

**Model SC4AJ
Conductivity Sensor**

IM 12D08F03-02E

◆ Introduction

Thank you for purchasing our inductive conductivity measurement system.

This manual describes the method of installing for the SC4AJ.

To ensure that this measurement system can be operated safely and also exhibit its full performance, be sure to read this manual before use.

This manual does not describe the units in Table shown below which are the component units of the conductivity measuring system. Each of these units comes with an instruction manual, so read the applicable manuals for details of the units concerned.

Manual Name		IM No.
FLXA202, FLXA21	2-Wire Analyzer	IM 12A01A02-01E
FLXA402	4-Wire Converter	IM 12A01F01-02EN IM 12A01F03-01EN etc.
SC450G	Conductivity Converter	IM 12D08N05-01E
SA11	SA11 Smart Adapter	IM 12A06S01-00EN-P

Upon delivery, unpack the instrument carefully and inspect it to ensure that it was not damaged during shipment. If damage is found, retain the original packing materials (including the outer box) and then immediately notify the carrier and the relevant YOKOGAWA sales office.

Make sure the model code on the label affixed to the cable agrees with your order. For the meaning of the model code, refer to the Model and Suffix code table (Section 2.2).

◆ For the safe use of this equipment

■ Safety, Protection, and Modification of the Product

- In order to protect the system controlled by the product and the product itself and ensure safe operation, observe the safety precautions described in this user's manual. We assume no liability for safety if users fail to observe these instructions when operating the product.
- If this instrument is used in a manner not specified in this user's manual, the protection provided by this instrument may be impaired.
- Be sure to use the spare parts approved by Yokogawa Electric Corporation (hereafter simply referred to as YOKOGAWA) when replacing parts or consumables.
- Modification of the product is strictly prohibited.
- The following symbols are used in the product and user's manual to indicate that there are precautions for safety:

■ Notes on Handling User's Manuals

- Please hand over the user's manuals to your end users so that they can keep the user's manuals on hand for convenient reference.
- Please read the information thoroughly before using the product.
- The purpose of these user's manuals is not to warrant that the product is well suited to any particular purpose but rather to describe the functional details of the product.
- No part of the user's manuals may be transferred or reproduced without prior written consent from YOKOGAWA.
- YOKOGAWA reserves the right to make improvements in the user's manuals and product at any time, without notice or obligation.
- If you have any questions, or you find mistakes or omissions in the user's manuals, please contact our sales representative or your local distributor.

■ Warning and Disclaimer

The product is provided on an "as is" basis. YOKOGAWA shall have neither liability nor responsibility to any person or entity with respect to any direct or indirect loss or damage arising from using the product or any defect of the product that YOKOGAWA can not predict in advance.

■ Compliance with the simple apparatus requirements

SC4AJ meet the simple apparatus requirements defined in the following standards.

Note: TIS certified types cannot be connected.

Use the sensors under the conditions of use required by the standards.

Applicable standards:

ANSI/ISA-60079-11 (2014)

ANSI/ISA-60079-0 (2009)

CAN/CSA-C22.2 NO. 60079-11:14

CAN/CSA-C22.2 NO. 60079-0:11

방호장치 의무안전인증 고시

GB 3836.4-2010

Conditions of use:

- (1) Use in combination with an internally isolated transmitter, or use with, a transmitter in combination with isolated barrier.

The FLXA202/FLXA21 is internally isolated.

- (2) Upper limit of the process temperature.

The upper limit of process temperature is indicated below when the sensor is used in combination with a YOKOGAWA transmitter.

For FLXA202/FLXA21, model and suffix code below is available.

FLXA21-D-□-D-◇-C1-○-A-N-LA-N-NN

- : can be any value.
- ◇: must be EA, CD, CH, or EG.
- : must be NN or C1.
- Any option code is available.

FLXA202-D-□-D-◇-C1-○-A-N-LA-N-NN

- : can be any value.
- ◇: must be CD, CH, or CG.
- : must be NN or C1.
- Any option code is available

Upper limit of process temperature on the SC4AJ

Transmitter used in combination Ambient temperature Ta Temperature class	FLXA21	
	40°C	60°C
T6	49	49
T5	95 (*1)	64
T4	110	99
T3	110	110
T2	110	110
T1	110	110

*1: Care about upper limit 100°C of temperature class T5 should be taken.

Other warnings are provided in the following.

 **WARNING**

Handling precautions:

- (1) Potential electrostatic charging hazard Electrostatic charge may cause an explosion hazard. Avoid any actions that cause the generation of electrostatic charge, e.g., rubbing with a dry cloth.
- (2) IEC60079-14 (Electrical installations in hazardous areas) requires a label indicating 'simple apparatus', stick this label to this sensor if necessary.

■ Symbol Marks

Throughout this user's manual, you will find several different types of symbols are used to identify different sections of text. This section describes these icons.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

CAUTION

Indicates that operating the hardware or software in this manner may damage it or lead to system failure.

NOTE

Draws attention to information essential for understanding the operation and features.

■ Trademark policy

FLXA is a registered trademark of Yokogawa Electric Corporation.

All other company and product names mentioned in this user's manual are trademarks or registered trademarks of their respective companies.

We do not use TM or ® mark to indicate those trademarks or registered trademarks in this user's manual.

