

Electrochemical Sensors



From patented glass contact thermometers to analytical measurement technology



JUMO's success story is closely linked to glass technology. It began in 1907 with Hermann Juchheim, father of Moritz Juchheim, the founder of the present company M. K. JUCHHEIM GmbH & Co KG. The Gebrüder Juchheim (Juchheim Bros.) company was established back in 1934, in Ilmenau in Thuringia, and manufactured glass thermometers. Since 1947, laboratory and industrial thermometers have been produced at a new location, Fulda, in Hesse (Germany), under the JUMO brand name. In the seventies, on the basis of these experiences in working with glass as a material, JUMO started to produce glass parts for electrochemical sensors for pH value, redox potential, conductivity and temperature. The modern-day JUMO Analytical Measurement product line emerged from these beginnings. Since then, production of pH and redox electrodes has outstripped the success of the glass thermometer. Today, JUMO is one of the largest manufacturers of electrochemical sensors in Europe. Many customers purchase their electrodes from JUMO marked with their own company logo – the production of such OEM versions and special styles is one of our strengths.

As well as the pH and redox electrodes, we also manufacture the necessary protection fittings, electronic instrument amplifiers and controllers. Measuring cells for electrolytic conductivity, dissolved oxygen, chlorine, chlorine dioxide, and a patented hydrogen peroxide sensor round off the product spectrum.

Nowadays, the manufacture of electrochemical sensors is carried out in semi-automated and fully-automated production stages. As a result, a consistently high quality is achieved. In addition, computer-aided measurement stations, e.g. during the final inspection, ensure that quality-related parameters are maintained. Each individual JUMO electrode is therefore routinely tested before dispatch. Experienced staff in the glass-blowing shop produce items ranging from individual sensors to mass production runs in many different styles, for almost all conceivable applications.

Right from the start, the important thing was obtaining the expertise in membrane glasses. These "recipes" are an essential component of a top-quality pH electrode. Today, JUMO can supply pH membrane glasses for the widest possible range of applications, based on their own internal research. However, the other components of a pH and redox electrode also have to be optimized for the corresponding application. Liquid, high-viscosity reference electrolyte and high-temperature gels up to 135 °C with a cartridge system ensure a stable reference voltage; this is a guarantee for reproducible values with potentiometric measurements.

JUMO pH and redox electrodes are used in almost all sectors: drinking water and swimming pool water, urban and industrial waste water, neutralization plants, final inspection, chemical industry, process and rinsing water, food technology, laboratory measurement, biotechnology and aquaria.

Membrane glasses

The pH-sensitive part of a pH electrode is made of special glass, known as membrane glass. In the simplest case, the membrane glass is blown into a glass ball. Other forms of membrane glass are cone, rounded, insertion or flat membranes. Years of experience are needed to design a membrane glass suitable for practical use. If the composition of a glass melt is changed, then a lengthy series of tests is required to ensure that the sensor functions correctly. Because of the various physical and chemical conditions, there is no “universal” form of membrane glass for all areas of use. Here, JUMO offers a selection of tried and tested membrane glasses of their own design.

JUMO HT glass

Special high-temperature glass up to 135 °C operating temperature. Normally, high temperatures are detrimental to a pH electrode. The special glass mixture used, together with special GH high-temperature gel, makes the electrodes more reliable in this case.

JUMO U glass

The proven, universal, low-resistance pH membrane glass for all normal applications for pH values 0 - 12 (14 for short periods). Typical temperature range up to 80 °C.

JUMO HA glass

The HA glass has a similar composition to the HT glass. The pH electrodes with HA glass are optimized for measurements in the high alkali range up to pH 14.

JUMO DS glass

During (steam) sterilization, the pH electrode is exposed to an elevated temperature for a certain period of time. The subsequent operating temperature is below the sterilization temperature. The DS glass allows repeated (steam) sterilization of the pH electrode at temperatures up to 135 °C. The outstanding feature of these membrane glasses is the high reproducibility.

JUMO CM glass

Special membrane glass mixture, e.g. for insertion-type pH electrodes. Electrodes with CM membrane glass are used in food testing or in semi-solid media.

JUMO TT glass

Membrane glasses have the property of greatly increasing their internal resistance at low temperatures. So that measurements are generally still possible at sub-zero temperatures, this membrane glass has a special low-resistance composition. Measurements can then be made between -30 and +30 °C.

JUMO C glass

Fluorides attack glass and so, of course, the sensitive glass membrane. Membranes made of JUMO C glass are particularly fluoride-tolerant (up to 1000 mg of HF per liter).

