

Ion Selective Electrodes

For HANNA's New Generation of Instruments

ISE Electrode Types

HANNA's ion selective electrodes can be grouped into three general categories based upon construction.



Solid State Electrodes are available as both single half-cells or as combination electrodes complete with reference electrode. These electrodes incorporate a solid sensing surface made of compressed silver halides, or solid crystalline material. HANNA's offering includes sensors for the determination of bromide, cadmium, chloride, cupric, cyanide, fluoride, iodide, lead and silver ions. Solid body construction is rugged for long life.

Theory: A solid state electrode develops a voltage due to ion-exchange occurring between the sample and the inorganic membrane. An equilibrium mechanism occurs due to the very limited solubility of the membrane material in the sample.

Liquid Membrane Electrodes are available as single half-cells or as combination electrodes complete with reference electrode. The sensing surfaces of these electrodes are comprised of a homogeneous polymer matrix containing organic ion-exchangers selective for the determined ion. These sensors incorporate easily replaceable membrane modules and are available for measurements of nitrate, potassium and calcium.

Theory: The potassium electrode was one of the earliest liquid membrane sensors developed of this type. The membrane is usually in the form of a thin disc of PVC impregnated with the antibiotic valinomycin. The exchanger, also known as an ionophore, is a ring structure that fits potassium ions inside like a lock and key. This type of membrane is not as rugged as the solid state type so they are designed for easy replacement of the sensing module.

Gas Sensors are combination electrodes that detect dissolved gases in a solution. No external reference is required for these electrodes. The sensing element is separated from the sample solution by a gas permeable membrane. HANNA's offering includes the HI 4101 Ammonia electrode and the HI 4105 Carbon Dioxide electrode.

Theory: A gas sensor works due to the partial pressure of the measured gas in solution. The dissolved gas in the sample diffuses into the membrane and changes the pH in a thin film of unbuffered electrolyte on the surface of the internal pH sensor. Diffusion continues until the partial pressure of the sample and the thin film is the same. The pH change is proportional to the dissolved gas in the sample.

Reference and Combination Electrodes

HANNA's reference electrode is used with our half-cell ISE sensors to provide accurate and repeatable measurements. HANNA's combination electrodes incorporate the measuring electrode with the reference making them ideal for field measurements.



Reference Electrodes are used to provide a stable voltage and electrolytic contact to permit a voltage gradient to be measured across a measurement membrane such as an ISE. HANNA has designed an easy to use, unbreakable plastic, double junction, quick fill, sleeve style reference electrode with a cone style junction to work with the ion selective electrode family of sensors. The design forms the liquid junction with the test solution at the tip of the junction cone and not further up the cone surface. The design produces a highly stable reference electrode with reasonable

low flow rates. The model HI 5315 is a silver/silver chloride electrode half-cell with a permanent gel filled internal cell. The outer fill solution is easily replaceable and serves as a buffer zone between the internal chloride ion containing gel and the sample solution. HANNA offers a complete line of silver-free fill solutions to optimize your ion measurement. A fast responding liquid junction, excellent reproducibility, and ease of use will mark this reference as your "best" in the lab.

Combination Electrodes include a sensor and reference electrode in a single electrode body. Our combination ion selective electrodes provide the same selectivity and response as our ISE half-cells, but include our superior double junction reference into the same electrode body. Combination solid state electrodes have a built in solid state sensor and quick refillable reference electrode. Our liquid membrane and fluoride combination electrodes have replaceable module construction and the HANNA double junction reference stability.

Three Methods of Analysis

Potentiometric ion analyses with ISEs are performed by use of one of three methods, each entailing its own advantages: Direct Potentiometry, Incremental Methods, and Potentiometric Titration. HANNA offers a solution for each of these methods, for more details please refer to our Solutions Section.

