

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 and chlorine dioxide 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 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 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 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 UW glass

This type of membrane glass is distinguished by an extremely low resistance. At 25 °C it only amounts to about 60 MΩ.

JUMO C glass

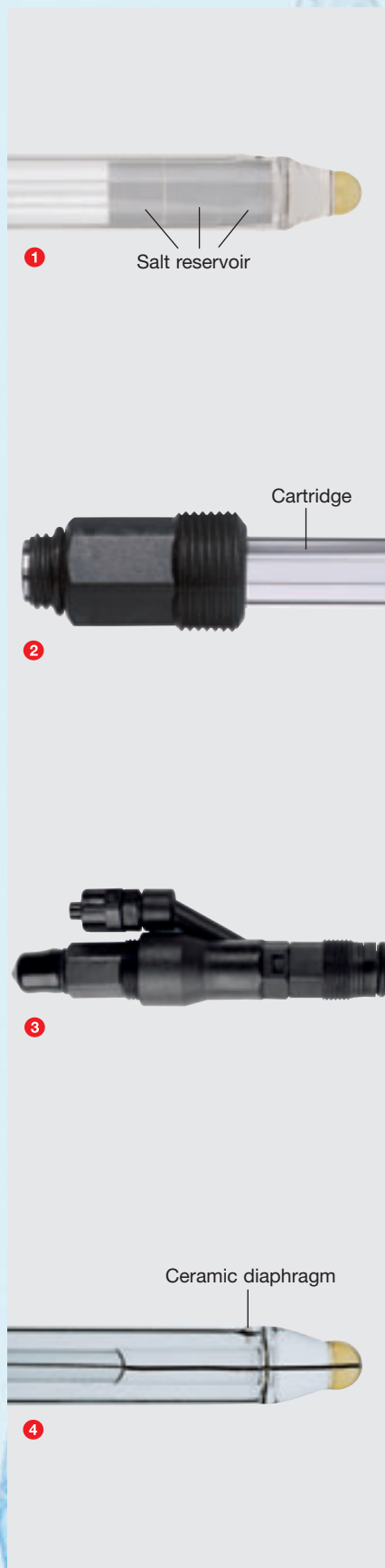
Fluorides attack glass and so, of course, the sensitive glass membrane. Membranes made of JUMO C glass are particularly fluoride-tolerant (up to 1000 mg of HF per liter).

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

Solidified (polymerized) reference electrolyte. Especially for applications in heavily polluted media, emulsions and suspensions, or for use in media containing proteins or sulfides. 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 as an electrolyte can be delivered with a separate KCl connection **3**.

This ensures a continuous supply of electrolyte to the electrode (when used together with a KCl reservoir).

Double chamber

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.

The operating principle of the *glass fiber diaphragm* 5 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* 6 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.

Diaphragms that are perforated or have an annular gap 7 and open boundaries can only be used in connection with a solid electrolyte.

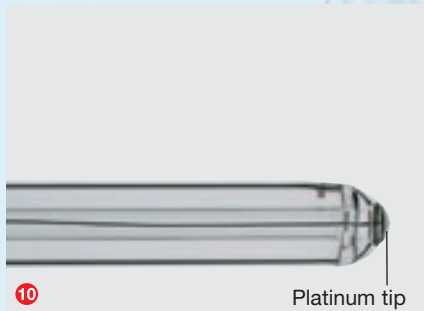
A blockage of the diaphragm can be effectively excluded in this case, since the solid electrolyte that is used will swell somewhat in the medium, and this results in a self-cleaning effect.

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



Platinum tip

10



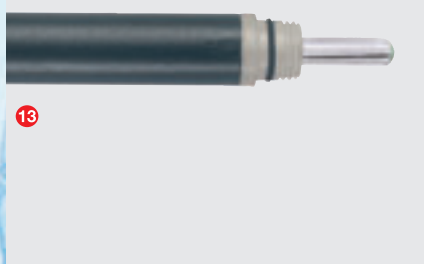
Gold tip

11



Pt or gold pin

12



13

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 10

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 tip 11

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 12

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.

Ion-sensitive electrodes - ammonia sensor 13

This special membrane-covered sensor is available for measuring ammonia concentrations in aqueous systems.

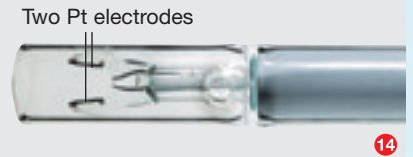
A typical application for this sensor is, for instance, monitoring for leaks in refrigeration plant that is operated with ammonia.

