Instruction Manual

Model SC200
2-wire Conductivity or Resistivity transmitter

YOKOGAWA

IM 12D7B2-E-H
4th edition
**ADJUSTMENT KEYS**

- >: Choose digit for adjustment
- ∧: Adjust digit (to decrease pass through zero)
- ENT: Enter new value

**SELECTION KEYS**

- YES: Accept setting
- NO: Change to new setting

**SELECT MODE MEASURE/Maintenance**

Can be used to escape program at any time.

**Note:** First digit changes from 1,-1,- to blank.
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1. INTRODUCTION

1-1. Application
The EXA SC200 transmitter is a 2-wire conductivity instrument intended to be used in industrial installations in the field. For easy maintenance and operation it should be located close to the sensors. The cable length is limited to 10 metre. It is powered from a remote low voltage DC power supply through the 2-wire connection.

The instrument is available in two versions:
- A general purpose version for use in safe areas.
- An intrinsically safe version for use in hazardous areas. The instrument can then be installed in Zone 1 with the sensors in Zone 0 or Zone 1.

The micro-processor is used in this instrument for continuous loop diagnostics, flexible on site commissioning and fine tuning by advanced functions.

In general a conductivity loop can be set up for different purposes:
- To be part of a total process control system.
- To indicate dangerous limits of a process.
- To monitor product quality.

1-2. Required components for conductivity measurement
A. a conductivity sensor (also called conductivity cell) with integral temperature sensor Ni-100 or Pt-1000.
B. a fitting for the above sensor with accessories.
C. a signal cable with or without extension boxes etc.
D. the EXA SC200 2-wire transmitter with universal mounting accessory for wall, pipe or panel mounting.
E. a DC power supply (nominal 24 V DC) with cabling and optional zener barriers or an intrinsic safe power supply.
F. peripherals: e.g. strip-chart recorder, panel indicator, PID-controller

1-3. Identification
The instrument has an identification label, which is fixed to the front plate. This serves as a reference for the full model code, power supply voltage and serial number. This label also carries authorised marks to certify compliance with the current regulatory norms.

MODEL
SERIAL NO.
SUPPLY
2. SPECIFICATIONS

2-1. General specifications

A. Intrinsic safety (model SC200S only)
- BASEEFA: Certified by and meets the requirements of EEx [ia] ib IIC T4 of CENELEC
  Certificate No.: 89C2379.
- FM: For IS CL1, DIV1, GP ABCD
  T3B for TA-30 to 70°C
  T4 for TA-30 to 40°C
  Approval report: J.I. 1Y1A7.AX
- CSA: For Ex[ia] Class 1, Div. 1, Groups C and D, T4A
  Approval file: LR 102851-1

B. Indicating range
0.055µS/cm to 2000 mS/cm at 25°C reference temperature with cell-constants between 0.01 to 10 cm⁻¹

C. Transmission signal
4 - 20 mA DC; maximum load: 550 Ω

D. Transmission range
User programmable to any range within the indicating range with a maximum of 60% zero suppression.
A user programmable output table can be set up in 21 steps.

E. Power supply
- Model SC200G: 17 to 40 V DC, dependent on load.
- Model SC200S: 17 to 31.5 V DC, powered from a certified zener barrier or isolated power supply

F. Climatic condition
- Ambient temperature: -10 to +55 °C (10 to 130°F)
- Storage temperature: -30 to +70 °C (-20 to 160°F)
- Relative humidity: 10 to 90%
- Weather protection: Rain and dust-tight to IP65 (NEMA 4X)
- Interference protection: EMI Class B
  RFI less than 2% at 5 V/m for 20 MHz to 1 GHz.

G. Display method
- Main display: 31/2 digit, 12.5 mm high.
- Message display: 6 alphanumeric characters, 7 mm.
- Special fields: Flags for status indication.
- Units: µS/cm, mS/cm.
- Key prompts: YES, NO, ^, >, ENT

H. Keys
6 keys operated through the flexible window with tactile feedback and one hidden key behind the front cover.

I. Housing
- Body material: Cast aluminium with chemical resistant coating.
- Window: Flexible poly carbonat.
- Colours used: Moss green/ off-white.
- Cable glands: Polyamide
- Cable entries: Two glands PG 16 (¼" NPT adapter for US Model).
  Hose connection optional.
- Terminals: For maximum 2.5mm² cable (cable finishings preferred).
- Earth connection: For external ground.

J. Mounting possibilities
- Bracket mounting: Two M6 bolts, 9 mm length.
  Wall, or pipe mounting by the optional mounting kit, panel mounting by self tapping screws.

K. Shipping details
- Dimensions: 162 x 178 x 115 mm (6.5 x 7 x 4.5”)
- Package: 290 x 225 x 170 mm (11.5 x 8.9 x 6.7”)
- Weight: approx. 2.5 kg (5 lbs)

L. Safety and security
- Data protection: Non volatile memory (EEPROM).
- All data is stored 3 times.
- Data backup: according to IEC 801.
- Interference test: no effect, reset to measurement.
- Power down: Operation
  All 3 levels can be protected with a 3 digit passcode.
2-2. Functional description

The EXA SC200 is a real time micro-controller operated conductivity-analyzing system. It uses a dedicated micro-controller to control all function necessary in such a system. The input and output functions are concentrated in the analogue section of the instrument. Even these functions are operated through special interfaces designed to give a minimum of interference problems to the digital functions. A separation of function is strictly executed.

By using very low power components it is possible to make a complete micro-computer system work on less than 4 mA current. By using an EEPROM for essential information the operating parameters are fixed in memory without the need for batteries. The supply-voltage is stabilized by regulators to the internal supply system. Any voltage between 17 and 40 Volt is acceptable.

The user-interface is limited to a basic set of 6 keys accessible through the flexible window cover.

The software is designed with the user in mind. It uses a simple 3 layer set-up to communicate with the operator by giving messages on the second line of the display area and indicating which keys are to be pressed in the display too.

The keys are scanned continuously and the actions are taken immediately. An extensive system of checking values and parameters is implemented.

The EXA SC200 operates just like a normal 2-wire instrument but with additional functions. These extra functions are possible by using a micro-controller at the heart of the system.

- Continuous sensor polarisation checking during measurement.
- Automatic optimisation of measuring pulse frequency and reference voltage.
- Accurate temperature compensation by non liner NaCl algorithm.
- Simple output range adaptation making it a versatile instrument.
- A HOLD-function for the current output signal.
- Selection of temperature sensors.
- Passcode protection.

Additionally YOKOGAWA designed the instrument in such a way that an intrinsically safe version is available with the same features and specifications. In fact the instrument is only adapted slightly to fulfil the requirements of CENELEC.

