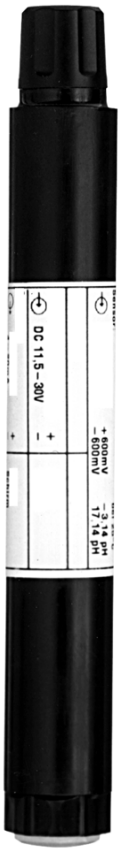
2-wire transmitter

for pH type 202701/10
for redox type 202701/20



B 202701.0
Operating Manual

2013-12-11/00348688

The choice of cable and the electrical connection of the device must conform to the requirements of VDE 0100 "Regulations on the Installation of Power Circuits with nominal voltages below 1000 V" or the appropriate local regulations.

In the neighbourhood of the device there must be no excessive magnetic or electrical fields, e.g. through transformers, portable telephones or electrostatic discharges.

During maintenance and installation operations on the equipment (sensors, controllers, recorders etc.) it is essential to prevent any undesired processes (e.g. due to the switching of relay contacts).

Signal and supply lines should be run separately and not parallel to each other.

The device is not suitable for installation in hazardous areas.

When installing the 2-wire transmitter on the combination electrode it is important to ensure that neither moisture nor dirt can come into contact with the input socket of the 2-wire transmitter.

Content

Content

NOTE!

All necessary operations are described in these Operating Instructions. If, however, any difficulties should arise during start-up, you are asked not to carry out any manipulations on the device which are not permitted. You could endanger your rights under the warranty.

Please contact the supplier.

Other applications have to be agreed with the manufacturer and confirmed in writing.

1.1 General application

The 2-wire transmitters are intended for linking a pH or redox combination electrode with plug connection to indicators/controllers, PLC or PC with a 4 to 20 mA input. On the output side they have a 2-wire connection for supply and standard signal.

When linking the transmitter to a PLC/PC or more complex systems it is **essential** to use an isolated supply unit (supply isolator).

Zero and slope of pH combination electrodes are adjusted not at the transmitter but at the indicator/controller or through a PLC/PC program. No zero or slope calibration is required for redox combination electrodes. The 2-wire transmitter is screwed directly on to the electrode head of the combination electrodes. This arrangement largely prevents interference from dirt, humidity, or electrical fields from live conductors. A conventional coaxial cable is sufficient as connection between the transmitter and the indicator. This permits trouble-free transmission over larger distances between the transmitter and the indicator.

Type 202701/10

The 2-wire transmitter converts the high-impedance signal of the pH electrode (up to 1000 MOhm) into a standard (4 to 20 mA) signal.

Type 202701/20

The 2-wire transmitter converts the signal of the redox electrode into a standard (4 to 20 mA) signal.

1 Description

1.2 Order details

			(1)	**Basic type**
		202701/10		2-wire transmitter for pH
		202701/20		2-wire transmitter for redox
			(2)	**Electrical connection - input**
x	x	86		Cable socket
			(3)	**Electrical connection - output**
x	x	21		Plug cap (S7)
x	x	32		Harting connector (Harax M12)
x	x	83		M12 connector (4-pole)
			(4)	**Measuring span**
x		01		+600 to -600 mV (for pH)
	x	02		-1000 to +1000 mV (for redox)
x		03		-600 to +600 mV (special pH version)
	x	04		-500 to +500 mV (special redox version)

	(1)		**(2)**		**(3)**		**(4)**
Order code		-		-		-	
Order example	202701/10	-	86	-	21	-	01

1.3 Accessories (optional)

Type	**Part no.**
Cable socket, type 2991-00-0/Ø 5 mm (only for connection 21)	00057350
M12 connector (4-pole), serie 713 (matching only to electrical connection 83)	00458581

1.4 Technical data

Input

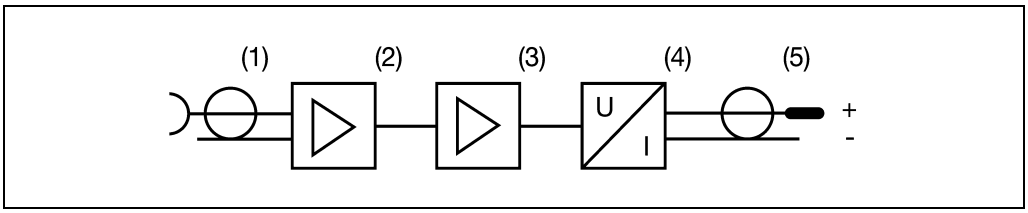
Type 202701/10 (for pH)	The high-impedance voltage signal of the pH combination electrode in the range +600 to -600 mV is converted into a standard 4 to 20 mA signal.
Type 202701/20 (for redox)	The voltage signal of the redox electrode in the range of -1000 to +1000 mV is converted to a standard 4 to 20 mA signal.