HI 4101 • HI 4002 • HI 4102 • HI 4003 • HI 4103

Ammonia • Bromide • Cadmium*Ion Selective Electrodes*

PARAMETER	AMMONIA	BROMIDE		CADMIUM	
CODE	HI 4101	HI 4002	HI 4102	HI 4003	HI 4103
Type	Gas-Sensing; Combination	Solid-state; Half-cell	Solid-state; Combination	Solid-state; Half-cell	Solid-state; Combination
Measurement Range	1M to 1X 10 ⁻⁶ M 17000 to 0.02 ppm	1M to 1X 10 ⁻⁶ M 79910 to 0.08 ppm	1M to 1X 10 ⁻⁶ M 79910 to 0.08 ppm	1M to 1X 10 ⁻⁷ M 11200 to 0.01 ppm	1M to 1X 10 ⁻⁷ M 11200 to 0.01 ppm
Optimum pH Range	>11	2 to 12.5	2 to 12.5	2 to 12.5	2 to 12.5
Temperature Range	0 to 40°C	0 to 80°C	0 to 80°C	0 to 80°C	0 to 80°C
Approximate Slope	-56	-56	-56	+28	+28
Body O.D.	12 mm	12 mm	12 mm	12 mm	12 mm
Insertion Length	120 mm	120 mm	120 mm	120 mm	120 mm
Body Material	Delrin	Epoxy	PEI	Epoxy	PEI
Cable	1m coaxial	1m coaxial	1m coaxial	1m coaxial	1m coaxial
Connector	BNC	BNC	BNC	BNC	BNC
Possible Applications	Determination of ammonium, ammonia in wine, beer, water, waste water and soil	Determination of free bromide ions in emulsified food products, beverages, plants, soils and as an indicator for titration		Used as an indicator for titrations using chelates	

