LABORATORY ELECTRODES

pH – Redox

HAMILTON

Contents

GLP Laboratory electrodes

HAMILTON pH electrodes offer you more! Our electrodes are precision instruments known for their high quality, long lifetime and fabulous performance in a wide range of applications. In order to continue meeting these rigorous requirements, HAMILTON constantly strives toward new horizons in electrode technology e.g. the Single Pore concept or the POLISOLVE electrolyte. PTB (Physikalisch-Technische Bundesanstalt) has stated that the most accurate laboratory electrode is the SINGLE PORE GLASS from HAMILTON. Other advantages of the electrodes are the design, the watering cap as well as the certificate which is delivered with the electrodes.

Design offers many advantages

- All electrodes are printed with an indelible serial number
- Ergonomic electrode head
- Proven electrolyte sealing system for the refilling opening
- Blue inner buffer provides visual indication of contact with the pH membrane
- High-quality seal between electrode head and cable (IP 68)

Watering cap with screw lock

- Easy removal of the watering cap by means of the screw lock
- Secure sealing of the watering cap
- No spilling of electrolyte when removing the watering cap

Individual test certificates with measured millivolt values

Innovations in electrochemistry

The SINGLE PORE concept

Precise, reliable, and rapid readings with a patented system that ensures contact between the electrolyte and the sample.

Since its introduction in 1991, the patented SINGLE PORE concept just continues to become more and more successful. The advantage of this solution is clear to see: Instead of the many tiny pores in a ceramic diaphragm, a SINGLE PORE about 200 times larger in cross-section (in the form of a capillary) performs the task. This SINGLE PORE is practically impossible to clog. In combination with a dedicated electrolyte, the flow rate through the pore is defined, resulting in enhanced contact between the reference electrode and the measurement medium. This leads to a faster electrode response and more accurate readings.

However, even after 15 very successful years, HAMILTON has found a way to improve the design of the SINGLE PORE, so that today the SINGLE PORE GLASS electrode is even more robust and user-friendly than ever.

Note: The PTB (Physikalisch-Technische Bundesanstalt (Physical-Technical Federal Institute)) in Braunschweig, Germany, in a very wide-ranging and well documented study, determined the SINGLE PORE pH electrode to be the most accurate laboratory electrode in the test. Further information can be found in "Traceability of pH measurement" by Petra Spitzer: ISBN 3-89429-877-4 or ISSN 0947-7063.

POLISOLVE and POLISOLVE PLUS electrolyte

The innovative polymer reference electrolyte that solves so many application problems

Contrary to the widespread belief that pH electrodes with a polymer electrolyte cannot be used over the entire pH or temperature range, HAMILTON has succeeded in developing the innovative POLISOLVE polymer electrolyte that can be used over the complete pH range from 0 to 14, and in a temperature range from -10°C to 130°C.
POLISOLVE is compatible with most organic solvents, and is completely Acrylamide free. The combination of POLISOLVE electrolyte with the modified SINGLE PORE concept results in an extremely versatile laboratory electrode that is perfectly suited to pH measurement in a wide range of uses, for example in:

- Ground water and coolants
- Galvanic baths
- Solutions containing color pigments
- Samples containing oil and fat
- Suspensions
- Solutions containing protein

And now, with POLISOLVE PLUS, HAMILTON has achieved an important new development that means even more stable reference signals. Thanks to an ingenious integrated filter system, reference poisons remain harmless for even longer. At the same time, troublesome diffusion potentials are minimized and measurement accuracy is enhanced. In short: POLISOLVE PLUS represents a significant improvement in extending the life of pH electrodes.

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 that prevents the loss of silver chloride during temperature swings which allows the use of silver-free electrolyte.

The EVEREF® B labyrinth system used in the POLILYTE LAB electrodes further extends the diffusion distance, considerably lengthening electrode life in aggressive media. These electrodes provide outstanding results in ion-weak and partially aqueous solutions.

HAMILTON pH membrane glass

Guarantee the accuracy of your measurements

The continuous improvement of our pH membrane glass offers many previously unavailable benefits. Most laboratory electrodes have a "V" or a "HF" type glass membrane. This unique glass possesses excellent mechanical stability and very low membrane resistance. This makes measurements possible in solutions with low conductivity.
"HF" glass is a development that guarantees the longest possible electrode life in processes containing hydrofluoric acid. In addition, this glass is well suited to the production of flat pH membranes. These are of great advantage, for example, with the Flatrode for readings of small volumes or on a flat surface areas.

HAMILTON "H" glass displays excellent characteristics and stable measurement values in media with low water content, for example in anhydrous or only partially aqueous solutions.
The low alkali error of "H" glass ensures accurate measurements even at high pH values.

Conductivity standards

Certified by an accredited laboratory
Fulfills all requirements of United States Pharmacopia USP Chapter 625

HAMILTON is the first vendor in the world of conductivity standards to offer 1.3 and 5 µS/cm with a certified accuracy of ±1 % and a lifetime of 1 and 3 years, respectively. The composition of these standards is patented. The measurement procedure for determining conductivity has been developed in collaboration with DFM[1]. A number of state metrological institutes that deal with measurement of electrolytic conductivity have started using these HAMILTON standards, since they lie in a low conductivity range and exhibit a previously unknown level of stability, confirmed by measurements performed by PTB[2].

For this reason, in an inter-laboratory test among prestigious European metrological institutes (PTB, DFM, DKD[3]) it was HAMILTON standards that were used as the measurement solution.

See page 18/19 for details

[1] DFM: Danish Institute of Fundamental Metrology, Danemark
[2] PTB: Physikalisch-Technische Bundesanstalt, Braunschweig
[3] DKD: Deutscher Kalibrierdienst

Duracal pH buffers

Certified by an accredited laboratory
Easy handling and 5-year stability

A complete range of patented stable pH buffer solutions from pH 1.09 to 12.00. HAMILTON guarantees DURACAL pH buffers to last for five years from the date of manufacture. The pH 9.21 and pH 10.1 buffers are even stable in air. High buffer capacities enable quick, stable calibrations.

Closed-loop traceability: In contrast with other manufacturers, who operate using only hierarchical (top-down) traceability, HAMILTON has developed a new approach featuring "closed-loop" traceability for the values 4.01, 7.00, 9.21 and 10.01. For users of DURACAL pH buffer solutions, this ensures 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 batch manufactured, a representative quantity is measured at DKD. This ensures an external, independent verification by an accredited institute.
DKD issues an official calibration certificate for the corresponding DURACAL production batch.

See page 16/17 for details

HAMILTON

Electrodes for general laboratory applications

LIQ-GLASS Family

- Robust, combination pH electrode for daily laboratory use
- Universally applicable, in strong acids as well as in strong bases
- Ideally suited for acid/base titrations
- Serial number, certificate

Specifications:

pH: 0 to 14
Electrolyte: 3M KCl (refillable)
Diaphragm: ceramic
T: -10 to 100°C
Shaft material: glass
Reference system: EVEREF

LIQ-GLASS

PN 238000 Liq-Glass

Temperature sensor: no
Electrical connection: S7 connector head

LIQ-GLASS

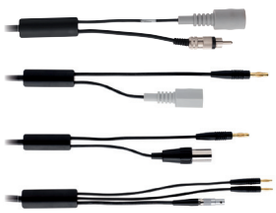
PN 238180 Liq-Glass BNC
PN 238185 Liq-Glass DIN

Temperature sensor: no
Electrical connection: 1m cable with BNC or DIN plug

LIQ-GLASS TEMP

PN 242055 Liq-Glass Temp BNC/Cinch
PN 242056 Liq-Glass Temp BNC
PN 238406 Liq-Glass Temp DIN
PN 242054 Liq-Glass Temp Lemo

Temperature sensor: NTC 30 kOhm (PN 238406, 242055); Pt1000 (PN 242054, 242056)
Electrical connection:



PN 242055: 1m BNC cable / 1 x cinch plug

PN 242056: 1m BNC cable / 1 x 4 mm banana plug

PN 238406: 1m DIN cable / 1 x 4 mm banana plug

PN 242054: 1m LEMO cable / 2 x 2 mm banana plug
(2 adapters for 4 mm banana plug included)

ACCESSORIES ON PAGE 14

Electrodes for general laboratory applications

SINGLE PORE GLASS

PN 238160 **Single Pore Glass**

- Highest accuracy and fast response time thanks to patented SINGLE PORE diaphragm
- Robust design for easy cleaning
- Wide applicability, use for emulsions, ion-weak media or general laboratory applications
- Reported by PTB to be the most accurate laboratory electrode tested
- Minimal alkali error
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 100°C
Electrolyte: SKYLYTE-CL (refillable)	Shaft material: glass
Diaphragm: SINGLE PORE	Reference system: EVEREF
Temperature sensor: no	Electrical connetion: S7 connector head

POLILYTE LAB Family

- Maintenance-free, robust, combination easy-to-use pH electrode
- Universally applicable, well suited for measurements in emulsions and suspensions
- Thanks to the SINGLE PORE clogging of the diaphragm is practically impossible
- Serial number, certificate

Specifications:

pH: 0 to 14	T: -10 to 80°C
Electrolyte: POLISOLVE (maintenance-free)	Shaft material: glass
Diaphragm: SINGLE PORE	Reference system: EVEREF-B

POLILYTE LAB

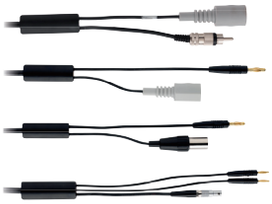
PN 238403 **Polilyte Lab**

Temperature sensor: no
Electrical connection: S7 connector head

POLILYTE LAB TEMP

PN 242059 **Polilyte Lab Temp BNC/Cinch**
PN 242060 **Polilyte Lab Temp BNC**
PN 242058 **Polilyte Lab Temp DIN**
PN 242062 **Polilyte Lab Temp Lemo**

Temperature sensor: NTC 30 kOhm (PN 242058, 242059): Pt1000 (PN 242060, 242062)
Electrical connection:



PN 242059: 1m BNC cable / 1 x cinch plug

PN 242060: 1m BNC cable / 1 x 4 mm banana plug

PN 242058: 1m DIN cable / 1 x 4 mm banana plug

PN 242062: 1m LEMO cable / 2 x 2 mm banana plug
(2 adapters for 4 mm banana plug included)

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HAMILTON

Electrodes for special laboratory applications

FLUSHTRODE

PN 238060 **Flushtrode**

- Easy-to-clean, combination glass electrode with sleeve diaphragm
- Ideally suited for viscous samples, ion-weak media, or media containing protein (e.g. cosmetics)
- For samples containing protein, the electrolyte should be replaced with PROTELYTE (PN 238038)
- Serial number, certificate

Specifications:

pH: 0 to 14	T: -10 to 80°C
Electrolyte: 3M KCl (refillable)	Shaft material: glass
Diaphragm: sleeve diaphragm	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

SLIMTRODE

PN 238150 **Slimtrode**

- pH electrode with 6 mm shaft diameter, for measurements in test tubes
- Universally applicable, even in strong acids as well as in normal laboratory use
- Long-term-stable EVEREF system
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 100°C
Electrolyte: 3M KCl (refillable)	Shaft material: glass
Diaphragm: ceramic	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

FILLTRODE

PN 242064 **Filltrode**

- Robust pH electrode with plastic shaft
- Multiple applications, thanks to its flat membrane: e.g. for viscous media
- Easy to clean
- The ring diaphragm prevents clogging
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 60°C
Electrolyte: SKYLYTE-CL (refillable)	Shaft material: plastic
Diaphragm: ring diaphragm	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

GEL-GLASS

PN 238025 **Gel-Glass**

- Maintenance-free, excellent value, pH electrode for less rigorous applications
- Serial number, certificate

Specifications:

pH: 0 to 14	T: -10 to 60°C
Electrolyte: gel (maintenance-free)	Shaft material: glass
Diaphragm: ceramic	Reference system: Ag/AgCl
Temperature sensor: no	Electrical connection: S7 connector head

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Electrodes for special laboratory applications

BIOTRODE

PN 238140 **Biotrode**

- Combination pH electrode for measurements in very small volumes, e.g. microtiter plates
- Ideally suited for solutions containing protein, as PROTELYTE prevents clogging of the diaphragm
- Long-term-stable EVEREF system
- Requires an immersion depth of only 7 mm
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 100°C
Electrolyte: Protelyte (refillable)	Shaft material: glass
Diaphragm: ceramic	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

MINITRODE

PN 238100 **Minitrode**

- Combination pH electrode for measurements in very small volumes, e.g. vials
- Long-term-stable EVEREF system
- Requires an immersion depth of only 7 mm
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 100°C
Electrolyte: 3M KCl (refillable)	Shaft material: glass
Diaphragm: ceramic	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

SPINTRODE

PN 238197 **Spintrode**

- Combination pH electrode for measurements in very small volumes, e.g. NMR tubes
- Long-term-stable EVEREF system
- Requires an immersion depth of only 7 mm
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 100°C
Electrolyte: 3M KCl (refillable)	Shaft material: glass
Diaphragm: ceramic	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

FLATRODE

PN 238401 **Flatrode**

- pH electrode with a true flat membrane for measurements of surfaces, e.g. paper, agar plates
- Robust plastic shaft and ring diaphragm
- Ring diaphragm guarantees quick response time because of enhanced contact between sample and reference
- Long-term-stable EVEREF system
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 60°C
Electrolyte: SKYLYTE-CL (refillable)	Shaft material: Plastic
Diaphragm: ring diaphragm	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

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Electrodes for foodstuff applications

FOODTRODE

PN 238285 Foodtrode

- Robust, combination pH electrode for measurements in media containing proteins
- 3 ceramic diaphragms guarantee quick and accurate measurements
- Easy to clean
- Long-term-stable, thanks to EVEREF system
- Serial number, certificate

Specifications:

pH: 0 to 14	T: -10 to 100°C
Electrolyte: PROTELYTE (refillable)	Shaft material: glass
Diaphragm: 3 x ceramic	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

DOUBLE PORE

PN 238400 Double Pore

- Maintenance-free, combination pH puncture electrode
- Especially for use with solid and semisolid samples
- Ideally suited for measurements in meat and cheese
- 2 SINLGE POREs makes clogging of the diaphragm practically impossible
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 60°C
Electrolyte: POLISOLVE (maintenance-free)	Shaft material: glass
Diaphragm: 2 x SINGLE POREs	Reference system: Ag/AgCl
Temperature sensor: no	Electrical connection: S7 connector head

TIPTRODE

PN 238080 Tiptrode

- Refillable, combination pH puncture electrode
- Especially for use with solid and semisolid samples
- Long-term-stable EVEREF system
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 100°C
Electrolyte: PROTELYTE (refillable)	Shaft material: glass
Diaphragm: ceramic	Reference system: EVEREF
Temperature sensor: no	Electrical connection: S7 connector head

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Electrodes for portable equipment applications

POLYPLAST Family

- Robust, maintenance-free, combination pH electrode
- Shatter-proof plastic shaft
- Exellent for water and sewage
- Serial number, certificate

Specifications:

pH: 0 to 14 — T: 0 to 60°C
Electrolyte: POLISOLVE (maintenance-free) — Shaft material: Plastic
Diaphragm: SINGLE PORE — Reference system: Ag/AgCl

