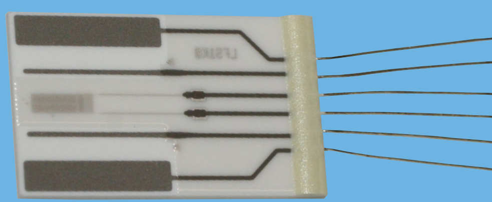
INNOVATIVE SENSOR TECHNOLOGY

CONDUCTIVITY SENSORS

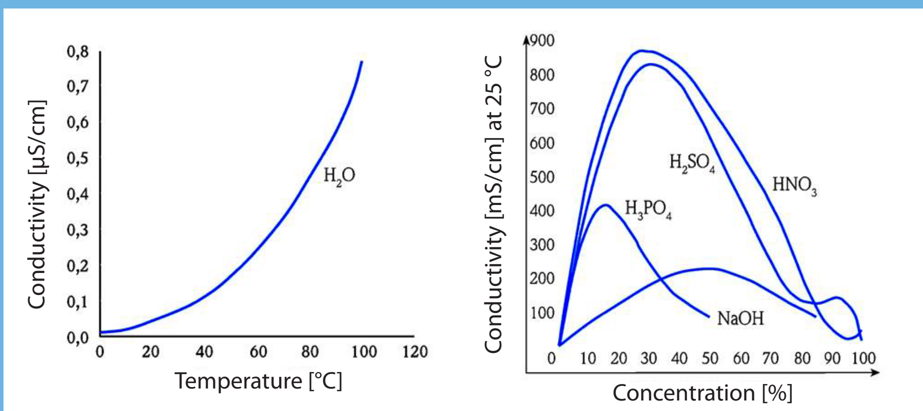
Conductivity sensors

Despite its simplicity, the measurement of electrical conductivity in liquid substances is a very powerful analytical and diagnostic tool in a variety of applications. The modern, thin-film conductivity sensor element is a viable alternative to the classical, bulky conductivity sensors of the past.



Theoretical background

An electrolyte is a liquid containing ions. Under a voltage, ions act as charge carriers and a current flows. Therefore, quality of the liquid can be assessed by determining the conductivity. The conductivity of the liquid depends on two temperature-dependent parameters: ion concentration and their mobility. For improved accuracy a temperature sensor is placed directly at the point of measurement.



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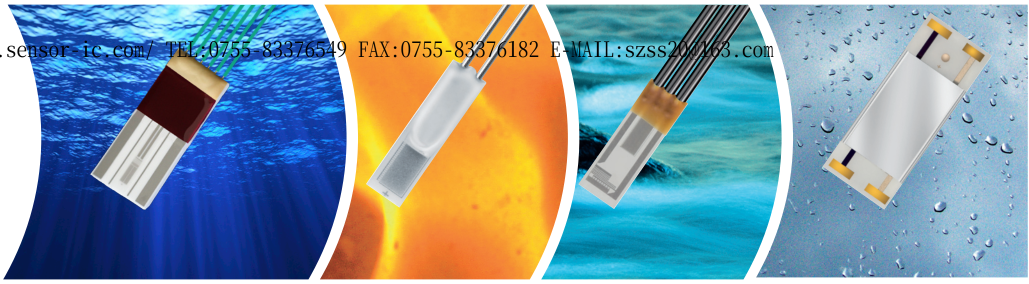


