Instruction Manual

Model FU24F
pH/ORP SENCOM® sensor

CE

YOKOGAWA

IM 12B06J08-01E-E
4th edition

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(LT)
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1. PREFACE

1.1 Introduction

This Instruction Manual provides information for the installation and use of the FU24F SENCOM® sensor. This digital sensor shows how Yokogawa applies the motto "Simply the Best" to sensor technology. Setup of the sensor is very easy because all sensor specific characteristics, such as calibration data, are stored in the sensor. The FU24F SENCOM® sensor holds four separate measuring elements in one unbreakable and chemical resistant PPS 40GF (Ryton™) wide body:

- pH glass electrode.
- Long life saturated Ag/AgCl reference system with double junction, combined with ion-trap to prolong the lifetime of the reference probe even in chemically unfavorable environments.
- Integral Pt1000 element for accurate temperature measurements.
- Solid Platinum ORP/LE electrode for accurate simultaneous pH and ORP measurements.

The Model FU24F offers a simple and cost effective solution for process applications with fluctuating pressure and/ or temperature which normally limits the lifetime of a sensor.

By using the patented Bellow system a strong pressure compensation mechanism is created. This ensures immediate interior pressure equalization to the outside process pressure, making the sensor virtually insensitive to process pressure variations.

A slight overpressure caused by the bellow tension prevents process fluid ingress and maintains a positive ion flow out of the sensor. This feature is of particular interest in pure water applications.

Other valuable features of the sensor:

- PTFE reference diaphragm to prevent fouling.
- Polymerized electrolyte to extend the sensor lifetime.
- Available in two versions, a robust dome shape model for applications with a limited amount of solids, and a flat surface model for application in slurries, such as in the pulp and paper industry.
- Versatile in-line or off-line installation.

The FU24F is provided with a multipole M9 male connector for connection to the Yokogawa FLXA analyzer using the WU11 interconnection cable for SENCOM® sensors. This cable, available in 4 fixed lengths, is specified for reliable transfer of digital signals and especially designed to be installed in a heavy industrial environment. The double shielded cable will protect both the sensor and the analyzer for interference from high voltages and currents which are present on other cables.

1.2 Unpacking and Checking

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

1.3 Warranty and Service

Yokogawa products are guaranteed free from defects in workmanship and materials 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 is excluded from this warranty coverage. In the event of a warranty claim, the defective goods should be sent (freight paid) to the Service Department of the relevant Yokogawa Sales office 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) has been exposed.

1.4 Serial Number definition

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: Example: N3P600028

Table 1: Production Year code

Year	Year code	Year	Year code
2014	P	2026	3
2015	R	2027	4
2016	S	2028	5
2017	T	2029	6
2018	U	2030	7
2019	V	2031	8
2020	W	2032	9
2021	X	2033	A
2022	Y	2034	B
2023	Z	2035	C
2024	1	2036	D
2025	2	2037	E

Table 2: Production 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

2.1 Measuring elements

pH glass electrode
Ag/AgCl reference
Solid Platinum electrode
Pt1000 temperature sensor

2.2 Wetted parts

Sensor body	: PPS 40GF (Ryton™ with glass filling)
Measuring sensor	: G-glass
LE glass tube	: AR-glass
Reference junction	: Porous PTFE
Earth pin	: Solid Platinum
O-ring	: Viton
Bellow system	: Viton

2.3 Functional specifications (at 25°C)

Measuring system

Isothermal point	: pH 7
Reference system	: Ag/AgCl with saturated KCl
Glass impedance	
- Dome shape	: 100 MΩ nominal
- Flat surface	: 500 MΩ nominal
Liquid junction	: Non-flow double junction
Junction resistance	: 1 to 15 kΩ
Temperature element	: Pt1000 to IEC 751
Asymmetry potential(zero)	: 8 ± 15 mV
Slope	: > 96 % (of theoretical value)

Note: The FU24F temperature sensor is designed for cell compensation and for indication. It is **NOT** designed for process temperature control.

