1. PREFACE

1.1 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 salt sensitive reference electrode – dramatically improving measurement reliability in many demanding applications. Typical applications for the SM23 are found in industrial process control.

1.2 Unpacking and Checking

Upon delivery, unpack the sensor carefully and inspect it to ensure it was not damaged during shipment. If damage is found, retain the original packing materials and then immediately notify the carrier and the relevant Yokogawa sales office.
Make sure the Model Code and Serial Number on the sensor are the same as on the packing list. Also, check any option(s) that were ordered are included and correct.

1.3 Warranty and Service

Yokogawa products and parts are guaranteed free from defects in workmanship and material under normal use and service for a period of (typically) 12 months from the date of shipment from the manufacturer. Individual sales organizations can deviate from the typical warranty period, and the conditions of sale relating to the original purchase order should be consulted.
Damage caused by wear and tear, inadequate maintenance, corrosion, or by the effects of chemical processes are excluded from this warranty coverage. In the event of warranty claim, the defective goods should be sent (freight paid) to the Service Department of the relevant sales Organization for repair or replacement (at Yokogawa's discretion).

The following information must be included in the letter accompanying the returned goods:
- Model Code and Serial Number.
- Original Purchase Order and Date.
- Length of time in service and description of the process.
- Description of the fault and circumstances of the failure.
- Process/environmental conditions that may be related to the failure of the sensor
- Statement as to whether warranty or non-warranty service is requested.
- Complete shipping and billing instructions for return of material, plus the name and phone number of a contact person that can be reached for further information.
- Clean Statement

Returned goods that have been in contact with process fluids must be decontaminated and disinfected prior to shipment. Goods should carry a certificate to this effect, for the health and safety of our employees. Material Safety Data sheets must be included for all components of the process to which the sensor(options) have been exposed.

1.4 Serial number

The Serial number is defined by nine (9) alphanumeric characters:

X_1X_2	Production location
X_3X_4	Year/Month code
$X_5X_6X_7X_8X_9$	Tracking number

Example: N3T500034

Table 1: Production Year

Year	Year code
2023	Z
2024	1
2025	2
2026	3
2027	4
2028	5
2029	6
2030	7
2031	8
2032	9
2033	A
2034	B

Table 2: Month code

Month	Month code
January	1
February	2
March	3
April	4
May	5
June	6
July	7
August	8
September	9
October	A
November	B
December	C

2. General specifications

The specifications for the sensor are clearly shown on the type plate attached to the electrode cap. For detailed specification please download GS 12B06J07-20EN-P.

2.1. Sensitivity to Li^+, K^+, Na^+, Mg^{2+}, Ca^{2+} 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^+, Na^+ and H^+ (ref Figure 1). There is less sensitivity to multivalent cations, such as Mg^{2+} or Ca^{2+}.

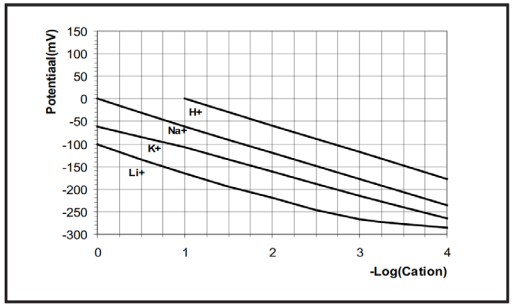

Fig.1. SM23 sensitivity to monovalent cations

2.2. 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.

3. Installation

3.1. 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.

3.2 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} Ω.

4. 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.

4.1 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.
The calibration must be done following the instructions for MANUAL CALIBRATION in the FLXA analyzer.

4.2 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.

5. 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.

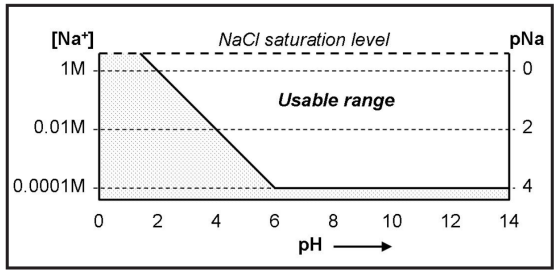

Fig.2. Application range for the SM23 as a reference electrode in pH measurement

5.1 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.