Flat membrane

Flat membrane electrodes normally have particularly robust glass membranes; these also permit measurement on surfaces.



Reference electrolyte and diaphragm



Reference electrolyte

A pH or redox electrode needs a reference electrode as the counter electrode. This reference electrode has to supply a stable potential, independent of the pH value, against which the potential of the glass or metal electrode is measured. With the combination electrode, the pH glass or metal electrode is arranged together with the reference electrode in one shaft.

Electrolyte types are classified as follows:

Liquid KCl

Usually a 3-molar solution. Electrodes can be refilled and so have a long service life. However, these electrodes need regular care, i.e. the out-flowing electrolyte must be regularly topped up. This type of electrode has the best measuring properties.

High-viscosity KCl solution (JUMO gel)

Liquid KCl is thickened (set) by additives not harmful to health. Standard with JUMO – the good characteristics of a liquid-filled electrode are largely unchanged. An additional salt reservoir **1** (recognizable by salt crystals in the interior) means increased service life and low-maintenance.

Solid electrolyte / gel

Solidified (polymerized) reference electrolyte. Measurement results are usually more inaccurate and have poorer reproducibility.

Conductive system

The conductive system used as standard by JUMO in the reference electrode is the cartridge system **2**. Silver / silver chloride is immersed in the reference electrolyte in a small glass or plastic tube. The tube is closed with a fleece material. As a result, the remaining reference electrolyte is free from silver ions. This style is the industry standard. With simple electrodes, on hand-held instruments, for example, a wire conductor is used. The reference electrolyte is then contaminated with silver ions, which can lead to chemical reactions / blockages in the diaphragm.

pH or redox electrodes that are filled with liquid KCl electrolyte can be manufactured with spherical or cylindrical extended glass bodies **3**. The tubing nipple serves as a refilling port or for connection of KCl storage reservoirs.

Doka

For special applications, the 2-chamber system is available. The cartridge is separated from the actual external diaphragm by a second chamber. The second chamber can be filled with a KNO_3 solution, for example, allowing permanent measurements to be made in specific media that react chemically with KCl. Because of the longer diffusion path, the impurity ions that are harmful to the electrodes cannot gain access as readily.

Diaphragm

The diaphragm is the part of a pH or reference electrode that is most crucial for reliable, reproducible and rapid measurements. The requirements of the most variegated applications are satisfied by the various styles available.

Today, high-quality industrial electrodes are fitted with a zirconium dioxide *ceramic diaphragm* ④ as standard. Its optimal diffusion properties are particularly important with gel electrodes or electrodes with high-viscosity KCl solution. A more basic ceramic quality is used on lower-cost electrodes. JUMO uses zirconium dioxide as standard. Depending on the application, up to three diaphragms can be sealed together. Increasing the number of diaphragms allows the electrodes to be used with low conductivity values too, in the pure water range, for example. Electrodes with ground diaphragms are recommended for use with high-purity water.

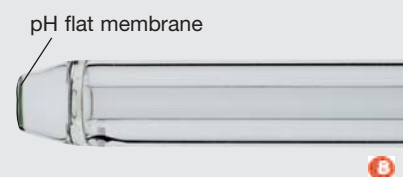
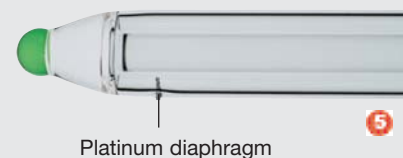
With electrodes that are filled with a liquid KCl solution, a *platinum diaphragm* ⑤ (Pt diaphragm) can be supplied. A number of platinum fibers form a braid that is sealed into the shaft glass. Because of the high KCl throughput, electrodes with Pt diaphragms are relatively insensitive to flow. The platinum material is also highly chemically resistant.

The operating principle of the *glass fiber diaphragm* ⑥ is based on capillary action. A bundle of glass fibers is inserted in a rubber reinforcement – standard with JUMO on electrodes with a plastic shaft. A simpler variation of the glass fiber diaphragm is the fiber diaphragm made of polyolefin. The fiber diaphragm is used on lower-cost electrodes for hand-held instruments or aquaria.