◆ After-sales Warranty

- **Do not modify the product.**

- **During the warranty period, for repair under warranty consult the local sales representative or service office. Yokogawa will replace or repair any damaged parts. Before consulting for repair under warranty, provide us with the model name and serial number and a description of the problem. Any diagrams or data explaining the problem would also be appreciated.**
 - If we replace the product with a new one, we won't provide you with a repair report.
 - Yokogawa warrants the product for the period stated in the pre-purchase quotation. Yokogawa shall conduct defined warranty service based on its standard. When the customer site is located outside of the service area, a fee for dispatching the maintenance engineer will be charged to the customer.

- **In the following cases, customer will be charged repair fee regardless of warranty period.**
 - Failure of components which are out of scope of warranty stated in instruction manual.
 - Failure caused by usage of software, hardware or auxiliary equipment, which Yokogawa Electric did not supply.
 - Failure due to improper or insufficient maintenance by user.
 - Failure due to modification, misuse or outside-of-specifications operation which Yokogawa does not authorize.
 - Failure due to power supply (voltage, frequency) being outside specifications or abnormal.
 - Failure caused by any usage out of scope of recommended usage.
 - Any damage from fire, earthquake, storms and floods, lightning, disturbances, riots, warfare, radiation and other natural changes.

- **Yokogawa does not warrant conformance with the specific application at the user site. Yokogawa will not bear direct/indirect responsibility for damage due to a specific application.**

- **Yokogawa Electric will not bear responsibility when the user configures the product into systems or resells the product.**

- **Maintenance service and supplying repair parts will be covered for five years after the production ends. For repair for this product, please contact the nearest sales office described in this instruction manual.**

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Model SC4AJ Conductivity Sensor

IM 12D08F03-02E 11th Edition

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1. General

The SC4AJ is developed with the intention for the low conductivity applications found in the semiconductor, power, and pharmaceutical industries. The SC4AJ is in a convenient compact style.

The cell has been made available with either a titanium or stainless steel electrode. The electrode is the 2-electrode system with cell constants of 0.02 cm^{-1} or 0.10 cm^{-1} , and with a fixed cable 3 to 20 meters in length. In response to customer demands, a variety of fittings for SC4AJ are also available.

2. Specifications

2.1 Standard Specifications

Cable with pin terminals (applicable to FLXA202, FLXA21, FLXA402)

Cable with M3 ring terminals (applicable to FLXA402, SC450G)

Cable with M4 ring terminals (applicable to FLXA202, FLXA21)

Variopin connector (applicable to SA11)

Object of measurement:	Conductivity of solutions
Measuring principle:	Two-electrode system
Cell constant:	0.02 cm ⁻¹ , 0.1 cm ⁻¹

Measuring range:

For a cell constant: 0.02 cm⁻¹: 0-0.5 μS/cm to 0-200 μS/cm

For a cell constant: 0.1 cm⁻¹: 0-5 μS/cm to 1 mS/cm

Temperature Range: For electrode, 0 to 110°C
For holder, see Figure 1

Sterilization for electrode: 135°C (275°F), within 30 minutes in Steam Sterilization

Pressure range : For electrode, 0 to 1 MPa
For holder, see Figure 1

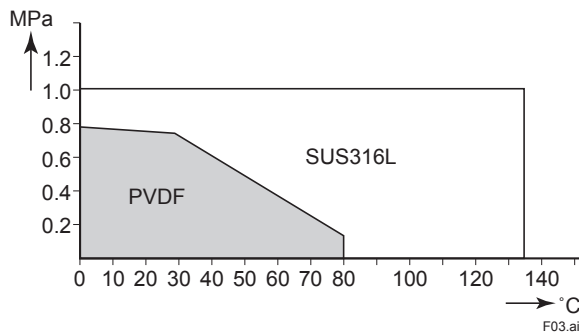


Figure 2.1 The range of tolerance of holders (option: /PS, /PF, /RS, /RF, /SA1, /SA2, /SB1, /SB2, /SC1) for temperature and pressure

Sample solution condition:

Although flow rate is not limited in measurement, air bubbles should not be mixed in the sample solutions to obtain correct measured values.

Temperature sensor: Pt1000

Materials

Body & Electrode: Stainless steel (316L SS) (for all Fitting-type) or Titanium (only for adapter mounting type-AD), Fluoro rubber (FKM) O-ring, EPDM O-ring (for -SA with Variopin)

Mounting adapter: Polyvinylidene difluoride (for /PF and /RF) or Stainless steel (316 SS), Stainless steel (316L SS)

Weight:

Sensors:

Adapter mounting type (SC4AJ-S-AD-09-002-03): approx. 0.3 kg

Adapter mounting type (SC4AJ-S-AD-15-002-03): approx. 0.4 kg

Welding socket type (SC4AJ-S-SA-NN-002-03): approx. 0.5 kg

1 or 1.5 inch welding clamp type (SC4AJ-S-SB-NN-002-03): approx. 0.4 kg

2 inch welding clamp type (SC4AJ-S-SC-NN-002-03): approx. 0.5 kg

Note: There are weight differences among SC4AJ sensors. In order to know the more accurate weight of each type of sensors, please calculate it from following information. The cable weighs 0.07 kg/m. The SC4AJ with 0.02 cm⁻¹ cell constant is 0.02 kg heavier than the SC4AJ with 0.1 cm⁻¹ cell constant. 314L SS electrode is 0.04 kg heavier than Titanium electrode.