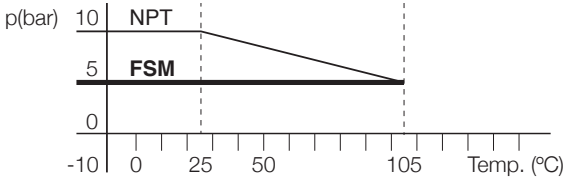
2.4 Dynamic specifications

Startup time sensor	: < 60 sec.
Response time pH	: t_{90} < 15 sec. (for 7 to 4 pH step at 25 ºC)
Response time temperature	
- Dome shape	: t_{90} < 1 min. (for 10 °C step)
- Flat surface	: t_{90} < 4 min. (for 10 °C step)
Stabilization time pH	: < 2 min. (for 0.02 pH unit during 10 sec.)

2.5 Operating range

pH : 0 to 14
ORP : -1500 to 1500 mV
rH : 0 to 100
Temperature
- Dome shape : -10 °C to 105 °C (14 °F to 221 °F)
- Flat surface : +15 °C to 105 °C (59 °F to 221 °F)

Pressure :



Conductivity : > 10 µS/cm

Note: The pH operating range is 0-14 pH, but using the sensor at temperature- and / or pH-extremes will seriously shorten the lifetime.

Note: Sensor is suitable for pure water applications.

2.6 Transmission signal (Data + and Data -)

General : Bi-directional digital communication (RS 485) with limited MODBUS support
Data rate : 9600 b/s (8,E,1)
Output function : pH or temperature compensated pH
ORP, pH compensated ORP, rH
Temperature
Junction resistance
Sensor details (Model, Serial Number, production date)
Sensor calibration data (zero, slope, temperature offset)
Sensor status signals (e.g. Glass impedance detection)

Note: The output functions and settings of the sensor are accessible using a dedicated device such as the Yokogawa FLXA analyzer.

2.7 Power supply (Supply+ versus Supply Gnd)

Operating range : +2.7 to +3.6 VDC
Power consumption : ≤ 20 mW

Pin #	Signal description
1	Data -
2	Data +
3	Supply +
4	Shield
5	Supply Gnd

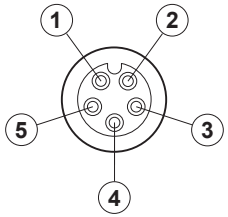


Figure 1: Sensor connector (front view) with gold plated contacts

2.8 Regulatory standards

CE : Decision 768/2008/EC

- ATEX : Directive 2014/34/EU, as amended by Regulation (EC) no. 1882/2003

  Certificate no. : DEKRA 11ATEX0064 X
  II 1 G Ex ia IIC T3...T6 Ga

  Electrical data : For sensor input circuits (by connector) connected to a certified intrinsically safe circuit with the following maximum values
  Ui = 6.1 V; Ii = 230 mA; Pi = 1.2 W; Li = 4 µH; Ci = 30 µF
  or
  Certified intrinsically safe Yokogawa transmitter
  Model FLXA21 series.

  Special conditions (X) : T6 for Tamb. -40 °C to +60 °C
  T5 for Tamb. -40 °C to +75 °C
  T4 for Tamb. -40 °C to +110 °C
  T3 for Tamb. -40 °C to +125 °C

  WARNING : Electrostatic charges on the sensor enclosure shall be avoided.

- Pressure : Directive 2014/68/EU, as amended by Regulation (EC) no. 1882/2003

  Applying article : 4.3 (Sound Engineering Practice)

  WARNING : Damaging the screw thread of the sensor might influence the maximum process pressure.

- EMC : Directive 2014/30/EU
  IEC 61326-1: 2006 Class A (control and laboratory use)
  IEC 61326-2-3: 2006 (use in industrial locations)

- Low Voltage : Directive 2014/35/EU

  WARNING Sensor contains glass parts which if broken can cause cutting injuries.