POLYPLAST — PN 238380 — Polyplast

Temperature sensor: no
Electrical connection: S7 connector head

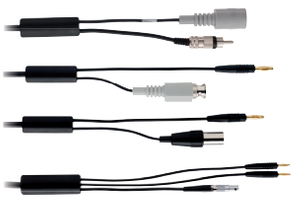
POLYPLAST — PN 238381 — Polyplast BNC

Temperature sensor: no
Electrical connection: 1m cable with BNC Plug

POLYPLAST TEMP

PN 242051 — **Polyplast Temp BNC/Cinch**
PN 242050 — **Polyplast Temp BNC**
PN 238404 — **Polyplast Temp DIN**
PN 242052 — **Polyplast Temp Lemo**

Temperature sensor: NTC 30 kOhm (PN 238404, 242051): Pt 1000 (PN 242050, 242052)
Electrical connection:



PN 242051: 1m BNC cable / 1 x cinch plug

PN 242050: 1m BNC cable / 1 x 4 mm banana plug

PN 238404: 1m DIN cable / 1 x 4 mm banana plug

PN 242052: 1m LEMO cable / 2 x 2 mm banana plug
(2 adapters for 4 mm banana plug included)

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HAMILTON

Electrodes for Portamess® equipment

These electrodes are especially well suited for KNICK Portamess® equipment
The electrode head creates a hermetic seal with the Portamess® storage tube

LIQ-GLASS KNICK®

PN 242068 Liq-Glass Knick Temp DIN

- Combination electrode for daily laboratory use, with glass shaft
- Universally applicable, even in strong acid as well as in normal use
- Serial number, certificate

Specifications:

pH: 0 to 14	T: -10 to 100°C
Electrolyte: 3M KCl (refillable)	Shaft material: glass
Diaphragm: ceramic	Reference system: EVEREF
Temperature sensor: yes	Pt1000
Electrical connection:	1m cable + DIN plug / 1 x 4 mm banana plug

POLYPLAST KNICK®

PN 242070 Polyplast Knick Temp DIN

- Robust plastic shaft
- Ideally suited for field measurements
- Clog-free SINGLE PORE guarantees quick and reliable measurements
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 60°C
Electrolyte: POLISOLVE (maintenance-free)	Shaft material: Plastic
Diaphragm: SINGLE PORE	Reference system: Ag/AgCl
Temperature sensor: yes	Pt1000
Electrical connection:	1m cable + DIN plug / 1 x 4 mm banana plug

DOUBLE PORE KNICK®

PN 242066 Double Pore Knick

- Robust PEEK shaft
- Smallest possible surface sample contact with glass
- Ideally suited for measurements of solid and semisolid samples (e.g. cheese, meat)
- 2 SINGLE POREs makes clogging of the diaphragm practically impossible
- Serial number, certificate

Specifications:

pH: 0 to 14	T: 0 to 60° C
Electrolyte: POLISOLVE (maintenance-free)	Shaft material: PEEK (high-performance plastic)
Diaphragm: 2 SINGLE POREs	Reference system: Ag/AgCl
Temperature sensor: no	Electrical connection: 1m cable + DIN plug

Electrodes for Redox measurement

LIQ-GLASS ORP

PN 238145 **Liq-Glass ORP**

- Robust, combination Redox electrode for all usual Redox measurements in the laboratory
- Universally applicable, in strong acids as well as in strong bases
- Long-term-stable EVEREF system
- Serial number, certificate

Specifications:

Redox: ± 2000 mV
Electrolyte: 3M KCl (refillable)
Diaphragm: 3 x ceramic
Temperature sensor: no
T: -10 to 100°C
Shaft material: glass
Reference system: EVEREF
Electrical connection: S7 connector head

POLYPLAST ORP Family

- Robust, maintenance-free, combination Redox electrode
- Shatter-proof plastic shaft
- Excellent for water and sewage
- Serial number, certificate

Specifications:

Redox: ± 2000 mV
Electrolyte: POLISOLVE (maintenance-free)
Diaphragm: SINGLE PORE
T: 0 to 60°C
Shaft material: Plastic
Reference system: Ag/AgCl

POLYPLAST ORP

PN 238385 **Polyplast ORP**

Temperature sensor: no
Electrical connection: S7 connector head

POLYPLAST ORP

PN 238384 **Polyplast ORP BNC**

Temperature sensor: no
Electrical connection: 1m cable with BNC plug

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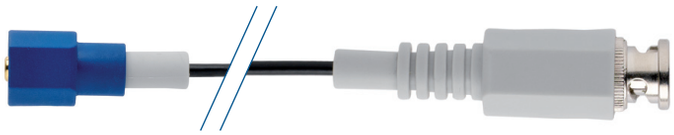
Accessories

Cables

Cables are fitted with an S7 socket. The equipment-side plug must be chosen to fit the pH meter.
The cables have a diameter of 3 mm and a standard length of 1m, 3m, and 5m.

1m cable S7 / BNC*; PN 355173
3m cable S7 / BNC*; PN 355176
5m cable S7 / BNC*; PN 355178



1m cable S7 / DIN; PN 355174
3m cable S7 / DIN; PN 355177
5m cable S7 / DIN; PN 355179

1m cable S7 Lemo; PN 355175

* All BNC plugs have a moveable protective cover.
  This helps ensure consistent results, as the plug is better protected from fluid splashes.

Electrolytes and solutions

Electrolyte:
3M KCl, 100 ml; PN 238036
3M KCl, 500 ml; PN 238936
SKYLYTE-CL, 100 ml; PN 242080
PROTELYTE, 100 ml; PN 238038

Storage solution
For long life and faster electrode response times, it is best to store electrodes in our storage solution. This is an acid-buffered solution that in addition to providing optimized storage, also ensures regeneration of the electrode.

Storage solution, 500 ml; PN 238931

Cleaning solutions
Depending on the type of the application the pH glass or diaphragm can become contaminated. This is indicated by slow response of the electrode, or even incorrect readings. To overcome these problems, HAMILTON has developed a cleaning solution set.
The set comprises Cleaning Solution A, Cleaning Solution B, and a storage solution, each 500 ml in volume.

Cleaning solution set; PN 238290

pH-SIMULATORS

Applications for pH simulators:

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

Testing cables and measurement devices:
Sometimes pH measurement problems are attributed to defective or poorly-chosen pH electrodes. 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 also make reliable pH measurement impossible. These problems can be detected with the pH simulator, eliminating costly and time-consuming trials of different electrodes.

ISO 9000 test device monitoring:
To adapt the simulator for ISO 9000-compliant test device monitoring on the shop floor, the device must be certified by DKD, the German calibration service, which is accredited by PTB (Physikalisch-Technische Bundesanstalt, Braunschweig) for the measurements involved. The DKD certificate contains the measured mV values, which must be displayed by the measurement device being tested within the given tolerances.

pH-SIMULATOR LAB

Simulates pH and Redox electrodes
For testing cables and measurement devices
16 test values, including NIST pH buffer values
Testing of pH input 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 input resistance and the often poor resistance of pH cables
- Battery level display ensures correct operation and eliminates unnecessary battery changes
- Waterproof front
- DKD certificate with measured mV values available as an option

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 operation
Output	BNC plugs, various adapter cables
Battery state display	LED
Power source	4 x AAA batteries
Operating temperature	0 to 40°C
Permissible air humidity	80% up to 30°C , linear decrease up to 50% at 40°C
Measurements	Approximately 140 x 170 x 35 mm

Label	PN
pH SIMULATOR LAB	237556
pH SIMULATOR LAB with certificate	237560
pH SIMULATOR PRO	237550
pH SIMULATOR PRO with certificate	237566

Replacement parts:

Rubber protective cover	237552

HAMILTON

DURACAL pH buffers

Can you trust your buffer solution?

GMP, GLP, ISO 9001, EN 45000, calibration, verification, traceability, certification from an accredited organization: key expressions 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 pH stability never before achieved. HAMILTON guarantees DURACAL pH buffers 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. The growth of fungus and micro-organisms is prevented.

