1. General introduction

This instruction manual provides information for the installation and use of the SM23-Series Sodium sensitive (pNa) electrodes. This sensor is suitable for long term, reliable Sodium ion monitoring, as well as several other cations. Despite the name “Sodium sensor”, the most common application of the SM23 is pH measurement. In this application, the SM23 is used as a reference electrode – dramatically improving measurement reliability in many demanding applications. Typical applications for the SM23 are found in industrial process control.

Features

- “All glass” construction.
- Dimensions and design meet the requirements of DIN 19263
- Isothermal point of intersection: pNa = 0 (nominal value at 0 mV).
- Maximum pressure 1000 kPa (10 bar).
- Metal foil screening.
- Fast responding (ball shaped), and heavy-duty (dome shaped) membranes

1.1 Type coding

Model	Suffix code	Desecription
SM23		Sodium (pNa) sensor
Sensor configuration	-AN4	Shockproof (bulb)
	-AN6	Heavy duty (dome)

1.2 General Specifications

Operating range

pNa range	<0 to 4
pH range	pH > pNa+2
Na+ range	0.0001M -saturation
Temperature	0 - 100°C
Pressure	0 - 10 bar

General Model SM23-AN4:

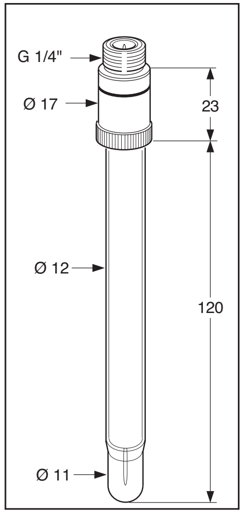
Glass impedance (25°C)	100 - 300MΩ
Sensor tip	Ball shaped, Shock proof
Reference system	Ag/AgCl, 1m NaCl
Connector	Yokogawa CAP

General Model SM23-AN6:

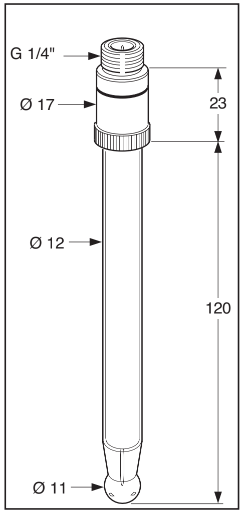
Glass impedance (25°C)	450 - 700 MΩ
Application	Heavy duty
Sensor tip	Dome shaped
Reference system	Ag/AgCl, 1m NaCl
Connector	Yokogawa CAP

1.3 Sensor dimensions

SM23-AN4



SM23-AN6



1.4 **Sensitivity to Li+, K+ and H+ ions**

The SM23 is comparable to conventional glass pH electrodes. The SM23 is 100 times more sensitive for H3O+ ions than for Na+ ions. This means that an accurate pNa reading is obtained when the pH is 2 units higher than the pNa value. The SM23 also shows sensitivity to other cations, i.e. Li+, K+, and H+ (ref Figure 1). There is no sensitivity to multivalent cations, such as Mg2+ or Ca2+.

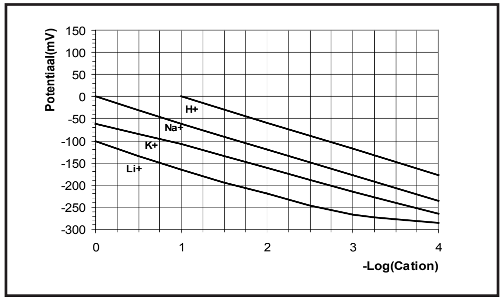


Figure 1: SM23 sensitivity to monovalent cations

1.5 Minimal cation concentration

For a fast responding electrode, a small amount of Na+ ions needs to be present in the process solution. The minimum required Na+ concentration for the SM23 is 0.0001M (pNa = 4), which is equivalent to 5.8mg NaCl per liter.

2. User instructions

2.1 Sensor preparation

For accurate measurement, a gel layer must be formed on the glass membrane surface. For this reason the ion sensitive part of the electrode should be soaked for 24 hours before the electrode is used. When an electrode has been stored dry and you need to use it immediately (there is no time for soaking), you may do so, but as a result initial regular re-calibration will be required until the gel layer is formed.

When dispatched, the SM23 has a protective cap filled with 0.1 molar NaCl solution around the membrane. This ensures that the sensor can be used immediately after delivery.

Note: When polar solvents are used for special cleaning purposes, it is necessary to soak the electrode for some time after cleaning as the polar solvent influences the gel layer. When an a-polar solvent is used (benzin, ether, toluene) follow up treatment with a polar solvent (methanol, aceton) and soaking is necessary.

2.2 Regular calibration

The pNa sensor may change its measuring characteristics during its economical lifetime and should therefore be recalibrated periodically just like any pH sensor.

2.3 Electrical isolation

Since the electrical resistance of the glass electrode is extremely high it is necessary to guarantee a high insulation between measuring electrode and screening. This requires a dry and clean connector before fitting and in addition, the connection to the electrode must be made by means of the correct electrode cable. When a connection box is used this must also be dry and clean. The SM23 sensor must be connected to a high impedance input of the measuring analyzer. The input specification must be > $10^{12}\Omega$.

