Instruction Manual

Model FU20

pH/ORP Combination sensor

YOKOGAWA

IM 12B06J03-02E-E
10th edition

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(PL)
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CONTENTS

1. PREFACE

1.1 Introduction

This instruction manual provides information for the installation and use of the FU20, four-in-one wide body pH sensors. The FU20 is the choice for the majority of typical waste water and process applications.

The Model **FU20** offers a simple and cost effective solution for a wide variety of waste water and process applications. This all-in-one sensor provides simultaneous measurement of pH, redox (ORP) and temperature if desired. Chemical compatibility in the target application is secured by the choice of body material. The rugged Ryton body is designed for easy installation into on-line and immersion applications via the 3/4" NPT threaded connections provided on both ends of the sensor. In application where the sensor is exposed to some concentrated acid or in high temperature acid environment, the material of choice will be PVDF. Optional quick-removal adapters in both stainless steel and titanium are available to make calibration and maintenance even easier.

The Ryton FU20 comes with an integral cable of optional lengths designed to minimize the adverse affects noise can have on the measurement. This cable is pre-finished to make connection to any industrial pH instrument as simple as possible. For both Ryton and the PVDF version of the FU20 sensors with a multipole VP connector are available. These require seperate cable type WU10-V-D that is available in 5 fixed lengths.

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_6 X_7X_8 X_9	Tracking number

Example: N3P600028

Method used for year/month numbering

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
: Silver chloride reference
: Solid platinum electrode
: Pt1000 temperature sensor.

2.2 Wetted parts

Sensor body	: NPT, FSM: PPS GF40: FTD : PVDF- (GF25+TZ24)
Earthing pin	: Solid Platinum
Measuring sensor	: G-glass
LE glass tube	: AR-glass
O-ring	: Viton
Reference junction	: Porous PTFE

2.3 Functional specifications (at 25°C)

Isothermal point	: pH 7 / 3.3 M KCL
Reference system	: Ag/AgCl with saturated KCl
Glass impedance	
- Dome shape	: 200 MΩ nominal
- Flat Surface	: 700 MΩ nominal
Junction resistance	: 1.0 to 10 kΩ
Liquid outlet	: non-flow double junction
Temperature element	: Pt1000/Pt100 to IEC 751
Asymmetry potential	: 8 ± 15 mV
Slope	: > 96 % (of theoretical value)

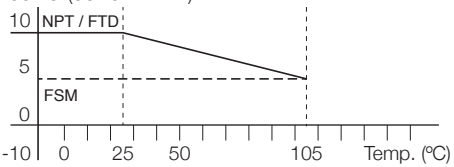
NOTE: The temperature sensor included in the FU20 is designed for cell compensation and for indication. It is **NOT** designed for process temperature control.

2.4 Dynamic specifications

Response time pH	: t_{90} < 15 sec. (for 7 to 4 pH step)
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
Temperature	
- Dome shape	: -10 to 105 ºC (14 to 221 ºF)
- Flat Surface	: 15 to 105 ºC (59 to 221 ºF)
Pressure	: p(bar)



Conductivity : > 10 µS/cm

NOTE: The pH operating range at room temperature is 0-14 pH, but at high temperatures or range outside 2-12 pH the lifetime will be seriously shortened.

2.6 Regulatory standards (only for sensor with Pt1000 temp. element)

CE : Decision 768/2008/EC CE

- ATEX : Directive 94/9/EC,
  as amended by Regulation (EC) no. 1882/2003

  Certificate no. : DEKRA 11ATEX0014 X
  Ex II 1 G Ex ia IIC T3...T6 Ga

  Electrical data : For sensor input circuit connected to a certified intrinsically safe circuit with the following maximum values:
  Ui = 18 V; Ii = 170 mA; Pi = 0.4 W; Li = 0 mH;
  Ci = 0 nF (VP type) or 3.6 nF (permanently connected cable)
  or
  Certified intrinsically safe Yokogawa pH/ORP transmitter Model FLXA21 series or Model PH202S series.

