



## Ion-selective Measurements

Ion-selective measurement is a method for determining the concentration of dissolved ions. Potassium ions, sodium ions, fluoride or chloride are examples of such cations and anions that are directly measured in solutions. Indirect methods such as titration allow the determination of aluminum, nickel ions, or sulfate.

Measurement with ISEs, like the measurement of pH, is a potentiometric method. ISEs are in two configurations:

1. Separate ion-selective electrode and reference electrode
2. Combined ion-selective electrode with built-in reference electrode

The ion-selective membrane of the electrode consists of a sparingly soluble salt of the ion to be measured (solid state electrodes), a PVC-membrane, modified by an ion exchanger or ion carrier (matrix electrodes), glass (glass electrode) or a gas-permeable plastic (gas-sensitive electrodes). The activity of the ions to be measured determines the electrode current. With increasing activity of the anions the voltage turns more negative; with increasing activity of cations, more positive. A pH/ISE meter uses the electrode signal to calculate the concentration of the sample.

The wide range of possible applications include the measurement of fluoride concentration according to DIN 38 405. Chloride content determination in concrete samples or nitrate concentration determination in fruit juices are further examples of the ways in which ion-selective measurement technology can be applied. An

introduction to ion-selective measurement technology, as well as application reports, are available on our CD-ROM entitled "Principles of measurement technology".

Determination of	Application
Lead (Pb <sup>2+</sup> )	Soil samples
Bromide (Br <sup>-</sup> )	Wine, plants
Cadmium (Cd <sup>2+</sup> )	Soil samples
Calcium (Ca <sup>2+</sup> )	Dairy products
Chloride (Cl <sup>-</sup> )	Drinking water, food
Cyanide (CN <sup>-</sup> )	Electroplating baths
Fluoride (F <sup>-</sup> )	Toothpaste, cement
Iodide (I <sup>-</sup> )	Saltwater
Potassium (K <sup>+</sup> )	Wine, fertilizer
Copper (Cu <sup>2+</sup> )	Electroplating baths
Sodium (Na <sup>+</sup> )	Wine, boiler feed water
Nitrate (NO <sub>3</sub> <sup>-</sup> )	Baby food, fertilizer, wastewater
Silver (Ag <sup>+</sup> )	Electroplating baths
Sulfide (S <sup>2-</sup> )	Proteins, sediments

## Ion-selective Electrodes

WTW offers a complete range of ion-selective electrodes for challenging ISE applications. Choose between two types: the 500 Series half cells, which require a separate reference electrode, or the 800 Series combination electrodes. These combination electrodes with built-in reference are easy-to-use, and offer the option of measuring in small volume samples. Plus, they have an out-standing price performance ratio.