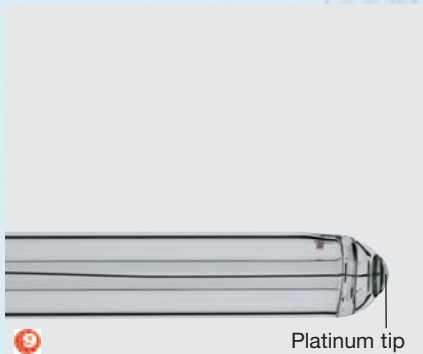
The *Teflon ring diaphragm* ⑦ is employed in electrodes that are used in heavily polluted media. Because of the “self-cleaning” effect of the Teflon material and the large ring-shaped surface, the electrode is especially suitable for use with media containing oil and grease.

pH electrode with flat membrane ⑧

Flat membrane electrodes normally have particularly robust glass membranes. So special glasses, JUMO glass C, for example, permit use in abrasive media, such as in galvanizing or etching processes, etc. The electrodes can be supplied with either ceramic or Teflon ring diaphragm. Versions with a plastic shaft are also available; these also permit measurement on surfaces.



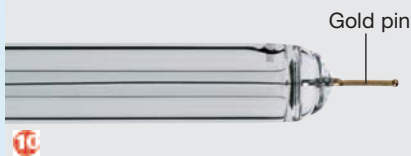
Redox electrodes



JUMO produces quality sensors for redox potential measurement in all applications in drinking water and swimming pool water disinfection, industrial and urban waste water treatment, or process monitoring. What is referred to as the glass membrane on pH electrodes, is called the “active element” on a redox electrode. This consists of a platinum or gold electrode in rounded or pin design. There is no difference between the rounded and pin type from the measurement point of view. Like the pH electrodes, the redox combination electrode contains a reference electrode and can be supplied with various electrolytes and diaphragms, depending on the application.

Redox combination electrode with rounded platinum tip 9

Universal redox sensor for industrial use, e.g. nitrite oxidation or swimming pool and drinking water monitoring. Ceramic or teflon ring diaphragm possible.



Redox combination electrode with gold pin 10

Universal redox sensor for industrial use, e.g. chromate reduction or cyanide decontamination. Ceramic or Teflon ring diaphragm possible.



Metal twin electrodes with platinum-platinum or platinum-gold active elements 11

An AC voltage is applied to the two precious metal electrodes using suitable instrument amplifiers. A conventional reference electrode forms the reference potential. Also used in laboratories for the Karl-Fischer titration.

Glass sensors for conductivity and temperature

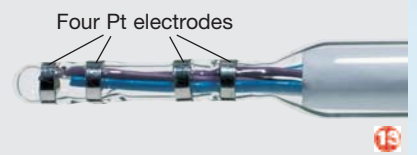
Glass conductivity measuring cells with platinum electrodes 12

For measurement of the electrolytic conductivity using the 2-electrode method. Can be supplied with or without integral temperature probe.



Glass conductivity measuring cells with platinum electrodes 13

For measurement of the electrolytic conductivity using the 4-electrode method. Can be supplied with or without integral temperature probe.



Glass thermometer Pt 100 or Pt 1000 (compensation thermometer) 14

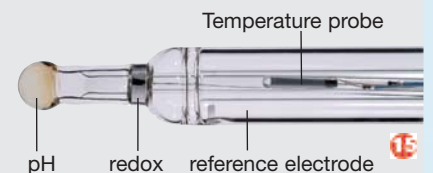
Used to measure the temperature of the medium and for temperature compensation, in pH measurement, for example. Particularly chemically resistant because of the glass shaft. Can be supplied as twin Pt 100 or Pt 1000 on request.



