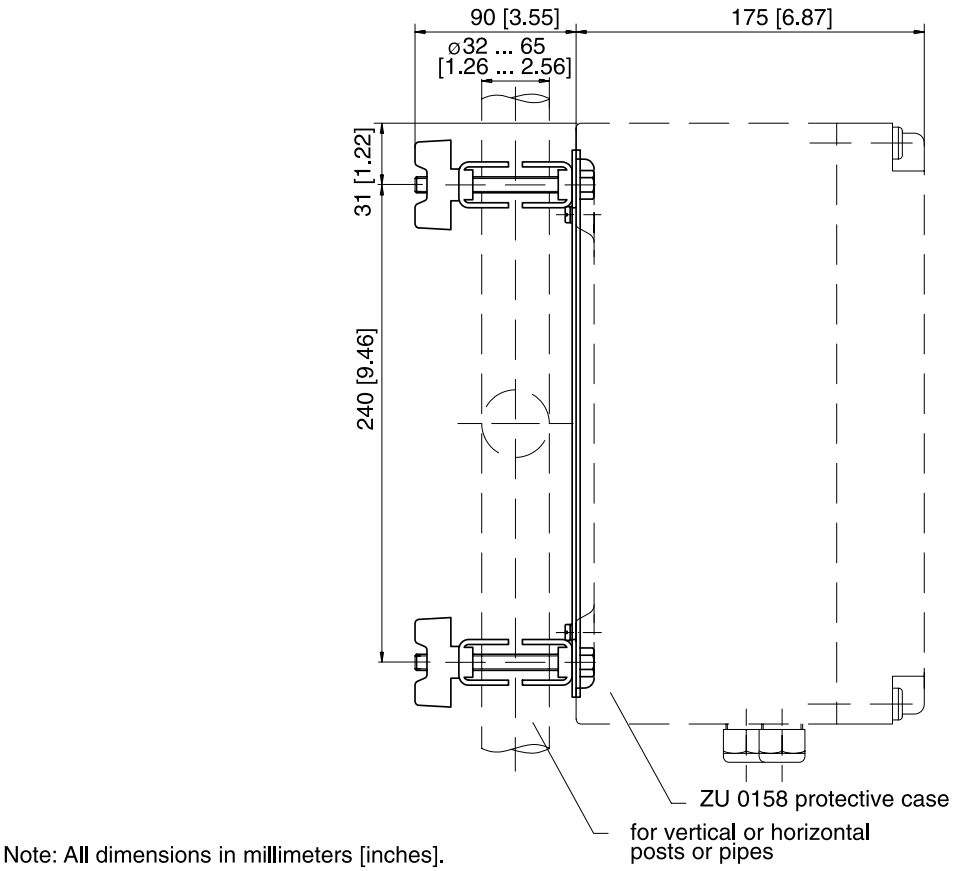


Fig. 1-2 ZU 0136 mounting plate, ZU 0157 protective hood and ZU 0125 bracket kit



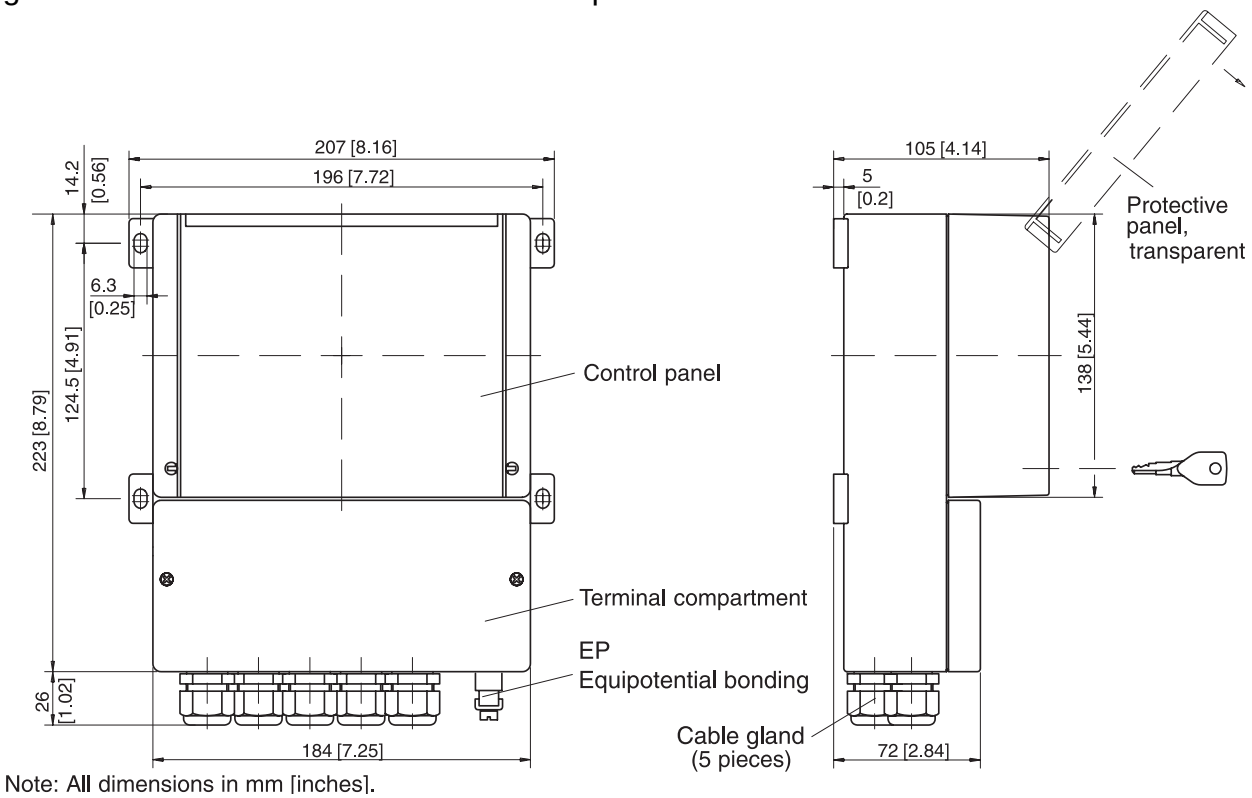
Note: All dimensions in mm [inches].

Fig. 1-3 Dimension drawing of ZU 0158 protective case



Note: All dimensions in millimeters [inches].

Fig. 1-4 ZU 0220 bracket kit for ZU 0158 protective case



Note: All dimensions in mm [inches].

Fig. 1-5 Transmitter with lockable protective panel (Opt. 432)

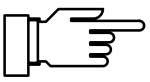
Installation and commissioning

- Installation and commissioning of the pH Transmitter 2220(X) may only be carried out by trained experts in accordance with this instruction manual and as per applicable local and national codes. Be sure to observe the technical specifications and input ratings.
- All parameters must be set by a system administrator prior to commissioning.
- Be sure to observe the safety precautions on Pg VIII and the following!

Before connecting the pH Transmitter 2220 to a supply unit, make sure that its output voltage cannot exceed 40 V DC and that the current loop is fused with a maximum of 100 mA.

Before connecting the pH Transmitter 2220X to a supply unit, make sure that it cannot output more than 30 V DC, 100 mA and 0.8 W

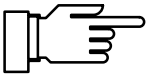
To connect the pH Transmitter 2220(X), open the cover of the terminal compartment (lower part of the Transmitter) by removing the two screws. The terminals are suitable for single wires and flexible leads up to 2.5 mm^2 (AWG 14). On the right-hand side next to the terminals there are two contact holes for connecting a HART® hand-held terminal.



As delivered, all terminals are open to allow easy insertion of the connecting wires. If the terminals are only half open, it may occur that the wire is pushed below the contacting element and does not make contact when the terminal is closed.
Connection examples are shown on Pg 2-3 and the following.

pH Transmitter 2220X:
The outer EP (PA) terminal must be connected with equipotential bonding to divert electrostatic charges from the front panel overlay.

Notes concerning performance



At ambient temperatures below 0 °C the readability of the LC display may be reduced. This does not impair the instrument functions.

The real-time clock, logbook, cal record and sensor statistics are battery-backed for approx. 1 year. After longer power outages these data can be lost. The Transmitter then displays the message “Warn Time/Date”, and the date is reset to 01/01/1990. Time and date must be reentered.

Maintenance and cleaning

The pH Transmitter 2220(X) contains no user repairable components.

To remove dust, dirt and spots, the external surfaces of the Transmitter may be wiped with a damp, lint-free cloth. A mild household cleaner may also be used if necessary.

When operating the Transmitter in a hazardous area, pay attention to electrostatic discharge!

Only clean the Transmitter with a moistened cloth!

Also the ZU 0158 protective case and the lockable protective panel (Opt. 432) may only be cleaned with a moistened cloth!

2 Capabilities of pH Transmitter 2220(X)

Overview of pH Transmitter 2220(X)

Commissioning of the pH Transmitter 2220(X) may only be carried out by trained experts in accordance with this instruction manual. Be sure to observe the technical specifications and input ratings during installation.

All parameters must be set by a system administrator prior to commissioning.

Never use the pH Transmitter 2220 for measurements in hazardous locations.

The pH Transmitter 2220X is approved for operation in hazardous locations.

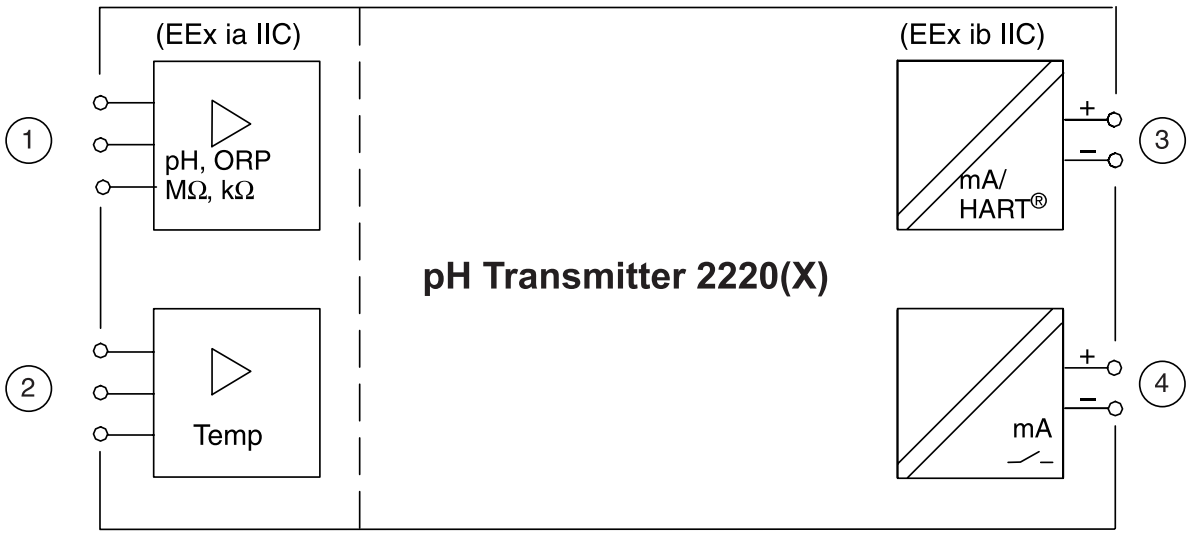


Fig. 2-1 System functions of pH Transmitter 2220(X)

Fig. 2-1 shows the system functions. In addition to inputs for glass and reference electrodes ① and a temperature probe ② , you can connect an equipotential bonding electrode that simultaneously serves as the auxiliary electrode for electrode monitoring (Sensocheck®).

If a suitable electrode is chosen – e.g. a platinum electrode – the ORP can simultaneously be measured. This not only allows you to detect the pH value and ORP, but also to calculate and display the pH-compensated ORP, the so-called rH value.

Output 1 ③ is galvanically isolated and operates as a current sink for the 4 to 20 mA (22 mA) loop current (supply unit required).
It supplies the Transmitter with power from the loop current and analogously transmits the configured process variable.

The galvanically isolated Output 2 ④ also operates as a 0(4) to 20 mA (22 mA) current sink (supply unit required). It can transmit a further user-defined process variable or can be used as a switching or controller output.

Outputs 1 and 2 are additionally capable of transmitting alarm and warning messages as 22 mA signals. Parameter setting is described from Page 4-24 on in the “Alarm processing / NAMUR signals” chapter.

pH measurement

Fig. 2-2 shows you how to connect a combination pH electrode to the pH Transmitter 2220(X). Terminals 3 and 4 must be jumpered!

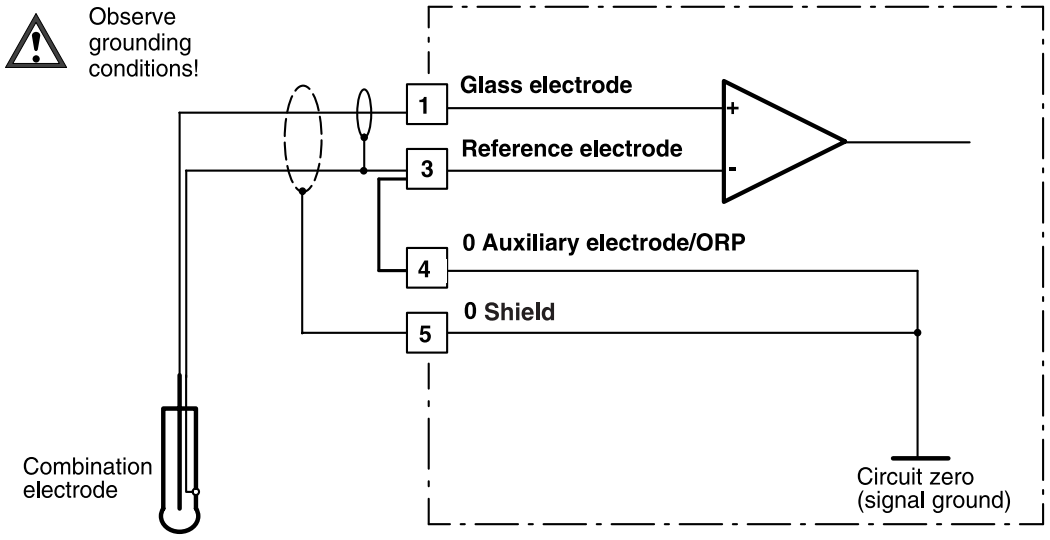
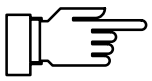


Fig. 2-2 Wiring of the pH input for simple pH measurement with impedance measurement of the glass electrode



Refer to Pg 2-5 for details on how to also monitor the reference electrode with Sensocheck® electrode monitoring.

Wiring notes on Fig. 2-2

Potential conditions

Do not ground terminals 3, 4, and 5! Terminals 3 and 4 must be jumpered!

Shielding

Be sure to shield the lead of the glass electrode (to ref. el. terminal 3). If there is an outer shield, it must be connected to terminal 5.

Possible measurement problems

Measuring errors occur if terminals 3 and 4 are jumpered and simultaneously grounded or if an auxiliary electrode is connected.
In the event of interference (e.g. via the loop current), it may be useful to remove the jumper across 3 and 4 and to connect terminal 4 to the grounded tank wall. Interferences will then no longer be dissipated through the reference electrode, but through the tank wall (see Fig. 2-3).

Temperature measurement

When installing the temperature probe, make sure it is close to the pH electrode (temperature gradient). Also pay attention to the problems of detecting the temperature during calibration.

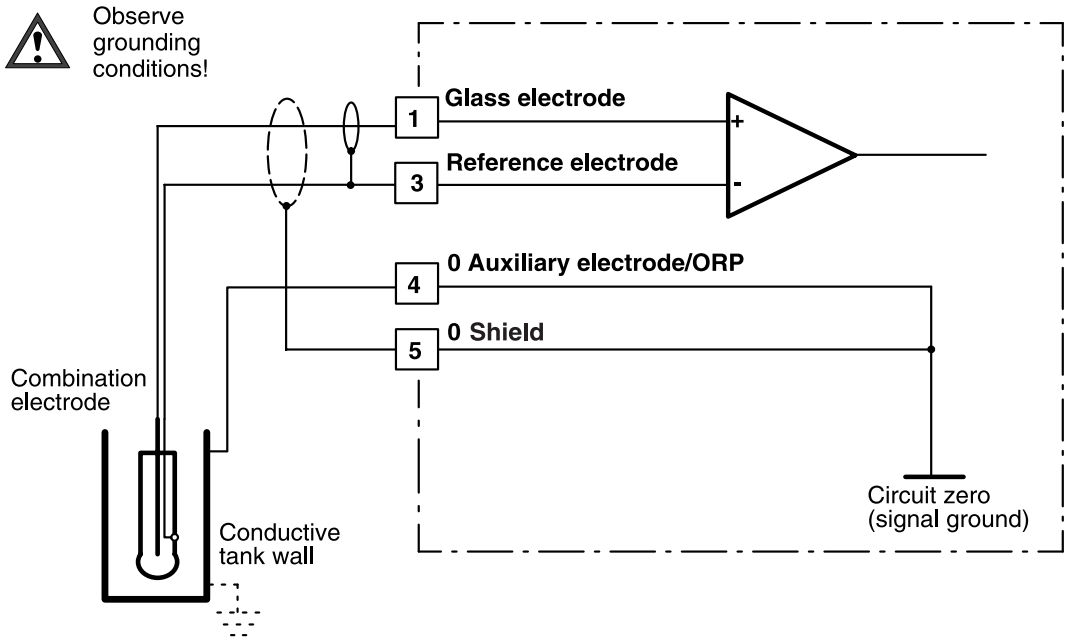


Fig. 2-3 Wiring of pH input with impedance measurement of glass and reference electrode, also with the process medium grounded

Wiring notes on Fig. 2-3

Potential conditions

Terminals 4 and 5 may be grounded. The electrode potential is defined via terminal 4 (tank wall). Therefore, the tank wall and electrode must be connected through the conductive process medium.

Shielding

Be sure to shield the lead of the glass electrode (to ref. el. terminal 3). If there is an outer shield, it must always be connected to terminal 5.

Possible measurement problems

Measurement errors occur when terminals 3 and 4 are jumpered.

The potential difference between terminals 3 and 4 must not become greater than 2 V as otherwise measurement errors will occur. Large-scale discrepancies may occur due to media through which current flows (electroplating).

During calibration, an auxiliary electrode (terminal 4) must also be immersed in the buffer solution.

Temperature measurement

When installing the temperature probe, make sure it is close to the pH electrode (temperature gradient). Also pay attention to the problems of detecting the temperature during calibration.

Sensocheck® electrode monitoring

Sensocheck® electrode monitoring measures the impedance of the glass electrode and of the reference electrode. This measurement takes place continuously together with pH measurement.

The electrode impedance values are a good measure of the condition of the electrodes, contamination (of the reference electrode), glass breakage (of the glass electrode), aging, and open circuit conditions.

If you only want to monitor the glass electrode impedance, you can connect the electrode as shown in Fig. 2-2.
An auxiliary electrode (Fig. 2-4) or a conductive tank wall (Fig. 2-3) are needed to measure and monitor the reference electrode impedance.

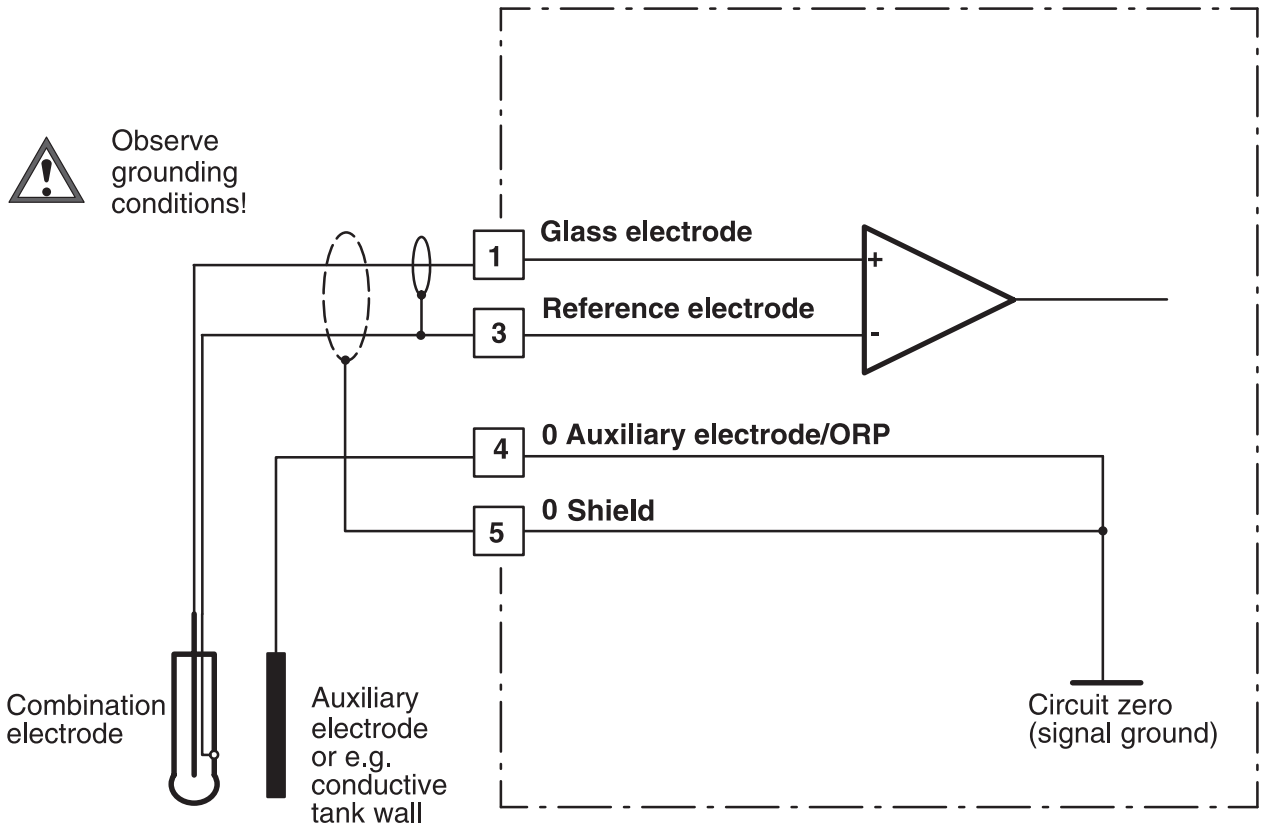


Fig. 2-4 Wiring of pH input with impedance measurement of glass and reference electrode

Wiring notes on Fig. 2-4

Potential conditions

Do not ground terminals 4 and 5! The electrode potential is defined with the auxiliary electrode at terminal 4. Therefore, the auxiliary electrode and pH electrode must be connected through the conductive process medium.
Simultaneous ORP measurement is possible when a platinum electrode is connected to terminal 4 (Fig. 2-6).

Shielding

Be sure to shield the lead of the glass electrode (to ref. el. terminal 3). If there is an outer shield, it must be connected to terminal 5.

Possible measurement problems

Measurement errors occur when terminals 3 and 4 are jumpered.

The potential difference between terminals 3 and 4 must not become greater than 2 V as otherwise measurement errors will occur. Large-scale discrepancies may occur due to media through which current flows (electroplating).

During calibration, an auxiliary electrode (terminal 4) must also be immersed in the buffer solution.

Temperature measurement

When installing the temperature probe, make sure it is close to the pH electrode (temperature gradient). Also pay attention to the problems of detecting the temperature during calibration.