Adapters:

3/4NPT stainless steel adapter (/PS): approx. 0.1 kg

R3/4 stainless steel adapter (/RS): approx. 0.1 kg

3/4NPT PVDF adapter (/PF): approx. 0.04 kg

R3/4 PVDF adapter (/RF): approx. 0.04 kg

Straight welding socket (/SA1): approx. 0.3 kg

Angle welding socket 15 (/SA2): approx. 0.3 kg

Welding clamp 1 inch (/SB1): approx. 0.3 kg

Welding clamp 1.5 inch (/SB2): approx. 0.3 kg

Welding clamp 2 inch (/SC1): approx. 0.4 kg **NOTE**

Do not submerge the sensor itself in process water, as the seams between the mold and the metal of the sensor are not waterproof.

2.2 Model and Suffix Codes

Model	Suffix Code	Option Code	Description
SC4AJ	.....	.....	Conductivity sensor
Material	-T -S	.....	Titanium (Only for -AD) 316L SS
Fitting type	-AD -SA -SB -SC	.....	Adapter mounting type Welding socket type (*1) 1 or 1.5 inch welding clamp type (*2) 2 inch welding clamp type (*2)
Sensor length	-09 -15 -NN	.....	9 cm (Code for -AD) 15 cm (Code for -AD) fixed length (Code for -SA, -SB, -SC)
Cell constant	-002 -010	.....	0.02 cm ⁻¹ 0.1 cm ⁻¹
Cable length	-03 -05 -10 -15 -20 -X1 -X2 -X3 -X4 -X5 -Y1 -Y2 -Y3 -Y4 -Y5 -VS	.....	3 m (pin terminals) 5 m (pin terminals) 10 m (pin terminals) 15 m (pin terminals) 20 m (pin terminals) 3 m (M4 ring terminals) (*4) 5 m (M4 ring terminals) (*4) 10 m (M4 ring terminals) (*4) 15 m (M4 ring terminals) (*4) 20 m (M4 ring terminals) (*4) 3 m (M3 ring terminals) (*5) 5 m (M3 ring terminals) (*5) 10 m (M3 ring terminals) (*5) 15 m (M3 ring terminals) (*5) 20 m (M3 ring terminals) (*5) Variopin connector (*6)
Temperature sensor	-T1	.....	Pt1000
Option	For AD only For SA only For SB only For SC only Oil prohibit	/PS /PF /RS /RF /SA1 /SA2 /SB1 /SB2 /SC1 /DG1	3/4NPT adapter 316 SS 3/4NPT adapter PVDF R3/4 adapter 316 SS R3/4 adapter PVDF Straight welding socket 316L SS Angled welding socket 15° 316L SS Welding clamp 1 inch 316L SS Welding clamp 1.5 inch 316L SS Welding clamp 2 inch 316L SS Oil-prohibited use (*3)

- *1: When you select Fitting type -SA, place an order on the SC4AJ with Option code /SA1 or /SA2.
- *2: When you select Fitting type -SB, place an order on the SC4AJ with Option code /SB1 or /SB2 (including seal ring),
When you select Fitting type -SC, place an order on the SC4AJ with Option code /SC1 (including seal ring).
- *3: Washing treatment of wet part with alcohol.
- *4: Used for connection to FLXA202, FLXA21.
- *5: Used for connection to FLXA402, SC450G.
- *6: Used for connection with SA11. Sensor length -09 is not selectable.

2.3 Converter and analyzer suitable for SC4AJ

FLXA202/FLXA21: 2-Wire Analyzer
 FLXA402: 4-Wire Converter
 SC450G: conductivity converter

Converter \ Type of terminals	Pin	Ring M4	Ring M3
SC450G	(*1)	N.A.	Yes
FLXA402 (:2)	Yes	N.A	Yes
FLXA202/FLXA21	Yes	Yes	N.A.

*1: Both pin and M3 ring can be used, but M3 ring are recommended.

*2: FLXA402 when connected to a SA11 can be connected with sensors equipped with Variopin connector. (SC4A..-VS, SC42-□V, SX42..□V, SC4AJ..-VS, SC8SG..-VS)

SA11 Smart Adapter can connect to Variopin connector.

2.4 Spare parts

The following spare parts are necessary in maintaining SC4AJ or changing the installed place.

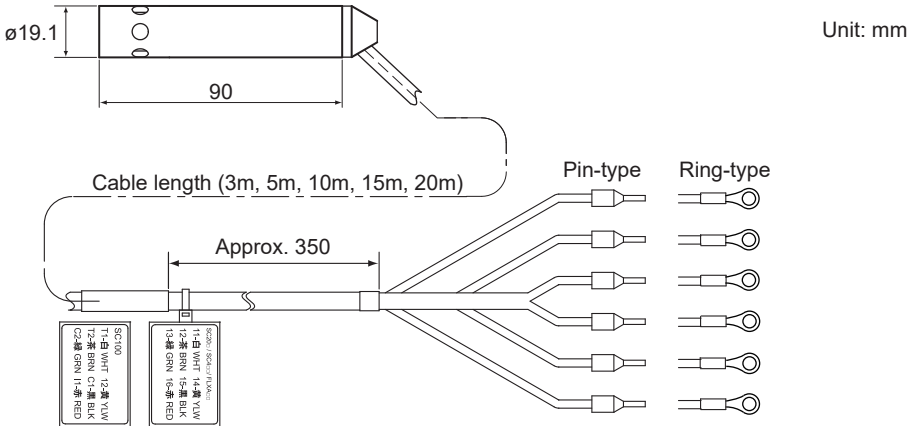
Previously procure the parts related to each conductivity sensor type.