- WEEE : Directive 2012/19/EU

- RoHS : Directive 2011/65/EU

IECEx

Applying standards : IEC 60079-0: 2007
IEC 60079-11: 2006
IEC 60079-26: 2006

Certificate no. : IECEx DEK 11.0065X
Ex ia IIC T3...T6 Ga

CSA

Certificate no.	: 2516979
Master contract no.	: 182892
	IS, Class I Div. 1, GP A, B, C, D T3…T6
Electrical data	: For sensor input circuits (by connector), connected to a certified intrinsically safe circuit, with the following maximum values
	: Ui = 6.1 V; Ii = 230 mA; Pi = 1.2 W; Li = 4 µH; Ci = 30 µF
	or
	Certified intrinsically safe Yokogawa transmitter Model FLXA21 series.
Ambient temperature	: T6 for Tamb. -40 °C to +60 °C
	T5 for Tamb. -40 °C to +75 °C
	T4 for Tamb. -40 °C to +110 °C
	T3 for Tamb. -40 °C to +125 °C

Note: Intrinsically safe when connected as per Control Drawing FF1-K1226QV (see Fig 2)

Control Drawing CSA

The FU24F SENCOM® sensor shall be installed to a certified intrinsically safe circuit meeting the entity parameters of the sensor as shown in the table as maximum values, or to a certified intrinsically safe Yokogawa transmitter Model FLXA21 series.

When installing this equipment, follow the manufacturer's control drawing. Installation should be in accordance with Canadian Electrical Code, Part 1 or CEC, Part 1.

WARNING

To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing or read, understand and adhere to the manufacturer's live maintenance procedures.

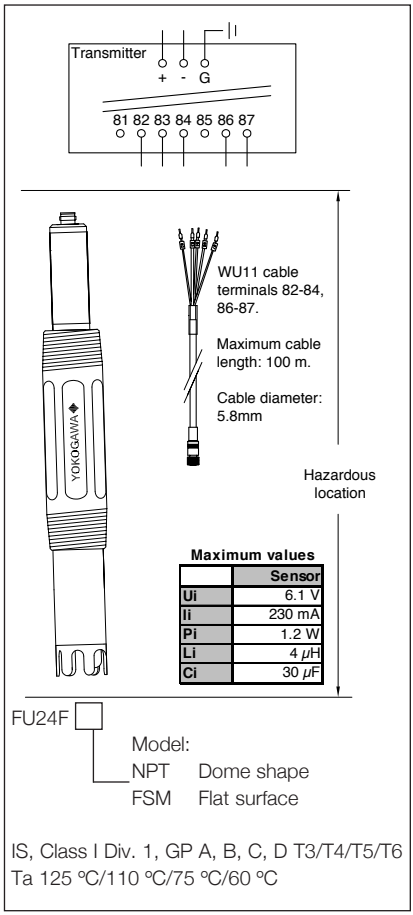


Fig 2: FF1-K1226QV Control Drawing CSA

FM

Certificate no. : 3046277
IS, Class I Div. 1, GP A, B, C, D T3…T6

Electrical data : For sensor input circuits (by connector), connected to a FM approved intrinsically safe apparatus meeting the entity parameters of the SENCOM® sensor:
Ui = 6.1 V; Ii = 230 mA; Pi = 1.2 W; Li = 4 µH; Ci = 30 µF
or
FM approved intrinsically safe Yokogawa transmitter Model FLXA21 series.

Ambient temperature: T6 for Tamb. -40 °C to +60 °C
T5 for Tamb. -40 °C to +75 °C
T4 for Tamb. -40 °C to +85 °C
T3 for Tamb. -40 °C to +85 °C

Note: Intrinsically safe when connected as per Control Drawing FF1-K1226QT (see Fig 3)

Control Drawing FM

The FU24F SENCOM® sensor shall be installed to a FM approved intrinsically safe apparatus meeting the entity parameters of the sensor as shown in the table as maximum values, or to a FM certified intrinsically safe Yokogawa transmitter Model FLXA21 series.

When installing this equipment, follow the manufacturer's control drawing. Installation should be in accordance with ANSI/ISA RP 12.06.01 "Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations" and the National Electrical Code (ANSI/NFPA 70).

WARNING

To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing or read, understand and adhere to the manufacturer's live maintenance procedures.