Connection of VP cable

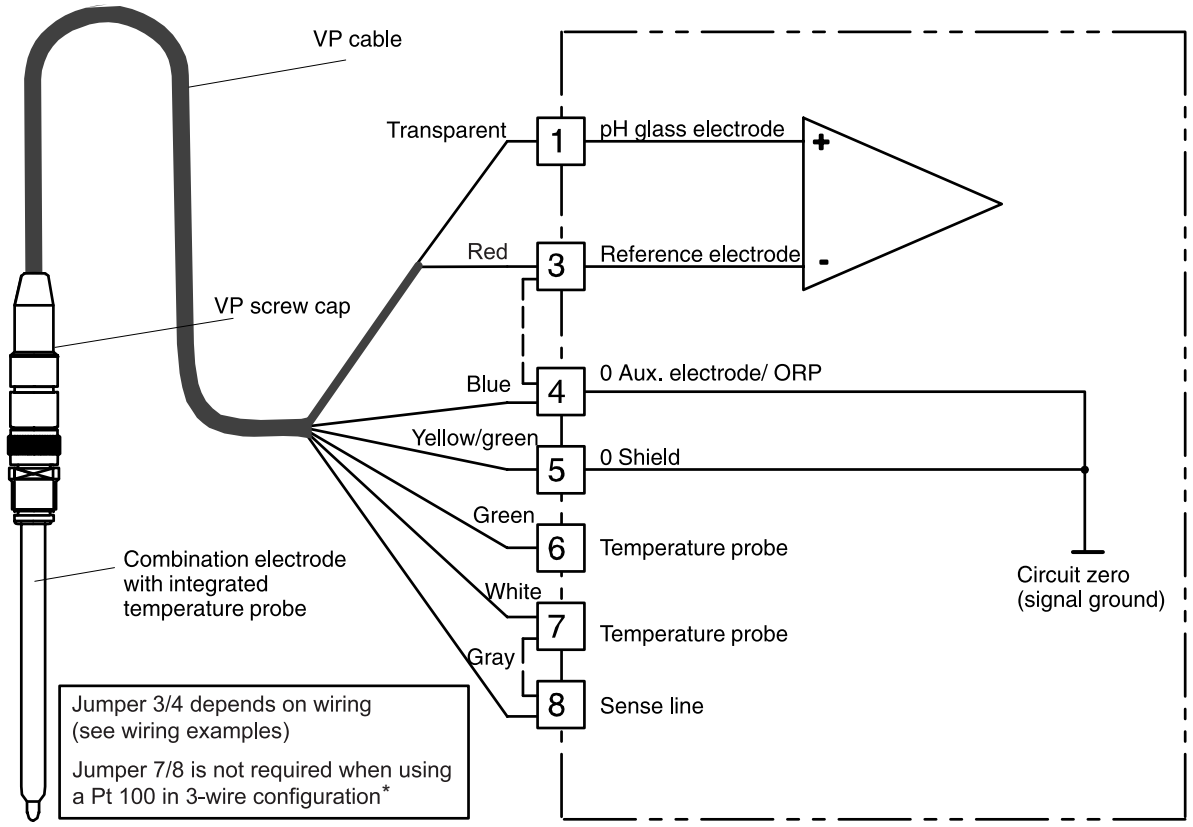


Fig. 2-5 VP connector system: Connection of a combination electrode with integrated temperature probe

* 3-wire connection must be implemented in electrode, see electrode specifications

Simultaneous pH and ORP measurement

If you use a platinum electrode as auxiliary electrode, you can simultaneously measure the pH value and the ORP.
If the pH Transmitter 2220(X) is equipped with Option 487 (Second current output, passive), you can output two values at the same time.

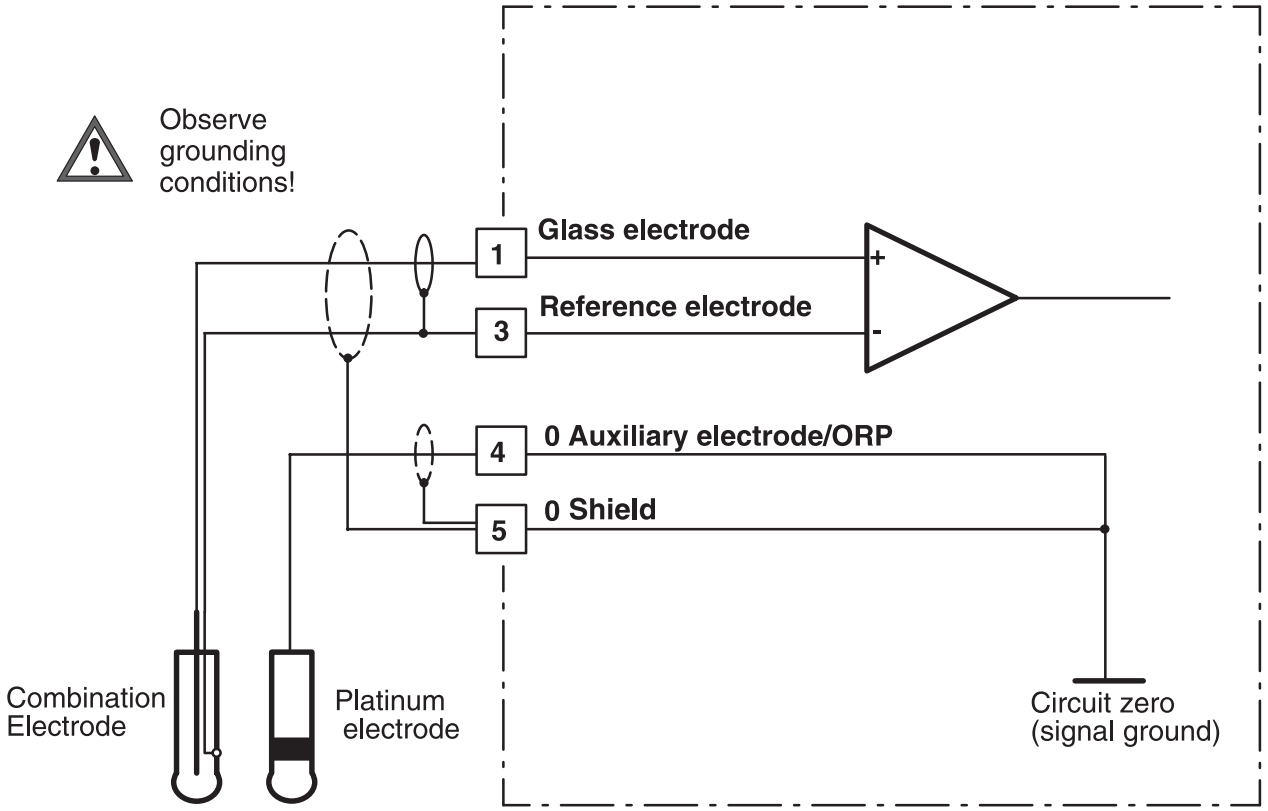


Fig. 2-6 Simultaneous pH and ORP measurement with impedance measurement of glass and reference electrode.

Wiring notes on Fig. 2-6

Potential conditions

Do not ground terminals 4 and 5! The electrode potential is defined with the platinum electrode at terminal 4. Therefore, the platinum electrode and pH electrode must be connected through the conductive process medium.

Shielding

Be sure to shield the lead of the glass electrode (to ref. el. terminal 3). If there is an outer shield, it must be connected to terminal 5.

Possible measurement problems

Measurement errors occur when terminals 3 and 4 are jumpered.

During calibration, an auxiliary electrode (terminal 4) must also be immersed in the buffer solution.

Temperature measurement

When installing the temperature probe, make sure it is close to the pH electrode (temperature gradient). Also pay attention to the problems of detecting the temperature during calibration.

rH measurement

The pH Transmitter 2220(X) calculates the rH value from two separately measured values (pH value and ORP).
Although direct calibration of rH measurement is not possible, the pH electrode can be calibrated separately.
You can use a combination electrode for pH measurement. The additionally required metal (platinum) electrode is connected to terminal 4 and at the same time serves as auxiliary electrode for electrode monitoring (see Fig. 2-6).

ORP measurement

When taking ORP measurements, it is necessary to specify – in addition to the measured result – the reference electrode used or whether the result has been converted to the standard hydrogen electrode.

Specification of ORP is completed by information on the measuring electrode used (e.g. “platinum”) as well as the measuring temperature and the pH value.

Standard potentials [mV] of some reference electrodes

(Voltages [mV] related to the standard hydrogen electrode)

Data: Galster; pH-Messung, Weinheim. VCH, 1990 (partly interpolated/extrapolated)

	“Silver chloride”, “Argenthal”, “Silamid” Ag/AgCl, KCl				“Calomel” Hg/Hg_2C_2, KCl			“Thalamid” Tl,Hg/TlCl,KCl	“Mercury sulfate” Hg/Hg_2SO_4, K_2SO_4
Temp [°C]	1 mol/l	3 mol/l	3.5 mol/l	Saturated	0.1 mol/l	1 mol/l	Saturated	3.5 mol/l	Saturated
0	249.3	224.2	222.1	220.5	333.8	285.4	260.2	–558.5	671.8
5	246.9	220.9	218.7	216.1	334.1	284.7	257.2	–561.0	667.6
10	244.4	217.4	215.2	211.5	334.3	283.9	254.1	–563.5	663.5
15	241.8	214.0	211.5	206.8	334.2	282.7	250.9	–566.0	659.4
20	239.6	210.5	207.6	201.9	334.0	281.5	247.7	–568.6	655.3
25	236.3	207.0	203.7	197.0	333.7	280.1	244.4	–571.3	651.3
30	233.4	203.4	199.6	191.9	333.2	278.6	241.1	–574.0	647.3
35	230.4	199.8	195.4	186.7	332.4	277.0	237.7	–576.7	643.3
40	227.3	196.1	191.2	181.4	331.6	275.3	234.3	–579.6	639.2
45	224.1	192.3	186.8	176.1	330.6	273.5	230.8	–582.5	635.1
50	220.8	188.4	182.4	170.7	329.6	271.6	227.2	–585.4	630.9
55	217.4	184.4	178.0	165.3		269.5	223.6	–588.5	626.6
60	213.9	180.3	173.5	159.8		267.3	219.9	–591.6	622.6
65	210.4	176.4	169.0	154.3		264.8	216.2	–594.8	617.7
70	206.9	172.1	164.5	148.8		262.2	212.4	–598.0	613.3
75	203.4	167.7	160.0	143.3				–601.4	608.4
80	199.9	163.1	155.6	137.8				–604.8	603.4
85	196.3	158.3	151.1	132.3				–608.3	598.4
90	192.7	153.3	146.8	126.9				–611.9	593.1
95	189.1	148.1	142.5	121.5				–615.6	578.6

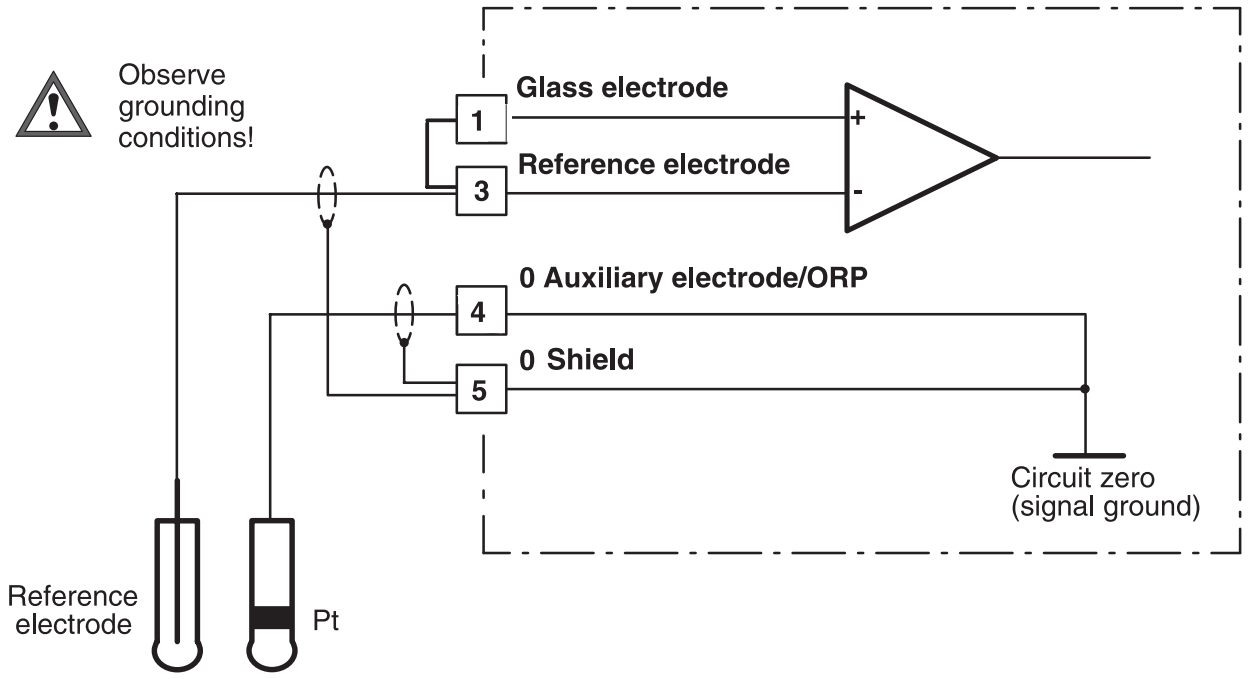


Fig. 2-7 ORP measurement with impedance measurement of the reference electrode

Wiring notes on Fig. 2-7

Potential conditions

Terminals 1 and 3 must be jumpered.
Terminals 4 and 5 may be grounded.

Shielding

Existing shields must be connected to terminal 5.

Temperature measurement

When installing the temperature probe, make sure it is close to the two electrodes (temperature gradient). Also pay attention to the problems of detecting the temperature during ORP check.

Temperature detection

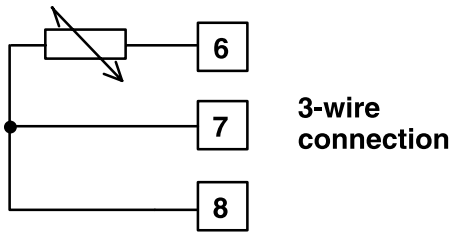
Why temperature compensation?

There are two important reasons for determining the temperature of the process or buffer solution:

- The slope of the pH electrode is temperature-dependent (Nernst equation). Therefore the measured voltage must be corrected by the temperature influence.
- The pH value of the buffer solution is temperature-dependent. For calibration, the buffer solution temperature must therefore be known in order to choose the actual pH value from the buffer table.

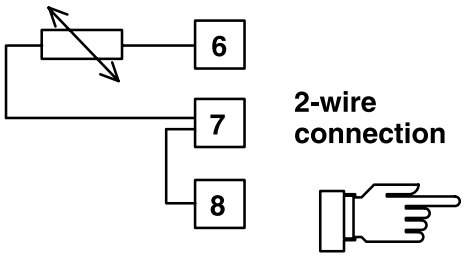
Automatic temperature compensation

For automatic temperature compensation, the pH Transmitter 2220(X) detects the process temperature with a temperature probe (Pt 100 / Pt 1000 / NTC 30 kΩ).



3-wire connection

3-wire configuration of the temperature probe eliminates the temperature measurement error caused by the lead resistance (important for Pt 100!).
The lines to terminals 6 and 7 must have the same cross section.



2-wire connection

For 2-wire connection, connect the temperature probe to terminals 6 and 7. A jumper must be set across terminals 7 and 8.

Passive output 2

If your Transmitter is equipped with Option 487 (Second current output, passive), an additional output is available to you.
This output is passive. It must be supplied by an additional power supply (e.g. WG 20 isolated supply).

Output 2 can be used either as 0 – 20 mA (22 mA) current output or as switching output (alarm contact or limit contact).

As a current output it can be defined for the various process variables. In addition, a message for failure, warning and functional check can be output as 22 mA signal.

If your Transmitter is also equipped with Option 353 (Controller function), you can use the output as an analog or switching controller output.

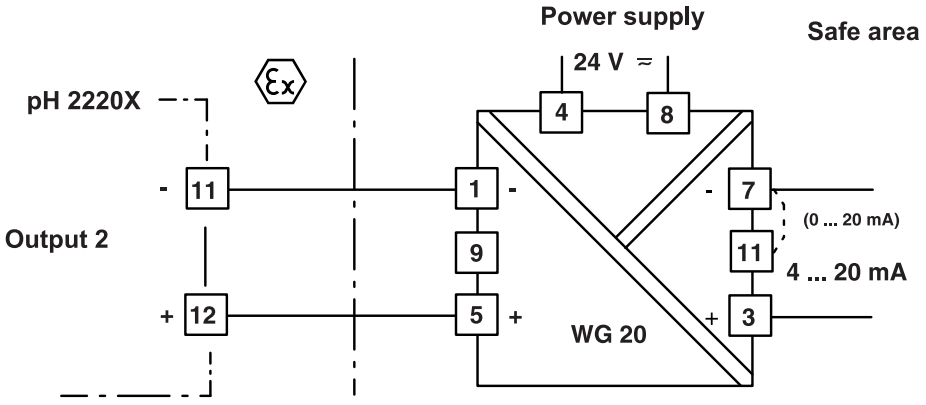


Fig. 2-8 Connection of output 2 as current output with WG 20

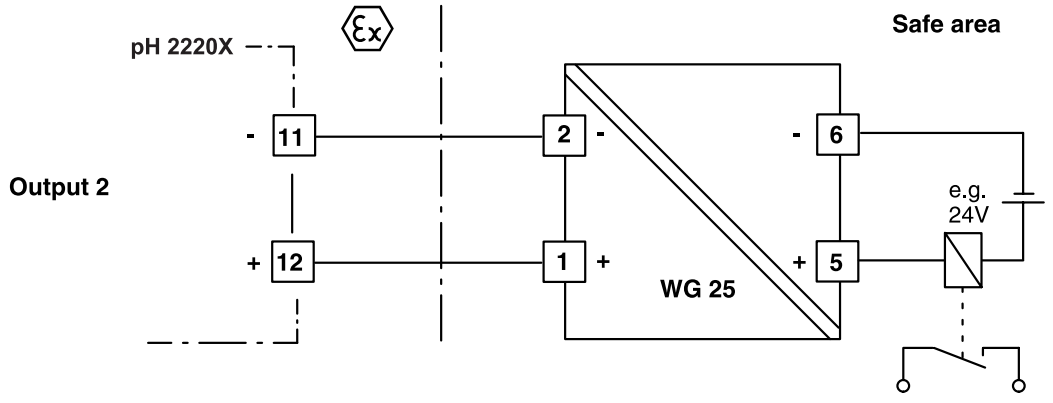


Fig. 2-9 Connection of output 2 as switching output with WG 25
(Observe the technical specifications of WG 25.)

Typical wirings

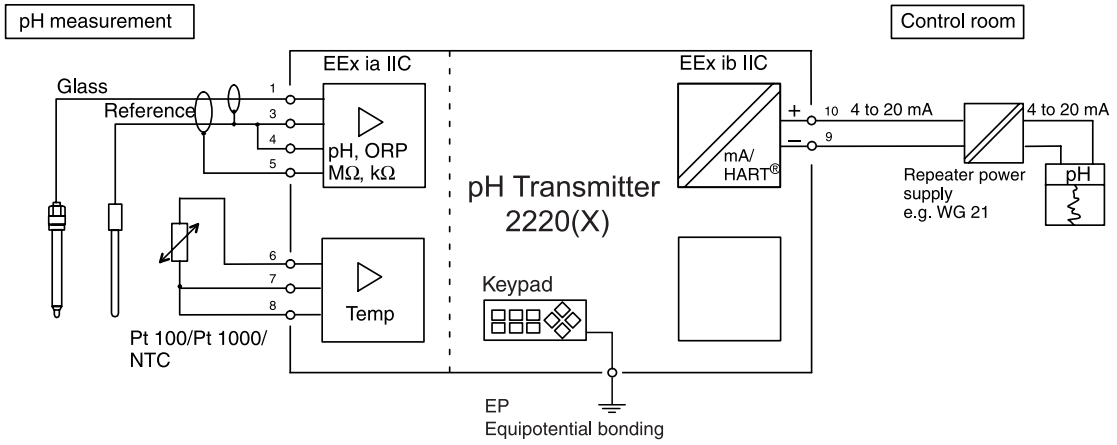


Fig. 2-10 pH measurement with recorder evaluation

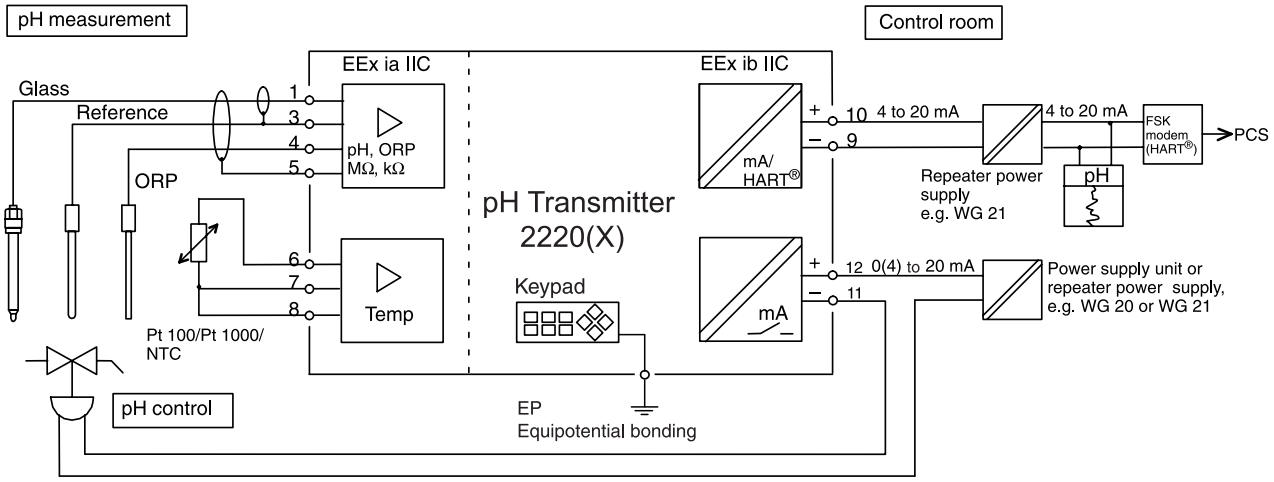


Fig. 2-11 pH and ORP measurement with control, recorder evaluation, and connection to a process control system

pH Transmitter 2220X:
Connect EP terminal to equipotential bonding!
See Fig. 1-1 and Fig. 1-5 on Pg 1-2 and the following.

Terminal assignments

Insert jumper 3, 4 if necessary!
(also see Pg 2-3)

Insert jumper 7, 8 if necessary!
(also see Pg 2-12)

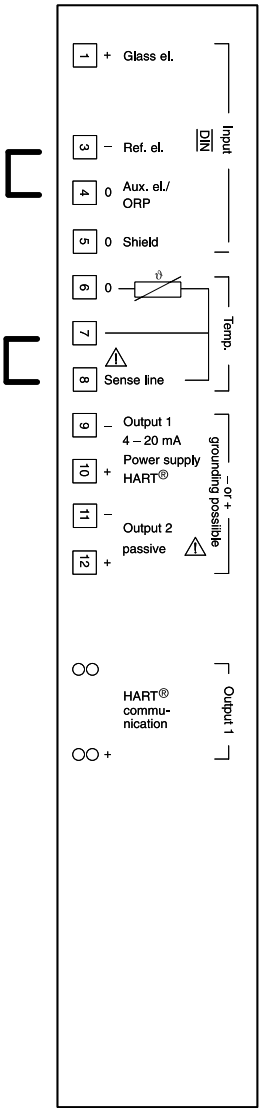


Fig. 2-12 Terminal assignments

This page has been left empty for technical reasons.

3 Operating pH Transmitter 2220(X)

Commissioning of the pH Transmitter 2220(X) may only be carried out by trained experts in accordance with this instruction manual.

All parameters must be set by a system administrator prior to commissioning.