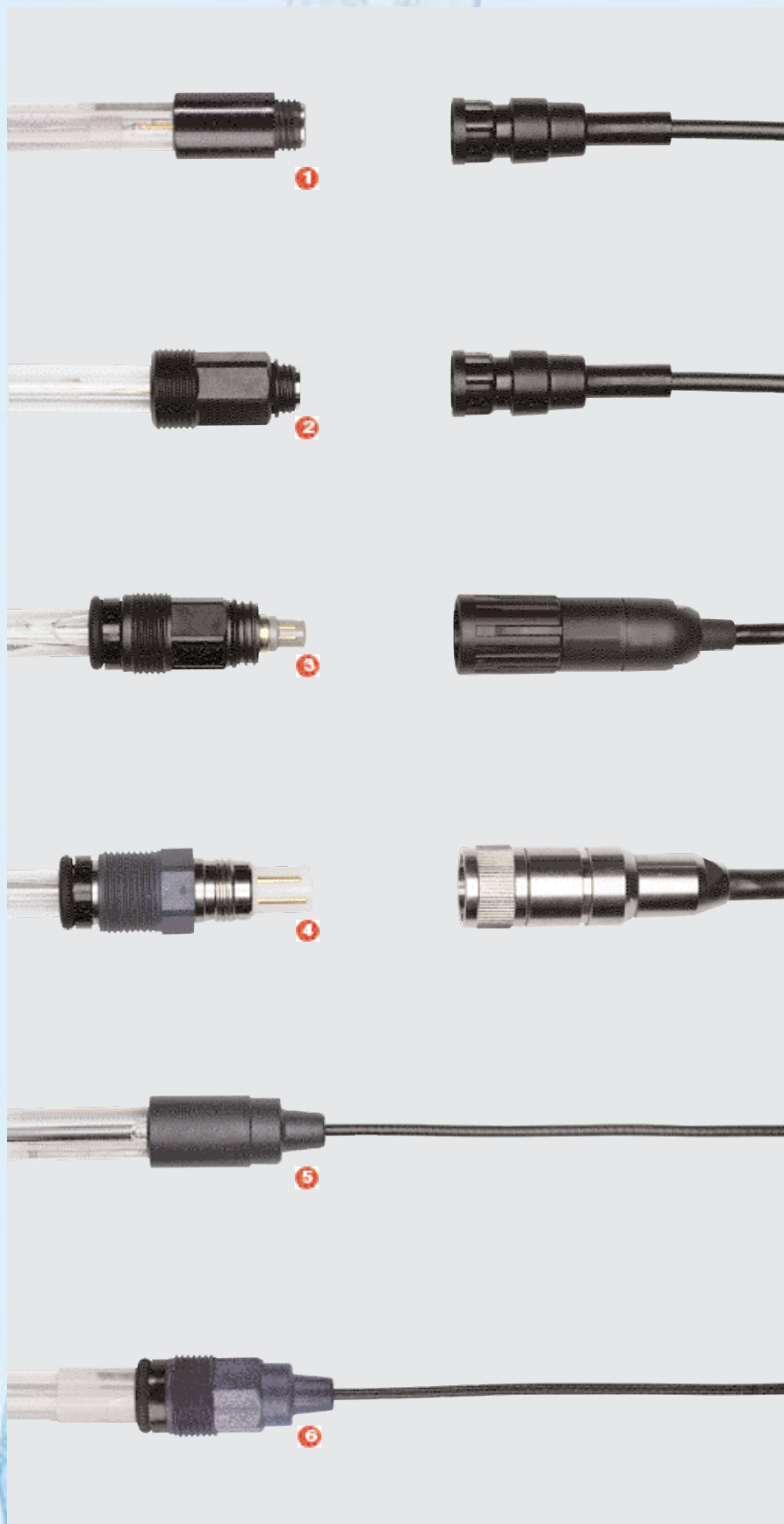
Multisensors

Multisensor JUMO Multitrode 15

Simultaneous measurement of pH value, redox potential and temperature with only one sensor.



Electrode connections and cable



Because of the high-impedance nature of pH measurement, great care is needed with the electrical connections of the sensor and the connected instrument amplifier / controller. All contacts must be gold-plated type.

The 2-pole cap N type terminal head for connection of the pH and redox electrodes is now widely used in Europe. There are versions with **2** or without **1** Pg 13.5 male thread. This cap system is also known under the names S7 and S8 and has been tested in service over many years.

For multiparameter electrodes (e.g. combination of pH combination electrode and temperature probe or with the JUMO Multitrode), JUMO use several different cap systems. The preferred type is the SixPlug system **3** (formerly designated SMEK). The use of this system is now firmly established with a number of electrode manufacturers as standard, and provides a reliable electrode connection with IP68 protection. On the basis of NAMUR recommendations, JUMO uses this cap system as standard.

However, as a manufacturer of pH / redox electrodes, JUMO also offers customers other readily available cap systems, such as the VP / Variopin or the Variopol **4** system. Of course, JUMO can also supply all sensors with a fixed cable connection (with **6** and without **5** Pg 13.5 thread).

Electrode connection and cable

JUMO offers all standard connector systems for the instrument-side connection plug.

N plug 1

(cable socket Type N, rotating (S7 / S8) and cable plug)

DIN plug 2

(for portable and bench instruments)

BNC plug 3

(for industrial measurement and control instruments, bench instruments, etc.)