General

Case	PVC
Electrical connection	
Input	Coaxial connector suitable for most commercially available electrode connector heads
Output	Coaxial screw-plug connection suitable for cable socket N (**not** isolated from input)
Voltage supply U_B	DC 11.5 to 30 V Nominally DC 24 V
Max. current uptake	40 mA approx.
Voltage supply influence	0.02 % max. of span per Volt deviation from DC 24 V
Output signal	Max. burden $\leq (U_B - 11.5\ V) \div 0.02\ A$
Deviation of characteristic	2.5 % max. reffered to span
Ambient temperature error	0.2 % max. of span per 10 °C referred to span
Burden error	0.02 % max. of span per 100 Ohm burden
Permitted ambient temperature	-5 to +55 °C
Protection	IP65 to EN 60529
CE symbol	EN 50081 Part 1 EN 50082 Part 2
Dimensions	
Diameter	20 mm approx.
Length	145 mm approx.
Weight	200 g max.

1 Description

1.5 Block diagram



1.6 Operation

The combination electrode is connected to the cable socket N (1). The input voltage is passed to the amplifier (2). Stage (3) determines the start and end of the signal assignment. Stage (4) converts the voltage into a proportional 4 to 20 mA current. The connector (5) connects the 2-wire transmitter to the next instruments.

2.1 Location and climatic conditions

The location should be as free as possible from shock and vibration. Electromagnetic fields, e.g. caused by motors, transformers etc., should be avoided.

The ambient temperature at the location must not be outside the range -5 to +55 °C.

Corrosive air and fumes reduce the life of the device.

2.2 Fitting in position

The operating position of the device is unrestricted (note the permitted operating position of the combination electrode).

When fitting the 2-wire transmitter it is important to ensure that the O-rings are correctly positioned and undamaged (one between combination electrode and transmitter, and one between transmitter and cable connector).

When installing the 2-wire transmitter on the combination electrode it is important to ensure that neither moisture nor dirt can come into contact with the input socket of the 2-wire transmitter.

After the electrode connection and the electrical connection have been made, the 2-wire transmitter is ready vor operation.

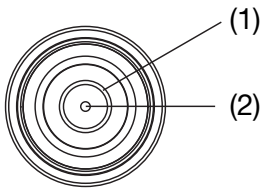
2 Installation

Connection N cable socket (input)

Coaxial plug		**Coaxial cable**	
Outer sleeve	–	Screen	–
Inner pin	+	Inner conductor	+

The current (4 to 20 mA) in the output circuit provides the supply to the 2-wire transmitter (4 mA) and the output signal (4 to 20 mA).

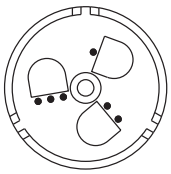
Connection plug (output)



(1) Outer sleeve –

(2) Inner pin +

Connection Harting plug (output)

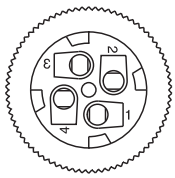


· +

·· –

··· NC

Connection M12 plug (output)



1 +

2 –

3 –

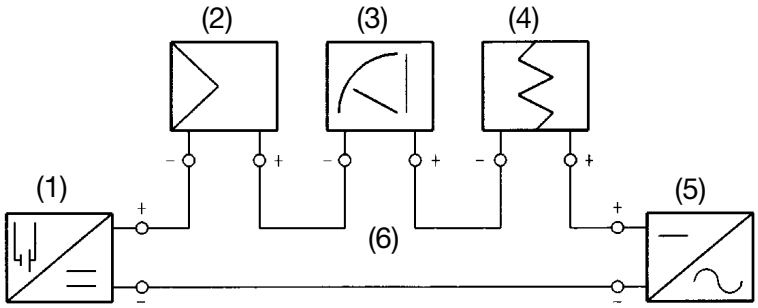
4 +

Supply units suitable for the 2-wire transmitter

e.g. supply units according to data sheet 707500 with galvanic isolation.

