Instruction Manual
Model FU20
pH/ORP Combination sensor

YOKOGAWA
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1. GENERAL

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. 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. Optional quick-removal adapters in both stainless steel and titanium are available to make calibration and maintenance even easier.

The 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. The FU20 can also include a multipole VP connector and then requires separate cable type WU10-V-S 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 (including outer box) and then immediately notify the carrier and the relevant Yokogawa sales office. Make sure the Model Code on the sensor is the same as on the packing list. Also, check any option(s) that were ordered are included and correct. The sensor has an identification number on the cable with the full Model Code and a Serial Number included.

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:
1. Model Code and Serial Number.
2. Original Purchase Order and Date.
3. Length of time in service and description of the process.
4. Description of the fault and circumstances of the failure.
5. Process/environmental conditions that may be related to the failure of the sensor
6. Statement as to whether warranty or non-warranty service is requested.
7. 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.

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 sensors/fittings have been exposed.
2. GENERAL SPECIFICATIONS FU20

2-1. Measuring elements
- pH glass electrode
- Silver chloride reference
- Solid platinum electrode
- Pt1000 temperature sensor.

2-2. Construction materials
Body: PPS 40GF (Ryton with glass filling)
Earthing pin: Solid Platinum
O-ring: Viton
Reference junction: Porous PTFE
Cable: Coaxial with 4 extra leads

2-3. Functional specifications (at 25°C)
- Isothermal point: pH 7
- Glass impedance:
  - Dome shape: 250 to 500 MΩ
  - Flat Surface: 400 to 1000 MΩ
- Reference system: Ag/AgCl with saturated KCl
- Junction resistance: 1.0 to 10 kΩ
- Liquid outlet: non-flow double junction
- Temperature element: Pt1000 to IEC 751
- Asymmetry potential: 8 ± 15 mV
- Slope: > 96 % (of theoretical value)

NOTE: The temperature sensor included in the FU20 is intended to provide indication and cell compensation. The construction has not been tested to the pressure vessel standards required for plant temperature control.

2-4. Dynamic specifications
- Response time pH step (7 to 4): < 15 sec for 90%
- Response time temp step (10°C):
  - Dome shape: < 3 min for 90%
  - Flat Surface: < 6 min for 90%
- Stabilisation time (0.02 pH unit/ 10 s): < 2 minutes

2-5. Operating range
- pH: 0 to 14
- Temperature: -10 to 105 °C (14 to 221 °F)
- Pressure: 0 to 10 bar (0 to 145 PSIG)
- Conductivity: > 50 µS/cm
- Storage temperature: -10 to 50 °C (14 to 122 °F)

NOTE: Specifications should not be considered in isolation. For example the pH range can be 2-12 pH, where the measurement is at elevated temperatures. For advice about specific applications please contact your local sales office.
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 threads on either end of the body $\frac{3}{4}$" NPT to allow installation in a wide variety of applications.

3-1. Typical Installation
The FU20 sensor is designed for in-line installation, via a bypass loop as an immersion assembly. For best results the FU20 should be mounted with the process coming towards the sensor (Figure 2) and positioned at least 15° above the horizontal plane to eliminate air bubbles in the glass bulb.

3-2. Preparing the Sensor for Use
Remove the sensor from its shipping box and slide off the "wet pocket" (the tube filled with solution to keep the measuring elements from drying out in storage or shipment).

**IMPORTANT NOTICE**
Before mounting the sensor, it should be calibrated. The calibration procedure is normally described in the Instruction Manual of the pH transmitter, but a general calibration is given in section 5 of this manual.

3.3 Mounting the Sensor
The FU20 can be mounted using the threads on the body of the sensor (Figure 1). Apply Teflon tape to the appropriate threaded end, then install in the process.