### Applications for Ion-selective and Gas-sensitive Electrodes

Electrode type	Membrane®	Determinable ions	ISE Type 500 (Half cell, reference electrode necessary)	Reference electrode	Combined ISE Type 800 (Built-in reference electrode)	Measuring range	Bridge electrolyte	Ionic strength adjustment solution	Standard solution (Conc. 10 g/l)	pH range
Ammonia (NH <sub>4</sub> <sup>+</sup> )		Ammonia	NH 500/2	—	—	0.02...900 mg/l 10 <sup>-6</sup> ...5 x 10 <sup>-2</sup> mol/l	—	MZ/NH <sub>3</sub> /CN	ES/NH <sub>4</sub>	4-12
Lead (Pb <sup>2+</sup> )	S	Lead	Pb 500	For all ion-selective electrodes from the 500 series:	Pb 800	0.2...20000 mg/l 10 <sup>-6</sup> ...10 <sup>-1</sup> mol/l	ELY/BR/503	ISA/FK	ES/Pb	4-7
Bromide (Br <sup>-</sup> )	S	Bromide	Br 500		Br 800	0.4...79000 mg/l 5 x 10 <sup>-6</sup> ...1 mol/l	ELY/BR/503	ISA/FK	ES/Br	1-12
Cadmium (Cd <sup>2+</sup> )	S	Cadmium	Cd 500		Cd 800	0.01...11000 mg/l 10 <sup>-7</sup> ...10 <sup>-1</sup> mol/l	ELY/BR/503	ISA/FK	—	2-8
Calcium (Ca <sup>2+</sup> )	L	Calcium, Magnesium <sup>①</sup>	Ca 500 <sup>①</sup>		Ca 800 <sup>①</sup>	0.02...40000 mg/l 5 x 10 <sup>-7</sup> ...1 mol/l	ELY/BR/503	ISA/Ca	ES/Ca	2,5-11
Chloride (Cl <sup>-</sup> )	S	Chloride	Cl 500		Cl 800	2...35000 mg/l 5 x 10 <sup>-5</sup> ...1 mol/l	ELY/BR/503	ISA/FK	ES/Cl	2-12
Cyanide (CN <sup>-</sup> ) <sup>②</sup>	S	Cyanide	CN 500		R 503/P (2 mm pin plug) or R 503 D (4 mm banana plug)	CN 800	0.2...260 mg/l 8 x 10 <sup>-6</sup> ...10 <sup>-2</sup> mol/l	ELY/BR/503	MZ/NH <sub>3</sub> /CN	—
Fluoride (F <sup>-</sup> )	S	Fluoride, Aluminum Phosphate <sup>③</sup> , Lithium <sup>③</sup>	F 500	F 800		0.02...sat. mg/l 10 <sup>-6</sup> ...sat. mol/l	ELY/BR/503	TISAB	ES/F	5-7
Iodide (I <sup>-</sup> )	S	Iodide, Thiosulfate Mercury	I 500	For all ion-selective electrodes from the 500 series:	I 800	0.006...127000 mg/l 10 x 10 <sup>-8</sup> ...1 mol/l	ELY/BR/503	ISA/FK	ES/I	0-14
Potassium (K <sup>+</sup> ) <sup>④</sup>	L	Potassium	K 500 <sup>④</sup>		K 800 <sup>④</sup>	0.04...39000 mg/l 10 <sup>-6</sup> ...1 mol/l	ELY/BR/503/K	ISA/K	ES/K	2-12
Copper (Cu <sup>2+</sup> )	S	Copper, Nickel <sup>⑤</sup>	Cu 500	For all ion-selective electrodes from the 500 series:	Cu 800	0.0006...6400 mg/l 10 <sup>-8</sup> ...10 <sup>-1</sup> mol/l	ELY/BR/503	ISA/FK	ES/Cu	2-6
Sodium (Na <sup>+</sup> ) <sup>⑤</sup>	G	Sodium	DX 223 NA			0.05...23000 mg/l 2 x 10 <sup>-6</sup> ...1 mol/l	—	ISA/Na	ES/Na	>10
Nitrate (NO <sub>3</sub> <sup>-</sup> ) <sup>⑤</sup>	L	Nitrate	NO 500 <sup>⑤</sup>		NO 800 <sup>⑤</sup>	0.4...62000 mg/l 7 x 10 <sup>-6</sup> ...1 mol/l	ELY/BR/503/N	TISAB/NO <sub>3</sub>	ES/NO <sub>3</sub>	2,5-11
Silver (Ag <sup>+</sup> ) <sup>⑤</sup>	S	Silver	Ag/S 500		Ag/S 800	0.01...108000 mg/l 10 <sup>-7</sup> ...1 mol/l	ELY/BR/503	ISA/FK	—	2-12
Sulfide (S <sup>2-</sup> ) <sup>⑤</sup>	S	Sulfide	Ag/S 500		Ag/S 800	0.003...32000 mg/l 10 <sup>-7</sup> ...1 mol/l	ELY/BR/503	④	—	2-12

① Exchange measuring head

② S = solid state electrode, L = matrix electrode, G = glass electrode

③ Titration

④ Use according to operating instructions

⑤ Formulations for additionally required solutions are given in the application steps and operating instructions

For ordering information for ISE electrodes and accessories, see WTW Product Details.

## Application Range Ion-selective Measurements

● Recommended by WTW

○ Suitable

Application Range	inoLab® benchtop meters				Portable meters
	pH/ION 735/ 7350*	pH/ION 740/ 7400*	pH 740/7400*, pH/Cond 740/ 7400*, Multi 740/7400*	pH/ION/Cond 750/ 7500*	pH/ION 340i/ 3400i*, Multi 350i/3500i*
Occasional, simple ISE measurement	○	○	●	○	●
Routine and standard measurement	●	●	○	●	○
Advanced methods and procedures	●	●	-	●	-
<i>see page</i>	38	39	25, 64	39, 66	41, 69

## Laboratory ISE Benchtop Meters

### inoLab® pH/ION 735/7350\*

- Precise pH and ISE measurement
- Advanced incremental methods
- Menu-driven user interface

#### pH, mV and ISE measurements with a single instrument

Whether routine measurements or demanding analysis, the pH/ION 735/7350\* is the ideal precision instrument for all uses. A graphical user interface makes high-resolution pH and ISE measurement easy and convenient. 5-point calibration for pH and up to 7 calibration points for ISE measurements guarantees a high-precision measurement by calculating non-linear calibration curves. The Model pH/ION 735/7350\* has user defined method capability as well as preprogrammed incremental techniques.