In this case, the system monitors the possible leakage of ammonia in the cooling circuit.

Glass sensors for conductivity and temperature

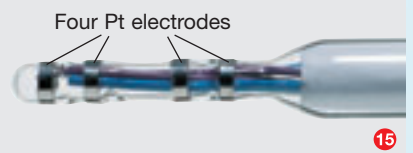
Glass conductivity measuring cells with platinum electrodes 14

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 15

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



Glass thermometer Pt100 or Pt1000 (compensation thermometer) 16

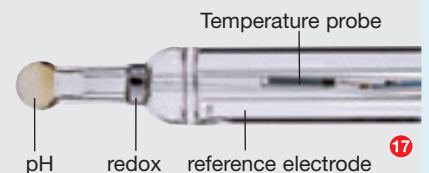
Used to measure the temperature of the medium and for temperature compensation, in pH measurement, for example. Particularly chemically resistant because of the glass shaft. Can be supplied as twin Pt100 or Pt1000 on request.



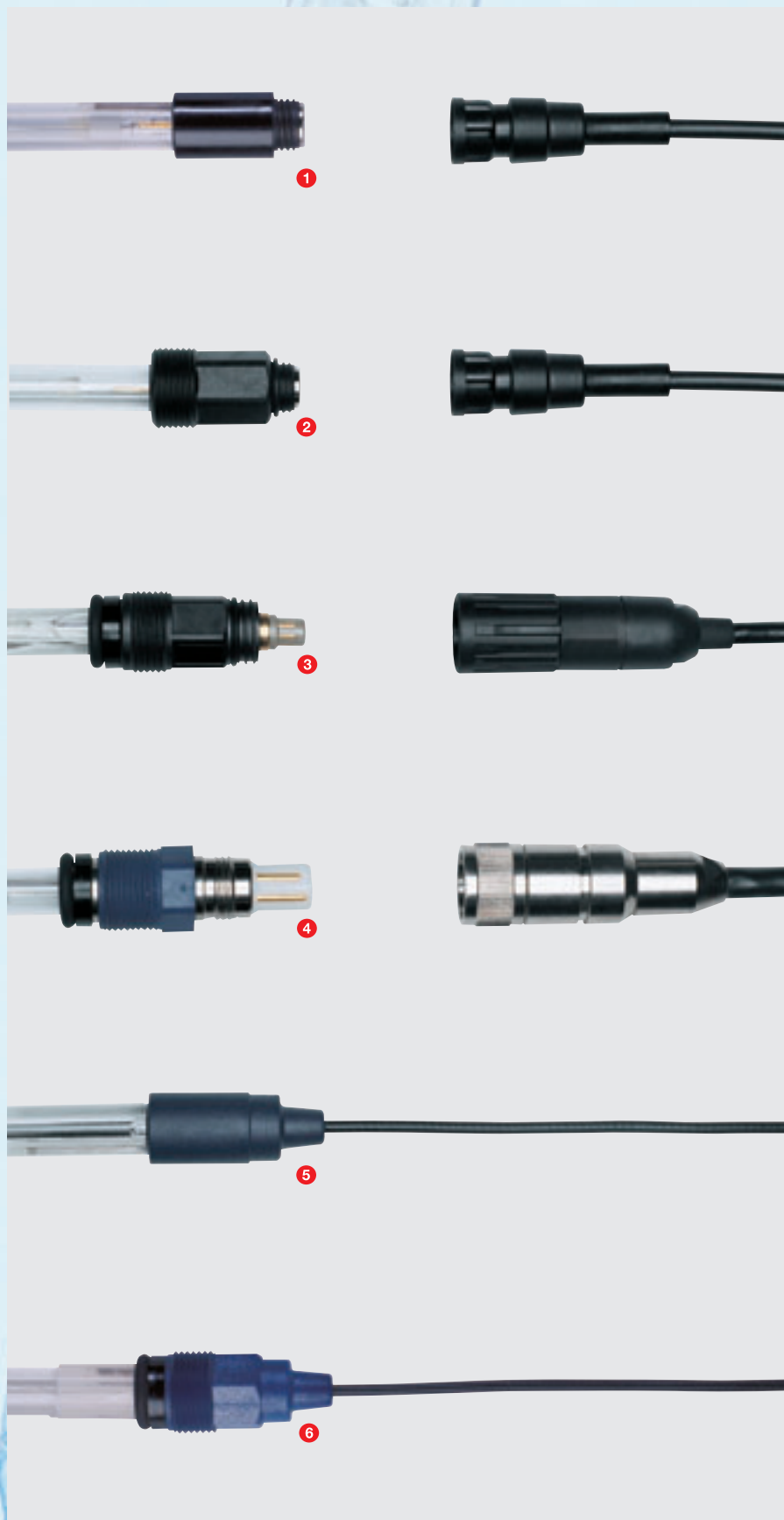
Multisensors

Multisensor JUMO Multitrode 17

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)

