

PROCESS SENSORS



pH – Oxygen – Conductivity




HAMILTON

Product Overview

To order products from this catalog, please contact your HAMILTON process sensor distributor or HAMILTON company for the distributor in your area.

Other product lines made by HAMILTON:

-  ARC System: Intelligent Process Sensors with Integrated Transmitter Capabilities
- pH Electrodes for Laboratory and Portable Use
- Customized Sensors and Accessories
- Syringes
- SoftGrip™ Pipettes
- Diluters/Dispensers
- Valves
- OEM Components
- Pipetting Robots
- Automated Analyzers
- BioLevigator™
- DeCapper

HAMILTON

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Innovation in Sensor Technology

HAMILTON manufactures more than pH sensors. Our electrochemical and optical sensors are reliable tools for application-oriented use and are characterized by high quality, long life and competitive pricing. In order to meet these rigorous requirements we are constantly striving to find unique sensor designs. Extensive work by our research and development department enables HAMILTON to offer the following detailed solutions:

The SINGLE PORE concept:

Precise, reliable, fast readings with a "never clog" liquid junction



Since its introduction in 1991, the SINGLE PORE concept has been increasingly successful. The advantage of this solution is clear: instead of many tiny pores in a ceramic diaphragm, a single pore about 2000 times larger (in the form of a glass capillary) is used. The SINGLE PORE is practically impossible to clog. In combination with a special electrolyte, the flow rate through the pore is faster and provides much better contact between the reference electrode and sample. This results in a faster response time and more accurate readings.

Note:

The PTB (Physikalisch-Technische-Bundesanstalt = Physical Technical Federal Institute) in Braunschweig, Germany determined the SINGLE PORE pH electrode to be the most accurate laboratory electrode. Further information can be found in "Traceability of pH measurement" by Petra Spitzer; ISBN 3-89429-877-4 or ISSN 0947-7063

The POLISOLVE electrolyte:

Most innovative polymer reference electrolyte



It used to be that pH electrodes with a polymer electrolyte could not be used over the entire pH or temperature range. HAMILTON has designed the innovative POLISOLVE polymer electrolyte sensors that cover a pH range from 0 to 14 and temperatures from -10°C to 130°C. As an added benefit the POLISOLVE polymer is also stable to most organic solvents and free of toxic acrylamide.

When you combine the POLISOLVE with the SINGLE PORE concept you have the solution to pH measurement in a wide application range including:

- Industrial waste water
- Hot sugar juice
- Samples containing color pigments
- Oily samples
- Fermentation process

With the POLISOLVE PLUS electrolyte, HAMILTON has achieved an important new development that means even more stable reference signals. Thanks to an ingenious built-in filter system, reference poisons remain harmless for a lot longer. At the same time, troublesome diffusion potentials are minimized. POLISOLVE PLUS represents a significant contribution to long lasting pH sensors.

The EVEREF reference system:

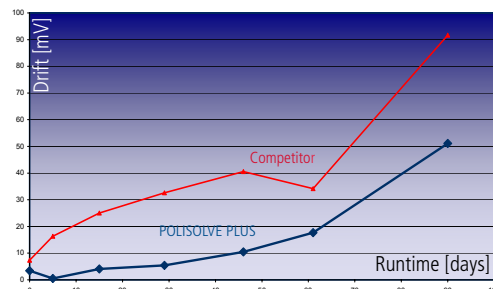
Long electrode life thanks to stable reference potentials



Stable reference systems are at the heart of reliable, long-life electrodes. This is why many HAMILTON electrodes are equipped with reference systems from the EVEREF family. The silver chloride reservoir is separated from the reference electrolyte by a diffusion distance which prevents the loss of silver chloride due to temperature variations, and allows the use of silver-free electrolytes. The EVEREF-L labyrinth system used in the POLILYTE electrodes further extends the diffusion distance to almost 200 mm, greatly increasing electrode life in aggressive media. The EVEREF-F system contains a silver barrier which prolongs electrode life in aggressive samples.

The POLISOLVE PLUS Electrolyte:

Drift while aging the sensors in 80°C hot deionized water.



Innovation in Electrochemistry

NEW

HAMILTON pH glasses:

Guarantee the accuracy of your measurements.



Continuous improvement to our pH glass provides benefits that have not been previously available.

Our high performance glasses, the PHI glass and the recently developed HB glass, were developed to withstand frequent steam sterilization, autoclavation and CIP cleaning using hot caustics. PHI and HB glass provide the lowest drift and show almost no shift after sterilization and cleaning procedures.

The HAMILTON H glass has excellent aging characteristics and offers stable readings even in samples with a low water content such as anhydrous or only partially aqueous solutions. The low alkali error of H glass means accurate measurements even at high pH or high operating temperatures.

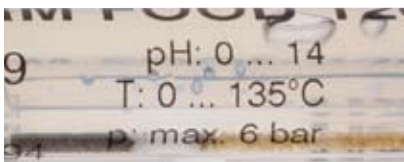
HF glass is one of the latest developments to ensure the longest possible lifetime in processes containing hydrofluoric acid.

Most electrodes for low-temperature applications have a membrane made of V glass. This unique development has a very low membrane resistance.

Generally, our pH glasses allow stable measurements for a long time.

FOODLYTE:

The biocompatible reference electrolyte.



FOODLYTE was developed especially for the needs of the biotechnology, pharmaceutical and food industry. FOODLYTE withstands sterilization and cleaning in place (CIP) up to 135°C and it can be used up to 6 bar pressure. TÜV Rheinland Produkt und Umwelt GmbH confirms: "This product complies with the German Food and Feed Act (Lebensmittel-Bedarfsgegenstände- und Futtermittelgesetzbuch: LFGB, §2 (6) 1) in conjunction with EC Regulation 1935/2004: The product is a commodity which is intended and foreseen to come into contact with foodstuffs."

FOODLYTE is taste- and odourless and harmless for micro organisms. The biocompatibility is approved by MDT¹ according to EN ISO 10993-5² and USP 31, 2008 Chapter 87³ and according to international GLP⁴ guidelines.



¹ Medical Device Testing GmbH Ochsenhausen

² Biological evaluation of medical devices -- Part 5: Tests for in vitro cytotoxicity

³ Biological Activity Tests, In Vitro

⁴ Good Laboratory Practice

The oxygen sensor OXYGOLD B:

Dissolved oxygen measurement with absolutely no interference from CO₂



Dissolved oxygen is an important parameter used to control the shelf life of beverages, especially beer, sweet soda drinks and fruit juice.

The traditional technology used to measure oxygen in these applications has been based on an amperometric, membrane-covered Clark cells filled with alkaline electrolyte. The gases from the sample diffuse through the membrane resulting in a measurement signal when they react with the the sensor. Guess what happens when the pH of the electrolyte changes? The measurement performance will change and so will the signal. This is the case when acidic gases like carbon dioxide are present. They change the pH of the originally alkaline electrolyte in the Clark cell. The results are drifting and uncertain measurements.

HAMILTON invested a couple of years in the development of the unique OXYGOLD B sensors that are filled with a CO₂-stable acidic electrolyte called OXYLYTE B. The unique performance of this dissolved oxygen sensor has made it a reliable measuring tool for breweries around the world!

Intelligent Sensor Technology

VISIFERM™ DO

Reliable measurement of Oxygen concentrations and optimal application of the result

Customer benefits:

- Measurement: VISIFERM™ DO's measurement principle does not use electrolyte. Therefore, leaking electrolyte from a loose electrode cannot cause any problems.
- Compatibility: VISIFERM™ DO can be connected without any problems to existing transmitters (via ECS interface) or programmable logic controllers (via 4-20 mA interface).
- Digital connection: By means of the Modbus RTU interface VISIFERM™ DO can directly communicate with computers or other VISIFERMs™.
- Data storage: Calibration data is stored in the sensor head. VISIFERM™ DO can be calibrated in the laboratory before it is installed into the process.
- Diagnostics: A diagnostic function integrated into the sensor detects damages to the oxygen-sensitive luminophore. The diagnostic data is accessible via Modbus RTU.
- Cross sensitivity: The luminophore does not interfere with CO₂ and H₂S, so the sensor can be used in difficult applications with these gases.
- The sensor cap can be replaced as easily as the top screw cap on a bottle.
- Signal stability: VISIFERM™ DO must be rarely recalibrated.
- Pressure stability: The very robust membrane withstands pressure spikes up to 80 bar.
- No flow needed: VISIFERM™ DO measures very precisely even in static fluids.

For further information please check page 32.

VISIFERM™ DO



Easyferm Plus™
Memosens®

Memosens®

Easier installation, operation and maintenance of pH sensors.

Innovations with Memosens®:

The new Memosens® technology is used for pH sensors.

- Data storage inside the sensor: Memosens sensor heads store the actual calibration data and further information useful for proactive maintenance, like total uptime, times within a certain range of pH or temperature.
- Digital signal transmission: The electric analogue measurement values are transformed into stable digital signals in the sensor head.
- Inductive signal transmission: The transmission of the digital signals to the cable happens inductively, without direct metallic contact.
- Signal transmission in both directions: Digital signals can go from the sensor to the transmitter, as well as from the transmitter to the sensor.
- Simple connection: Connector head attaches with a bayonet coupling.

Memosens® in practice:

- Easy replacement of calibrated sensors.
- No calibration in the process is necessary, because high quality laboratory calibrations are possible.
- Easy installation because greater distances between the sensor and the transmitter are possible.
- Problems with analogue measurements like moisture, corrosion or EMV are principally removed.
- Improper wiring of the sensor is impossible.
- Up to 40% longer life span with Memosens® sensors and less calibration due to optimized sensor maintenance.

Memosens® is a registered trademark of Endress + Hauser.

Innovation at Process Connections

HYGIENIC SOCKET™

Time and cost saving mounting and maintenance, sanitary and safe in service.

With its space-saving design, excellent sterilizability and simple maintenance, the HAMILTON HYGIENIC SOCKET™ is ideally suited for installation in fermenters in the biotechnological and foodstuffs industries. The advantages are numerous for other applications with tanks or pipes for water treatment, and in the pharmaceutical and chemical industries.

The HYGIENIC SOCKET™ offers:

- Only one seal in the process: An o-ring creates a hygienic seal between sensor and process. Visual checks or replacements require only a few seconds.
- Minimal space requirement: With a total diameter of only 28 mm, the HYGIENIC SOCKET™ is the most compact solution for professionally mounting pH sensors in steel pipes, fermenters, or other containers.
- No finishing - grinding after welding on a 25 mm socket is eliminated.
- Variable mounting: The depth a sensor protrudes into the process can be easily adjusted.
- CIP, sterilization and autoclaving are problem-free with the HYGIENIC SOCKET™.
- Personal safety: During disassembly of the sensor, two 'Life Guard' boreholes warn against an uncontrolled escape of process media.

For further information please check page 38.

HYGIENIC SOCKET™
and sensor



RETRACTEX™,
dismounted into
modules

RETRACTEX™

The RETRACTEX - a pneumatic modular retractable armature with many talents.

The all-rounder RETRACTEX™:

- Maintenance: RETRACTEX™ enables maintenance and calibration work even if the process is running.
- Adaptable: Increases process security by various adaptations to the process.
- Future-proof: Protects investments by the simple and modular assembly.
- Safe: Avoids damage to the personnel, the media and the armature by various safety mechanisms.
- Controllable: Enables a simple automatization of your measuring point.
- Simple installation: Protects installation and application of the armature by size- and color-coded pneumatic connections. This makes it hard to connect hoses incorrectly.

For further information please check page 46.

Innovation in Electrochemistry

Conductivity Standards:

Certified from an accredited laboratory.
Fulfills USP chapter 625 requirements.



HAMILTON is the first seller worldwide of conductivity standards at 1.3 and 5 $\mu\text{S}/\text{cm}$ with a certified accuracy of $\pm 1\%$ and a durability of 1.5 or 3 years. The composition of these standards is patented. The measurement procedure for determining conductivity has been developed in collaboration with DFM¹. Governmental metrological institutes that deal with measurement of electrolytic conductivity have become aware of these HAMILTON standards, since they lie in a low conductivity range and exhibit a previously unknown level of stability which has been confirmed by measurements done by PTB². In an interlaboratory test among prestigious European metrological institutes (PTB, DFM, DKD³), HAMILTON standards were used as a measurement solution.

¹ DFM: Danish Institute of Fundamental Metrology, Lyngby / DK

² PTB: Physikalisch-Technische Bundesanstalt, Braunschweig / DE

³ DKD: Deutscher Kalibrierdienst, Wolfen / DE

Duracal pH Buffers:

Certified from an accredited laboratory.
5-year stability and easy handling.



A complete range of patented pH buffer solutions provides never before achieved pH stability. HAMILTON guarantees DURACAL pH buffers to last for five years from the date of manufacture. The pH 9.21 and pH 10.01 buffers are even stable in air. High buffer capacities enable quick and stable calibrations.

Closed-loop traceability: In contrast with other manufacturers who operate with a hierarchical (top-down) traceability, HAMILTON has developed a new approach featuring "closed-loop" traceability. For users of DURACAL pH buffer solutions this means a unique level of reliability.

Top-down traceability: With HAMILTON the pH value of the DURACAL buffer is determined by a comparison with two secondary reference solutions.

Bottom-up traceability: From each lot manufactured, a representative quantity is measured at DKD. This ensures an external independent verification by an accredited institute.

The DKD issues an official calibration certificate for every DURACAL batch manufactured.

Tested quality:

Results of the final check documented in a Declaration of Quality.



For many of HAMILTON's pH sensor types, the results of the final checks are shown in a "Declaration of Quality".

Furthermore, the Declaration contains information about the materials of the sensor which are in contact with the medium.

All HAMILTON sensors are provided with a serial number.

The HAMILTON pH sensor types with a declaration of quality are listed in the table on page 52.



HAMILTON's pHeasy Technology

pHeasy® technology:

Ensures accurate measurements without recalibration and predicts loss of measurement accuracy.



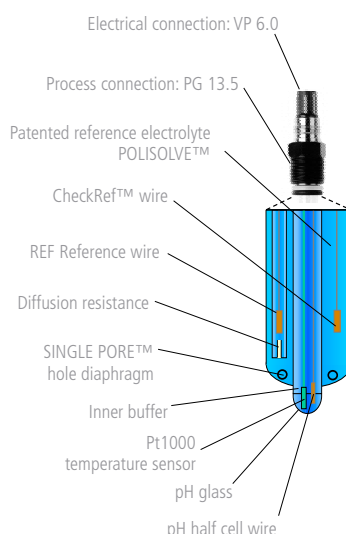
Stable reference systems are the heart of reliably functioning, long-lasting electrodes. In pH measurement up till now, the user was not spared the need for frequent calibration. The reason for this lies in shifting reference potentials due to chloride loss in the reference electrolyte. However, contaminated and partially clogged diaphragms also contribute considerably to changing properties in pH electrodes, which can only be resolved with a fresh calibration. For pH measurements where a very high degree of accuracy is required, it should therefore be sufficient if the pH sensor is calibrated just before measuring. But in industrial applications - especially in the case of online pH measurement - this is possible only with a great deal of effort, if at all. Even if a calibration with certified pH buffers is correctly carried out, the very next measurement will not necessarily be accurate! Depending on the age of the electrode or, more precisely, the state of the diaphragm and the chloride content in the reference electrolyte, different diffusion potentials may occur in buffers and measurement medium. Technically speaking, it is impossible to eliminate this source of error entirely, but with pHeasy technology it is possible to detect it online!

HAMILTON, with its pH glasses and the ingenious inner buffer, has built true long term stability into pHeasy electrodes.

pH measurement with pHeasy® has many advantages

pHeasy® technology consists of these hardware components: clog-free SINGLE PORE hole diaphragm, patented POLISOLVE electrolyte, extremely stable reference outlet, and CheckRef outlet. The difference in potential between REF and CheckRef is measured with a Redox or pH inlet and reveals the uncertainty of the measurement. By means of limit contacts, warnings and alarms (for example at 30 and 50 mV) can be triggered.

- The measuring device can provide notification of needed replacement of the electrode.
- The Checkref provides early detection and monitoring of reference poisons. This is because the pHeasy Checkref is positioned closer to the junction than the sensor reference.
- Interfering diffusion potentials can be monitored in-situ using pHeasy®.



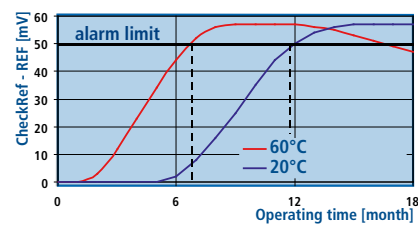
Never recalibrate

With pHeasy® only one calibration at the start of operation is needed.

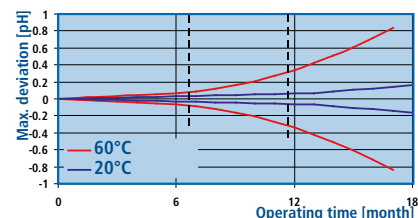
pHeasy®

- pH 0 - 14
- Pressure range: 0 - 6 bar
- Certificate
- Serial number
- Temperature range:
 - 0 - 60°C (pHeasy);
 - 0 - 130°C (pHeasy HT)
- Pt 1000

Simple pHeasy® alarm signal



No recalibrating thanks pHeasy®



Recognize hidden inaccuracies

- Every measurement solution produces a certain diffusion potential across the reference system. The error arising from this is small, as long as the reference system still has a high chloride concentration.
- Over time the electrode loses chloride, and the measurement error increases during the measurement depending on the medium. Needless to say, this error is undetectable in the pH buffer solutions due to the buffer composition, and is not removed during calibration. The result is an inaccurate measurement.
- That is why old electrodes are less accurate. pHeasy® monitors these hidden inaccuracies!

Conductivity Standards

HAMILTON Conductivity Standards – leading in long-term stability

Although seemingly a minor matter, calibration and verification of conductivity sensors is far from simple. This is particularly the case with measurements in the low conductivity range, for which stable and reliable calibration standards have been completely lacking up to now. Since a conductivity standard is not a buffer solution, contamination or entry of CO_2 has a much greater effect the lower the value of the conductivity standard.

HAMILTON is the first manufacturer to offer conductivity standards in 1.3 and 5 $\mu\text{S}/\text{cm}$ with a certified accuracy of $\pm 1\%$, and a lifetime of 1 and 3 years respectively. The composition of these standards is patented, and the procedure for determining conductivity has been developed in collaboration with DFM¹. Governmental metrological institutes that deal with measurement of electrolytic conductivity have become aware of HAMILTON standards since they lie in a low conductivity range and exhibit the type of stability that has never been achieved before (see illus., Stability over 3 years, with test measurements by PTB². During an interlaboratory test among prestigious metrological institutes (CENAM⁵, DFM, DKD³) HAMILTON standards were used as a measurement solution (Zentrum für Messen und Kalibrieren GmbH, Wolfen: Intercomparison on electrolytic conductivity 2007).

HAMILTON is different:

HAMILTON offers conductivity standards with different conductivity values, whose stability of $\pm 1\%$ is guaranteed over a life cycle of up to 3 years. These standards can be used several times, on condition that the bottle is not left open (without its lid) for more than 1 hour in total.

In order to ensure the accuracy of the conductivity standards a representative number of bottles from each batch are measured by DFM. The DFM value is recorded on the calibration certificate and on each bottle. DFM enjoys the highest prestige in Europe in the area of electrolytic conductivity and is equipped with an absolute measurement cell

that was developed in collaboration with NIST⁴ and is accredited by the Danish accreditation agency DANAK to a conductivity of 0.9 $\mu\text{S}/\text{cm}$. DFM and NIST have made comparisons of their measurement uncertainty and have confirmed in a series of scientific publications that the measurement accuracy is in each case the same. Since in the low conductivity range no primary standards exist, we depend on absolute measurement cells which trace electrical conductivity back to the SI units meter and volt. Testing of HAMILTON standards is thus carried out on the most precise measurement apparatus in the world and certified accordingly.