6. Mounting

The electrode must be fitted with an electrode cable (type WU20-PC..). For the pH electrode please mark with a red strip.
The mounting of an electrode in a fitting should be carried out as shown in the example figure 4 or 5.
The electrode fits any Yokogawa cable fitted with the standard nut of which the dimensions are shown in figure 3. The nut can be ordered under part number K1500DW.

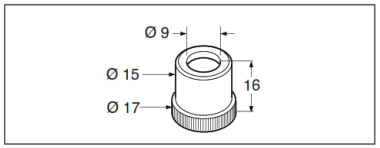

Fig.3. K1500DW (set of 12 cable nuts)

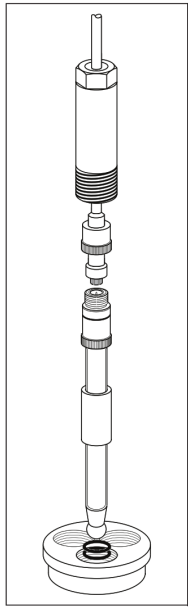

Fig. 4. With mounting set FP20-R12, FP20-S12

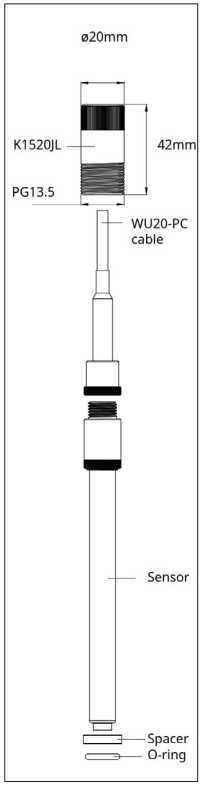

Fig 5. Mounting PG13.5 for Y-CAP sensors

7. Dimensions

For electrode dimensions refer to figure 6 or data in GS 12B06J07-20EN-P

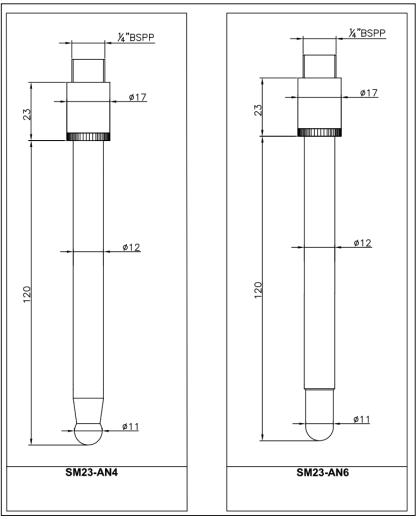

Fig.6. SM23 dimensions

8. Spare parts

Spare parts are listed in table 3.

Table 3: Sodium sensitive electrodes spare part list

Part number	Description
K1520BF	Buffer Solution pH4/7/9+pNa 0 (3x 0.5L)
K1520BG	Buffer Solution pH 2 + pNa 0 (3x 0.5L)
K1520BH	Buffer Solution pH 4 + pNa 0 (3x 0.5L)
K1520BJ	Buffer Solution pH 7 + pNa 0 (3x 0.5L)
K1520BK	Buffer Solution pH 9 + pNa 0 (3x 0.5L)
K1520JL	ADAPTER Y-CAP - PG13.5 SS
K1523JA	Adapter PG13.5 in F*40 PPO
K1523JB	Adapter PG13.5 to ¾"NPT PPO
K1523JC	Adapter PG13.5-sensors in F*40 SS
K1523JD	Adapter PG13.5 to ¾" NPT SS
K1524AA	O-RING SIL. 10.77x2.62&SLIDE RING (1PC)
K1598AC	Flow fitting (3.1), for SC4A

6. Regulatory compliance

CE

YOKOGAWA

EU DECLARATION OF CONFORMITY

We: **Yokogawa Process Analyzers Europe B.V.**
Euroweg 2, 3825 HD Amersfoort
The Netherlands

Herewith declare under our sole responsibility that the products, model: **SM21, SM21D and SM23**

further specified with model suffix- and option codes: **As listed in Annex-1 in this document**

is manufactured in accordance with the requirements for CE-marking of products as stated in EC Decision:

768/2008/EC on a common framework for the marketing of products

by applying the following standards:

EN-ISO 9001: 2015 Quality management systems - Requirements

Subject product is:
- Produced according to appropriate quality control procedures.
- In compliance with the essential requirements of the specific product legislation:

- **Pressure Equipment** **Directive 2014/68/EU (PED)**
by applying Article 4.3: Sound Engineering Practice

- **RoHS** **Directive 2011/65/EU**
Commission Delegated Directive (EU) 2015/863 amending Annex II as regards the list of restricted substances, by applying the following standards:
EN-IEC 63000: 2018 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.