  Special conditions (X) : T6 for Tamb. -40 °C to +40 °C
  T4 and T5 for Tamb. -40 °C to +55 °C
  T3 for Tam. -40 °C to +105 °C

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

- Pressure : Directive 97/23/EC,
  as amended by Regulation (EC) no. 1882/2003

  Applying article : 3.3 (Sound Engineering Practice)

  WARNING : Damaging the screw thread of the sensor might influence the maximum process pressure.
  : Sensor contains glass parts which if broken can cause cutting injuries.

IECEx

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

Certificate no. : IECEx DEK 11.0064X
Ex ia IIC T3...T6 Ga

Note: When the sensor has been connected to none 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.

2.7 Shipping details

	FU20-03/05/10	FU20-20	FU20-VP
Package size (L x W x H)	: 410 x 130 x 75	360 x 220 x 105	300 x 100 x 75 mm
	16.1 x 5.1 x 3.0	14.2 x 8.7 x 4.1	11.8 x 3.9 x 3.0 inch
Package weight (max.)	: 0.92 kg (2.02 lbs)	1.62 kg (3.57 lbs)	0.33 kg (0.73 lbs)

2.8 Environmental conditions

Storage temperature : -10 to 50 ºC (14 to 122 ºF)
Water proof : IP67 (conform IEC 60529)

2.9 Mechanical Specifications

Max torque on sensor body: - NPT, FSM 12 Nm
- FTD 8 Nm

3. INSTALLATION OF FU20

For optimum measurement results, the FU20 should be installed in a location that offers an acceptable representation of the process composition and **DOES NOT** exceed the specifications of the sensor. The FU20 is designed with 3/4" NPT threaded connections on both ends of the sensor to allow installation in a wide variety of applications.

3.1 Typical installation

The FU20 sensor is designed for versatile in-line, immersion or off-line installation. For best results the FU20 should be mounted with the process flow coming towards the sensor, and positioned at least 15° above the horizontal plane to eliminate air bubbles in the pH glass bulb (see Figure 1).

3.2 Preparing the sensor for use

Remove the sensor from its shipping box and slide of the so-called 'wet pocket', the tube filled with solution to prevent drying out of the measuring elements during shipment or storage. Although on the Quality Inspection Certificate (QIC) all factory calibration data is stored, it is recommended to calibrate the sensor before first use. A general calibration procedure is described in Section 6 of this Instruction Manual.

3.3 Mounting the sensor

The simplest mounting is to use one of the 3/4" NPT threaded connection of the sensor. Apply Teflon tape to the appropriate threaded end, then install the sensor in the process (see Figure 2).

Note: Do not overtighten the sensor body. Max. torque applicable in paragraph 2.9