User interface

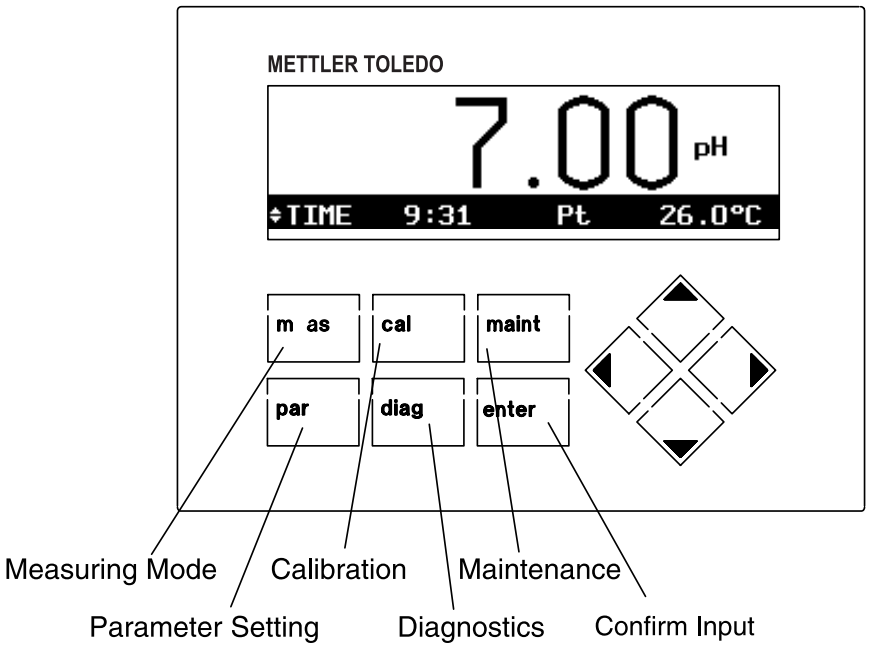
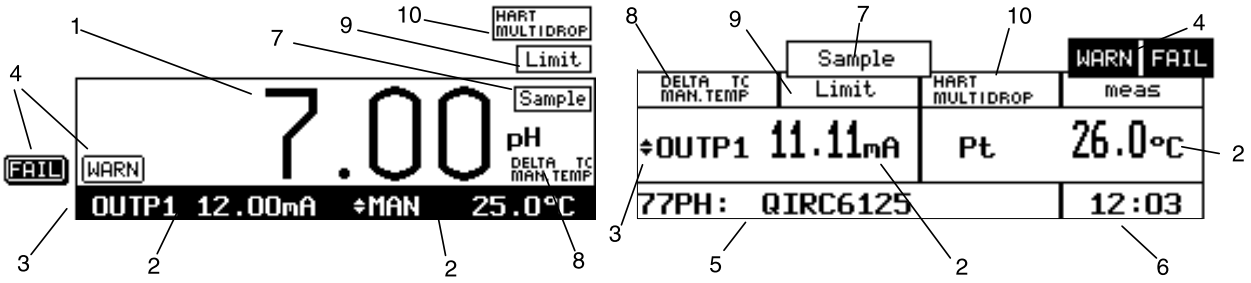


Fig. 3-1 User interface of pH Transmitter 2220(X)

Measuring mode

In the measuring mode, two different types of numerical displays are available. If your Transmitter is equipped with Option 448 (Measurement recorder), the variation of any two measured values can also be represented graphically. By pressing **meas** you can switch between the different display types.



The display consists of the following elements:

1 The measured value in the main display is selected during Parameter Setting (see Pg 4-3)

2 The measured values in the secondary displays are selected using ▲ and ▼ .

3 The selection symbol ⇕ indicates which secondary display can be edited.
By pressing ◀ or ▶ you can switch between the two secondary displays.

4 NAMUR messages: Warning (maintenance required) and failure

5 Tag number or note (Switch with **enter**)

6 Current time

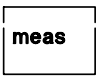
7 Sampling for calibration

8 Reference to dependencies of process variables

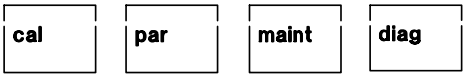
9 Limit values exceeded

10 HART® Multidrop mode is active. Output current 1 is permanently set to 4 mA. The measured value is digitally modulated onto the current.

Keypad assignment in measuring mode

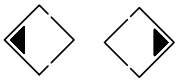


switches between the two different types of measured value display. With Option 448 also to the measurement recorder.

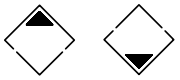


activates Calibration, Parameter Setting, Maintenance or Diagnostics.

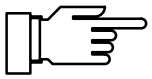
switches between tag number and note.



select secondary display for changing the process variable.



change process variable in the secondary display.

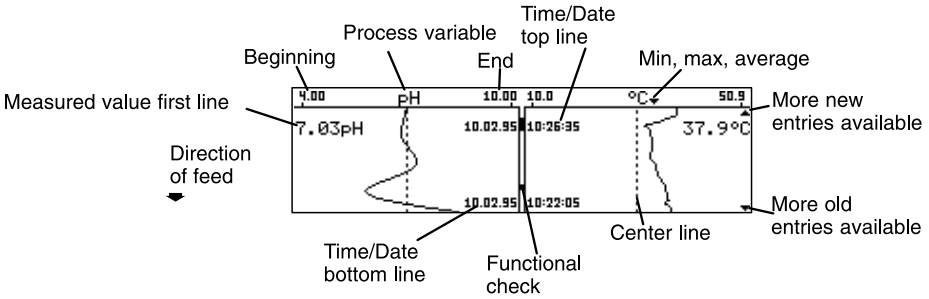


Refer to Page 4-3 for an overview of the process variables that can be displayed.

Measurement recorder

With the integrated measurement recorder (Option 448), the pH Transmitter 2220(X) provides you with a two-channel “on-site recorder”. For process visualization or, for example, for controller optimizing, the measurement recorder continuously registers two user-defined process variables and simultaneously displays them graphically next to each other in the system display. Process variable, measurement range, recording method and time feed (scanning interval) parameters can be set within broad limits (see Pg 4-30). The last 500 measured values are stored with time and date in the recorder memory of your Transmitter. You can also display them numerically (see Pg 6-6).

This option (Measurement recorder) can be retrofitted via TAN (see Pg 4-30).



Keypad assignment for measurement recorder

meas — switches to measurement display

cal **par** **maint** **diag** — activates Calibration, Parameter Setting, Maintenance or Diagnostics.

enter — jumps to current entry.

◀ ▶ — scroll to next or previous page.

▲ ▼ — scroll to next or previous line.

▲ + **enter** — jumps to current entry.

▼ + **enter** — jumps to oldest entry.

Menu structure

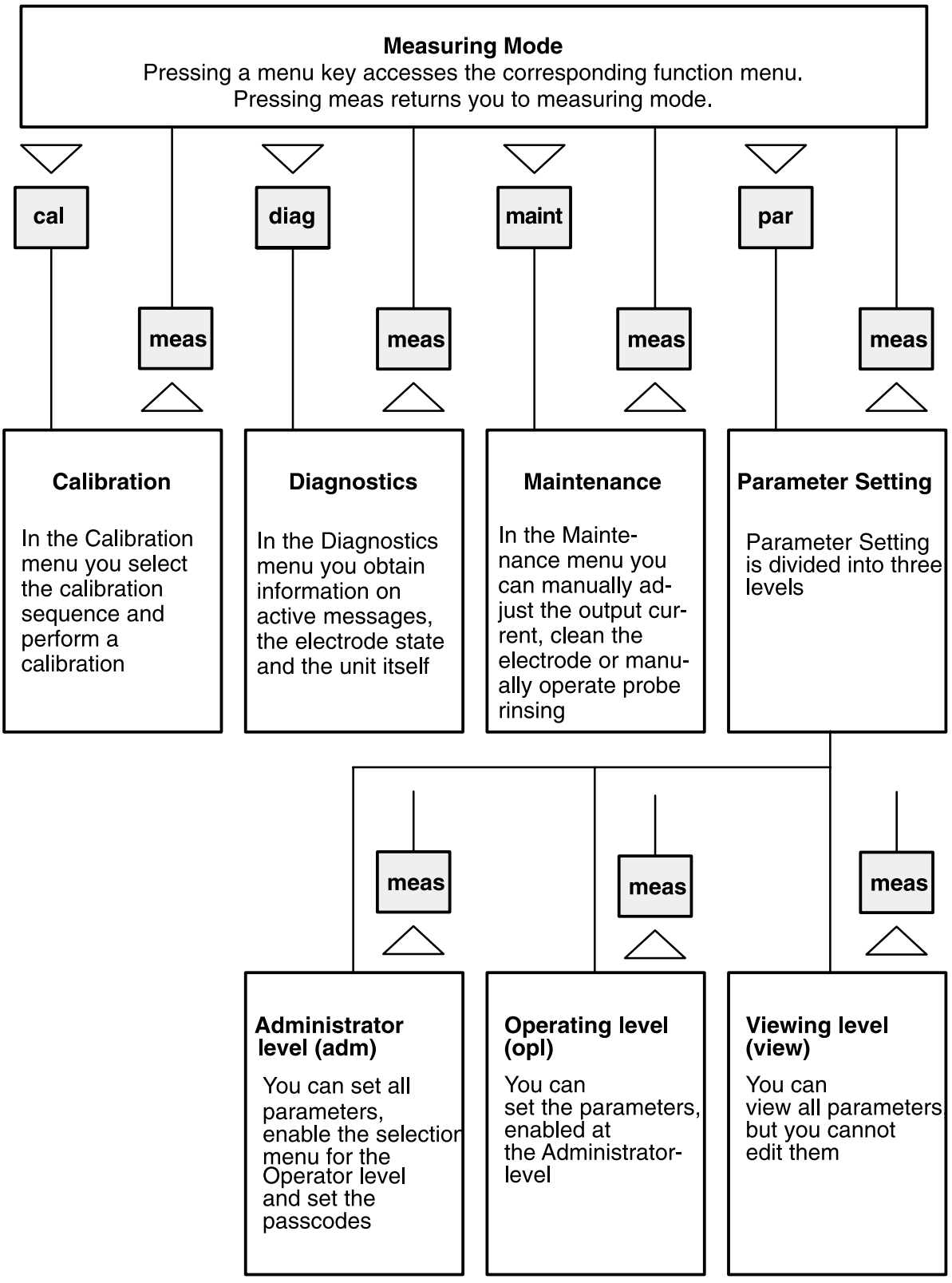


Fig. 3-2 Menu structure

Menu operation

When Calibration, Maintenance, Parameter Setting or Diagnostics are active, the display shows the respective menu for operating the functions.

Operator guidance is supported by a 7-line plaintext display with information texts. During operation, the measured value display (4) and the active status messages (3) remain visible.

The menu display consists of the following elements:

1 The abbreviation shows you which menu you are in:

cal	Calibration menu
maint	Maintenance menu
view	Parameter Setting, Viewing level
opl	Parameter Setting, Operator level
adm	Parameter setting, Administrator level
diag	Diagnostics menu
par	Parameter setting, language selection

2 The menu heading indicates the current menu level.

3 The status display shows active warning ($_W$) and/or failure messages (^{F}).

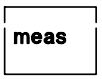
4 The measured value is also visible in the menus.

5 The » symbol indicates that this menu item contains a submenu.

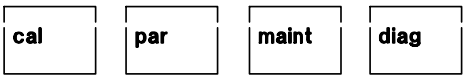
6 The marker setting is only visible in the Parameter Setting menu. At the Administrator level you can block individual menu items for the Operator level (see Pg 4-2).

7 In longer menus it is not possible to display all lines at the same time. The ↑ and ↓ symbols indicate that there are further menu lines.

Keypad assignment for menu operation:

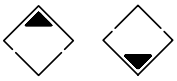


exits the menu system and returns to measuring mode. In the Calibration or Maintenance menus you are prompted to confirm that your equipment is ready for measurement.



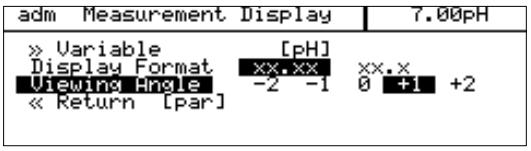
Cancel: To cancel an entry (without storing) or to exit a submenu, you can use the corresponding menu key.
That means: Parameter Setting can be canceled by pressing **par** , Diagnostics by pressing **diag** , etc.

How to select a menu item:

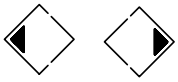


Select the desired menu item using the scrolling keys. The selected line is marked by a dark bar (reverse video).
The scrolling keys provide a repeat function: When a key is held down, the lines are scrolled through.

Pressing ▶ or **enter** accesses the next (lower) menu level.

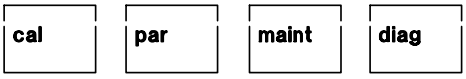


How to change a setting:

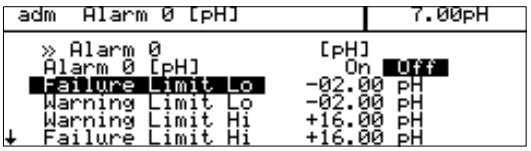


Pressing a cursor key changes the setting. The selected position is shown in reverse video.
The entry position flashes, as it has been modified but not yet stored.

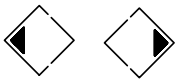
Pressing **enter** stores the new setting. Flashing stops.



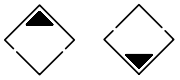
Pressing the menu key (e.g. **par**) instead of **enter** restores the old setting.



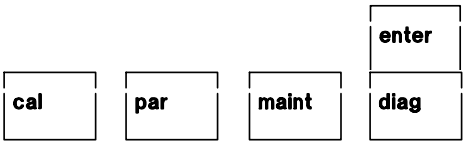
How to change numerical values:



Moves the cursor within the entry area. With these keys, you select the entry position.
When the entry value has a sign, it can be selected by pressing ◀.
If you edit a numerical value with an entry area covering several decades (e.g. conductivity), the ⇆ symbol appears in front of the numerical value. Now you can displace the decimal point using the cursor keys.

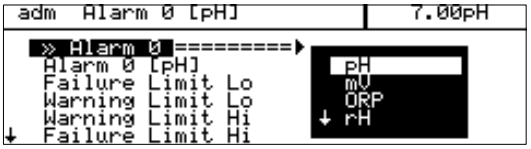


Pressing a scrolling key scrolls the numbers from 0 through 9 or changes the sign.



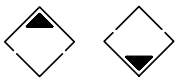
Pressing **enter** stores the edited setting.

Pressing the menu key (e.g. **par**) instead of **enter** restores the old setting.



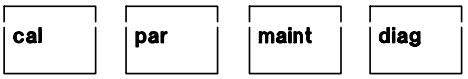
How to select parameters in a pull-down menu:

Pressing ▶ or **enter** accesses pull-down selection. An inverted menu is displayed.



Select the desired menu line using the scrolling keys. The selected line is highlighted.
The entry line flashes, as it has been modified but not yet stored.

Pressing **enter** stores the new setting. Flashing stops.



Pressing the menu key (e.g. **par**) instead of **enter** restores the old setting.

4 Parameter setting

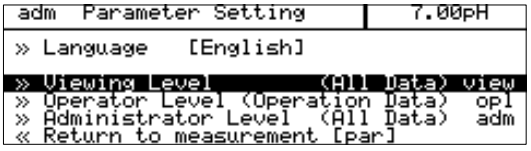
Installation and commissioning of the pH Transmitter 2220(X) may only be carried out by trained experts in accordance with this instruction manual and as per applicable local and national codes. Be sure to observe the technical specifications and input ratings during installation.

All parameters must be set by a system administrator prior to commissioning.

Language selection

When you access the Parameter Setting level, you can select the language for the displays and menu texts. German, English, French, Italian, and Spanish are available.
(Optionally Swedish instead of Spanish)

The three levels of parameter setting



The Parameter Setting menu is divided into the Viewing, Operator, and Administrator levels according to the user's degree of specialization.

- At the Viewing level the settings can be displayed but not edited.
- At the Operator level only the marked menu items can be edited.
- At the Administrator level all parameter setting functions can be accessed. In addition, markers can be set for each menu item to create an optimal user menu for the Operator level.
  Passcodes protect the Operator and Administrator level against unauthorized access. The passcode protection for the Operator level can be switched off if required.

The levels are identified by abbreviations in the upper left corner of the display:

view – Viewing level
opl – Operator level
adm – Administrator level

Access to the Operator level can be protected with a passcode if necessary. Access to the Administrator level is always protected with a passcode.

Viewing level

At the Viewing level you can have a look at all settings of the Transmitter.
The settings cannot be edited!

Operator level

At the Operator level you can only edit those parameters (menu items) which have been enabled at the Administrator level.

Whether a menu item has been enabled is indicated by the dot preceding the corresponding menu line.

- ● This menu item can be edited.
- ○ This menu item is locked: It cannot be edited. The menu item is skipped during scrolling. However, it can be accessed at the Viewing level.

Access to the Operator level can be protected with a passcode if necessary.

Administrator level

At the Administrator level you can edit all instrument settings including the passcodes. In addition, the marker function allows you to lock individual menu items to prevent access from the Operator level.

As delivered, all menu items are enabled.

Access to the Administrator level is always protected with a passcode.

Marker setting

An information text explains the marker setting at the Administrator level.

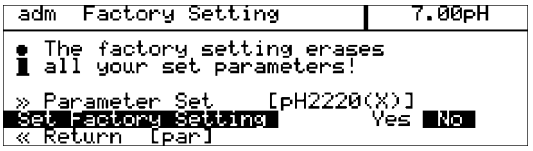
By setting markers you can enable or lock individual menu items at the highest level of the Parameter Setting menu (except “Passcode Protection”) for the Operator level:

- ● This menu item has been enabled: It can be edited at the Operator level.
- ○ This menu item is locked: It cannot be edited at the Operator level. However, it can be accessed at the Viewing level.

How to set a marker

Press ◀ to select the marker.
Press ▼ or ▲ to enable (●) or lock (○) the menu item.
Confirm the setting with **enter** .

Factory setting



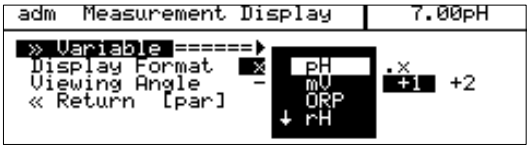
At the Administrator level, you can reset all settings to the initial factory setting.

Before the pH Transmitter 2220(X) is started again, a complete parameter setting procedure must be performed by a system administrator.

Measurement display

During parameter setting you can define which measured value is to appear in the large display in measuring mode. The following process variables can be displayed:

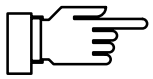
- pH value
- mV value
- ORP value
- rH value
- Measured temperature (°C)
- Time



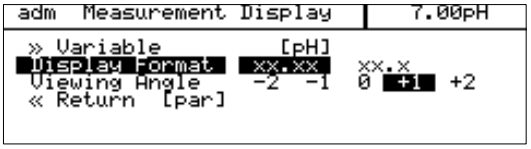
The following variables can be shown in the secondary displays:

- MAN Manual measuring temperature (°C)
- OUTP1 Output current 1
- OUTP2 Output current 2
  (with Option 487 and current 2 active)
- Xw Controller setpoint
  (with Option 353 and active controller)
- CTL-Y Controller output
  (with Option 353 and active controller)
- REF Reference electrode impedance

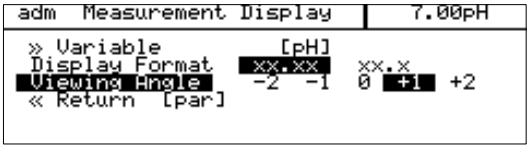
- GLASS Glass electrode impedance
- DATE Date
- CTIME Calibration timer



See Pg 3-2 for how to select the process variables for the secondary displays.



If you have set “Variable pH”, you can select “Display Format” to define whether the pH value will be displayed with one (xx.x) or two (xx.xx) decimal places.

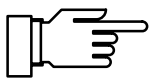


The “Viewing Angle” menu item allows you to adjust the viewing angle of the display.

When the Transmitter is mounted at a very high or a very low position, you can adjust the viewing angle for optimum display readability.
Select the desired viewing angle using ◀ and ▶ (+ means viewing angle upwards and – means viewing angle downwards) and confirm your choice by pressing **enter**.
You see the change immediately in the display.

Input filter

To increase the immunity to interference during pH measurement, an input filter can be switched on. When the filter is switched on, momentary interference pulses will be suppressed, slow changes in the measured value will be detected.



If fast measured-value changes are to be detected, you must switch off the input filter.

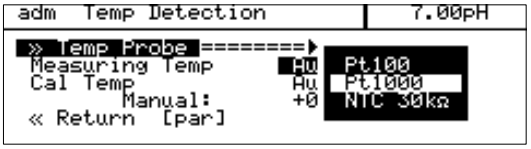
Temperature detection

Why temperature compensation?

There are two important reasons for determining the temperature of the process or buffer solution:

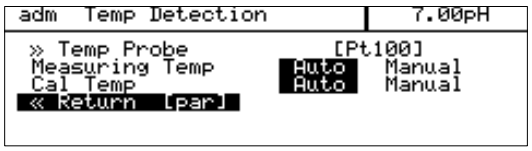
- The slope of the pH electrode is temperature-dependent (Nernst equation). Therefore the measured voltage must be corrected by the temperature influence.
- The pH value of the buffer solution is temperature-dependent. For calibration, the buffer solution temperature must therefore be known in order to choose the actual pH value from the buffer table.

During parameter setting you define whether the process and/or cal temperature is measured automatically or must be entered manually.



Automatic temperature compensation

For automatic temperature compensation, the pH Transmitter 2220(X) detects the process temperature with a temperature probe (Pt 100 / Pt 1000 / NTC 30 kΩ).
Select the connected temperature probe and confirm with **enter**.

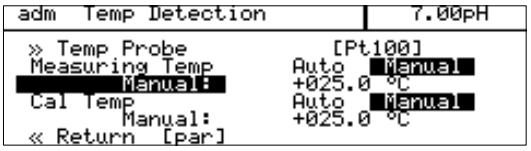


If you work with automatic temperature compensation, a temperature probe connected to the temperature input of the pH Transmitter 2220(X) must be in the process medium.
If no temperature probe is connected to the pH Transmitter 2220(X), the measuring temperature must be entered manually.

Manual temperature compensation

Manual temperature compensation only makes sense if the process is running at a constant temperature!
If “Measuring Temp Manual” is selected, this is indicated by “MAN.TEMP” in the lower right corner of the display. The “MAN.TEMP” message does not appear if the measuring temperature is shown on the measurement display. You can show the manually defined temperature on the secondary display (see Pg 3-2).

When “Measuring Temp Manual” is set, the automatic temperature measurement continues to run and the display, limits, and alarm messages are controlled by the measured value.



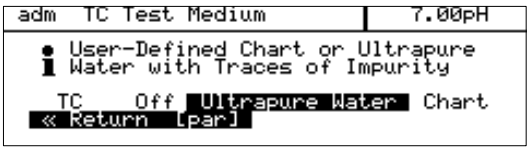
Enter the process temperature:

Measure the temperature of the process medium using a glass thermometer, for example.
or
make sure that the temperature of the process medium is at a constant level, e.g. using a thermostat.

Manual compensation of the calibration temperature should be selected if the temperature probe remains in the process during calibration.

Temperature compensation of the process medium

Ultrapure water



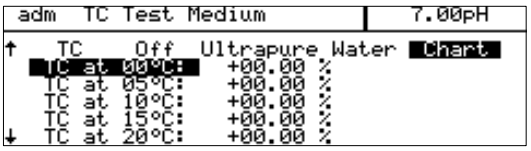
If you measure “ultrapure water with traces of impurities”, the pH value can be correspondingly calculated for the correct temperature.

It is corrected according to the following equation:

pH(25 °C) = pH(T) + corr(T)

pH (25°C)	pH corrected for 25 °C
pH(T)	pH measured at T[°C]
corr(T)	Correction value [pH] from chart

The correction chart stored in the pH Transmitter 2220(X) has been calculated for completely dissociated electrolytes (strong acids and bases) and for the weakly dissociating electrolyte ammonia. This is of special interest for power plant applications where the pH determining substance is mainly ammonia.