HI 4004 • HI 4104 • HI 4105 • HI 4007 • HI 4107

Calcium • Carbon Dioxide • Chloride

Ion Selective Electrodes

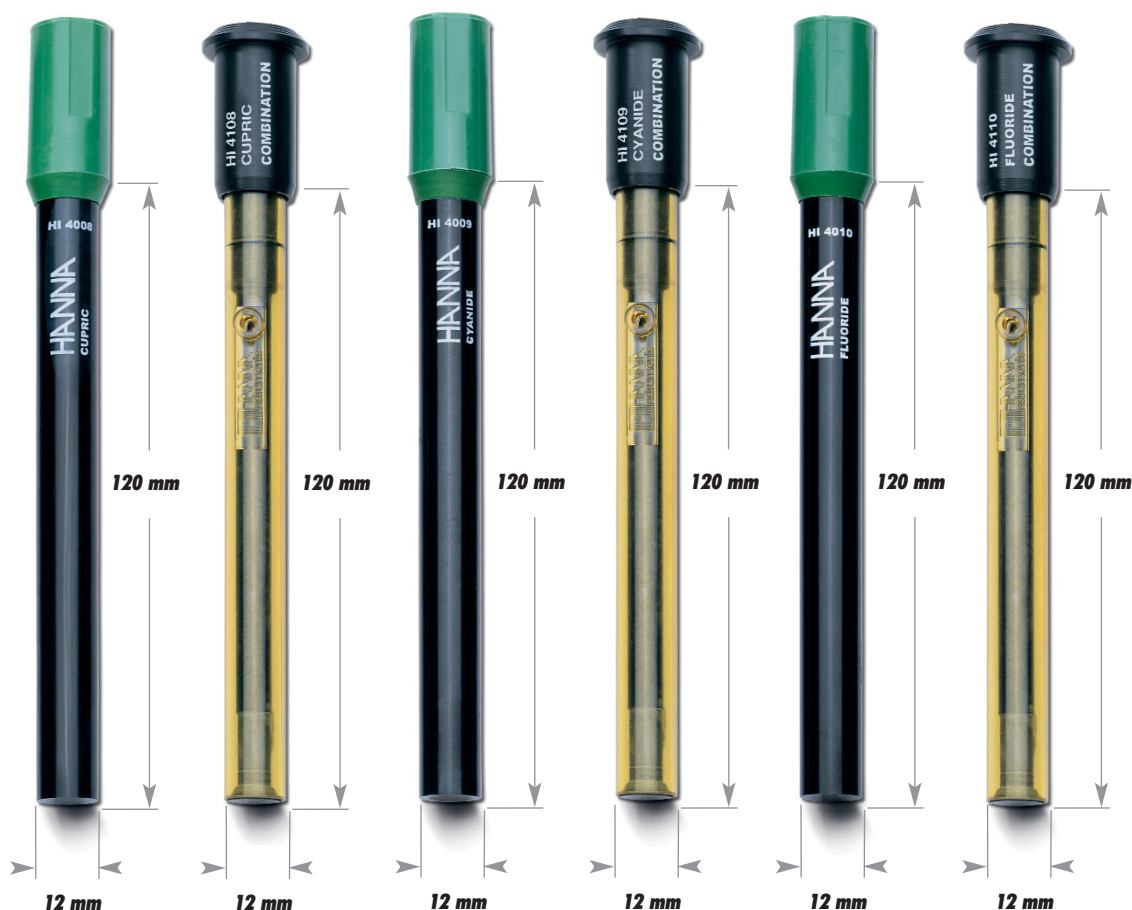
5

ISE/pH



PARAMETER	CALCIUM		CARBON DIOXIDE	CHLORIDE	
CODE	HI 4004	HI 4104	HI 4105	HI 4007	HI 4107
Type	Polymer Membrane; Half-cell	Polymer Membrane; Combination	Gas Sensing; Combination	Solid-state; Half-cell	Solid-state; Combination
Measurement Range	1M to 3X 10 ⁻⁶ M 40080 to 0.12 ppm	1M to 3X 10 ⁻⁶ M 40080 to 0.12 ppm	1X 10 ⁻² M to 1X 10 ⁻⁴ M 440 to 4.4 ppm	1M to 5X 10 ⁻³ M 35000 to 1.8 ppm	1M to 5X 10 ⁻³ M 35000 to 1.8 ppm
Optimum pH Range	4 to 10	4 to 10	4.2 to 5.2	2 to 11	2 to 11
Temperature Range	0 to 40°C	0 to 40°C	0 to 40°C	0 to 80°C	0 to 80°C
Approximate Slope	+28	+28	+54	-57	-57
Body O.D.	12 mm	12 mm	12 mm	12 mm	12 mm
Insertion Length	120 mm	120 mm	120 mm	120 mm	120 mm
Body Material	PVC	PEI/PVC	Delrin	Epoxy	PEI
Cable	1m coaxial	1m coaxial	1m coaxial	1m coaxial	1m coaxial
Connector	BNC	BNC	BNC	BNC	BNC
Possible Applications	Determination of free calcium in beverages, water, and seawater		Determination of carbonates as CO ₂ in water, soft drinks and wine samples	Determination of free chloride ions in emulsified food products, beverages, plants, soils and as an indicator for titration	

