

Thermo Scientific Orion Ion Selective Electrode Theory

Measurements using an ion selective electrode (ISE) are applicable in virtually every laboratory. ISEs can be used to measure ion concentrations in water, food, pharmaceuticals and biological samples. Many analytical methods using ISEs have been developed and published worldwide. The main advantage of ion selective electrode technology is the variety of analytical methods that are available. Ion selective electrodes can be used as endpoint indicators or to perform direct measurements and incremental techniques.

Electrode measurements are simpler and faster than other analytical techniques. Time-consuming sample preparation steps such as filtration and distillations are rarely needed. Analysis time is typically under one minute. In comparison to methods such as atomic absorption or ion chromatography, the setup cost is less and does not require expensive equipment. Methods are adaptable to the lab or field. Sample color or turbidity does not affect the measurement. A variety of analytical techniques are available to the analyst.

Choosing the right measurement technique

	Within Linear Response Range	Within Non-Linear Response Range	Increased Precision	Occasional Sampling	Small Sample Volume	Large Number of Samples	Reduce Chemical Usage	Field Measurement	Ionic Strength > 0.1 M	Non-specific Ion Measurement
Direct Measurement	✓				✓	✓		✓		
Known Addition	✓			✓		✓	✓		✓	
Titration	✓		✓							
Low Level Measurement		✓				✓		✓		
Analate Subtraction				✓	✓	✓	✓		✓	
Indicator Titration										✓

Direct measurement is a simple procedure for measuring a large number of samples. Only one meter reading is required for each sample. Calibration is performed in a series of standards. The concentration of the samples is determined by comparison to the standards. Orion ISE meters calculate and store the calibration curves, saving you time in analysis and ensuring an accurate result. Ionic strength adjustor is added to all solutions to ensure that samples and standards have similar ionic strength, proper pH, and to reduce the effect of interfering ions.

Low level measurement is a similar method to direct measurement. This method is recommended when the expected sample concentration is within the non-linear response range of the electrode. A minimum 3 point calibration is recommended to compensate for the electrodes non-linear response at the concentrations. Calibration is performed in one beaker, reducing the chance of cross contamination of the solutions.















Known addition is a useful method for measuring samples, since calibration is not required. This method is recommended when measuring only a few samples, or when samples have a high (>0.1 M) ionic strength, or when there is complicated background matrix. The electrodes are immersed in the




sample solution and an aliquot of standard solution, containing the measured species, is added to the sample. The original sample concentration is determined from the changes in potential before and after the addition. As in direct calibration, any convenient concentration unit can be used. Many Orion ISE meters automate this measurement, by performing the additions and automatically calculating the result.

Analate subtraction is also a useful method for measuring samples, since calibration is not required. The electrodes are immersed in a reagent solution that contains a species that the electrode senses, and that reacts with the sample. It is useful when sample size is small, for samples for which a stable standard is difficult to prepare, and for viscous or very concentrated samples. The method is not suited for very diluted samples. It is also necessary to know the stoichiometric ratio between standard and sample.

Titrations are quantitative analytical techniques for measuring the concentration of a species by incremental addition of a reagent (titrant) that reacts with the sample species. Sensing electrodes can be used for determination of the titration end point. Ion selective electrodes are useful as end point detectors, because they are unaffected by sample color or turbidity.