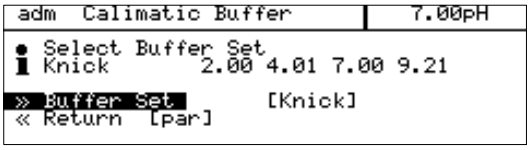
$$pH_{corr} = pH \left(1 + \frac{corr(T)}{100}\right)$$

Chart

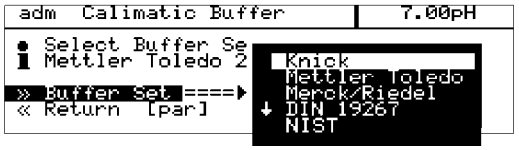
When measuring media with a known temperature behavior, the output pH value can be corrected using a chart.
TC can be entered for temperatures between 0 and +95 °C in 5 °C steps. Then, the output pH value is corrected by the corresponding TC value depending on the measuring temperature. Intermediate values are linearly interpolated. In the case of lower or higher temperatures (< 0 °C or > +95 °C), the last chart value is used for calculation.

If the delta function has been activated (see Pg 4-12) simultaneously with temperature compensation, the temperature is compensated first and then the delta value is subtracted.
When the TC correction for process medium is switched on, “TC” appears in the display in measuring mode.

Calimatic® buffer set



For automatic calibration using Calimatic®, you must define the buffer set you want to use. For calibration, you must then use buffer solutions from this buffer set in any order. The information text shows the selected buffer set with the nominal values of the individual buffer solutions.



The pull-down menu shows all buffer sets available.

For buffer tables, refer to Chap. 11.

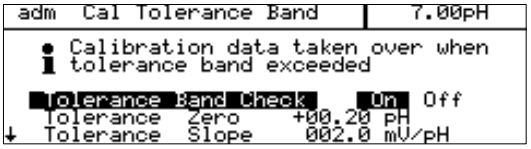
Tolerance band calibration

You can only make use of the tolerance band calibration if your Transmitter is equipped with Option 447 (Tolerance band calibration and tolerance band recorder).

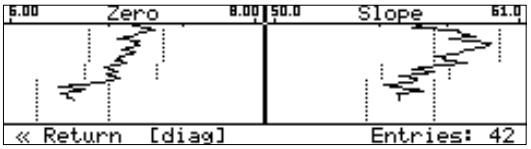
Why tolerance band calibration?

Tolerance band calibration prevents that slight calibration scatter of zero and slope, as usually occurs in practice, immediately leads to a readjustment of the calibration data and thus to a shifting of the measured value. The calibration data are only readjusted if the values lie outside the user-defined tolerance band, i.e. only in the event of significant changes.

Tolerance band calibration and tolerance band recorder

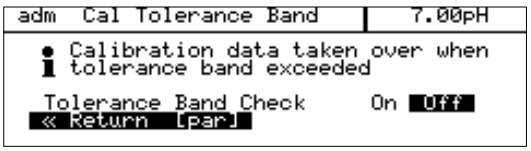


The tolerable error limits are defined for zero point and slope.



The tolerance band recorder graphically depicts the determined calibration data and the selected tolerance bands on the display. Drift due to aging or calibration scatter can be identified at a glance, thus allowing to draw conclusions as to electrode life and the required calibration interval.

If the zero and slope values determined during calibration remain within their tolerance bands, the new data are not stored. The measured value is not adjusted. If one of the calibration values lies outside the tolerance band, **both** values are stored as new calibration data. In the Cal record you can see whether the data have been stored (“New el data”) or whether the old calibration data can still be tolerated (“Old el data”).

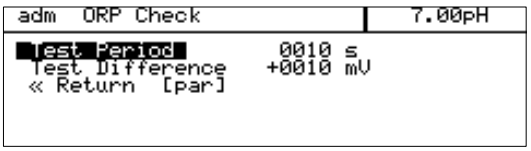


When tolerance band check is switched off, every calibration is accepted directly. There is no tolerance band entry in the Cal record. The tolerance band recorder shows the calibration data without tolerance limits.

If you want to use the Cal tolerance band, but your Transmitter is not equipped with Option 447, you

can retrofit the option. See Release of options on Page 4-33.

ORP check



For ORP measurements, ther is no point in standardizing the electrode. To check the electrode, its running-in behavior is evaluated under defined conditions. To do this, you can enter the test difference and test period parameters.

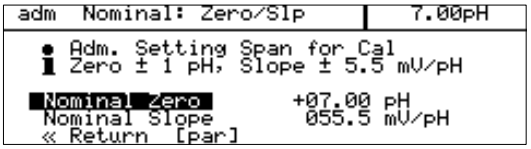
The pH Transmitter 2220(X) allows you to check electrode systems with a reference electrode of the “3 mol/l KCl-Ag/AgCl” type.

The redox buffer solution rH 28.4 (Mettler Toledo, Order Number 20 9881 250) is used as reference solution. If the difference between electrode potential and setpoint of the reference solution falls below the test difference within the preset test period, the electrode is considered stable and checking is terminated.

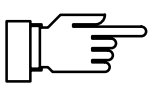
If the electrode only reaches the test difference after the test period has elapsed, the “Warn Sensor Unstable“ warning is generated. If the voltage does not fall below the test difference even after the double test period has elapsed, the “Fail Sensor Failure” message is generated.

Nominal electrode zero point and slope

The Option 356 (integrated as standard in all instruments) allows to define the nominal zero and slope of the electrode if you use electrodes with a zero point other than pH 7.

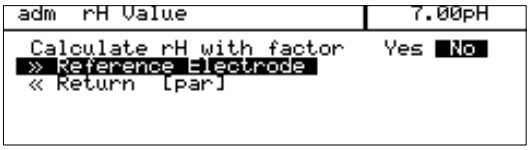


Therefore, automatic calibration using Calimatic® can also be performed for electrodes with a zero point at pH = 4.6, for example.



Calibration is valid if electrode zero deviates by < ± 1 pH and slope deviates by < ± 5.5 mV/pH from the nominal value.

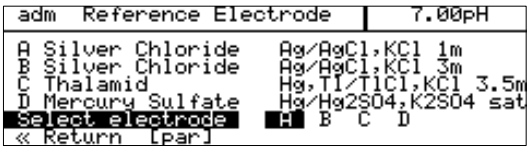
rH measurement



The pH Transmitter 2220(X) calculates the rH value from two separately measured values (pH and ORP).
Although direct calibration of rH measurement is not possible, the pH electrode can be calibrated separately.
You can use a combination electrode for pH measurement. The additionally required metal (platinum) electrode also serves as auxiliary electrode for impedance measurement to permit electrode monitoring (for wiring, see Fig. 2-6 on Pg 2-8).

Calibration is performed with ordinary pH buffer solutions because the additional platinum electrode can be regarded as being calibration-free.

After pH calibration, the pH and rH values can be checked using rH buffer solutions.



In the Parameter Setting menu you can choose between different reference electrodes. Their temperature-dependent reference potentials E_{ref} against standard hydrogen electrode (SHE) are listed in the pH Transmitter 2220(X).

- Silver chloride — Ag/AgCl, KCl 1M
- Silver chloride — Ag/AgCl, KCl 3M
- Thalamid — Hg,Tl/TlCl, KCl 3.5M
- Mercury sulfate — $Hg/Hg_2\ SO_4$, K_2SO_4 sat

Notes on the theory of rH measurement

The **red**uction **ox**idation behavior (redox) of substances in an acqeous solution is correctly described by specifying the potential E_H across a chemically indifferent metallic electrode and the standard hydrogen electrode (SHE), as well as the measuring temperature.
Since ORP (oxidation-reduction potential) is pH-dependent in most cases, you must also indicate the pH value.

The sensing electrode is a chemically non-reactive, electron-sensitive electrode consisting of a noble metal such as platinum.

$E_H = ORP + E_{ref}$

Usually, the SHE is not taken as the reference electrode, but an electrode that is easier to handle, such as an Ag/AgCl electrode. Its temperature-dependent potential E_{ref} related to SHE must be known. It must be added to the measured potential.

Another measure of redox behavior is the **rH value**. It is calculated from the pH value and the so-called pe value, which describes the redox behavior.The pe value is a theoretical auxiliary value calculated by multiplication of E_H with $1/E_N$ (reciprocal of Nernst potential).

The rH value is defined as follows:

$rH = (pe+pH) * 2$ or $rH = (E_H/E_N + pH) * 2$.

The pH Transmitter 2220(X) processes this equation in the following way:

$rH = (((ORP + E_{ref}) / E_N) + pH) * 2 * factor$.

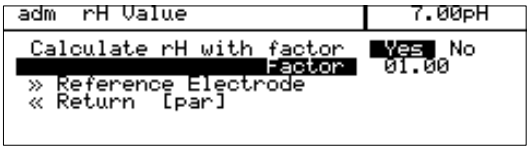
With

ORP:	Potential measured across platinum and reference electrode
E_{ref}:	Listed, temperature-dependent potential of the reference electrode (user-defined) against SHE
E_N:	Nernst potential (temperature-dependent)
pH:	Currently measured pH value
„2“:	Theoretical factor for rH value
Factor:	Additional, empirical factor (user defined, default: 1)

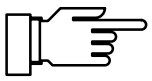
Thus, two potentials across three electrodes are required for rH measurement:
Glass electrode against reference electrode (pH electrode system) and platinum electrode against reference electrode (ORP electrode system).
ORP and pH are combined to form the rH value to obtain a pH-independent measure of redox behavior. However, this is only valid if the following conditions apply, among others:

- Protons play a decisive role in the reaction.
- Preferably exactly one mole of protons is transformed.
- The range of pH variation is as small as possible.

The rH value can be measured “directly” by measuring the potential across a platinum and a glass electrode of a so-called rH electrode system. However, you can calculate neither the pH not the ORP value from this value. Therefore, automatic calculation fo rH as provided by the pH Transmitter 2220(X) should be given preference.

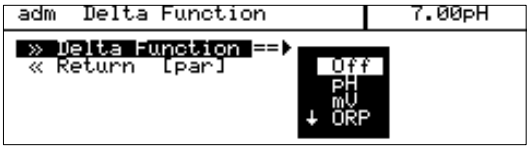


The factor “2” in the equation for determining the rH value results from the fact that an H_2 molecule dissociates into two protons.
The equation also includes a user-defined additional factor for some special empirical measurement procedures used in the chemical production industry.

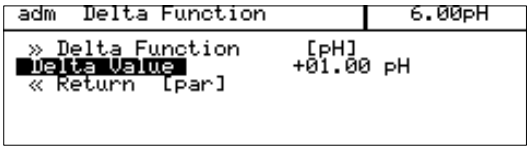


The equation for determining the theoretical rH value only applies if you have set “Calculate rH with factor No” or if you have set the factor to 1 during parameter setting.

Delta function



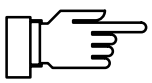
The delta function allows you to calculate and directly display and output differential values for the measured pH, mV, and ORP values.
For example, this is used to directly relate a measured ORP value to a standard hydrogen electrode (see Pg 2-10).



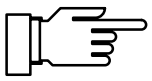
To do this, you must enter a delta value that will be subtracted from the selected process variable.

The delta value to be entered is the temperature-corrected table value multiplied by –1 (sign inverted).

Output value = measured value – delta value

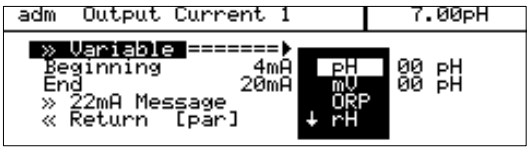


Refer to the table on Page 2-10.



Current outputs, controller, and limit values are driven by the output value. The output value is also shown in the displays. In measuring mode “DELTA” appears on the display.
If temperature compensation has been activated at the same time, the temperature is compensated first and then the delta value is subtracted.

Output 1



Output 1 is galvanically isolated and operates as a current sink for the 4 to 20 mA loop current (supply unit required).
It supplies the Transmitter with power from the loop current and analogously transmits the configured process variable.
The output current can be shown in a secondary display (see Pg 3-2).
The output current can be assigned to one of the following process variables:

- pH value
- Measured mV value
- ORP value
- rH value
- Measured temperature (°C)

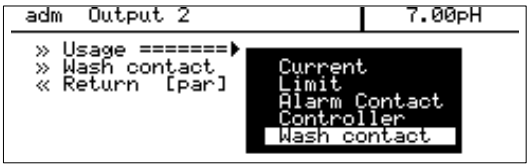
The output current is frozen at its last value:

- during calibration
- in the current source function (manual entry)
- in the "**maint** Meas. Point Maint." menu
- during a wash cycle

Current output 1 can be defined for output of the NAMUR signals Failure, Warning and Functional check (22 mA message).
The output current is then set to 22 mA in the case of a message.
(Also see Alarm processing on Pg 4-24)

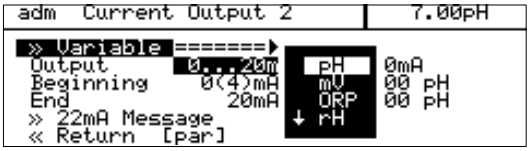
During Multidrop mode of the HART® interface output current 1 is permanently set to 4 mA.
In Multidrop mode the Transmitter momentarily draws a current of approx. 22 mA when switched on.

Output 2



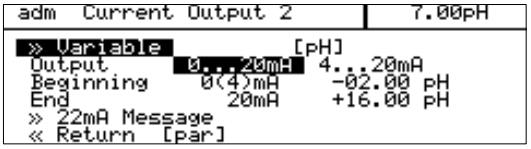
If your Transmitter is equipped with Option 487, you can use an additional output.
The galvanically isolated output 2 also functions as a 0 (4) – 20 mA current sink (supply unit required).
It serves to transmit an additional definable process variable, can be used as a switching output for limits or alarms or as wash contact.
If your Transmitter is also equipped with Option 353 (Controller function), you can use the output as a controller output.

Set as a current output



If output 2 is set as a current output, one of the following process variables can be output:

- pH value
- mV value
- ORP value
- rH value
- Measured temperature

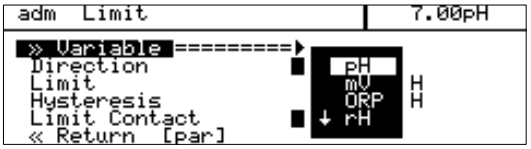


Besides the process variable, you can set the output current (0 – 20 mA or 4 – 20 mA), and the beginning and end of scale.

Current output 2 can be defined for output of the NAMUR signals Failure, Warning and Functional check (22 mA message). The output current is then set to 22 mA in the case of a message.
(Also see Alarm processing on Pg 4-24)

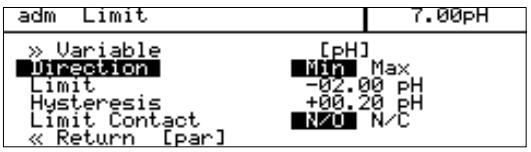
Output 2 is passive. It must be supplied by an additional power supply (e.g. WG 21 isolated supply).

Set as a limit contact



If output 2 is set as a limit contact, it can be controlled by the following process variables:

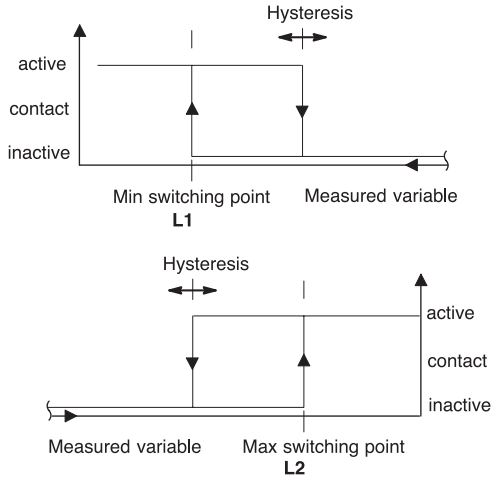
- pH value
- mV value
- ORP value
- rH value
- Measured temperature



You can define the contact as follows:

- The Variable controls the limit contact.

Limits and Hysteresis

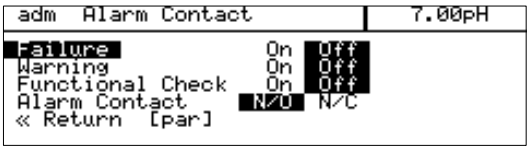


- The Direction
  specifies whether the contact will be activated when the measured value falls below (Min) or exceeds (Max) the limit value.
- The Limit
  defines the switching threshold.
- The Hysteresis
  specifies how far the measured value must fall below (Max) or exceed (Min) the limit value before the contact switches back.
- N/O or N/C contact
  specifies whether the active contact is closed (N/O) or open (N/C).

When the measured value falls below or exceeds the set limit, “Limit” appears in the display.
Output 2 is active.

During calibration the limit contact is inactive!
During sample calibration the “Limit” display is covered up by “Sample”!

Set as an alarm contact



The alarm contact is used to output the NAMUR signals Failure, Warning, and Functional check. These are triggered by alarm processing.
You can choose between a normally-open and a normally-closed contact. (Also see Alarm processing on Pg 4-24)

Set as a controller

You can only make use of the controller function if your Transmitter is equipped with Option 353.

You can choose between a digital (time-proportioning) controller and an analog PI controller. The controller can only operate unilaterally because only output 2 is available for outputting the manipulated variable. Therefore, you must select the range in which the controller is to operate:

- Range below setpoint: 0 ... +100 %
- Range above setpoint: 0 ... –100 %

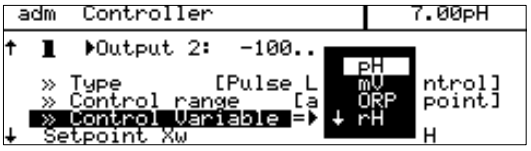
The controller only operates bilaterally when actuating a 3-way mixing valve.

For a pure P controller (reset time = 0), you only need to define the control range used. For the range not used, however, it is necessary to enter reasonable parameters as otherwise the error message “Warn Control Para” will be output.

When using the controller as a PI controler (reset time ≠ 0), it is absolutely necessary to define the unused range. The manipulated variable (controller output) is influenced by both control ranges due to the integration time.

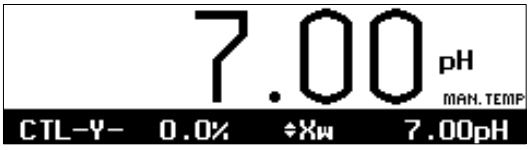
The following four controller types are available:

- Pulse frequency controller (digital)
- Pulse length controller (digital)
- 3-way mixing valve (analog)
- Straightway valve (analog)



The following **controlled variables** can be defined:

- pH value
- mV value
- ORP value
- rH value
- Measured temperature (°C)



The current value of the controller output (CTL-Y [%]) and the controller setpoint (X_w) can be shown in the secondary display in measuring mode.

With the definable **feed time alarm**, you can monitor the time during which the controller output is at +100 % or –100 %, i.e. how long the valve is fully open.

If this time is exceeded, this may be due to a shortage of feed chemical or a defective valve, for example.

Control characteristic

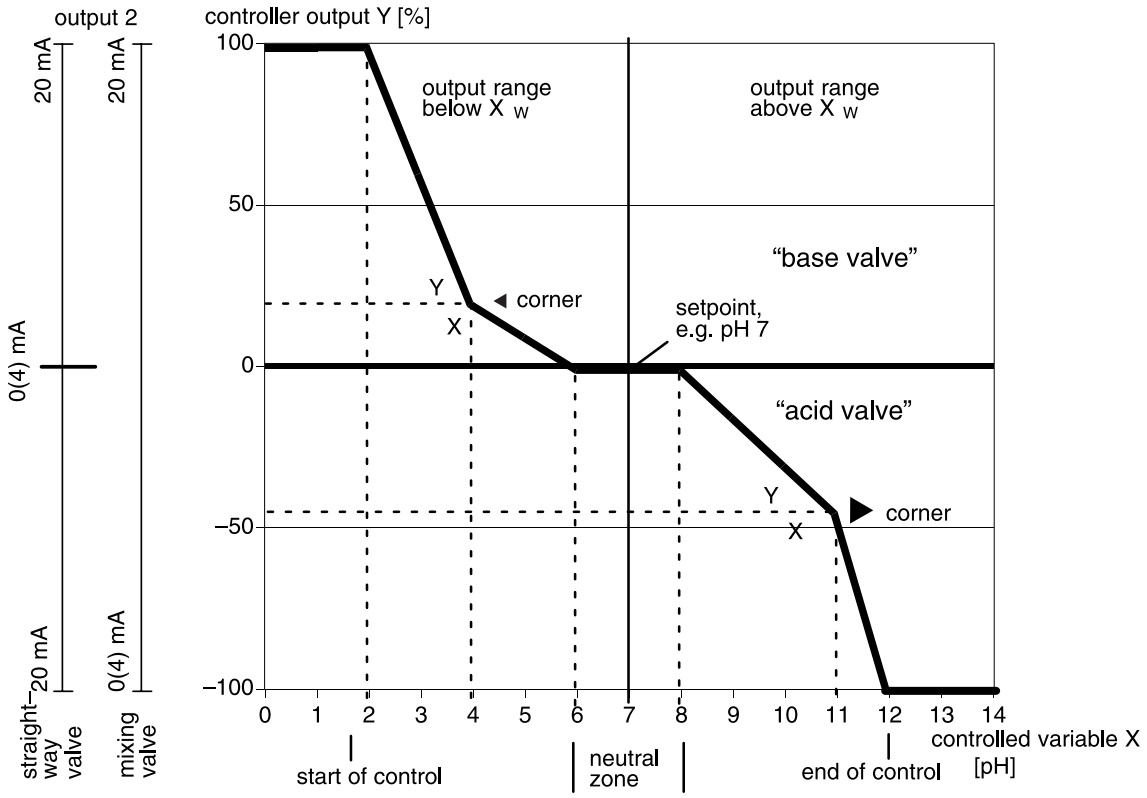


Fig. 4-1 Control characteristic

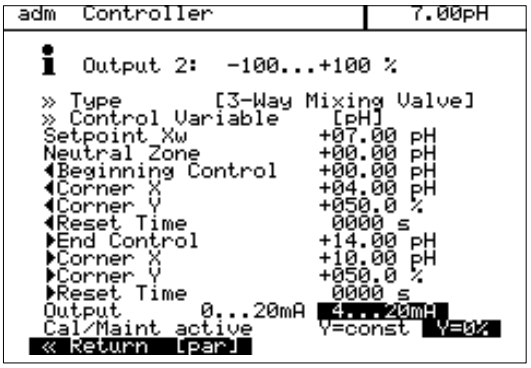


Fig. 4-1shows the characteristic of the controller in the pH Transmitter 2220(X). All points of the curve can be defined.

- The control range specifies the range in which the controller is active: above or below the setpoint X_W (not for 3-way mixing valve).
- Values are adjusted toward the setpoint.
- Beginning of control and
- End of control
  define the control range.
  Outside the control range the controller output remains at +100 % or -100 %.
- In the neutral zone no control takes place.
  The neutral zone is symmetrical to the setpoint and its width can be defined.

- With corner X and corner Y you can define a corner point for each control range (◀ : controlled variable < setpoint and ▶ : Controlled variable > setpoint). This allows you to define two different slopes to obtain an optimal control characteristic for strongly nonlinear titration curves, for example.
- The reset time specifies the I-action component of the controller. If you set " Reset Time 0000 s", the I-action component is turned off. The reset time can be defined separately for both control ranges (◀ : controlled variable < setpoint and ▶ : Controlled variable > setpoint).
- With Cal/Maint active, you select whether the controller output is frozen at its last value (Y = const) or whether it goes to 0 % (Y = 0 %) during calibration and maintenance.

For test purposes, you can manually enter the controller output Y in the Maintenance menu (see Pg 7-3).