Parts No.	Description
K9670MA	O-ring for -SA (excluding -VS)
K9675VY	O-ring set for -SA (for -VS)
K9670MK	Seal rings for /SB1 or /SB2
K9670MP	Seal rings for /SC1
K9670MT	3/4 NPT Stainless steel adapter for -AD
K9670MU	3/4 NPT PVDF Adapter for -AD
K9670MV	R3/4 Stainless steel adapter for -AD
K9670MW	R3/4 PVDF Adapter for -AD
K9670MD	Angled welding socket and mounting nut for -SA
K9670ME	Staight welding socket for -SA
K9670MB	Angled welding socket for -SA
K9670MC	Straight welding socket for -SA
K9670ML	Welding clamp 1 or 1.5 inch for -SB
K9670MQ	Welding clamp 2 inch for -SC

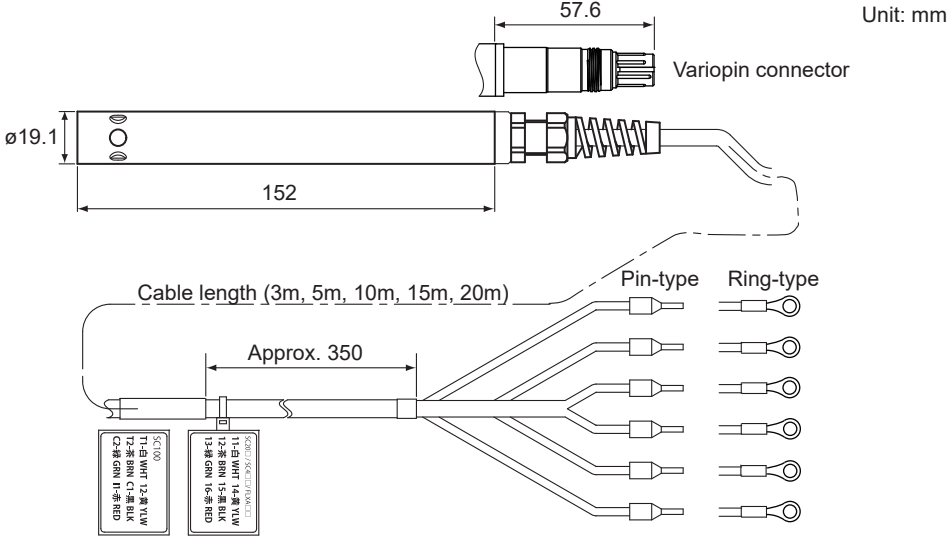
2.5 Drawings and Dimensions

<Adapter mounting type>

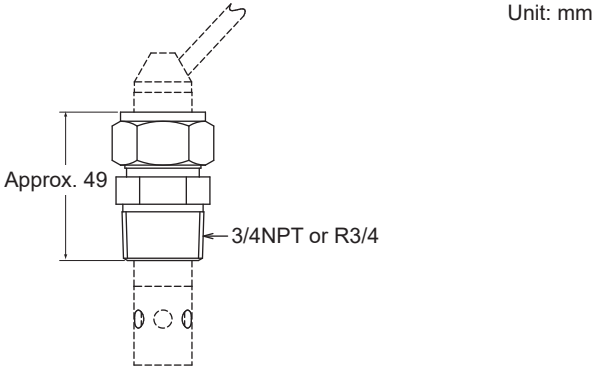
SC4AJ-□-AD-09
Sensor length: 09 (9 cm)



SC4AJ-□-AD-15
Sensor length: 15 (15 cm)



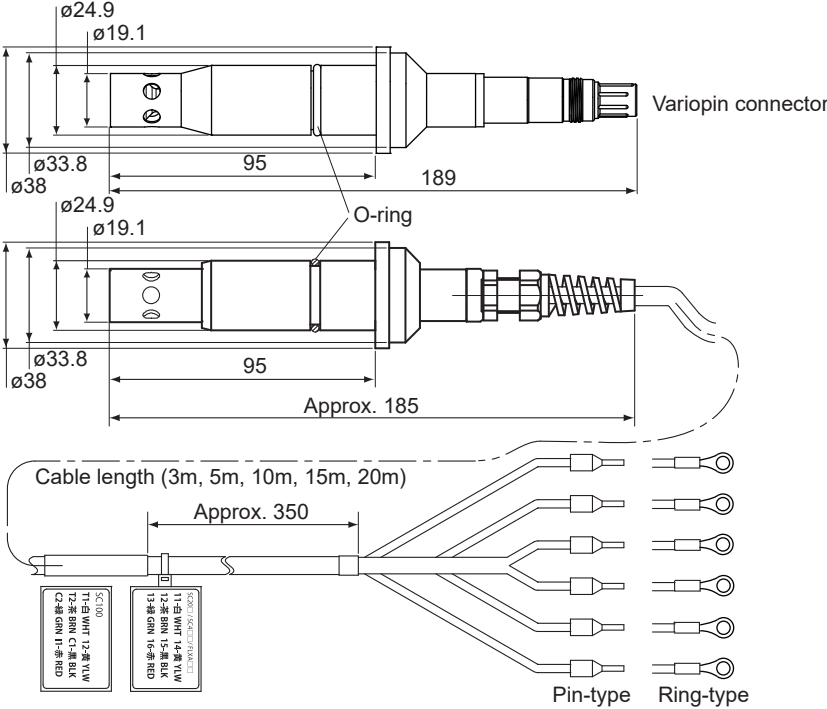
- Option: Adapter mounting type (-AD) /PS (Stainless Steel) /PF (PVDF) /RS (Stainless Steel) /RF (PVDF)