- ¹ DFM: Danish Institute of Fundamental Metrology
- ² PTB: Physikalisch-Technische Bundesanstalt, Braunschweig, Germany
- ³ DKD: Deutscher Kalibrierdienst, Germany
- ⁴ NIST: National Institute of Standards and Technology, Gaithersburg MD, USA
- ⁵ CENAM: Centro Nacional de Metrología, México

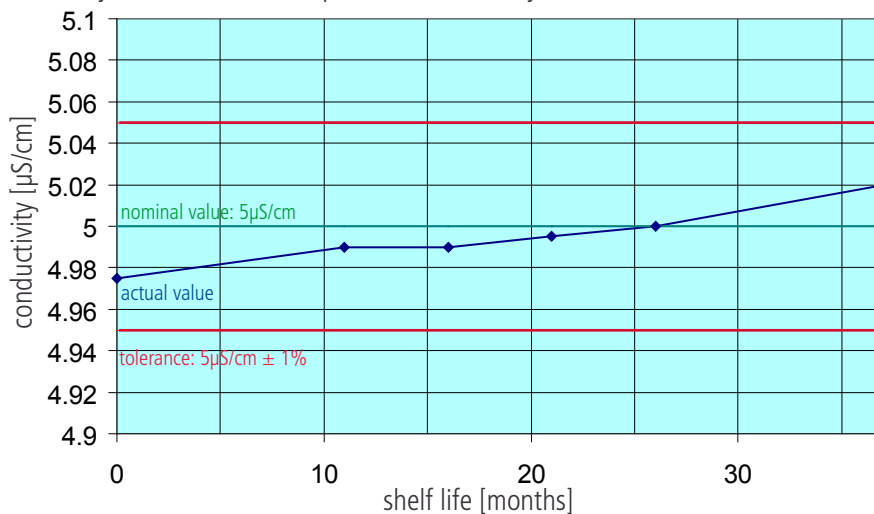


Conductivity Standards

Unique Advantages:

- Stable for at least 1 year (1.3 $\mu\text{S/cm}$), up to 3 years
- Certified standards with traceable calibration from DFM (can be viewed at www.hamiltoncompany.com)
- Expiration date on every bottle
- Bottles can remain open for up to 60 minutes and retain the certified value.

Stability of HAMILTON's 5 $\mu\text{S/cm}$ conductivity standards over 36 months



Calibration certificate
Electrolytic conductivity

Client: Hamilton Biomatrix AG
Address: Via Grumelt 8, CH-7402 Bonaduz, Switzerland
Telephone/fax: +41 91 880 8888
Contact person: Dr. Philipp Angold
Date received: 2008-08-13

Identification: Conductivity standard 1.3 $\mu\text{S/cm}$
Batch: R/N-238973, WD 1345639
Date of calibration: 2008-08-13

Result: Conductivity standard 1.3 $\mu\text{S/cm}$, R/N 238973, WD 1345639, Sample 1
Laboratory measurement conditions: $T = 25.0 \pm 0.1^\circ\text{C}$, $\text{diss} = 45 \pm 5\%$, $p(\text{CO}_2)_{\text{lab}} = 300 \pm 50\text{ mmHg}$

| $\mu\text{S/cm}$ | $\pm 1\%$ (10000) | $\pm 0.005\%$ |
|------------------|-------------------|---------------|
| 1.300 | 1.2871 | 1.2878 |

The reported measurement uncertainty is given as the standard uncertainty multiplied with a coverage factor of $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty has been calculated in accordance with EN ISO 17025.

Report and status of the measurement is given on page 2.

This calibration is traceable to recognized national and international standards.

The calibration has been performed under the following conditions:

Parts of the calibration certificate can only be reproduced with the written consent of DFM.

Validated use of the certificate is the sole responsibility of the client.

This certificate is consistent with the conditions that are included in Appendix C of the IEC 60740-1-10 standard, which is a part of the IEC 60740-1-10 standard.

Date: 2008-08-13

Signature: P. Angold

DANAK accreditation 255
Danish Environmental Technology Ltd.
Internationalsvej 301, DK-2860 Kgs. Lyngby, Denmark
Page 2 of 2
Date: 2008-08-13

Method

The solution was supplied by the client. Solution samples were provided in glass bottles containing 300 mL. The bottles were closed with a screw cap and seal.

The conductivity has been derived from a measurement of the impedance of the solution in the frequency range from 100 Hz to 500 Hz and from the calibrated cell constant of the cell used. The cell was temperature controlled by submersion in an oil bath with stability better than $\pm 2\text{ mK}$. The value for the conductivity has been referred to the given temperature(s) using a correction based on the measurement of the temperature coefficient of the solution. At 25°C the average temperature deviation was $\pm 1\text{ mK}$ and the temperature coefficient was determined to $0.7\text{ mS/cm}^\circ\text{C}$.

The conductivity cell was last calibrated 2007-10-31 (DFM certificate CEC0704). The impedance bridge was last calibrated 2008-03-11 (DFM certificate CRO602). The thermometer used was last calibrated 2008-01-28 (DANAK 98 certificate 14341).

No uncertainty contribution for CO_2 sensitivity of the solution has been taken into account. The average CO_2 partial pressure was measured near the measurement position and is given with the result.

DFM participates in the international collaboration under the Metro Convention in the CCQM Electrochemical Analysis Working Group. This includes participation in international comparisons of measurement of conductivity.

International comparison results and approved measurement capabilities are available at <http://ccqm.lam.gov/>

DANAK (Danish Accreditation)

The Danish Accreditation and Monitoring Fund - DANAK - is managing the Danish accreditation scheme based on a contract with the Danish Safety Technology Authority under the Danish Ministry of Economic and Business Affairs who is responsible for the registration and accreditation in Denmark.

The fundamental criteria for accreditation are described in ISO/IEC 17025: "General requirements for the competence of testing and calibration laboratories" and in DANAK ISO/IEC 17025: "Technical specifications for the requirements for quality and competence" respectively. DANAK uses various documents to verify the requirements in the standards, which are considered to be relevant. These documents are listed in the "Technical specifications for accreditation" (SAC) or the "International Laboratory Accreditation Co-operation (ILAC) with a view to obtaining common criteria for accreditation worldwide". In addition, the Danish Safety Technology Authority issues technical regulations prepared by DANAK with specific requirements for accreditation that are not contained in the standards.

In order for a laboratory to be accredited it is, among other things, required:

- that the laboratory and its personnel are free from any commercial, financial or other pressures, which might influence their impartiality;
- that the laboratory operates a documented management system, and has a management that ensures that the system is followed and maintained;
- that the laboratory has at its disposal all the equipment, facilities and premises required for correct performance of the services it is accredited to perform;
- that the laboratory has at its disposal personnel with technical competence and practical experience in performing the services that they are accredited to perform;
- that the laboratory has procedures for traceability and uncertainty evaluation;
- that accredited testing, calibration or medical examination are performed in accordance with fully validated and documented methods;
- that accredited services are performed and reported in conformity with the customer and in compliance with the customer's request;
- that the laboratory keeps records which contain sufficient information to permit repetition of the accredited test, calibration or medical examination;
- that the laboratory is subject to surveillance by DANAK on a regular basis;
- that the laboratory shall take full responsibility, which covers liability in connection with the performance of accredited services.

Reports showing DANAK's accreditation mark are used when reporting accredited services and show that these have been performed in accordance with the rules for accreditation.

| Value at 25°C | Accuracy | Stability (Months) | Certified by | Package | Order No. |
|------------------------|-----------|--------------------|--------------|-----------------------|-----------|
| 1.3 $\mu\text{S/cm}$ | $\pm 1\%$ | 12 | DFM | Glass bottle 300 ml | 238 973 |
| 5 $\mu\text{S/cm}$ | $\pm 1\%$ | 36 | DFM | Glass bottle 300 ml | 238 926 |
| 15 $\mu\text{S/cm}$ | $\pm 1\%$ | 36 | DFM | Glass bottle 300 ml | 238 927 |
| 84 $\mu\text{S/cm}$ | $\pm 1\%$ | 18 | DFM | Calpack bottle 500 ml | 238 984 |
| 100 $\mu\text{S/cm}$ | $\pm 1\%$ | 36 | DFM | Glass bottle 300 ml | 238 934 |
| 147 $\mu\text{S/cm}$ | $\pm 1\%$ | 18 | DFM | Calpack bottle 500 ml | 238 985 |
| 1413 $\mu\text{S/cm}$ | $\pm 1\%$ | 36 | DFM | Glass bottle 300 ml | 238 928 |
| 1413 $\mu\text{S/cm}$ | $\pm 1\%$ | 18 | DFM | Calpack bottle 500 ml | 238 986 |
| 12880 $\mu\text{S/cm}$ | $\pm 1\%$ | 18 | DFM | Calpack bottle 500 ml | 238 988 |

DURACAL pH Buffers: certified for the highest accuracy

Can you trust your buffer solution?

GMP, GLP, ISO 9001, EN 45000, calibration, verification, traceability, certification from an accredited organization: key words that are increasingly important. The calibration of pH and Redox electrodes has never been easy. All calibration procedures assume that the labeled values of the calibration buffers are correct. But buffer values can change over time and so can your results.

A complete range of patented buffer solutions provides never before achieved pH stability. HAMILTON guarantees that DURACAL pH buffers will be stable for 5 years after the date of manufacture. The pH 9.21 and pH 10.01 buffers are even stable in air. High buffering capacity provides rapid, stable calibration. Preservatives are added to prevent microbial and mold growth.

Traceability

An important issue for the production of certified reference material is to ensure the traceability through an unbroken chain of comparisons to reference material of the highest metrological quality (primary reference material) from NIST¹ and PTB².

Unlike other manufacturers where only a top-down traceability is applied, HAMILTON works with a circular or closed-loop traceability. This closed-loop traceability ensures the users of HAMILTON DURACAL buffers unique reliability.

Top-down traceability: At HAMILTON, the pH value of DURACAL buffers is determined by comparison against two secondary reference buffer solutions. These are purchased from accredited suppliers for secondary reference materials. The solutions themselves are compared against primary reference solutions from PTB¹ or NIST². The measurement uncertainties from each measurement comparison are known and documented.

Bottom-up traceability: To ensure the highest possible accuracy and full reliability of the pH value, a representative number of samples from every single production lot are sent to a German DKD³ laboratory (DKD-K-06901) for an external, independent and impartial verification. In this laboratory, the DURACAL samples are compared against secondary reference solutions from DKD-K-06901.

The secondary reference solutions are of course compared against primary reference solutions from PTB. At this stage, the loop is closed: the PTB primary reference solution is the starting and end point of the traceability loop. DKD provides HAMILTON with a calibration certificate for every DURACAL production lot. Due to the complete traceability of the measurement procedure and the assignment of uncertainties to the particular testing steps, the DURACAL buffers can be classified as "certified reference material" (CRM-certified reference material).

¹ NIST :National Institute of Standards and Technology, Gaithersburg MD, USA

² PTB: Physikalisch Technische Bundesanstalt, Braunschweig, Germany

³ DKD: Deutscher Kalibrierdienst DKD-K-06901, Zentrum für Messen und Kalibrieren GmbH, Wolfen, Germany



Features

- Convenient 250 ml and 500 ml plastic bottle with built-in calibration compartment
- Economical, since only about 20 ml of buffer is used per calibration
- Actual value is determined by a DKD laboratory, accredited for pH measurement
- First class certificate with traceability to international standards
- Certificates available at <http://www.hamiltoncompany.com>
- Expiration date on the bottle
- Immune to micro-organisms



Accuracy by an external, accredited laboratory

Simple handling for professional operation:



Step 1: Open bottle



Step 2: Squeeze to fill



Step 3: Calibrate



Step 4: Empty

| pH value | Accuracy | Stability (months) | Certified by | Package contents | Order No. |
|-----------------|-----------------|--------------------|--------------|------------------|-----------|
| 1.09 | ± 0.02 | 60 | HAMILTON | 500 ml | 238 271 |
| 1.68 | ± 0.02 | 60 | HAMILTON | 500 ml | 238 272 |
| 2.00 | ± 0.02 | 60 | HAMILTON | 500 ml | 238 273 |
| 3.06 | ± 0.02 | 60 | HAMILTON | 500 ml | 238 274 |
| 4.01 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 250 ml | 238 317 |
| 4.01 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 500 ml | 238 217 |
| 4.01 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 3 x 500 ml | 238 917 |
| 4.01 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 5 l | 238 332 |
| 4.01 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 10 l | 238 194 |
| 4.01 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 1000 l | 238 895 |
| 5.00 | ± 0.02 | 60 | HAMILTON | 500 ml | 238 275 |
| 6.00 | ± 0.02 | 60 | HAMILTON | 500 ml | 238 276 |
| 7.00 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 250 ml | 238 318 |
| 7.00 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 500 ml | 238 218 |
| 7.00 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 3 x 500 ml | 238 918 |
| 7.00 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 5 l | 238 333 |
| 7.00 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 10 l | 238 188 |
| 7.00 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 1000 l | 238 896 |
| 8.00 | ± 0.02 | 60 | HAMILTON | 500 ml | 238 277 |
| 9.00 | ± 0.02 | 60 | HAMILTON | 5 l | 238 334 |
| 9.21 | ± 0.02 | 60 | DKD | 250 ml | 238 319 |
| 9.21 | ± 0.02 | 60 | DKD | 500 ml | 238 219 |
| 9.21 | ± 0.02 | 60 | DKD | 3 x 500 ml | 238 919 |
| 9.21 | ± 0.02 | 60 | DKD | 10 l | 238 216 |
| 9.21 | ± 0.02 | 60 | DKD | 1000 l | 238 897 |
| 10.01 | ± 0.02 | 60 | DKD | 250 ml | 238 321 |
| 10.01 | ± 0.02 | 60 | DKD | 500 ml | 238 223 |
| 10.01 | ± 0.02 | 60 | DKD | 3 x 500 ml | 238 923 |
| 10.01 | ± 0.02 | 60 | DKD | 10 l | 238 187 |
| 10.01 | ± 0.02 | 60 | DKD | 1000 l | 238 898 |
| 11.00 | ± 0.05 | 24 | HAMILTON | 500 ml | 238 278 |
| 12.00 | ± 0.05 | 24 | HAMILTON | 500 ml | 238 279 |
| 4.01/7.00/9.21 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 500 ml, mixed | 238 922 |
| 4.01/7.00/10.01 | ± 0.01 / ± 0.02 | 24 / 60 | DKD | 500 ml, mixed | 238 924 |

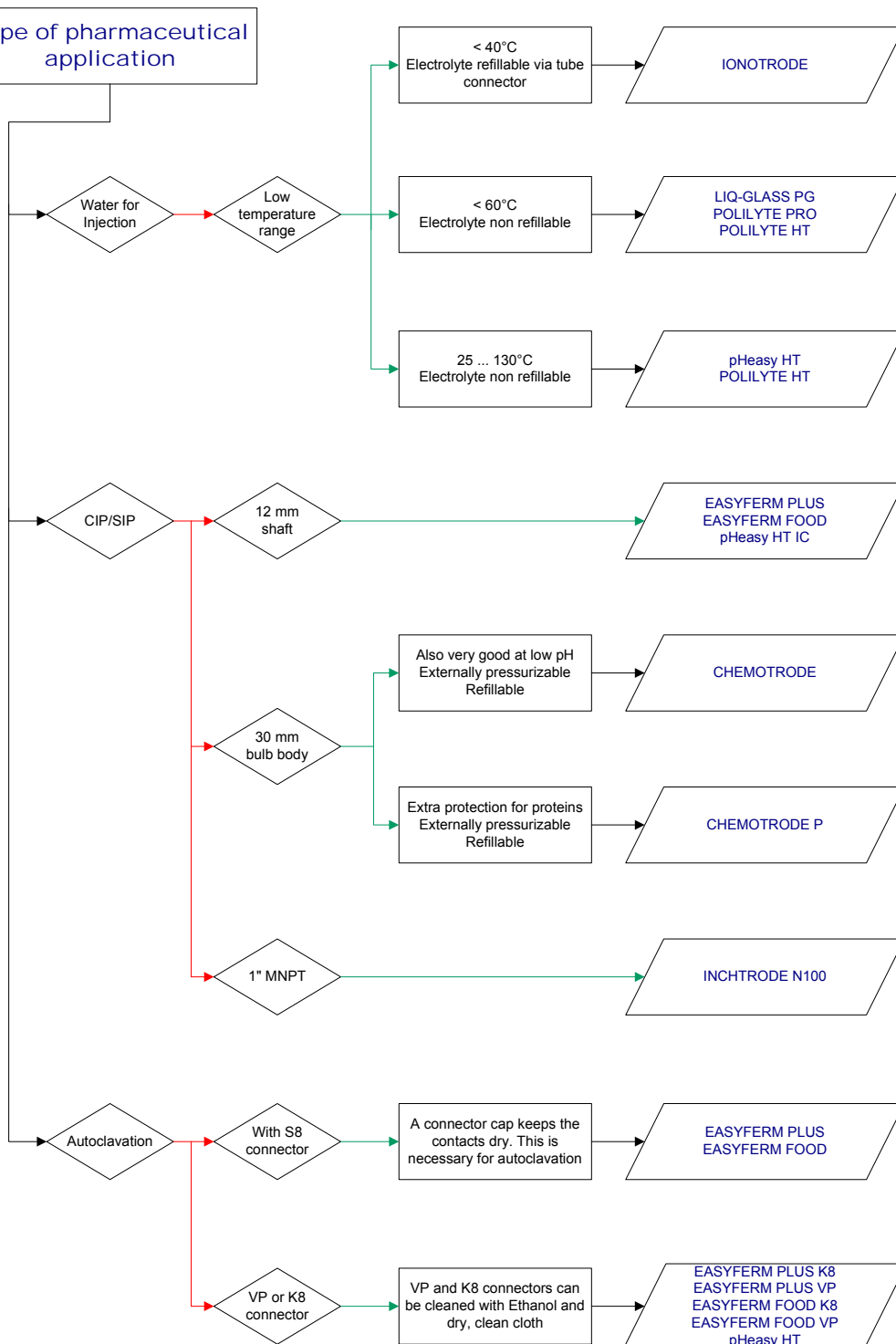
Redox Buffers:

| Redox value | Accuracy | Stability (months) | Certificate | Package contents | Order No. |
|-------------|----------|--------------------|-------------|------------------|-----------|
| 271 mV | ± 5 mV | 24 | none | 500 ml | 238 228 |
| 475 mV | ± 5 mV | 24 | none | 250 ml | 238 322 |
| 475 mV | ± 5 mV | 24 | none | 500 ml | 238 227 |

pH Pathfinder™ for Pharmaceuticals Industry

pH Pathfinder™

Type of pharmaceutical application



EASYFERM Plus EASYFERM Plus VP EASYFERM Plus K8

pH: 0 - 14

0 - 135°C

Max. 6 bar at 135°C

Pressurized PHERMLYTE
reference electrolyte

Temperature: Pt100 in VP version

- Stable measurement signals after steam sterilization, autoclaving and CIP
- Almost drift-free measurement
- Prepressurized PHERMLYTE reference electrolyte ensures a clog-free diaphragm
- High performance "HP" COATRAMIC diaphragm
- Almost drift-free HAMILTON "PHI" pH glass

VP K8



| Name | Order No. |
|----------------------|-----------|
| EASYFERM Plus 120 | 238 643 |
| EASYFERM Plus 160 | 238 679 |
| EASYFERM Plus 225 | 238 644 |
| EASYFERM Plus 325 | 238 645 |
| EASYFERM Plus 360 | 238 642 |
| EASYFERM Plus 425 | 238 674 |
| EASYFERM Plus VP 120 | 238 633 |
| EASYFERM Plus VP 225 | 238 634 |
| EASYFERM Plus VP 325 | 238 635 |
| EASYFERM Plus VP 360 | 238 632 |
| EASYFERM Plus VP 425 | 238 636 |
| EASYFERM Plus K8 120 | 238 625 |
| EASYFERM Plus K8 160 | 238 630 |
| EASYFERM Plus K8 200 | 238 627 |
| EASYFERM Plus K8 325 | 238 628 |
| EASYFERM Plus K8 425 | 238 629 |

Accessory:

Connecting cable (page 36)

pH: Pharmaceuticals and Fermentation

NEW

EASYFERM Plus MS

pH: 0 - 14
0 - 135°C
Max. 6 bar at 135°C
Pressurized PHERMLYTE
reference electrolyte
Temperature: NTC 30 kOhm

- EASYFERM Plus with an inductive, digital connection to the measurement device (Memosens®)
- Transformation of the analogue signal in the sensor head
- Storage of the calibration data in the sensor; no field calibration necessary
- High quality laboratory calibration possible
- Easy installation because of larger distance between sensor and transmitter
- Typical problems of analogue measurement systems like moisture, corrosion, EMI eliminated



EASYFERM Food EASYFERM Food VP EASYFERM Food K8

pH: 0 - 14
0 - 135°C
Max. 6 bar at 135°C
Pressurized FOODLYTE
reference electrolyte
Temperature: Pt 100 in VP version