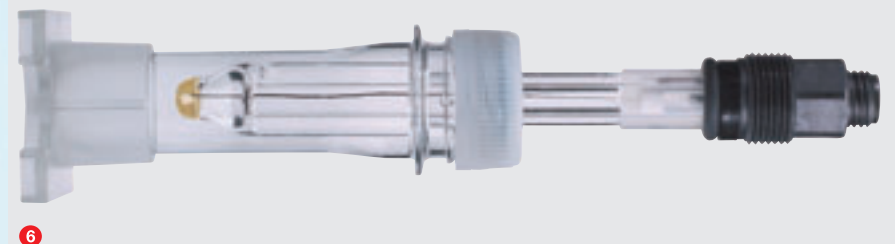
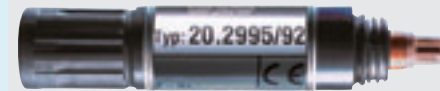
BNC plug 3
(for industrial measurement and control instruments, bench instruments, etc.)

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.



Selection guide for electrodes

Application	JUMO ecoLine	JUMO BlackLine	JUMO tecLine	empfohlener Typ
Drinking water treatment	+	+	+	JUMO ecoLine, glass stem, ceramic diaphragm, gel filling
Swimming baths	+	+	+	JUMO ecoLine, glass stem, ceramic diaphragm, gel filling, salt reservoir
Aquaria	+	+	+	JUMO ecoLine
Greenhouses	+	+	+	JUMO BlackLine
Lightly polluted media	+	+	+	JUMO ecoLine
Rainwater, pond or surface water	+	+	+	JUMO ecoLine pH, glass stem, ceramic diaphragm, gel filling, U glass (universal glass)
Electroplating	+	-	+	JUMO tecLine pH, glass stem, ceramic diaphragm, gel filling, U glass (universal glass)
Industrial process and wastewater	+	-	+	JUMO tecLine pH, glass stem, PTFE diaphragm, gel filling, U glass (universal glass)
High-purity water	-	-	+	JUMO tecLine pH, glass stem, ground diaphragm, KCl liquid electrolyte, U glass (universal glass)
Therapeutic baths	-	-	+	JUMO tecLine pH, glass stem, ceramic diaphragm, gel filling, U glass (universal glass)
Biotechnology, sterilization processes	-	-	+	JUMO tecLine pH, glass stem, ceramic diaphragm, gel filling, DS glass (steam-sterilizable membrane glass); applications up to 80 °C; sterilization up to 140 °C, briefly (20 min)
Industrial water and wastewater engineering	-	-	+	JUMO tecLine pH, glass stem, ceramic diaphragm, gel filling
Suspensions, varnishes and heavily polluted media	-	-	+	JUMO tecLine pH, glass stem, perforated or annular-gap diaphragm, solid electrolyte
Low-ion media	-	-	+	JUMO tecLine pH, glass stem, two or three ceramic diaphragms, KCl liquid electrolyte
Highly alkaline applications	-	-	+	JUMO tecLine pH, glass stem, ceramic diaphragm, gel filling, HA glass (high-alkali glass)
High-temperature applications	-	-	+	JUMO tecLine pH, glass stem, ceramic diaphragm, high-temperature gel filling, HT glass (high-temperature glass)
Media containing fluorides	-	-	+	JUMO tecLine pH, glass stem, ceramic diaphragm, gel filling, C glass (fluoride-resistant membrane glass)

JUMO Analytical Measurement product range

The image displays a variety of JUMO analytical measurement equipment against a blue background with water droplets. The products are arranged to showcase different measurement capabilities:

- Redox:** A blue transmitter with a digital display showing 'MEASUREMENT 25.9' and '25.0°C mS/cm'. It features buttons for K1, K2, PGM, and EXIT, along with up and down arrow keys.
- O₂ / Ozone:** Two black cables with specialized sensors at the end.
- pH:** A transmitter with a red digital display showing '8.20' and a green display showing '25.0'. It includes buttons for PGM and EXIT, and up/down arrow keys.
- Chlorine:** A transmitter with a digital display showing '900' and 'µS/cm'. It features buttons for K1 and EXIT, and up/down arrow keys.
- Conductivity:** Two glass electrodes with black caps, one of which has 'JUMO' printed on it.