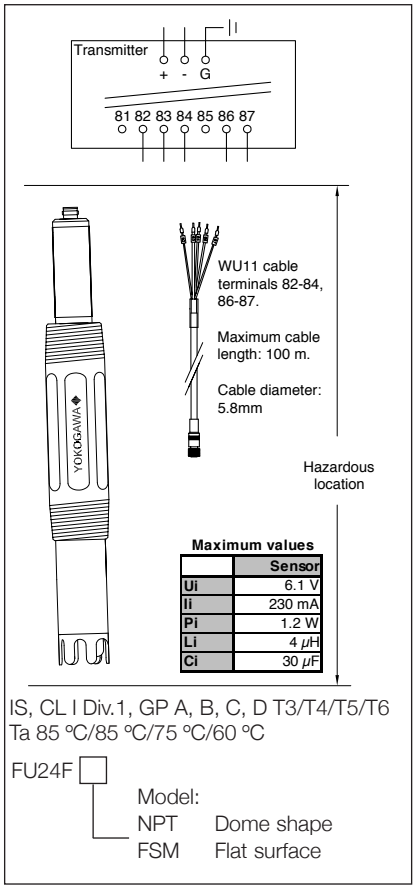


Fig 3: FF1-K1226QT Control Drawing FM

Note: When the sensor has been connected to not intrinsically safe equipment which exceeds the restrictions regarding the sensor input circuit (see electrical data), the sensor is not suitable anymore for intrinsically safe use.

2.9 Shipping details

Package size (L x W x H) : 300 x 100 x 75 mm (11.8 x 3.9 x 3.0 inch)
Package weight : app. 0.33 kg (0.73 lbs)

2.10 Environment and operational conditions

Storage temperature : -10 ºC to 50 °C (14 ºF to 122 °F)
Sensor connection : Hot swapping possible
Water proof : IP67 (conform IEC 60529)

2.11 Mechanical specifications

Max. torque
on sensor body : 7,5 Nm

3. INSTALLATION OF FU24F

For optimum measurement results, the FU24F should be installed in a location that offers an acceptable representation of the process fluid composition and does not exceed the specifications of the sensor. The FU24F is designed with 1" NPT threads on either end of the body to allow installation in a wide variety of applications.

3.1 Typical installation

The FU24F sensor can be installed in-line, in a bypass loop or in an immersion assembly. For best results the FU24F should be mounted with the process fluid flowing towards the sensor.
The sensor can also be mounted horizontally or any other angle.

3.2 Mounting the sensor

The FU24F can be mounted using the threads on the body of the sensor. Apply Teflon tape to the appropriate threaded end. Do not overtighten the sensor. When using a (fork) wrench, the maximum applicable torque is 7,5 Nm.

For mounting the sensor in a flow fitting (FF20-*22, FF20-*33) or subassembly (FS20-*22, FS20-*32), use spare part K1521JA or K1521JB.

See Section 5 for instructions to wire the sensor to the instrument.

3.3 Preparing the sensor for use

Remove the sensor from its shipping box and slide off the "wet pocket" (the flask including the rubber ring) This wet pocket is filled with a saline solution to prevent the sensor from drying out during storage.

Important: Inserting a sharp pointed device in the hole in the measuring end of the sensor, might damage the sensor and result in severely reduced life time!

Before mounting the sensor, it should be validated with buffer solutions and calibrated when necessary. The specific calibration procedure is described in the Instruction Manual of the pH transmitter, but a general procedure is also provided in section 6 of this manual.

4. DIMENSIONS

Dimensions in mm (inches)