3 Electrical connection

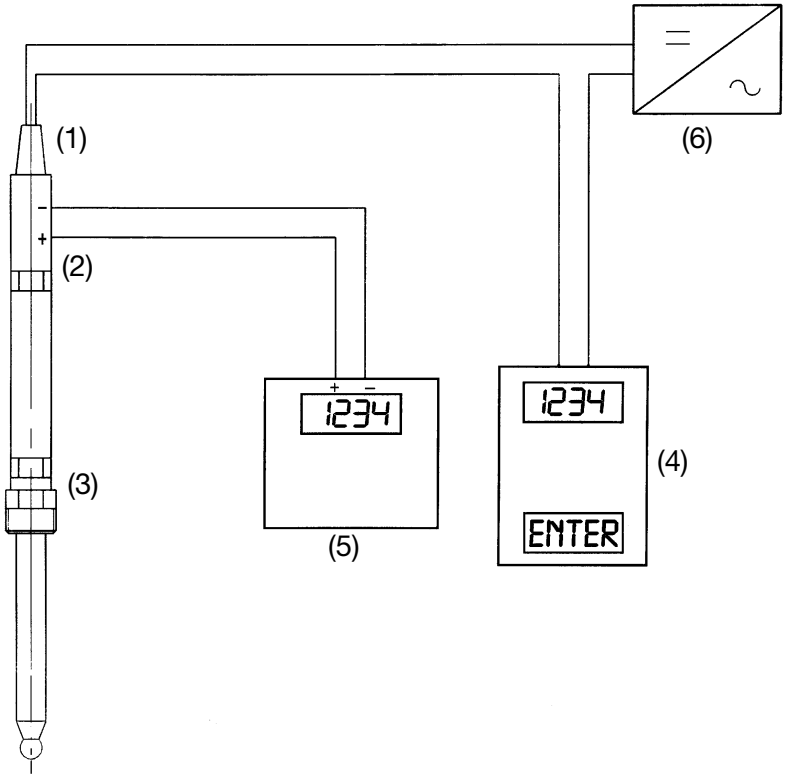
System diagram



(1) 2-wire transmitter
(2) Controller
(3) Indicator
(4) Recorder
(5) Supply unit DC 11.5 to 30 V
(6) 4 to 20 mA current loop

Example

Possible arrangement of a complete measurement circuit for determining electrode parameters using adapter and multimeter.
Supply unit for 2-wire transmitter, with isolation if required.



(1) Measurement adapter (option)
(2) 2-wire transmitter
(3) Combination electrode
(4) µP indicator or controller, or PLC, PC
(5) Multimeter
(6) Supply unit for 2-wire transmitter

The 2-wire transmitter are intended for linking pH and redox combination electrodes with plug connectors to indicators/controllers with 4 to 20 mA input.

At the output they have a 2-wire connection for supply and standard signal.

The current output of the 2-wire transmitter has to be connected to an indicator which then indicates the corresponding pH or redox values.

Definitions

I_O : Instantaneous output current of the 2-wire transmitter in mA

I_{O1} : Output current 1 of the 2-wire transmitter corresponding to buffer solution 1, in mA

I_{O2} : Output current 2 of the 2-wire transmitter corresponding to buffer solution 2, in mA

RS : Theoretical range start of the 2-wire transmitter in pH

Z : Zero of the pH combination electrode

pH : Instantaneous pH of the test solution

pH_1 : pH of buffer solution 1

pH_2 : pH of buffer solution 2

S : Slope of pH combination electrode in mV/pH

S_T : Transfer slope of the 2-wire transmitter in mA/pH

S_{TT} : Transfer slope of the 2-wire transmitter in mA/pH, temperatur-compensated