Controller output (manipulated variable)

The manipulated variable is output via output 2. For the pulse length or pulse frequency controller or for control with an analog straightway valve, you must select the output range:

- Control range below setpoint X_W:
  Controller output range0 to +100 %
  corresponding to [0 (4) to 20 mA]
- Control range above setpoint X_W:
  Controller output range0 to -100 %
  corresponding to [0 (4) to 20 mA]

With the 3-way mixing valve, output 2 operates over the entire control range:

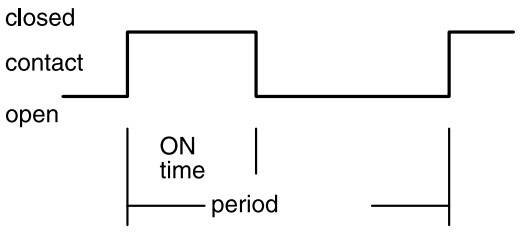
- Y = –100 to +100 %
  corresponding to [0 (4) to 20 mA]

When set as a digital controller, output 2 is used as a contact. It can be used, for example, to control valves or metering pumps. Contact ON time or switching frequency vary in accordance with the controller output.

When set as an analog controller, output 2 is used as a current output, either 0 to 20 mA or 4 to 20 mA. The valve type determines the behavior of the output current. You can choose between a 3-way mixing valve or a straightway valve.

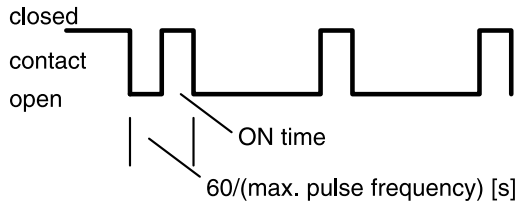
The current controller output and the setpoint can be shown in the secondary display (see Pg 3-2).

Pulse length controller



The pulse length controller is used to operate a valve as an actuator.
It switches the contact on for a time that depends on the controller output.
The period is constant.
A minimum ON time is maintained even if the controller output takes corresponding values. This allows, for example, to take the reaction time of a valve into consideration.
If you set the minimum ON time to 0, the actual minimum ON time will be 0.25 sec for technical reasons.

Pulse frequency controller

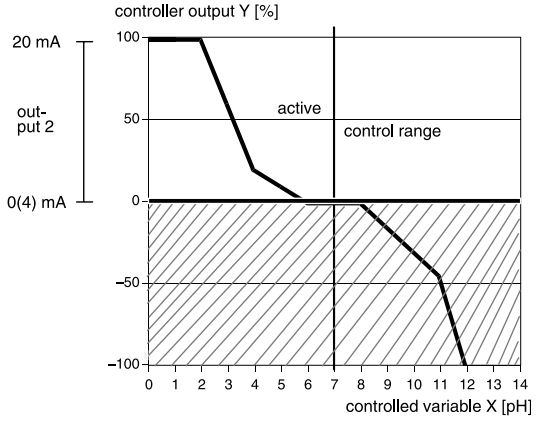


The pulse frequency controller is used to operate a (frequency-controlled) metering pump as an actuator.
It varies the frequency with which the contacts are switched on.
The maximum pulse frequency [pulses/min] can be defined. It depends on the metering pump used.
The maximum value to be entered is 120 pulses/min.
The Contact ON time is constant.
It is automatically calculated from the user-defined maximum pulse frequency:

ON time [s] =
30 / max. pulse frequency [pulses/min]

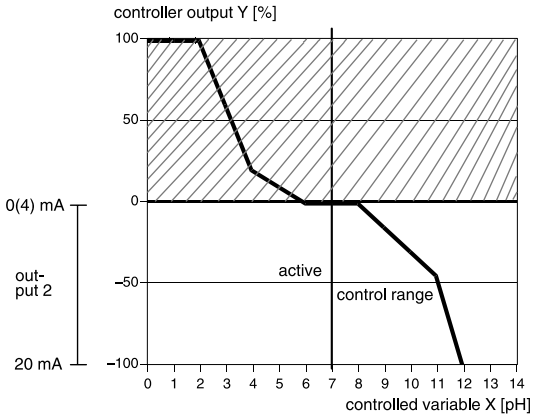
Straightway valve

In the straightway valve mode an analog control valve is actuated with 0 (4) to 20 mA.
You define the output range in the Parameter Setting menu.



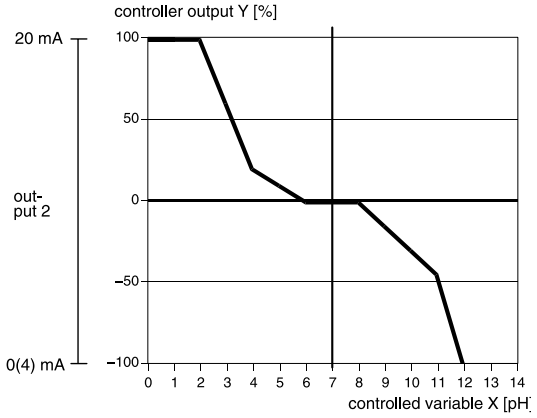
Output range below setpoint X_W

For the straightway valve, the analog controller output operates in the manipulated variable range 0 to +100 %.
with +100 % corresponding to a current of 20 mA.
The controller only outputs the manipulated variable below the setpoint. Above the setpoint the manipulated variable cannot be output and the output remains at 0 (4) mA.



Output range above setpoint X_W

For the straightway valve, the analog controller output operates in the manipulated variable range 0 to -100 %.
with –100 % corresponding to a current of 20 mA.
The controller only outputs the manipulated variable above the setpoint. Below the setpoint the manipulated variable cannot be output and the output remains at 0 (4) mA.



3-way mixing valve

For the 3-way mixing valve, output 2 is used for the entire control range. A controller output Y = 0 % then corresponds to a current of 10 or 12 mA, resp.

Error messages for controller settings

The controller will be switched off (manipulated variable Y = 0 %) and the alarm message “Warn Control Para” will be activated if any of the following conditions applies:

All controller types:

- Beginning ≥ setpoint – neutral zone / 2
- ◀ Corner X < beginning
- ◀ Corner X > setpoint – neutral zone / 2
- End ≤ setpoint + neutral zone / 2
- ▶ Corner X < setpoint + neutral zone / 2
- ▶ Corner X > end
- ◀ Corner Y>100 %
- Neutral zone < 0
- ▶ Corner Y>100 %

Pulse length controller only:

- ◀ Period < min. ON time x 2
- ▶ Period < min. ON time x 2

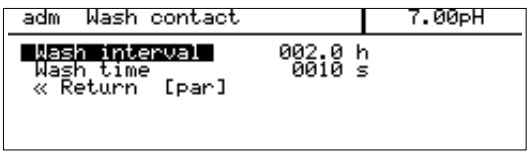
Pulse frequency controller only:

- Max. pulse frequency ≤ 0 pulses/min
- Max. pulse frequency > 120 pulses/min

With the definable feed time alarm (see Pg 4-22) you can monitor the time during which the controller output is at +100 % or –100 %, i.e. how long the valve is fully open. If this time is exceeded, this may be due to a shortage of feed chemical or a defective valve, for example.

Set as a wash contact

If output 2 is set as a wash contact, the electrode can be automatically cleaned using an appropriate probe.

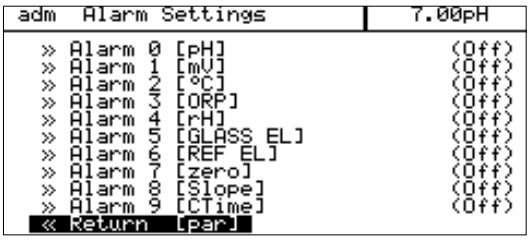


Wash interval and wash time are freely definable. If either of the two parameters is set to 0, the function is disabled.

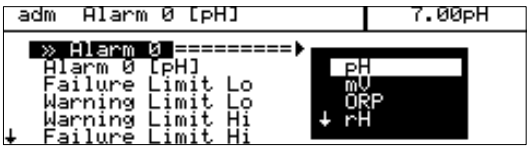
During calibration and maintenance a wash interval is not started.

During the wash time the NAMUR Functional Check signal is active, the output currents are frozen at their last values or set to 22 mA.

Alarm settings



The pH Transmitter 2220(X) allows you to monitor up to 10 different measured values by warning and failure messages. These alarms are numbered from 0 through 9. For each alarm, you can separately define the process variable and the high and low limits for warning and failure messages. In addition, each alarm can be switched on or off. The alarm limits remain stored even when the alarm is switched off.

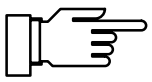


You can set warning and failure limits for each of the following process variables:

- pH value
- Measured mV value
- Measured ORP value
- Measured temperature
- Reference electrode impedance
- Glass electrode impedance
- rH value
- Electrode zero point
- Electrode slope
- Feed time (controller output at ±100%) (only with controller enabled)
- Cal timer

You can define four independent alarm limits for each of these variables (except cal timer and feed time):

- Failure Limit Lo
  If the measured value falls below this limit, the NAMUR “Failure” contact will be activated, the display will read “FAIL”.
- Warning Limit Lo
  If the measured value falls below this limit, the NAMUR “Warning” contact will be activated, the display will read “WARN”.
- Warning Limit Hi
  If the measured value exceeds this limit, the NAMUR “Warning” contact will be activated, the display will read “WARN”.
- Failure Limit Hi
  If the measured value exceeds this limit, the NAMUR “Failure” contact will be activated, the display will read “FAIL”.



You can view the currently active alarm messages in the “Message List” of the Diagnostics menu (see Pg 6-1).

Alarm processing / NAMUR signals

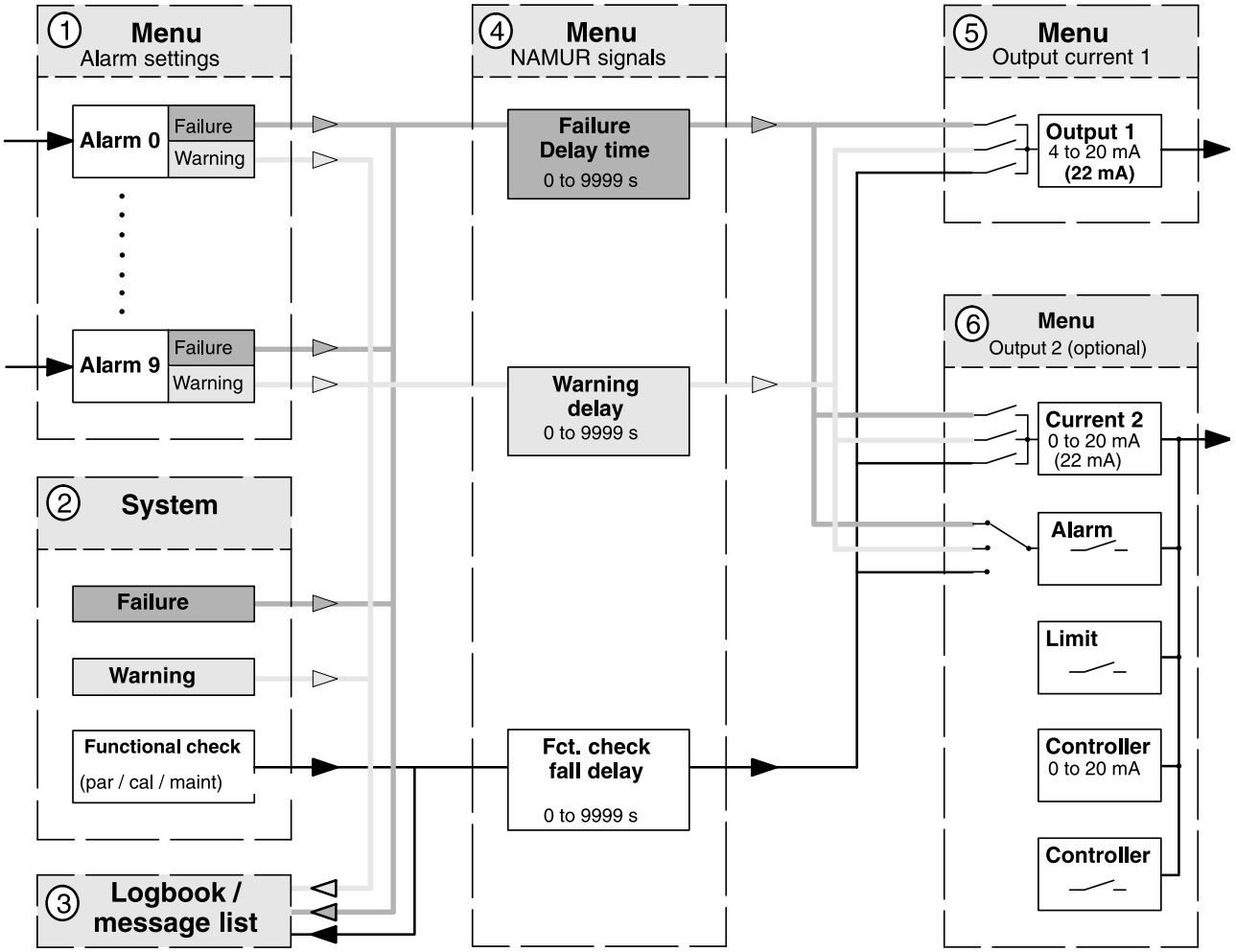
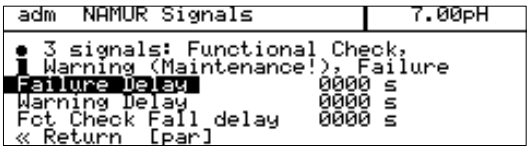


Fig. 4-2 Alarm processing

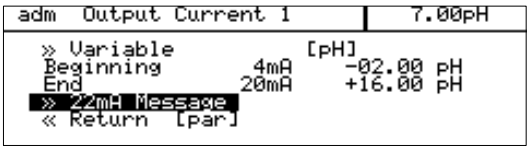
The defined alarms 0 to 9 ① and the system ② generate the NAMUR signals Failure and Warning. In addition, the system ② also generates the Functional Check signal during parameter setting, calibration, and maintenance.

These signals are immediately entered in the message list and logbook ③ (Opt. 354).

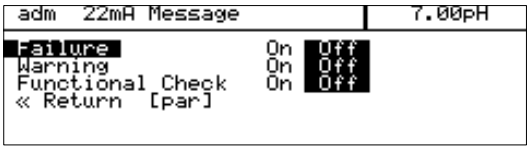


In the NAMUR Signals menu ④ , you can define individual delay times for these messages.

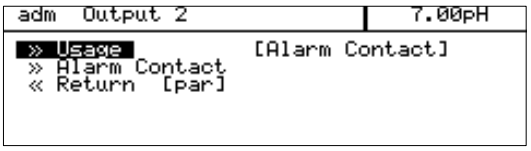
For functional check, the defined delay time acts as a fall delay!
This has the advantage that, for example, any temperature or measurement settling times following an electrode calibration can be bridged with a correspondingly defined fall delay time.



The messages can be output via output current 1 ⑤ or output 2 ⑥ (if current 2 is active) as a 22 mA signal.

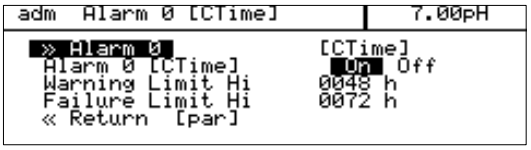


To do so, all three messages can be activated separately or in any combination in the 22 mA Message submenu.



If output 2 is set as an alarm contact, it can be used to output these messages. In this menu the alarm contact can be set as a normally open or a normally closed contact.

Cal timer



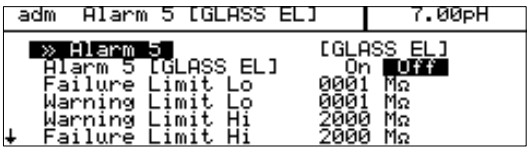
The cal timer allows you to monitor whether the electrode is calibrated regularly.
The cal timer counts the time passed since the last calibration. When the preset time is reached, a message is released.
In the “Alarm Settings” menu you can preset one interval each for a warning and a failure message.

The cal timer count can be shown in the secondary display (see Pg 3-2).

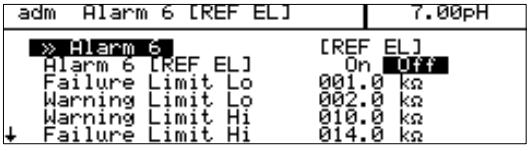
Sensocheck® electrode monitoring

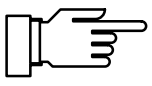
Sensocheck® electrode monitoring measures the impedance of the glass electrode and of the reference electrode. This measurement takes place continuously together with pH measurement.

The electrode impedance values are a good measure of the condition of the electrodes, contamination (of the reference electrode), glass breakage (of the glass electrode), aging, and open circuit conditions.



The absolute electrode impedance values considerably depend on the manufacturer and type.Therefore, you must take a new electrode to determine the desired values for the electrode in use. To do so, you can assign the values for the glass and reference electrode impedance to the secondary displays (see Pg 3-1) or take them from the data listed in the calibration record (see Pg 6-1).
In the “Alarm Settings” menu you define the limits for warning and failure messages. If the value for the glass or reference electrode impedance exceeds such a preset limit, a warning or a failure message will be activated.





Glass electrode impedance above upper limit: cable broken or electrode dry.
Glass electrode impedance below lower limit: glass broken.
Reference electrode impedance above upper limit: reference electrode dirty.
Reference electrode impedance below lower limit: short circuit.

The glass electrode and the reference electrode impedances can be shown in the secondary display (see Pg 3-2).

Information on impedance measurement

To ensure correct monitoring of the glass electrode impedance, you must connect the electrode using suitable cables with a sufficiently low cable capacitance.

Electrode monitoring is not possible when using a pH isolation amplifier!

The electrode impedance values are measured dynamically at a low AC voltage. The resulting values for the glass electrode impedance are approximately 0.8 times the values from static measurement according to IEC 746 Part 2.
The capacitance of the electrode cable does not influence the measurement as long as it does not exceed a value of 2 nF (corresponding to a cable length of approx. 20 m). As the low value of the reference electrode impedance can only be detected via the measuring electrolyte, the intrinsic conductivity if the electrolyte influences total impedance measured. Therefore, the resulting impedance values may be substantially higher than when measuring according to IEC 746 Part 2.

If you use a reference electrode with a very low resistance (< 100 Ω), you can connect a 100 Ω resistor in series so that the measurement range for the pH Transmitter 2220(X) will not be exceeded.

The impedance values are continuously evaluated by calculating a mean value after several messages. If the alarm window (defined by a minimum and a maximum value) is exceeded, a warning or failure message will be activated. Since the electrode impedance values – especially the glass membrane impedance – are temperature-dependent, they are calculated for a reference temperature of 25 °C. This allows you to display and evaluate comparable impedance values even with strongly varying measuring temperatures. It also makes it easier to define appropriate ranges for electrode monitoring.

HART® Communication

With Option 467 “HART® Communication” you can, for example, communicate with the pH Transmitter 2220(X) via the loop current using a handheld terminal or from the control room. Device data, measured values, and messages can be retrieved. The pH Transmitter 2220(X) can be addressed from the master in two different ways: via a long, permanent address, which is unique world-wide, or via a selectable short address.

Device address

The device address is unique world-wide for each device. It is composed of the manufacturer ID, the device type and the serial number.

Short address

The short address has two functions. You select the address 00 for a **point-to-point connection.** The output current then continues to be controlled by the measurement signal.

In the **bus mode** (multidrop) each connected device must have a unique short address. The addresses 01 to 15 are used for this purpose. All devices supply a constant 4 mA at the current output. The data are transmitted completely via the HART® signal.

Write protection

The write protection protects the settings from being changed via the HART® interface. The write protection can only be switched on or off via the menu.

When activated, the write protection also prevents the short address from being changed with the HART® commands.

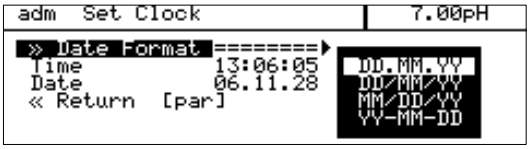
You can select the short address of the Transmitter and activate or deactivate the write protection. From pull-down menus, you can select the respective process variables for the HART® “Secondary Variable”, “Tertiary Variable” and “4th Variable”. The “Primary Variable” is always assigned to the process variable of output current 1.

The selected process variables can be read out with the HART® command #3 (Read Dynamic Variables and P.V. Current). This allows to transmit and evaluate up to four process variables using standard HART programs (without Device Description).

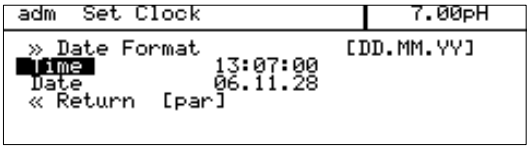
HART® commands

A list of the HART® commands for the pH Transmitter 2220(X) can be found in the enclosed „Process Unit 77 ... Transmitter-Specific Command Specification" (with Option 467 only).

Setting the clock

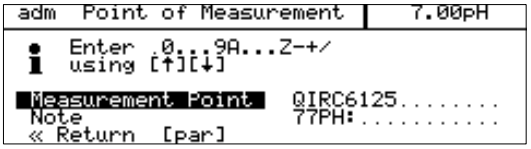


In the Date Format pull-down menu, you can select the desired type of display.



On pressing **enter**, the clock starts running at the entered value.
Pressing **par** cancels the entry (Undo). The clock then keeps the old time.

Point of measurement/note

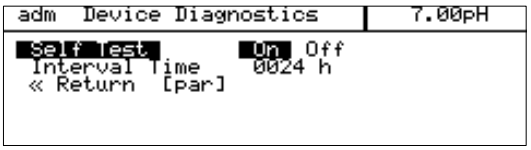


In the Point of Measurement menu, you can specify the point of measurement according to DIN 19227 (ISO 3511) by entering a tag number. In addition, you can enter a note.
Each entry may be up to 16 characters long.
In measuring mode, there is a display with the tag number or note beneath the secondary displays.
Pressing **enter** switches between the displays.

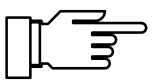
With the "HART® Descriptor" you can, for example, enter operating instructions as a note, which is then shown in the display. With HART® communication, only the first 8 characters of the tag number are used (HART® Specification).

Device	HART®	Character length
Meas. point	TAG	16 (HART®: 8)
Note	DESCRIPTOR	16
–	MESSAGE	32

Device diagnostics



The pH Transmitter 2220(X) can perform an automatic self test (memory test) at regular intervals. In the case of a defective memory, the "Warn Device Diagnostics" message is output.
The automatic self test is only carried out when the Transmitter is in measuring mode and the interval time is not set to 0000 h. During the testing, measurement is countinued in the background. All outputs remain active.



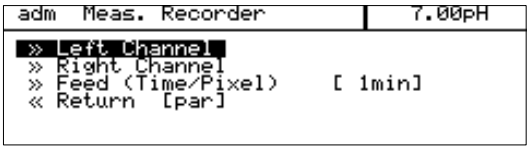
The device tests can be executed manually in the "Device Diagnostics" menu. The respective results are displayed (see Pg 6-4).

Measurement recorder

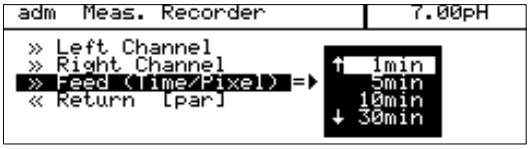
If you want to use the measurement recorder, but your Transmitter is not equipped with Option 448, you can retrofit the option. See Release of options on Page 4-33.

“On-site recorder”

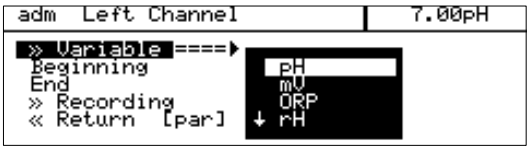
For process visualization or, for example, for controller optimizing, the measurement recorder continuously registers two user-defined process variables and simultaneously displays them graphically next to each other in the system display.
Process variable, measurement range, recording method and time feed (scanning interval) parameters can be set within broad limits. The last 500 measured values are available with time and date in the form of a graph and as numerical values.