The FU20 can also be mounted using the threaded end of the quick release adapter. Apply Teflon (PTFE) tape to the threaded end of the quick release adapter (step 2). Then install the adapter (/NSS, /NTI, /BSP or /BTI) in the process, tightening it by applying a suitable torque using a spanner on the adapter flats, steps 1 & 3.

Next, slide the mating part of the adapter from the cable end of the FU20 (step 4) sensor and mount into the adapter making sure that the O-ring seats properly (step 5 & 6). Hand tightened the adapter nut (step 7).

**NOTE:**
DO NOT over tighten the sensor, as damage may result.

See Section 4 for instructions to wire the sensor to the instrument.

![Figure 1. Sensor Installation](image)
Figure 2. Sensor & adapter Installation

1. Wrench Flats
2. Teflon Tape
3. Do NOT overtighten
4. Teflon Tape
5. 
6. 
7. 

15° Minimum
Figure 3. Installation examples for the FU20
Figure 4. Dimensions FU20

Figure 5. Dimensions 1" FU20 adapter  Stainless Steel & Titanium

Figure 6. Dimensions FU20 adapter for FF40, F S40 and FD40 fittings (K1523DD)
4. WIRING

4.1. Cable marking and pin allocation.

<table>
<thead>
<tr>
<th>Signal description</th>
<th>FU20 cable Wire color</th>
<th>FU20 cable wires (EXA terminal) number</th>
<th>VP connector Pin</th>
<th>FU20-V cable Wire color</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Clear</td>
<td>15</td>
<td>A</td>
<td>Clear</td>
</tr>
<tr>
<td>pH-Shield</td>
<td>Brown</td>
<td>16</td>
<td>C</td>
<td>Black</td>
</tr>
<tr>
<td>Reference</td>
<td>Black</td>
<td>13</td>
<td>B</td>
<td>Brown</td>
</tr>
<tr>
<td>ORP/Liquid earth</td>
<td>Yellow</td>
<td>14</td>
<td>D</td>
<td>Yellow</td>
</tr>
<tr>
<td>Temp-1</td>
<td>Red</td>
<td>11</td>
<td>E</td>
<td>Red</td>
</tr>
<tr>
<td>Temp-2</td>
<td>Blue</td>
<td>12</td>
<td>F</td>
<td>Blue</td>
</tr>
</tbody>
</table>

4.2. Instrument connection of sensor as function of measurement

<table>
<thead>
<tr>
<th>Signal descr.</th>
<th>Function</th>
<th>pH</th>
<th>pH&amp;ORP</th>
<th>pH&amp;rH</th>
<th>ORP</th>
<th>pH compensated ORP</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>13</td>
</tr>
<tr>
<td>Shield of pH</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>REF</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ORP/Liquid Earth</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>TEMP</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>TEMP(2)</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Jumper</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>13-14</td>
<td>14-15</td>
</tr>
</tbody>
</table>

The settings for the pH converters must be set according to the instructions in the Instruction Manual of the converter. In the following table these settings are summarized.
4.2.1. Settings for PH402G and PH202G(S)

<table>
<thead>
<tr>
<th>Function</th>
<th>pH (default)</th>
<th>pH&amp;ORP</th>
<th>pH&amp;rH</th>
<th>ORP</th>
<th>pH compensated ORP</th>
</tr>
</thead>
<tbody>
<tr>
<td>code 01</td>
<td>0(pH)</td>
<td>0(pH)</td>
<td>0(pH)</td>
<td>1(ORP)</td>
<td>1(ORP)</td>
</tr>
<tr>
<td>code 02</td>
<td>0(off)</td>
<td>1(ORP)</td>
<td>2(rH)</td>
<td>0(off)</td>
<td>0(off)</td>
</tr>
<tr>
<td>code 03</td>
<td>1.1.1</td>
<td>1.1.1</td>
<td>1.1.1</td>
<td>0.0.1</td>
<td>0.0.1</td>
</tr>
<tr>
<td>code 04</td>
<td>0.0.1</td>
<td>0.0.1</td>
<td>0.0.1</td>
<td>0.0.1</td>
<td>1.1.1</td>
</tr>
<tr>
<td>code 31</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>jumper input 1</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>jumper input 2</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