- Suited for applications in biotechnology, Food and Beverage, and pharmaceuticals
- Cleanability tested and certified according to EHEDG criteria
- Biocompatibility tested and certified by MDT (see page 5)
- Odorless and tasteless gel electrolyte (tested by TÜV Rheinland)
- Suited for small reactor volumes of down to 0,5 l
- Stable measurement signals after steam sterilization, autoclavation and CIP
- Small sensitivity to disturbances and easily calibrated because of HAMILTON HB glass



CHEMOTRODE CHEMOTRODE VP CHEMOTRODE ORP CHEMOTRODE P

pH: 0 - 14 or
Redox/ORP: +/- 2000 mV
0 - 130°C; Max. 6 bar
Refillable 3 M KCl-LR or
PROTELYTE electrolyte
Pt1000 in VP version

- Precise pH measurement using electrolytes pressurized with air
- Viscous 3 M KCl electrolyte "KCl-LR" or PROTELYTE electrolyte for very long life cycle in solutions containing proteins
- EVEREF-F reference cartridge extends life cycle in samples containing protein
- Increased security of measurement thanks to 3 high-performance ceramic diaphragms
- CHEMOTRODE ORP is the redox version with a platinum ring
- Can be inserted in almost all pressurizable armatures for electrodes on the market with an electrolyte reservoir



| Name | Order No. |
|----------------------|-----------|
| EASYFERM Plus MS 120 | 242 650 |
| EASYFERM Plus MS 225 | 242 651 |
| EASYFERM Plus MS 325 | 242 652 |
| EASYFERM Plus MS 360 | 242 653 |

| Name | Order No. |
|----------------------|-----------|
| EASYFERM Food 120 | 243 642 |
| EASYFERM Food 225 | 243 643 |
| EASYFERM Food 325 | 243 644 |
| EASYFERM Food 425 | 243 645 |
| EASYFERM Food VP 120 | 243 632 |
| EASYFERM Food VP 225 | 243 633 |
| EASYFERM Food VP 325 | 243 634 |
| EASYFERM Food VP 425 | 243 635 |
| EASYFERM Food K8 120 | 243 625 |
| EASYFERM Food K8 160 | 243 626 |
| EASYFERM Food K8 200 | 243 627 |
| EASYFERM Food K8 225 | 243 628 |
| EASYFERM Food K8 325 | 243 629 |
| EASYFERM Food K8 425 | 243 630 |

Accessories:

Connecting cable (page 36)
HYGIENIC SOCKET™ (page 38)
RETRACTEX™ (page 46)

| Name | Order No. |
|--------------------|-----------|
| CHEMOTRODE 120 | 238 760 |
| CHEMOTRODE 150 | 238 762 |
| CHEMOTRODE 200 | 238 764 |
| CHEMOTRODE 250 | 238 766 |
| CHEMOTRODE VP 120 | 242 700 |
| CHEMOTRODE VP 150 | 242 701 |
| CHEMOTRODE VP 250 | 242 703 |
| CHEMOTRODE ORP 120 | 238 740 |
| CHEMOTRODE ORP 150 | 238 742 |
| CHEMOTRODE P 120 | 238 761 |
| CHEMOTRODE P 150 | 238 763 |
| CHEMOTRODE P 250 | 238 767 |

Accessories:

Storage solution 500 ml 238 931
PROTELYTE 100 ml 238 038
MASTERFIT (page 43)
Connecting cable (page 36)

pH: Sugar Industry, Food and Beverage

NEW

EASYFERM Food EASYFERM Food VP EASYFERM Food K8

pH: 0 - 14

0 - 135°C

Max. 6 bar at 135°C

Pressurized FOODLYTE
reference electrolyte

Temperature: Pt 100 in VP version



- Suited for applications in biotechnology, Food and Beverage, and pharmaceuticals
- Cleanability tested and certified according to EHEDG criteria
- Biocompatibility tested and certified by MDT (see page 5)
- Odorless and tasteless gel electrolyte (tested by TÜV Rheinland)
- Suited for small reactor volumes of down to 0,5 l
- Stable measurement signals after steam sterilization, autoclavation and CIP
- Small sensitivity to disturbances and easily calibrated because of HAMILTON HB glass



| Name | Order No. |
|----------------------|-----------|
| EASYFERM Food 120 | 243 642 |
| EASYFERM Food 225 | 243 643 |
| EASYFERM Food 325 | 243 644 |
| EASYFERM Food 425 | 243 645 |
| EASYFERM Food VP 120 | 243 632 |
| EASYFERM Food VP 225 | 243 633 |
| EASYFERM Food VP 325 | 243 634 |
| EASYFERM Food VP 425 | 243 635 |
| EASYFERM Food K8 120 | 243 625 |
| EASYFERM Food K8 160 | 243 626 |
| EASYFERM Food K8 200 | 243 627 |
| EASYFERM Food K8 225 | 243 628 |
| EASYFERM Food K8 325 | 243 629 |
| EASYFERM Food K8 425 | 243 630 |

Accessories:

Connecting cable (page 36)
HYGIENIC SOCKET™ (page 38)
RETRACTEX™ (page 46)

POLILYTE HT POLILYTE HTVP

pH: 0 - 14

0 - 130°C

Max. 6 bar at 130°C

Temperature: Pt100 in
HTVP version



- POLISOLVE electrolyte (page 4)
- Best measurement accuracy both in high-alkali processes and in samples with very low conductivity.
- Sterilizable and autoclavable
- Perfect for the sugar industry
- 2 SINGLE POREs for clog-free contact of electrolyte with measurement medium
- Upside-down mounting possible with VP sensor types
- HAMILTON "H" pH glass



| Name | Order No. |
|-------------------|-----------|
| POLILYTE HT 120 | 238 431 |
| POLILYTE HT 225 | 238 432 |
| POLILYTE HT 425 | 238 467 |
| POLILYTE HTVP 120 | 238 428 |
| POLILYTE HTVP 225 | 238 429 |
| POLILYTE HTVP 425 | 238 449 |

Accessories:

Storage solution 500 ml 238 931
HYGIENIC SOCKET™ (page 36)
RETRACTEX™ (page 46)
Connecting cable (page 36)

INCHTRODE N100F

pH: 0 - 14

-10 - 130°C

Max. 10 bar at 25°C

Max. 6 bar at 130°C

Liquid Earth

Temperature: Pt1000



- Flat pH membrane
- Almost unbreakable PVDF housing (FDA)
- Very long-lasting reference system
- Steam-sterilizable
- Simple installation without additional armature
- NPT 1" thread
- SINGLE PORE technology for clog-free contact of electrolyte with medium

| Name | Order No. |
|-----------------|-----------|
| INCHTRODE N100F | 238 352 |

Accessories:

Storage solution 500 ml 238 931
Connecting cable (page 36)

pH: Low Conductivity, Ion-Weak Media

IONOTRODE

pH: 0 - 14
-10 - 40°C
Max. 0.5 bar or higher on
pressurization by side-arm
attachment

- Offers highest accuracy over a long period of time
- Stable measurements in samples with low conductivity of at least 0.2 $\mu\text{S}/\text{cm}$
- Removable PTFE sleeve diaphragm to check electrolyte outflow
- Very large "F" pH glass membrane
- Side-arm attachment via tube to a storage vessel containing 3 M KCl, and control of electrolyte flow with the PTFE diaphragm ring



| Name | Order No. |
|---------------|-----------|
| IONOTRODE 120 | 238 525 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| 3 M KCL, 500 ml | 238 936 |
| FLEXIFLOW SL 10 (page 40) | 237 340 |
| Connecting cable (page 36) | |

LIQ-GLASS PG

pH: 1 - 12
-5 - 60°C
Max. 2 bar at 60°C
Maintenance-free - no refilling

- Suitable for process temperatures up to 60°C and samples with conductivity of only 2 $\mu\text{S}/\text{cm}$
- Maintenance-free, simple handling
- A special electrolyte ensures more easily reproducible measurement results in ion-weak samples as compared to traditional sensors
- 3 ceramic diaphragms for flow-independent measurement results
- HAMILTON "F" pH glass provides stable measurement values



| Name | Order No. |
|------------------|-----------|
| LIQ-GLASS PG 120 | 238 515 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| FLEXIFLOW SL 10 (page 40) | 237 340 |
| Connecting cable (page 36) | |

POLILYTE PLUS POLILYTE PLUS VP POLILYTE PLUS MS

pH: 0 - 14
0 - 130°C
Max. 6 bar at 130°C
Liquid Earth and
Temperature: Pt1000 in
VP version



- Unbeaten in comparative tests (see page 4)
- Highly reproducible measurements thanks to POLISOLVE PLUS (page 4) reference, very stable over long periods of time
- Minimal diffusion potential
- 2 SINGLE PORES for direct contact between POLISOLVE PLUS electrolyte and medium.
- HAMILTON "H" pH glass, stable for long periods plus a patented reference system
- Upside-down mounting possible for VP versions



| Name | Order No. |
|----------------------|-----------|
| POLILYTE PLUS 120 | 242 431 |
| POLILYTE PLUS 225 | 242 432 |
| POLILYTE PLUS 325 | 242 433 |
| POLILYTE PLUS 360 | 242 434 |
| POLILYTE PLUS 425 | 242 435 |
| POLILYTE PLUS VP 120 | 242 428 |
| POLILYTE PLUS VP 225 | 242 429 |
| POLILYTE PLUS VP 325 | 242 439 |
| POLILYTE PLUS VP 360 | 242 442 |
| POLILYTE PLUS VP 425 | 242 449 |
| POLILYTE PLUS MS 120 | 242 660 |
| POLILYTE PLUS MS 225 | 242 661 |
| POLILYTE PLUS MS 360 | 242 663 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| HYGIENIC SOCKET™ (page 38) | |
| RETRACTEX™ (page 46) | |
| Connecting cable (page 36) | |

pH: Chemical Industry

EASYFERM Plus EASYFERM Plus VP EASYFERM Plus K8

pH: 0 - 14
0 - 135°C
Max. 6 bar at 135°C
Pressurized PHERMLYTE
Reference electrolyte
Temperature: Pt 100 in VP version

- Almost drift-free measurement
- PHERMLYTE Reference electrolyte factory prepressurized for a clog-free diaphragm and minimized diaphragm potentials
- High performance HP COATRAMIC Diaphragm
- EVEREF-F Reference cartridge for silver-free electrolytes
- Poison resistant "PHI" pH glass
- Also available with Memosens® (see page 6, 15)



| Name | Order No. |
|----------------------|-----------|
| EASYFERM Plus 120 | 238 643 |
| EASYFERM Plus 160 | 238 679 |
| EASYFERM Plus 225 | 238 644 |
| EASYFERM Plus 325 | 238 645 |
| EASYFERM Plus 360 | 238 642 |
| EASYFERM Plus 425 | 238 674 |
| EASYFERM Plus VP 120 | 238 633 |
| EASYFERM Plus VP 225 | 238 634 |
| EASYFERM Plus VP 325 | 238 635 |
| EASYFERM Plus VP 360 | 238 632 |
| EASYFERM Plus VP 425 | 238 636 |
| EASYFERM Plus K8 120 | 238 625 |
| EASYFERM Plus K8 160 | 238 630 |
| EASYFERM Plus K8 200 | 238 627 |
| EASYFERM Plus K8 325 | 238 628 |
| EASYFERM Plus K8 425 | 238 629 |

Accessory:

Connecting cable (page 36)

POLILYTE PLUS POLILYTE PLUS VP

pH: 0 - 14
0 - 130°C
Max. 6 bar at 130°C
Liquid Earth and
Temperature: Pt1000
in VP version

- Unbeaten in comparative tests (see page 4)
- Highly reproducible measuring thanks to POLISOLVE PLUS (page 4) reference, stable over long periods
- Minimal diffusion potentials
- 2 SINGLE POREs for direct contact between POLISOLVE PLUS electrolyte and medium. No clogging!
- HAMILTON "H" pH glass with low alkali error and patented reference system
- Upside-down mounting with VP version possible



| Name | Order No. |
|----------------------|-----------|
| POLILYTE PLUS 120 | 242 431 |
| POLILYTE PLUS 225 | 242 432 |
| POLILYTE PLUS 325 | 242 433 |
| POLILYTE PLUS 360 | 242 434 |
| POLILYTE PLUS 425 | 242 435 |
| POLILYTE PLUS VP 120 | 242 428 |
| POLILYTE PLUS VP 225 | 242 429 |
| POLILYTE PLUS VP 325 | 242 439 |
| POLILYTE PLUS VP 360 | 242 442 |
| POLILYTE PLUS VP 425 | 242 449 |

Accessories:

Storage solution 500 ml 238 931
HYGIENIC SOCKET™ (page 38)
RETRACTEX™ (page 46)
Connecting cable (page 36)

POLILYTE PLUS MS

pH: 0 - 14
0 - 130°C
Max. 6 bar at 130°C
Temperature: NTC 30 kOhm

- POLILYTE Plus with an inductive, digital connection (Memosens®)
- Transformation of the analogue signal in the sensor head
- Storage of the calibration data in the sensor; no field calibration necessary; high quality laboratory calibration possible
- Easy installation because of larger distance between sensor and transmitter
- Typical problems of analogue measurement systems like moisture, corrosion, EMI eliminated
- Upside-down mounting possible



| Name | Order No. |
|----------------------|-----------|
| POLILYTE PLUS MS 120 | 242 660 |
| POLILYTE PLUS MS 225 | 242 661 |
| POLILYTE PLUS MS 360 | 242 663 |

Accessories:

Storage solution 500 ml 238 931
HYGIENIC SOCKET™ (page 38)
RETRACTEX™ (page 46)
Connecting cable (page 36)

pH: Chemical Industry, Hydrofluoric Acid

pHeasy HT

pH: 0 - 14
0 - 130°C
Max. 6 bar
Accuracy monitoring
CheckRef
Temperature: Pt1000

- One of the first pH sensors in the world with built-in accuracy monitoring
- CheckRef for constant monitoring of KCl concentration
- Extends service intervals and increases reliability of pH measurement applications
- Upside-down mounting possible
- 2 SINGLE PORES for clog-free contact between measurement medium and POLISOLVE electrolyte



CLARYTRODE CLARYTRODE VP

pH: 0 - 14
-5 - 100°C
Max. 6 bar at 100°C
For < 0.01M / 200 mg/l HF at 20°C
or 0.05M / 1000 mg/l HF at 50°C
Temperature: Pt 100 in VP version

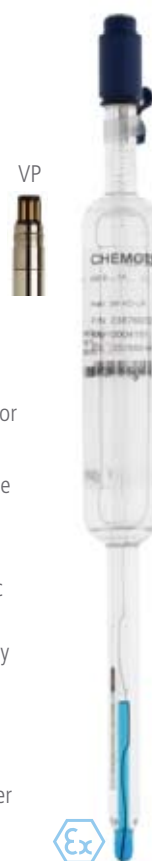
- It's a POLISOLVE Sensor (p. 4)
- HF applications containing oxides destroy normal pH glass when pH values are low
- HAMILTON "HF" pH glass withstands HF better than other pH glasses. This significantly extends sensor life.
- Stable measurement values under tough conditions
- 2 SINGLE PORES for interference-free contact of POLISOLVE electrolyte with measurement medium



CHEMOTRODE CHEMOTRODE VP CHEMOTRODE ORP

pH: 0 - 14 or
Redox: +/- 2000 mV
0 - 130°C; Max. 6 bar
Refillable 3 M KCl-LR Electrolyte
Temperature: Pt1000
in VP version

- Viscous 3 M KCl Electrolyte "KCl-LR" air-pressurizable for low interference potentials
- EVEREF-F reference cartridge extends electrode life in aggressive media
- 3 high-performance ceramic diaphragms for significantly higher measurement security
- CHEMOTRODE ORP is the Redox version with a large platinum ring
- Serialized with batch number
- Insertable into almost all pressurizable armatures for electrodes with an electrolyte reservoir



| Name | Order No. |
|---------------|-----------|
| pHeasy HT 120 | 238 893 |
| pHeasy HT 225 | 238 894 |

Connection to suitable pH measurement transmitter:

Suitable measurement transmitters are those having two inputs (pH/pH or pH/Redox). The pH measurement is carried out with the first pH input. Connect the CheckRef to the 2nd input (pH-Glass or Redox connection clamp). If there is a separate 2nd reference connection, bridge this with the first reference input. Use +/- 35 mV or pH < 6.4 and pH > 7.6 as alarm limiting values for any inaccuracies that may occur. More information on page 7.

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| Connecting cable (page 34) | |

| Name | Order No. |
|-------------------|-----------|
| CLARYTRODE 120 | 238 821 |
| CLARYTRODE VP 120 | 238 831 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| HYGIENIC SOCKET™ (page 38) | |
| FLEXIFIT BIO (page 42) | |
| Connecting cable (page 36) | |

| Name | Order No. |
|--------------------|-----------|
| CHEMOTRODE 120 | 238 760 |
| CHEMOTRODE 150 | 238 762 |
| CHEMOTRODE 200 | 238 764 |
| CHEMOTRODE 250 | 238 766 |
| CHEMOTRODE 550 | 238 775 |
| CHEMOTRODE VP 120 | 242 700 |
| CHEMOTRODE VP 150 | 242 701 |
| CHEMOTRODE ORP 120 | 238 740 |
| CHEMOTRODE ORP 150 | 238 742 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| 3 M KCl-LR 500 ml | 238 939 |
| MASTERFIT (page 43) | |
| Connecting cable (page 36) | |

pH: Chemical and Paper Industry

INCHTRODE N75F INCHTRODE N75P

pH: 0 - 14
-10 - 130°C (N75F)
0 - 130°C (N75P)
Max. 10 bar at 25°C
Max. 6 bar at 130°C
Liquid Earth
Temperature: Pt 1000

- VP head version
- Almost unbreakable PPS (Ryton) housing
- Flat (F) or cylindric (P) pH membrane
- Reference system very stable for long periods
- Single Pore technology for clog-free contact of electrolyte with medium
- HAMILTON "HF" pH glass (F) or "PHI" glass (P)
- NPT 3/4" thread

N75F



INCHTRODE N75FC10 INCHTRODE N75PC10

pH: 0 - 14
-10 - 130°C (N75FC10)
0 - 130°C (N75PC10)
Max. 10 bar at 25°C
Max. 6 bar at 130°C
Liquid Earth
Temperature: Pt 100

- 10 m fixed cable (C10) version
- Almost unbreakable PPS (Ryton) housing
- Flat (F) or cylindric (P) pH membrane
- Reference system very stable for long periods
- Single Pore technology for clog-free contact of electrolyte with medium
- HAMILTON "HF" pH glass (F) or "PHI" glass (P)
- NPT 3/4" thread

N75PC10



INCHTRODE N100F

pH: 0 - 14
-10 - 130°C
Max. 10 bar at 25°C
Max. 6 bar at 130°C
Liquid Earth
Temperature: Pt 1000

- Flat pH membrane
- Almost unbreakable PVDF housing (FDA)
- Reference system very stable for long periods
- Steam-sterilizable
- Simple installation without additional armature
- NPT 1" thread
- Single Pore technology for clog-free contact of electrolyte with medium
- HAMILTON "HF" pH glass



| Name | Order No. |
|----------------|-----------|
| INCHTRODE N75F | 238 346 |
| INCHTRODE N75P | 238 342 |

| Name | Order No. |
|-------------------|-----------|
| INCHTRODE N75FC10 | 238 364 |
| INCHTRODE N75PC10 | 238 359 |

| Name | Order No. |
|-----------------|-----------|
| INCHTRODE N100F | 238 352 |

Accessories

Storage solution 500 ml 238 931
Connecting cable (page 36)

Accessories

Storage solution 500 ml 238 931

Accessories:

Storage solution 500 ml 238 931
Connecting cable (page 36)

pH: Swimming Pools, Sea Water, Fish Farming

POLYPLAST PRO POLYPLAST PRO RX

pH: 0 - 14 or
Redox: +/- 2000 mV
-10 - 40°C (briefly 60°C)
Max. 6 bar at 60°C

- Economical and long lasting pH and Redox sensors
- It has POLISOLVE Electrolyte (pg. 4)!
- Epoxy shaft with pH glass bulb protection
- Suitable for process temperatures up to 60°C
- POLILYTE RX is the redox sensor version of the same product family
- SINGLE PORE for direct sample contact with the POLISOLVE electrolyte. No clogging!
- HAMILTON "V" pH glass for quick response and stable readings even at low temperatures