The measurement recorder can be adjusted like an ordinary recorder: The right and left channel can be separately defined. The feed (scanning interval) applies to both channels.

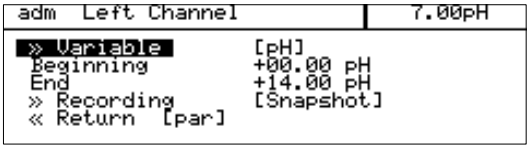


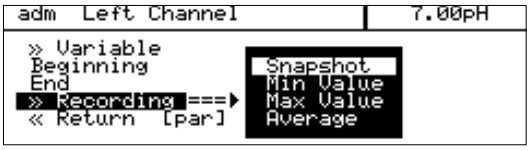
You can choose feed rates from 2 seconds up to 10 hours per recorder entry. With a rate of 2 seconds, the recorder shows the data of the last 16 minutes, with a 10 hour rate, it shows the data of the last 7 months.



Right and left channel:
Select the controlling process variable from the Variable pull-down menu.
The following process variables are available:

- pH value
- mV value
- ORP value
- rH value
- Measured temperature (°C)
- OUTP1 Output current 1
- OUTP2 Output current 2 (with Option 487 and output current 2 activated)
- REF-EL Reference electrode impedance
- GLASS-EL Glass electrode impedance





Beginning and End define the recorder range. These value only refer to the graphic representation in the display. All measured values are stored with their complete number of digits.

In the Recording pull-down menu, you can choose between four methods:

- **Snapshot**
  The currently measured value is recorded after expiration of the feed time.
- **Min Value**
  Each measured value is checked in the measurement recorder. The lowest value within the feed time is entered in the recorder memory.
- **Max Value**
  Each measured value is checked in the measurement recorder. The highest value within the feed time is entered in the recorder memory.
- **Average**
  The measurement recorder calculates a mean value of all values measured, i.e. the value entered in the recorder memory is the arithmetical average of all values measured within the feed time.
  Since the measured pH is a logarithmic entity, it is only partly suitable for averaging.

Passcode entry

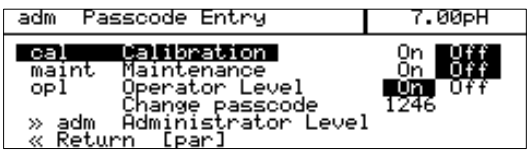
Access to the Calibration and Maintenance menus and to parameter setting at the Operator and Administrator levels can be protected with passcodes. You can set or disable each passcode individually (the Administrator passcode cannot be disabled).

When a passcode is disabled, there is no protection against unauthorized access to the corresponding menu!

For safety reasons, you should not use the standard passcodes!

The factory-set passcodes are the same for all Transmitters. Therefore, you should define your own passcodes.

The “Change passcode” line only appears when a passcode is enabled. The passcode remains stored even if it has been disabled.

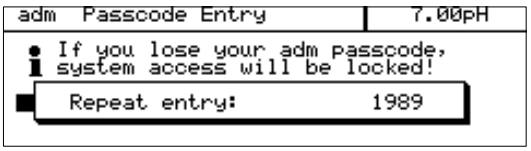


Setting the Administrator passcode

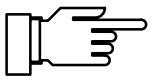
If the Administrator passcode is lost, system access is locked! The Administrator level cannot be accessed for parameter setting.
All menu items locked for the Operator level can no longer be edited.

In this case, please contact:

Mettler-Toledo GmbH
Hotline
Im Hackacker 15
8902 Urdorf/Switzerland
Phone: +41-1-736 22 14
Telefax: +41-1-736 26 36



After having entered the Administrator passcode, you are prompted to repeat the input for safety reasons.
If the second entry does not correspond to the first entry or if you cancel by pressing **par** , the Administrator passcode will not be changed.



When you set the Administrator passcode to “0000”, the Administrator level can be accessed without passcode entry by pressing **enter** at the passcode prompt.

When you set the Administrator passcode to “0000”, menus and device settings will not be protected against unauthorized access!
Improper changing of the device settings may lead to malfunctions of the pH Transmitter 2220(X) and to incorrect measured-value outputs!

Factory-set passcodes

As delivered, the following passcodes are set in the pH Transmitter 2220(X):

- Calibration passcode: 1147
- Maintenance passcode: 2958
- Operator passcode: 1246
- Administrator passcode: 1989

Release of options

You can retrofit software options at any time on the site without dismantling the Transmitter. To do so, you require a device-specific, unique transaction number (TAN).

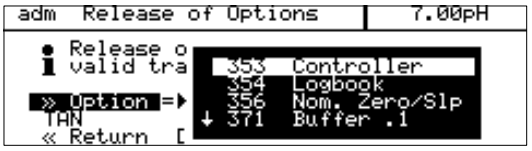
To release an option, you require:

- the desired option number,
- the model designation (pH Transmitter 2220(X))
- and the serial number of your Transmitter.

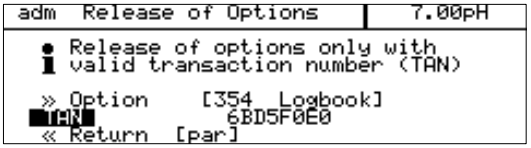
Please refer to the Diagnostics/Device Description menu (see Pg 6-4) for this information. The price of the option depends on the currently valid price list. A list of available options is provided on Page 9-1.

The transaction number (TAN) can be obtained from your Mettler Toledo representative.

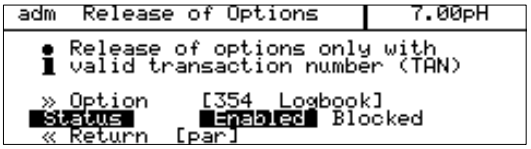
Option release with transaction number (TAN): Contact the address above specifying the option number, model designation and serial number.



1. Select the desired option from the Option pull-down menu.



2. Enter the transaction number you have received and confirm your entry by pressing **enter**.



3. With the correct TAN you can enable or disable the option. The transaction number can be used repeatedly with this pH Transmitter 2220(X) to enable or disable the option at any time.

This page has been left empty for technical reasons.

5 Calibration

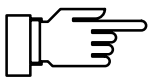
Why do you have to calibrate?

Every **pH electrode** has its individual **zero point** and its individual **slope**. Both values are altered by aging and wear. For sufficiently high accuracy of pH measurement, the Transmitter must be regularly adjusted for the electrode data (calibration). The pH Transmitter 2220(X) corrects the voltage delivered by the electrode with regard to electrode zero and slope and displays it as the pH value.

For calibration, the electrode is immersed in (one or two) **buffer solutions** whose pH value is exactly known. The pH Transmitter 2220(X) measures the voltages from the electrode and the buffer solution temperature and automatically calculates the electrode zero and slope.

Without calibration every pH meter delivers an imprecise or wrong output value!
Especially after replacing the electrode, you must perform a calibration!

Monitoring functions for calibration

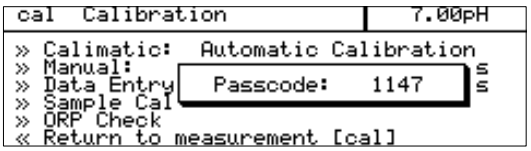


The pH Transmitter 2220(X) provides functions for monitoring proper calibration performance and the electrode condition. This allows documentation for quality management to ISO 9000 and **GMP**.

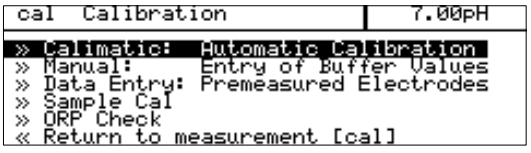
- Sensocheck® monitors the electrode condition by measuring the glass and reference electrode impedance (see Pg 4-26).
- Regular calibration can be monitored by the **cal timer** (see Pg 4-26).
- The **calibration record** provides all relevant data of the last calibration (GMP) (see Pg 6-1).
- The **electrode statistics** show the behavior of the electrode parameters during the last three calibrations compared to the **First Calibration** (see Pg 6-2).

- **Tolerance band calibration** (Option 447) prevents that slight calibration scatter of zero and slope, as usually occurs in practice, immediately leads to a readjustment of the calibration data and thus to a shifting of the measured value. The calibration data are only readjusted if the values lie outside the user-defined tolerance band, i.e. only in the event of significant changes (see Pg 4-8).
- The **tolerance band recorder** (Option 447) graphically depicts the determined calibration data and the selected tolerance bands on the display. Drift due to aging or calibration scatter can be identified at a glance, thus allowing to draw conclusions as to electrode life and the required calibration interval (see Pg 6-3).
- The **logbook** provides time and date stamped records of calibrations performed within the last 200 events (see Pg 6-4).
- You can define limits for **warning** and **failure messages** for the electrode slope and zero point (see Pg 4-22). This permits automatic monitoring of the electrode state and aging using the calibration data.

Calibration menu

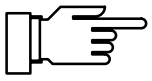


If calibration is protected with a passcode, you must enter the correct passcode to access the Calibration menu.
The calibration passcode can be defined or disabled at the Administrator level (see Pg 4-31).

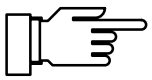


Five different calibration methods are available:

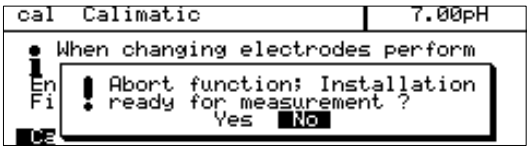
- Automatic buffer recognition by Calimatic®
- Manual entry of buffer values
- Entry of previously measured calibration data
- Calibration with sampling
- ORP check



When you activate the Calibration menu, the Transmitter automatically proposes the previous calibration method.



After passcode entry, the NAMUR functional check signal is active, the output currents are frozen at their last values or set to 22 mA, the limit contact is inactive, the controller output can either be frozen or set to zero (see Pg 4-18), a wash interval is not started.



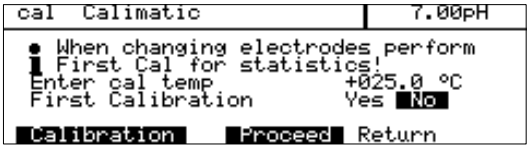
If you press **meas** before calibrating with the first buffer, you are asked whether you really wish to abort calibration.

If you abort, the old calibration data remain valid.

If you press **meas** after having calibrated with the first buffer, you are asked again whether you really wish to abort calibration.

If you abort, the new zero point is valid but the previous slope value is retained.

What does “First Calibration” mean?



During first calibration, the electrode data are stored as reference values for electrode statistics.

The “Electrode Statistics” Diagnostics menu shows the deviations of zero, slope, glass and reference electrode impedances of the last three calibrations with respect to the reference values of the first calibration. This allows evaluation of the drift behavior and aging of the electrode.

When do you have to perform a First Calibration?

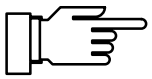
Each time you replace the electrode, you must perform a First Calibration! The tolerance band recorder (Opt. 447) is reset with every First Calibration. This prevents confusion between the data of the old and new electrodes.

Temperature detection during calibration

Why temperature compensation?

There are two important reasons for determining the temperature of the buffer solution:

- The slope of the pH electrode is temperature-dependent. Therefore the measured voltage must be corrected by the temperature influence (Nernst equation).
- The pH value of the buffer solution is temperature-dependent. For calibration, the buffer solution temperature must therefore be known in order to choose the actual pH value from the buffer table.



During parameter setting you define whether cal temperature is measured automatically or must be entered manually (see Pg 4-5).

Automatic temperature compensation

For automatic temperature compensation, the pH Transmitter 2220(X) detects the cal temperature with a temperature probe (Pt 100 / Pt 1000 / NTC 30 kΩ).

If you work with automatic temperature compensation during calibration, a temperature probe connected to the temperature input of the pH Transmitter 2220(X) must be in the buffer solution. Otherwise, you must select manual entry of calibration temperature.

When “Cal Temp automatic” is set, “Measured Cal Temp” appears in the menu.
When “Cal Temp manual” is set, “Enter Cal Temp” appears in the menu.

One-point or two-point calibration?

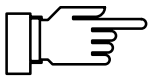
For the calibration methods

- Automatic calibration with Calimatic®
- Calibration with manual entry of buffer values

you can choose between one- and two-point calibration.

Two-point calibration

The electrode is calibrated with two buffer solutions. This allows you to determine the zero and slope of the electrode.

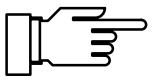


Two-point calibration is required if

- the pH value fluctuates considerably,
- there is great difference between the measured pH value and the electrode zero,
- the pH measurement must be very accurate or
- the electrode is subject to extreme wear.

One-point calibration

The electrode is calibrated with one buffer solution only.
Thus, only the zero point of the electrode can be determined and taken into account by the pH Transmitter 2220(X).



One-point calibration is appropriate and permissible whenever the measured values lie near the electrode zero point so that slope changes do not have much of an impact.

Automatic calibration with Calimatic®

Automatic calibration using Calimatic® is performed with one or two buffer solutions.
After immersion of the electrode in the buffer solution, the pH Transmitter 2220(X) automatically detects the nominal buffer value on the basis of the electrode potential and the measured temperature.
Any sequence of buffer solutions is possible, but they must belong to the **buffer set** (see Pg 4-7) defined during parameter setting.
The Calimatic® takes the temperature dependence of the buffer value into account.

All calibration data is converted using a reference temperature of 25 °C.
During calibration, the NAMUR functional check signal is active, the output currents are frozen at their last values or set to 22 mA, the limit contact is inactive, the controller output can either be frozen or set to zero (see Pg 4-18), a wash interval is not started.

Calibration of electrodes with a zero point other than pH 7

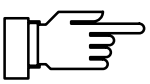
The Option 356 (integrated as standard in all instruments) allows to define the nominal zero and slope of the electrode (see Pg 4-9).

Therefore, automatic calibration using Calimatic® can then also be performed for electrodes with a zero point at pH = 4.6, for example.

Calibration is valid if electrode zero deviates by < ± 1 pH and slope deviates by <± 5.5 mV/pH from the nominal value.

What you have to know for calibration

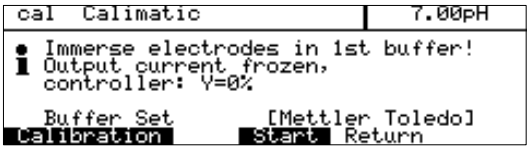
Only ever use fresh, undiluted buffer solutions!
Buffer solutions must belong to the selected buffer set (see Pg 4-7)!



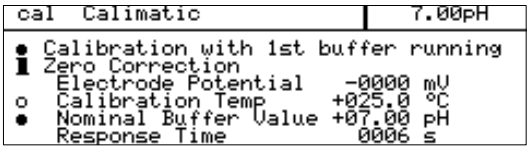
For measurement of reference electrode impedance (jumper removed from terminal 3 and 4), the buffer solution must be electrically connected to terminal 4 during calibration.

To do so, immerse an auxiliary electrode in the buffer solution and connect the auxiliary electrode to terminal 4.

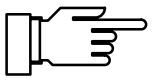
Calibration sequence



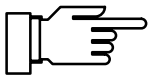
Remove the electrode and immerse it in the first buffer solution. Start calibration.



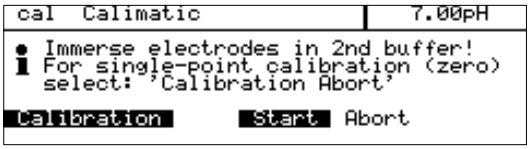
When the pH Transmitter 2220(X) has recognized the buffer solution, its nominal value is displayed. From the **response time**, you see how much time the electrode needs for the measured value to stabilize.



You can press **cal** to reduce the waiting time before stabilization of the measured value. However, this reduces the accuracy of the calibration values!

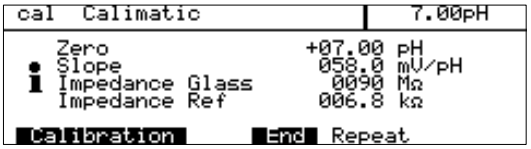


If the electrode potential or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min.

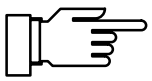


Rinse the electrode thoroughly. For a two-point calibration, immerse the electrode in the second buffer solution and start the second calibration step. Calibration is performed with the second buffer.

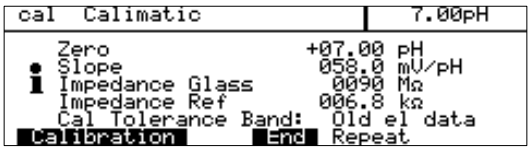
For one-point calibration, install the electrode and select “Calibration Abort” to exit the menu.



When calibration has been successfully completed, the electrode data is displayed.
In the case of a calibration error an error message is displayed. The calibration must then be repeated.



If your Transmitter is equipped with Option 447, each calibration is entered in the tolerance band recorder (see Pg 4-8).

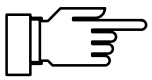


With Option 447 and cal tolerance band enabled, calibration data is not accepted from every calibration. The “Cal Tolerance Band” line informs you whether the tolerance limit has been exceeded and the calibration data has been accepted (“New el data”) or whether calibration data has not been accepted because it is within the tolerance band (“Old el data”).

Calibration with manual entry of buffer values

Calibration with manual entry of buffer values is performed with one or two buffer solutions.

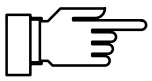
The pH Transmitter 2220(X) displays the measured temperature after the electrode has been immersed in the buffer solution.
You must then enter the temperature-corrected buffer values. To do so, refer to the buffer table (e.g. on the bottle) and enter the buffer value belonging to the displayed temperature. Intermediate temperature values must be interpolated.



All calibration data is converted using a reference temperature of 25 °C.
During calibration, the NAMUR functional check signal is active, the output currents are frozen at their last values or set to 22 mA, the limit contact is inactive, the controller output can either be frozen or set to zero (see Pg 4-18), a wash interval is not started.

What you have to know for calibration

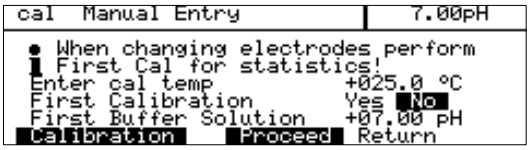
Only ever use fresh, undiluted buffer solutions!



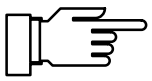
For measurement of reference electrode impedance (jumper removed from terminal 3 and 4), the buffer solution must be electrically connected to terminal 4 during calibration.

To do so, immerse an auxiliary electrode in the buffer solution and connect the auxiliary electrode to terminal 4.

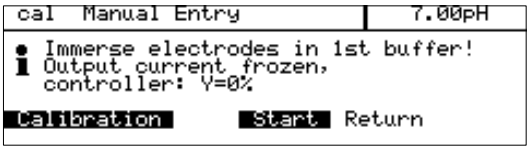
Calibration sequence



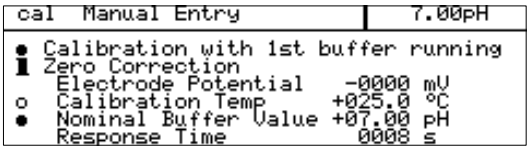
Remove the electrode and immerse it in the first buffer solution.
The measured cal temperature is displayed or must be entered manually.
Enter the temperature-corrected first buffer value.



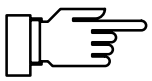
You must enter the temperature-corrected buffer value. To do so, refer to the buffer table and enter the buffer value belonging to the displayed calibration temperature.



Start calibration.

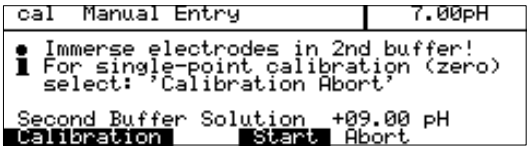


From the **response time**, you see how much time the electrode needs for the measured value to stabilize.



You can press **cal** to reduce the waiting time before stabilization of the measured value. However, this reduces the accuracy of the calibration values!

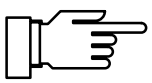
If the electrode potential or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min.



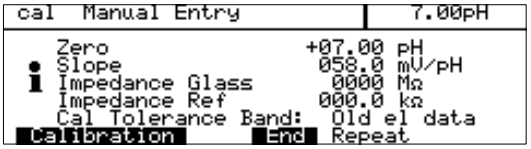
Rinse the electrode thoroughly.
For two-point calibration, immerse the electrode in the second buffer solution.
Enter the temperature-corrected second buffer value and start calibration.

For one-point calibration, select „Calibration Abort" to exit the menu.

When calibration has been successfully completed, the electrode data is displayed.
In the case of a calibration error an error message is displayed. The calibration must then be repeated.



If your Transmitter is equipped with Option 447, each calibration is entered in the tolerance band recorder (see Pg 4-8).



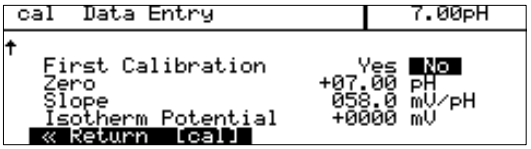
With Option 447 and cal tolerance band enabled, calibration data is not accepted from every calibration. The “Cal Tolerance Band” line informs you whether the tolerance limit has been exceeded and the calibration data has been accepted (“New el data”) or whether calibration data has not been accepted because it is within the tolerance band (“Old el data”).

Calibration by entering data from premeasured electrodes

You can directly enter the values for zero, slope, and isothermal potential of an electrode. The values must be known, e.g. determined beforehand in the laboratory.

For an explanation of the isothermal potential, see Pg 12-3.

When you enter an isothermal potential V_{iso}, this value remains stored for the Calimatic®, Manual Entry, and Sample Calibration methods.



Enter the premeasured values in the “Data Entry” menu.
If your Transmitter is equipped with Option 447, the calibration data is entered in the tolerance band recorder.

When making a Data Entry, the values are always accepted, even if they lie within the cal tolerance band!

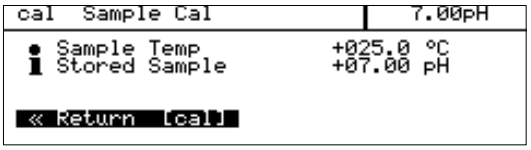
Calibration with sampling

When the electrode cannot be removed, e.g. for sterility reasons (for biotechnical processes), the electrode zero point can be determined with “sampling”.

To do so, the currently measured process value is stored by the pH Transmitter 2220(X). Immediately afterwards, you take a sample from the process. The pH value of the sample is measured in the lab. The lab value is entered in the pH Transmitter 2220(X). The pH Transmitter 2220(X) calculates the electrode zero from the difference between the process value and the lab value (this method only allows one-point calibration).

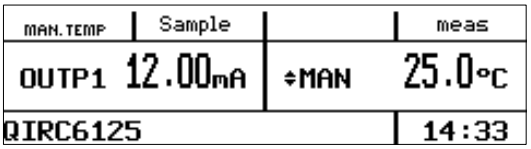
All calibration data is converted using a reference temperature of 25 °C.
During calibration, the NAMUR functional check signal is active, the output currents are frozen at their last values or set to 22 mA, the limit contact is inactive, the controller output can either be frozen or set to zero (see Pg 4-18), a wash interval is not started.

Calibration sequence



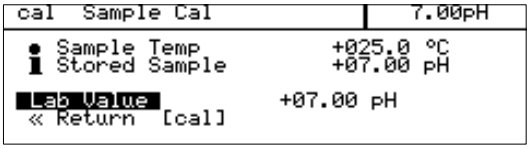
For sampling, open the “Sample Cal” submenu of Calibration. The measured sample temperature and the current pH value of the process medium are displayed and stored.
To exit calibration, press **cal**.

In measuring mode the word “Sample” in the upper right corner of the display indicates that a sample value has been stored for calibration. The Transmitter expects entry of the lab value, however continues to measure using the old zero point.



Take sample

Take a sample from the process and measure its pH value in the lab, for example.
Note that the pH value of the sample is temperature-dependent. Therefore, laboratory measurement should be performed at the sample temperature shown in the display, if possible.
As far as possible, you should transport the sample in an insulated container (Dewar).
The pH value may also be altered due to escaping of volatile substances.