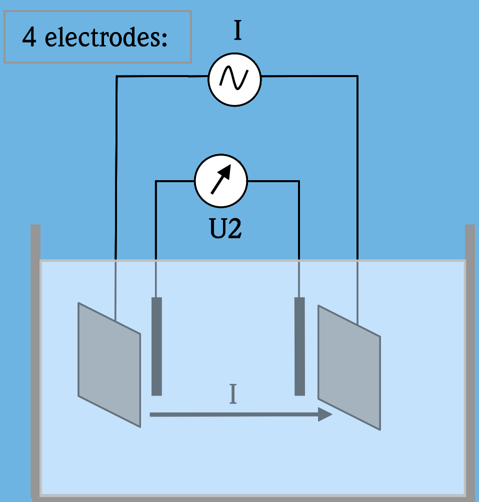
SELECTED CONDUCTIVITY OF ELECTROLYTES

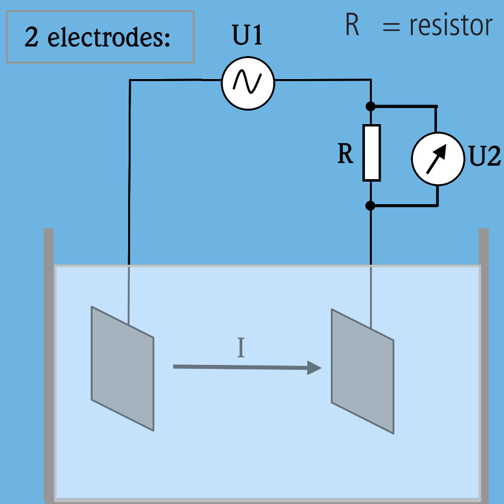
Electrolyte	Electrical conductivity µS/cm	S/m
Ultra pure water	0.05-0.1	$5\text{-}10 \cdot 10^{-6}$
Tap water	300-800	0.03-0.08
NaCl (0.2 g/l)	4'000	0.4
NaCl (2 g/l)	38'600	3.86
Seawater	~ 56'000	~ 5.6
Bulk silver (for comparison)	$62.5 \cdot 10^{6}$	6'250

THE MEASUREMENT PRINCIPLES

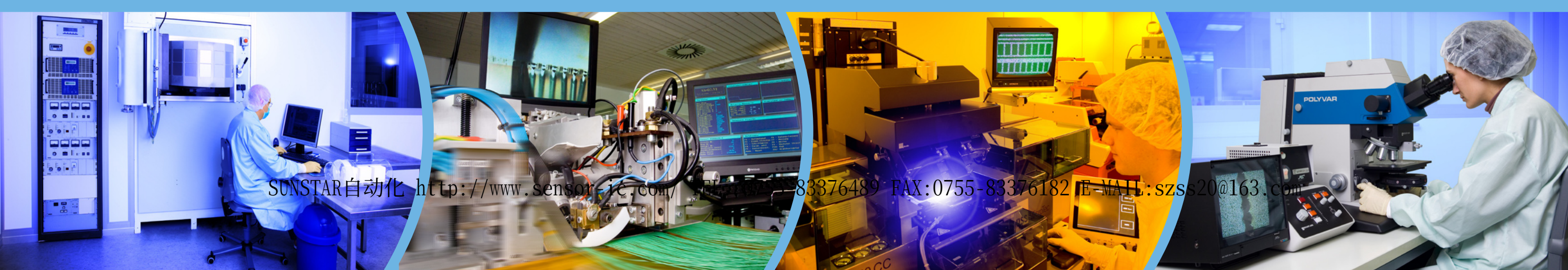
Conductivity (using electrodes)

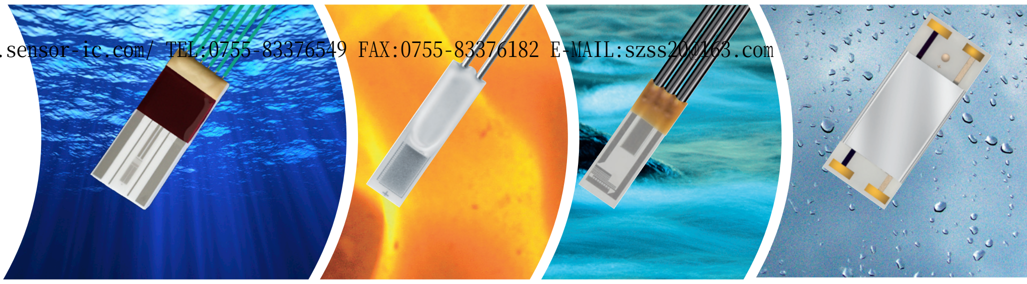
U1 = input signal (AC)
U2 = output signal (AC)
I = current flow
R = resistor





AC excitation is recommended to reduce degradation of the electrode and electrolyte