POLILYTE PRO POLILYTE PRO VP POLILYTE RX

pH: 0 - 14 or
Redox: +/- 2000 mV
-10 - 60°C
Max. 6 bar at 60°C
Pt1000 in VP version

- It has POLISOLVE Electrolyte (page 4)
- Suitable for process temperatures up to 60°C
- POLILYTE PRO VP sensors are equipped with a built-in Pt1000
- POLILYTE RX is the redox sensor version of the same product family
- SINGLE PORE for direct sample contact with the POLISOLVE electrolyte. No clogging!
- Glass shaft and "V" pH glass
- Also available with Memosens® (see page 6)



EASYCONTROL EASYCONTROL ORP

pH: 0 - 14 or
Redox: +/- 2000 mV
0 - 60°C
Max. 2 bar at 60°C

- Suitable for applications in water
- EASYCONTROL is the pH sensor
- EASYCONTROL ORP is the redox sensor version of the same product family
- Ceramic diaphragm liquid junction



| Name | Order No. |
|------------------|-----------|
| POLYPLAST PRO | 238 408 |
| POLYPLAST PRO RX | 238 409 |

| Name | Order No. |
|---------------------|-----------|
| POLILYTE PRO 120 | 238 411 |
| POLILYTE PRO VP 120 | 238 417 |
| POLILYTE PRO MS 120 | 242 633 |
| POLILYTE RX 120 | 238 433 |

| Name | Order No. |
|---------------------|-----------|
| EASYCONTROL 120 | 238 522 |
| EASYCONTROL ORP 120 | 238 523 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| HYGIENIC SOCKET™ (page 38) | |
| FLEXIFIT BIO (page 42) | |
| Connecting cable (page 36) | |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| HYGIENIC SOCKET™ (page 38) | |
| FLEXIFIT BIO (page 42) | |
| Connecting cable (page 36) | |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| HYGIENIC SOCKET™ (page 38) | |
| FLEXIFIT BIO (page 42) | |
| Connecting cable (page 36) | |

pH: Ground Water, Drinking Water, Waste Water

POLILYTE PLUS POLILYTE PLUS VP POLILYTE PLUS MS

pH: 0 - 14
0 - 130°C
Max. 6 bar at 130°C
Liquid Earth and
Temperature: Pt1000
in VP-Version



- Unbeaten in comparative tests (see page 4)
- Highly reproducible measurements thanks to POLISOLVE PLUS (p. 4) reference, stable over long periods
- Minimal diffusion potentials
- 2 SINGLE POREs for direct contact between POLISOLVE PLUS electrolyte and medium. No clogging!
- HAMILTON "H" pH glass with low alkali error and patented reference system
- Upside-down mounting possible in VP version
- Also available with Memosens® (see page 6)

POLILYTE PLUS XP POLILYTE PLUS XPVP

pH: 0 - 14
0 - 60°C
Max. 50 bar at 60°C
Liquid Earth and
Temperature: Pt1000
in VP-Version



- Suited for very high pressures up to 40 bar!
- Highly reproducible measurements thanks to POLISOLVE PLUS (p. 4) reference, stable over long periods
- Minimal diffusion potentials
- 2 SINGLE POREs for direct contact between POLISOLVE PLUS Electrolyte and medium. No clogging!
- HAMILTON "H" pH glass with low alkali error and patented reference system
- Upside-down mounting possible in VP version

MECOTRODE MECOTRODE VP OXYTRODE PT

pH: 0 - 14 oor
Redox: +/- 2000 mV
0 - 130°C; Max. 16 bar at
25°C or 6 bar at 130°C
Temperature: Pt100
in VP version



- Maintenance free reference gel electrolyte
- 3 high performance ceramic diaphragms for reduced flowing potentials when mounted in pipes
- HAMILTON "H" pH glass provides the most accurate readings at high pH values or high temperatures
- OXYTRODE PT is a Redox sensor with a platinum wire coil welded onto the glass

| Name | Order No. |
|----------------------|-----------|
| POLILYTE PLUS 120 | 242 431 |
| POLILYTE PLUS 225 | 242 432 |
| POLILYTE PLUS 325 | 242 433 |
| POLILYTE PLUS 360 | 242 434 |
| POLILYTE PLUS 425 | 242 435 |
| POLILYTE PLUS VP 120 | 242 428 |
| POLILYTE PLUS VP 225 | 242 429 |
| POLILYTE PLUS VP 325 | 242 439 |
| POLILYTE PLUS VP 360 | 242 442 |
| POLILYTE PLUS VP 425 | 242 449 |
| POLILYTE PLUS MS 120 | 242 660 |
| POLILYTE PLUS MS 225 | 242 661 |
| POLILYTE PLUS MS 360 | 242 663 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| HYGIENIC SOCKET™ (page 38) | |
| RETRACTEX™ (page 46) | |
| Connecting cable (page 36) | |

| Name | Order No. |
|------------------------|-----------|
| POLILYTE PLUS XP 120 | 238 811 |
| POLILYTE PLUS XPVP 120 | 242 415 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| HYGIENIC SOCKET™ (page 38) | |
| Connecting cable (page 36) | |

| Name | Order No. |
|------------------|-----------|
| MECOTRODE 120 | 238 801 |
| MECOTRODE 225 | 238 806 |
| MECOTRODE VP 120 | 238 437 |
| OXYTRODE PT 120 | 238 810 |

Accessories:

| | |
|----------------------------|---------|
| Storage solution 500 ml | 238 931 |
| HYGIENIC SOCKET™ (page 36) | |
| RETRACTEX™ (page 44) | |
| Connecting cable (page 34) | |

pH Simulators

Applications for pH Simulators:

- Testing cable and measurement devices
- ISO 9000 test device monitoring with DKD certificate

Testing cable and measurement devices:

Typically, failures of pH measurement are attributed to defective or poorly-chosen pH sensors. But often the cause is poor-quality, worn or defective pH cables, which no longer fulfill the high demands of insulation resistance. Not to be forgotten are similar faults in measurement devices that make reliable pH measurement impossible! These problems can be detected with the pH Simulator and costly and time-consuming trials of different electrodes can be avoided.

ISO 9000 test device monitoring:

In order to use the pH Simulator for ISO 9000 compliant control of monitoring and measuring equipment, the device needs to be certified by DKD, the German calibration service, which is accredited for the respective type of measurement by PTB (Physikalisch-Technische Bundesanstalt), Braunschweig. The DKD certificate contains the actual mV values which must be displayed by the measurement device being tested within the given tolerances.

pH SIMULATOR LAB

Simulates pH and Redox sensors in buffer

For testing cables and measurement devices

16 test values, including NIST pH buffer values

Testing of pH inlet resistance (Hi Z)

Adapter cable for BNC, standard S7 plug

- Easy and safe operation using high-quality touch buttons
- Simple one hand operation
- Large, easy-to-read illuminated display
- Testing of high-ohm measurement device inlet resistance. Also test commonly encountered, poorly insulated pH cables
- Battery level display ensures correct operation and eliminates unnecessary battery changes
- The simulator front is waterproof
- DKD certificate with actual mV values available as an option.

pH-SIMULATOR LAB



pH SIMULATOR PRO

The same as the SIMULATOR LAB but also includes:

- rubber protective cover with collapsible support
- Adapter cable for VP plug with Pt100 and Pt1000 simulation at 25°C
- Case with room for 2 x 250 mL pH buffer
- With the SIMULATOR PRO, the rubber protective cover guards against slippage, mechanical damage, and also helps to prop up the device for ease of readability.
- The SIMULATOR PRO is equipped with extra adapter cables for VP cable tests including Pt100 or Pt1000 simulation.
- DKD certificate with actual mV values available as an option.

pH-SIMULATOR PRO



| Specifications | |
|---------------------------------|---|
| pH simulation values | pH 1.00, 1.68, 4.01, 6.86, 7.00, 9.18, 10.01, 12.45 |
| pH simulation accuracy | +/- 0.02 pH |
| mV simulation values | -1800, -900, -390, +390, +900, +1800 mV |
| mV simulation accuracy | +/- 1 mV |
| pH input resistance test (Hi Z) | 1 GOhm at pH 4.01 and 10.01 |
| Display | LEDs, values separated for ease of recognition |
| Output | BNC connector; various adapter cables |
| Battery state display | LED |
| Power source | 4 'AAA' Batteries |
| Operating temperature | 0 - 40°C |
| Permissible air humidity | 80% up to 30°C, linear decrease up to 50% at 40°C |
| Measurements | ca. 140 x 170 x 35 mm |

| Name | Order No. |
|-----------------------------------|-----------|
| pH SIMULATOR LAB | 237 556 |
| pH SIMULATOR LAB with certificate | 237 560 |
| pH SIMULATOR PRO | 237 550 |
| pH SIMULATOR PRO with certificate | 237 566 |

Spare parts:

| | |
|-------------------------|---------|
| Rubber protective cover | 237 552 |
|-------------------------|---------|

Accessories:

| | |
|------------------------------------|---------|
| DURACAL pH buffer pH 4.01, 250 ml | 238 317 |
| DURACAL pH buffer pH 7.00, 250 ml | 238 318 |
| DURACAL pH buffer pH 9.21, 250 ml | 238 319 |
| DURACAL pH buffer pH 10.01, 250 ml | 238 321 |

Principles of Conductivity Measurement

Importance of conductivity in process technology

The Electrolytic conductivity is important for the characterization of liquids in laboratories and factories. Measurements of single samples or a continuous process facilitates monitoring the health of the system.

Conductivity is a measure for the total ion concentration in a sample. The more acids, bases and salts present in a solution, the higher the conductivity. In water and waste water mainly ions of dissolved salts are present. Therefore, conductivity is a likely indicator for the salt contamination of water and waste water. Additionally the determination of the salt content in food is very important.



Conductivity measurements help to determine the purity of water

Why liquids are conductive

The electrolytic conductivity of liquids is caused by the decomposition of dissolved acids, bases or salts into positive cations and negative anions. For example, common salt (NaCl) decomposes into Sodium ions (Na⁺) and Chloride ions (Cl⁻). The conductivity of ultra pure water is very low, because approximately one molecule of water (H₂O) in a billion decomposes into H⁺ and OH⁻ ions. This intrinsic conductivity of water also represents the lower border of the conductivity scale. It is of greatest importance in the control of pure water in power plants, electronics and the pharmaceutical industry.

Conductivity measurement

Electrolytic conductivity is determined by a resistance measurement. In the easiest case the measurement cell consists of two metal electrodes. Between these alternating voltage is applied. The more ions that are in the sample solution, the higher the current between the electrodes. With help of Ohm's law the conductivity is calculated. The unit of the electrolytic conductivity is Siemens per centimeter (S/cm).

| | | |
|---------|---|------------|
| 1 S/cm | = | 1000 mS/cm |
| 1 mS/cm | = | 1000 µS/cm |

The cell constant

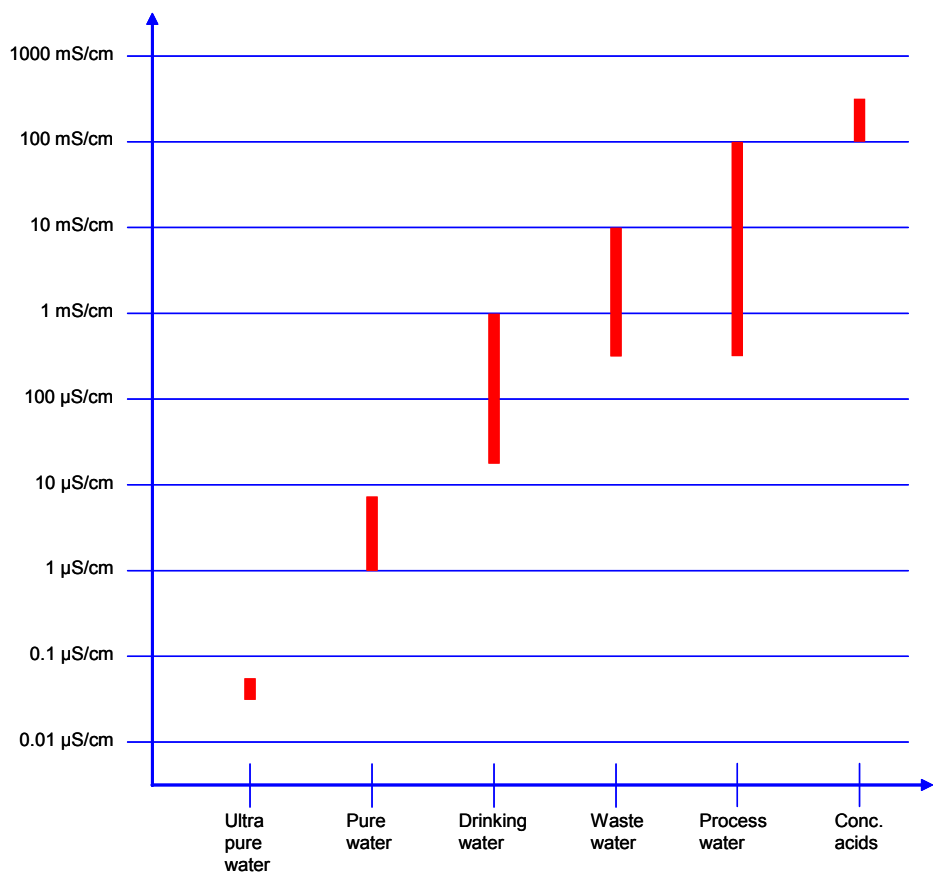
There are countless types of conductivity sensors whose measurement values vary by a great margin - depending on the electrode assembly.

To compensate for the geometry of the conductivity cell a cell constant is used:

$$\text{Conductivity [S/cm]} = \text{Measurement [S]} \times \text{Cell constant [1/cm]}$$

The cell constant is either known or it is determined by means of conductivity standards (view page 10). The cell constant has to be put into the transmitter prior to measurement.

Conductivity ranges of aqueous solutions:



Conductivity Sensor Types

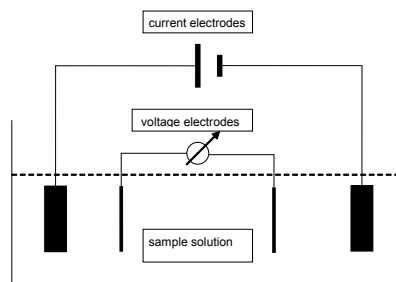
Types of conductivity sensors

Generally there are two types of conductivity sensors:

- 2 electrode sensors are constructed in a simple way. They are suited for measurements in clean solutions. Contaminations, e.g. by lime, affect the measurement
- 4 electrode sensors consist of two current and two voltage electrodes. Between the two current electrodes there is a constant electric current. With the two voltage electrodes a voltage drop is measured across the sample. The voltage drop depends on the conductivity of the sample. Because of this measurement principle, 4 electrode sensors have a much broader linear measurement range and are not sensitive to contamination.



HAMILTON 2 electrode sensors with graphite contacts



Scheme of a 4 pin conductivity cell

Hygienic:

The flat electrode assembly of a four pole HAMILTON conductivity cell can be easily cleaned. When assembled into a HYGIENIC SOCKET™ (view page 38) its cleanability complies with EHEDG criteria. That was confirmed by the TU München (Test No 180 / 10.10.2008).



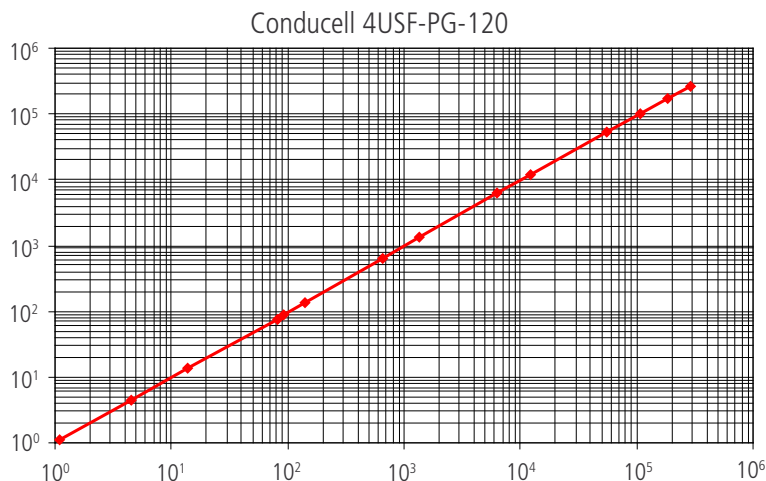
EHEDG: Sets criteria for cleanability



The flat tip of CONDUCELL 4USF-PG

Unique linearity:

A Conducell 4USF-PG, calibrated with a 1413 $\mu\text{S}/\text{cm}$ standard solution, is capable of determining standard solutions covering a wide range of conductivities with extremely small deviations.



The effect of temperature

The conductivity of a solution strongly depends on temperature. In order to compare measurement results, the measurements must refer to a standard temperature of 25°C. The notion "Temperature compensation" means the translation of a conductivity obtained at any temperature to the theoretical measurand at 25°C.

For most aqueous solutions the conductivity changes almost linearly by approximately 2% /°C. Most conductivity sensors contain a temperature probe to compensate for the temperature effect. Additionally, with some transmitters temperature compensation can be adapted to the sample.



Tested hygiene: CONDUCELL in HYGIENIC SOCKET™



Report of TU München: EHEDG cleanability test

Conductivity and 6-in-1 Sensors

JACOTRODE VP

6-in-1 Sensors

pH: 0 - 14

Temperature: Pt1000

Redox: +/- 2000 mV and/or

Cell constant: $c \approx 0.4/\text{cm}$ and/or

Liquid earth

Built-in reference for pH/Redox

- Steam-sterilizable and autoclavable, limited CIP use
- 2 large platinum rings for Redox, conductivity and liquid earth
- Sanitary feature: only one o-ring for several parameters
- EVEREF-F cartridge and SKYLYTE Electrolyte
- HP-COATRAMIC diaphragm prevents protein deposits
- Max. 4 bar at 130°C
- HAMILTON "V" pH glass



| Name | Order No. |
|------------------|-----------|
| JACOTRODE VP 120 | 238 442 |
| JACOTRODE VP 225 | 238 443 |

Accessories:

Storage solution 500 ml
HYGIENIC SOCKET™ (page 38)
RETRACTEX™ (page 46)
Connecting cable (page 36)

238 931

CONDUCELL 2DC-PG

2-Pole Conductivity Sensors for non-critical applications

1.0 - 200 $\mu\text{S}/\text{cm}$ or

50 - 100'000 $\mu\text{S}/\text{cm}$ linearized

Cell constant: $c \approx 1/\text{cm}$

Max. 20 bar at 130°C

Temperature sensor: Pt1000

- 2 large graphite electrodes
- In contact with media: plastic, graphite, FDA-EPDM
- Measurement range depends on transmitter
- Mechanically-stable
- Easily cleanable
- Ideal for water and waste water applications



| Name | Order No. |
|----------------------|-----------|
| CONDUCELL 2DC-PG-120 | 237 610 |

Accessories:

Conductivity standards (page 10)
HYGIENIC SOCKET™ (page 38)
Connecting cable (page 36)

CONDUCELL 4USF-PG

CONDUCELL 4UHF-PG

CONDUCELL 4UTF-PG

4-Pole Conductivity Sensors

1 - 500 000 $\mu\text{S}/\text{cm}$

Cell constant: $c = 0.36/\text{cm}$

Max. 10 bar / 150°C; 20 bar / 135°C

T: -20 - 150°C

Temperature sensor: Pt1000

- Very good linearity. Especially for situations with sharp variations in conductivity
- Suitable for steam sterilization, autoclaving and CIP
- Can be inserted in many standard armatures. Around the tip of the electrode there should be a space of 10 mm.
- All parts in contact with media are FDA-compliant: PEEK, stainless steel DIN 1.4435 (4USF types), EPDM
- Sanitary: surface quality is N5 (0.4 μm), electro-polished
- Sensor is very easy to clean due to the forward-facing, flush arrangement of electrodes, EHEDG certified with HYGIENIC SOCKET (page 25, 38)



| Name | Order No. |
|-----------------------|-----------|
| CONDUCELL 4USF-PG 120 | 237 620 |
| CONDUCELL 4UHF-PG 120 | 237 627 |
| CONDUCELL 4UTF-PG 120 | 237 630 |

The code in the sensor name

4: 4 pole

U: Undefined field

S: Stainless steel; H: Hastelloy C; T: Titanium

F: Flat electrode assembly for easy cleaning

Process connection:

PG: PG 13.5

Accessories:

Conductivity standards (page 10)
HYGIENIC SOCKET™ (page 38)
Connecting cable (page 36)

Conductivity Sensors

CONDUCELL 4USF-VV CONDUCELL 4USF-BC CONDUCELL 4USF-TC200

Description same as CONDUCELL 4USF-PG, but there are different process connections:

VV - Tuchenhausen Varivent DN50/60

BC - Neumo Bioconnect

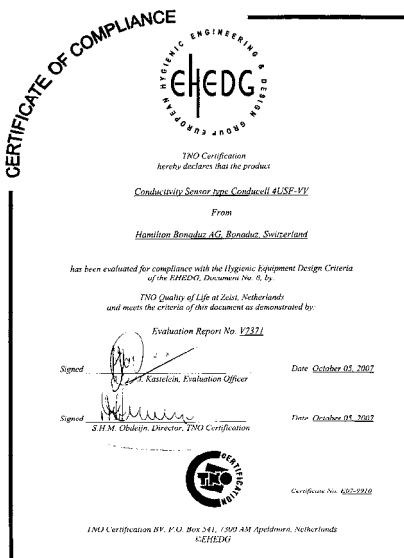
TC - Triclamp

Ask for others!