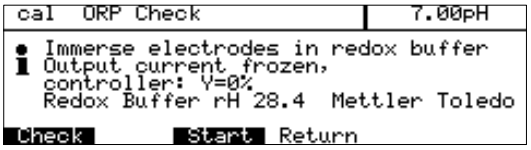


When you have determined the sample value, open the “Sample Cal” submenu again. The measured sample temperature and the stored pH value are displayed.
Enter the pH value measured (“Lab Value”). The new electrode zero point is automatically calculated and stored.
If your Transmitter is equipped with Option 447, the calibration data is entered in the tolerance band recorder.

The values obtained by Sample Calibration are always accepted, even if they lie within the cal tolerance band!

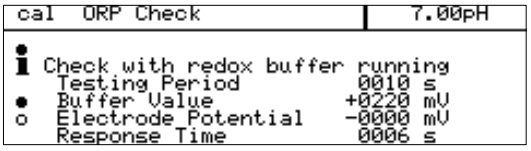
ORP check

For ORP measurements, there is no point in standardizing the electrode. To check the electrode, its running-in behavior is evaluated under defined conditions. To do this, you can enter the **test difference** and **test period** parameters (see Pg 4-9).

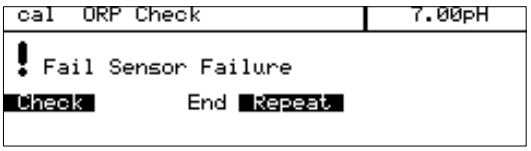


The pH Transmitter 2220(X) allows you to check electrode systems with a reference electrode of the “3 mol/l KCl-Ag/AgCl” type.
The redox buffer solution rH 28.4 (Mettler Toledo, Order Number 20 9881 250) is used as reference solution. The temperature compensation chart for this buffer solution is stored in the pH Transmitter 2220(X).

First immerse the electrode in a conditioning solution. The type of solution depends on the respective application.



Then immerse the electrode (after rinsing, if necessary) in the redox buffer solution and start the checking procedure. The voltage difference between elecctrode potential and nominal value of the buffer solution is evaluated and displayed.



If this differential voltage falls below the test difference within the preset test period, the electrode is considered stable and checking is terminated.
If the electrode only reaches the test difference after the test period has elapsed, the following message is generated:
“Warn Sensor Unstable”
If the value does not fall below the test difference even after the double test period has elapsed, the following message is generated: “Fail Sensor Failure”.

When taking ORP measurements, you must specify – in addition to the measured result – the reference electrode used or whether the result has been converted to the standard hydrogen electrode. Direct conversion to the standard hydrogen electrode is possible using the delta function (see Pg 4-12). Specification of ORP is completed by information on the measuring electrode used (e.g. “platinum”)

as well as the measuring temperature and the pH value.

Standard potentials [mV] of some reference electrodes

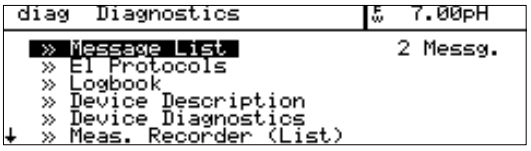
(Voltages [mV] related to the standard hydrogen electrode)

Data: Galster; pH-Messung, Weinheim. VCH, 1990 (partly interpolated/extrapolated)

	“Silver chloride”, “Argenthal”, “Silamid” Ag/AgCl, KCl				”Calomel” Hg/Hg_2C_2, KCl			”Thalamid” Tl,Hg/TlCl,KCl	”Mercury sulfate” Hg/Hg_2SO_4, K_2SO_4
Temp [°C]	1 mol/l	3 mol/l	3.5 mol/l	Saturated	0.1 mol/l	1 mol/l	Saturated	3.5 mol/l	Saturated
0	249.3	224.2	222.1	220.5	333.8	285.4	260.2	–558.5	671.8
5	246.9	220.9	218.7	216.1	334.1	284.7	257.2	–561.0	667.6
10	244.4	217.4	215.2	211.5	334.3	283.9	254.1	–563.5	663.5
15	241.8	214.0	211.5	206.8	334.2	282.7	250.9	–566.0	659.4
20	239.6	210.5	207.6	201.9	334.0	281.5	247.7	–568.6	655.3
25	236.3	207.0	203.7	197.0	333.7	280.1	244.4	–571.3	651.3
30	233.4	203.4	199.6	191.9	333.2	278.6	241.1	–574.0	647.3
35	230.4	199.8	195.4	186.7	332.4	277.0	237.7	–576.7	643.3
40	227.3	196.1	191.2	181.4	331.6	275.3	234.3	–579.6	639.2
45	224.1	192.3	186.8	176.1	330.6	273.5	230.8	–582.5	635.1
50	220.8	188.4	182.4	170.7	329.6	271.6	227.2	–585.4	630.9
55	217.4	184.4	178.0	165.3		269.5	223.6	–588.5	626.6
60	213.9	180.3	173.5	159.8		267.3	219.9	–591.6	622.6
65	210.4	176.4	169.0	154.3		264.8	216.2	–594.8	617.7
70	206.9	172.1	164.5	148.8		262.2	212.4	–598.0	613.3
75	203.4	167.7	160.0	143.3				–601.4	608.4
80	199.9	163.1	155.6	137.8				–604.8	603.4
85	196.3	158.3	151.1	132.3				–608.3	598.4
90	192.7	153.3	146.8	126.9				–611.9	593.1
95	189.1	148.1	142.5	121.5				–615.6	578.6

This page has been left empty for technical reasons.

6 Diagnostics menu



The Diagnostics menu provides all relevant information on the instrument status.
During diagnostics all measuring functions of the pH Transmitter 2220(X) continue to be active. All outputs continue to be operated and warning and failure message are output via the NAMUR contacts.

If no key is pressed within **20 minutes**, the Diagnostics menu is automatically exited.

Message list

The message list shows the number of currently activated messages and the individual warning or failure messages in plain text.

For explanations of the individual messages please refer to Chapter 8.

Electrode records

Calibration record

The Cal Record displays all relevant data of the last calibration for preparing documentation in accordance with ISO 9000 and GMP.

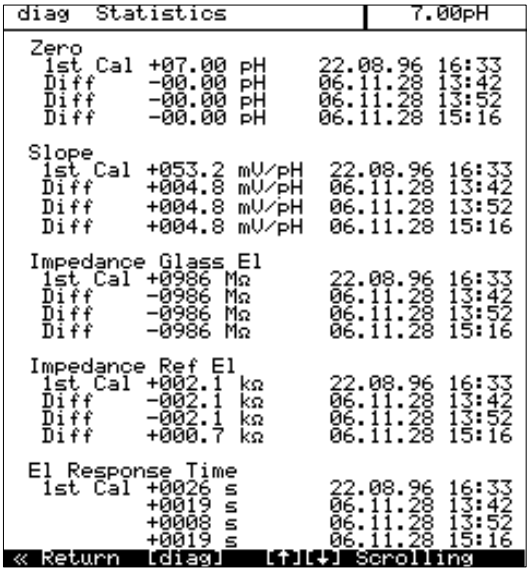
- Date and time of last calibration
- Cal tolerance band: new data/old data (if tolerance band calibration enabled)
- Calibration mode (e.g. Calimatic®)
- Electrode zero point
- Electrode slope
- V_{iso} isothermal potential

For first and second buffer:

- Nominal buffer value
- (Measured) electrode potential
- Calibration temperature
- Response time of electrode until measured voltage has stabilized

For some calibration procedures, such as Data Entry, not all measured values are available. The respective positions are then covered with a gray bar.

Statistics



When you perform a **First Calibration** (see Pg 5-3), the following values are stored as **reference values**:

- Date and time of first calibration
- Zero point of electrode
- Electrode slope
- Glass electrode impedance
- Reference electrode impedance
- Electrode response time of First Calibration

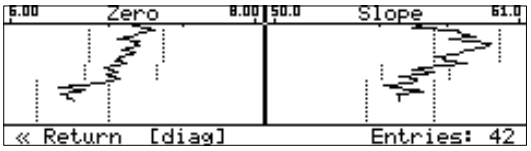
When you then perform ordinary calibrations, the following data will be listed in the electrode statistics for the last three calibrations:

- Date and time of calibration
- Deviation of zero point from First Calibration to calibration
- Deviation of electrode slope
- Deviation of glass electrode impedance
- Deviation of reference electrode impedance
- Electrode response time during calibration

This provides you with important information on electrode condition, aging and the time for the next due calibration.
If the time between two calibrations is less than 6 minutes, the Transmitter interprets the second calibration as repetition of the first one (e.g. when an error has occurred). It does not create a new record. The last calibration record is overwritten with the new values.

Tolerance band recorder (graphic)

Option 447 (Tolerance band recorder) can be retrofitted via TAN (see Pg 4-33).



From the graphical representation of the electrode data, drift due to aging or calibration scatter of the last 45 calibrations can be recognized at a glance. This allows you to draw conclusions regarding electrode life and the required calibration interval.

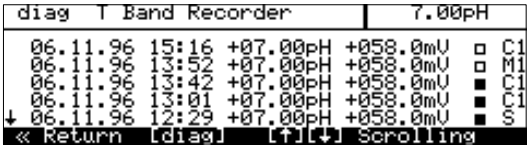
The dotted lines indicate the user-defined tolerance band. If zero and/or slope of the electrode leave their tolerance bands, the data is accepted as calibration data (New el data) and the tolerance band limits are displaced (symmetrically to the new electrode data).

Entries in the tolerance band recorder cannot be edited!

Tolerance band recorder (listing)

Option 447 (Tolerance band recorder) can be retrofitted via TAN (see Pg 4-33).

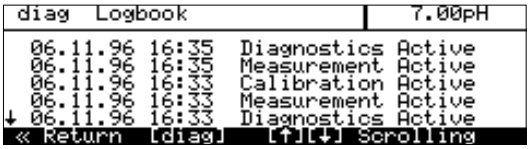
As a supplement to the graphical representation, the listing of the tolerance band recorder shows the exact data of the last 45 calibrations. The listing includes:



- Date and time of calibration
- Determined zero and slope values
- Electrode data accepted (■)
  or tolerated (□)
- Calibration mode:
  C1/C2 = Calimatic® one/two-point calibration
  M1/M2 = Manual one/two-point calibration
  D =Data entry
  S = Sampling

Logbook

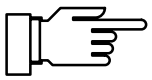
Option 354 (Logbook) can be retrofitted via TAN (see Pg 4-33).



The logbook contains the last 200 events with date and time and displays them.
Error messages occurring during parameter setting, calibration or maintenance are ignored.
The following events are recorded:

- Transmitter in measuring mode
- Transmitter turned on/off
- ■: Start of warning and failure messages
- □: End of warning and failure messages
- Calibration messages
- Parameter setting, calibration, maintenance or diagnostics active
- Entry of a wrong passcode

The logbook entries can be used for quality management documentation to ISO 9000 and GMP.



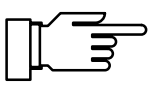
Logbook entries cannot be edited!

Device description

The Device Description contains information on the model designation, serial number and instrument options.

The display indicates:

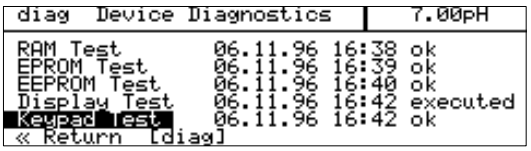
- Model designation
- Serial number
- Hardware and software version
- Program module code
- Instrument options



The software version must correspond to the version indicated at the bottom right of the second page of this manual.

Device diagnostics

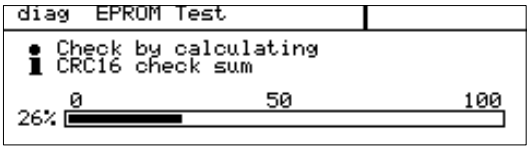
The Device Diagnostics feature allows you to perform extensive tests to check the function of the pH Transmitter 2220(X).
This permits quality management documentation to ISO 9000.
Instrument settings and parameters are not affected.



In the Device Diagnostics menu you see when each test was performed and what the result was.

Start the selected test with **enter**.

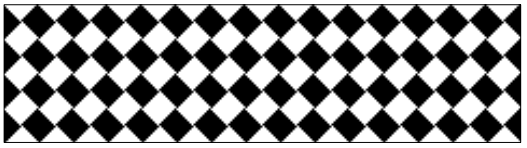
Memory test



Select “RAM Test”, “EPROM Test” or “EEPROM test”.
The Transmitter forms a CRC checksum for the calculated data and compares it with the setpoint.

If “Failure” appears in the menu after the test is completed, the Transmitter must be sent in to the manufacturer for repair.

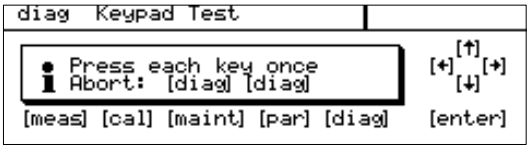
Display test



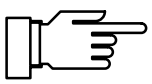
Several test patterns will be displayed allowing you to check whether all pixels, lines and columns function properly.

If there are disturbances in the test patterns, the Transmitter should be sent in to the manufacturer for repair.

Keypad test



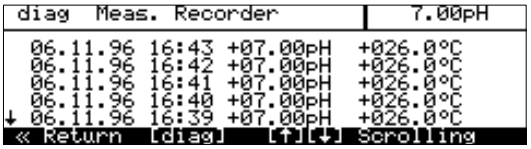
Each key must be pressed once during keypad testing. Keys that have been pressed are highlighted.



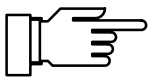
If “Keypad Test Failure” appears in the menu after the test, the Transmitter must be sent in to the manufacturer for repair.

Measurement recorder (listing)

Option 448 (Measurement recorder) can be retrofitted via TAN (see Pg 4-33).

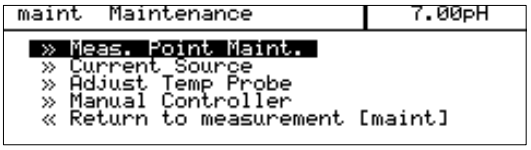


In addition to the graphic display of the measurement recorder (see Pg 3-4), the Diagnostics menu provides the last 500 measured value pairs from the recorder memory as a listing.
Each recorder entry occupies one display line. The measured values of both channels are recorded with date and time. The symbols for min (▼), max (▲) or mean value (~) are displayed after the measurement symbol, if applicable.



Entries in the measurement recorder cannot be edited!

7 Maintenance menu

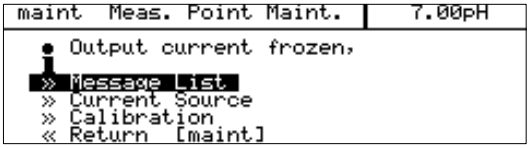


The Maintenance menu provides all functions for sensor maintenance and adjustment of connected instruments.

Access to the Maintenance level can be protected with a passcode.

- The current source allows manual adjustement of all active output currents for configuring and checking connected peripheral devices (such as indicators or recorders).
- Temperature probe adjustment allows individual calibration of the connected temperature probe.
- If the Transmitter is equipped with the controller function (Option 353) and the controller has been activated, you can manually enter the controller output (manipulated variable Y).

Measurement point maintenance



Measurement point maintenance allows you to remove the sensor. While the Transmitter is in measurement point maintenance mode, you can clean or replace and calibrate the sensors.

The output current is frozen at its last value or can be set to a specific value with the current sensor. The controller output is either frozen or set to zero.

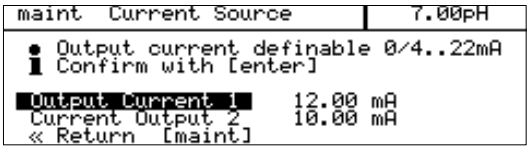
In the measurement point maintenance mode you can view the message list, activate the current source or start calibration.

- Message list
  In this submenu you can view the message list containing all active messages (without releasing the outputs) (see Pg 6-1).
- Current source
  In this submenu you can manually specify the output currents during maintenance (for current source function, see Pg 7-2).
- Calibration
  In this submenu you can start a calibration directly from the Maintenance menu without having to release the outputs (for calibration, see Pg 5-1 and the following).

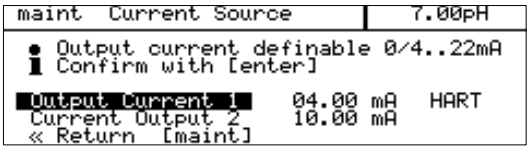
Current source function

During current source function the output currents do not follow the measured value!
The values can be entered manually.

Therefore, you must make sure that the connected devices (control room, controllers, indicators) do not interpret the current value as a measured value!



In the Current Source menu you can manually adjust the values for the output currents, for example to check connected peripheral devices.



During Multidrop mode the output current 1 is permanently set to 4 mA. This is indicated by the word “HART”.

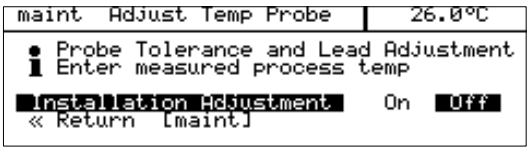
Temperature probe adjustment

During temperature probe adjustment you compensate for the individual tolerance of the temperature probe and the influence of the lead resistances. This increases the accuracy of the temperature measurement.

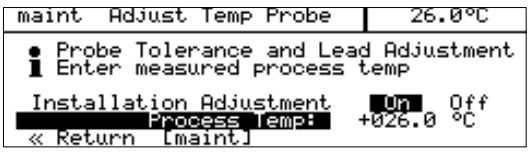
Adjustment may only be carried out after the process temperature has been precisely measured using a calibrated reference thermometer!
The measurement error of the reference thermometer should be less than 0.1 °C.

Adjustment without precise measurement might result in considerable deviations of the pH value displayed!

To simplify the adjustment procedure, set “Measurement Display: Variable °C” (see Pg 4-3).



When the measurement display has been set accordingly, the temperature measured by the temperature probe is displayed in the upper right corner.



Switch on Installation Adjustment and enter the process temperature measured by the reference thermometer.

Now the compensated temperature from the temperature probe is displayed in the upper right corner.

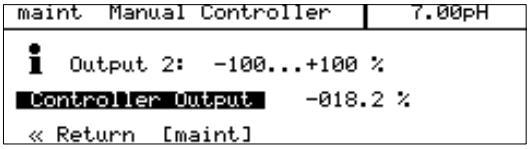
The permissible adjustment range is ±5 °C from the value measured by the temperature probe.

Manual entry of controller output

If the Transmitter is equipped with the controller function (Option 353) and the controller has been activated, you can manually adjust the controller output (manipulated variable Y) for test purposes or to start a process.

When you manually adjust the controller output, it no longer follows the controlled variable!

Therefore, you must make sure that the connected actuators and the control loop are monitored accordingly!



You can enter the controller output in the range from –100 % to +100 %, for example to check connected actuators.
When you exit manual controller entry, the Transmitter switches back to automatic controller operation.
With a PI controller (reset time ≠ 0), switchover is smooth. This allows you to rapidly start processes with large time constants or dead times.

With the definable feed time alarm, you can monitor the time during which the controller output is at +100 % or –100 %, i.e. how long the valve is fully open. If this time is exceeded, this may be due to a shortage of feed chemical or a defective valve, for example.

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8 Error messages

Error message	Cause
No message	No errors
Fail Hi pH Value	Measured value > pH 16 or above failure limit
Warn Hi pH Value	Measured pH value above warning limit
Warn Lo pH Value	Measured pH value below warning limit
Fail Lo pH Value	Measured value < pH -2 or below failure limit
Fail Hi mV Value	Measured value > +2000 mV or above failure limit
Warn Hi mV Value	Measured mV value above warning limit
Warn Lo mV Value	Measured mV value above warning limit
Fail Lo mV Value	Measured value < -2000 mV or below failure limit
Fail Hi rH Value	Measured value > 200 rH or above failure limit
Warn Hi rH Value	Measured rH value above warning limit
Warn Lo rH Value	Measured rH value below warning limit
Fail Lo rH Value	Measured value < 0 rH or below failure limit
Fail Hi ORP Value	Measured value > +2000 mV or above failure limit
Warn Hi ORP Value	Measured ORP value above warning limit
Warn Lo ORP Value	Measured ORP value below warning limit
Fail Lo ORP Value	Measured value < -2000 mV or below failure limit
Fail Hi El Zero	Electrode zero point > (nominal zero point + 1 pH unit) or above failure limit
Warn Hi El Zero	Electrode zero point above warning limit
Warn Lo El Zero	Electrode zero point below warning limit
Fail Lo El Zero	Electrode zero point < pH 0 or < (nominal zero point - 1 pH unit) or below failure limit
Fail Hi El Slope	Electrode slope > 61 mV/pH or > (nominal slope + 5.5 mV/pH) or above failure limit
Warn Hi El Slope	Electrode slope above warning limit
Warn Lo El Slope	Electrode slope below warning limit
Fail Lo El Slope	Electrode slope < 50 mV/pH or < (nominal slope - 5.5 mV/pH) or below failure limit
Warn Hi Viso	Input value of isothermal potential V_{iso} > +1000 mV
Warn Lo Viso	Input value of isothermal potential V_{iso} < -1000 mV
Fail Hi Glass El	Glass electrode impedance above failure limit
Warn Hi Glass El	Glass electrode impedance above warning limit
Warn Lo Glass El	Glass electrode impedance below warning limit
Fail Lo Glass El	Glass electrode impedance below failure limit

Error message	Cause
Fail Hi Ref El Warn Hi Ref El Warn Lo Ref El Fail Lo Ref El	Reference electrode impedance above failure limit Reference electrode impedance above warning limit Reference electrode impedance below warning limit Reference electrode impedance below failure limit
Warn Buf Unknown Warn Identical Buf Warn Buf Exchanged	Buffer not contained in defined Calimatic buffer set Calibration with identical buffer solutions For manual calibration only: Sequence of buffers interchanged
Fail Hi Temp Warn Hi Temp Warn Lo Temp Fail Lo Temp	Temperature > 250 °C or above failure limit Measured temperature above warning limit Measured temperature below warning limit Temperature < -50 °C or below failure limit
Fail Hi Cal Time Warn Hi Cal Time	Cal timer interval above failure alarm limit Cal timer interval above warning alarm limit
Warn Current1 Span Warn Current1 < 0/4 mA Warn Current1 > 20 mA	Current output 1: Start and end value too close Current output 1: Output current below defined start value Current output 1: Output current above defined end value
Warn Current2 Span Warn Current2 < 0/4 mA Warn Current2 > 20 mA	Current output 2: Start and end value too close Current output 2: Output current below defined start value Current output 2: Output current above defined end value
Warn Cal Temp Warn Sensor Unstable Fail Sensor Failure	Calibration temperature out of range Measured value not stable for > 10 sec Measured value not stable for > 60 sec
Warn Time/Date	Time had to be automatically initialized: The clock must be reset!
Warn Control Para	Parameter error for controller, see Pg 4-15
Fail CRC Error par	CRC data error during parameter setting: Check all settings at the Administrator level!
Fail Hi Feed Time Warn Hi Feed Time	Controller: Feed time above failure limit Controller: Feed time above warning limit
Warn Write Protection	Write protection violation at “WriteProtect” (for HART® only)
Warn Device Diag Fail System Failure	Diagnostics error: Instrument self-test defective Clock failure, CRC error in factory settings

9 Product line and accessories

Instruments	Ref. No.
pH Transmitter 2220	pH 2220
pH Transmitter 2220X	pH 2220X

Mounting accessories	
Mounting plate, extruded profile AlMg3, 20 µm anodized (not required for direct wall mounting)	ZU 0136
Bracket kit, brackets hot galvanized, screws stainless steel, wing nuts aluminum anodized (only in conjunction with ZU 0136 mounting plate)	ZU 0125
Protective hood, aluminum AlMg1, 25 µm anodized, (only in conjunction with ZU 0136 mounting plate)	ZU 0157
Protective polyester case, IP 65, protective macrolon panel, complete with mounting kit	ZU 0158
Bracket kit for protective case, brackets hot galvanized, screws stainless steel, wing nuts aluminum anodized (only in conjunction with ZU 0158)	ZU 0220