The instrument comes in 2 versions only:
- A general purpose model.
- An intrinsically safe model.

This makes it easy to set up the instrument on site and valuable for large scale exchanges or emergency operations.
3. INSTALLATION AND WIRING

3-1. Installation and dimensions
3-1-1. Installation site
As the transmitter is a rain-tight type, it can be installed outdoors as well as indoors. It should, however, be installed as close as possible to the sensors avoiding long cable lengths between sensors and transmitter. The certified version can be installed in Zone 1.

Select an installation site where:
- mechanical vibrations and shocks are negligible;
- no relay/power switches are in the direct environment;
- the transmitter is not mounted in direct sunlight and severe weather conditions;
- maintenance activities are possible (no corrosive atmospheres).

The ambient temperature and humidity should be the limits of the specifications.

3-1-2. Mounting methods
The EXA SC200 transmitter has universal mounting possibilities:
- panel mounting using selftapping screws;
- surface mounting on a plate (by bolts from the back);
- wall mounting on a bracket (e.g. thick brick wall);
- pipe mounting using a bracket on a horizontal or vertical pipe (maximum diameter 50 mm);

Panel-mounting
Surface mounting
Cut-out dimensions for panelmounting
Dimensions
Universal pipe/wall mounting

Wall mounting

Pipe mounting (vertical)

Pipe mounting (horizontal)
3-2. Wiring of sensors

3-2-1. General precautions
Generally, transmission of signals from the conductivity sensor is at a low voltage and high impedance level. Thus care must be taken to avoid interference. Before connecting the sensor cable to the transmitter make sure the next conditions are met:
- the sensor cable is not to be mounted in tracks together with high voltage and or power switching cables;
- use only the standard conductivity cable with a maximum length of 10 metre;
- mount the transmitter within the distance of the cable.

NOTE:
The outside earth terminal should be connected to site ground by a large area conductor (e.g. a flat earth strip) for best protection against interference.

3-2-2. Additional precautions for installations in hazardous areas
Make sure that the total of capacitances and inductances connected to the input terminals of the EXA SC200 do not exceed the limits given in the certificate. This sets a limit to the cable and extensions used.

The intrinsic safe version of the EXA SC200 instrument can be erected in Zone 1.

The sensors can be installed in Zone 0 or Zone 1 if a safety barrier according to the limits given in the system certificate is used.

3-2-3. Grounding the liquid
In all circumstances, the sensor side of the measuring loop is grounded to the measuring liquid through one of the electrode contacts in the conductivity cell. The supply and output signal are isolated to avoid unintentional ground loops.

3-2-4. Access to terminal and cable entry
1. To access terminals remove the front cover of the EXA SC200 by releasing the 4 captive screws.
2. Pull the sensor cable into connection space and connected the wires to the terminals as indicated by the numbers on the wires. Make sure all connections are firm and do not touch each other.
3. Screw the gland securely and tighten it to keep out moisture. DO NOT use a wrench to tighten the nut.
4. A hose connection can be used to guide the cables coming from an immersion fitting through a protective plastic tubing to the transmitter. This adaptor has to be bought separately.
3-2-5. Connecting diagram for sensors

**2-Electrode system**

- Use cable WU40/LH...
- Max. recommended length 10 m
- Use Cells SC41 or SC42

**Range selection**

- C= 10/cm
- C= 1/cm
- C= 0.1/cm
- C= 0.01/cm

**4-Electrode system**

- Use cable WU40/LH...
- Max. recommended length 10 m
- Use Cells SC49

**Range selection**

- C= 10/cm
- C= 1/cm
- C= 0.1/cm
- C= 0.01/cm
3-3. Wiring of power supply

3-3-1. General precautions
Do not activate the power supply yet. First make sure that the DC-power supply is according to the specifications given. WARNING: DO NOT USE ALTERNATING CURRENT OR MAINS POWER SUPPLY! ! The cable leading to the distributor (power supply) or safety barrier transports power to and output signal from the transmitter. Use a two conductor shielded cable with a size of at least 1.25 mm² and an outside diameter of 9 to 15 mm. The cable gland supplied with the instrument accepts these diameters. The maximum length of the cable is 2000 metre. This ensures the minimum operating voltage for the instrument.

3-3-2. Additional precautions for installation in hazardous areas
1. Ensure that the total of capacitances and inductances connected to the terminals of the EXA SC200 do not exceed the limits given in the certificate of the safety barrier or distributor.
2. The cable used should preferably have a BLUE colour or marking on the outside.
3. Grounding:
   • If the transmitter is mounted on a non-conducting surface (e.g. a brick wall) it is recommended to ground the shield of the 2-wire cable at the distributor end.
4. Installation for EEx ia (sensors in Zone 0 or 1):

Generally, the distributor with input/output isolation has no external earth connection. If there is an earth connection on the distributor and the external connection of the transmitter is connected to "protective" earth, the shield of the 2-wire cable may NOT be connected to "protective" earth at the distributor too.

3-3-3. Access to terminal and cable entry
The terminal strip is accessed by removing the cover from the transmitter as was described in § 3-2-4. Use the left-hand gland to insert the 2-wire cable to the transmitter. Connect the supply to the terminals marked +, - and G as is indicated in the figures on pages 9 & 10.

3-3-4. Power on
After all connections are made and checked, the power can be switched on from the distributor. Observe the correct activation of the instrument at the display. If for any reason the display does not indicate a value, consult the trouble shooting section.
Wiring diagrams for power supply

General purpose design
Conductivity transmitter
EXA SC200G

NOTE:
The outside earth terminal should be connected to site ground by a large area conductor (e.g. a flat earth strip) for best protection against interference.