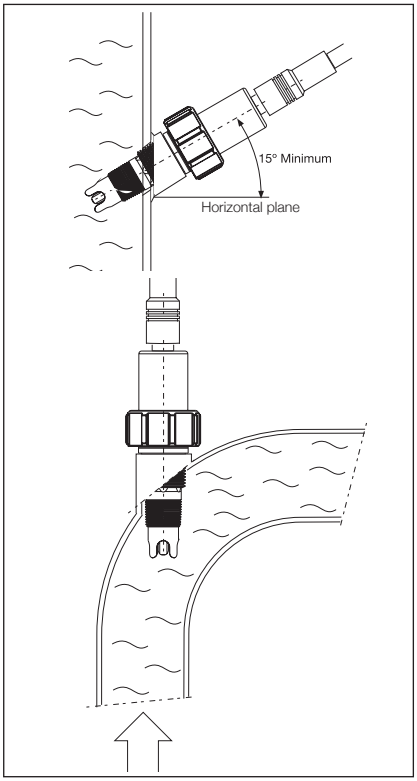


Figure 1: Sensor installation

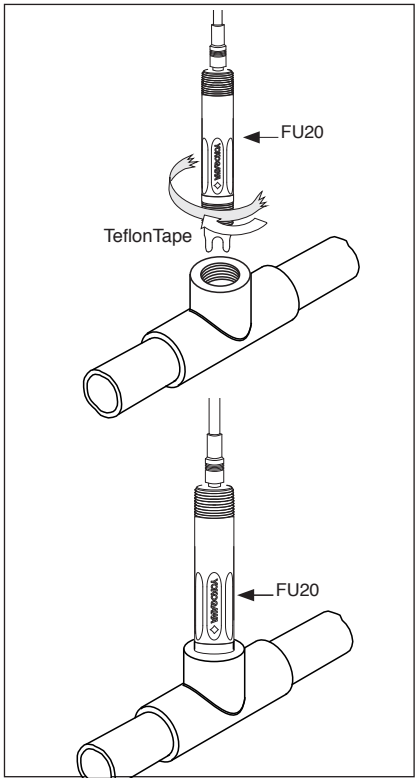


Figure 2: Simple mounting of sensor

The FU20 can also be mounted using one of the optional quick-removal adapters (/NSS, /NTI, /BSS, /BTI, see Figure 3). For a detailed description of these adapters see Sections 4 and 7 of this Instruction Manual.

Note: DO NOT over tighten the adapter to prevent damage.