For those who need to document their results: a data logger with storage for 4,500 entries, bi-directional RS 232 interface, real-time clock, and GLP-supporting calibration protocols, as well as date, time and selectable sample identification number identify all data sets.

This instrument is also available with a built-in printer.



\* North American version

## inoLab® pH/ION 740/7400\*

- Advanced incremental methods
- Free software downloads
- Comprehensive documentation options

### Flexible and powerful

High-performance pH/mV/ISE meter with graphic display and digital recorder function for pH, temperature and ion-selective measurement, automatic temperature compensation, high resolution (0.001 pH), MultiCal® calibration system, built-in measurement storage with GLP-conform documentation and digital interface. PC keyboard interface for connecting an external keyboard or barcode reader, and software for direct control by PC are included. Built-in printer option is available.

## inoLab® pH/ION/Cond 750/7500\*

- Two galvanically isolated pH/mV/ISE inputs
- Menu-operated with back-lit graphic display
- One pH and one ISE calibration record per each input

### Premium instruments from WTW:

Two galvanically isolated inputs allow independent measurements of pH-value, ORP or ion concentration. For accurate measurements along the characteristic curve of the electrode, it is possible to carry out calibrations with up to seven standard solutions. The calculation of the calibration curve by using a modified Nikolski algorithm also takes the non-linear parts of the curve into account. The following methods are used to evaluate the ionic concentration:

- Known addition/known subtraction
- Sample addition/sample subtraction
- Double known addition
- Blank value correction
- Known addition with blank value correction
- Reference measurement

### Features

- 5-point pH calibration by linear regression
- Selectable buffer sets
- Graphic evaluation possible
- Built-in digital recorder
- Connection for barcode reader or PC keyboard
- User selectable languages
- Multi-level GLP functions (password-protected operator levels)
- Free-of-charge downloads for MultiLab® pilot or terminal
- Four to seven point ISE calibration with a modified Nikolski algorithm
- Known addition, double-known addition and known subtraction
- Sample addition/subtraction
- Blank value addition



This instrument also features the option for conductivity measurements. Not only can specific resistance, salinity, and TDS be determined, but also sample-specific temperature coefficients. A wide range of additional functions like data administration, PC-operation using MultiLab® pilot, GLP-compliant calibration and data recording make this instrument essential in every laboratory.

For further details see page 66.

\* North American version

## Technical Data inoLab® pH/ION 735/7350\* and 740/7400\*

Model		pH/ION 735/7350*	pH/ION 740/7400*
Range/ Resolution	pH	-2.000 ... +20.000 pH	-2.000 ... +20.000 pH
	mV	-999.9 ... +999.9 mV	-999.9 ... +999.9 mV
Concentration	Temperature	-2000 ... +2000 mV	-2000 ... +2000 mV
	Concentration	-5 ... +105 °C/0.1 °C (23.0 ... 221 °F)	-5 ... +105 °C/0.1 °C (23.0 ... 221 °F)
		0.000 ... 10.000 mg/l	Measuring range 1 (Resolution): 0.000 ... 9.999 (0.001) mg/l
		0.00 ... 100.00 mg/l	Measuring range 2: 0.00 ... 99.9 (0.01) mg/l
Accuracy (±1 digit)		0.0 ... 1000.0 mg/l	Measuring range 3: 0.0 ... 999.9 (0.1) mg/l
		0 ... 2000 mg/l	Measuring range 4: 0 ... 1999 mg/l
	pH	±0.004 pH	±0.004 pH
	mV	±0.01 pH	±0.01 pH
Calibration	Temperature	±0.2 mV, ±1 mV	±0.2 mV, ±1 mV
		±0.1 K	±0.1 K
Calibration	MultiCal® automatic calibration:	MultiCal® automatic calibration:	MultiCal® automatic calibration:
	AutoCal AutoCal-Tec ConCal® ISECal	2-/3-/4-/5-point 2-/3-/4-/5-point 1-/2-point 2- to 7-point Special functions: Known addition (single) Known subtraction Sample addition Sample subtraction Blank value addition Standard addition with blank value correction	2-/3-/4-/5-point 2-/3-/4-/5-point 1-/2-point 2- to 7-point Special functions: Known addition (single and double) Known subtraction Sample addition Sample subtraction Blank value addition Blank value correction