Certified hygiene

The part of the conductivity sensor CONDUCELL 4USF-VV which is in contact with the media can be cleaned in place (CIP). The cleanability is tested and certified according to the criteria of the EHEDG (European Hygienic Engineering and Design Group).



CONDUCELL 4US 4-Pole Conductivity Cells

0.1 - 500 000 µS/cm

Cell constant: $c = 0.147/\text{cm}$

Max. 6 bar at 135°C

T: -20 - 135°C

Temperature sensor: Pt1000

- Very good linearity over 6 decades. Specially for situations with wide variations in conductivity
- Suitable for steam sterilization, autoclaving and CIP
- Certificates confirm: all parts in contact with media are FDA-compliant: PEEK, stainless steel DIN 1.4435, EPDM
- Sanitary: surface quality is N5 (0.4 µm), electro-polished, sensor is easy to clean
- Fixed cable 5 m



| Name | Order No. |
|----------------------|-------------|
| CONDUCELL 4USF-VV | 237 640 |
| CONDUCELL 4USF-BC | 237 650 |
| CONDUCELL 4USF-TC200 | 238999-2661 |
| CONDUCELL 4USF-AF200 | On request |
| CONDUCELL 4USF-DF80 | request |

Other sensor types on request!

| Name | Order No. |
|------------------------|-----------|
| CONDUCELL 4US-G125 | 37 700-OP |
| CONDUCELL 4US-T150-50 | 237 750 |
| CONDUCELL 4US-T150-100 | 237 760 |

The code in the sensor name

4: 4 pole

U: Undefined field

S: Stainless steel

Process connection:

G125: G1,25"; T150: Triclamp 1,5" connection

Example for a special design (4US-G125-62/25):

62: 62 mm shaft length

/25: (optional) o-ring seals at 25 mm

Accessories:

Accessories:

Conductivity standards (page 10)

Connection cable (page 36)

Conductivity standards (page 10)

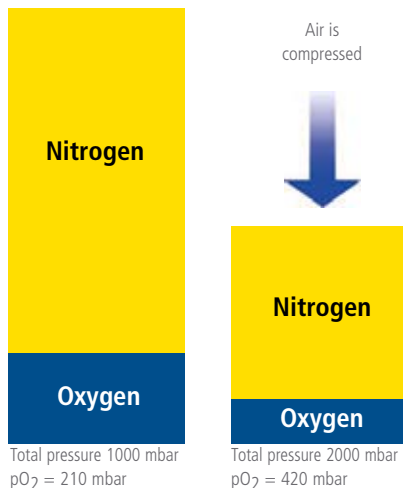
Basics of Oxygen Measurement

Basic concepts

Partial pressure

Oxygen sensors actually measure the partial pressure pO_2 of oxygen. The sensor signal is directly proportional to the pO_2 . Partial pressure is not a customary unit, since concentrations of matter are mostly given in weight per volume (mg/l). Because of the compressible nature of gas mixtures such as air, concentrations per volume do not make sense. The content of a gas component is therefore given as a part of the total pressure.

Example 1: Air with 21% oxygen, 78% nitrogen and 1% other gases



Doubling of partial pressure is correctly shown by the oxygen sensor.

Effect of air humidity

The amount of water vapor that air can hold is correlated to temperature. At 20°C the maximum water vapor pressure is 23 mbar (corresponds to 100% humidity or to a sensor immersed in air saturated water). The partial pressure of oxygen in this situation is $pO_2 = 205$ mbar.

If the sensor is calibrated in dry air at 20°C versus water saturated air the calibration error is about 2.5%. This error quickly grows once the temperature increases. At 82°C an error of 100% will arise if the sensor was calibrated in dry air versus air containing 100% humidity.

Example 2 :
When dissolved oxygen is measured in water it is essential that the water vapor partial pressure be taken into account. At 82°C the water vapor partial pressure at 100% humidity is 500 mbar.

Total pressure: 1000 mbar
Water vapor pressure at 82°C: 500 mbar
Percent oxygen: 21%
 pO_2 : 105 mbar
(1000 - 500) mbar * 21%
= 105 mbar pO_2



The 50% reduction of oxygen partial pressure is correctly measured by the sensor.

Oxygen partial pressure pO_2 in a solution

Water can absorb a certain amount of air. At high temperatures gas solubility is weaker, something that is apparent from bubble formation when water is heated. Equilibrium is reached when the particular partial pressures in the solution and in the gas phase (mainly air) are identical to one another. Water saturated with air and air saturated with water exhibit identical partial pressures for oxygen and other gases. The oxygen sensor therefore displays the same value in both phases.

Concentration of oxygen in solution in ppm, ppb or mg/l

The solubility of oxygen in water decreases as temperature rises. Furthermore, solubility is proportional to air pressure:

| Oxygen | Air pressure |
|----------------|--------------|
| 15°C 9.76 mg/l | 1013 hPa |
| 20°C 8.84 mg/l | 1013 hPa |
| 25°C 8.11 mg/l | 1013 hPa |
| 25°C 7.61 mg/l | 950 hPa |

In order to determine the concentration in ppm (mg/l) from the partial pressure measured, we must know the temperature, the air pressure and the solubility (usually in a table depending on temperature). In most devices the solubility table for oxygen in water is built in. The compensation of air pressure is often neglected, since the differences are small. Most oxygen sensors possess an internal temperature sensor. This fulfills two functions: it helps to pinpoint the right solubility from the solubility table and also to compensate the sensor signal. Thus the temperature-dependent nature of oxygen diffusion is taken into consideration by the membrane. 1 ppb = 0.001 ppm

Salt effect

The solubility of oxygen in water is affected by other substances. Salts reduce solubility, organic additives like alcohol increase solubility. These differences are not measurable with an oxygen sensor since the partial pressure of these additives is independent. The salt effect must be sought by means of other measurement methods for a more precise evaluation in ppm or mg/l.

Oxygen saturation

In applications at constant temperature like fermentation the usual procedure is to use saturation as a measure of oxygen content. Calibration is very easy where the sensor is in humid air or in an air-saturated solution and the device is set to 100%.

The value may however exceed 100% if the pressure increases. This is often the case when the oxygen sensor is fitted into a closed vessel or a pipe. A measurement value of, say, 130% saturation is therefore quite correct, since the partial pressure does in fact increase with a rise in pressure.

Amperometrical Oxygen Measurement

What is important for oxygen measurements?

Oxygen measurement today is performed in a very wide range of applications and is one of the most important parameters of process control technology. Since their introduction in 1995, HAMILTON oxygen sensors have become world leaders because of their signal performance and low maintenance requirements.

Building on the success of the first OXYFERM sensor, our family of amperometric oxygen sensors has been continuously extended and now comprises three groups. The OXYGOLD sensor with its very low limit of detection has ideal properties for applications in brewing, boiler feed water and for all applications requiring a low limit of detection. The sterilizable and autoclavable OXYFERM sensors represent a new standard in biotechnology. In addition to the PG 13.5 versions with their various lengths, they are now also available as 25 mm versions. The OXYSENS sensors have been developed as 100% maintenance-free, low cost sensors for water management and fish farming.

Measurement principle

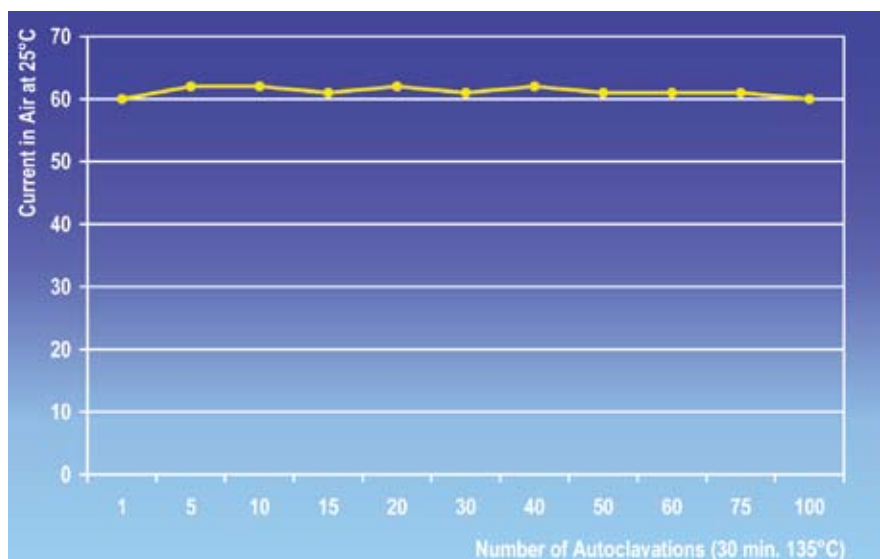
The oxygen content in liquids is traditionally measured with cells using Clark's principle. These cells generate an electrical current proportional to the oxygen partial pressure which can be evaluated with a suitable measurement converter. In order to prevent interference effects, the Clark's cell is covered with a gas-permeable membrane. The PTFE membranes typically used, however, are mechanically very fragile, with the result that they must be frequently changed to allow reliable measurement. It is difficult to handle such fragile membranes.

As a solution, HAMILTON developed the OPTIFLOW membrane. This membrane is very mechanically stable and is manufactured as a laminate around a steel mesh. OPTIFLOW membranes are stable under harsh ambient conditions as well as high pressures. This ingenious design allows fast response times to be combined with unusually low flow dependence.

Outstanding performance

Short response times

The outstanding properties of the new membrane material result in fast response times of 30 to 60 seconds.



Low maintenance and long life

Maintenance is rarely necessary due to the improved design of the sensor. The construction of the electrode guarantees excellent stability even after numerous sterilization cycles. The graph illustrates the excellent performance of OXYFERM electrodes even after 100 sterilizations without the need for maintenance. Other types of oxygen sensor subjected to the same conditions require maintenance after 5 to 10 sterilization cycles.

Low sensitivity to flow speed

Many other oxygen sensors show a clear dependence on the flow rate

especially with slowly flowing samples. This can lead to excessively low or erratic readings. As a result of the OXYFERM design, the effect of the flow rate on the reading is negligible.

Short stabilization time

The stabilization time is the time between connection of the oxygen sensor to the amplifier and the time when accurate measurements can be expected. There is a stabilization time, because after a voltage is applied, the oxygen around the cathode has to be reduced. A diffusion gradient of oxygen has to be established, which depends on the oxygen concentration in the sample solution. The OXYSENS stabilization time is typically less than 15 minutes.

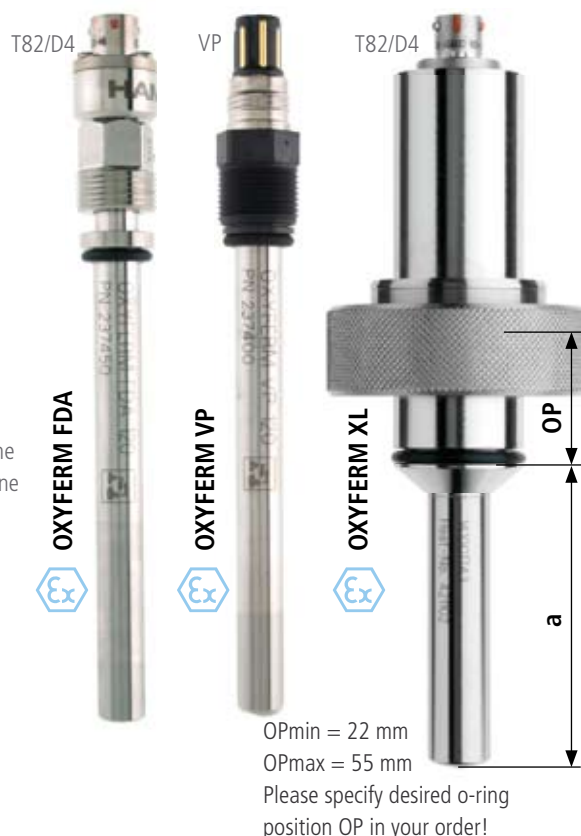
Classic Amperometric Oxygen Sensors

OXYFERM FDA OXYFERM VP OXYFERM XL

O₂: 10 ppb to saturation or
0.1% - 200% of air oxygen
0 - 130°C; max. 4 bar
TC*: NTC 22 kOhm

- Suitable for steam sterilization, autoclaving and CIP
- Shaft and membrane have their own serial and melt numbers
- Sanitary feature: the silicon membrane seals without a gap to steel membrane body (no additional o-ring)
- Little drift, fast response, short polarization time
- Reduced operating costs thanks to a longer service cycle
- OXYFERM FDA is shipped with a replacement FDA membrane body
- Replacing the cathode is child's play
- Material and test certificate by series
- Unique feature: upside-down insertion is possible when using OXYLYTE USD electrolyte. This is very useful for measurements in nearly empty tanks/containers.
- 12 mm or 25 mm (XL version) shaft diameter
- With XL option, the o-ring position OP can be optimally matched to the weld-in socket from 22 to 55 mm. Please state the OP you want when ordering. Example: Order no. 237175-50 for OP = 50 mm (Sartorius-B.Braun safety sockets) or 237175-25 for standard sockets 237202 (see page 41).
- A selection of membrane materials (Standard, CIP and FDA membrane) and a selection of different membrane body shapes, with a protective edge or rounded (preferred in the case of insertion through the lid from above, to prevent gas bubbles collecting) are all available.

* TC: Temperature sensor



Simple cathode replacement:

Remove the old cathode assembly with a pull and insert the new assembly!

| Name | Order No. |
|-----------------------------|------------|
| OXYFERM FDA 120 | 237 450 |
| OXYFERM FDA 160 | 237 455 |
| OXYFERM FDA 225 | 237 452 |
| OXYFERM FDA 325 | 237 453 |
| OXYFERM FDA 425 | 237 454 |
| OXYFERM VP 120 | 237 400 |
| OXYFERM VP 225 | 237 401 |
| OXYFERM VP 325 | 237 402 |
| OXYFERM XL (a = 56 mm) | 237 175-OP |
| Accessories: | |
| OXYFERM MEMBRANE KIT | 237 123 |
| MEMBRANE KIT CIP | 237 126 |
| MEMBRANE KIT FDA | 237 140 |
| OXYLYTE 50 mL | 237 118 |
| OXYLYTE USD 50 mL | 237 136 |
| Replacement Cathode Oxyferm | 237 306 |
| Autoclavation Cap Oxyferm | 242 000 |
| Connecting cable (page 37) | |

OXYSENS

O₂: 40 ppb to saturation
0 - 60°C, max. 4 bar
TC*: NTC 22 kOhm
Maintenance-free

- First maintenance-free DO sensor on the market; no changing of membrane or electrolyte required
- Developed for use in water, waste water, swimming pools, fish farms and composting facilities
- Insensitive to soiling
- Almost flow-independent
- OXYSENS has a built-in NTC 22 kOhm for temperature compensation
- Very short polarization and response times
- 5 m fixed cable, VP head only on request.
- 12 mm stainless steel shaft, 120 mm shaft length and PG 13.5 thread

| Name | Order No. |
|-------------|-----------|
| OXYSENS 120 | 237 150 |

Accessory:

| | |
|-------------------------------|---------|
| Stainless Steel Immersing Set | 237 158 |
|-------------------------------|---------|

Advanced Amperometric Oxygen Sensors

Replacement Membranes and Polarization Modules

OXYGOLD Membrane Kit

3 OXYGOLD membranes, spare o-ring, pipette. Electrolyte must be ordered separately.



OXYFERM Membrane Kit

3 membrane bodies, Oxylyte, pipette, spare o-ring, polishing strip



Membrane Kit CIP

As above, but with a special membrane for intensive CIP cleaning



Membrane Kit FDA

FDA membrane material and rounded design to prevent accumulation of gas bubbles



Polarization modules

These prepare replacement sensors not connected to an amplifier for immediate use



| Name | Order No. |
|--|-----------|
| OXYGOLD MEMBRANE KIT | 237 135 |
| OXYFERM MEMBRANE KIT | 237 123 |
| MEMBRANE KIT CIP | 237 126 |
| MEMBRANE KIT FDA | 237 140 |
| POLARIZATION MODULE T for OXYFERM /~FDA/~XL | 237 370 |
| POLARIZATION MODULE G for OXYFERM VP, OXYGOLD G | 237 350 |
| POLARIZATION MODULE B for OXYGOLD B | 237 360 |

Accessories:

| | |
|-------------------------|---------|
| OXYGOLD OXYLYTE G 50 mL | 237 139 |
| OXYGOLD OXYLYTE B 50 mL | 237 138 |
| OXYFERM OXYLYTE 50 mL | 237 118 |
| OXYLYTE USD 50 mL | 237 136 |

OXYGOLD G

Dissolved oxygen sensor for general use in trace measurement

O₂: 1 ppb to saturation or
0.012% - 200% of air oxygen
0 - 130°C, max. 12 bar
TC: NTC 22 kOhm

- Developed for use in power plants, chemical, pharmaceutical and semiconductor industries
- Suitable for use at high temperatures, high pressures, during sterilization and CIP
- Easy to maintain
- Inner body can be replaced by user
- Little flow sensitivity
- Fast response time: $t_{98\%} < 60$ sec.
- Materials and inspection certificate
- 12 mm shaft diameter, VP plug



| Name | Order No. |
|---------------|-----------|
| OXYGOLD G 120 | 237 395 |
| OXYGOLD G 225 | 237 396 |

Accessories:

| | |
|-------------------------------|---------|
| OXYGOLD MEMBRANE KIT | 237 135 |
| OXYLYTE G 50 mL | 237 139 |
| POLARIZATION MODULE G | 237 350 |
| Replacement Cathode OxyGold G | 237 427 |
| HYGIENIC SOCKET™ (page 38) | |
| RETRACTEX™ (page 46) | |
| Connecting cable (page 37) | |

OXYGOLD B

Dissolved oxygen sensor for measurements in media containing acidic gases CO₂, in beer

O₂: 8 ppb to saturation or
0.1% - 200% of air oxygen
0 - 100°C, max. 12 bar
TC: NTC 22 kOhm

- Absolutely no cross-sensitivity to CO₂
- Developed for use in brewing, Cola, fruit-juice, sparkling wine and special chemical processes
- Pressure and CIP stable
- Easy to maintain
- Inner body can be replaced by user
- Shortest response time on the market from air to pure CO₂: $t_{98\%} < 60$ sec
- Materials and inspection certificate
- Works with the same polarization voltages in calibration and measurement. So you don't get false measurement values when measuring in samples like beer.
- 12 mm shaft, VP plug



| Name | Order No. |
|---------------|-----------|
| OXYGOLD B 120 | 237 180 |
| OXYGOLD B 225 | 237 185 |

Accessories:

| | |
|-------------------------------|---------|
| OXYGOLD MEMBRANE KIT | 237 135 |
| OXYLYTE B 50 mL | 237 138 |
| POLARIZATION MODULE B | 237 360 |
| Replacement Cathode OxyGold B | 237 437 |
| HYGIENIC SOCKET™ (page 38) | |
| RETRACTEX™ (page 46) | |
| Connecting cable (page 37) | |

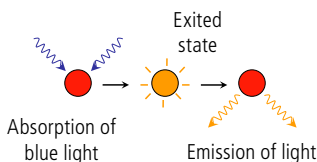
HAMILTON VISIFERM™ DO Sensors

Optical oxygen measurement with built-in analyzer, in 12 mm format

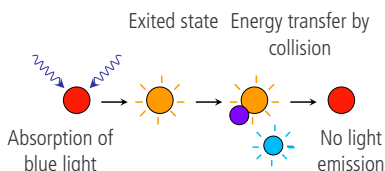
With VISIFERM™ DO, HAMILTON is the first company to offer self-contained oxygen measurement in the popular 12 mm format similar to standard process pH electrodes. Combined in the VISIFERM™ sensor shaft are: high-temperature-resistant optical electronics, microprocessor, 4 to 20 mA analog output, digital RS 485 interface with ModBus protocol, and ECS interface. ECS stands for Electro-Chemical Sensor. Use of the 4 to 20 mA analog output or the digital RS 485 interface (both integrated into the 12 mm shaft) makes an external measurement amplifier unnecessary, allowing measurement signals to be fed directly into a process control system.