<Welding socket type>

SC4AJ-□-SA-NN

Unit: mm

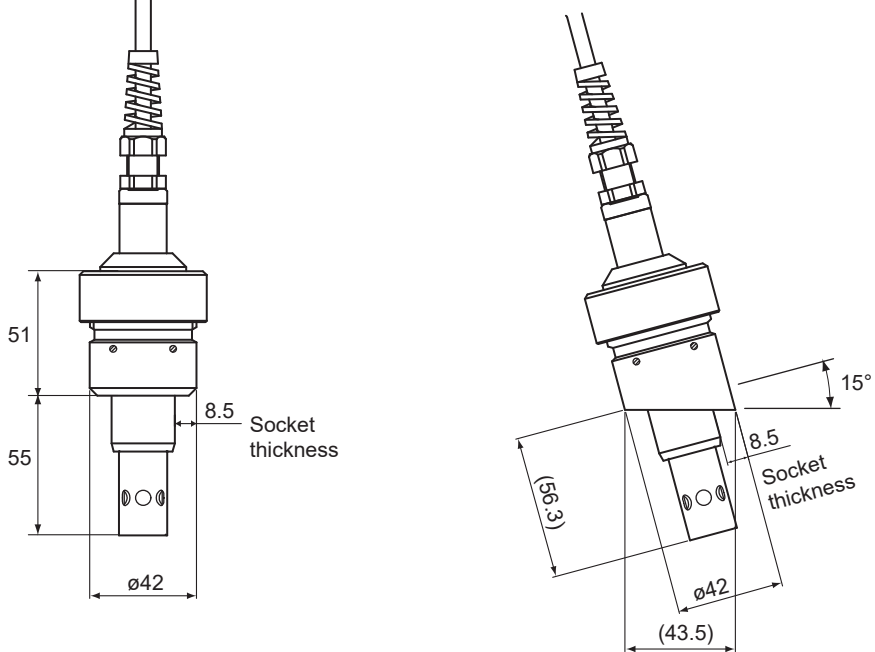


● Option: Welding socket type (-SA)

Straight welding socket: /SA1

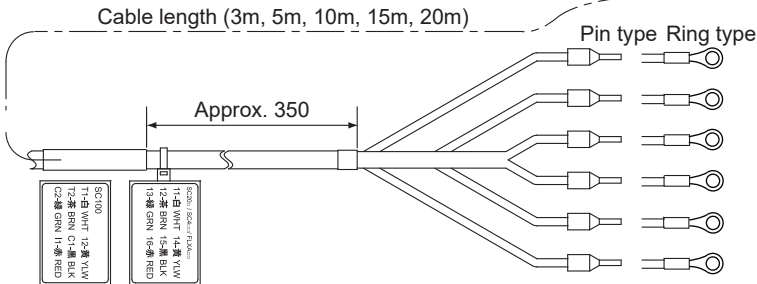
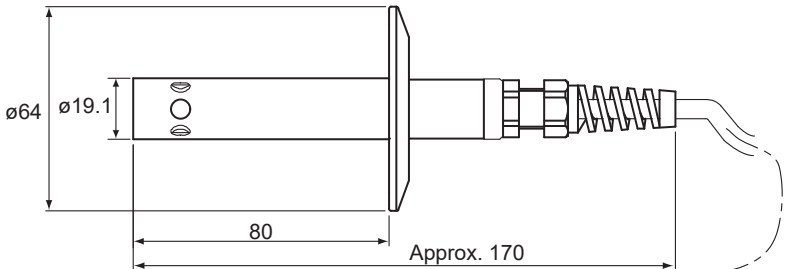
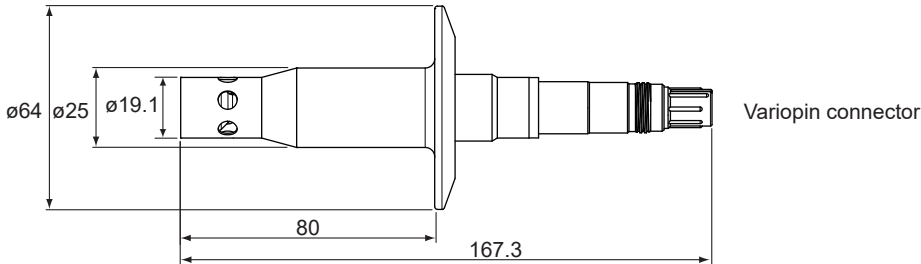
Angled welding socket: /SA2

Unit: mm



Sensor SC4AJ-□-SC-NN

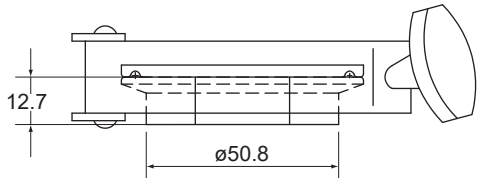
Unit: mm



● Option: Welding clamp type (-SC)

Welding clamp 2 inch: /SC1

Unit: mm



3. Mounting and Wiring

3.1 Mounting

Before mounting an electrode in a process plant environment, the following points should be considered.