4.2.2. Settings for PH150 and PH450G

<table>
<thead>
<tr>
<th>Function</th>
<th>pH (default)</th>
<th>pH&amp;ORP</th>
<th>pH&amp;rH</th>
<th>ORP</th>
<th>pH compensated ORP</th>
</tr>
</thead>
<tbody>
<tr>
<td>sensor setup</td>
<td>pH</td>
<td>pH+ORP</td>
<td>pH+ORP</td>
<td>ORP</td>
<td>ORP</td>
</tr>
<tr>
<td>measurement setup</td>
<td>pH+ORP</td>
<td>pH+ORP</td>
<td>pH+rH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impedance setting</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>input 1</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>jumper input 1</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>jumper input 2</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

5. GENERAL CALIBRATION & MAINTENANCE PROCEDURE

5-1. Calibration for pH measurement
To calibrate a pH 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 7.00) or alkaline (above 7.00). Normally, the IEC buffers (4.01, 6.87 and 9.18) are used.

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

1. Clean the sensor (deposits may be removed using a 5% (approximate) solution of HCl).
2. Rinse sensor thoroughly with clean water.
3. Immerse the sensor in the first buffer (6.87 pH is recommended).
4. Refer to appropriate Instrument Instruction Manual for Calibration procedures (Auto; Manual; Sample, etc.).
5. Rinse sensor thoroughly with clean water.
6. Immerse the sensor in the second buffer (4.01 or 9.18 recommended).
7. Repeat Step 4.

During calibration the temperature compensation should be active. The instrument automatically compensates for the sensitivity change of the pH sensor at different temperatures. After the calibration is complete replace or re-install the sensor into the process.

5-2. Calibration of ORP and rH measurements
For calibration of ORP and rH the procedures for MANUAL CALIBRATION can be used as described in the instruction manual of the analyser. The commonly used standards for ORP and rH calibration are made from Chinhydron (Quinhydrone) powder dissolved in pH buffer solutions (1 gram/200 ml) The ORP value is a function of the Reference cell of the measurement and the pH value of the buffer solution.
The FU20 has a reference system of Saturated Silver/Silver Chloride and the values are given in the following table as function of the measurement function (4.2).

<table>
<thead>
<tr>
<th>Function</th>
<th>ORP</th>
<th>pH comp. ORP</th>
<th>rH</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH= 1.68</td>
<td>403</td>
<td>88</td>
<td>23.6</td>
</tr>
<tr>
<td>pH= 4.01</td>
<td>265</td>
<td>88</td>
<td>23.6</td>
</tr>
<tr>
<td>pH= 6.87</td>
<td>96</td>
<td>88</td>
<td>23.6</td>
</tr>
<tr>
<td>pH= 7.00</td>
<td>88</td>
<td>88</td>
<td>23.6</td>
</tr>
</tbody>
</table>

The accuracy of the standard values is approximately +/- 10 mV.

5-3. Maintenance

All pH sensors require routine maintenance to keep the measuring elements clean and functioning. Depending on the process, different cleaning solutions may be required.

**EXAMPLES:**
1. Deposits of limes, hydroxides or carbonates can be removed by immersing the sensor in a solution containing dilute hydrochloric acid (5% is recommended). Afterwards rinse 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 8.5ml concentrated hydrochloric acid and 10 grams of pepsin in 1 liter of water will do.

After cleaning the probe is reinserted into the process by following the reverse procedure.

**NOTE:**
Avoid using non-polar solvent like tri-chloro ethylene, toluene or hexane. Cleaning with iso-propanol or methanol is acceptable.