The CE-mark has been affixed on the product in 2019 for the first time.

If applicable, the product is checked against the latest official released revision of the standards mentioned above; differences do not affect the certified product identified on this declaration.

Amersfoort – November 14, 2022

S. Kiyono
General Manager
Yokogawa Process Analyzers Europe B.V.

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Annex-1

Model	Suffix Code	Option code	Description
SM21			
	-AG2		Meas. pH, gen. purp
	-AG4		Meas. pH, shockproof
	-AG6		Meas. pH, heavy duty
	-AL4		Meas. pH, shockproof, H.temp.
	-AL6		Meas. pH, heavy duty, H.temp.
	-AS4		Meas. pH, shockproof, low R
	-AS6		Meas. pH, heavy duty, low R

Model	Suffix Code	Option code	Description
SM21D			
	-AG4		Meas. pH, shockproof
	-AG6		Meas. pH, heavy duty
	-AL4		Meas. pH, shockproof, H.temp.
	-AL6		Meas. pH, heavy duty, H.temp.

Model	Suffix Code	Option code	Description
SM23			Ion selective sensor
	-AN4		Sodium sensitive (pNa)
	-AN6		Sodium sensitive (pNa) Heavy duty

UK CA

YOKOGAWA

EU DECLARATION OF CONFORMITY

We:

Manufacturer:
Yokogawa Process Analyzers Europe B.V.
Euroweg 2, 3825 HD Amersfoort
The Netherlands

Importer:
Yokogawa UK Ltd.
17 Stuart Road, Runcorn WA7 1TR
United Kingdom

Herewith declare under our sole responsibility that the products, model: **SM21, SM21D and SM23**

further specified with model suffix- and option codes: **As listed in Annex-1 in this document**

is manufactured/imported in accordance with the requirements for CE-marking of products by applying the following standards:

EN-ISO 9001: 2015 Quality management systems - Requirements

Subject product is:
- Produced according to appropriate quality control procedures.
- In compliance with the essential requirements of the specific product legislation:

- **Pressure Equipment** **Pressure Equipment (Safety) Regulation 2016**
by applying Article 8: Sound Engineering Practice

- **RoHS** **The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012**

The UKCA-mark has been affixed on the product in 2022 for the first time.

If applicable, the product is checked against the latest official released revision of the standards mentioned above; differences do not affect the certified product identified on this declaration.

Amersfoort – November 14, 2022

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General Manager
Yokogawa Process Analyzers Europe B.V.

Instruction Manual

SC21, SC25V, SC25F, SC29, SM21, SM23,
SM60, SR20, FU20, FU20F, FU24, FU24F, PH21

Protection of Environment (Use in China)

This manual is valid only in China.

产品中有害物质的名称及含量

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
传感器	×	○	○	○	○	○
电缆	×	○	○	○	○	○

○：表示该有害物质在该部件中所有均质材料中的含有量都在GB/T26572所规定的限量要求以下。
×：表示该有害物质至少在该部件的某一均质材料中的含有量超出 GB/T26572 所规定的限量要求。

环保使用期限：这个标志是基于SJ/T11364，在中国（不包括台湾，香港，澳门）贩售的电子电器产品所适用的环保使用期限。
只要遵守产品上关于安全及使用上的注意事项，从制造之日起计算在该年限内，不会发生制品内的有害物质外泄，突然变异，对环境或人体以及财产产生重大影响的情况。
（注） 该年限是《环境保护使用期限》，不是产品的保质期限。
另外，关于替换部件的推荐替换周期，请阅读使用说明书。

Production date

关于生产日期

生产日期在产品铭牌上9位数的序列号中，用以下形式表示生产日期。

从左数第3位数：生产年份

R:2015，S:2016，T:2017，U:2018，V:2019，W:2020，X:2021，Y:2022，Z:2023，
1:2024，2:2025，3:2026，…

从左数第4位数：生产月份

1：1月，2：2月，3：3月，…，9：9月，A：10月，B：11月，C：12月
（示例）N3S700001：2016 年 7 月

Subject to change without notice

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User Manual

Directions for use SM23 Sodium Sensor

YOKOGAWA

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