HI 4008 • HI 4108 • HI 4009 • HI 4109 • HI 4010 • HI 4110

Cupric • Cyanide • Fluoride*Ion Selective Electrodes*

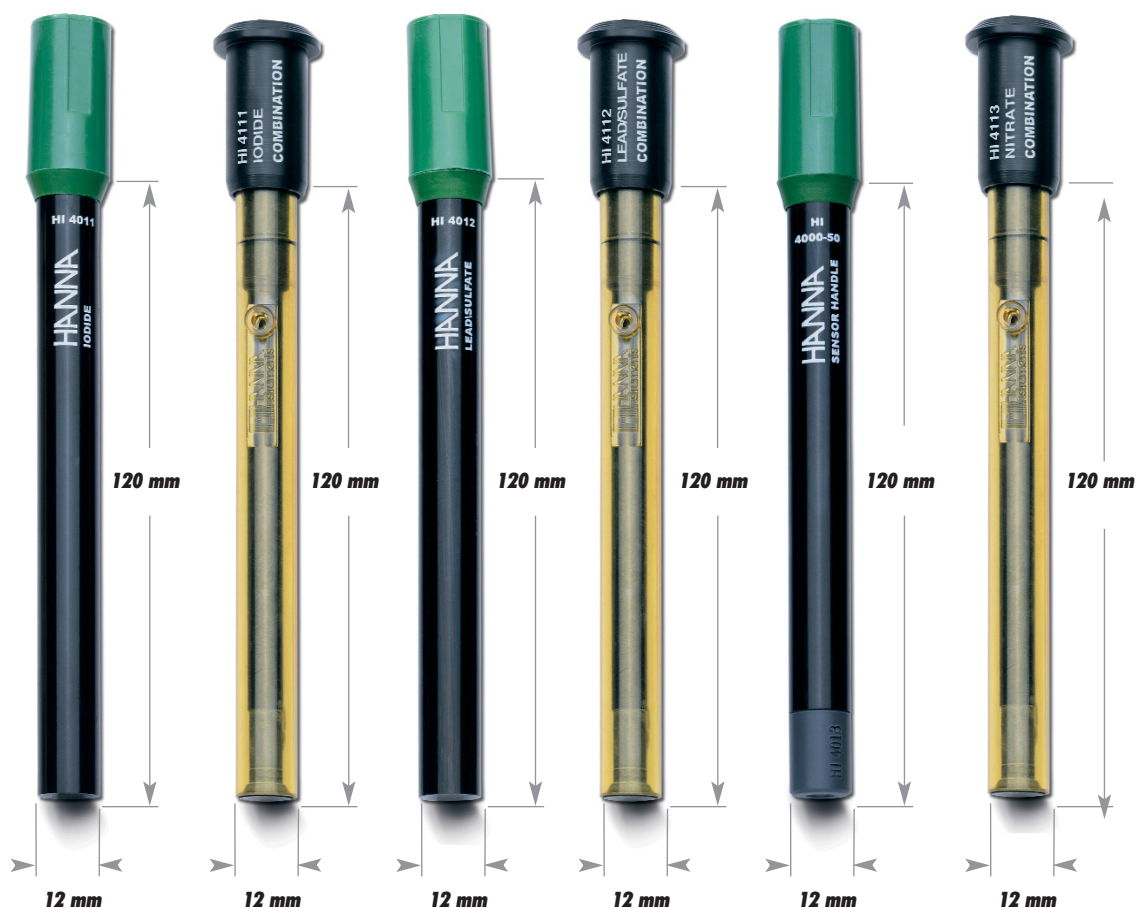
PARAMETER	CUPRIC		CYANIDE		FLUORIDE	
CODE	HI 4008	HI 4108	HI 4009	HI 4109	HI 4010	HI 4110
Type	Solid-state; Half-cell	Solid-state; Combination	Solid-state; Half-cell	Solid-state; Combination	Solid-state; Half-cell	Solid-state; Combination
Measurement Range	0.1M to 1X 10 ⁻⁶ M 6354 to 0.06 ppm	0.1M to 1X 10 ⁻⁶ M 6354 to 0.06 ppm	10 ⁻³ M to 1X 10 ⁻⁶ M 260 to 0.02 ppm	10 ⁻³ M to 1X 10 ⁻⁶ M 260 to 0.02 ppm	1M to 1X 10 ⁻⁶ M Sat. to 0.02 ppm	1M to 1X 10 ⁻⁶ M Sat. to 0.02 ppm
Optimum pH Range	2 to 12.5	2 to 12.5	>11	>11	5 to 8	5 to 8
Temperature Range	0 to 80°C	0 to 80°C	0 to 80°C	0 to 80°C	0 to 80°C	0 to 80°C
Approximate Slope	26	26	-57	-57	-56	-56
Body O.D.	12 mm	12 mm	12 mm	12 mm	12 mm	12 mm
Insertion Length	120 mm	120 mm	120 mm	120 mm	120 mm	120 mm
Body Material	Epoxy	PEI	Epoxy	PEI	Epoxy	PEI/Epoxy
Cable	1m coaxial	1m coaxial	1m coaxial	1m coaxial	1m coaxial	1m coaxial
Connector	BNC	BNC	BNC	BNC	BNC	BNC
Possible Applications	Used as an indicator for titrations using chelates		Determination of free cyanide ions in plating baths, waste water and in plant and soil samples		Determination of free fluoride in potable water, soft drinks, wine, plants, emulsified food products, plating and pickling acids	