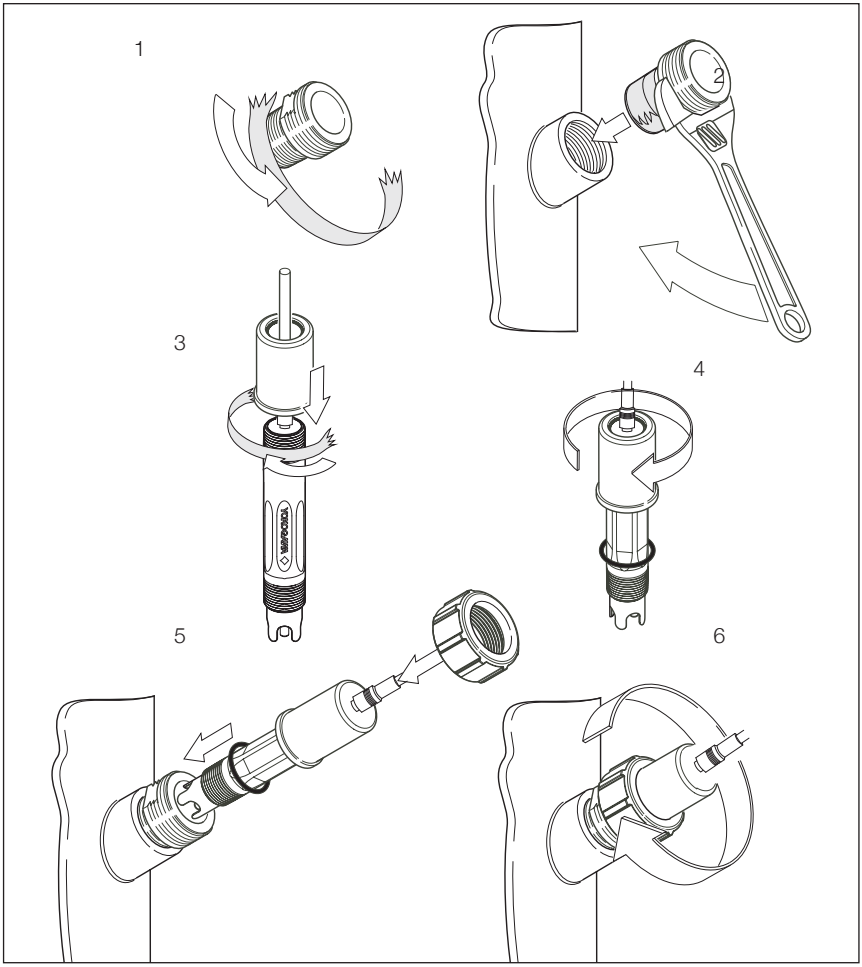


Figure 3: Mounting of sensor with option /NSS, /NTI, /BSS or /BTI

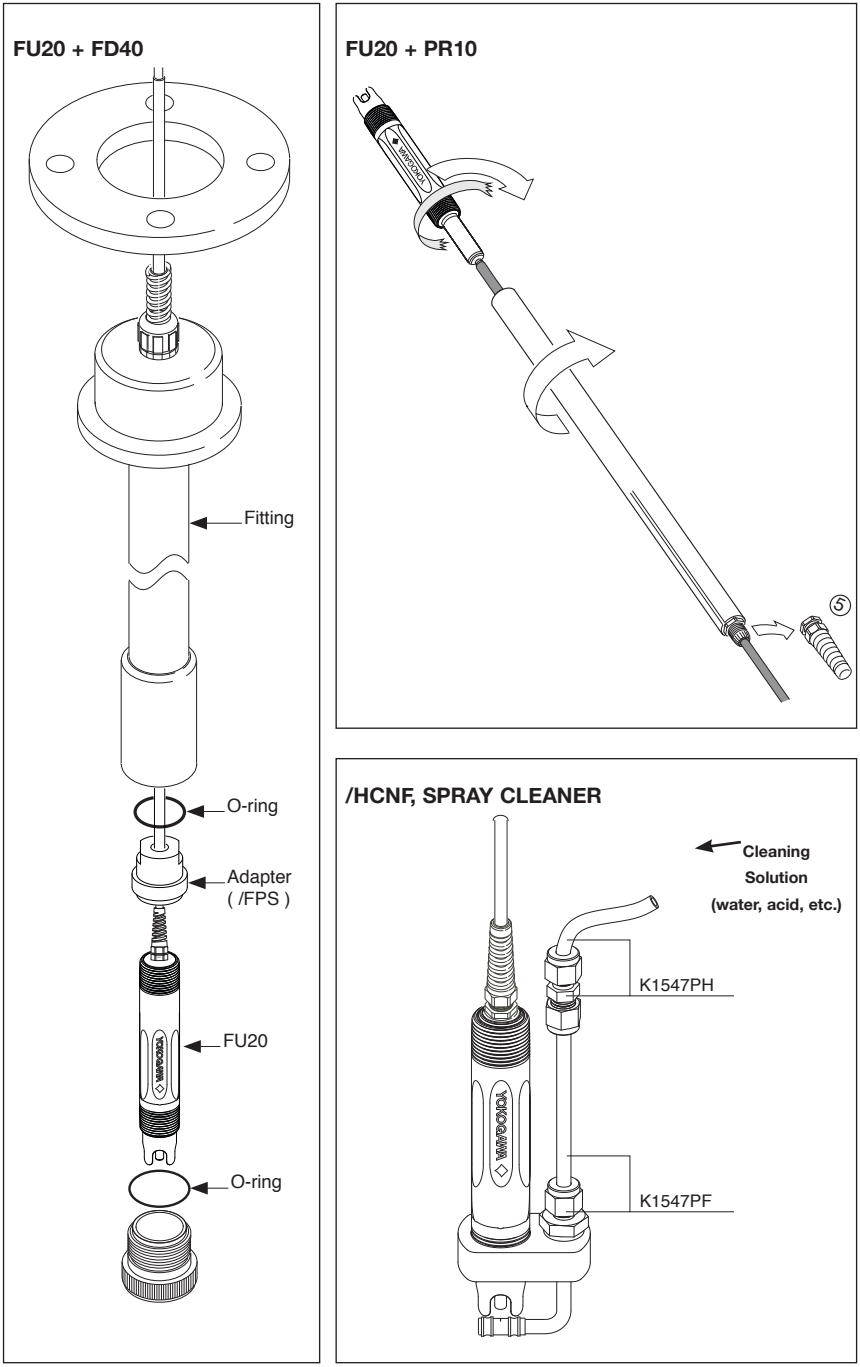


Figure 4. Installation examples for the FU20

4. DIMENSIONS

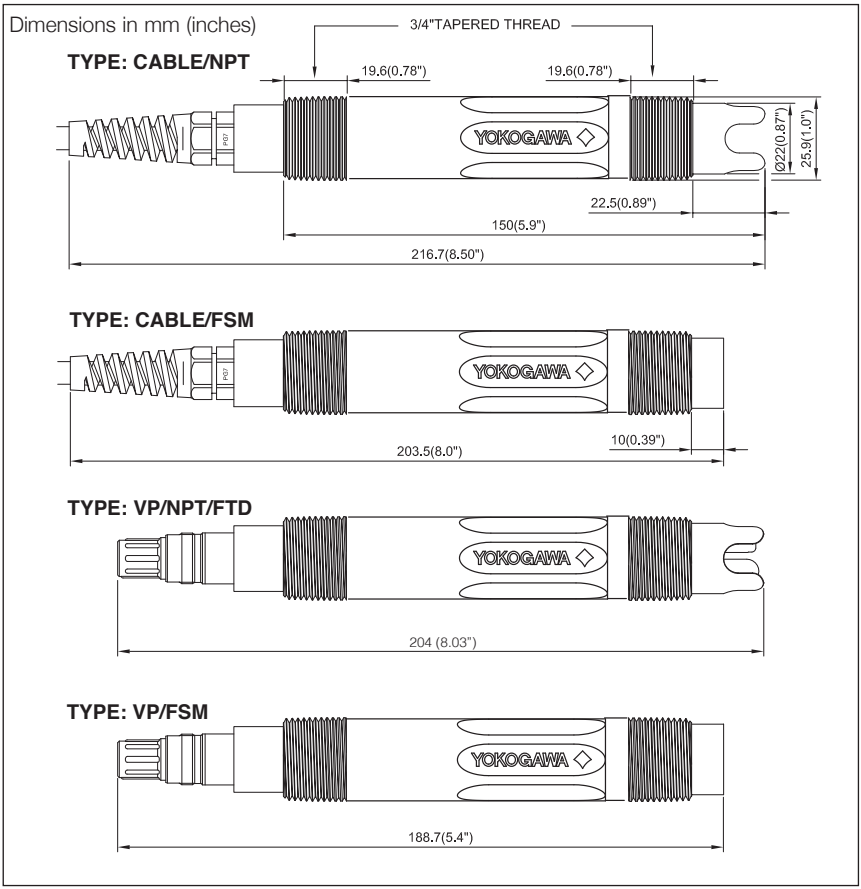


Figure 5. Dimensions FU20

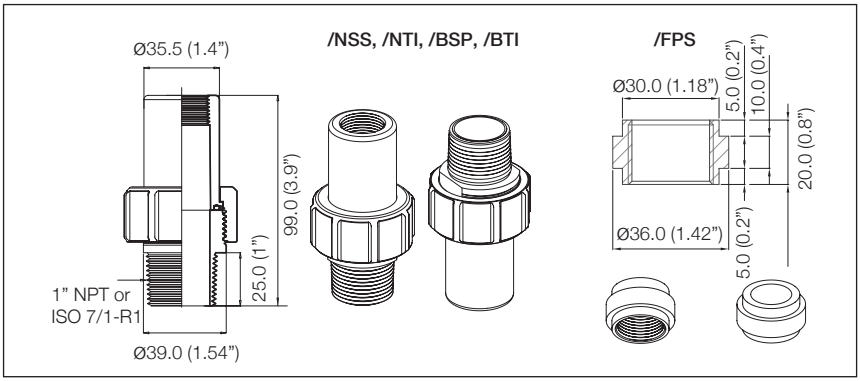


Figure 6. Dimensions 1" FU20 adapter Stainless Steel & Titanium and FU20 adapter for FF40, FS40 and FD40 fittings

5. WIRING

5.1 Connections