Dependance of load to supply voltage

![Graph showing the relationship between supply voltage and load resistance. The x-axis represents supply voltage (V) ranging from 0 to 1200 Ohm, and the y-axis represents load resistance (Ω) ranging from 0 to 1200 Ohm. The graph shows an upward trend indicating that as the supply voltage increases, the load resistance also increases.]
Wiring diagrams for hazardous areas

Intrinsically safe design
(CELENEC standard EEX ib [a] IIC T4)
Conductivity transmitter
EXA SC200S

EEx ib certified safety barrier
Electronic current
Vmax: 31.5 V
Imax: 35 mA
Pmax: 0.66 W
Zener barrier with resistor
Vmax: 28 V
Imax: 93.3 mA
Pmax: 0.66 W

Distributor
Output

Sensor
Protective earth
Hazardous area
Zone 0 of 1
Zone 1
Safe area
Supply

Protective earth

Intrinsically safe design
(CELENEC standard EEX ib [a] IIC T4)
Conductivity transmitter
EXA SC200S

EEx ib Certified distributor with input/output isolation
Shunt zener-barrier or supply unit or isolated repeater
Vmax: 22 V
Imax: 85 mA

Output
Supply

Sensor
Protective earth
Hazardous area
Zone 0 of 1
Zone 1
Safe area
### 4. COMMISSIONING

#### 4-1. Operations overview

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<th>Routine</th>
<th>Use</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operation by keys through the closed cover</strong></td>
<td>CAL</td>
<td>Calibration</td>
</tr>
<tr>
<td></td>
<td>DISPLAY</td>
<td>Show or fix additional values</td>
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<tr>
<td></td>
<td>HOLD</td>
<td>Switching hold function on/off</td>
</tr>
<tr>
<td>COMMISSIONING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>**Operation by <em>-<em>key when cover is removed</em></em></td>
<td>OUTPUT</td>
<td>Adjusting the output range</td>
</tr>
<tr>
<td></td>
<td>SET HOLD</td>
<td>Activating the hold function</td>
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<td></td>
<td>TEMPERATURE</td>
<td>Temperature compensation</td>
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<tr>
<td>SERVICE</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operation by coded entry from commissioning</strong></td>
<td>SERVICE</td>
<td>Fine tuning the performance</td>
</tr>
</tbody>
</table>

Note: All levels can be protected by a 3 digit passcode. See §7-15.
4-2. Output range adjustment

1. Access output

Remove cover by releasing 4 screws.

Access commissioning menu

select output function

Select OUTPUT

YES

NOTE:
If the output is commissioned to be via a table this whole item will be skipped! Default is a linear range.

2. Adjust low span value

Display will show * 0%

Adjust value for low span
Select digit to adjust or decimal point and units

Adjust digit

Confirm adjusted value

MODE

Return to measurement

3. Adjust high span value

Display will show *100%

Adjust value for high span
Select digit to adjust or decimal point units

Adjust digit

Confirm adjusted value

MODE

ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.
4-2. Output range adjustment

1. What is the output range?
The display will always show the full range of the instrument from 0-2000 mS/cm. Maximum resolution is assured by autoranging, where the position of the decimal point and the measuring units (microSiemens/-milliSiemens) are moved to best fit the actual value.

For control or recording the current output can be ranged to a specific part of the total measuring span. When selecting the measuring range care must be taken to use the appropriate conductivity cell. For any given cell constant there is a defined range of operation which should not be exceeded.

From the factory the instrument has a linear output range 0-1 mS/cm in combination with a cell constant C=0.1 cm⁻¹.

Other linear ranges can be programmed in this routine. It is also possible to program non linear output ranges for specific applications. These are programmed in the service level, see sections 7-5 and 7-6.

2. Programming a linear output range
A linear output range is programmed by entering two values:
- 0% the conductivity at the start of the output range which corresponds to 4 mA
- 100% the conductivity at the end of the output range which corresponds to 20 mA

When programming a range which does not start at zero conductivity, take care to respect the minimum value corresponding to 60% of the maximum value.

3. Example
The EXA SC200 has an output table which can be programmed to give any non-linear output characteristic. Activation of this table is described in §7-5. Once the table is activated the linear OUTPUT routine will no longer have any effect and will not be accessible in the commissioning menu. Programming of the 21 step table is described in § 7-6.

Non-linear outputs are commonly used for measurements in pure water where high resolution is required over a small range combined with trend indication over a larger range. Common forms of output for these applications are given in §7-17. The non-linear output can also be used to follow a concentration curve for a specific product. Care must be taken to ensure that the temperature compensation is also set up for the measured fluid under representative conditions. It should also be noted that conductivity measurements are not specific, so it can be influenced by impurities present or changes in the fluid composition.

4. Other possibilities
Programming a percent by weight indication on the second display line §7-13
4-3. Set up HOLD function

1. Access HOLD routine

2. Activate HOLD function

3. Adjust value to hold

Access commissioning menu

Select SET HOLD

Move pointer to SET HOLD

SELECT choice

Activate (de-activate) HOLD

Change setting

Conform setting

Select HOLD fixed or last

Change selection

Confirm selection

Adjust fixed value

Select digit to adjust

Adjust value of digit

Accept value

Return to measurement

ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.
4-3. Set up HOLD function

1. What is HOLD?
HOLD is a function freezing the output signal temporary, during normal maintenance, preventing all sorts of alarming situations to occur.
Two possibilities are generally used:

a. Keeping the output at the LAST value just before the start of maintenance. This can only be used when a recorder is connected.

b. Keep the output at a preset FIXED value which will not cause any of the alarms to go off or any controlling action to be taken. This is the preferred situation when dealing with Conductivity-control systems.

2. How does it work?
The HOLD-function has to be activated from the *-menu before it can be used.

The EXA SC200 will keep the output frozen during the following events:
- Access to the *-menu.
- Access to the calibration mode.
- Switching it from the MODE-menu.

HOLD is signalled in the display by a special field.

The operator is prompted to switch HOLD on or off before returning to normal measurement.

3. Example
In a storage tank the concentration of sodium hydroxide (caustic soda) has to be kept at 5%. The mixing process is controlled by a conductivity transmitter and electro-magnetic valves.
During maintenance of the conductivity cell or the transmitter the HOLD function is activated to keep the mixing process from wasting precious chemicals to the sewer.
The HOLD function is set for a fixed output so that the dosing valves will not be activated.

4. Time out
Hold will be de-activated after 20 minutes if no key is pressed. To cancel this function see 7-8.
4-4. Temperature compensation

1. Access temperature compensation routine

- Access the maintenance menu
- Select temperature compensation routine
- Move pointer to TEMP
- Select temperature compensation function

2. Select automatic NaCl temperature compensation

- Select automatic compensation
- Change displayed selection
- Confirm selection

TEMP = Temperature compensation function
NaCl = Automatic temperature compensation

3 Select temperature coefficient compensation

- Adjustment of the conductivity value
- Select digit to adjust
- Adjust manual temperature
- Confirm adjusted value

The setting of the temperature coefficient is done by adjusting a conductivity value, at process temperature, to the conductivity value that was measured at reference temperature.

NOTE:
1. If NaCl is chosen the temperature compensation will be according to NaCl solutions.
2. If *NaCl and *T.C. do not appear, this indicates that Matrix compensation is selected in service code 13.

Error E2 indicates that the temperature coefficient is less than -10%/°C or more than +10%/°C.

NOTE:
Direct setting of the compensation factor is possible. Refer to §7-12.