Thermo Scientific Orion Ion Selective Electrode Selection Guide

	Species	Cat. No.	Construction	Measurement Range	Optimum Temperature Range	Required Reference Electrode	Reference Filling Solution	Calibration Standards	Required ISA
	Ammonia standard (NH ₃)	9512BNWP ¹ 951201 ³	Gas sensing combination	5 x 10 ⁻⁷ to 1.0 M 0.01 to 17,000 ppm	0 to 50 °C	Included	951202	0.1 M NH ₄ Cl / 951006	951211 
	Ammonia high performance	9512HPBNWP ¹ 9512HP01 ³	Gas sensing combination	5 x 10 ⁻⁷ to 1.0 M 0.01 to 17,000 ppm	0 to 50 °C	Included	951209	0.1 M NH ₄ Cl / 951006	951011 
	Ammonium (NH ₄ ⁺)	931801 ⁸	Plastic membrane half-cell	5 x 10 ⁻⁷ to 1.0 M 0.01 to 17,000 ppm	0 to 50 °C	900200	900002 inner / 900018 outer	1000 ppm as N / 951007	--
	Bromide (Br ⁻) ionplus Design	9635BNWP ¹	ionplus Sure-Flow solid state combination	5 x 10 ⁻⁶ to 1.0 M 0.40 to 79,900 ppm	0 to 80 °C	Included	900063	0.1 M NaBr / 943506	940011
	Bromide (Br ⁻)	9435BN ² 9435SC ⁴	Solid state half-cell	5 x 10 ⁻⁶ to 1.0 M 0.40 to 79,900 ppm	0 to 80 °C	900200	900002 inner / 900003 outer	0.1 M NaBr / 943506	940011
	Cadmium (Cd ²⁺) ionplus Design	9648BNWP ¹	ionplus Sure-Flow solid state combination	1 x 10 ⁻⁷ to 0.1 M 0.01 to 11,200 ppm	0 to 80 °C	Included	900061	Consult user guide	940011
	Cadmium (Cd ²⁺)	9448BN ² 9448SC ⁴	Solid state half-cell	1 x 10 ⁻⁷ to 0.1 M 0.01 to 11,200 ppm	0 to 80 °C	900200	900002 inner / 900003 outer	Consult user guide	940011
	Calcium (Ca ²⁺) ionplus Design	9720BNWP ¹	ionplus Sure-Flow plastic membrane combination	5 x 10 ⁻⁷ to 1.0 M 0.02 to 40,100 ppm	0 to 40 °C	Included	900061	0.1 M CaCl ₂ / 922006 100 ppm CaCO ₃ / 923206	932011
	Calcium (Ca ²⁺)	9320BN ²	Plastic membrane half-cell	5 x 10 ⁻⁷ to 1.0 M 0.02 to 40,100 ppm	0 to 40 °C	900100	900011	0.1 M CaCl ₂ / 922006 100 ppm CaCO ₃ / 923206	932011
	Carbon Dioxide (CO ₂)	9502BNWP ¹	Gas sensing combination	1 x 10 ⁻⁴ to 1 x 10 ⁻² M 4.4 to 440 ppm	0 to 50 °C	Included	950202	0.1 M NaHCO ₃ / 950206 1000 ppm as CaCO ₃ / 950207	950210
	Chloride (Cl ⁻) ionplus Design	9617BNWP ¹	ionplus Sure-Flow solid state combination	5 x 10 ⁻⁵ to 1.0 M 1.8 to 35,500 ppm	0 to 80 °C	Included	900062	0.1 M NaCl / 941706 100 ppm Cl ⁻ / 941707 1000 ppm Cl ⁻ / 941708	940011 or 941709 / CISA 