The FU20 sensor is provided with a fixed cable or Variopin (VP) connector. The connections of both the wire as the VP connector are given in Figure 7.

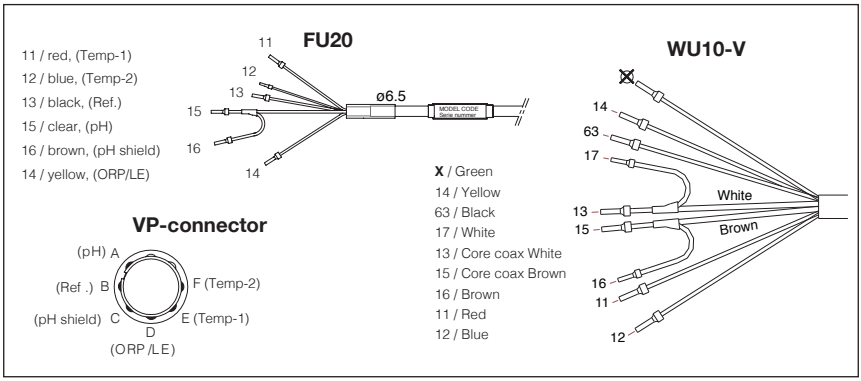


Figure 7. Cable marking and pin locations

5.2 Definition EXA/FLXA terminal numbers to FU20 sensor

	FU20-03/05/10/20 wire #		
EXA/FLXA terminal #	**pH pH+ORP pH+rH**	**ORP**	**ORP pH compensated**
11	11	11	11
12	12	12	12
13	13	13	15
14	14		
15	15	14	14
16	16		
17			16