MODE
ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.
4-4. Temperature compensation

1. Why is temperature compensation necessary?
The conductivity of a solution is very strongly influenced by temperature. Typically for every 1°C change in temperature the solution conductivity will change by approximately 2%.

The effect of temperature varies from one solution to another and is determined by several factors: solution composition, concentration and temperature range. In very pure water the temperature influence increases dramatically with increasing purity to approximately 6%/°C.

A coefficient (a) is used to express the amount of temperature influence in % change in conductivity/°C.

In almost all applications this temperature influence must be compensated before the conductivity reading can be interpreted as a measure of concentration or purity.

2. Automatic temperature compensation with EXA SC200
From the factory EXA SC200 instruments are calibrated with a general temperature-compensation function based on a sodium-chloride salt solution. This is suitable for many applications and is compatible with the compensation functions of typical laboratory or portable instruments.

As conductivity decreases into the range of pure water the instrument will follow the non-linear compensation function of neutral NaCl solutions. In the high conductivity region the effect of temperature decreases and the compensation factor is decreased too. In these extreme regions the temperature compensation factor is calculated with a square equation.

A temperature compensation factor is derived from the following equation:

\[
\alpha = \frac{K_t - K_{ref}}{T - T_{ref}} \times \frac{100}{K_{ref}}
\]

\(\alpha = \text{Temperature compensation factor (in } \%/\text{°C)}\)
\(T = \text{Measured temperature (°C)}\)
\(K_t = \text{Conductivity at } T\)
\(T_{ref} = \text{Reference temperature (25°C)}\)
\(K_{ref} = \text{Conductivity at } T_{ref}\)

3. Manual setting of temperature compensation with EXA SC200
If the general compensation function is found to be inaccurate for the sample in question, the instrument can be set manually for a linear factor on site to match the application.

The procedure is as follows:
1. Take a representative sample of the process liquid during operation.
2. Heat or cool this sample to the reference temperature of the instrument (usually 25°C). Note: see §7-4.
3. Measure the conductivity of the solution with the SC200 and note the reading of the display.
4. Bring the sample to the typical process temperature. (Check the temperature with the display routine.)
5. Adjust the reading of the display to the previously noted value at the reference temperature.
6. Check that the temperature compensation factor has been changed (from the display routine).
7. Insert the conductivity cell into the process again.

4. Other possibilities
Manual temperature coefficient §7-12.
4-5. Sensor selection and diagnostics

4-5-1. General remarks
The EXA SC200 continuous sensor diagnostics can lead to the indication of faults due to the fouling of the connected sensor. The fault will be indicated with a signal field on the display and (if activated) by a 22 mA signal. The selection of the correct conductivity cell with the suitable cell constant is explained in the next section.

4-5-2. Selecting a conductivity cell
First select the range limits for the EXA instrument.
For conductivity values below 1 µS/cm the only choice is a cell with cell constant 0.01 cm⁻¹. From 1 µS/cm up to 10 mS/cm a cell with cell constant 0.1 cm⁻¹ can be used. A cell constant of 1 cm⁻¹ is used between 10 µS/cm up to 100 mS/cm. The cell with cell constant 10 cm⁻¹ is used from 100 µS/cm to 1 S/cm. All these values refer to the actual measured values at the operating temperature.
Above 20 mS/cm with \( C = 1 \) cm⁻¹ and 200 mS/cm with \( C = 10 \) cm⁻¹ 4-electrode cells are advised.

Yokogawa delivers cells from a choice of chemically resistant materials like stainless steel, epoxy resin, PTFE and PVDF.

4-5-3. Selecting a different cell constant
The EXA SC200 can be programmed to accept any cell with a cell constant between 0.01 and 50/cm. The adjustment of the cell constant must be executed from the service level §7-7.

4-5-4. Integral temperature sensor
The factory setting for the temperature sensor is a Pt-1000 element. To get a different temperature setting the service level setting at § 7-4 is used.
A separate temperature sensor can be connected, if no integral temperature element is present in the conductivity cell.
Choose a Ni-100, NTC or Pt-1000 sensor to get the correct temperature reading.

4-5-5. Sensor diagnostics and related error messages
The check for polarisation of the electrodes is only working correctly when the cell constant has been chosen to match the measuring range. The check is automatically switched off when the 4-electrode measuring principle is selected. The check can manually be switched on or off: refer to §7-14. The factory setting for the polarisation check is off.
5. MAINTENANCE
5-1. Calibration

1. Access calibration routine

2. Adjust value

3. End calibration

---

**MODE** Access maintenance mode

**YES** Conform start of adjustment

Adjust process value to previously determined value (e.g. from hand-held conductivity-meter)

**NO** Continue routine to calibrate second point (repeat step 2)

---

**YES** Select digit to adjust

**ENT** Select calibration

Error E3 indicates that the calibration value is deviating more than 20% from the originally measured value.

**MODE** ESCAPE TO MEASUREMENT can be used at any stage to abort operation. WARNING: If the HOLD function is activated the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.
5-1. Calibration

1. When is calibration necessary?
Calibration of conductivity instruments is not normally required since conductivity cells are manufactured within controlled tolerances and do not alter in use.

If the cell has been severely fouled or subject to abrasion (possibly during cleaning) it may be necessary to calibrate.

Alternatively calibration may be carried out with a simulator to check the electronics only.

2. How is calibration done?
Calibration is carried out by measuring a solution which has a known conductivity and adjusting the instrument to show the correct conductivity value.

Calibration solutions can be made up in the laboratory. A solution of salt is made with precise concentration. Temperature is stabilised to the reference temperature of the instrument (usually 25°C). The conductivity of the solution is taken from tables.

Alternatively the instrument may be calibrated in an unspecified solution against a standard instrument. Here care should be taken to make measurement at the reference temperature since differences in the type of temperature compensation of the instruments may cause an error.

3. Typical calibration solutions
The table below shows typical conductivity values for solutions which may be made up in the laboratory.