Large, stylized text labels for 'Redox', 'O₂', 'Ozone', 'pH', 'Chlorine', and 'Conductivity' are overlaid on the image to identify the measurement types.

- 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

High-profile products and services

e-mail: mail@jumo.net

Phone: +49 661 6003-0



Analytical Measurement

- pH/redox: sensors and transmitters/controllers
- Conductivity instrumentation: conductive and inductive
- Dissolved oxygen measurement
- Chlorine, chlorine dioxide, ozone, hydrogen peroxide and peracetic acid instrumentation
- Fittings and accessories



Controllers, Power units, System/Recording technology

- Process controls and programmers
- Automation software
- Electronic thermostats/microstats
- Safety temperature monitor/limiter
- Digital indicators
- Process controller
- Recording instruments
- Temperature transmitters
- Thyristor power switches/power units
- Software and accessories



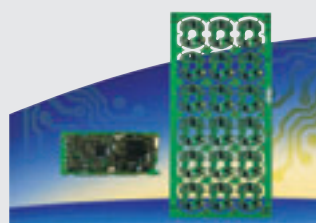
Thermostats and Dial Thermometers

- Panel and surface mounting thermostats in TR, TW, TB, STW and STB versions
- Room thermostats
- Warm-air thermostats
- Ex thermostats (ATEX)
- Electronic thermostats
- Dial thermometers as indicating and control instruments
- Bimetallic temperature switches
- Electronic temperature indicators with transmitter



Pressure measurement technology

- Pressure transmitters
- Level probes
- Pressure gauge
- Pressure switch
- Pressure cells
- Chemical seals and accessories



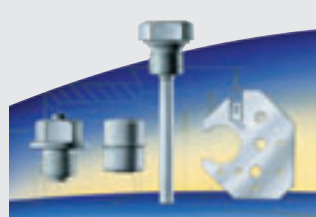
Electronic modules

- CAD layouting
- Component procurement
- THT and SMD placing
- AOI-testing
- In-circuit testing
- Functional testing
- Run-In
- Final assembly
- Final instrument test



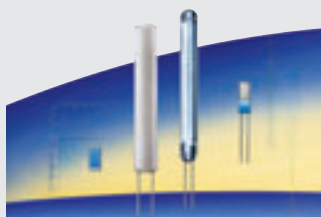
Transducers for Temperature and Humidity

- Thermocouples
- Resistance thermometers
- Ex temperature probes (ATEX)
- Wireless temperature probe
- Humidity measuring instruments
- DKD (German Calibration Service) laboratory
- Nationally accredited testing station for heat



Metalworking

- Stamping and forming systems
- Tool manufacture
- Flexible sheet metal working
- Welding, jointing and assembly systems
- Surface engineering
- Machining
- Float
- Materials laboratory



Platinum temperature sensors

in wirewound technology:

- Glass
- Glass with glass extension
- Ceramic
- Foil

in thin-film technology:

- Chip with connecting wires
- Chip in SMD style on epoxy board
- Chip with terminal clamps
- Chip in cylindrical style
- Chip in SMD style



Service

- Planning and project design for automation solutions
- German Calibration Service (DKD) for temperature
- Support during commissioning and optimization
- Worldwide service network
- Technical support line
- Seminars and workshops
- Fieldbus center
- Technical literature
- JUMO home page: www.jumo.net



Stammhaus • Head office •

Maison-mère Fulda
JUMO GmbH & Co. KG
 +49 661 6003-0
 mail@jumo.net
 www.jumo.net

Darmstadt
 +49 6151 3508-0
 http://darmstadt.jumo.info

Essen
 +49 201 86627-0
 http://essen.jumo.info

Hannover
 +49 5723 9432-0
 http://hannover.jumo.info

Ingolstadt
 +49 841 37934-0
 http://ingolstadt.jumo.info

Leipzig
 +49 341 4900810
 http://leipzig.jumo.info

Stuttgart
 +49 7021 95091-0
 http://stuttgart.jumo.info

Belgien • Belgium • Belgique
JUMO Automation S.P.R.L./P.G.M.B.H./B.V.B.A.
 +32 87 59 53 00
 info@jumo.be
 www.jumo.be