Traceability

An important issue for the production of Certified Reference Material is to ensure traceability through an unbroken chain of comparisons to reference material of the highest metrological quality (Primary Reference Material) from NIST[1] and PTB[2] .

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

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 of secondary reference materials. The solutions themselves are compared against primary reference solutions from PTB[1] or NIST[2]. The measurement uncertainties from each measurement comparison are known and documented.

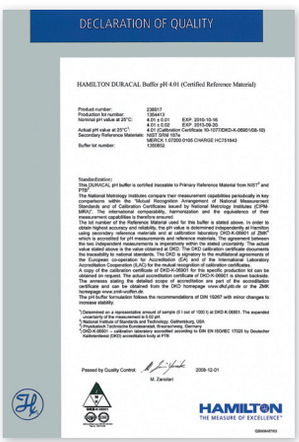
Bottom-up traceability: To ensure the highest possible accuracy and full reliability of the pH value, a representative number of samples from every single production lot is sent to a German DKD[3] laboratory (DKD-K-06901) for external, independent and impartial verification. In this laboratory, the DURACAL samples are compared against secondary reference solutions from DKD-K-06901. These secondary reference solutions are compared to a primary reference solution from PTB or NIST. At this stage, the loop is closed: the primary reference solutions are the start- and end-points of the circular traceability loop. DKD provides HAMILTON with a calibration certificate for every DURACAL production batch.

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).

Features

- Convenient 250 mL or 500 mL bottle with built-in calibration compartment
- Economical, only about 15 mL of buffer is used per calibration
- Certified pH value from a DKD laboratory accredited for pH measurement
- First class certificate with traceability to international standards
- Certificates available at www.hamiltoncompany.com
- Expiration date on the bottle
- Immune to micro-organisms

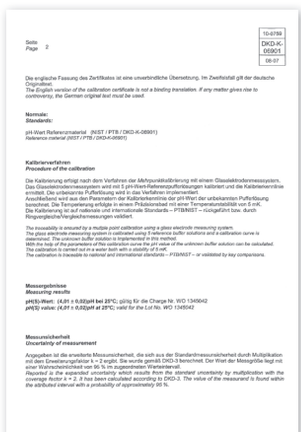
1) NIST: National Institute of Standards and Technology, Gaithersburg MD, USA
2) PTB: Physikalisch Technische Bundesanstalt, Braunschweig, Germany
3) DKD: Deutscher Kalibrierdienst DKD-K-06901, Zentrum for Messen und Kalibrieren GmbH, Wolfen, Germany


DECLARATION OF QUALITY

HAMILTON DURACAL Buffer pH 4.01 (Certified Reference Material)


Deutscher Kalibrierdienst (DKD)
Akkreditierungsstelle
vertreten im
Deutschen AkkreditierungsRat
Akkreditierung


DEUTSCHER KALIBRIERDIENST DKD



DURACAL pH buffers

Simple handling for professional results:

Step 1 Open bottle

Step 2 Fill calibration compartment

Step 3 Calibrate electrode

Step 4 Empty calibration compartment

pH buffers

pH Value	Accuracy	Stability (in months)	Certified by	Packaging unit	PN
1.09	±0.02	60	HAMILTON	500 mL	238271
1.68	±0.02	60	HAMILTON	500 mL	238272
2.00	±0.02	60	HAMILTON	500 mL	238273
3.06	±0.02	60	HAMILTON	500 mL	238274
4.01	±0.01 / ±0.02	24 / 60	DKD	250 mL	238317
4.01	±0.01 / ±0.02	24 / 60	DKD	500 mL	238217
4.01	±0.01 / ±0.02	24 / 60	DKD	3 x 500 mL	238917
4.01	±0.01 / ±0.02	24 / 60	DKD	5 L	238332
4.01	±0.01 / ±0.02	24 / 60	DKD	10 L	238194
4.01	±0.01 / ±0.02	24 / 60	DKD	1000 L	238895
5.00	±0.02	60	HAMILTON	500 mL	238275
6.00	±0.02	60	HAMILTON	500 mL	238276
7.00	±0.01 / ±0.02	24 / 60	DKD	250 mL	238318
7.00	±0.01 / ±0.02	24 / 60	DKD	500 mL	238218
7.00	±0.01 / ±0.02	24 / 60	DKD	3 x 500 mL	238918
7.00	±0.01 / ±0.02	24 / 60	DKD	5 L	238333
7.00	±0.01 / ±0.02	24 / 60	DKD	10 L	238188
7.00	±0.01 / ±0.02	24 / 60	DKD	1000 L	238896
8.00	±0.02	60	HAMILTON	500 mL	238277
9.21	±0.02	60	DKD	250 mL	238319
9.21	±0.02	60	DKD	500 mL	238219
9.21	±0.02	60	DKD	3 x 500 mL	238919
9.21	±0.02	60	DKD	10 L	238216
9.21	±0.02	60	DKD	1000 L	238897
10.01	±0.02	60	DKD	250 mL	238321
10.01	±0.02	60	DKD	500 mL	238223
10.01	±0.02	60	DKD	3 x 500 mL	238923
10.01	±0.02	60	DKD	10 L	238187
10.01	±0.02	60	DKD	1000 L	238898
11.00	±0.02	24	HAMILTON	500 mL	238278
12.00	±0.02	24	HAMILTON	500 mL	238279
4.01/7.00/9.21	±0.01 / ±0.02	24 / 60	DKD	500 mL, mixed	238922
4.01/7.00/10.01	±0.01 / ±0.02	24 / 60	DKD	500 mL, mixed	238924

Redox buffers

Redox value	Accuracy	Stability (monthly)	Certified by	Packing unit	PN
271 mV	±5 mV	24	None	500 mL	238228
475 mV	±5 mV	24	None	250 mL	238322
475 mV	±5 mV	24	None	500 mL	238227

Conductivity standards

HAMILTON conductivity standards – leading in long-term stability and accuracy

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, the lower the value of the conductivity standard, then the greater the effect of entry of CO_2 or contamination.

HAMILTON is the first manufacturer to offer conductivity standards of 1.3 and 5 µS/cm with a certified accuracy of ±1%, and a lifetime of 1 and 3 years respectively. The composition of these standards is patented; the procedure for determining conductivity was developed in collaboration with DFM[1]. Many state metrological institutes that deal with measurement of electrolytic conductivity use HAMILTON standards, since they lie in a low conductivity range and exhibit the type of stability that has never been achieved before (see illustration "Stability over 3 years" on page 19, with test measurements by PTB[2]). During an interlaboratory test among prestigious European metrological institutes (PTB , DFM, DKD3) HAMILTON standards were used as the measurement solution.

HAMILTON is different

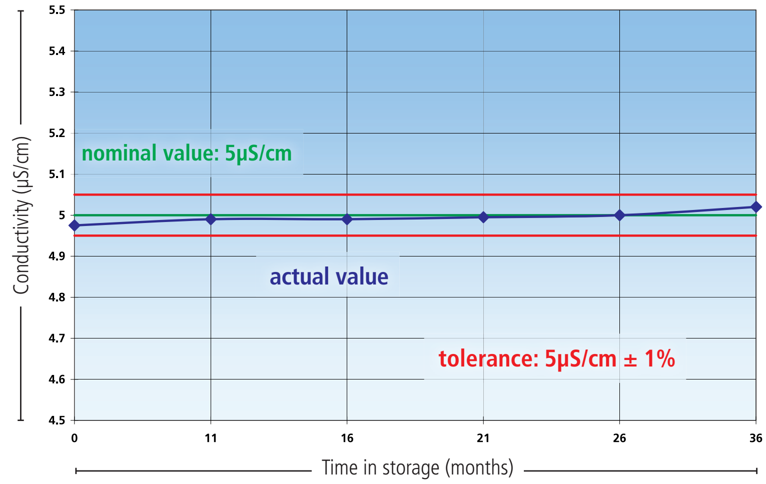
HAMILTON offers conductivity standards with various conductivity values, whose stability of ±1% is guaranteed over a lifetime of up to 3 years. These standards can be used repeatedly, on condition that the bottle is not left open (without its lid) for more than 1 hour in total.
In order to ensure the 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 NIST, and is accredited by the Danish accreditation agency DANAK to a conductivity of 0.9 µS/cm. DFM and NIST[4] 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. Because no primary standards exist in the low conductivity range, 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.