Further accessories	
Input sockets for mounting instead of cable glands	
Input socket for a combination or glass electrode with DIN plug	ZU 0160
Input socket for a combination or glass electrode with Mettler Toledo SK 7/ Schott 9903 screwed plug and equivalent types	ZU 0161
Power supply/isolator for 24 V AC/DC	WG 20 A2
Repeater power supply for 90 to 253 V AC (optional 24 V AC/DC)	WG 21 A7
Repeater power supply with HART® transmission	WG 21 A7 Opt. 470
IS loop-powered supply with HART® transmission	WG 25 A7

Options	TAN	Ref. No.
Controller function (only in conjunction with Opt. 487)	x	353
Logbook	x	354
Reference electrode input for differential probes		413
Key-lockable cover		432
Tolerance band calibration and tolerance band recorder	x	447
Measurement recorder	x	448
HART® communication		467
Language selection German, English, French, Italian and Swedish instead of German, English, French, Italian and Spanish		477
Second current output (passive)	x	487

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10 Specifications

Inputs	1 input for pH or mV		
pH 2220X: EEx ia IIC	1 input for ORP **		
	1 input for Pt 100 / Pt 1000 / NTC 30 kΩ		
Ranges	pH value	–2.00 to +16.00	
	Electrode potential	–2000 to +2000 mV	
	ORP (redox potential)	–2000 to +2000 mV	
	rH value	0.0 ... 42.5	
	Glass impedance	0.5 ... 1000 MΩ	
	Reference impedance	0.1 ... 200.0 kΩ	
	Temperature	–50.0 to +250.0°C	
	with NTC	–20.0 to +130.0°C	
Display	Graphic LCD, 240 x 64 matrix		
	Main display	character height approx. 20 mm	
	Secondary display	character height approx. 6 mm	
	Dialog display	7 lines, character height approx. 4 mm	
Display options	Main display	Secondary display	
	pH value	pH value	[pH]
	Electrode potential	Electrode potential	[mV]
	ORP (redox potential)	ORP	[mV]
	rH value	rH value	[rH]
	Temperature	temperature	[°C]
	Time	Time	[h,min]
		Date	[d,m,y]
		Current output 1	[mA]
		Current output 2	[mA]
		Cal timer	[h]
		Glass impedance	[MΩ]
		Ref. impedance	[kΩ , MΩ]
		Man. temperature	[°C]
		Controller output	[%]
		controller setpoint X_w	
2-channel measurement recorder * (Option 448)	Graphic representation of two process variables in the display user-defined for pH, mV, ORP, rH, °C, output 1, output 2, glass impedance and reference impedance Span and time base definable, Recording of: Snapshot, min, max or mean value, 500 measurement points with time and date		
Languages *****	German, English, French, Italian, Spanish Option 477: Swedish instead of Spanish		

* User-defined
** Oxidation-reduction potential

pH/ORP input

Glass electrode input	Input resistance	> 1 * 10^{12} Ω
	Input current (20 °C)***	< 1 * 10^{-12}A
	Offset voltage	<0.5 mV
	TC of offset voltage	<10 µV/K
Reference electrode input	Input resistance	> 1 * 10^{11} Ω
	Input current (20 °C)***	< 1 * 10^{-11} A
	Offset voltage	<0.5 mV
	TC of offset voltage	<10 µV/K
Accuracy (± 1 count)	pH value	< 0,01
	Electrode potential	< 0.1 % measured value
	ORP (redox potential)	< 0.1 % measured value
Impedance measurement error (± 1 count)	Glass electrode	< 10 % 2 ... 200 MΩ < 20 % < 2 MΩ / > 200 MΩ
	Reference electrode	< 10 % 0,5 ... 50 kΩ < 20 % < 0,5 kΩ / > 50 kΩ
Permissible cable capacitance pH	< 2 nF	(approx. 20 m measuring cable length)
Permissible voltage ORP + pH (mV)	± 2 V, terminals 1, 3 against terminal 4	

Electrode standardization pH Operating modes *

- Calimatic® automatic calibration and buffer identification with fixed buffer sets:

Knick technical buffers	2.00/4.01/7.00/9.21
Mettler Toledo technical buffers	2.00/4.01/7.00/9.21
Merck/Riedel de Haën	2.00/4.00/7.00/9.00/12.00
Techn. buf. DIN 19267	1.09/4.65/6.79/9.23/12.75
Ciba (94)	2.06/4.00/7.00/10.00
Technical buffers to NIST	1.68/4.00/7.00/10.01/12.46

  Customer-specific buffer sets (Option 357)
- Input of individual buffer values
- Sample calibration
- Input of premeasured calibration data
- Automatic check of ORP electrodes

Calibration ranges	Zero	pH = 6 to 8
	Slope	50 to 61 mV/pH (25 °C)
	V_{iso}	–200 to +200 mV
Nominal electrode zero and slope * (Option 356)	Zero	pH = 0 to 14
	Adjustment range	Δ pH = ± 1
	Slope	25 to 61 mV/pH
	Adjustment range	± 5.5 mV/pH
	V_{iso}	-1000 to +1000 mV
	e.g. for Pfaudler and antimony probes	

Temperature input	Pt 100 / Pt 1000 / NTC 30 kΩ, 2 or 3-wire connection	
Range	–50 to +250 °C; with NTC 30 kΩ: –20 to +130°C	
Temp measuring error (± 1 count)	< 0.2 % meas. value + 0.3 K	
Temp compensation pH*	Automatic	with Pt100/Pt1000/NTC 30 kΩ
	Manual	–50.0 to +250.0 °C
Temperature compensation media-dependent *	• none • Ultrapure water with traces of impurity	
Sensocheck®	Monitoring of glass and reference electrode	

* User defined

*** Doubles every 10 K

Output 1 * (current loop)	4 to 20 mA (22 mA), floating, supply unit required definable for pH, mV, ORP, rH, °C	
Start/end of scale *	As desired within range	
Spans *	pH value Electrode potential ORP rH value Temperature	1.00 to 20.00 100 to 2000 mV 100 to 2000 mV 10.0 to 200.0 10.0 to 300.0 °C
Output current error	< 0.3 % meas. value + 20 µA	
Current source function	4.00 mA to 22.00 mA	
Supply voltage	pH 2220 : pH 2220X (EEx ib IIC):	14.3 to 40 V; I_{max} = 100 mA 14.3 to 30 V; I_{max} = 100 mA; P_{max} = 0.8 W
Output 2 * (passive) (Option 487)	4 to 20 mA (22 mA), floating, supply unit required definable for pH, mV, ORP, rH, °C or as an analog controller output	
Start/end of scale *	As desired within range	
Spans *	pH value Electrode potential ORP rH value Temperature	1.00 to 20.00 100 to 2000 mV 100 to 2000 mV 10.0 to 200.0 10.0 to 300.0 °C
Output current error	< 0.3 % meas. value + 20 µA	
Current source function	0.00 mA to 22.00 mA	
Supply voltage	pH 2220 : pH 2220X (EEx ib IIC):	1.3 to 40 V; I_{max} = 100 mA 1.3 to 30 V; I_{max} = 100 mA; P_{max} = 0.8 W
Defined as switching output	Switching controller, limit or alarm output	
Loadability	pH 2220 : pH 2220X (EEx ib IIC):	DC V_{max} = 40 V; I_{max} = 100 mA; voltage drop: < 1.3 V DC V_{max} = 30 V; I_{max} = 100 mA; P_{max} = 0.8 W; voltage drop: < 1.3 V
HART® Communication (Option 467)	Digital communication by FSK**** modulation of loop current (output 1 only), HART protocol (Version 6.2) point-to-point connection or Multidrop (bus) *	
PI controller (Option 353)	Quasi continuous switching controller via output 2 (Option 487) Pulse duration or pulse frequency definable or continuous controller via output 2 (Option 487) User defined for pH, mV, ORP, rH, and °C	
Clock	Real-time clock with date, self-contained Date format user-definable	
Records	For quality management documentation to ISO 9000.	
Logbook (Option 354)	Recording of Storage capacity	function activations, appearance and disappearance of warning and failure messages, with date and time 200 entries available
Instrument self-test	Test of RAM, EPROM, EEPROM, display and keypad	
Electrode statistics	Electrode data from the last three pH calibrations and first calibration	
pH calibration record	All relevant data of the last pH calibrations for documentation to GMP	
Tolerance band recorder (Option 447)	Registers zero and slope of the electrode and the selected tolerance bands, graphical representation.	

* User defined

**** Frequency shift keying

Data retention in case of power failure	Parameters and factory settings	>10 years (EEPROM)
	Logbook, statistics, cal record	> 1 year (lithium battery)
	Clock (reserve power)	> 1 year (lithium battery)
	No battery replacement required according to NAMUR NE 32	
Explosion protection pH 2220X	II 2 (1) G EEx ib [ia] IIC T6 , PTB 00 ATEX 2191	
EMC	EN 61326	/ VDE 0843 Part 20: 1998-01
	EN 61326 /A1	/ VDE 0843 Part 20/A1: 1999-05
	Interference immunity to NAMUR EMC recommendation for process and laboratory control equipment	
Ambient temperature	Operation *****	-20 to +50 °C
	Transport and storage	-20 to +70 °C
Enclosure	Case with separate terminal compartment, suitable for outdoor mounting Material: acrylonitrile butadiene styrene, Front: polyester Ingress protection: IP 65	
Cable glands	Metric cable glands	
Dimensions	See dimension drawing	
Weight	Approx. 1.5 kg	

***** At ambient temperatures below 0 °C the readability of the display may be reduced.
This does not impair the instrument functions.

11 Buffer tables

“Knick” Knick technical buffers

°C	pH			
0	2.03	4.01	7.12	9.52
5	2.02	4.01	7.09	9.45
10	2.01	4.00	7.06	9.38
15	2.00	4.00	7.04	9.32
20	2.00	4.00	7.02	9.26
25	**2.00**	**4.01**	**7.00**	**9.21**
30	1.99	4.01	6.99	9.16
35	1.99	4.02	6.98	9.11
40	1.98	4.03	6.97	9.06
45	1.98	4.04	6.97	9.03
50	1.98	4.06	6.97	8.99
55	1.98	4.08	6.98	8.96
60	1.98	4.10	6.98	8.93
65	1.99	4.13	6.99	8.90
70	1.99	4.16	7.00	8.88
75	2.00	4.19	7.02	8.85
80	2.00	4.22	7.04	8.83
85	2.00	4.26	7.06	8.81
90	2.00	4.30	7.09	8.79
95	2.00	4.35	7.12	8.77

“Mettler Toledo” Mettler-Toledo technical buffers (correspond to Ingold technical buffers)

°C	pH			
0	2.03	4.01	7.12	9.52
5	2.02	4.01	7.09	9.45
10	2.01	4.00	7.06	9.38
15	2.00	4.00	7.04	9.32
20	2.00	4.00	7.02	9.26
25	**2.00**	**4.01**	**7.00**	**9.21**
30	1.99	4.01	6.99	9.16
35	1.99	4.02	6.98	9.11
40	1.98	4.03	6.97	9.06
45	1.98	4.04	6.97	9.03
50	1.98	4.06	6.97	8.99
55	1.98	4.08	6.98	8.96
60	1.98	4.10	6.98	8.93
65	1.99	4.13	6.99	8.90
70	1.99	4.16	7.00	8.88
75	2.00	4.19	7.02	8.85
80	2.00	4.22	7.04	8.83
85	2.00	4.26	7.06	8.81
90	2.00	4.30	7.09	8.79
95	2.00	4.35	7.12	8.77

“Merck/Riedel” Merck Titrisol buffers and ready-to-use buffers,
Riedel Fixanal buffers and ready-to-use buffers

°C	pH				
0	2.01	4.05	7.13	9.24	12.58
5	2.01	4.04	7.07	9.16	12.41
10	2.01	4.02	7.05	9.11	12.26
15	2.00	4.01	7.02	9.05	12.10
20	**2.00**	**4.00**	**7.00**	**9.00**	**12.00**
25	2.00	4.01	6.98	8.95	11.88
30	2.00	4.01	6.98	8.91	11.72
35	2.00	4.01	6.96	8.88	11.67
40	2.00	4.01	6.95	8.85	11.54
45	2.00	4.01	6.95	8.82	11.44
50	2.00	4.00	6.95	8.79	11.33
55	2.00	4.00	6.95	8.76	11.19
60	2.00	4.00	6.96	8.73	11.04
65	2.00	4.00	6.96	8.72	10.97
70	2.01	4.00	6.96	8.70	10.90
75	2.01	4.00	6.96	8.68	10.80
80	2.01	4.00	6.97	8.66	10.70
85	2.01	4.00	6.98	8.65	10.59
90	2.01	4.00	7.00	8.64	10.48
95	2.01	4.00	7.02	8.64	10.37

“DIN” Technical buffers to DIN 19 267

°C	pH				
0	1.08	4.67	6.89	9.48	13.95*
5	1.08	4.67	6.87	9.43	13.63*
10	1.09	4.66	6.84	9.37	13.37
15	1.09	4.66	6.82	9.32	13.16
20	1.09	4.65	6.80	9.27	12.96
25	**1.09**	**4.65**	**6.79**	**9.23**	**12.75**
30	1.10	4.65	6.78	9.18	12.61
35	1.10	4.65	6.77	9.13	12.45
40	1.10	4.66	6.76	9.09	12.29
45	1.10	4.67	6.76	9.04	12.09
50	1.11	4.68	6.76	9.00	11.98
55	1.11	4.69	6.76	8.96	11.79
60	1.11	4.70	6.76	8.92	11.69
65	1.11	4.71	6.76	8.90	11.56
70	1.11	4.72	6.76	8.88	11.43
75	1.11	4.73	6.77	8.86	11.31
80	1.12	4.75	6.78	8.85	11.19
85	1.12	4.77	6.79	8.83	11.09
90	1.13	4.79	6.80	8.82	10.99
95	1.13*	4.82*	6.81*	8.81*	10.89*

*) extrapolated

“Ciba (94)” Ciba (94) buffers,
Nominal values: 2.06, 4.00, 7.00, 10.00

°C	pH			
0	2.04	4.00	7.10	10.30
5	2.09	4.02	7.08	10.21
10	2.07	4.00	7.05	10.14
15	2.08	4.00	7.02	10.06
20	2.09	4.01	6.98	9.99
25	2.08	4.02	6.98	9.95
30	2.06	4.00	6.96	9.89
35	2.06	4.01	6.95	9.85
40	2.07	4.02	6.94	9.81
45	2.06	4.03	6.93	9.77
50	2.06	4.04	6.93	9.73
55	2.05	4.05	6.91	9.68
60	2.08	4.10	6.93	9.66
65	2.07*	4.10*	6.92*	9.61*
70	2.07	4.11	6.92	9.57
75	2.04*	4.13*	6.92*	9.54*
80	2.02	4.15	6.93	9.52
85	2.03*	4.17*	6.95*	9.47*
90	2.04	4.20	6.97	9.43
95	2.05*	4.22*	6.99*	9.38*

*) extrapolated

“NIST” Technical buffers to NIST
Nominal values: 1.68 4.00 7.00 10.01 12.46

°C	pH				
0	1.67	4.00	7.12	10.32	13.42
5	1.67	4.00	7.09	10.25	13.21
10	1.67	4.00	7.06	10.18	13.01
15	1.67	4.00	7.04	10.12	12.80
20	1.68	4.00	7.02	10.06	12.64
25	1.68	4.00	7.00	10.01	12.46
30	1.68	4.02	6.99	9.97	12.30
35	1.69	4.03	6.98	9.93	12.13
40	1.69	4.03	6.98	9.89	11.99
45	1.70	4.05	6.98	9.86	11.84
50	1.71	4.06	6.97	9.83	11.71
55	1.72	4.08	6.97	9.83	11.57
60	1.72	4.09	6.97	9.83	11.45
65	1.73	4.10	6.98	9.83	11.45
70	1.74	4.13	6.99	9.83	11.45
75	1.75	4.14	7.01	9.83	11.45
80	1.77	4.16	7.03	9.83	11.45
85	1.78	4.18	7.05	9.83	11.45
90	1.79	4.21	7.08	9.83	11.45
95	1.81	4.23	7.11	9.83	11.45

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12 Glossary

3-wire connection
Connection of the Pt 100/Pt 1000 temperature probe with a (third) sense line for compensating for the supply lead resistances. Required for exact temperature measurement with long wires.

Administrator level
“adm”, menu level of the Parameter Setting menu. All device settings and the passcodes can be defined.

Administrator passcode
Protects access to the Administrator level. Can be set at the Administrator level.

Alarm limit
For each process variable, you can define high and low warning and failure limits. The alarm (NAMUR signal) can be activated individually for each variable. If an alarm limit is exceeded, an error message appears. If output 1 or output 2 are correspondingly defined, a current of 22 mA is output in the event of an alarm.

Alarm processing
In the alarm processing function, delay times can be set for the NAMUR Failure, Warning and Functional Check signals. The delay times are treated separately. Alarms can be output as 22 mA signals via outputs 1 and 2 (see Alarm processing, Pg 4-24)

Auxiliary electrode
Metallic rod (e.g. platinum) required for monitoring the reference electrode impedance.

Buffer set
Contains selected buffer solutions which can be used for automatic calibration with Calimatic®. The buffer set must be entered.

cal
Menu key for the Calibration menu

Cal timer
Counts the time passed since the last calibration. The cal timer count can be monitored with alarm limits.

Cal tolerance band
Tolerance for zero and slope of the pH electrode. The new calibration values are only accepted if the tolerance limit has been exceeded.

Calibration menu
For calibrating the Transmitter.

Calibration method
Five different methods are available for calibration:
Automatic calibration with Calimatic®,
Calibration with manual entry of buffer values,
Data entry of premeasured electrodes,
Sample calibration,
ORP check.

Calibration passcode	Protects access to calibration. Can be set or disabled at the Administrator level.
Calibration record	The calibration record shows all relevant data of the last calibration for documentation to GMP.
Combination electrode	Glass and reference electrode combined in one system.
Controlled variable	User-defined variable that acts on the controller.
Cursor keys	◀ and ▶, serve to select entry positions or digits during number entry.
diag	Menu key for the Diagnostics menu
Diagnostics menu	Display of all relevant information on the device status.
Electrode slope	Specified in mV/pH. It is different for each electrode and changes with age and wear.
Electrode statistics	The electrode statistics provide the electrode data of the last three calibrations and the first calibration.
Electrode zero point	See zero point.
enter	Key for confirming entries.
Equipotential bonding electrode	Serves to connect the process solution to the measuring circuit of the pH meter.
Failure	Failure is a NAMUR signal. The limits are set in the Alarm Settings menu. Failure means that the equipment no longer operates properly or that a process parameter has reached a critical value.
Feed time alarm	Monitors the time during which the controller output is at 100 %.
First calibration	During first calibration, the electrode data are stored as reference values for electrode statistics.
Functional check	Functional check is a NAMUR signal. This signal is active during parameter setting, calibration and maintenance (see Alarm processing, Pg 4-24).
GMP	Good Manufacturing Practice: Rules for performance and documentation of measurements.
HART®	Digital communication by superimposing digital signals on the loop current.
Information display	Information text for operator guidance or indication of device status. Marked with **i** .
Interval	Time from the start of one device test to the start of the next device test, user defined.

Isothermal potential

The isothermal intersection point is the point of intersection between two calibration lines at two different temperatures. The potential difference between the electrode zero point and this intersection point is the isothermal potential "V_{iso}". It may cause measurement errors depending on the temperature. These measurement errors can be compensated for by defining the "V_{iso}" value. Measurement errors are avoided by calibrating at measuring temperature or at an invariable temperature.

Language selection

In the Parameter Setting menu, you can select the user interface language: The language can be selected without entering a passcode.

Limit contact

Is controlled by a user-defiable process variable. The limit contact is activated if the measured value falls below or exceeds an alarm limit, depending on the user-defined effective direction.

Logbook

The logbook shows the last 200 events with date and time, e.g. calibrations, warning and failure messages, power failure etc. This permits quality management documentation to ISO 9000.

Main display

Large measured-value display in the measuring mode. You can select which process variable is to be displayed. The process variable of the main display is shown in the menus in the upper right corner.

maint

Menu key for the Maintenance menu.

Maintenance menu

The Maintenance menu provides all functions for sensor maintenance and adjustment of connected devices.

Maintenance passcode

Protects access to Maintenance. Can be set or disabled at the Administrator level.

Manipulated variable

Output variable of the controller, controls output 2.

meas

Menu key. Pressing **meas** allows return to measuring mode from all other menus.

Measurement recorder

Two-channel recorder for optical display of the process development on the system display. One process variable can be assigned to each channel.

Measuring mode

When no menu function is activated, the Transmitter is in measuring mode. The selected measured value is displayed. You can always return to the measuring mode by pressing **meas** .

Menu
Pressing a menu key (**cal**, **diag** , **maint** or **par**), gives access to a menu from which you can select the corresponding functions.

Menu level
The menu is divided into several menu levels. You can switch between the different levels by pressing the corresponding menu key or a cursor key (◀ or ▶).

Message list
The message list shows the number of currently activated messages and the individual warning or failure messages in plain text.

NAMUR
German committee for measurement and control standards in the chemical industry

NAMUR signals
Failure, warning and functional check are NAMUR signals. They can be assigned to outputs 1 and 2 as 22 mA signals. The limits for failure and warning are set in the Alarm Settings menu.

Operator level
“opl”, menu level of the Parameter Setting menu. You can edit the device settings that have been enabled at the Administrator level.

Operator passcode
Protects access to the Operator level. Can be set or disabled at the Administrator level.

ORP
Oxidation Reduction Potential, measured across the reference electrode and an auxiliary (platinum) electrode

ORP check
Checks the running-in behavior of the ORP electrode under defined conditions. To do this, you can enter the test difference and test period parameters.

par
Menu key for the Parameter Setting menu.

Parameter Setting menu
The Parameter Setting menu is divided into three submenus: Viewing level (view), Operator level (opl) and Administrator level (adm).

Passcode protection
Access to the Calibration, Maintenance, Operator and Administrator levels is protected by passcodes. The passcodes can be defined or disabled at the Administrator level.

pH electrode
A pH electrode system consists of a glass and a reference electrode. If the two electrodes are combined in a single body, they are called combination electrode.

Pulse suppression
To increase immunity to interference, a disconnectable input filter suppresses transient interference

	pulses while slow changes of the measured value are detected immediately.
Recorder	See measurement recorder.
Response time	Time from the start of a calibration step to the stabilization of the electrode potential.
Scrolling key	▲ and ▼: Keys for selecting menu lines or entering numbers.
Secondary display	Two small displays located below the main display in measuring mode. The process variables to be displayed can be selected using ▲ / ▼ and ◀ / ▶.
Slope	See Electrode slope.
Tag number	Can be defined to identify the Transmitter and can be displayed in the diag menu. For HART® transmission, the first 8 characters are used as “TAG”.
TAN	Transaction number for later installation of software options.
Temperature coefficient	With temperature compensation activated, the measured value is calculated to the value at the reference temperature using the temperature coefficient.
Temperature compensation	Calculates the measured value for a reference temperature.
Tolerance band recorder	The tolerance band recorder displays the data of the last 45 pH calibrations graphically or as a listing. This allows you to draw conclusions regarding electrode life and the required calibration interval.
Viewing level	“view”, menu level of the Parameter Setting menu. Display of all device settings, however no editing possible.
Warning (maintenance required)	Warning is a NAMUR signal. The limits are set in the Alarm Settings menu. Means that the equipment is still operating properly but should be serviced, or that process parameters have reached a value requiring intervention.
Zero point	pH value at which the pH electrode outputs the voltage 0mV. It is different for each electrode and changes with age and wear.

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