3. SM23 as a Sodium sensor

The method, using the SM23 for measuring the Sodium ion concentration (pNa) is very similar to conventional pH measurement. The standard Yokogawa pH analyzer measures the signal from the SM23 against a reference electrode with liquid junction.

Note: Sodium measurement is not a standard setting on Yokogawa analyzers. When the display shows pH, the user must read pNa. The ITP must be set to 0.

3.1 Measurement Calibration

Calibration of the pNa analyzer is similar to conventional pH analyzers calibration, with the exception that now Sodium calibration solutions are used instead of pH buffer solutions. These calibration solutions are commercially available, but are also easy to produce.

Buffer solutions

Prod. No.	Description
K1520BG	Buffer Solution PH 2 + PNA 0
K1520BH	Buffer Solution PH 4 + PNA 0
K1520BJ	Buffer Solution PH 7 + PNA 0
K1520BK	Buffer Solution PH 9 + PNA 0
K1520BF	Buffer Solution PH 4/7/9 + PNA 0

Sodium salt* in demi water	Molarity	pNa (-log Na+)
58.44g NaCl/l	1	0
5.844g NaCl/l	0.1	1
584.4mg NaCl/l	0.01	2
58.44mg NaCl/l	0.001	3
5.84mg NaCl/l	0.0001	4

* Use high purity salt (p.a. 99.9%)

The calibration must be done following the instructions for MANUAL CALIBRATION in the EXA analyzer.

3.2 Temperature Compensation

The slope of the pNa sensor has a temperature dependency. This is conforming the Nernst formula, the same as to a standard pH sensor. So, the pH analyzer takes care of the correct temperature.

4. SM23 as reference electrode

In pH measurement the function of the reference cell is to supply a mV signal that is not influenced by pH changes. Conventional reference cells have a metal/insoluble metal salt and a salt solution that is in open electrolytic contact with the process solution. The diffusion potentials that can build up across the liquid junction and the possible poisoning of the reference element by diffusion from the process make the reference cell to contribute to 80-90% of the maintenance troubles of a pH measurement.

In many applications the salt content of the process does not change drastically over time. In that case the Cation sensitive SM23 sensor can be used as reference cell of the pH measurement, thus eliminating 80-90% of the necessary maintenance. In this application an analyzer with dual high impedance inputs is required.

Fluctuations in the Na+ concentration have a limited effect on the stability of the pH reading – allowing the SM23 to be used in many process control applications. For example: an increase of ~23% in Na+ concentration produces a pH offset of 0.1.

Note: It is important to remember that the Sodium sensor has a sensitivity to H+ ions. The usable range (ref. Figure 2) indicates the area where the influence of H+ on the output of the SM23 is neglectable. Also a minimal Na+ concentration of 0.0001M is required to guarantee a fast response of the SM23.

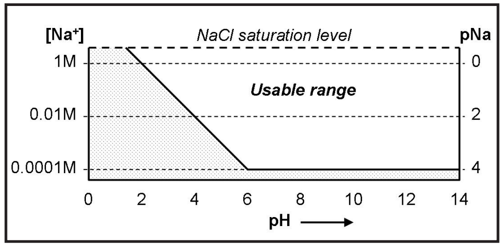


Figure 2: Application range for the SM23 as a reference electrode in pH measurement

Note that at high-pH and low-pNa (high Sodium ion concentration), the output of the pH electrode will be affected by interference from Na+ ions, i.e. the Sodium error (or Alkaline error). This area is not indicated in Figure 2.

4.1 Measurement Calibration

Calibration of the pH loop is similar to conventional pH analyzers calibration but not the same.
The reference sensor responds to salt content changes, so both pH buffers must have the same salt concentration to calibrate for ASYMMETRY POTENTIAL and SLOPE.
Recipes of such salt adjusted pH buffers can be found on http://www.liv.ac.uk/buffers/

The calibrated ASYMMETRY POTENTIAL is only valid for the process measurement if the buffers have the same salt content as the process.

Pragmatic calibration

Use the pH analyzer in default settings:
ITP= 7 pH, ASY= 0 mV and SLOPE= 100%.

- Immerse the sensor in buffer 7 and adjust the pH reading to the value of the buffer.
- Immerse the sensor in buffer 4 and record the pH reading. If this is in between 3.5 and 4.5 pH, then proceed to the next step.
- Mount the sensor in the process and record the pH reading when stable. Pull a sample from the process and measure the pH with a off-line pH meter, e.g. PH71 or PH72. Adjust the pH reading of the in-line pH analyzer to this value using MANUAL CALIBRATION method.

True calibration

Prepare buffer solutions with the same ionic strength as the process.
Calculate the ITP of the sensor in the process solution. This value is the 7 pNa. Program this value in the pH analyzer.

- Immerse the sensor in buffer 7 and adjust the pH reading to the value of the buffer.
- Immerse the sensor in buffer 4 and adjust the pH reading to the value of the buffer.
- Mount the sensor in the process and record the pH reading when stable. Pull a sample from the process and measure the pH with a off-line pH meter, e.g. PH71 or PH72. Adjust the pH reading of the in-line pH analyzer to this value using MANUAL CALIBRATION method.

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Yokogawa has an extensive sales and distribution network.
Please refer to the European website (www.yokogawa.com/eu) to contact your nearest representative.

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User Manual

SM23
Sodium Sensor

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