	Chloride (Cl ⁻)	9417BN ² 9417SC ⁴	Solid state half-cell	5 x 10 ⁻⁵ to 1.0 M 1.8 to 35,500 ppm	0 to 80 °C	900200	900002 inner / 900003 outer	0.1 M NaCl / 941706 100 ppm Cl ⁻ / 941707 1000 ppm Cl ⁻ / 941708	940011 or 941709 / CISA 
	Chloride (Cl ⁻)	931701 ⁸	Plastic membrane half-cell	5 x 10 ⁻⁶ to 1.0 M 0.18 to 35,500 ppm	0 to 50 °C	900200	900002 inner / 0.1 M KCl outer	0.1 M NaCl / 941706 100 ppm Cl ⁻ / 941707 1000 ppm Cl ⁻ / 941708	None required
	Chlorine (Cl ₂)	9770BNWP ¹ 9770SC ⁴	Solid state combination	1 x 10 ⁻⁷ to 3 x 10 ⁻⁴ M 0.01 to 20 ppm	0 to 50 °C	Included	None required	100 ppm as Cl ₂ / 977007	977010 / iodide reagent 977011 / acid reagent 
	Cupric (Cu ²⁺) ionplus Design	9629BNWP ¹	ionplus Sure-Flow solid state combination	1 x 10 ⁻⁸ to 0.1 M 6.4 x 10 ⁻⁴ to 6350 ppm	0 to 80 °C	Included	900063	0.1 M Cu(NO ₃) ₂ / 942906	940011
	Cupric (Cu ²⁺)	9429BN ² 9429SC ⁴	Solid state half-cell	1 x 10 ⁻⁸ to 0.1 M 6.4 x 10 ⁻⁴ to 6350 ppm	0 to 80 °C	900200	900002 inner / 900003 outer	0.1 M Cu(NO ₃) ₂ / 942906	940011
	Cyanide (CN ⁻) ionplus Design	9606BNWP ¹	ionplus Sure-Flow solid state combination	8 x 10 ⁻⁶ to 1 x 10 ⁻² M 0.2 to 260 ppm	0 to 80 °C	Included	900062	Consult user guide	951011 
	Cyanide (CN ⁻)	9406BN ² 9406SC ⁴	Solid state half-cell	8 x 10 ⁻⁶ to 1 x 10 ⁻² M 0.2 to 260 ppm	0 to 80 °C	900200	900002 inner / 900003 outer	Consult user guide	951011 
	Fluoride (F ⁻) ionplus Design	9609BNWP ¹ 960900 ³	ionplus Sure-Flow solid state combination	1 x 10 ⁻⁶ M to saturated 0.02 ppm to saturated	0 to 80 °C	Included	900061	0.1 M NaF / 940906 100 ppm F ⁻ / 940907 1 ppm F w/ TISAB II / 040906 2 ppm F w/ TISAB II / 040907 10 ppm F w/ TISAB II / 040908	940909 / TISAB II 940911 / TISAB III
	Fluoride (F ⁻)	9409BN ² 940900 ³ 9409SC ⁴	Solid state half-cell	1 x 10 ⁻⁶ M to saturated 0.02 ppm to saturated	0 to 80 °C	900100	900001	0.1 M NaF / 940906 100 ppm F ⁻ / 940907 1 ppm F w/ TISAB II / 040906 2 ppm F w/ TISAB II / 040907 10 ppm F w/ TISAB II / 040908	940909 / TISAB II 940911 / TISAB III
	Fluoroborate (BF ₄ ⁻)	9305BN ²	Plastic membrane half-cell	7 x 10 ⁻⁶ to 1.0 M 0.6 to 86,800 ppm	0 to 40 °C	900200	900002 inner / dilute ISA outer	Consult user guide	930711