The non-polar solvents will break up the gel-layer on the glass bulb and requires that the electrode to be soaked in water for at least 12 hours before functioning normally again. The Teflon (PTFE) diaphragm of the sensor can sometimes be regenerated by putting it in hot (60 to 80°C) 3 molar Potassium Chlorine (KCl) solution and letting it cool to room temperature. This procedure clears the junction of process material and then “draws” the conductive (KCl) back into the junction.

6. MODEL CODES

<table>
<thead>
<tr>
<th>Model Code</th>
<th>Suffix Code</th>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FU20</td>
<td></td>
<td></td>
<td>Wide body sensor</td>
</tr>
<tr>
<td>Cable length</td>
<td>-03</td>
<td></td>
<td>3 mtr</td>
</tr>
<tr>
<td></td>
<td>-05</td>
<td></td>
<td>5 mtr</td>
</tr>
<tr>
<td></td>
<td>-10</td>
<td></td>
<td>10 mtr</td>
</tr>
<tr>
<td></td>
<td>-20</td>
<td></td>
<td>20 mtr</td>
</tr>
<tr>
<td></td>
<td>-VP</td>
<td></td>
<td>Vario Pinconnector (no cable)</td>
</tr>
<tr>
<td>Temp. element</td>
<td>-T1</td>
<td></td>
<td>Pt1000</td>
</tr>
<tr>
<td>Model</td>
<td>-NPT</td>
<td></td>
<td>Dome shape model</td>
</tr>
<tr>
<td></td>
<td>-FSM</td>
<td></td>
<td>Flat surface model</td>
</tr>
<tr>
<td>Options</td>
<td>/HCNF</td>
<td></td>
<td>Hastelloy cleaning system</td>
</tr>
<tr>
<td></td>
<td>/FPS</td>
<td></td>
<td>Adapter F*40 from noryl</td>
</tr>
<tr>
<td></td>
<td>/NSS</td>
<td></td>
<td>1” NPT adapter, SS (316L)</td>
</tr>
<tr>
<td></td>
<td>/NTI</td>
<td></td>
<td>1” NPT adapter, Titanium</td>
</tr>
<tr>
<td></td>
<td>/BSS</td>
<td></td>
<td>1” BSP adapter, SS (316L)</td>
</tr>
<tr>
<td></td>
<td>/BTI</td>
<td></td>
<td>1” BSP adapter, Titanium</td>
</tr>
</tbody>
</table>
## 7. SPARE PARTS

<table>
<thead>
<tr>
<th>Spare part</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FU20</strong></td>
<td></td>
</tr>
<tr>
<td>K1523DD</td>
<td>/FPS Adapter for FF40, FS40 and FD40 fittings (PPO)</td>
</tr>
<tr>
<td>K1547PK</td>
<td>/NSS 1&quot; NPT, Stainless Steel adapter (Viton O-ring)</td>
</tr>
<tr>
<td>K1547PL</td>
<td>/BSS ISO 7/1-R1, Stainless Steel adapter (Viton O-ring)</td>
</tr>
<tr>
<td>K1547PM</td>
<td>/NTI 1&quot; NPT, Titanium adapter (Viton O-ring)</td>
</tr>
<tr>
<td>K1547PN</td>
<td>/BTI ISO 7/1-R1, Titanium adapter (Viton O-ring)</td>
</tr>
<tr>
<td>K1500 FR</td>
<td>Viton O-rings 29.82*2.62 (5 pcs) for 1&quot; adapter</td>
</tr>
<tr>
<td>K1500FS</td>
<td>EPDM O-rings 29.82*2.62 (5 pcs) for 1&quot; adapter</td>
</tr>
<tr>
<td>K1500FT</td>
<td>Silicone O-rings 29.82*2.62 (5 pcs) for 1&quot; adapter</td>
</tr>
</tbody>
</table>

**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 lengths (XXX = 005, 010, 025 & 050 m)
- WU10-V-S-XX Variopin cable (XX = 02, 05, 10, 15 and 20 m)