- The electrode must be mounted in the process in such a way that the flow through it represents the true composition of the liquid. The flow through the cell should be uninterrupted and the cell should not be mounted at a dead angle.
- A cell must be immersed in the process liquid to a level above the outlet to ensure an uninterrupted liquid path between the electrodes.
- The sensor should be mounted in such a way to allow safe and easy removal for maintenance, and to release the process liquid pressure for the removal.
- Check the process pressure for mounting place is below the pressure range of the SC4AJ and its adapter.
- Do not submerge the sensor itself in process water, as the seams between the mold and the metal of the sensor are not waterproof.

CAUTION

When ultra-pure water flows through plastic pipe, electrostatic charge may be produced. When the sensor is installed on this plastic pipe, the electrostatic charge goes through the sensor, and into a converter circuit through terminals on the converter which is connected to the sensor. This electrostatic charge will discharge and damage electronic parts on the converter circuit.

3.1.1 Adapter mounting type (-AD)

Option code /PS, /RS (material: stainless steel) and /PF, /RF (material: PVDF) are for the adapters special for the Adapter Mounting Type of the SC4AJ. As for their dimensions, refer to section 2.5. Mounting is done by the combination of the sensor with the adapter. Mount the sensor by the correct insertion order of adapter parts according to Figure 3.1.

Note: Screwing the nut by the incorrect order of the parts can cause trouble of the mounting system and sealing defective.

Tighten the nut with a torque of approx. 190 N•m. This corresponds approximately to first tightening with the fingers, then using a spanner or the like to tighten by one and a quarter turns.

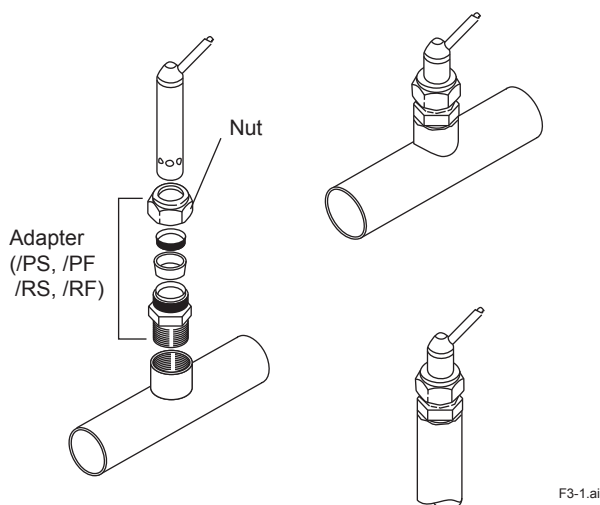


Figure 3.1 Mounted sensor (SC4AJ-AD)

3.1.2 Welding socket type (-SA)

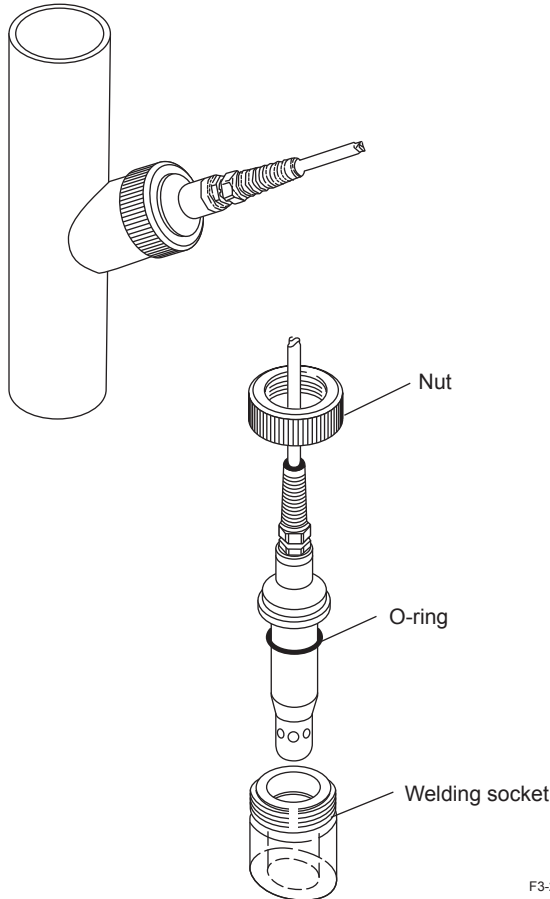
Option code /SA1 and /SA2 are for the adapters special for the Welding Socket Type of the SC4AJ. As for their dimensions, refer to section 2.5.

As shown in Figure 3.2, weld the welding socket to a pipe in which a process liquid flows.

After inserting the SC4AJ sensor into the welding socket, screw the nut with your hand.

Note: Before inserting the sensor, check the following matter.

- The socket is cooled to room temperature after welding is done.
- The O-ring is attached to the sensor.



F3-2.ai

Figure 3.2 Mounting sensor (SC4AJ-SA)

3.1.3 Welding clamp type (-SB, -SC)

Option code /SB1 and /SB2 are for the adapters special for the Welding Socket Type of the SC4AJ (-SB), and /SC1 is for the SC4AJ (-SC). As for their dimensions, refer to section 2.5.

As shown in Figure 3.3, weld the flange to a pipe in which a process liquid flows. Insert the SC4AJ sensor with the seal ring into the flange. Fix the sensor with the clamp.