Shieldkon 4

(e.g. transition from coax to screw terminals)

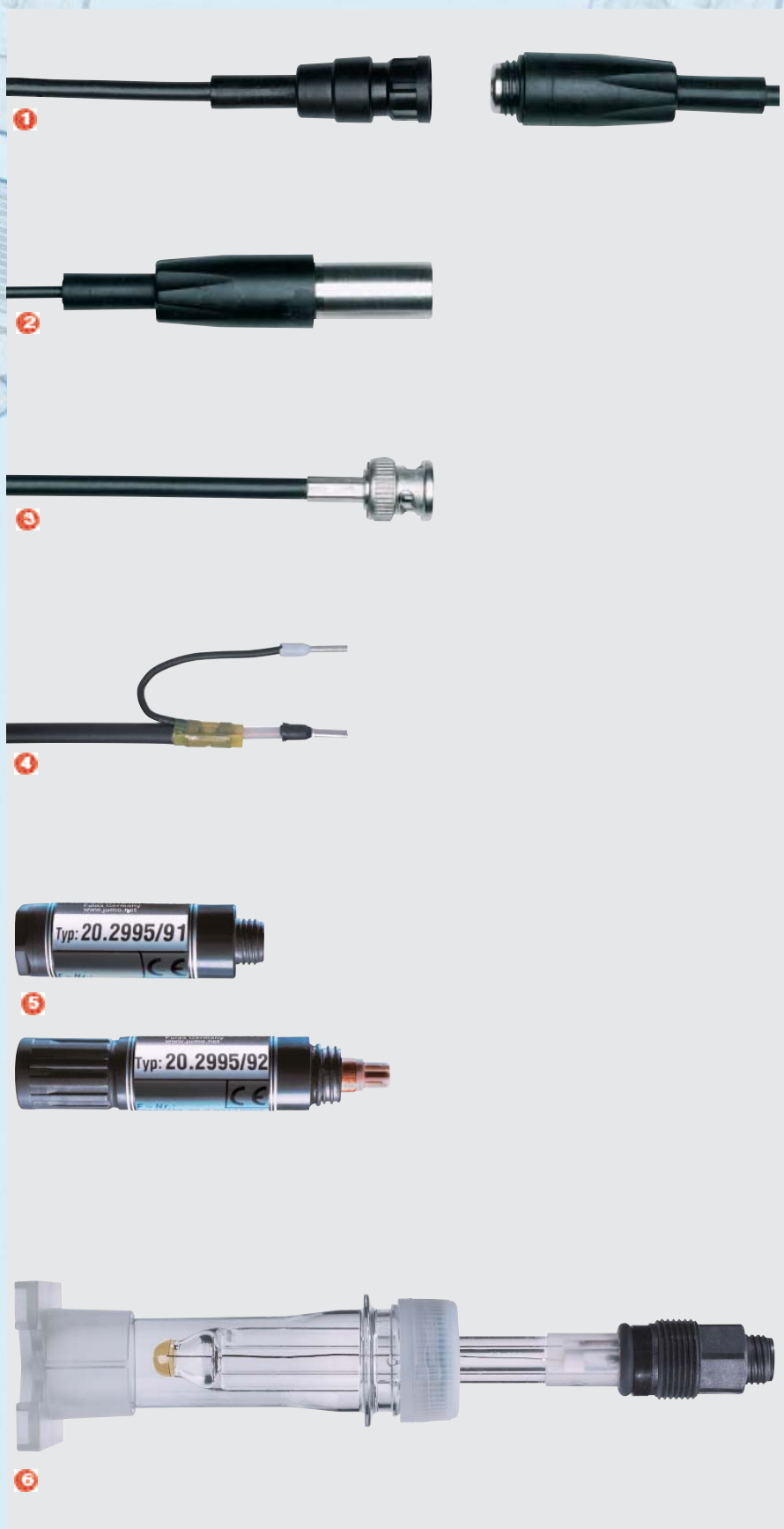
Other types on request!

The impedance converter 5

ensures an interference-proof transmission of the high-impedance voltage signal of a pH electrode, particularly with long cable lengths (> 20m) or in critical surroundings. With redox electrodes it provides stabilization of the measurement signal. A long-life lithium battery permits retrofit without additional wiring. Available for S7 / S8 and SMEK caps.

KCl reservoir 6

The delivery program also includes containers for transportation and storage of pH / redox electrodes (electrode case). The removable foot can be used as a tool for screwing the electrodes in and out. On request we can supply you with JUMO electrodes pre-packed in the reservoir.