Conductivity and cell constant

The conductivity value, as a result of the measurement, depends additionally on the cell geometry. The influence of the cell geometry can be eliminated by introducing the so-called cell constant. Using the following formula, the electrical conductivity, κ, can be obtained at a specific temperature:

$$\kappa = \frac{k * I}{U}$$

k = cell constant
U = measurement voltage
I = current flow
κ = electrical conductivity

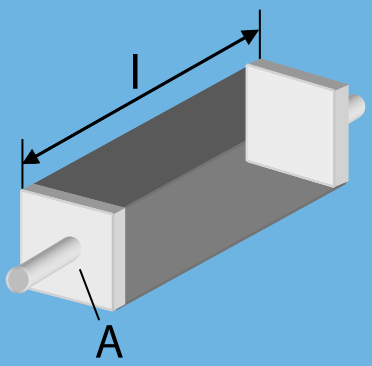
The exact value of the cell constant can be obtained as a result of calibration measurements in standard solutions. To avoid additional measurement errors, it is important to use a solution with electrical conductivity values close to the values of the intended application solution.

Conducitivity

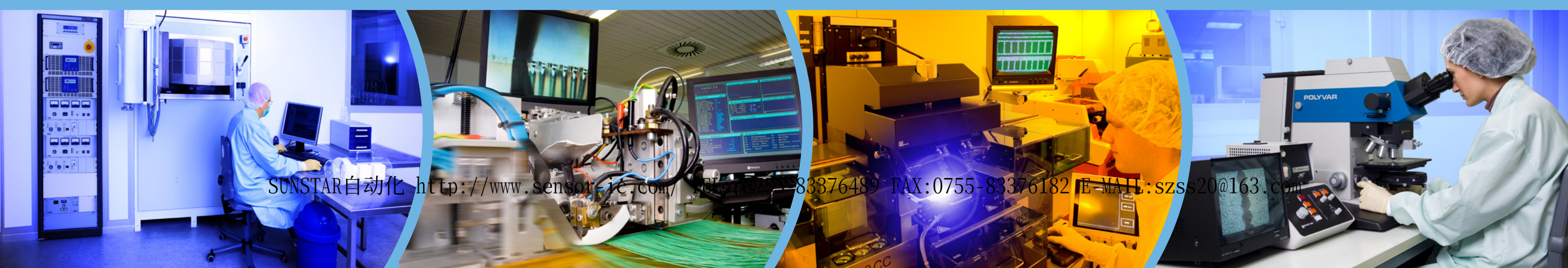
$$R = \frac{l}{\kappa * A}$$

$$\Rightarrow \kappa = \frac{l}{R * A}$$

κ = electrical conductivity
l = length
A = area



Cell constant is influenced by
- Boundary effects
- Planar geometry of chip layout



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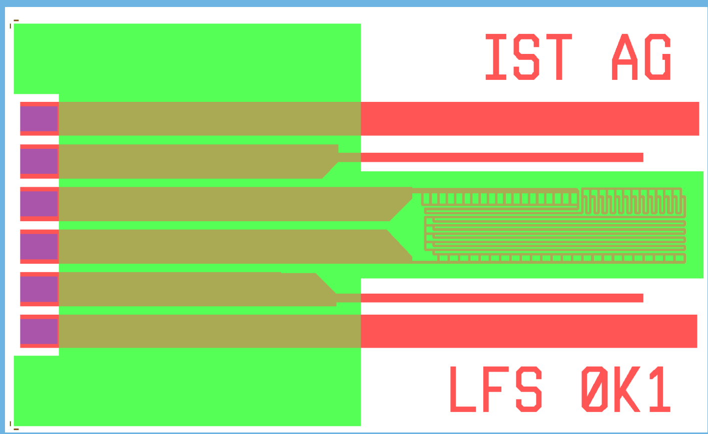
Basic layout: 4 electrodes linear



Key parameters for customer specific designs

- Measurement liquid characteristics (stability of platinum electrodes)
  - Customer testing mostly required
  - Samples can be provided

- Measurement range (cell constant)
  - Can be adjusted by the geometry of the electrodes

- Read-out
  - Recommendation: AC 300 – 3000 Hz, 1.6 V_{pp} or less

- Assembly method
  - Encapsulated wires and fixation

- Customer expectations
  - Only chip
  - Assembly
  - Electrical read-out (under development)

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