S_{25} : Slope of the pH combination electrode in mV/pH at 25 °C

x : Indication on PC or PLC in pH or mV

T : Current temperature of the test solution in °C

4 Operation

4.1 Use of the 2-wire transmitter type 202701/10 for pH for subordinate measurement

On the assumption that the combination electrode used has the ideal electrode parameters (slope = 59.16 mV/pH at 25 °C, zero at pH 7.00), the equation for the indicated pH is as follows:

$$\text{Indicator} = \frac{\left(\frac{I_A - 4\ \text{mA}}{16\ \text{mA}} \cdot 1200\ \text{mV}\right) - 600\ \text{mV}}{59.16\ \text{mV/pH}} + \text{pH } 7.00$$

This equation can be incorporated in a PLC or PC program. The PLC or PC measures the output current of the 2-wire transmitter and can then from the above formula determine the value of the pH and indicate it and/or use it for control purposes.

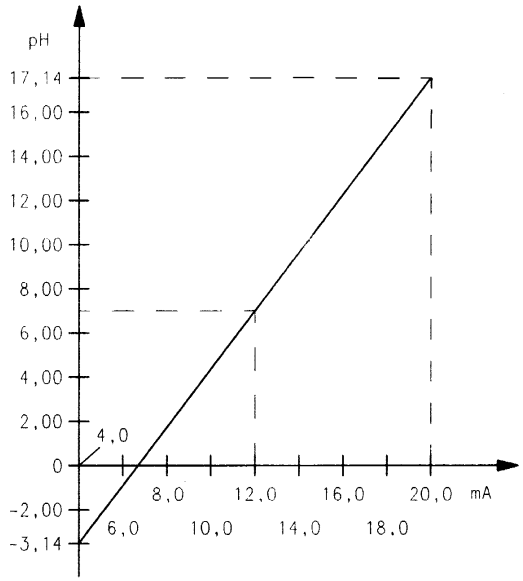
Example

The measured output current is 10.146 mA.

$$\text{Indication} = \frac{\left(\frac{10.146\ \text{mA} - 4\ \text{mA}}{16\ \text{mA}} \cdot 1200\ \text{mV}\right) - 600\ \text{mV}}{59.16\ \text{mV/pH}} + \text{pH } 7.00$$

$$\text{Indication} = \text{pH } 4.65$$

The diagram below has been prepared for an ideal pH electrode with the parameters:
electrode zero at pH 7.00; electrode slope 59.16 mV/pH at 25 °C



4.2 Use of the 2-wire transmitter type 202701/10 for pH with a µP indicator/controller and 4 to 20 mA current input

The calibration of the µP indicator/controller to the output current of the 2-wire transmitter can only be described in general terms (the variation of Nernst voltage with temperature is neglected).

Two pairs of values have to be determined, consisting of buffer 1 (pH_1) with the corresponding output current 1 (I_{O1}) and of buffer 2 (pH_2) with the corresponding output current 2 (I_{O2}).

The pH values are exact only if the test solution has the same temperature as the buffer solutions.

Step 1

Switch the µP indicator/controller to the calibration mode (refer to its Operating Instructions).

Step 2

The pH combination electrode, fitted with the 2-wire transmitter, is immersed with its sensitive part into buffer 1; on the µP indicator/controller the value of buffer 1 is edited.

Step 3

The pH combination electrode, fitted with the 2-wire transmitter, is immersed with its sensitive part into buffer 2; on the µP indicator/controller the value of buffer 2 is edited.

Step 4

The µP indicator/controller now determines the equation of the straight line through which it converts the output current of the 2-wire transmitter into pH.

Step 5

If necessary, return the µP indicator/controller to its normal operating mode.

The system comprising pH combination electrode, 2-wire transmitter and µP indicator/controller is now calibrated.

In order to provide temperature compensation it would be necessary to determine additionally the temperature of the test solution and to be able to input the equations according to chapter 4.3.2 on the µP indicator/controller.

4.3 Use of the 2-wire transmitter type 202701/10 for pH with a PLC or PC and 4 to 20 mA current input

The calibration of a PLC or PC to the output current of the 2-wire transmitter can only be described in general terms.

4.3.1 The variation of Nernst voltage with temperature is neglected

Two pairs of values have to be determined, consisting of buffer pH_1 with the corresponding output current I_{O1} and of buffer pH_2 with the corresponding output current I_{O2}.

The temperature of the buffer solutions corresponds to that of the test solution used later.