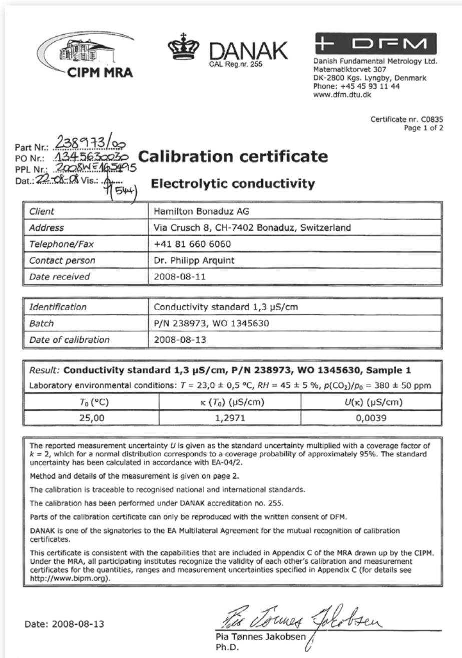
[1] DFM: Danish Institute of Fundamental Metrology, Dänemark
[2] PTB: Physikalisch-Technische Bundesanstalt, Braunschweig
[3] DKD: Deutscher Kalibrierdienst
[4] NIST: National Institute of Standards and Technology, Gaithersburg MD, USA

Unique advantages:

- Remains stable for a minimum of 1 year for 1.3 µS/cm, and up to 3 years for all other values
- Certificate with calibration document from DFM (available at www.hamiltoncompany.com)
- Expiration date shown on every bottle
- Bottles are permitted to stay open for a total of 60 minutes

Stability of the HAMILTON 5µS/cm Conductivity Standard over 36 months
(Check measurment by PTB[2])





CIPM MRA | DANAK CAL Reg.nr. 255 | DFM

Danish Fundamental Metrology Ltd.
Matematiktorvet 307
DK-2800 Kgs. Lyngby, Denmark
Phone: +45 45 93 11 44
www.dfm.dtu.dk

Certificate nr. C0835
Page 1 of 2

Part Nr.: 238973/00
PO Nr.: 1345630030
PPL Nr.: 2008WE165495
Dat.: 22-08-08 Vis.:

Calibration certificate

Electrolytic conductivity

Client	Hamilton Bonaduz AG
Address	Via Crusch 8, CH-7402 Bonaduz, Switzerland
Telephone/Fax	+41 81 660 6060
Contact person	Dr. Philipp Arquint
Date received	2008-08-11

Identification	Conductivity standard 1,3 µS/cm
Batch	P/N 238973, WO 1345630
Date of calibration	2008-08-13

Result: **Conductivity standard 1,3 µS/cm, P/N 238973, WO 1345630, Sample 1**
Laboratory environmental conditions: T = 23,0 ± 0,5 °C, RH = 45 ± 5 %, $p(CO_2)/p_0$ = 380 ± 50 ppm

T_0 (°C)	κ (T_0) (µS/cm)	U(κ) (µS/cm)
25,00	1,2971	0,0039

The reported measurement uncertainty U 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 EA-04/2.

Method and details of the measurement is given on page 2.

The calibration is traceable to recognised national and international standards.

The calibration has been performed under DANAK accreditation no. 255.

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

DANAK is one of the signatories to the EA Multilateral Agreement for the mutual recognition of calibration certificates.

This certificate is consistent with the capabilities that are included in Appendix C of the MRA drawn up by the CIPM. Under the MRA, all participating institutes recognize the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (for details see http://www.bipm.org).

Date: 2008-08-13

Pia Tønnes Jakobsen
Ph.D.

Value at 25°C	Accuracy	Stability (in months)	Certificate from	Packaging unit	PN
1.3 µS/cm	±1%	12	DFM	Glass bottle 300 mL	238973
5 µS/cm	±1%	36	DFM	Glass bottle 300 mL	238926
15 µS/cm	±1%	36	DFM	Glass bottle 300 mL	238927
84 µS/cm	±1%	18	DFM	1 Calpack bottle 500 mL	238984
100 µS/cm	±1%	36	DFM	Glass bottle 300 mL	238934
147 µS/cm	±1%	18	DFM	1 Calpack bottle 500 mL	238985
1413 µS/cm	±1%	36	DFM	Glass bottle 300 mL	238928
1413 µS/cm	±1%	18	DFM	1 Calpack bottle 500 mL	238986
12880 µS/cm	±1%	18	DFM	1 Calpack bottle 500 mL	238988

Practical advice for pH and Redox electrodes

Construction of a pH or Redox electrode

Connector head S7

Electrolyte plug
for easy refilling and secure closure

Reference electrolyte
All HAMILTON electrolytes are silver-free, for trouble free measurements

EVEREF Reference system
Guarantees stable measurement and reduces measurement errors

Diaphragm / SINGLE PORE

Inner buffer

pH membrane
Shape and glass type are optimized for each application

Length of the electrode

What is the a-length, and where does it start?

The a-length depends on the construction of the electrode. With electrodes that have a 12 mm shaft passing all the way through the body (see picture A) the a-length is measured from the connector head to the end of the electrode.

With electrodes that have a shaft diameter of less than 12 mm, the a-length begins at the smaller diameter (see picture B).

A

B

pH Measurement Theory

Definition of pH value
The pH value describes if a solution is acid, neutral or basic. Most aqueous solutions have a pH value between 0 (strong acid) and 14 (strong base).

A very small part of pure water decomposes to ions namely to a hydronium ions (H_3O^+) and to a hydroxide ions (OH^-).
Only in neutral water is the proportion of both ions is 1:1. This proportion is explained through the equilibrium constant of water:

$K_W = [H_3O^+]\,[OH^-] = 10^{-14}\ (mol/L)^2$

To characterize the proportion of the two ions it is sufficient to know one of the concentrations. Normally the hydronium (hydrogen) ion concentration is measured and varies between 1 and 10^{-14} mol/L.

pH can also be described as the negative logarithm of the hydronium ion concentration in a solution, where a low pH indicates a high concentration of hydronium ions and a high pH indicates a low concentrations of hydronium ions.

$pH = -lg\,[H_3O^+]$

The pH Measurement
The determination of the pH values is based on the principle of the potentiometric measurement – the measurement of electrical voltage. A pH electrode consists of two electrodes (pH glass membrane and reference) that are combined into one device in a combination pH electrode. Between these two electrodes a voltage is measured. The pH membrane of the electrode is made of special glass that is impermeable and electrically isolated. This glass (pH glass) forms a hydrated layer in water and responds selectively to hydrogen ions (H^+). Sodium ions (Na^+) of the glass are replaced by hydrogen ions (H+), which causes a change in free energy and an electrical potential that the pH meter measures. The amount of Na^+ and H^+ exchange across the pH glass depends strongly on the pH of the solution. The higher the pH the less hydrogen ions are in the solution, therefore less sodium ions are replaced across the pH glass. The liquid inside the pH glass is a buffer solution with a known and constant hydrogen ion concentration. Depending on the difference in pH between the inner buffer and the measuring solution a galvanic voltage is going to be produced between the inner and the outer layer of the pH glass. This voltage is measured by two Ag/AgCl electrodes. One electrode is located in the inner buffer the other in the reference electrolyte. Most pH electrodes have a nearly linear behavior in the measuring range of pH 0 to 14. Taking advantage of this behavior a pH electrode is calibrated between two different well known pH values, for example pH 4.01 and 7.00. Between those two values a linear extrapolation and also a linear interpolation is conducted.