<table>
<thead>
<tr>
<th>% weight</th>
<th>mg/kg</th>
<th>Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001</td>
<td>10</td>
<td>21.4 µS/cm</td>
</tr>
<tr>
<td>0.003</td>
<td>30</td>
<td>64.0 µS/cm</td>
</tr>
<tr>
<td>0.005</td>
<td>50</td>
<td>106 µS/cm</td>
</tr>
<tr>
<td>0.01</td>
<td>100</td>
<td>210 µS/cm</td>
</tr>
<tr>
<td>0.03</td>
<td>300</td>
<td>617 µS/cm</td>
</tr>
<tr>
<td>0.05</td>
<td>500</td>
<td>1.03 mS/cm</td>
</tr>
<tr>
<td>0.1</td>
<td>1000</td>
<td>1.99 mS/cm</td>
</tr>
<tr>
<td>0.3</td>
<td>3000</td>
<td>5.69 mS/cm</td>
</tr>
<tr>
<td>0.5</td>
<td>5000</td>
<td>9.48 mS/cm</td>
</tr>
<tr>
<td>1</td>
<td>10000</td>
<td>17.6 mS/cm</td>
</tr>
<tr>
<td>3</td>
<td>30000</td>
<td>48.6 mS/cm</td>
</tr>
<tr>
<td>5</td>
<td>50000</td>
<td>81.0 mS/cm</td>
</tr>
<tr>
<td>10</td>
<td>100000</td>
<td>140 mS/cm</td>
</tr>
</tbody>
</table>
5-2. Selecting a value to display

1. Access display routine

<table>
<thead>
<tr>
<th>DISP</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MODE</td>
<td></td>
</tr>
</tbody>
</table>

Access maintenance mode

Select display

Move pointer to DISPLAY

DiISP = DISPLAY routine

Select Display routine

2. Read data

<table>
<thead>
<tr>
<th>20.4°C</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MODE</td>
<td></td>
</tr>
</tbody>
</table>

Read data

To read values only

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>°C/°F</td>
</tr>
<tr>
<td>Output signal</td>
<td>mA</td>
</tr>
<tr>
<td>% by weight</td>
<td>%</td>
</tr>
<tr>
<td>Cell constant</td>
<td>cm⁻¹</td>
</tr>
<tr>
<td>Reference temperature</td>
<td>°C/°F</td>
</tr>
<tr>
<td>Temperature</td>
<td>°C/°F</td>
</tr>
<tr>
<td>Compensation coefficient</td>
<td>standard/manual</td>
</tr>
</tbody>
</table>

REL - software release

Return to measure

3. Reprogram data display

<table>
<thead>
<tr>
<th>20.4°C</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MODE</td>
<td></td>
</tr>
</tbody>
</table>

Reprogram data display

Move to desired value for display

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>°C/°F</td>
</tr>
<tr>
<td>Output signal</td>
<td>mA</td>
</tr>
<tr>
<td>% by weight</td>
<td>%</td>
</tr>
<tr>
<td>Cell constant</td>
<td>cm⁻¹</td>
</tr>
<tr>
<td>Reference temperature</td>
<td>°C/°F</td>
</tr>
<tr>
<td>Temperature</td>
<td>°C/°F</td>
</tr>
<tr>
<td>Compensation coefficient</td>
<td>standard/manual</td>
</tr>
</tbody>
</table>

REL - software release

To select a value for permanent display during measurement

ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.
5-2. Selecting a value to display

1. What is the display routine?
The second line in the display is intended to be used to:
- Show actual status
- Show messages
- Show errors

When delivered from the factory the EXASC200 shows the temperature on the second line.
You can make the instrument show a different parameter on the second line by selecting it from the list at right.

2. What can you read?
Temperature is an actual value.
Output is an actual value.
Percent by weight is an actual value.
Cell constant is programmed.
Reference temperature is programmed.
NaCl or temperature coefficient is programmed.
The choice of temperature units is done from the Service level.
Error messages have priority over other messages.

Note: Percent by weight is only visible when activated from the service level §7-13.

3. Example
To check the value of the output signal (4...20 mA) it is displayed on the second line.
Measuring range 0...100 µS/cm
Output signal 4...20 mA
Process value 60 µS/cm
Output value 13.6 mA

When the second line is changed to display output the current signal is visible all the time.
Whenever HOLD is activated the value on the display is frozen to the programmed value (using the FIXED setting).
Pressing MODE will take you back to measuring and the temperature will show again.
5-3. Use of HOLD function

1. Access hold

   [Diagram showing the process of accessing hold]

   Access maintenance mode
   Select HOLD function
   Move pointer to HOLD

   HOLD = HOLD output function
   Select HOLD function
   Select HOLD

2. Switch hold on/off

   [Diagram showing the process of switching hold on/off]

   Display will blink HOLD and YES/NO
   Switch hold OFF
   Switch hold ON

   HOLD in left top of display is switched

NOTE: This function can only be used if activated during commissioning (see chapter 4-3).

ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.
5-3. Use of HOLD function

1. What is HOLD?
Hold is a function which freezes the output signal temporarily, it is normally used during maintenance when the cell is removed from the measured solution to prevent unwanted controller reaction.

The HOLD function must be commissioned from the programming menu before it can be switched on or off. See commissioning the hold function for more details.

Note:
AUTO RETURN will switch off HOLD after 20 minutes, see § 7-8.

2. How does it work?
From this level the HOLD function can only be switched ON or OFF. HOLD is switched on when you press YES when HOLD and YES/NO are blinking. When you press NO hold will be switched off.
A flag is kept in memory and an indication is made in the upper left corner of the display field.

The HOLD function only influences the output signal, no other functions are influenced.

The operator is prompted to switch HOLD on or off after having performed a maintenance function.

3. Example
During the transfer of cleaning liquid into a batch reactor with a conductivity-control system, the HOLD function is switched ON to prevent the controlling instruments from running wild. After cleaning has ceased and the new batch has been started HOLD is switched OFF again and conductivity control resumes.
6. TROUBLE SHOOTING

6-1. Introduction
The EXA SC200 microprocessor based conductivity analyser continuously monitors the condition of all key components of the measuring system to ensure that measurement is dependable. If a fault is detected this is immediately signalled. Errors are shown on the display with a code. The following table shows the errors which can be detected and gives information to help locate the fault or identify the error. Faults detected whilst the instrument is on line can also be signalled by a (temporary) high output signal (22 mA).

6-2. Self diagnostics of the conductivity cell
During measurement the instrument adjusts the measuring frequency to give the best conditions for the actual value being measured. At low conductivity there is risk of error due to capacitive effects in the cable and cell. These are reduced by using a low measuring frequency. At high conductivity these capacitive effects become negligible and errors are more likely to be caused by polarisation or fouling of the cell. These errors are reduced by increasing the measuring frequency.

At all values the instrument checks the signal from the cell to search for distortion which is typical of capacitive or polarisation errors. If there is a problem with the installation or the cell becomes fouled this will trigger an error message on the display possibly accompanied by a fault signal through a (temporary) high output current (22 mA).

6-3. Self diagnostics of the temperature sensor
The temperature sensor, which is normally built into the conductivity cell, is checked to detect damage or faulty connections.

NOTE:
A temperature fault may be caused by incorrect programming of the temperature element!

6-4. Self diagnostics of the electronics
The microprocessor operation is checked by a watchdog which initiates an electronic reset if the normal function suffers severe interference. During reset the instrument checks the program and all stored data. If a fault is then detected an alarm is given.