## Technical Data inoLab® pH/ION/Cond 750/7500\*

Model		pH/ION/Cond 750/7500*
Range/ Resolution	pH	-2 ... 20.000 pH
	mV	-2.00 ... 20.00 pH
Concentration (mg/l)	mV	-999.9 ... +999.9 mV
	Concentration (mg/l)	-2000 ... +2000 mV
		0.000 ... 10.000
		0.00 ... 100.00
Temperature	Temperature	0.0 ... 1000.0
		0 ... 2000
Accuracy (±1 digit)	pH	-5 ... +105 °C (23 ... 221 °F)
	mV	±0.004 pH
Temperature compensation		±0.01 pH
	Automatic	±0.2 mV, ±1 mV
	Manual	-5 ... +105 °C (23.0 ... 221 °F)
	NTC Pt 1000	-5.0 ... 100 °C (23.0 ... 212 °F) -20 ... +130 °C (-4 ... 266 °F) 30 KOhm: ±0.1 ±0.1 K
Calibration	AutoCal	MultiCal® automatic calibration:
	AutoCal-Tec ConCal® ISECal	2-/3-/4-/5-point 2-/3-/4-/5-point 1-/2-point 2- to 7-point Special functions: Known addition (single and double) Known subtraction Sample addition Sample subtraction Blank value addition, Blank value correction

## Ordering Information

inoLab® Laboratory ISE Meters – with universal power supply 100-240 VAC (50/60 Hz) included		□ Order No.	▲ Order No.
pH/ION 735P/7350P*	inoLab® pH/ION 735P/7350P* with built-in printer for GLP-compliant documentation	1G21-210	1G21-110
pH/ION 740P/7400P*	inoLab® pH/ION 740P/7400P* with built-in printer for GLP-compliant documentation; extended measuring and storage options	1G31-210	1G31-110
pH/ION/Cond 750/7500*	Flexible and powerful precision benchtop pH/mV/ISE/conductivity meter with two inputs, single instrument	1K30-210	1K30-110



□ with BNC plug ▲ with DIN plug  
\* North American version

# Portable ISE Meter

## pH/ION 340i/3400i\*

- Handy, waterproof
- Up to 1500 hours continuous operation
- GLP

### pH, mV and ISE measurements in one hand

The pH/mV and ISE meter pH/ION 340i/3400i\* offer the highest degree of flexibility possible. For pH measurements the instrument can be calibrated manually or automatically and offers simultaneous display of pH and temperature.

For measurements with ion-selective electrodes the pH/ION 340i/3400i\* offers concentration display in mg/l. Direct display in mV to  $\pm 999.9$  mV in 0.1 mV steps; and to  $\pm 1999$  mV in 1 mV steps.

Even in these higher ranges the concentration is calculated from a mV resolution of 0.1 mV. Calibration is carried out with up to three standards (selected from 16 standards in the range of 0.01 to 1000 mg/l).

The instrument can be used in-the-lab or in-the-field, operating on either AC power or rechargeable battery for up to 1500 hours, with convenient "LoBat" warning.



Lightweight and compact, these robust meters are both waterproof and submersible to IP 66/67.

The built-in data logger for up to 500 measurements together with GLP calibration protocol offer a comprehensive system for documenting results. With analog or digital data transfer (RS 232), automatic recognition of stable measurements (AutoRead), electrode evaluation and calibration interval monitoring functions ensure reproducible and comprehensible measurements.

Technical Data	
Model	pH/ION 340i/3400i*
Range/Resolution	pH -2.000 ... +19.999 pH mV -999.9 ... +999.9 mV -1999 ... +1999 mV Temperature Concentration -5 ... +105 °C/0.1 °C (23.0 ... 221 °F) 0.01 ... 1999 mg/l
Accuracy (±1 digit)	±0.003 pH ±0.01 pH ±0.2 mV, ±1 mV ±0.1 K
Calibration	MultiCal® automatic calibration: AutoCal 2-point AutoCal-Tec 2-point ConCal® 1-/2-point ISECal 2-/3-point

Ordering Information		Order No.
Portable ISE Meter		
pH/ION 340i/3400i*	Robust and waterproof portable ISE meter with data logger and serial interface	2G30-100
Universal power supply	100 V - 240 V, 50-60 Hz; for 340i series	902 867



\* North American version