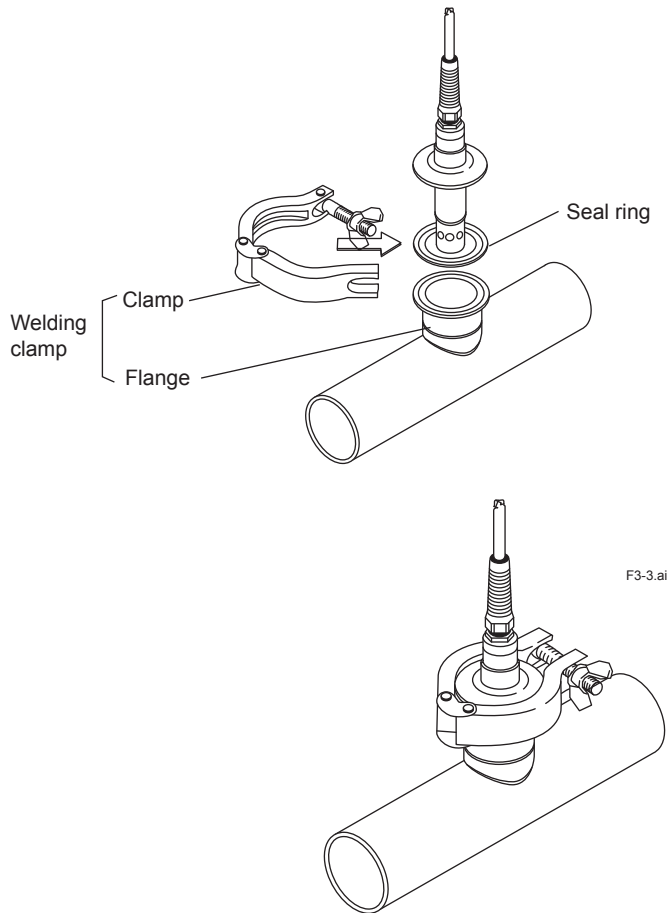
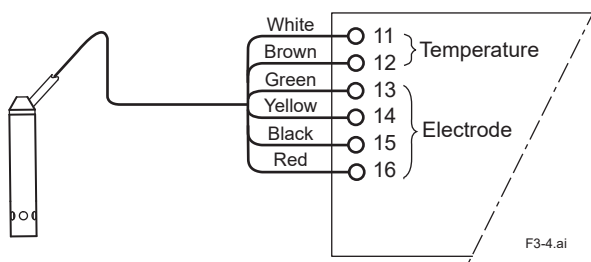


Figure 3.3 Mounted sensor (SC4AJ-SB, -SC)

3.2 Wiring

The conductivity sensor can be used with 2-Wire Analyzer (FLXA202/FLXA21), 4-Wire Converter (FLXA402) or conductivity converter (SC450G).

To connect the sensor and analyzer/converter, simply match the terminal numbers in the analyzer/converter with the identification numbers on the cable ends.



Applicable Converter / Analyzer : FLXA402, SC450G, FLXA202/FLXA21

Figure 3.4 Wiring between SC4AJ and converter/analyzer

For -VS (Variopin connector), SA11 is connected.

4. Operation

Before operation, check following items.

Check that sensor cable connections are correct.

Check that there are no problems in flowing the measured solution.

Check piping connections for measured solution leaks.

Check that pressure and temperature are within the permitted operating ranges.

Check that the solution level reaches the measured solution outlet when the flow of measured solution is started.

4.1 Set of cell constant value

Enter the factory calibrated cell constant value for the converter or the transmitter connected to the SC4AJ.

The factory calibrated cell constant value is labelled on the cable.

As for the procedure of the entry, refer to Instruction Manual of the converter or the transmitter.

4.2 Calibration with a solution of known conductivity

The cell constant is determined in laboratory conditions. It is possible that slight variations in the cell constant may occur dependant on the installation.

This possible error can be corrected by recalibrating with a solution of known conductivity value.

NOTE

The specific conductivity value of the solution of known value must be near the value of the liquid to be measured. Specific conductivity is highly temperature dependent, therefore in the above calibration procedure the temperature of the cell and the liquid should be allowed to equalize and should be accurately measured with a calibrated thermometer.

5. Maintenance

If the cell becomes fouled, an insulating layer may be formed on the electrodes. As the result, an apparent increase in cell constant may occur, giving a measuring error. Check and maintain the sensor in case of an error occurrence.

5.1 Cleaning of the cell

- For lime, hydroxides, etc. : 5 to 10% solution of hydrochloric acid is recommended.
- For organic foul (oil, fats, etc.) : they can be removed with ethyl alcohol or acetone.
- For algae bacteria or moulds : use a chlorinated solution (domestic bleach).
- For normal applications : hot water with domestic washing-up liquid will be effective.

WARNING

Do not mix hydrochloric acid with chlorinated solvents (bleach), otherwise toxic chlorine gas may be generated.

After cleaning, inspect visually to confirm there is no damage or deformation of the cell.

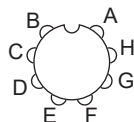
5.2 Confirming sensor abnormality

If there seems any problem on the sensor, fully dry the cell and measure the resistivity between cable terminals with digital multimeter or the like.

When resistivity is out of the range shown below, sensor is in abnormal status. Replace the sensor.