VISIFERM™ DO measurement principles

The unique design of VISIFERM™ DO enables HAMILTON to monitor the status of the sensor's blue LED using one of the photodiodes. The other photodiode with the red filter measures the oxygen-dependent red light generated on the luminophore through luminescence (fluorescence) caused after excitation by the blue light. Electrons are excited to a higher energy level, and return to their original level after emission of red light.

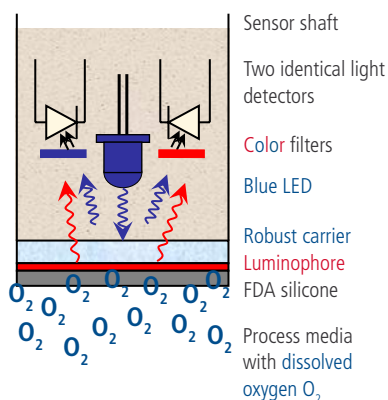


When the luminophore comes into contact with elemental oxygen, the O_2 molecules absorb the increased energy, thus preventing the emission of red light. Therefore, the amount of Oxygen is inversely proportional to the intensity and duration of the luminescence.



2-channel optics for optimal function and diagnostics

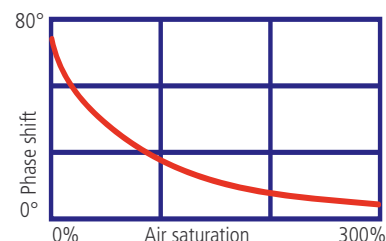
HAMILTON chose a mechanically- and thermally-stable symmetrical design directly in the sensor casing.



High precision measurement of the optical phase shift between the blue and red light pulses provides accurate indication of oxygen concentration.

The difference in intensity is analyzed by the instrument's self-monitoring system to pinpoint photobleaching (bleaching of the luminophore).

Measurement, calculation, and output of the measured value occur entirely inside the sensor.



Notice that VISIFERM™ DO sensors measure the partial pressure of oxygen (pO_2) just like classical sensors. This can be displayed as % air saturation, concentration in mg/l, ppm, or even as ppb.

The measurement range is from 0.05% to 300% air saturation (4 ppb to 25 ppm).

Application fields

VISIFERM™ DO sensors have been evaluated in a variety of applications:

- Biotechnology. VISIFERM™ DO sensors are developed to be steam-sterilized, autoclaved and cleaned in place (CIP) without difficulty. Therefore VISIFERM™ DO is ideal for use in fermenters and similar demanding applications.
- Waste water treatment.
- Ground water monitoring.
- River water monitoring.
- Breweries.

With the standard design form of a classical 12 mm sensor with PG 13.5 thread VISIFERM™ DO can be used with existing armatures.



Comparison of VISIFERM™ DO (top) and a classical DO sensor (bottom)

Optical, Sterilizable Oxygen Sensor

Operational reliability is paramount

A comparison with classical measurement technology

The most common malfunction of classical Clark Cells is caused by damage to the mechanically sensitive oxygen membrane. VISIFERM™ DO does not suffer from this problem, because it has no fragile membrane and no electrolyte; instead, it has a robust, solid Sensor Cap.

Cable transmission of very low Clark Cell currents to amplifiers represents a further problem. Measurement results of VISIFERM™ DO can be sent from the sensor as robust 4 to 20 mA analog, or digital signals. Both are far more tolerant of difficult process conditions than the sensitive (nA) signals of a classical electrochemical dissolved oxygen sensor.



Blue light: A decisive part of the VISIFERM™ measurement principle.

Technology that sets new standards

Intelligent Sensor

VISIFERM™ DO gives the designation 'intelligent sensor' new meaning, with respect to its integrated functionality:

- Precise measurement optics, stable up to 130°C, built into a 12 mm shaft.
- Easily replaceable Sensor Cap containing the sensing element.
- Monitoring of all sensor functions, status of the replaceable Sensor Cap.
- Configurable using the RS 485 interface with notebook, PC or by using the Modbus RTU connection from the process control system.
- Saving of all process relevant information: Sensor and calibration data, operating hours, cleaning and sterilization cycles, etc.
- Compatible with new ARC System products:
 - ARC View Handheld
 - ARC Wi Sensor Adapter
 - ARC Sensor Configurator



VISIFERM™ with different shaft lengths.

VISIFERM™ DO – All-in-One Sensor

Three options to connect

Fieldbus:

VISIFERM™ DO offers the widely-used Modbus RTU interface, enabling up to 32 sensors or other devices to be wired onto the same bus, in a highly cost-effective installation. The Modbus interface offers users comprehensive information, including input from the sensor's diagnostics and health indicator. Numerous gateways are available to interface Modbus to Foundation Fieldbus, Profibus, and others.

Robust 4 to 20 mA current:

Connects VISIFERM™ DO directly to a PLC or PCS, with no transmitter.

ECS:

The Electro-Chemical Sensor interface connects VISIFERM™ DO to traditional transmitters/analyzers for electrochemical oxygen sensors. ECS option can be selected using the ARC Sensor Configurator™.

Safe trace measurements




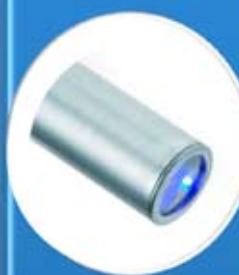

Trace measurements with classical sensors are not considered particularly accurate or safe, since in the absence of oxygen, no O₂ molecules are reduced, so no electrical current can flow. The same happens when a cable breaks.


VISIFERM™ DO does not suffer from these problems because it is at low oxygen concentrations that the greatest amount of red light is emitted, and the measured phase shift is at its greatest.

Operational reliability and simple maintenance

User friendliness is a critical quality in a sensor. Every procedure made redundant signifies an increase in operational reliability. Achieving simple maintenance is of particular value.

When a problem occurs during the night shift, with only limited personnel available to perform maintenance and calibration, VISIFERM™ DO really helps. All you have to replace is a Sensor Cap, and it is as quick and easy as opening and closing a bottle of soda: the Sensor Cap twists off, and the new one twists on. Job done. You need only perform calibration in air, although ideally, also in nitrogen or carbon dioxide. The sensor can be conveniently calibrated in the laboratory and remains calibrated for the next process run.

| | | | | |
|--|--|---|---|---|
|  |  |  |  |  |
| Interfaces <ul style="list-style-type: none">• Modbus Fieldbus• 4-20 mA (Namur)• ECS (Clark cell simulation)• Power supply | Memory <ul style="list-style-type: none">• Calibration data• Cap wear• CIP & SIP counter• Alarm history• TAG#, Serial#, ... | Processor <ul style="list-style-type: none">• Calibration• Sensor health• Password check• Watch dog | Optics <ul style="list-style-type: none">• Dual channel• Self diagnostics• Diagnostics for luminophore | Cap <ul style="list-style-type: none">• Replaceable• Robust, sensing Luminophore• FDA conform materials only |



Optical, Sterilizable Oxygen Sensor

VISIFERM™ DO accessories

Sensor Cap



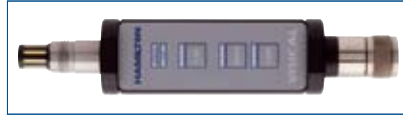
With VISIFERM™, there is only one consumable. Under normal conditions, even with frequent steam sterilizing, autoclaving, and CIPs, the Sensor Cap has a lifetime of more than one year.

Sensor cable VP 8.0



Various lengths available, see page 37.

VISICAL™ calibration tool



Simplifies air and zero point calibration when using the 4 to 20 mA interface, or when precalibrating the sensor in a laboratory. It also displays overall sensor status, and indicates when a Sensor Cap needs to be replaced soon.

VISIFERM-D4 power adapter

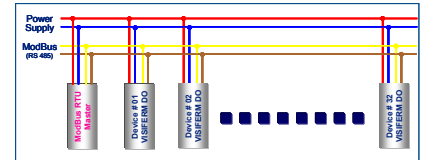


Connects VISIFERM™ DO in ECS mode to the cable of classical sterilizable oxygen sensor with four-pole plug (D4, T82) such as HAMILTON's OXYFERM FDA. Includes a wall plug power supply.

USB-RS485 Modbus converter

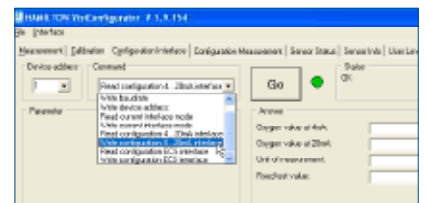


Connects the VISIFERM™ DO to a PC with USB port.



The PC acts as a Master, using ARC Sensor Configurator™ freeware or any other Modbus terminal software.

ARC Sensor Configurator™ freeware



Why users are excited about VISIFERM™ DO:

Application:

- No fragile membrane – with a solid Sensor Cap
- Instantly stable values, low drift, quick response
- Flow-independent
- Electrolyte-free, so no leakage
- No H₂S or CO₂ effect

Maintenance:

- Just one single, simple, replaceable spare part – the robust Sensor Cap
- Convenient calibration in the laboratory, because calibration data is stored in the sensor
- Precalibrated, ready-to-use sensors from stock minimize service time and costs

Installation:

- Backwards compatible with classical oxygen sensors, operates with traditional transmitters and SOPs, or -
- Can be connected directly to a PLC or PCS using a 4 to 20 mA or Modbus RTU interface

Name

| | |
|------------------|------------|
| VISIFERM™ DO 120 | 242 450-0X |
| VISIFERM™ DO 160 | 242 451-0X |
| VISIFERM™ DO 225 | 242 452-0X |
| VISIFERM™ DO 325 | 242 453-0X |
| VISIFERM™ DO 425 | 242 454-0X |

OX:

- 01: Mode 4 - 20mA
- 02: Mode ECS

Accessories:

| | |
|--------------------------------------|---------|
| VISICAL™ calibration tool | 242 410 |
| USB-RS485 Modbus converter | 242 411 |
| 4-20 mA galvanic isolation amplifier | 242 412 |
| VISIFERM™-D4 power adapter | 242 413 |
| VISIFERM™ replacement sensor cap | 242 427 |

Connecting cables:

| | |
|--|--------------|
| Demo cable (1m, open end) | 355 194 |
| Demo cable (1m, BNC plug, e.g. for Applikon) | 238999-2767 |
| Demo cable (1m, for New Brunswick-Fermenter) | 238999-2768 |
| Sensor cable VP 8.0, various lengths | View page 37 |

Connecting Cables for Sensors



For sensors with standard (S7) plug. Measurement device side no plug (free end)

Order No.

Length: 1 m, Diameter: 5 mm

355 072

Length: 5 m, Diameter: 5 mm

355 066

Length: 10 m, Diameter: 5 mm

355 080



For sensors with standard (S7) plug. Measurement device side has BNC connector

Order No.

Length: 1 m, Diameter: 3 mm

355 043

Length: 3 m, Diameter: 3 mm

355 057

Length: 5 m, Diameter: 3 mm

355 056



For sensors with standard (S7) plug. Measurement device side has DIN plug

Order No.

Length: 1 m, Diameter: 3 mm

355 045

Length: 3 m, Diameter: 3 mm

355 059

Length: 5 m, Diameter: 3 mm

355 058



For sensors with K8 plug. Measurement device side has no plug (free end)

Order No.

Length: 1 m, Diameter: 5 mm

355 153

Length: 3 m, Diameter: 5 mm

355 154

Length: 5 m, Diameter: 5 mm

355 155

Length: 10 m, Diameter: 5 mm

355 156



For sensors with K8 plug. Measurement device side has DIN plug

Order No.

Length: 1 m, Diameter: 5 mm

355 157

Length: 2 m, Diameter: 5 mm

355 158

Length: 3 m, Diameter: 5 mm

355 159

Connecting Cables for Sensors



| VP 6.0 single coaxial cable (free end): Ideal for sensors with VP 6.0 connector head | Order No. |
|---|------------------|
| Length: 1 m, Diameter: 7,5 mm | 355 108 |
| Length: 3 m, Diameter: 7,5 mm | 355 109 |
| Length: 5 m, Diameter: 7,5 mm | 355 110 |
| Length: 10 m, Diameter: 7,5 mm | 355 111 |
| Length: 20 m, Diameter: 7,5 mm | 355 112 |



| For OXYFERM sensors with T82 / D4 connector. Measurement device side has no plug (free end) | Order No. |
|--|------------------|
| Length: 1 m, Diameter: 5 mm | 355 087 |
| Length: 3 m, Diameter: 5 mm | 355 088 |
| Length: 5 m, Diameter: 5 mm | 355 089 |



| VP 8.0 double coaxial cable (free end): For sensors with 8.0 connector, e. g. VISIFERMTM DO | Order No. |
|--|------------------|
| Length: 1 m, Diameter: 7,5 mm | 355 217 |
| Length: 3 m, Diameter: 7,5 mm | 355 218 |
| Length: 5 m, Diameter: 7,5 mm | 355 219 |
| Length: 10 m, Diameter: 7,5 mm | 355 220 |
| Length: 15 m, Diameter: 7,5 mm | 355 221 |
| Length: 20 m, Diameter: 7,5 mm | 355 222 |



| For OXYFERM sensors with T82 / D4 connector. Measurement device side has LEMO plug | Order No. |
|---|------------------|
| Length: 1 m, Diameter: 5 mm | 355 160 |
| Length: 2 m, Diameter: 5 mm | 355 161 |
| Length: 3 m, Diameter: 5 mm | 355 162 |
| Length: 5 m, Diameter: 5 mm | 355 163 |

HYGIENIC SOCKET™

HAMILTON HYGIENIC SOCKET™

Application areas:

With its space-saving design, excellent sterilizability, and simple maintenance, the HAMILTON HYGIENIC SOCKET™ is ideally suited for installation in fermenters in the biotechnological and foodstuffs industries. The advantages are also numerous for many other applications with tanks or pipes for water treatment, and in the pharmaceutical and chemical industries.

Installation

The steel mantle can be welded into a hole in the tank wall at virtually any depth. As a result, the sensor is always immersed to exactly the desired position in the tank.

In comparison to weld-in-sockets with built-in armatures or flange armatures, the HYGIENIC SOCKET™ needs less space on a tank or pipe. Therefore it can be mounted on smaller pipes or vessels than usual models. Except for the diameter of the steel mantle, only the length of the sensor, which immerses into the cavity, limits the minimal size of the pipe or vessel.

The o-ring at the inside of the tank in which the HYGIENIC SOCKET™ is mounted can be easily reached:

The "Seal Pusher", which contains the the o-ring, can easily be pulled out of the steel mantle. Then, the o-ring can be removed simply and without destruction. If it is damaged, it can be replaced easily. Therefore the maintenance of the HAMILTON HYGIENIC SOCKET™ is very easy and time saving.



Maintenance

Armatures in applications involving hot processes or cleaning have to be regularly maintained in order to replace the fast-fatiguing o-rings. This also happens to the o-ring in the HAMILTON HYGIENIC SOCKET™, but you have to exchange just one o-ring - instead of two in an armature mounted in a 25 mm socket.

Seal to the process

As soon as a sensor is screwed into the hygienic socket, the inner module compresses the o-ring between the steel jacket and the sensor shaft. As a result, the sensor is sealed to the process medium with virtually no gap. The o-ring is decompressed again as soon as the sensor is slightly loosened. This prevents friction loads on the o-ring.

Cleanability

The HAMILTON HYGIENIC SOCKET™ was designed in accordance with EHEDG guidelines. If the steel jacket is welded flush with the inside wall of the tank or pipe, there is no depression at this point thanks to the clever arrangement of the o-ring. The process can thus be cleaned there efficiently and thoroughly (CIP).

By screwing in an adapter instead of a pH sensor, conductivity or oxygen sensors can be mounted practically flush with the tank wall, so that they are only inserted into the tank a minimal amount. There is no obstacle which accumulates debris or that impedes flow: The cleanability of the assembly improves.

Human safety

The two holes in the side of the steel mantle are referred to as "Life Guard" bore holes because in extreme cases they can actually save human lives.

As soon as the sensor is loosened for dismantling, the o-ring between the sensor and the steel jacket stops sealing. Process medium enters the steel jacket and leaks

Cleanable according to EHEDG criteria:
Conducell 4USF-PG in HYGIENIC SOCKET™



out through the Life Guard holes before the sensor is completely released from the thread. The fact that liquid is dripping out alerts the operator to the presence of process medium, and the sensor can be tightened again before it has a chance to shoot across the room. Although the socket is now fouled, this is not a major problem because it can be rinsed with water, for instance, through the two holes in the outside walls.

Sterility

The HAMILTON HYGIENIC SOCKET™ can not only be sterilized on the process side, it can also be autoclaved complete with the inserted internals, module and built-in sensor. The Life Guard holes can additionally be used for steam sterilization of the electrode shaft. In this case, however, the human safety function described above is no longer operative. The large holes provided in the plug-in module permit a high flow rate and fast distribution of the steam for rapid steam sterilization.

All novelties at one glance:

- CIP cleaning, sterilization, and autoclaving are problem-free with the HYGIENIC SOCKET™. Cleanability according to EHEDG confirmed by TU München: View page 25
- Only one seal in the process: An o-ring creates a hygienic seal between sensor and process. Visual checks or replacements require only a few seconds. A patent is applied for the o-ring arrangement.
- Minimal space requirement: With a total diameter of only 28 mm, the HYGIENIC SOCKET™ is the most compact solution for professionally mounting pH sensors in steel pipes, fermenters, or other containers.
- Smaller pipe diameter: The HYGIENIC SOCKET™ is better suited to smaller pipe diameters than previous process connectors.
- Variable mounting: The depth to which a sensor protrudes into the process can be easily adjusted.
- No finishing - for example, grinding after welding on a 25 mm socket - is necessary.
- Personal safety: During disassembly of the sensor, two 'Life Guard' boreholes warn against an uncontrolled escape of process media.

| Name | Order No. |
|-------------------------------------|-----------|
| HAMILTON HYGIENIC SOCKET™ 1.4404 | 242 535 |
| HAMILTON HYGIENIC SOCKET™ 1.4435 | 242 545 |
| HAMILTON HYGIENIC SOCKET™ 1.4571 | 242 548 |
| HAMILTON HYGIENIC SOCKET™ Alloy-C22 | 242 550 |

Accessories:

| | |
|--|---------|
| HAMILTON HYGIENIC SOCKET DO Adapter* | 242 538 |
| Replacement Kit Seal Pusher | 242 532 |
| HAMILTON HYGIENIC SOCKET o-ring set EPDM** | 242 595 |
| HAMILTON HYGIENIC SOCKET o-ring set VITON** | 242 596 |
| HAMILTON HYGIENIC SOCKET o-ring set SILICONE** | 242 597 |
| HAMILTON HYGIENIC SOCKET o-ring set KALREZ*** | 242 598 |

* Suited for HAMILTON oxygen and conductivity sensors with a shaft length of 120 mm

** 10 o-rings per package

*** 2 o-rings per package



Flow-Through Cells

FLOWCELL: Double chamber flow-through cell

This flow-through cell was developed for the mounting of two 120 mm-sensors with PG 13.5-threads.

Many applications in biotechnology, water treatment or power plant construction need the information from various measurements at the same spot. The construction is completely made of stainless steel with PEEK insert. It is virtually deadlock free, self-evacuating, materials with FDA-allowance and material certificate. Flexible connection possibilities: For example Tricomp from 1/4" to 1/2" or Swagelok.



| Name | Order No. |
|----------|-------------|
| FLOWCELL | 242 585-XYZ |

How to order the right FLOWCELL:

The tubes which contain the sensors (measuring station), the connections to the pipes (pipe connection) and the o-rings you can choose with the 3 digits at the end of the order number:

242 585-XYZ

X = Measuring station

X = 1: only pH

X = 2: Conductivity or oxygen

X = 3: Conductivity or Oxygen and pH

Y = Pipe connection

Y = 1: 1/4"TC25

Y = 2: 3/8"TC25

Y = 3: 1/2"TC25

Y = 4: Swagelok 6 mm

Y = 5: Swagelok 10 mm

Z = o-ring material

Z = 1: EPDM

Further variations on request!