6-5. Checking during operation
Whenever the instrument is being programmed or calibrated, data is checked and an error is shown when appropriate. Should this occur the new data is rejected and the instrument continues to work with the previous settings.
## 6-6. Error messages and explanation

<table>
<thead>
<tr>
<th>Code</th>
<th>Error description</th>
<th>Possible cause</th>
<th>Suggested remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1*</td>
<td>Faulty signal from conductivity cell</td>
<td>Polarisation</td>
<td>Check cell is correct for range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cell is fouled</td>
<td>Clean cell</td>
</tr>
<tr>
<td>E2</td>
<td>Wrong temperature coefficient during calibration</td>
<td>Incorrect data entered</td>
<td>Repeat temperature calibration</td>
</tr>
<tr>
<td>E3</td>
<td>Calibration out of limits</td>
<td>Calibration value deviates more than 20%</td>
<td>Check cell, connections or reference</td>
</tr>
<tr>
<td>E5*</td>
<td>Conductivity too high</td>
<td>Measurement is out of range</td>
<td>Check cell range, reprogram range</td>
</tr>
<tr>
<td>E6*</td>
<td>Conductivity too low</td>
<td>Measurement is out of range</td>
<td>Check cell range, reprogram range</td>
</tr>
<tr>
<td>E7*</td>
<td>Temperature too high</td>
<td>Wrong temperature sensor selected</td>
<td>Program sensor type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fault in connections</td>
<td>Check connections</td>
</tr>
<tr>
<td>E8*</td>
<td>Temperature too low</td>
<td>Wrong temperature sensor selected</td>
<td>Program sensor type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fault in connections</td>
<td>Check connections</td>
</tr>
<tr>
<td>E10*</td>
<td>EEPROM write failure</td>
<td>Fault in electronics</td>
<td>Call your YOKOGAWA service organisation</td>
</tr>
<tr>
<td>E15</td>
<td>Temperature correction outside limits (&gt; 5Ω)</td>
<td>Fault in cable or wrong temperature sensor selected</td>
<td>Check connections or program correct sensor type</td>
</tr>
<tr>
<td>E17</td>
<td>Output span too small</td>
<td>0% range value set too high</td>
<td>Program value &lt;60% of high range</td>
</tr>
<tr>
<td>E18</td>
<td>Output table makes no sense</td>
<td>Table changes from ascending to descending or vice versa</td>
<td>Check programming of table</td>
</tr>
<tr>
<td>E19</td>
<td>Programmed value not accepted</td>
<td>Values not acceptable</td>
<td>Reprogram with new values</td>
</tr>
<tr>
<td>E20*</td>
<td>Data lost</td>
<td>Data, including initial setting, lost</td>
<td>Call your YOKOGAWA service organisation</td>
</tr>
</tbody>
</table>

* These errors will trigger the FAIL-status.
7. SERVICE MODE

7-1. Introduction
Generally speaking their is no necessity to adjust the settings of the service section. All parameters are pre-programmed to values (so-called defaults) enabling you to start working immediately.

The advanced functions available through this section are only needed in some specific applications. This fine-tuning of the instrument gives a superior performance over conventional 2-wire instruments.

If a function has to be adjusted it is called up with the code mentioned. Having selected the code then give you the possibility to either activate or adjust the values for this function. After this you will return to the entry point to make other adjustments or go back to the measuring status.

If errors are made during the programming process, these will be indicated, no action will be taken and you can start the programming again.

<table>
<thead>
<tr>
<th>Code</th>
<th>Routine</th>
<th>Use</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Temperature sensors and units</td>
<td>Select sensor type</td>
<td>7-3</td>
</tr>
<tr>
<td>02</td>
<td>Reference temperature</td>
<td>Select °C or °F</td>
<td>7-4</td>
</tr>
<tr>
<td>03</td>
<td>Output table or linear</td>
<td>Select which to use</td>
<td>7-5</td>
</tr>
<tr>
<td>04</td>
<td>Program output table</td>
<td>Set values in table</td>
<td>7-6</td>
</tr>
<tr>
<td>05</td>
<td>Cell constant</td>
<td>Adjust cell-constant</td>
<td>7-7</td>
</tr>
<tr>
<td>06</td>
<td>Auto return function</td>
<td>Switch on or off</td>
<td>7-8</td>
</tr>
<tr>
<td>07</td>
<td>Measuring principle</td>
<td>Select 2 or 4 electrode</td>
<td>7-9</td>
</tr>
<tr>
<td>08</td>
<td>Temperature adjust</td>
<td>Correct cable error</td>
<td>7-10</td>
</tr>
<tr>
<td>09</td>
<td>Signal errors or output</td>
<td>Switch on or off</td>
<td>7-11</td>
</tr>
<tr>
<td>10</td>
<td>Temperature compensation factor</td>
<td>Adjust factor</td>
<td>7-12</td>
</tr>
<tr>
<td>11</td>
<td>%-indication on second display line</td>
<td>Switch on or off and set values</td>
<td>7-13</td>
</tr>
<tr>
<td>12</td>
<td>Polarisation check</td>
<td>Switch on or off</td>
<td>7-14</td>
</tr>
<tr>
<td>13</td>
<td>Matrix compensation</td>
<td>Select 5x5 matrix compensation</td>
<td>10-2</td>
</tr>
<tr>
<td>14</td>
<td>Matrix temperature</td>
<td>Set temperatures for user matrix</td>
<td>10-3</td>
</tr>
<tr>
<td>15-19</td>
<td>Matrix data</td>
<td>Set data for user matrix</td>
<td>10-4</td>
</tr>
<tr>
<td>20</td>
<td>“Soft”/“hard” fail situation</td>
<td>Select “soft” or “hard” fail message per fail code</td>
<td>10-5</td>
</tr>
<tr>
<td>21</td>
<td>E6-fail message</td>
<td>Switch on or off</td>
<td>10-6</td>
</tr>
<tr>
<td>33</td>
<td>Passcode activation</td>
<td>Protecting levels</td>
<td>7-15</td>
</tr>
<tr>
<td>55</td>
<td>Restore defaults</td>
<td>Erase values</td>
<td>7-16</td>
</tr>
</tbody>
</table>
7-2. Access to service settings

1. Access service

- Access commissioning menu

- Select service function
  Move pointer to service

*SERV = Service settings

- YES Select SERVICE

2. Enter code to select required function

- Display will show *CODE

- Enter access code to select routine
  Select digit to adjust

- Adjust code for entry

- Confirm choice

3. Adjust setting (see individual routines)

- Display shows current setting
  Values adjusted access to individual routine description