	FU20-VP with WU10-V wire color		
EXA/FLXA terminal #	**pH pH+ORP pH+rH**	**ORP**	**ORP pH compensated**
11	Red	Red	Red
12	Blue	Blue	Blue
13	Brown	Brown	Clear
14	Yellow		
15	Clear	Yellow	Yellow
16	Black		
17			Black

Note: For ORP measurement the EXA/FLXA terminals 13 and 14 should be interconnected. For ORP pH compensated measurement the EXA/FLXA terminals 14 and 15 should be interconnected.

5.3 Settings for PH402G and PH202G(S)

Function / Setting	pH (default)	pH&ORP	pH&rH	ORP	pH compensated ORP
code 01	0(pH)	0(pH)	0(pH)	1(ORP)	1(ORP)
code 02	0(off)	1(ORP)	2(rH)	0(off)	0(off)
code 03	1.1.1	1.1.1	1.1.1	0.0.1	0.0.1
code 04	0.0.1	0.0.1	0.0.1	0.0.1	1.1.1
code 31	0	2	2		
jumper input 1	no	no	no	yes	yes
jumper input 2	yes	yes	yes	yes	no

5.4 Settings for PH150, PH450G and FLXA

Function / Setting	pH (default)	pH&ORP	pH&rH	ORP	pH compensated ORP
sensor setup	pH	pH+ORP	pH+ORP	ORP	ORP
measurement setup		pH+ORP	pH+rH		
Impedance setting					
input1	High	High	High	Low	Low
input 2	Low	Low	Low	Low	High
jumper input 1	no	no	no	yes	yes
jumper input 2	yes	yes	yes	yes	no

6. GENERAL CALIBRATION & MAINTENANCE PROCEDURE

6.1 Calibration for pH measurement

To calibrate the FU20 pH/ORP 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.
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.
6. Rinse sensor thoroughly with demineralized water.

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

After calibration, replace or 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 analyzer.

The rH value is a function of the reference system and the pH value of the buffer solution. The FU20 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 3 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 3: ORP, pH compensated ORP and rH as function of pH buffer solution with Chinhydron powder.

pH buffer	ORP (mV) ORP (mV)	pH compensated	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 FU20 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 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 solvent 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 Chlorine (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 CODES

Model Code	Suffix	Option	Description
FU20			Wide Body sensor
Cable length	-03		3 m cable } not available for FTD and FTS
	-05		5 m cable
	-10		10 m cable
	-20		20 m cable
	-VP		No Cable; Vario Pin connector
Temp. Sensor	-T1		Pt1000
	-T2		Pt100 (not available for FTD and FTS)
Model	-NPT		PPS body / Tapered Thread / Dome shaped
	-FSM		PPS body / Tapered Thread / Flat Surface
	-FTD		PVDF body / Tapered Thread / Dome shaped
	-FTS		PVDF body / Tapered Thread / Salt Sensitive membrane
Options		/HCNF	Complete Hastelloy cleaning system
		/FPS	Adapter F*40 from PPO
		/NSS	1" NPT, SS316
		/NTI	1" NPT, Titanium
		/BSS	1" BSP, SS316
		/BTI	1" BSP, Titanium

For suffix –NPT, -FSM: further specifications can be found in GS12B6J3- 02E- E
For suffix –FTS: further specifications can be found in GS12B6J3- 05E- E