Accessory:

| | |
|---|---------|
| FLOWCELL o-ring-kit EPDM 10 pcs each /pk | 237 387 |
|---|---------|

Flow-through cell PEEK TC 1,5"

This flow-through cell made of FDA-approved PEEK facilitates insertion of CONDUCELL 4US-T150-50 in pipework. It is suited for temperatures up to 140°C.



Further flow-through cells on request!

| Name | Order No. |
|--------------------------------|-----------|
| Flow-through cell PEEK TC 1.5" | 237 931 |

FLEXIFLOW SL 10

The FLEXIFLOW Armature is a flow-through armature. It can be used in all cases where pH or oxygen must be reliably measured in ion-weak media including coolant piping in power generating stations.

The sample is fed into the armature from the bottom at a low flow speed, and out of the armature again at the side. Dependable Swagelok connectors serve as process connections for 10 mm diameter pipe. A groove cut into the FLEXIFLOW allows it to be attached anywhere with commercially available screws, for example to a plate. Materials: DIN 1.4435 and o-rings of FDA-EPDM. Suitable sensors: PG 13.5; 12 x 120 mm.



| Name | Order No. |
|-----------------|-----------|
| FLEXIFLOW SL 10 | 237 340 |

Weld-in Sockets / 25 mm Ports

The classic: 25 mm weld-in socket, 15°

This robust weld-in socket has proven its value in the industry many times. It is made of stainless steel DIN 1.4571, which is welded at a 15° angle.

All armatures which have an o-ring position of 25 mm can be used with this socket.



| Name | Order No. |
|--------------------|-----------|
| Weld-in Socket 15° | 237 202 |
| Accessory: | |
| Blind Plug | 237 230 |

SAFETY SOCKET

Versatile weld-in socket in hygienic design

HAMILTON offers hygienic weld-in sockets adequate for hygienic armatures like FLEXIFIT BIO.

They are offered for 3 different o-ring positions (OP) to cover different standards:

OP = 25 mm

OP = 50 mm

OP = 55 mm

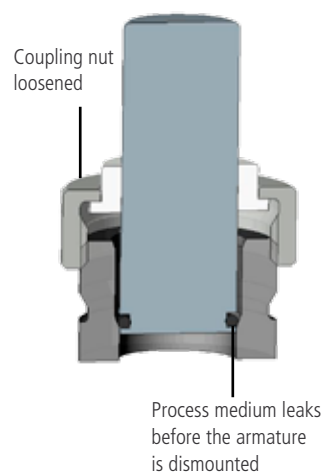
Furthermore, you can choose between two kinds of steel (DIN 1.4404 and DIN 1.4435) and two angles (0 and 15°) for your SAFETY SOCKET. Therefore the SAFETY SOCKET is suited for a wide variety of applications and installations.

The safety of the SAFETY SOCKETS

The SAFETY SOCKET narrows at the o-ring position. Therefore, the SAFETY SOCKET seals only if the o-ring of the armature is exactly at the right place. If the screw connection is only loosened by

a few millimeters, the o-ring does not seal anymore. Process medium leaks through the G 1 1/4"- coupling nut. If the process is under pressure, dripping process medium can be a strong hint that the armature should not be loosened entirely.

Blind plug in SAFETY SOCKET,
screw connection loosened



A clean family: SAFETY SOCKETS from HAMILTON



| Name | Order No. |
|---|-----------|
| SAFETY SOCKET 1.4404-15-25 | 242 570 |
| SAFETY SOCKET 1.4404-15-50 | 242 571 |
| SAFETY SOCKET 1.4404-15-55 | 242 572 |
| SAFETY SOCKET 1.4404-0-25 | 242 573 |
| SAFETY SOCKET 1.4404-0-50 | 242 574 |
| SAFETY SOCKET 1.4404-0-55 | 242 575 |
| SAFETY SOCKET 1.4435-15-25 | 242 576 |
| SAFETY SOCKET 1.4435-15-50 | 242 577 |
| SAFETY SOCKET 1.4435-15-55 | 242 578 |
| SAFETY SOCKET 1.4435-0-25 | 242 579 |
| SAFETY SOCKET 1.4435-0-50 | 242 580 |
| SAFETY SOCKET 1.4435-0-55 | 242 581 |
| Accessories: | |
| Blind plug 1.4404-25 | 242 560 |
| Blind plug 1.4404-50 | 242 562 |
| Blind plug 1.4404-55 | 242 564 |
| Blind plug 1.4435-25 | 242 565 |
| Blind plug 1.4435-50 | 242 567 |
| Blind plug 1.4435-55 | 242 569 |
| Meaning of the numbers: | |
| SAFETY SOCKET steel - angle - o-ring position | |
| Blind plug steel - o-ring position | |

Standard Armatures

FLEXIFIT VV

The FLEXIFIT VV is an armature suitable for Tuchenhausen VARIVENT sanitary process connections (DN40/DN50 or 2"/2.5"). It fits industrial sensors with a standard 12 x 120 mm design and PG 13.5 thread. FLEXIFIT VV-O is the upright (0°) version, whereby the sensor is fitted perpendicular to the process connection. The 15° version FLEXIFIT VV-15 enables positioning of the sensor in relation to the flow.



| Name | Order No. |
|----------------|-----------|
| FLEXIFIT VV-O | 237 344 |
| FLEXIFIT VV-15 | 237 345 |

FLEXIFIT TC

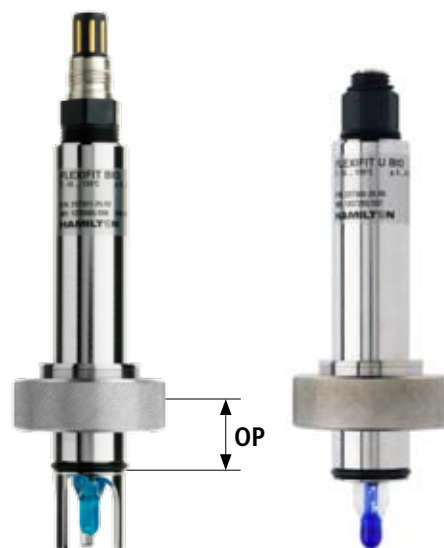
The FLEXIFIT TC is an armature designed for mounting on TriClamp process connections. The materials used are stainless steel DIN 1.4435 (SS 316L) and FDA approved EPDM o-rings. Steam sterilization, autoclavation and CIP cleaning are possible with the sanitary design. The short immersion depth makes this armature perfect for small flow-through cells. Maintenance-free sensors with a standard 12 x 120 mm design and PG 13.5 thread fit perfectly.



| Name | Order No. |
|-------------------|-----------|
| FLEXIFIT TC150-33 | 237 341 |

FLEXIFIT BIO, FLEXIFIT U BIO

The FLEXIFIT BIO armature provides the best of both worlds. It is the right compromise between good sensor protection (with 3 protection rods) and good sanitary design (easy cleaning). To achieve an even better cleanability the FLEXIFIT U BIO lacks the protection rods. FLEXIFIT BIO and U BIO are manufactured from stainless steel DIN 1.4435 (SS 316L). The surface quality is Ra = 0.4 µm (N5), electro-polished. The EPDM o-rings are FDA-approved. The armature comes with a material certificate. It is SIP, autoclavable, and CIP compatible.



| Name | Order No. |
|---|------------|
| FLEXIFIT BIO | 237 331-OP |
| FLEXIFIT U BIO | 237 380-OP |
| (o-ring seals at OP; 22 mm ≤ OP ≤ 55 mm) | |
| Accessories: | 237 219 |
| Service Kit Flexifit (Viton o-rings) | 237 366 |
| Service Kit Flexifit Bio (EPDM) | 237 319 |
| Service Kit Kalrez | |
| Weld-in socket (page 41) | |

Pressurizable Armatures

MASTERFIT

This armature is suitable for applications where high accuracy or long-term stability is required in conjunction with liquid electrolyte electrodes. Such electrodes must be pressurized to ensure flow of the electrolyte solution.

The MASTERFIT armature allows electrodes to be mounted on pipe work or tanks with a weld-in socket. Large windows allow visual inspection of the electrolyte level in the installed electrode. The manometer integrated into the housing is protected against physical damage. The armature closure mechanism is fitted with a tension lever that allows a slow release of the pressure in the armature in the event it needs to be

opened. This prevents the armature from being opened under pressure. The tension lever also makes it very easy to unscrew the housing and remove the sensor.

Advantages:

- Sealing feature prevents loss of pressure caused by soiling
- Pressure reduction on disassembly
- O-ring position selectable at time of order without extra charge



| Name | Order No. |
|-----------------------|------------|
| MASTERFIT 120 | 237 200-OP |
| MASTERFIT 150 | 237 225-OP |
| MASTERFIT 200 | 237 235-OP |
| Pressure connector | 237 252 |
| Service Kit Masterfit | 237 229 |
| Kalrez Kit Masterfit | 237 319 |

Retractable Armatures



RETRACTOFIT, RETRACTOFIT PEEK

The HAMILTON RETRACTOFIT is an ideal armature for industrial applications. The armature allows the user to install maintenance-free electrodes in critical processes. The main advantage of this design is that the sensor can be withdrawn while the process is running (i.e. for cleaning, calibration or even to replace the electrode), without interrupting the process. The design allows the use of sensors with 210 to 225 mm shaft length and a PG 13.5 thread, e.g. electrodes such as the EASYFERM Plus 225, MECOTRODE 225, OXYGOLD G 225 and VISIFERM™ DO.

The armature is very easy to use and maintain. Only one press of the red button is needed to move the electrode into or out of the process. All o-rings are easily replaced without special tools.

An integral safety mechanism prevents the armature from being inserted into the sample without an electrode installed. This prevents an open connection between the inside of the process vessel and the external environment. In the retracted position, the electrode is retained in a chamber where it can be kept moist, cleaned and even calibrated. This can all be done without process interruption or disassembly of the armature. Two tube connectors allow access to the rinsing chamber.

Two accessories are available for the RETRACTOFIT. A shortened insertion tube that allows use of the armature in narrow-bore pipes for which the standard insertion tube is too long. A closed insertion tube converts the RETRACTOFIT into a sampling system for diverse applications. Both accessories can easily be exchanged for the standard insertion tube using only gentle hand pressure.

The RETRACTOFIT BIO on page 45 is the sanitary designed version for biotechnology and food applications.

Advantages:

- One-hand operation
- Insertion is only possible with an electrode installed
- Electrode cannot be removed when in measurement position
- Visual check of o-rings
- Longer sensor life due to 225 mm sensor length

RETRACTOFIT PEEK:

All steel parts constantly exposed to the process are replaced with PEEK. This allows the holder to be used with highly corrosive media providing the calibration chamber is thoroughly rinsed after retraction.



| Name | Order No. |
|-----------------------|-----------|
| RETRACTOFIT | 237 240 |
| RETRACTOFIT PEEK 25 | 237 490 |
| RETRACTOFIT PEEK 38.5 | 237 460 |

Accessories:

| | |
|--------------------------|---------|
| Weld-in socket (page 40) | |
| Service Kit RETRACTOFIT | 237 239 |
| Kalrez Kit RETRACTOFIT | 237 339 |
| Insertion tube short | 237 255 |

Retractable Armature, Sanitary Version

RETRACTOFIT BIO

The HAMILTON RETRACTOFIT BIO is an armature designed for applications where sanitary concerns are critical. The armature is steam-sterilizable and autoclavable. The stainless steel DIN 1.4435 (SS 316) and the FDA-approved EPDM o-rings withstand typical CIP cleaning.

The main advantage of this armature is that the sensor can be withdrawn while the process is running (i.e. for cleaning, calibration or even to replace the electrode), without interrupting the process. The design allows the use of sensors with 210 to 225 mm shaft length and a PG 13.5 thread, e.g. sensors such as the HAMILTON EASYFERM Food 225, POLILYTE HTVP 225, EASYFERM Plus 225 and OXYFERM 225.

The armature is very easy to use and maintain. Only one press of the red button is needed to move the electrode into or out of the process. All o-rings are easily replaced without special tools.

An integral safety mechanism prevents the armature from being inserted into the sample without an electrode installed. This prevents the risk of open connection between the inside of the process vessel and the external environment. Two leakage detection openings indicate seal failures during operation.

In the retracted position, the electrode

is retained in a chamber where it can be kept moist, cleaned and even calibrated. This can all be done without process interruption or disassembly of the armature. Two tube connectors allow access to the rinsing chamber.

The RETRACTOFIT on page 44 is designed for applications in the chemical and waste water industry.

ATTENTION:

Check with your dealer for the right o-ring position or weld-in socket!

Advantages:

- Autoclavable
- One-hand operation
- Various leakage indicators
- Longer sensor life due to 225 mm sensor length
- Insertion is only possible with an electrode installed
- No removal of sensor when in measurement position



| Name | Order No. |
|---|-----------|
| RETRACTOFIT BIO 55 (o-ring seals at OP = 55mm) | 237 440 |
| RETRACTOFIT BIO 25 (o-ring seals at OP = 25mm) | 237 480 |
| Accessories: | |
| FDA Service Kit | 237 338 |
| Weld-in socket (page 41) | |

Pneumatically Powered Retractable Armature

RETRACTEX™ Concepts

The RETRACTEX™ Family Concept

By consequent standardization HAMILTON managed to realize a modular system for a pneumatically powered retractable armature. Therefore, the money spent to buy a RETRACTEX™ armature is well invested, even if the measurement station is changed, because only the process connection module has to be replaced in this case.

RETRACTEX™ armatures can be equipped with sensors that have a PG 13.5 thread, 12 mm shaft diameter and a shaft length of 225 mm. Compared to 120 mm sensors the increased electrolyte volume significantly increases the life span of the reference. Thus not only the electrode consumption is lowered, but also the zero point drift of 225 mm sensors is slower. Furthermore, the 225 mm sensors allow for a very compact construction.

Asset protection and simple maintenance by modularity

The actuator is the same for all RETRACTEX™ armatures, and you can even continue to use it if you change the process connection from DIN flange to BioConnect for example. The insertion tube is locked into the actuator. The orientation of its 'sensor window' can not be twisted to the actuator or the cleaning chamber. Therefore, by simple twisting of the RETRACTEX™ armature, the sensor can either be exposed to the main flow or be protected from it. This can be useful in pipes, if the process medium contains abrasive solids which may harm the glass membrane. On the other hand, for use under hygienic conditions a good fluid circulation around the sensor is essential for good cleaning in place.

The pneumatic actuator

The actuator is the core of the RETRACTEX™-family. It is compact, light but nevertheless very resilient mechanically. Its connection panel makes it easy to correctly connect the air hoses that are needed to run RETRACTEX™. There will not be much confusion because the pneumatic connections are systematically size and color coded. If the armature goes from the rinsing to the measuring position and back, HAMILTON's SOFTDRIVE™ function comes into operation: The change of the position only takes a split-seconds. During the last millimeters of the movement RETRACTEX™ brakes. This way, the expensive sensors are moved softly and smoothly from one position to the other.

The RETRACTEX™ construction kit:

Simply put together:



Actuator



Insertion tube



Process connection
with rinsing chamber



RETRACTEX™ tool



RETRACTEX™ BC

The RETRACTEX™ family

Assembly of the seals

Some users prefer o-rings on the inside because they are better protected from process medium, others prefer o-rings on the outside that can be easily replaced and inspected visually. HAMILTON offers both with the RETRACTEX™ family concept.

In the chemical industry version the o-rings are assembled on the inside, and protected by a deflector. Additionally, the integrated blocking water function keeps particles away while the sensor is moving.

In the hygienic version, the o-rings which are assembled at the outside can be easily inspected and exchanged to avoid potential contaminations and to ensure sterility.

Size doesn't matter, just quality does



Size comparison between RETRACTEX™ and the product of a competitor (gray)


The rinsing chamber

Another component of RETRACTEX™ armatures is the hygienically designed rinsing chamber with integrated process connection. In the "chemical" version RETRACTEX C™, the rinsing chamber and process connection can be separated from each other. Thus the same rinsing chamber can be used with various process connections.

Actuator, insertion tube and rinsing chamber can be disassembled and assembled within seconds. The only tool you will need for this is the RETRACTEX™ tool included in the package. All gaskets and the general state of the rinsing chamber can be checked quickly.

Safety is paramount!

HAMILTON included a huge bundle of safety features into the RETRACTEX™ armature family to prevent accidents:

1.  Personnel and facility safety: TÜV Rheinland confirmed that RETRACTEX™ armatures can be used without risk in ATEX-relevant ambience of category 1 to 3 (zone 0 to 2) because the armatures do not contain ignition sources.
2. Design tests: During and at the end of development intense tests were performed to assure trouble-free running of RETRACTEX™.
3. Risk assessment: As part of the HAMILTON design standards a risk analysis was performed to detect and eliminate potential weaknesses.
4. Personnel safety: Only when the sensor is entirely screwed into the armature, it can be moved into the process. That way no process media can escape uncontrolled if someone accidentally tries to move a sensorless armature into the process.
5. Protection of the process: Even if the sealing of the actuator is broken no compressed air will get into the process.
6. Protection of the drive: If a seal in the wetted part of the armature is broken, no process- or rinsing media will get into the pneumatic head or into the pneumatic control.
7. Protection of the sensor: The position of the sensor window is fixed, so the sensor can be either exposed to the flow or protected from it by twisting the insertion tube.
8. Protection from user error: The size and color coded pneumatic connectors assure the right hose system is applied - even in hectic times.
9. Sterility: Because of the intelligent cleaning concept fast heating and cleaning of the sensor is achieved. A further innovation is the patent protected HyCIP™ process connection. This allows the gap between armature and 25 mm weld-in socket to be cleaned and sterilized, and the entire rinsing chamber to be heated faster, because the cleaning agent enters the rinsing chamber at optimal spots.
10. Autoclavation: All medium contacted parts can be dismounted from the actuator within seconds and then autoclaved. The armature can be safely re-assembled at the same speed.
11. Hygienic Design: The RETRACTEX™ armatures were designed with the recommendations of the EHEDG in mind. Furthermore, this design offers advantages in rough and very dirty applications.
12. Cleanability: Cleanability tests with installed pH sensors and sticky contaminations confirm the unmatched cleanability of RETRACTEX™. This was achieved by applying the cleaning solution from optimally placed locations and through complete flow around the relevant seals.

RETRACTEX™ for hygienic processes

RETRACTEX™

Hygienic design versions

HAMILTON invested a lot to meet the high hygienic requirements of biotechnology and food and beverages industry. As a result, RETRACTEX™ is the pneumatic retractable armature closest to perfection for these application areas, and due to its various process connections it can be used with all vessels used in these industries.

More sterile safety and unique cleaning efficiency with HyCIP™

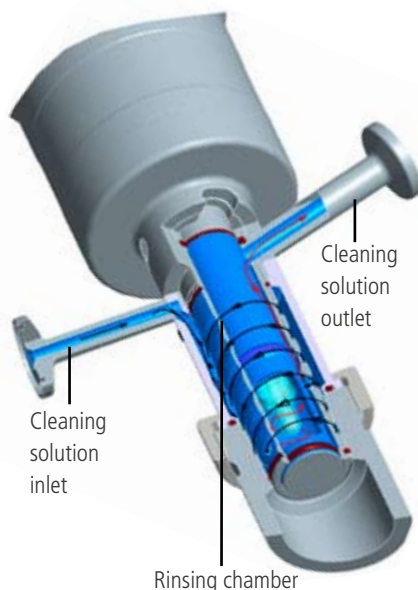
We would like to highlight the patent-protected HAMILTON HyCIP™ process connection for the widely used 25 mm weld-in sockets. This process connection has proven its value in general, but it leads to sterility problems time and again.

Frequent reasons for these sterility problems are:

a) Grooves at the inside of the socket that are a result of mounting and dismounting armatures with protection pins. The o-ring may still seal despite the grooves, but it is not a sterile barrier between the inside of a fermenter and the germ infested outside. Frequently, the upper part of the socket provides excellent growing conditions for germs.

b) Deformations of the socket's inner diameter (loss of circularity) that can occur when welding in the socket. The consequence is the same as the grooves described above.