- Adjust settings
  Select digit to adjust

- Adjust value

- Confirm adjusted value

- Return to measure

ESCAPE TO MEASURE can be used at any stage to abort operation. WARNING: If the HOLD function is activated the instrument returns with the question HOLD (flashing); answer YES or NO or MODE again to return to measurement.
7-3. Temperature sensors and units
ACCESS-CODE: 01 (see § 7-2)
DISPLAY : *T.CODE

Adjustment (X.X)

<table>
<thead>
<tr>
<th>X.X</th>
<th>Temperature sensor = Pt-1000</th>
<th>Temperature sensor = Ni-100</th>
<th>NTC sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Temperature displayed in °C</td>
<td>Temperature displayed in °F</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Explanations:
The code for the temperature units influences the temperature indication on the display only. Default value is °C. The indication here determines which temperature sensor is connected to the instrument. Check what sensor will be used in your plant and set the correct number for it. Default value is Pt-1000 for Yokogawa sensors, type SC42-.....

Default: °C

7-4. Reference temperature
ACCESS-CODE : 02 (see § 7-2)
DISPLAY : *T.R. °C or *T.R. °F

Adjustment : Adjust the value for the reference temperature used in the calculations. Normally this value will be 25°C.

Explanation:
All measured values are compensated for temperature to refer to comparable values at 25°C. This temperature is easily produced at laboratory conditions and most literature data use this temperature. In exceptional cases it is possible to use a different reference temperature in combination with a programmed temperature coefficient (e.g. Sulfuric acid measurement).

Default: 25°C

7-5. Output code selection
ACCESS-CODE: 03 (see § 7-2)
DISPLAY : *TABLE

Adjustment : 0=Linear range only 1=Output table with 20 steps

Explanation:
As a default a linear output is set and only 0% and 100% can be adjusted from the commissioning output function. When an output table is programmed by setting a 1, the table can be programmed at CODE 04. Otherwise CODE 04 will have no effect. See the entry at the next CODE.
7-6. Output table for non-linear range

ACCESS-CODE : 04 (see §7-2)
DISPLAY : 0% to 100%

Adjustment : A 21 step table can be programmed from this entry ONLY IF it was set in the previous CODE 03. It is possible to set up a bi-linear, semi-logarithmic or hyperbolic scale to cope with retro fitting on existing installations. Also linear output to concentration related curves can be programmed.

Explanation:
First you will be presented with the question YES/NO to give the opportunity to skip values from the table. To get a 10 step table you would skip every other value and only answer YES to enter a value. The instrument uses interpolation between entered values. Press NO to skip values. Press YES to adjust value. Now adjust the value by pressing > and ^.

The units can be adjusted as well as the decimal point position. Examples are mentioned in §7-17. Other possibilities: programming "% by weight" indication on second display line: refer to §7-13.

Example of output tables

<table>
<thead>
<tr>
<th>Output</th>
<th>bi-lin</th>
<th>log 2</th>
<th>log 3</th>
<th>hyp 2</th>
<th>hyp 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0.0</td>
<td>1.0</td>
<td>0.10</td>
<td>1.00</td>
<td>0.10</td>
</tr>
<tr>
<td>5%</td>
<td>1.0</td>
<td>1.3</td>
<td>0.14</td>
<td>1.20</td>
<td>0.27</td>
</tr>
<tr>
<td>10%</td>
<td>2.0</td>
<td>1.6</td>
<td>0.20</td>
<td>1.82</td>
<td>0.43</td>
</tr>
<tr>
<td>15%</td>
<td>3.0</td>
<td>2.0</td>
<td>0.28</td>
<td>1.90</td>
<td>0.61</td>
</tr>
<tr>
<td>20%</td>
<td>4.0</td>
<td>2.5</td>
<td>0.40</td>
<td>2.00</td>
<td>0.83</td>
</tr>
<tr>
<td>25%</td>
<td>5.0</td>
<td>3.2</td>
<td>0.56</td>
<td>3.75</td>
<td>1.10</td>
</tr>
<tr>
<td>30%</td>
<td>6.0</td>
<td>4.0</td>
<td>0.79</td>
<td>4.80</td>
<td>1.36</td>
</tr>
<tr>
<td>35%</td>
<td>7.0</td>
<td>5.0</td>
<td>1.12</td>
<td>5.92</td>
<td>1.68</td>
</tr>
<tr>
<td>40%</td>
<td>8.0</td>
<td>6.3</td>
<td>1.58</td>
<td>7.00</td>
<td>2.05</td>
</tr>
<tr>
<td>45%</td>
<td>9.0</td>
<td>7.9</td>
<td>2.24</td>
<td>8.31</td>
<td>2.49</td>
</tr>
<tr>
<td>50%</td>
<td>10.0</td>
<td>10.0</td>
<td>3.16</td>
<td>10.00</td>
<td>3.00</td>
</tr>
<tr>
<td>55%</td>
<td>20.0</td>
<td>12.6</td>
<td>4.47</td>
<td>11.85</td>
<td>3.66</td>
</tr>
<tr>
<td>60%</td>
<td>30.0</td>
<td>15.8</td>
<td>6.31</td>
<td>14.00</td>
<td>4.33</td>
</tr>
<tr>
<td>65%</td>
<td>40.0</td>
<td>20.0</td>
<td>8.91</td>
<td>16.65</td>
<td>5.22</td>
</tr>
<tr>
<td>70%</td>
<td>50.0</td>
<td>25.1</td>
<td>12.6</td>
<td>19.50</td>
<td>6.80</td>
</tr>
<tr>
<td>75%</td>
<td>60.0</td>
<td>31.6</td>
<td>17.8</td>
<td>23.80</td>
<td>8.25</td>
</tr>
<tr>
<td>80%</td>
<td>70.0</td>
<td>39.8</td>
<td>25.1</td>
<td>29.55</td>
<td>11.0</td>
</tr>
<tr>
<td>85%</td>
<td>80.0</td>
<td>50.1</td>
<td>35.5</td>
<td>36.70</td>
<td>14.8</td>
</tr>
<tr>
<td>90%</td>
<td>90.0</td>
<td>63.1</td>
<td>50.1</td>
<td>48.50</td>
<td>21.8</td>
</tr>
<tr>
<td>95%</td>
<td>100.0</td>
<td>79.4</td>
<td>70.8</td>
<td>68.60</td>
<td>36.5</td>
</tr>
<tr>
<td>100%</td>
<td>110.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

NOTE:
Multiply the values from the table with appropriate factors to get the end-scale value you want.