Bulgarien • Bulgaria • Bulgaria
JUMO Izmervatelni uredi i Regulatori
 +359 2 973 39 88
 jumobg@centrum-group.com

China • People's Republic of China • Chine
JUMO Automation Dalian Co. Ltd.
 +56 2 355 4400
 veto@veto.cl
 www.veto.cl

Dänemark • Denmark • Danemark
JUMO Måle- og Regulerings teknik A/S
 +45 46 19 46 66
 info.dk@jumo.net
 www.jumo.dk

England • United Kingdom • Angleterre
JUMO Instrument Co. Ltd.
 +44 1279 635533
 sales@jumo.co.uk
 www.jumo.co.uk

Frankreich • France • France
JUMO Régulation SAS
 +33 3 87 37 53 00
 info@jumo.fr
 www.jumo.fr

Italien • Italy • Italia
JUMO Italia SRL
 +39 02 24 13 55 1
 info@jumo.it
 www.jumo.it

Kroatien • Croatia • Croatie
JUMO Mess- u. Regelgeräte Ges.m.b.H
 +385 42 30 30 10
 info@jumo.hr
 www.jumo.hr

Niederlande • Netherlands • Pays-Bas
JUMO Meet- en Regeltechniek B.V.
 +31 294 49 14 91
 info@jumo.nl
 www.jumo.nl

Norwegen • Norway • Norvège
JUMO AS
 +47 67 97 37 10
 info.no@jumo.net
 www.jumo.no

Österreich • Austria • Autriche
JUMO Mess- und Regelgeräte Ges.m.b.H
 +43 1 6 10 6 1 0
 info@jumo.at
 www.jumo.at

Polen • Poland • Pologne
JUMO Sp.z.o.o.
 +48 71 3 39 82 39
 biuro@jumo.com.pl
 www.jumo.com.pl

Rumänien • Romania • Roumanie
S.C. JUMO Romania S.R.L.
 +402 573 48 499
 info@jumo.ro
 www.jumo.ro

Russland • Russia • Russie
JUMO GmbH
 +7 495 961 32 44
 jumo@jumo.ru
 www.jumo.ru

Saudi Arabien • Saudi Arabia • Arabie Saoudite
JUMO GmbH & Co. KG
 +971 4 347 2936
 info@jumo.ae
 www.jumo.ae

Schweden • Sweden • Suède
JUMO Mät- och Regelteknik AB
 +46 42 38 62 80
 info@jumo.se
 www.jumo.se

Schweiz • Switzerland • Suisse
JUMO Mess- und Regeltechnik AG
 +41 44 928 24 44
 info@jumo.ch
 www.jumo.ch

Serbien • Montenegro • Serbien / Montenegro • Serbie / Monténégro
JUMO Mereni i regulacioni uredjaji
 +381 11 285 2279
 sipljan@eunet.yu

Slowakische Republik • Slovakian Republic • Slovaquie
JUMO Slovensko s.r.o.
 +421 244 87 16 76
 jumo@stonline.sk
 www.jumo.sk

Slowenien • Slovenia • Slovénie
JUMO merilni in regulacijski aparati
 +386 2 421 51 83
 info@jumo.si
 www.jumo.si

Spanien • Spain • Espagne
JUMO Control S.A.
 +34 91 8863 153
 g.jentsch@jumo.es
 www.jumo.es

Tschechische Republik • Czech Republic • République Tchèque
JUMO Mereni a regulace s.r.o.
 +420 541 321 113
 info@jumo.cz
 www.jumo.cz

Ungarn • Hungary • Hongrie
JUMO HUNGARIA Kft.
 +36 1 467 08 35
 jumobudapest@jumo.hu
 www.jumo.hu

USA • USA • Etats-Unis
JUMO Process Control, Inc.
 +1 315-697-5866
 info@jumo.us
 www.JUMO.us

Vereinigte Arabische Emirate • United Arab Emirates • Les Emirats Arabes Unis
JUMO GmbH & Co. KG Middle East Office
 +971 4 347 2936
 jumomidleeast@eim.ae

Weitere Standorte unter www.jumo.net
 For further international locations please visit www.jumo.net
 Autres sites dans le monde sous www.jumo.net