Iodide • Lead/Sulfate • Nitrate

Ion Selective Electrodes

5

ISE/pH



PARAMETER	IODIDE		LEAD/SULFATE		NITRATE	
CODE	HI 4011	HI 4111	HI 4012	HI 4112	HI 4013	HI 4113
Type	Solid-state; Half-cell	Solid-state; Combination	Solid-state; Half-cell	Solid-state; Combination	Polymer Membrane; Half-cell	Polymer Membrane; Combination
Measurement Range	1M to 1X 10 ⁻⁷ M 127000 to 0.01 ppm	1M to 1X 10 ⁻⁷ M 127000 to 0.01 ppm	0.1M to 1X 10 ⁻⁶ M 20700 to 0.21 ppm	0.1M to 1X 10 ⁻⁶ M 20700 to 0.21 ppm	1.0M to 1X 10 ⁻⁶ M 6200 to .62 ppm	1.0M to 1X 10 ⁻⁶ M 6200 to .62 ppm
Optimum pH Range	2 to 13	2 to 13	4 to 7	4 to 7	3.0 to 8	3.0 to 8
Temperature Range	0 to 80°C	0 to 80°C	0 to 80°C	0 to 80°C	0 to 40°C	0 to 40°C
Approximate Slope	-56	-56	+25	+25	-56	-56
Body O.D.	12 mm	12 mm	12 mm	12 mm	12 mm	12 mm
Insertion Length	120 mm	120 mm	120 mm	120 mm	120 mm	120 mm
Body Material	Epoxy	PEI	Epoxy	PEI	PVC	PEI/PVC
Cable	1m coaxial	1m coaxial	1m coaxial	1m coaxial	1m coaxial	1m coaxial
Connector	BNC	BNC	BNC	BNC	BNC	BNC
Possible Applications	Determination of free iodide ions in emulsified food samples (iodized table salt), plants and for titration		Determination of lead ions in plating baths and as an indicator for titrations		Determination of free nitrate in natural waters (fresh and sea), and in emulsified food and plant samples	

4114 • HI 4015 • HI 4115 • HI 5315

Potassium • Silver/Sulfide • Reference*Ion Selective Electrodes*

PARAMETER	POTASSIUM		SILVER/SULFIDE		REFERENCE
CODE	HI 4014	HI 4114	HI 4015	HI 4115	HI 5315
Type	Polymer Membrane; Half-cell	Polymer Membrane; Combination	Solid-state; Half-cell	Solid-state; Combination	N/A
Measurement Range	1M to 1X 10 ⁻⁶ M 39100 to .039 ppm	1M to 1X 10 ⁻⁶ M 39100 to .039 ppm	Ag ⁺ 1.0M to 1X 10 ⁻⁶ M 107900 to 0.11 ppm S ²⁻ 1.0M to 1X 10 ⁻⁷ M 32100 to 0.003 ppm	Ag ⁺ 1.0M to 1X 10 ⁻⁶ M 107900 to 0.11 ppm S ²⁻ 1.0M to 1X 10 ⁻⁷ M 32100 to 0.003 ppm	N/A
Optimum pH Range	1.5 to 12.0	1.5 to 12.0	Ag ⁺ 2 to 8 S ²⁻ 12 to 14	Ag ⁺ 2 to 8 S ²⁻ 12 to 14	N/A
Temperature Range	0 to 40°C	0 to 40°C	0 to 80°C	0 to 80°C	0 to 80°C
Approximate Slope	+56	+56	+56 Ag ⁺ / -28 S ²⁻	+56 Ag ⁺ / -28 S ²⁻	N/A
Body O.D.	12 mm	12 mm	12 mm	12 mm	12 mm
Insertion Length	120 mm	120 mm	120 mm	120 mm	120 mm
Body Material	PVC	PEI/PVC	Epoxy	PEI	PEI
Cable	1m coaxial	1m coaxial	1m coaxial	1m coaxial	1m coaxial
Connector	BNC	BNC	BNC	BNC	Banana
Possible Applications	Determination of potassium ions in wine, waters, soils and biological samples.		As an indicator for titrations using silver nitrate. For the determination of sulfide ions in waters, paper liquors, natural waters and soils.		To complete the electrical circuit and to provide a stable reference voltage for ISE half-cells