The HyCIP™ solution is a huge improvement because the interior of the socket itself is sterilized. This is achieved by a second o-ring that seals at the outer side of the socket and by the sterilization of the resulting interspace. The HyCIP™ process connection leads the steam or cleaning solutions spirally through this interspace for optimal cleaning. The whole socket quickly reaches the temperature required for sterilization, creating an additional sterile area.



RETRACTEX™ HyCIP™ cleaning: Flow of the cleaning solution through the rinsing chamber

Furthermore, HyCIP™ process connections offer another advantage: If the sensor is in cleaning position, it can be cleaned and sterilized together with all medium contacting seals. In the HyCIP™ connection the cleaning solution is directed between armature and socket up to the process seal so the most remote parts of the chamber are rinsed. Thus HyCIP™ armatures are unmatched for their cleaning performance of the sensor and of all relevant seals.



RETRACTEX™ HyCIP with sensor and cable



RETRACTEX™ HyCIP process connection

RETRACTEX C™ for aggressive media

RETRACTEX C™

The chemistry version with blocking water feature

As opposed to biotechnology, in the chemical industry other properties are needed: Safe positioning and movement of the armature even if the media are sticky, trouble-free operation despite solids in the process medium, protection of the sensor if installed into pipes, resistance to corrosion, robust adaptations with flanges and safe operation in explosive areas. With RETRACTEX C™ armatures HAMILTON offers a whole range of features to meet these criteria. For example, the optional blocking water function rinses the media contacted seals and the sensor with water during position changes. This also prevents process water from getting into the rinsing chamber.

The insertion tube keeps its orientation when mounted, the sensor is protected by the slipstream of the insertion tube. Various medium contacted materials like PVDF, PEEK, Alloy C 22 or stainless steel DIN 1.4571 and the eligible seals made of EPDM, FPM/FKM or Kalrez® allow operation under extreme conditions.



RETRACTEX C™ with steel flange



The TÜV confirms: RETRACTEX™ does not have internal ignition sources and thus can be used safely in potentially explosive areas.

Accessories for RETRACTEX™



1. MiniClamp adapter
2. MiniClamp
3. EPDM o-ring (TC3/4")



RETRACTEX™ with MiniClamp adapter

Ordering information

| Name | Order No |
|---|-------------|
| RETRACTEX™ HyCIP 25 | 242 220-25* |
| RETRACTEX™ HyCIP 50 | 242 220-50* |
| RETRACTEX™ HyCIP 55 | 242 220-55* |
| RETRACTEX™ TC 200 (2" Triclamp) | 242 230 |
| RETRACTEX™ VV (Varivent N) | 242 240 |
| RETRACTEX™ BCI40 (BioConnect DN40 ISO-V) | 242 250 |
| RETRACTEX™ BCD40 (BioConnect DN40 DIN-V) | 242 260 |
| RETRACTEX C™, Plastic flange** | 242 671 |
| RETRACTEX C™, Steel flange** | 242 672 |
| Accessories: | |
| MiniClamp adapter to connect to the rinsing chamber (TC3/4" to G1/4") | 242 276 |
| MiniClamp adapter to connect to the rinsing chamber (TC3/4" to G1/8") | 242 691 |
| MiniClamp | 242 218 |
| MiniClamp seal made of EPDM (TC3/4") | 242 217 |
| Service Kit Retractable HyCIP EPDM (FDA, USP class VI) | 242 281 |
| Service Kit Retractable HyCIP FPM (Viton) | 242 282 |
| Service Kit Retractable HyCIP Kalrez (FDA) | 242 283 |
| Service Kit Retractable TC/VV/BC EPDM (FDA, USP class VI) | 242 286 |
| Service Kit Retractable TC/VV/BC FPM (Viton) | 242 287 |
| Rinsing chamber HyCIP | 242 296-OP |
| Rinsing chamber TC 200 | 242 297 |
| Rinsing chamber VV | 242 298 |
| Rinsing chamber BCI 40 | 242 219 |
| Rinsing chamber BCD 40 | 242 299 |
| RETRACTEX tool | 242 231 |

* 25, 50, 55 = Standard o-ring positions

** With various flange types and o-ring materials available on request

Technical Data: Armatures

| | RETRACTOFIT | RETRACTEX™ | RETRACTEX™ C | MASTERFIT | HYGIENIC SOCKET™ |
|--------------------------|--------------------|----------------------|--------------------|----------------------|----------------------|
| Process connection | G 1 1/4" | various (view p. 48) | various (s. S. 48) | G 1-1/4" | PG 13.5 |
| Minimum length | 420 mm | various | various | various (view p. 41) | 107 mm |
| Maximum length | 450 mm | various | various | various (view p. 41) | 128.5 mm |
| Maximum diameter | 70 mm | various | various | 60 mm | 28 mm |
| Sensor insertion depth | 70 mm | various | various | 70 mm | various (view p. 38) |
| Armature insertion depth | 105 mm | various | various | 80 mm | various (view p. 38) |
| Material | SS 316L/DIN 1.4571 | SS 316L/DIN 1.4435 | various | SS 316L/DIN 1.4435 | various (view p. 39) |
| Standard seals | VITON | EPDM (USP class VI) | various | FDA-EPDM | FDA-EPDM |
| Temperature range | -10 - +130°C | -10 - +140°C | -10 - +140°C | -10 - +130°C | -10 - +140°C |
| Maximum pressure | 6 bar | 10 bar | 10 bar | 6 bar | 16 bar |
| Weight | 1350 g | ca. 3.0 kg | ca. 3.0 kg | 1400 g | 350 g |
| For sensors with | 12 mm PG 13.5 | 12 mm PG 13.5 | 12 mm PG 13.5 | 30 mm standard | 12 mm PG 13.5 |
| Sensor shaft length | a = 225 mm | a = 225 mm | a = 225 mm | various | a = 120 mm |
| Catalog page | 44 | 48 | 48 | 43 | 38 |

| | FLEXIFLOW SL 10 | RETRACTOFIT BIO | FLEXIFIT VV | FLEXIFIT TC | FLEXIFIT BIO |
|--------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Process connection | Swagelok 10 mm | G 1-1/4" | Varivent | TriClamp 1.5" | G 1-1/4" |
| Minimum length | 175 mm | 366 mm | 100 mm | 133 mm | 133 mm |
| Maximum length | 175 mm | 443 mm | 100 mm | 133 mm | 133 mm |
| Maximum diameter | 65 mm | 70 mm | 85 mm | 50.5 mm | 50 mm |
| Sensor insertion depth | — | 70 mm | 30 mm | 32 mm | various |
| Armature insertion depth | — | 132 mm | 2 mm | 33 mm | various |
| Material | SS 316L/DIN 1.4435 | SS 316L/DIN 1.4435 | SS 316L/DIN 1.4435 | SS 316L/DIN 1.4435 | SS 316L/DIN 1.4435 |
| Standard seals | FDA-EPDM | FDA-EPDM | FDA-EPDM | FDA-EPDM | FDA-EPDM |
| Temperature range | -10 - +130°C | -10 - +135°C | -10 - +135°C | -10 - +135°C | -10 - +135°C |
| Maximum pressure | 16 bar | 6 bar | 6 bar | 6 bar | 6 bar |
| Weight | 1200 g | 1840 g | 950 g | 490 g | 490 g |
| For sensors with | 12 mm PG 13.5 | 12 mm PG 13.5 | 12 mm PG 13.5 | 12 mm PG 13.5 | 12 mm PG 13.5 |
| Sensor shaft length | a = 120 mm | a = 225 mm | a = 120 mm | a = 120 mm | a = 120 mm |
| Catalog page | 42 | 45 | 42 | 42 | 42 |

Technical Data: Oxygen Sensors

VISIFERM™ DO

| | |
|----------------------------------|---|
| Range of measurement: | 4 ppb - 25 ppm/0.05% ... 300% air saturation |
| Accuracy at 25°C: | 1 ± 0.05 %-vol: 21 ± 0.2%-vol; 50 ± 0.5 %-vol |
| Detection limit: | 0.01 %-vol |
| Response time t98%: | < 30 s at 25°C, from air to nitrogen |
| Oxygen consumption: | None |
| Required flow: | None |
| Drift under constant conditions: | < 0.2 %-vol oxygen per week in air at 30°C |
| Storage temperature: | -10 - 50°C |
| Operation temperature: | -10 - 130°C; the sensor provides no DO reading above 80°C |
| Pressure range: | -1 - 12 bar / 174 psi; pressure spikes up to 80 bar |
| Measurement principle: | Oxygen dependant luminescence |
| Medium affected materials: | stainless 316L/DIN 1.4435; Silicone and EPDM with FDA approval |
| Mounting: | PG 13.5 thread |
| Surface quality of steel: | Ra = 0.4 µm (N5) |
| Connector head: | VP 8.0 |
| Operating voltage: | 7-30 VDC |
| Continuous power: | Approx. 0.6 W; Start-up power: max. 1 W |
| Interfaces: | <ul style="list-style-type: none"> - Freely scalable 4-20 mA interface for a stable 4-20 mA signal of Visi ferm, that can be used for example in a process control system. - ECS interface for the simulation of an electrochemical sensor. Thus Visi ferm can be connected to a classical transmitter. |
| Fieldbus interface: | Digital USB-RS485 Modbus converter (2 wires) with Modbus RTU protocol. |
| Electrolyte: | None |
| Polarization voltage and time: | None. For thermal reasons (self-heating) it is necessary to wait for 5-10 minutes for very stable measured values after starting the power supply. |

| Amperometric sensors | OXYGOLD G | OXYGOLD B | OXYFERM VP/FDA | OXYFERM XL | OXYSENS |
|----------------------------|----------------|----------------|----------------------------|-----------------|-----------------|
| Measurement range | 1 ppb - 40 ppm | 8 ppb - 40 ppm | 10 ppb - 40 ppm | 10 ppb - 40 ppm | 40 ppb - 40 ppm |
| Polarization voltage | -670 +/- 50 mV | 0 mV | -670 +/- 50 mV | -670 +/- 50 mV | -670 +/- 50 mV |
| Signal in air at 25°C | 200 - 500 nA | 200 - 500 nA | 40 - 80 nA | 40 - 80 nA | 40 - 80 nA |
| Response time t98% at 25°C | 30 - 60 sec. | 30 - 60 sec. | 30 - 60 sec. | 30 - 60 sec. | 60 sec. |
| Minimum required flow | 0.1 m/sec. | 0.1 m/sec. | 0.03 m/sec. | 0.03 m/sec. | 0.03 m/sec. |
| Temperature range | 0 - 130°C | 0 - 100°C | 0 - 130°C | 0 - 130°C | 0 - 60°C |
| Pressure range (relative) | 0 - 12 bar | 0 - 12 bar | 0 - 4 bar | 0 - 4 bar | 0 - 4 bar |
| Drift at 25°C | < 1% / week | < 1% / week | < 1% / week | < 1% / week | < 5% / 2 months |
| Fitting | PG 13.5 thread | PG 13.5 thread | PG 13.5 thread | G 1 1/4" thread | PG 13.5 thread |
| Electric connection | VP 6.0 | VP 6.0 | VP or T82 / D4 | T82 / D4 | 5 m fixed cable |
| Temperature sensor | NTC 22kOhm | NTC 22kOhm | NTC 22kOhm | NTC 22kOhm | NTC 22kOhm |
| Standard seals | FDA-EPDM | FDA-EPDM | VP: Viton FDA: FDA-EPDM | FDA-EPDM | FDA-EPDM |
| Shaft material | DIN 1.4435 | DIN 1.4435 | DIN 1.4435 | DIN 1.4435 | DIN 1.4435 |
| Shaft diameter | 12 mm | 12 mm | 12 mm | 25 mm | 12 mm |
| Shaft length a | 120 or 215 mm | 120 or 215 mm | various | various | 120 mm |
| Catalog page | 31 | 31 | 30 | 30 | 30 |

Technical Data: pH Sensors

| pH-Sensors | Shaft material | pH Glass type | pH Glass resistance | Nominal measurement range | Reference system | Reference electrolyte | Number diaphragm |
|--------------------|-----------------|--------------------------------|---------------------|---|------------------|-----------------------|------------------|
| CHEMOTRODE | Glass | PHI | moderate | 0 - 14 | EVEREF-F | 3M KCl-LR | 3 |
| CHEMOTRODE P | Glass | PHI | moderate | 0 - 14 | EVEREF-F | PROTELYTE | 3 |
| CLARYTRODE | Glass | HF | moderate | 0 - 14 | EVEREF-L | POLISOLVE | 2 |
| EASYCONTROL | Glass | V | low | 0 - 14 | Ag/AgCl | Gel | 1 |
| EASYFERM Plus | Glass | PHI | moderate | 0 - 14 | EVEREF-F | PHERMLYTE | 1 |
| EASYFERM Food | Glass | HB | moderate | 0 - 14 | EVEREF-F | FOODLYTE | 1 |
| INCHTRODE N100F | PVDF, FDA grade | HF | moderate | 0 - 14 | EVEREF-L | POLISOLVE | 1 |
| INCHTRODE N75F | PPS - Ryton | HF | moderate | 0 - 14 | EVEREF-L | POLISOLVE | 1 |
| INCHTRODE N75FC10 | PPS - Ryton | HF | moderate | 0 - 14 | EVEREF-L | POLISOLVE | 1 |
| INCHTRODE N75P | PPS - Ryton | PHI | moderate | 0 - 14 | EVEREF-L | POLISOLVE | 1 |
| INCHTRODE N75PC10 | PPS - Ryton | PHI | moderate | 0 - 14 | EVEREF-L | POLISOLVE | 1 |
| IONOTRODE | Glass | F | very low | 0 - 14 | EVEREF | 3M KCl | 1 |
| LIQ-GlassS PG | Glass | F | low | 1 - 12 | EVEREF | liquid | 3 |
| MECOTRODE | Glass | H | moderate | 0 - 14 | EVEREF | Gel | 3 |
| pHeasy HT | Glass | PHI | moderate | 0 - 14 | EVEREF-L | POLISOLVE | 2 |
| POLILYTE HT | Glass | H | moderate | 0 - 14 | EVEREF-L | POLISOLVE | 2 |
| POLILYTE PLUS | Glass | H | moderate | 0 - 14 | EVEREF-L | POLISOLVE PLUS | 2 |
| POLILYTE PLUS XP | Glass | H | moderate | 0 - 14 | EVEREF L | POLISOLVE PLUS | 2 |
| POLILYTE PRO | Glass | V | low | 0 - 14 | EVEREF-B | POLISOLVE | 1 |
| POLYPLAST PRO | Plastic | V | moderate | 0 - 14 | Ag/AgCl | POLISOLVE | 1 |
| Combination Sensor | Shaft material | pH Glass type | pH Glass resistance | Nominal measurement Range | Reference system | Reference electrolyte | Number diaphragm |
| JACOTRODE | Glass | pH Glass V 2 Platinum Rings | low | 0 - 14 +/- 2000 mV 0.1 µS/cm - 1 mS/cm*** | EVEREF-F | SKYLYTE | 1 |
| Redox Sensors | Shaft material | pH Glass type | pH Glass resistance | Nominal measurement range | Reference system | Reference electrolyte | Number diaphragm |
| CHEMOTRODE ORP | Glass | Platinum Ring | — | +/- 2000 mV | EVEREF-F | 3M KCl-LR | 3 |
| EASYCONTROL ORP | Glass | Platinum Wire | — | +/- 2000 mV | Ag/AgCl | Gel | 1 |
| OXYTRODE PT | Glass | Platinum Wire | — | +/- 2000 mV | EVEREF | Gel | 3 |
| POLILYTE RX | Glass | Platinum Wire | — | +/- 2000 mV | EVEREF-B | POLISOLVE | 1 |
| POLYPLAST PRO RX | Plastic | Platinum Wire | — | +/- 2000 mV | Ag/AgCl | POLISOLVE | 1 |

* at 25°C; ** dependant on positioning of electrolyte container;

*** larger range possible with multipoint calibration

Technical Data: pH Sensors

| of gms | Diaphragm type | Sample: Min. conductivity | Temperature range | Pressure range | Shaft length (a) | Electrode head | Certificate | Catalog page |
|-----------|-------------------|------------------------------|----------------------|-------------------|---------------------|--------------------------|-------------|-----------------|
| | HP ceramic | 50 µS/cm | 0 - 130°C | < 6 bar | various | S7, VP | — | 15, 19 |
| | HP ceramic | 50 µS/cm | 0 - 130°C | < 6 bar | various | S7, VP | — | 15 |
| | SINGLE PORE | 5 µS/cm | -5 - 100°C | < 6 bar | 120 mm | S8, VP / PG 13.5 | Yes | 19 |
| | Ceramic | 50 µS/cm | 0 - 60°C | < 2 bar | various | S8 / PG 13.5 | — | 21 |
| | HP COATRAMIC | 100 µS/cm | 0 - 135°C | < 6 bar | various | S8, VP, K8, MS / PG 13.5 | Yes | 14, 18 |
| | HP COATRAMIC | 100 µS/cm | 0 - 135°C | < 6 bar | various | S8, VP, K8 / PG 13.5 | Yes | 15, 16 |
| | SINGLE PORE ring | 2 µS/cm | -10 - 130°C | < 10 bar * | | VP / 2 x NPT 1" | — | 16, 20 |
| | SINGLE PORE ring | 2 µS/cm | -10 - 130°C | < 10 bar * | | VP / 2 x NPT 3/4" | Yes | 20 |
| | SINGLE PORE ring | 2 µS/cm | -10 - 130°C | < 10 bar * | | Cable / 2 x NPT 3/4" | Yes | 20 |
| | SINGLE PORE ring | 50 µS/cm | 0 - 130°C | < 10 bar * | | VP / 2 x NPT 3/4" | Yes | 20 |
| | SINGLE PORE ring | 50 µS/cm | 0 - 130°C | < 10 bar * | | Cable / 2 x NPT 3/4" | Yes | 20 |
| | Ring, removeable | 0.2 µS/cm | -10 - 40°C | < 0.5 bar ** | 120 mm | S7 / PG 13.5 | — | 17 |
| | Ceramic | 2 µS/cm | -5 - 60°C | < 2 bar | 120 mm | S8 / PG 13.5 | — | 17 |
| | HP ceramic | 50 µS/cm | 0 - 130°C | < 16 bar | various | S8, VP / PG 13.5 | — | 22 |
| | SINGLE PORE | 50 µS/cm | 0 - 130°C | < 6 bar | various | VP / PG 13.5 | Yes | 19 |
| | SINGLE PORE | 2 µS/cm | 0 - 130°C | < 6 bar | various | S8, VP / PG 13.5 | Yes | 16 |
| | SINGLE PORE | 2 µS/cm | 0 - 130°C | < 6 bar | various | S8, VP, MS / PG 13.5 | Yes | 18, 22 |
| | SINGLE PORE | 2 µS/cm | 0 - 60°C | < 50 bar | various | S8, VP / PG 13.5 | Yes | 22 |
| | SINGLE PORE | 2 µS/cm | -10 - 60°C | < 6 bar | 120 mm | S8, MS / PG 13.5 | Yes | 21 |
| | SINGLE PORE | 50 µS/cm | -10 - 40/60°C | < 6 bar | 120 mm | S8 / PG 13.5 | — | 21 |

| of gms | Diaphragm type | Sample: Min. conductivity | Temperature range | Pressure range | Shaft length (a) | Electrode head | Certificate | Catalog page |
|-----------|-------------------|------------------------------|----------------------|-------------------|---------------------|----------------|-------------|-----------------|
| | HP COATRAMIC | 100 µS/cm | 0 - 130°C | < 4 bar | various | VP / PG 13.5 | — | 26 |

| of gms | Diaphragm type | Sample: Min. conductivity | Temperature range | Pressure range | Shaft length (a) | Electrode head | Certificate | Catalog page |
|-----------|-------------------|------------------------------|----------------------|-------------------|---------------------|----------------|-------------|-----------------|
| | HP ceramic | 50 µS/cm | 0 - 130°C | < 6 bar | various | S7, VP | — | 15, 19 |
| | Ceramic | 50 µS/cm | 0 - 60°C | < 2 bar | various | S8 / PG 13.5 | — | 21 |
| | HP ceramic | 50 µS/cm | 0 - 130°C | < 16 bar | 120 mm | S8 / PG 13.5 | — | 22 |
| | SINGLE PORE | 2 µS/cm | -10 - 60°C | < 6 bar | various | S8 / PG 13.5 | Yes | 21 |
| | SINGLE PORE | 50 µS/cm | -10 - 40/60°C | < 6 bar | 120 mm | S8 / PG 13.5 | — | 21 |

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