	Species	Cat. No.	Construction	Measurement Range	Optimum Temperature Range	Required Reference Electrode	Reference Filling Solution	Calibration Standards	Required ISA
	Iodide (I) ionplus Design	9653BNWP ¹	ionplus® Sure-Flow® solid state combination	5 x 10 ⁻⁸ to 1.0 M 5 x 10 ⁻³ to 127,000 ppm	0 to 80 °C	Included	900063	0.1 M NaI / 945306	940011
	Iodide (I)	9453BN ² 9453SC ⁴	Solid state half-cell	5 x 10 ⁻⁸ to 1.0 M 5 x 10 ⁻³ to 127,000 ppm	0 to 80 °C	900200	900002 inner / 900003 outer	0.1 M NaI / 945306	940011
	Lead (Pb) ionplus Design	9682BNWP ¹	ionplus Sure-Flow solid state combination	1 x 10 ⁻⁶ to 0.1 M 0.2 to 20,700 ppm	0 to 80 °C	Included	900062	0.1 M Pb(ClO ₄) ₂ / 948206 0.1 M Na ₂ SO ₄ / 948207	Consult instruction manual
	Lead (Pb)	9482BN ² 9482SC ⁴	Solid state half-cell	1 x 10 ⁻⁶ to 0.1 M 0.2 to 20,700 ppm	0 to 80 °C	900200	900002 inner / 900003 outer	0.1 M Pb(ClO ₄) ₂ / 948206 0.1 M Na ₂ SO ₄ / 948207	Consult instruction manual
EPA	Nitrate (NO ₃) ionplus Design	9707BNWP ¹	ionplus Sure-Flow plastic membrane combination	7 x 10 ⁻⁶ to 1.0 M 0.1 to 14,000 ppm as N	0 to 40 °C	Included	900046	0.1 M NaNO ₃ / 920706 1000 ppm N / 920707 100 ppm N / 930707	930711 or 930710 / nitrate ISS
EPA	Nitrate (NO ₃)	9307BNWP ¹	Plastic membrane half-cell	7 x 10 ⁻⁶ to 1.0 M 0.1 to 14,000 ppm as N	0 to 40 °C	900200	900002 inner / 900046 or ISA outer	0.1 M NaNO ₃ / 920706 1000 ppm N / 920707 100 ppm N / 930707	930711 or 930710 / nitrate ISS
	Nitrogen Oxide (NO _x)	9546BN ²	Gas sensing combination	4 x 10 ⁻⁶ to 5 x 10 ⁻³ M 0.18 to 230 ppm	0 to 50 °C	Included	954602	0.1 M NaNO ₂ / 954606	956410 
	Perchlorate (ClO ₄)	938101 ⁸	Plastic membrane half-cell	7 x 10 ⁻⁶ to 1.0 M 0.7 to 99,500 ppm	0 to 40 °C	900200	900002 inner / dilute ISA outer	Consult user guide	930711
	Potassium (K) ionplus Design	9719BNWP ¹	ionplus Sure-Flow plastic membrane combination	1 x 10 ⁻⁶ to 1.0 M 0.04 to 39,000 ppm	0 to 40 °C	Included	900065	0.1 M KCl / 921906	931911
	Potassium (K)	9319BN ²	Plastic membrane half-cell	1 x 10 ⁻⁶ to 1.0 M 0.04 to 39,000 ppm	0 to 40 °C	900200	900002 inner / dilute ISA outer	0.1 M KCl / 921906	931911
	Silver/Sulfide (Ag ⁺ /S ²⁻) ionplus Design	9616BNWP ¹	ionplus Sure-Flow solid state combination	1 x 10 ⁻⁷ to 1.0 M 0.01 to 107,900 ppm as Ag ⁺ 0.003 to 32,100 ppm as S ²⁻	0 to 80 °C	Included	900062 for Ag ⁺ /S ²⁻ 900067 for Ag ⁺ 900061 for S ²⁻	Consult user guide	940011 for Ag ⁺ 941609 for S ²⁻ 
	Silver/Sulfide (Ag ⁺ /S ²⁻)	9416BN ² 9416SC ⁴	Solid state half-cell	1 x 10 ⁻⁷ to 1.0 M 0.01 to 107,900 ppm as Ag ⁺ 0.003 to 32,100 ppm as S ²⁻	0 to 80 °C	900200	900002 inner / 900003 outer	Consult user guide	940011 for Ag ⁺ 941609 for S ²⁻ 
	Sodium (Na)	8611BNWP ¹	ROSS® Sure-Flow combination	1 x 10 ⁻⁶ M to saturated 0.02 ppm to saturated	0 to 100 °C	Included	900010 or 900012 for low level Na ⁺	10 ppm Na ⁺ / 941105 100 ppm Na ⁺ / 941107 1000 ppm Na ⁺ / 841108 KA standard kit, 1 M NaCl with ISA / 650700 0.1 M NaCl / 941706	841111 841113 / reconditioning solution
	Sodium (Na)	8411BN ²	ROSS half-cell	1 x 10 ⁻⁶ M to saturated 0.02 ppm to saturated	0 to 100 °C	800300 or 800500U	900010 or 900012 for low level Na ⁺	10 ppm Na ⁺ / 941105 100 ppm Na ⁺ / 941107 1000 ppm Na ⁺ / 841108 KA standard kit, 1 M NaCl with ISA / 650700 0.1 M NaCl / 941706	841111 841113 / reconditioning solution
	Sodium (Na)	9811BN ²	Micro combination	1 x 10 ⁻⁶ M to saturated 0.02 ppm to saturated	0 to 80 °C	Included	900004	0.1 M NaCl / 941706	841111
	Surfactant	9342BN ²	Plastic membrane half-cell	Endpoint indicator	0 to 40 °C	900200	900002 inner / 810007 outer	0.5 M Hyamine titrant / 654201	654203 / sample additive
	Thiocyanate (SCN)	9458BN ²	Solid state half-cell	5 x 10 ⁻⁶ to 1.0 M 0.29 to 58,100 ppm	0 to 50 °C	900200	900002 inner / 900003 outer	Consult user guide	940011
	Water Hardness (X ²⁺)	9332BNWP ¹	Plastic membrane half-cell	6 x 10 ⁻⁶ to 1.0 M	0 to 50 °C	900100	900011	100 ppm CaCO ₃ / 923206 0.1 M CaCl ₂ / 922006	None required



Compliant with EPA testing method


Signifies a hazardous solution. See terms and conditions for important shipping information at www.thermo.com/water


BNC



BNC connector



US Standard



Screw Cap

Key Information

1). BNC Waterproof connector 2). BNC connector 3). US Standard connector
4). Screw Cap connector, requires separate cable 8). Module only, requires separate
93 Series electrode handle (9300BNWP, 930000, or 9300SC)
All cap diameters are 16 mm at bottom of cap. All cable lengths are 1 meter.