Sensors and Accessories Reference Chart

ELECTRODE	TYPE	HALF-CELL	COMBINATION	ISA	FILLING SOLUTION	STD 1	STD 2	STD 3	OTHER
Ammonia	Gas	—	HI 4101	HI 4001-00	HI 4001-40	HI 4001-01 0.1 M	HI 4001-02 100 ppm	HI 4001-03 1000 ppm	HI 4000-52 replacement cap HI 4001-51 membrane kit HI 4000-51 replacement pH internal and cap for Ammonia HI 4001-45 conditioning solution HI 4000-47 4 and 7 pH with salt
Bromide	Solid	HI 4002	HI 4102	HI 4000-00	HI 7072	HI 4002-01 0.1 M			HI 4000-70 polishing strip
Cadmium	Solid	HI 4003	HI 4103	HI 4000-00	HI 7072	HI 4003-01 0.1 M			HI 4000-70 polishing strip
Calcium	Polymer membrane	HI 4004	HI 4104	HI 4004-00	HI 7082	HI 4004-01 0.1 M			HI 4004-51 module HI 4104-51 module for combination HI 4004-45 Conditioning Solution
Carbon Dioxide	Gas	—	HI 4105	HI 4005-00	HI 4005-40	HI 4005-01 0.1 M		HI 4005-03 1000 ppm	HI 4000-54 replacement pH internal & cap for CO ₂ HI 4005-53 CO ₂ membrane kit (3 pack) HI 4000-47 4 and 7 pH with salt HI 4005-45 Conditioning Solution
Chloride	Solid	HI 4007	HI 4107	HI 4000-00	HI 7072	HI 4007-01 0.1 M	HI 4007-02 100 ppm	HI 4007-03 1000 ppm	HI 4000-70 polishing strip
Cupric	Solid	HI 4008	HI 4108	HI 4000-00	HI 7072	HI 4008-01 0.1 M			HI 4000-70 polishing strip
Cyanide	Solid	HI 4009	HI 4109	HI 4001-00	HI 7072				HI 4000-70 polishing strip
Fluoride	Solid	HI 4010	HI 4110	HI 4010-00 HI 4010-05 HI 4010-06 HI 4010-30	HI 7075	HI 4010-01 0.1 M	HI 4010-02 100 ppm	HI 4010-03 1000 ppm	HI 4010-11 1 ppm with TISAB II HI 4010-12 2 ppm with TISAB II HI 4010-10 10 ppm with TISAB II HI 4110-51 module for combination HI 4010-30 Fluoride measurement kit
Iodide	Solid	HI 4011	HI 4111	HI 4000-00	HI 7072	HI 4011-01 0.1 M			HI 4000-70 polishing strip
Lead/Sulfate	Solid	HI 4012	HI 4112	HI 4012-00	HI 7072	HI 4012-01 Lead HI 4012-21 Sulfate 0.1 M			HI 4000-70 polishing strip
Nitrate	Polymer membrane	HI 4013	HI 4113	HI 4013-00	HI 7078	HI 4013-01 0.1 M	HI 4013-02 100 ppm	HI 4013-03 1000 ppm	HI 4013-53 module (3 pack) HI 4113-53 module for combination (3 pack) HI 4013-06 Interferent suppressant ISA
Potassium	Polymer membrane	HI 4014	HI 4114	HI 4014-00	HI 7076	HI 4014-01 0.1 M			HI 4014-51 module HI 4114-51 module for combination
Silver/Sulfide	Solid	HI 4015	HI 4115	HI 4000-00 (Ag ⁺) HI 4015-00 (S ²⁻)	HI 7072	HI 4015-01 0.1 M Silver			HI 4000-70 polishing strip
Reference	—	HI 5315			HI 7072 HI 7075 HI 7076 HI 7082 HI 7078				