Combination of Terminals		Standard Resistance (room temperature)
Cables (excluding -VS)	Variopin Connector (-VS) *	
11-12	E-F	1000 to 1137 Ω
11-13, 13-15, 12-15	E-C, C-A, F-A	more than 100 MΩ
13-14, 15-16	C-D, A-B	less than 10 Ω

* See the pin number of Variopin connector as shown below.

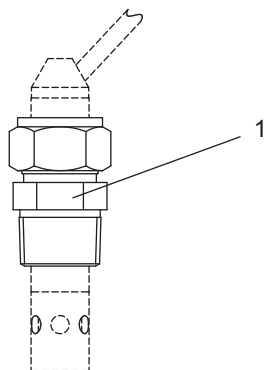


Customer Maintenance Parts List

Model SC4AJ Conductivity Sensor

Adapter

SC4AJ-□-AD-09

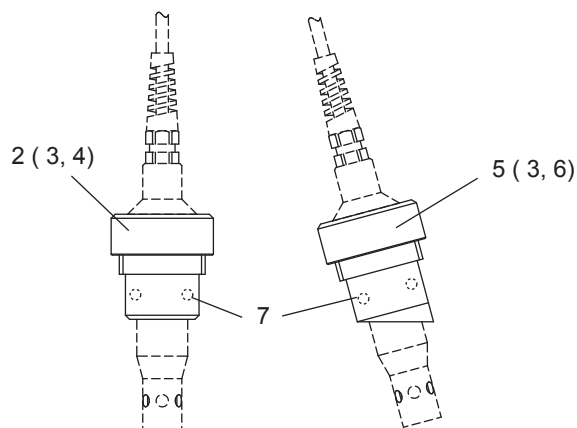


Welding Socket

SC4AJ-□-SA-NN

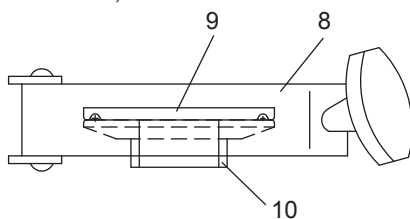
Option code: /SA1

/SA2

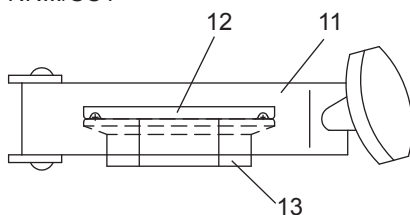


Welding Clamp

SC4AJ-□-SB-NN.../SB1, /SB2



SC4AJ-□-SB-NN.../SC1



<u>Item</u>	<u>Part No.</u>	<u>Qty</u>	<u>Description</u>
1	—		Adapter for suffix code -AD
	K9670MU	1	3/4NPT PVDF adapter
	K9670MT	1	3/4NPT Stainless steel adapter
	K9670MW	1	R3/4 PVDF adapter
	K9670MV	1	R3/4 Stainless steel adapter
2	K9670ME	1	Straight welding socket and mounting nut for /SA1
3	K9670MF	1	Nut
4	K9670MC	1	Socket
5	K9670MD	1	Angled welding socket and mounting nut for /SA2
6	K9670MB	1	Socket
7	K9670MA	1	O-ring
8	K9670ML	1	Welding clamp for /SB1, /SB2
9	K9670MK	1	Seal ring for /SB1, /SB2
10	—		Welding socket
	K9670MM	1	For /SB1
	K9670MN	1	For /SB2
11	K9670MQ	1	Welding clamp for /SC1
12	K9670MP	1	Seal ring for /SC1
13	K9670MR	1	Welding socket for /SC1

Revision Information

- Title : Model SC4AJ Conductivity Sensor
- Manual No. : IM 12D08F03-02E

Jan. 2021/11th Edition

Correction of drawing dimensions errors in SC4AJ-□-SB-NN. (P. 2-7)

Sep. 2019/10th Edition

Added Variopin Connector (-VS)

P i, Chapter 2, 3-4, 5-1.

Nov. 2018/9th Edition

Added FLXA402

P i, P2-1, P2-3, P2-4, P3-4.

Aug. 2017/8th Edition

Deleted SC202G, SC202SJ, SC100, SC400G, SC402G, transmitter.(p. i, iii,2-1, 2-3, 2-4, 3-4, 4-1)

Revised condition of use in compliance with simple apparatus requirements.(p.iii)

Oct. 2015/7th Edition

Added FLXA202

P i, P2-1, P2-3, P2-4, P3-4.

Unification of the material name

P2-1, P2-2.

Apr. 2015/6th Edition

P ii to iii Added to “■ Compliance with the simple apparatus requirements”.

P3-1 Symbol Marks of “IMPORTANT” added to “3.1 Mounting”.

Jul. 2013/5th Edition

P. 2-2 Some revision of material (option code of /PS, /RS changed);

P. 2-3 Some revision of option code (material of /PS, /RS changed to SUS316).

Jun. 2011/4th Edition

Pi Manual No. of FLXA21 added; P2 FLXA21 added; P4 Some of description for MS-code modified

(M4 ring terminal for FLXA21 added); P5 FLXA21 added to combination of sensor and converters;

P6 to P9 Some of cable label description on drawings and dimensions modified.

Mar. 2010/3rd Edition

Illustrations of each figure replaced more clearly drawings, no contents changed.

Jan. 2008/2nd Edition

Ring terminals added for SC450G converter.

May 2006/1st Edition

Newly published

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