If you would like to get more information regarding pH measurement you may contact us at contact@hamilton.ch or sales@hamiltoncompany.com to get a "pH measurement guide" for free.

Practical advice for pH and Redox electrodes

Calibration and measurement

- For quick and accurate results, the electrolyte plug should be open during measurements (Note: polymer electrolytes do not have an electrolyte plug).
- The electrode should be immersed far enough to cover the diaphragm. The height to which the electrolyte is filled must always be above that of the sample. This prevents the sample solution from entering into the electrode.
- Always wait for the electrode to reach the same temperature as the sample.
- Between measurements, the electrode should be rinsed with deionized water. If necessary, dab it dry with a paper towel. Never rub the electrode dry with a paper towel, as it will become electrostatically charged an slow response will result.
- To prevent problems, calibrate with DURACAL® buffer (see page 16/17). If you do not use DURACAL® buffer, never calibrate in the original bottle. Always use fresh buffer solution for calibration. Close the bottle after use.
- Dispose of used buffer responsibly.
- Read the operating instructions of the pH measurement device.

Temperature influences

Both the pH/Redox value of the sample and the characteristics of the electrode are temperature dependent. Usually, the temperature dependency of the sample is unknown. Therefore, it is important to always record the measurement temperature together with the measured value. The automatic temperature compensation of the measurement devices can only compensate for the temperature dependence of the electrode's characteristics curve (Nernst-Gleichung). For this purpose, temperature sensors (for example, Pt1000 or NTC 30 kOhm) are used. In order to obtain the most accurate measurement, the electrode should always be calibrated at the same temperature at which measurements will later take place. For measurements that will serve as a comparison between laboratory and process values, make sure that the laboratory measurement takes place at the same temperature as the process measurement.

Storage

For storage, place the electrode (with closed electrolyte plug) in the reference electrolyte, or better, in the HAMILTON storage solution (PN 238931). The storage solution helps to clean both the diaphragm and the pH glass. Electrodes must never be stored in deionized water.

Cleaning

Contamination of the diaphragm is the most frequent cause of measurement problems. Only infrequently do problems with the glass membrane occur. The diaphragm and the pH membrane should therefore be kept clean in order to avoid measurement errors and long response times. Use soap and water to remove oil, fat, and organic substances. In the event of contamination of the electrode by proteins, submerge the electrode in a fresh solution of 0.4% HCl, and 5 g/l pepsin. After every cleaning, the electrode should be conditioned in HAMILTON storage solution for at least 2 hours. After cleaning always perform a new calibration before carrying out measurements.
To simplify cleaning, HAMILTON has developed a special cleaning set (PN 238290) which easily remove most types of contamination from electrode diaphragm and pH glass.

Most frequent causes of calibration problems

The following three problems occur most often during calibration:

- Zero calibration error
- Electrode slope too low
- Slow response, for example, longer than 3 minutes

There are a variety of causes for the problems named above. The most frequent are:

a) The buffer solutions used are either contaminated or out-of-date. It could also be that one of the buffer solutions used is no longer the value labeled on the bottle – for this reason, never store buffer solutions in unmarked or dirty containers.

b) The reference electrolyte and / or the diaphragm are contaminated.

c) An old or defective electrode is used.

d) An electrode is used that has not been hydrated long enough (after dry storage or after cleaning with strong acid solution).

e) The pH membrane of the electrode is mechanically damaged, and has cracks.

f) The electrode is electrostatically charged (through rubbing of the electrode shaft with a cloth instead of careful dabbing with soft paper).

g) The temperature difference between electrode and buffer solution is more than 10°C.

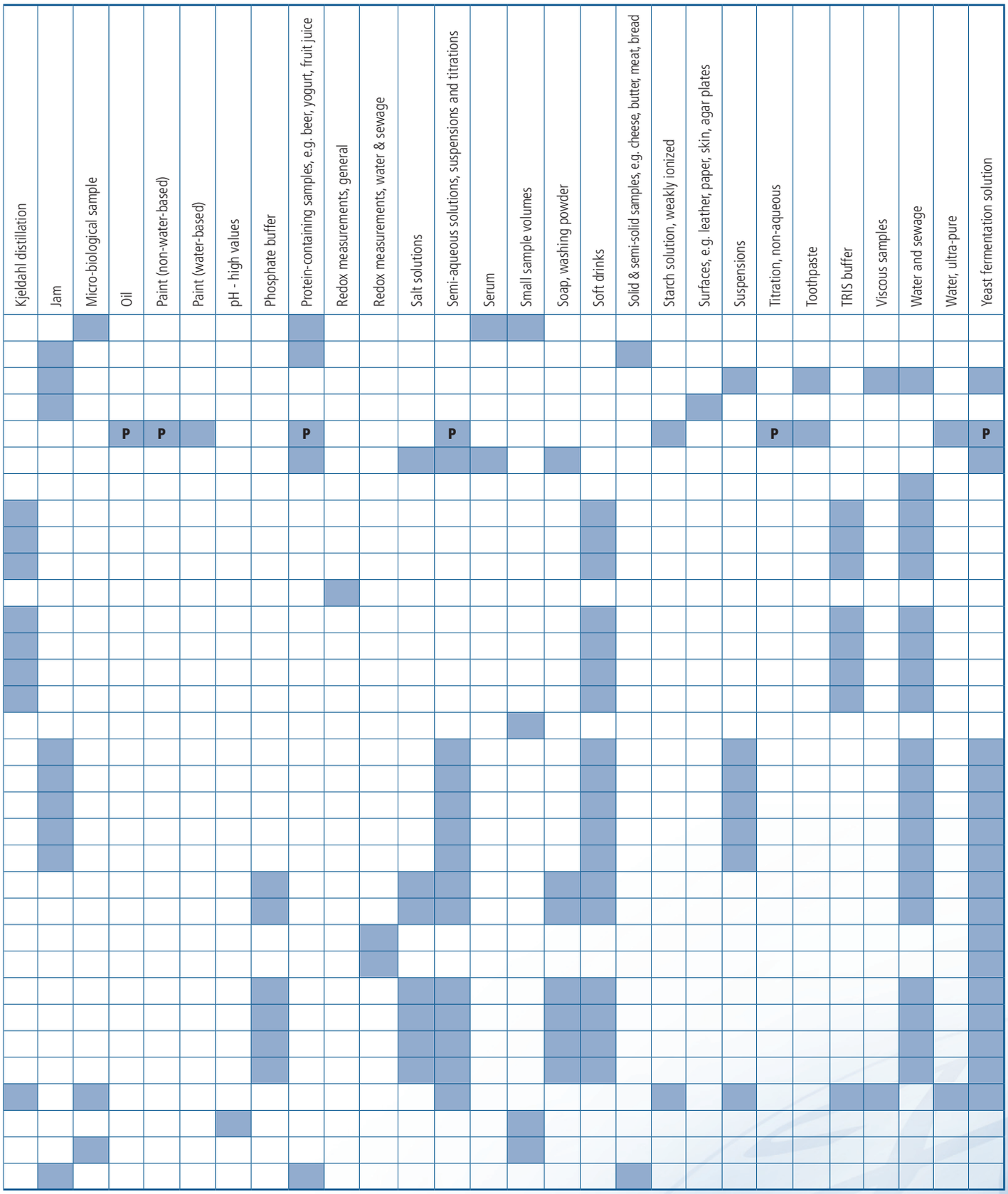
i) The connection between electrode and measurement device can also cause problems: for instance, a break in the cable, or a short-circuit caused by moisture in the cable or electrode plug.