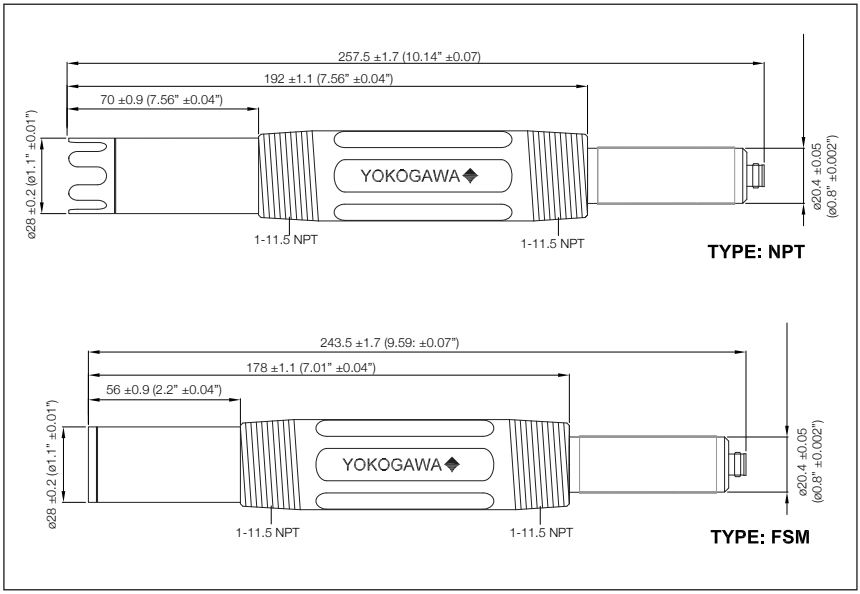


Fig 4: Dimensions FU24F sensor

5. WIRING

The FU24F is provided with a multipole M9 male connector for connection to the Yokogawa FLXA analyzer using the WU11 interconnection cable for SENCOM® sensors. The connections of this M9 male connector (see Section 2.7 for details), the WU11 interconnection cable and the FLXA terminal strip are given in Table 3.

Table 3: Definition M9 sensor connector pin to WU11 cable and FLXA analyzer

M9 Pin #	WU11 wire #	WU11 wire color	FLXA terminal #	Signal description
1	83	Yellow	83	Data -
2	84	Green	84	Data +
3	87	Brown	87	Supply +
4	82	Black	82	Shield
5	86	White	86	Supply Gnd

6. GENERAL CALIBRATION & MAINTENANCE PROCEDURE

Calibration of the FU24F pH/ORP SENCOM® sensor can be done on site with the FLXA analyzer connected, or in the laboratory with another FLXA analyzer or with the dedicated Yokogawa SENCOM® PC software, model SPS24. When using another FLXA analyzer, it has to be set correctly for each calibration. Refer to the FLXA analyzer Instruction Manual for details. After calibration all data will be stored in the sensor itself.
If the sensor is reconnected to the FLXA analyzer in the field, the calibration data of the sensor is automatically read by the analyzer.

6.1 Calibration for pH measurement

To calibrate the FU24F pH/ORP SENCOM® sensor, two buffer solutions with known pH values are required. It is recommended that one buffer solution has a value near to pH 7.00. Depending on the process value to be measured, the second buffer solution should be either acidic (below pH 7.00) or alkaline (above pH 7.00). Normally the IEC buffers (pH 4.01, 6.87 and 9.18) are used.

The following is a very general 2-point calibration procedure:

1. Clean the sensor using a 5% solution of HCl;
2. Rinse sensor thoroughly with demineralized water;
3. Immerse the sensor in the first buffer (pH 6.87 is recommended) and execute calibration as described in the Instruction Manual of the analyzer or SPS24 PC software;
4. Rinse sensor thoroughly with demineralized water;
5. Immerse the sensor in the second buffer (pH 4.01 or 9.18 is recommended) and execute calibration as described in the Instruction Manual of the analyzer or SPS24 PC software;
6. Rinse sensor thoroughly with demineralized water.

During calibration, the temperature compensation should be active. The FLXA analyzer automatically compensates for the sensitivity change of the pH sensor at different temperatures.

After calibration, re-install the sensor into the process.

6.2 Calibration for ORP and rH measurement

For calibration of ORP and rH, the procedure for MANUAL CALIBRATION can be used as described in the Instruction Manual of the FLXA analyzer.

The rH value is a function of the reference system and the pH value of the buffer solution. The FU24F sensor has a reference system of saturated Silver/Silver Chloride (Ag/AgCl). The commonly used standards for ORP and rH calibration are made from Chinhydron (Quinhydrone) powder dissolved in pH buffer solutions (1 g / 200 ml). In Table 4 the measurement values are given as function of the used pH buffer solution with Chinhydron powder. The accuracy of the standards is approximately ± 10 mV.