Step 1

The pH combination electrode, fitted with the 2-wire transmitter, is immersed with its sensitive part into buffer 1, and the corresponding output current I_{O1} is noted.

Step 2

The pH combination electrode, fitted with the 2-wire transmitter, is immersed with its sensitive part into buffer 2, and the corresponding output current I_{O2} is noted.

Step 3

Using these pairs of values the slope (S_T) in mA/pH can be determined:

$$S_T = \frac{I_{O2} - I_{O1}}{pH_2 - pH_1}$$

Step 4

Determine the theoretical range start RS in pH:

$$RS = \frac{S_T \cdot pH_1 - I_{O1} + 4\ mA}{S_T}$$

Step 5

Establish the equation for the output current in mA:

$$I_O = S_T \cdot (pH - RS) + 4\ mA$$

Step 6

Equation relating the indicated value in pH to any output current:

$$x = \frac{I_O + S_T \cdot RS - 4\ mA}{S_T}$$

This equation can be incorporated in a PLC or PC program. The PLC or PC measures the output current of the 2-wire transmitter and can determine the

pH using the above equation; it can then indicate this value and/or use it for control purposes.

Example for determining the components of the equation in chapter 4.3.1, neglecting the temperature of the test solution

Step 1

Determine the value pairs (values are examples).
pH_1 = 4.65 pH I_{O1} = 10.146 mA
pH_2 = 6.79 pH I_{O2} = 11.834 mA

Step 2

Calculate S_T in mA/pH:

$$S_T = \frac{11.834\ mA - 10.146\ mA}{pH\ 6.79 - pH\ 4.65}$$

$$S_T = 0.789\ mA$$

Step 3

Calculate the theoretical range start RS in

$$RS = \frac{0.789\ mA/pH \cdot pH\ 4.65 - 10.146\ mA + 4\ mA}{0.789\ mA/pH}$$

$$RS = -3.14\ pH$$

Step 4

Insert the values into the equation relating the indicated value in pH to any output current:

$$x = \frac{I_A + 0.789\ mA/pH \cdot (-3.14\ pH) - 4\ mA}{0.789\ mA/pH}$$

4.3.2 If the PLC or PC also evaluates the temperature of the test solution, it is possible to compensate the output current of the 2-wire transmitter for temperature

This involves relating the slope S_T to the temperature (T) of the test solution.

Two pairs of values have to be determined, consisting of buffer pH_1 with the corresponding output current I_{O1} and of buffer pH_2 with the corresponding output current I_{O2}.

The buffer solutions must have a temperature of 25 °C.

Step 1

The combination electrode, fitted with the 2-wire transmitter, is immersed with its sensitive part into buffer 1, and the corresponding output current I_{O1} is noted.

Step 2

The pH combination electrode, fitted with the 2-wire transmitter, is immersed with its sensitive part into buffer 2, and the corresponding output current I_{O2} is noted.

Step 3

Using these pairs of value the slope S_T in mA/pH can be determined:

$$S_T = \frac{I_{O2} - I_{O1}}{pH_2 - pH_1} - 0.00265 \cdot (T - 25\ °C)$$

Step 4

Determine the theoretical range start RS in pH:

$$RS = \frac{S_T \cdot pH_1 - I_{O1} + 4\ mA}{S_T}$$

Step 5

Establishing the equation for the output current in mA:

$$I_O = S_T \cdot (pH - RS) + 4\ mA$$

Step 6

Equation relating the indicated value in pH to any output current:

$$x = \frac{I_O + S_T \cdot RS - 4\ mA}{S_T}$$

This equation can be incorporated in a PLC or PC program.

The PLC or PC measures the output current of the 2-wire transmitter and can determine the pH using the above equation; it can then indicate this value and/or use it for control purposes.

4.4 Determining the electrode parameters of the combination electrode when using the 2-wire transmitter type 202701/10 for pH

Two pairs of values have to be determined, consisting of buffer pH_1 with the corresponding output current I_{O1} and of buffer pH_2 with the corresponding output current I_{O2}.

The buffer solutions must have a temperature of 25 °C.

Step 1

The pH combination electrode, fitted with the 2-wire transmitter, is immersed with its sensitive part into buffer 1, and the corresponding output current I_{O1} is noted.