Electrode Selection Table

	Electrode	PN	Page	Acid, battery	Acid, hydrofluoric	Aqueous emulsions, suspensions	Aqueous solutions	Calcium oxide solution	Calcium sulphate solution	Copper bath	Cosmetics	Crème fraîche, milk, cream	Cyanide decontamination	Disinfectant	Earth	Emulsions	Fat	Fertilizer solutions	Field measurements	Fixing baths	Fruit & vegetables	Galvanic baths	Hydrogen peroxide (30%)	Infusion solutions
	Biotrode	238140	9																					
	Double Pore	238400	10									■			■		■				■			
	Filltrode	242064	8		■		■					■				■			■					
	Flatrode	238401	9		■												■							
	Flushtrode*	238060	8					■	■		**P**	**P**	■									■		
	Foodtrode	238285	10									■												
	Gel-Glass	238025	8				■																	
Liq-Glass Family	Liq-Glass	238000	6	■			■							■						■				
Liq-Glass Family	Liq-Glass BNC	238180	6	■			■							■						■				
Liq-Glass Family	Liq-Glass DIN	238185	6	■			■							■						■				
Liq-Glass Family	Liq-Glass ORP	238145	13																					
Liq-Glass Family	Liq-Glass Temp BNC	242056	6	■			■							■						■				
Liq-Glass Family	Liq-Glass Temp BNC/Cinch	242055	6	■			■							■						■				
Liq-Glass Family	Liq-Glass Temp DIN	238406	6	■			■							■						■				
Liq-Glass Family	Liq-Glass Temp Lemo	242054	6	■			■							■						■				
	Minitrode	238100	9																					
Polilyte Family	Polilyte Lab	238403	7			■	■	■								■		■						
Polilyte Family	Polilyte Lab Temp BNC/Cinch	242059	7			■	■	■								■								
Polilyte Family	Polilyte Lab Temp BNC	242060	7			■	■	■								■								
Polilyte Family	Polilyte Lab Temp DIN	242058	7			■	■	■								■								
Polilyte Family	Polilyte Lab Temp Lemo	242062	7			■	■	■								■								
Polyplast Family	Polyplast	238380	11				■											■	■					
Polyplast Family	Polyplast BNC	238381	11			■	■											■	■					
Polyplast Family	Polyplast ORP	238385	13																					
Polyplast Family	Polyplast ORP BNC	238384	13																					
Polyplast Family	Polyplast Temp BNC	242050	11			■	■											■	■					
Polyplast Family	Polyplast Temp BNC/Cinch	242051	11			■	■											■	■					
Polyplast Family	Polyplast Temp DIN	238404	11			■	■											■	■					
Polyplast Family	Polyplast Temp Lemo	242052	11			■	■											■	■					
	Single Pore Glass	238160	7	■					■	■				■		■		■				■	■	■
	Slimtrode	238150	8																					
	Spintrode	238197	9																					
	Tiptrode	238080	10												■		■				■			

* For samples containing protein (**P**), replace the electrolyte 3 M KCl with the separately available electrolyte PROTELYTE (see page 14).

Electrode Selection Table



HAMILTON

Specifications

pH Electrode	Nominal measurement range	Temperature range	Reference electrolyte	Reference system	Shaft material	Shaft diameter (mm)	Shaft diameter below (mm)
BIOTRODE	0 to 14	0 to 100°C	PROTELYTE	EVEREF	Glass	12	3
DOUBLE PORE	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	Glass	12	6
DOUBLE PORE KNICK®	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	PEEK	12	6
FILLTRODE	0 to 14	0 to 60°C	SKYLYTE-CL	EVEREF	Plastic	12	12
FLATRODE	0 to 14	0 to 60°C	SKYLYTE-CL	EVEREF	Plastic	12	12
FLUSHTRODE*	0 to 14	-10 to 80°C	3M KCL	EVEREF	Glass	12	12
FOODTRODE	0 to 14	-10 to 100°C	PROTELYTE	EVEREF	Glass	12	12
GEL-GLASS	0 to 14	-10 to 60°C	GEL	Ag/AgCl	Glass	12	12
LIQ-GLASS	0 to 14	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
LIQ-GLASS BNC	0 to 14	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
LIQ-GLASS DIN	0 to 14	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
LIQ-GLASS Temp BNC/Cinch	0 to 14	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
LIQ-GLASS Temp BNC	0 to 14	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
LIQ-GLASS Temp DIN	0 to 14	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
LIQ-GLASS Temp Lemo	0 to 14	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
LIQ-GLASS KNICK®	0 to 14	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
MINITRODE	0 to 14	0 to 100°C	3M KCL	EVEREF	Glass	12	3
POLILYTE LAB	0 to 14	-10 to 80°C	POLISOLVE	EVEREF-B	Glass	12	12
POLILYTE LAB Temp BNC/Cinch	0 to 14	-10 to 80°C	POLISOLVE	EVEREF-B	Glass	12	12
POLILYTE LAB Temp BNC	0 to 14	-10 to 80°C	POLISOLVE	EVEREF-B	Glass	12	12
POLILYTE LAB Temp DIN	0 to 14	-10 to 80°C	POLISOLVE	EVEREF-B	Glass	12	12
POLILYTE LAB Temp Lemo	0 to 14	-10 to 80°C	POLISOLVE	EVEREF-B	Glass	12	12
POLYPLAST	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12
POLYPLAST BNC	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12
POLYPLAST Temp BNC/Cinch	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12
POLYPLAST Temp BNC	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12
POLYPLAST Temp DIN	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12
POLYPLAST Temp Lemo	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12
POLYPLAST KNICK®	0 to 14	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12
SINGLE PORE GLASS	0 to 14	0 to 100°C	SKYLYTE-CL	EVEREF	Glass	12	12
SLIMTRODE	0 to 14	0 to 100°C	3M KCL	EVEREF	Glass	12	6
SPINTRODE	0 to 14	0 to 100°C	3M KCL	EVEREF	Glass	12	3
TIPTRODE	0 to 14	0 to 100°C	PROTELYTE	EVEREF	Glass	12	6

Redox Electrode	Nominal measurement range	Temperature range	Reference electrolyte	Reference system	Shaft material	Shaft diameter (mm)	Shaft diameter below (mm)
LIQ-GLASS ORP	± 2000 mV	-10 to 100°C	3M KCL	EVEREF	Glass	12	12
POLYPLAST ORP	± 2000 mV	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12
POLYPLAST ORP BNC	± 2000 mV	0 to 60°C	POLISOLVE	Ag/AgCl	Plastic	12	12

* For samples containing protein, replace the 3 M KCl with the separately obtainable PROTELYTE electrolyte (see page 14).