Table 4: ORP, pH compensated ORP and rH as function of pH buffer solution with Chinhydron powder.

pH buffer	ORP (mV)	pH compensated ORP (mV)	rH
1.68	403	88	23.6
4.01	265	88	23.6
6.87	96	88	23.6
7.00	88	88	23.6

6.3 Maintenance of the FU24F sensor

A pH sensor requires routine maintenance to keep the measuring elements clean and functioning. Depending on the process, different cleaning solutions may be required.

WARNING Avoid cleaning the complete sensor with solution. Some cleaning solutions will damage the modelcode sticker and connector which are placed on the electronic housing on top of the sensor. Only clean the measuring elements at the bottom side of the sensor.

In most cases cleaning with water, iso-propanol or methanol is sufficient. In other cases the measuring elements of the sensor have to be cleaned with specific solutions.

Examples:

1. Deposits of limes, hydroxides or carbonates can be removed by immersing the bottom part of the sensor in a solution containing dilute hydrochloric acid (5% is recommended). Afterwards rinse the sensor with water.
2. Deposits of oil and fat can be removed with hot water with a detergent. When the results are unsatisfactory, a mild (carbonate based) abrasive can be used.
3. Protein deposits should be removed with a protein enzymatic solution, for instance a solution containing 8.5 mL concentrated hydrochloric acid and 10 grams of pepsin in 1 liter of water.

Note: Avoid cleaning with non-polar solvents like tri-chloro ethylene, toluene or hexane. The non-polar solvents will break up the gel-layer on the pH glass bulb and requires that the sensor has to be soaked in water for at least 12 hours before it will function again.

The Teflon diaphragm of the sensor can be regenerated by putting it in hot (± 70°C, 158°F) 3 molar Potassium Chloride (KCl) solution and letting it cool down to room temperature. This procedure clears the diaphragm and will soak the diaphragm with conductive KCl again.

7. MODEL CODE

Model Code	Suffix Code	Option	Description
FU24F			SENCOM® pH Wide Body Sensor
Model	- NPT		Dome shape model
	- FSM		Flat surface model

8. SPARE PARTS

Spare part	Description
	FU24F
K1521JA	SS holder 1" NPT for FF20-S3*
K1521JB	PVDF holder 1" NPT for FF20-F3*
	Buffer solutions
K1520BA	Buffer solutions pH 4.01, pH 6.87, pH 9.18 (500 ml each)
K1520BB	Buffer solution pH 1.68 (500 ml)
K1520BC	Buffer solution pH 4.01 (500 ml)
K1520BD	Buffer solution pH 6.87 (500 ml)
K1520BE	Buffer solution pH 9.18 (500 ml)
	Connection equipment
BA10	Junction box
WU11-M9-xx-WP-V	Interconnection Cable for SENCOM® Sensor, available lengths xx (03, 05, 10, 20 meter)