JUMO Analytical Measurement product range

- pH / redox: sensors and transmitters / controllers
- conductivity measurement systems: conductive and inductive
- dissolved oxygen measurement
- chlorine, chlorine dioxide, ozone and hydrogen peroxide measurement
- fittings and accessories
- buffer and test solutions, electrode cleaners
- customized solutions



Paperless recorder

JUMO LOGOSCREEN AQUA 500

Multiparameter acquisition system for analytical measurement

- equipped with three or six measurement channels
- for process variables, pH value, redox voltage, chlorine, chlorine dioxide, ozone conductivity and standard voltage signals
- for all measurement inputs:
 - evaluation of the electrode condition in plain text
 - log book of calibrations and sensor aging
 - integrated calibration procedures
 - up to three alarm relays
- wide choice of sensors for electrochemical values and temperature
- backup of data records on formatted 3.5" diskette

An acquisition system that can be used in many different ways with the widest possible range of different sensor signals has developed from the proven platform of the LOGOSCREEN 500. The LOGOSCREEN AQUA 500 can be equipped with three or six measurement channels.

As well as the standard current and voltage and temperature sensor signals, special parameters such as pH value, redox potential, chlorine, chlorine dioxide, ozone or conductivity are now used as input variables too. The multiplicity of functions as a recording instrument have all been fully retained.

A new feature here is that the calibration procedures, for the pH measurement, for example, are now integrated in the instrument, so a separate fully-equipped pH transmitter is not required. As well as the standard current and voltage signals (0 - 10V; 0(4) - 20mA) and resistance thermometer inputs

(Pt100, Pt500, Pt1000), the following process variables can be conditioned and calibrated:

pH / redox measurement

- standard pH and redox electrodes can be connected via a JUMO Type 202710 2-wire transmitter or using a Type 2AMZ-20 impedance converter
- menu-led calibration of the sensors
- 1-, 2- or 3-point calibration
- automatic temperature compensation

Conductivity

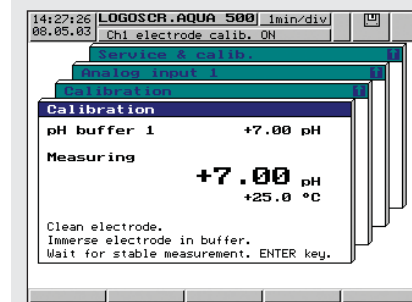
- connection of conductive and inductive measuring cells via standard signal, e.g. JUMO CTI-Junior to data sheet 20.2754
- calibration of cell constant and temperature coefficient
- automatic temperature compensation
- integrated non-linear concentration curves (H_2SO_4 , HNO_3 , HCl , $NaOH$, $NaCl$, KOH)
- high-purity water compensation to ASTM and USP

Free chlorine, chlorine dioxide and ozone measurement

- 1- point calibration
- pH value and temperature-corrected chlorine measurement

For all measurement inputs

- evaluation of the electrode condition in plain text
- log book of calibrations and sensor aging
- integrated calibration procedures
- up to three alarm relays
- interface (optional)



Fax reply

(for fax number see address below)

PR 20017 GB "Electrochemical sensors"

Please send me

Sender:

- ☐ full information (Data Sheet 20.2900)
- ☐ detailed information on the
JUMO LOGOSCREEN AQUA 500 (Data Sheet 20.2595)
- ☐ your sectional catalog "Analytical Measurement"
- ☐ "Information on high-purity water measurement"
(FAS 614)
- ☐ "Information on redox potential measurement"
(FAS 615)
- ☐ "Information on the amperometric measurement of
free chlorine, chlorine dioxide and ozone in water"
(FAS 619)
- ☐ "Information on conductivity measurement"
(FAS 624)
- ☐ your Product Guide
- ☐ your CD-ROM "Products"

Name

Company

Address

Industry

Phone

Fax

e-mail

Date

stamp and signature

with

Phone

Date / time



JUMO GmbH & Co. KG

Street address:
Moltkestraße 13 - 31
36039 Fulda, Germany
Postal address:
36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
e-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.

JUMO House
Temple Bank, Riverway
Harlow, Essex CM 20 2TT, UK
Phone: +44 12 79 63 55 33
Fax: +44 12 79 63 52 62
e-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO PROCESS CONTROL INC.

885 Fox Chase, Suite 103
Coatesville PA 19320, USA
Phone: 610-380-8002
1-800-554-JUMO
Fax: 610-380-8009
e-mail: info@JumoUSA.com
Internet: www.JumoUSA.com