** Adapter for 4 mm banana plug included.

ow	Shaft length (a)	Membrane glass	Membrane shape	Diaphragm	Number of diaphragms	Minimum immersion depth (mm)	Electrode head	Temperature sensor
	60 mm	HF glass	Cylindrical	Ceramic	1	7	S7	No
	35 mm	HF glass	Spear	SINGLE PORE	2	15	S7	No
	35 mm	V glass	Spear	SINGLE PORE	2	15	Fixed cable with DIN plug	No
	120 mm	HF glass	Flat	Ring	1	4	S7	No
	120 mm	HF glass	Flat	Ring	1	1	S7	No
	120 mm	HF glass	Cylindrical	Ground sleeve	1	30	S7	No
	120 mm	HF glass	Cylindrical	Ceramic	3	20	S7	No
	120 mm	HF glass	Cylindrical	Ceramic	1	15	S7	No
	120 mm	HF glass	Cylindrical	Ceramic	1	15	S7	No
	120 mm	HF glass	Cylindrical	Ceramic	1	15	Fixed cable with BNC plug	No
	120 mm	HF glass	Cylindrical	Ceramic	1	15	Fixed cable with DIN plug	No
	120 mm	HF glass	Cylindrical	Ceramic	1	15	Fixed cable with BNC plug / 1x Cinch	NTC 30 kOhm
	120 mm	HF glass	Cylindrical	Ceramic	1	15	Fixed cable with BNC plug / 1 x 4 mm banana plug	Pt1000
	120 mm	HF glass	Cylindrical	Ceramic	1	15	Fixed cable with DIN plug / 1 x 4 mm banana plug	NTC 30 kOhm
	120 mm	HF glass	Cylindrical	Ceramic	1	15	Fixed cable with Lemo plug / 2 x 2 mm banana plug**	Pt1000
	110 mm	HF glass	Cylindrical	Ceramic	1	15	Fixed cable with DIN plug / 1 x 4 mm banana plug	Pt1000
	60 mm	HF glass	Cylindrical	Ceramic	1	7	S7	No
	120 mm	HF glass	Cylindrical	SINGLE PORE	1	15	S7	No
	120 mm	HF glass	Cylindrical	SINGLE PORE	1	15	Fixed cable with BNC plug / 1x Cinch	NTC 30 kOhm
	120 mm	HF glass	Cylindrical	SINGLE PORE	1	15	Fixed cable with BNC plug / 1 x 4 mm banana plug	Pt1000
	120 mm	HF glass	Cylindrical	SINGLE PORE	1	15	Fixed cable with DIN plug / 1 x 4 mm banana plug	NTC 30 kOhm
	120 mm	HF glass	Cylindrical	SINGLE PORE	1	15	Fixed cable with Lemo plug / 2 x 2 mm banana plug**	Pt1000
	120 mm	V glass	Cylindrical	SINGLE PORE	1	10	S7	No
	120 mm	V glass	Cylindrical	SINGLE PORE	1	10	Fixed cable with BNC plug	No
	120 mm	V glass	Cylindrical	SINGLE PORE	1	10	Fixed cable with BNC plug / 1x Cinch	NTC 30 kOhm
	120 mm	V glass	Cylindrical	SINGLE PORE	1	10	Fixed cable with BNC plug / 1 x 4 mm banana plug	Pt1000
	120 mm	V glass	Cylindrical	SINGLE PORE	1	10	Fixed cable with DIN plug / 1 x 4 mm banana plug	NTC 30 kOhm
	120 mm	V glass	Cylindrical	SINGLE PORE	1	10	Fixed cable with Lemo plug / 2 x 2 mm banana plug**	Pt1000
	110 mm	V glass	Cylindrical	SINGLE PORE	1	10	Fixed cable with DIN plug / 1 x 4 mm banana plug	Pt1000
	120 mm	H glass	Cylindrical	SINGLE PORE	1	15	S7	No
	100 mm	HF glass	Cylindrical	Ceramic	1	15	S7	No
	180 mm	HF glass	Cylindrical	Ceramic	1	7	S7	No
	25 mm	HF glass	Spear	Ceramic	1	17	S7	No

ow	Shaft length (a)	Membrane glass	Membrane shape	Diaphragm	Number of diaphragms	Minimum immersion depth (mm)	Electrode head	Temperature sensor
	120 mm	Platin	Cylindrical	Ceramic	3	15	S7	No
	120 mm	Platin	Cylindrical	SINGLE PORE	1	10	S7	No
	120 mm	Platin	Cylindrical	SINGLE PORE	1	10	Fixed cable with BNC plug	No

pH meter cross reference

Blue squares indicate compatible electrodes and meters.

For connections to meters not listed above, please contact your HAMILTON laboratory electrode supplier.

Manufacturer	Model		238140 Biotrode	238400 Double Pore	242064 Filltrode	238401 Flatrode	238060 Flushtrode	238285 Foodtrode	238025 Gel-Glass	238000 Liq-Glass	238180 Liq-Glass BNC	238185 Liq-Glass DIN	238145 Liq-Glass ORP	242055 Liq-Glass Temp BNC/Cinch	242056 Liq-Glass Temp BNC	238406 Liq-Glass Temp DIN	242054 Liq-Glass Temp Lemo	238100 Minitrode	238403 Polilyte Lab	242059 Polilyte Lab Temp BNC/Cinch	242060 Polilyte Lab Temp BNC	242058 Polilyte Lab Temp DIN	242062 Polilyte Lab Temp Lemo	238380 Polyplast	238381 Polyplast BNC	238385 Polyplast ORP	238384 Polyplast ORP BNC	242051 Polyplast Temp BNC/Cinch	242050 Polyplast Temp BNC	238404 Polyplast Temp DIN	242052 Polyplast Temp Lemo	238160 SINGLE PORE Glass	238150 Slimtrode	238197 Spintrode	238080 Tiptrode
Crison	PH 25	BNC	■	■	■	■	■	■	■	■	■		■		■			■	■		■			■	■	■	■		■			■	■	■	■
	Basic 20	BNC	■	■	■	■	■	■	■	■	■		■		■			■	■		■			■	■	■	■		■			■	■	■	■
	GLP 21	BNC	■	■	■	■	■	■	■	■	■		■	■	■			■	■		■			■	■	■	■		■			■	■	■	■
	GLP 22	BNC	■	■	■	■	■	■	■	■	■		■	■	■			■	■		■			■	■	■	■		■			■	■	■	■
Eutech	EcoScan pH 5	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	EcoScan pH 6	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 11	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 110	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 300	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 310	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 510	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 1100	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 2100	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 1500	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 6000	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	CyberScan pH 6500	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
Hanna	HI 901	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	HI 902	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	HI 9813-6	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	HI 9813-5	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	HI 9813-0	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	HI 8010	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	HI 4212	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
	HI 4211	BNC	■	■	■	■	■	■	■	■	■		■					■	■					■	■	■	■					■	■	■	■
Metrohm	pH Meter 780	Lemo	■	■	■	■	■	■	■				■				■	■	■				■	■		■				■		■	■	■	■
	pH/Ion Meter 781	Lemo	■	■	■	■	■	■	■				■				■	■	■				■	■		■				■		■	■	■	■
	pH Mobile 826	Lemo	■	■	■	■	■	■	■				■				■	■	■				■	■		■				■		■	■	■	■
	pH Lab 827	Lemo	■	■	■	■	■	■	■				■				■	■	■				■	■		■				■		■	■	■	■
Mettler-Toledo	Seven Easy S20	BNC	■	■	■	■	■	■	■	■	■		■	■				■	■	■				■	■	■	■	■				■	■	■	■
	Seven Multi S40	BNC	■	■	■	■	■	■	■	■	■		■	■	■			■	■	■	■			■	■	■	■	■	■			■	■	■	■
	Seven Multi S47	BNC	■	■	■	■	■	■	■	■	■		■	■	■			■	■	■	■			■	■	■	■	■	■			■	■	■	■
	Seven Multi S80	BNC	■	■	■	■	■	■	■	■	■		■	■	■			■	■	■	■			■	■	■	■	■	■			■	■	■	■
	pH Meter 1120 (-X)	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	pH Meter 1140 (-X)	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	Seven Go pH SG2	BNC	■	■	■	■	■	■	■	■								■	■					■	■	■	■					■	■	■	■
Schott	CG 842	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	CG 843	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	CG 843 P	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	Handylab pH 11	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	Handylab pH 12	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	Handylab pH/LF 12	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
Testo	Testo 230	BNC	■	■	■	■	■	■	■	■			■					■	■					■	■	■	■					■	■	■	■
WTW	InoLab pH Level 1	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	InoLab pH Level 2	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	InoLab pH Level 3	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	PH 540 GLP	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	InoLab 720	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	InoLab 730	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	InoLab 740 / 750	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	ProfiLine 197i	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	Portable Meter 315	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	Portable Meter 330	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	Portable Meter 340	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■
	Portable Meter 350	DIN	■	■	■	■	■	■	■		■	■	■			■		■	■		■			■		■					■			■	■	■

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