9. CHEMICAL COMPATIBILITY CHART

			Material											
			Viton			PTFE (teflon)			PPS (Ryton)			Glass		
		Conc.% Temp. °C	20	60	100	20	60	100	20	60	100	20	60	100
Inorganic acid	Sulfuric acid	10	O	O	O	O	O	O	O	O	O	O	O	O
		50	O	O	O	O	O	O	X	X	X	O	O	O
		95	O	O	O	O	O	O	X	X	-	O	O	O
		fuming	O	O	O	O	O	O				O	O	O
	Hydrochloric acid	10	O	O	O	O	O	O	O	O	O	O	O	O
		sat.	O	O	O	O	O	O	O	O	O	O	O	O
	Nitric acid	25	O	O	X	O	O	O	O	O	O	O	O	O
		50	-	-	-	O	O	O	X	X	X	O	O	O
		95	-	-	-	O	O	O	-	-	-	O	O	O
		fuming	-	-	-	O	O	O				O	O	O
	Phosphoric acid	25	O	O	O	O	O	O	O	O	O	O	O	O
		50	O	O	O	O	O	O	O	O	O	O	O	O
		95	X	X	-	O	O	O	O	O	O	O	O	O
	Hydrofluoric acid	40	O	O	O	O	O	O	X	X	X	X	X	X
		75	O	O	X	O	O	O	-	-	-	-	-	-
Organic acid	Acetic acid	10	-	-	-	O	O	O	O	O	O	O	O	O
		glacial	-	-	-	O	O	O	O			O	O	O
	Formic acid	80	-	-	-	O	O	O	O	O		O	O	O
	Citric acid	50	O	O	O	O	O	O	O	O	O	O	O	O
Alkali	Calcium hydroxide	sat.	O	O	O	O	O	O	O	O	O	O	O	O
	Potassium hydroxide	50	O	O	O	O	O	O	O	O	O	O	O	X
	Sodium hydroxide	40	X	X	X	O	O	O	O	O	O	O	O	X
	Ammonia in water	30	X	X	X	O	O	O	O	O	O	O	O	X
Acid salt	Ammonium chloride	sat.	O	O	O	O	O	O	O	O	O	O	O	O
	Zinc chloride	50	O	O	O	O	O	O	O	O	O	O	O	O
	Iron(III) chloride	50	O	O	O	O	O	O	O			O	O	O
	Sodium sulfite	sat.	-	-	-	O	O	O	O	O	O	O	O	O
Basic salt	Sodium carbonate	sat.	O	O	O	O	O	O	O	O	O	O	O	O
	Potassium chloride	sat.	O	O	O	O	O	O	O	O	O	O	O	O
	Sodium sulfate	sat.	O	O	O	O	O	O	O	O	O	O	O	O
	Calcium chloride	sat.	O	O	O	O	O	O	O	O	O	O	O	O
Neutral salt	Sodium chloride	sat.	O	O	O	O	O	O	O	O	O	O	O	O
	Sodium nitrate	50	O	O	O	O	O	O	O	O	O	O	O	O
	Aluminium chloride	sat.	O	O	O	O	O	O	O	O	O	O	O	O
	Hydrogen peroxide	30	O	O	O	O	O	O	X	-	-	O	O	O
Oxidizing agent	Sodium Hypochloride	50	O	O	X	O	O	O	X			O	O	O
	Potassium dichromate	sat.	O	O	O	O	O	O	X			O	O	O
	Chlorinated lime					O	O	O				O	O	O
	Ethanol	80	X	-	-	O	O	O	O	O	O	O	O	O
Organic solvent	Cyclohexane		O	O	O	O	O	O	O	O	O	O	O	O
	Toluene		-	-	-	O	O	O	O	O	O	O	O	O
	Trichloroethane		X	X	X	O	O	O	O	O		O	O	O
	Water		O	O	O	O	O	X	O	O	O	O	O	O

O = can be used; X = shortens useful life; - = cannot be used; Blank = no data available

Note: Information in this list is based on our general experience and literature data and given in good faith. However Yokogawa is unable to accept responsibility for claims related to this information.

YOKOGAWA ELECTRIC CORPORATION
World Headquarters
9-32, Nakacho 2-chome, Musashino-shi
Tokyo 180-8750
Japan
www.yokogawa.com

YOKOGAWA CORPORATION OF AMERICA
2 Dart Road
Newnan GA 30265
USA
www.yokogawa.com/us

YOKOGAWA EUROPE BV
Euroweg 2
3825 HD AMERSFOORT
The Netherlands
www.yokogawa.com/eu

YOKOGAWA ELECTRIC ASIA Pte. LTD.
5 Bedok South Road
Singapore 469270
Singapore
www.yokogawa.com/sg

YOKOGAWA CHINA CO. LTD.
3F Tower D Cartelo Crocodile Building
No.568 West Tianshan Road Changing District
Shanghai, China
www.yokogawa.com/cn

YOKOGAWA MIDDLE EAST B.S.C.(c)
P.O. Box 10070, Manama
Building 577, Road 2516, Busaiteen 225
Muharraq, Bahrain
www.yokogawa.com/bh

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Please refer to the European website (www.yokogawa.com/eu) to contact your nearest representative.

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