8. SPARE PARTS

Spare part	Description	
	FU20	
K1523DD	/FPS	Adapter for FF40, FS40 and FD40 fittings (PPO)
K1547PK	/NSS	1" NPT, Stainless Steel adapter (Viton O-ring)
K1547PL	/BSS	ISO 7/1-R1, Stainless Steel adapter (Viton O-ring)
K1547PM	/NTI	1" NPT, Titanium adapter (Viton O-ring)
K1547PN	/BTI	ISO 7/1-R1, Titanium adapter (Viton O-ring)
K1500FR	Viton O-rings 29.82*2.62 (5 pcs) for 1" adapter	
K1500FS	EPDM O-rings 29.82*2.62 (5 pcs) for 1" adapter	
K1500FT	Silicone O-rings 29.82*2.62 (5 pcs) for 1" adapter	
	Cleaning system for FU20	
K1547PJ	Hastelloy cleaning system (HCNF)	
K1547PG	Hastelloy nozzle and mounting set (HCNF)	
K1547PH	Nylon tube (10 metre) and tube mounting set for chemical cleaning system	
	Buffer solutions	
K1520BA	Starters Kit: (3x 500 ml) Solution pH 4.01, pH 6.87, pH 9.18	
K1520BB	Buffer Solution (500 ml) pH 1.68	
K1520BC	Buffer Solution (500 ml) pH 4.01	
K1520BD	Buffer Solution (500 ml) pH 6.87	
K1520BE	Buffer Solution (500 ml) pH 9.18	
	Connection equipment	
BA10	Junction box for pH extension cables	
WF10-XXX-F	pH signal cable with terminated ends.	
	Available lenghts (XXX = 005, 010, 025 & 050 m)	
WU10-V-S-XX	Variopin cable (XX = 02, 05, 10, 15 and 20m)	

9. CHEMICAL COMPATIBILITY CHART

				Material															
				Viton			PTFE (teflon)			PVDF (Kynar)			PPS (Ryton)			Glass		
		Conc.%	Temp. °C	20	60	100	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	o	o	o
		50		o	o	o	o	o	o	o	o	o	x	x	x	o	o	o
		95		o	o	o	o	o	o	o	x	-	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	o	o	o
		sat.		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Nitric acid	25		o	o	x	o	o	o	o	o	x	o	o	o	o	o	o
		50		-	-	-	o	o	o	o	o	x	x	x	x	o	o	o
		95		-	-	-	o	o	o	o	x	-	-	-	-	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	o	o	o
		50		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		95		x	x	-	o	o	o	o	o	o	o	o	o	o	o	o
	Hydrofluoric acid	40		o	o	o	o	o	o	o	o	o	x	x	x	x	x	x
		75		o	o	x	o	o	o	o	o	o	-	-	-	-	-	-
Organic acid	Acetic acid	10		-	-	-	o	o	o	o	o	o	o	o	o	o	o	o
		glacial		-	-	-	o	o	o	o	x	-	o			o	o	o
	Formic acid	80		-	-	-	o	o	o	o	o	o	o	o		o	o	o
	Citric acid	50		o	o	o	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	o	o	o
	Potassium hydroxide	50		o	o	o	o	o	o	o	o	x	o	o	o	o	o	x
	Sodium hydroxide	40		x	x	x	o	o	o	o	o	x	o	o	o	o	o	x
	Ammonia in water	30		x	x	x	o	o	o	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	o	o	o
	Zinc chloride	50		o	o	o	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			o	o	o
	Sodium sulfite	sat.		-	-	-	o	o	o	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	o	o	o
	Potassium chloride	sat.		o	o	o	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	o	o	o
	Calcium chloride	sat.		o	o	o	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	o	o	o
	Sodium nitrate	50		o	o	o	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	o	o	o
	Hydrogen peroxide	30		o	o	o	o	o	o	o	o	o	x	-	-	o	o	o
Oxidizing agent	Sodium Hypochloride	50		o	o	x	o	o	o	o	o	o	x			o	o	o
	Potassium dichromate	sat.		o	o	o	o	o	o	o	x	-	x			o	o	o
	Chlorinated lime						o	o	o	o	o	o				o	o	o
	Ethanol	80		x	-	-	o	o	o	o	o	x	o	o	o	o	o	o
Organic solvent	Cyclohexane			o	o	o	o	o	o	o	o	x	o	o	o	o	o	o
	Toluene			-	-	-	o	o	o	o	o	o	o	o	o	o	o	o
	Trichloroethane			x	x	x	o	o	o	x	x	x	o	o		o	o	o
	Water			o	o	o	o	o	x	o	o	o	o	o	o	o	o	o

o = can be used / x = shortens useful life / - = cannot be used / Blank = currently 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 responsobility for claims related to this information.

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