Step 2

The pH combination electrode, fitted with the 2-wire transmitter, is immersed with its sensitive part into buffer 2, and the corresponding output current I_{O2} is noted.

Step 3

Calculating the electrode slope S in mV/pH:

$$S = \frac{(I_{O1} - I_{O2}) \cdot 75\ \text{mV/mA}}{pH_1 - pH_2}$$

Step 4

Calculating the electrode zero Z in pH:

$$Z = \frac{75\ \text{mV/mA} \cdot (I_{O1} - 4\ \text{mA}) - 600\ \text{mV}}{S} + pH_1$$

If the temperature of the buffer solutions was not equal to 25 °C, the electrode slope S_{25} at 25°C in mV/pH can be calculated from the following formula:

$$S_{25} = S - 0.1983 \cdot (T - 25\ °C)$$

No freh calculation of the electrode zero is required.

Example of determinging the electrode parameters using the equations in chapter 4.4

Step 1

Determine the value pairs (values are examples):
pH_1 = 4.65 pH I_{O1} = 10.146 mA
pH_2 = 6.79 pH I_{O2} = 11.834 mA

Step 2

Calculate the electrode slope S in mV/pH:

$$S = \frac{(10.133\ \text{mA} - 11.821\ \text{mA}) \cdot 75\ \text{mV/mA}}{\text{pH } 6.79 - \text{pH } 4.65}$$

$$S = 59.16\ \text{mV/pH}$$

Step 3

Calculate the electrode zero Z in pH:

$$Z = \frac{75\ \text{mV/mA} \cdot (10.133\ \text{mA} - 4\ \text{mA}) - 600\ \text{mV}}{59.16\ \text{mV/pH}} + \text{pH } 4.65$$

$$Z = \text{pH } 7.02$$

4.5 Use of the 2-wire transmitter type 202701/20 for redox

There is a fixed linear equation for the 2-wire transmitter type 202701/20 for redox.

Indicated value (x) in mV
Output current of the 2-wire transmitter I_O in mA:

$$x = \left(\frac{I_O - 4\ \text{mA}}{16\ \text{mA}} \cdot 2000\ \text{mV}\right) - 1000\ \text{mV}$$

This equation can be incorporated in a PLC program.

The PLC measures the output current of the 2-wire transmitter and can then determine the redox value using the formula indicated above; this can then be indicated and/or used for control purposes.

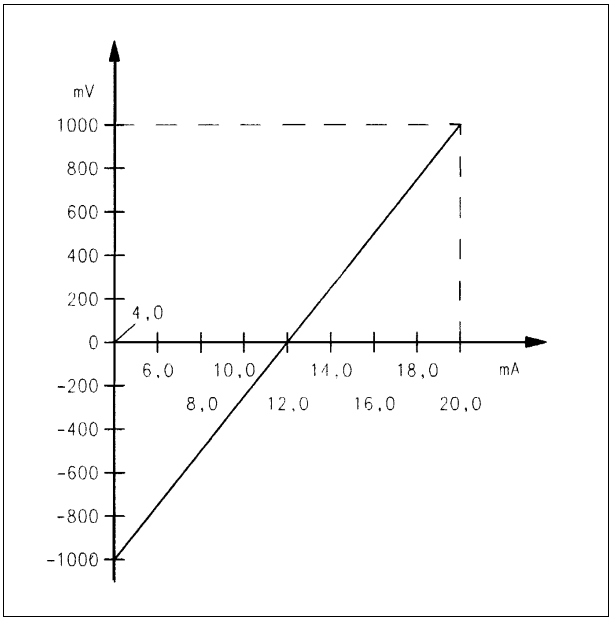
Example for determining the indicated value

Measured output current of the 2-wire transmitter = 8 mA.

$$x = \frac{8\ \text{mA} - 4\ \text{mA}}{16\ \text{mA}} \cdot 2000\ \text{mV} - 1000\ \text{mV}$$

Indicated value x = -500 mV

The following sketch is drawn according to the equation under 4.5.



The 2-wire transmitters type 202701/10 and type 202701/20 are maintenance-free.

In case of a malfunction send the device back to your supplier along with an error description.

5 Maintenance/Malfunction

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