Special concentration tables can be programmed by the user.
7-7. Cell constant adjustment
ACCESS-CODE : 05 (see §7-2)
DISPLAY : *CELL.C

Adjustment : Adjust the value to the cell-constant used with your instrument. Values between 0.01 and 50/cm can be programmed.

Explanation:
Every conductivity cell has a cell-constant, which can be indicated on the outside of the body. Sometimes the cell-constant can be indicated in the type-number of the sensor. Yokogawa produces several models with cell-constants of 0.01, 0.1, 1 and 10/cm. For accurate measurements the cell-constant can be determined in a laboratory test.

Default: 0.1 cm

7-8. Auto return function
ACCESS-CODE : 06 (see §7-2)
DISPLAY : *RET

Adjustment : X

| X | 
|---|---|
| 0 | OFF |
| 1 | ON |

Automatic return to measure after 10 minutes.

Explanation:
As a safeguard against long maintenance jobs or inadvertently pushing a button it is possible to let the system return to its normal function of measurement when no keys are pushed for 10 minutes.

Default: Auto return on

7-9. Measuring principle
ACCESS-CODE : 07 (see §7-2)
DISPLAY : *4ELEC

Adjustment : Select the measuring principle of the transmitter.

| X | 
|---|---|
| 0 | 2-electrode principle |
| 1 | 4-electrode principle |

Explanation:
Select the principle to cooperate with the measuring sensor. The conductivity cell determines which principle can be used. The 4-electrode principle is used for the high conductivity values in general.

Default: 2-electrode principle
7-10. Temperature sensor adjustment
ACCESS-CODE: 08 (see § 7-2)
DISPLAY: °T.ADJ

Adjustment
: Adjust the value of the indicated temperature (°C/°F) to that of the actual temperature.

Explanation:
The temperature measurement is a two wire resistance measurement. In this kind of measurement the length of the connecting cable can influence the accuracy of the temperature indication. To compensate for the extra resistance of the cable up to 5Ω can be calibrated. Connect the correct temperature sensor to the EXA instrument and insert it in a stable temperature bath of a known value.

Check the temperature indicated at this setting in °C or °F and adjust the value if necessary.

Now the EXA transmitter has been calibrated to compensate for the cable resistance.

7-11. Signalling of fail condition
ACCESS-CODE: 09 (see §7-2)
DISPLAY: °BURN

Adjustment: X.X

<table>
<thead>
<tr>
<th>X.X</th>
<th>0</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td>22 mA steady signal on fault.</td>
</tr>
<tr>
<td>2</td>
<td>ON</td>
<td>22 mA pulse during 30s at start of fault then normal output.</td>
</tr>
</tbody>
</table>

Explanation:
Besides an indication at the display in the field, sometimes an indication of errors in the control room is also necessary. This is possible by sending a special signal over the 2-wire connection to the receiving instrument.

A signal of 22 mA is used, because it is outside the normal analogue range of 4 to 20 mA. If at the receiving end an alarm is set to the value represented by 22 mA, it is obvious that the proper action can be taken from the control room too. The signal uses the same convention as used in thermocouple indications for detecting break of the sensor (burn-out).

Default: 0 = OFF

7-12. Temperature compensation coefficient adjustment
ACCESS-CODE: 10 (see § 7-2)
DISPLAY: °T.C.

Adjustment
: Adjust the value of the manually set compensation factor

NOTE:
Access to this routine is only possible when manually set temperature compensation factor (α) is selected in §4-4.

Explanation:
In addition to the procedure described in §4-4 it is possible to adjust the compensation factor directly. If the compensation factor of the sample liquid is known from laboratory experiments or has been previously determined, it can be introduced here.

Adjust the value between -10.00 to -10.00 % per °C. In combination with the reference temperature setting at §7-4 a linear compensation function is obtained, suitable for all kind of chemical solutions.

\[ \alpha = \frac{K_t - K_{ref}}{T - T_{ref}} \times \frac{100}{K_{ref}} \]

Default: skipped, compensation for NaCl is automatic.
7-13. Percent by weight indication on second display line
ACCESS-CODE : 11 (see § 7-2)
DISPLAY : *%

Adjustment: (X)

<table>
<thead>
<tr>
<th>X</th>
<th>0</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td></td>
</tr>
</tbody>
</table>

Select the possibility to display % by weight on the second display line. When % indication is activated (Select 1) the display range can be adjusted:
*0%: Adjust low span display value
*100%: Adjust high span display value

Explanation:
In case a conductivity measurement is used for concentration monitoring it can be convenient to link the measured conductivity value to a % by weight concentration value. A linear concentration indication in % units is programmed by entering two values.
- X in 3 digits corresponds to 0% of the output value (= 4 mA)
- Y in 3 digits corresponds to 100% of the output value (= 20 mA)

Example:
0% output is 93.0% by weight
100% output is 99.0% by weight

The instrument uses interpolation between the entered values. As the relation between percent by weight concentration and conductivity is not linear in most cases, the possibility to linearize the output to concentration units can be used. Refer to §7-5 and §7-6. The instrument becomes a concentration meter by output function and (second) display (line) based on a conductivity measurement.

Default: OFF

7-14. Polarisation check
ACCESS-CODE : 12 (see §7-2)
DISPLAY : *POL.CK

Adjustment: (X)

<table>
<thead>
<tr>
<th>X</th>
<th>0</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td></td>
</tr>
</tbody>
</table>

Generation of the fault E1 can be switched off.

Explanation:
The EXA SC200 normally checks the signal from the cell to search for distortion typical of capacitive or polarisation errors. If there is a problem with the installation or the cell becomes fouled this will trigger the E1 fault signal. In some installations this error detecting can cause unwanted signals during operation. Then the possibility to disable this check will be used.

Note: When 4-electrode measurement is chosen this checking is not performed.

Default: OFF
7-15. Passcode protection by three digit code
ACCESS-CODE : 33 (see § 7-2)
DISPLAY : *PASS

Adjustment(X.X.X)

<table>
<thead>
<tr>
<th>X.X.X</th>
<th>Protection on Maintenance level inactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>X.0.X</td>
<td>Protection on Commissioning level inactive</td>
</tr>
<tr>
<td>X.X.0</td>
<td>Protection on Service level inactive</td>
</tr>
<tr>
<td>#.X.X</td>
<td>Protection on Maintenance level activated</td>
</tr>
<tr>
<td>X.#.X</td>
<td>Protection on Commissioning level activated</td>
</tr>
<tr>
<td>X.X.#</td>
<td>Protection on Service level activated</td>
</tr>
</tbody>
</table>

Note: # can be a digit from 1 to 9, and it will give a protection according to the schematic below of the programmed level.

0 = No passcode  5 = Passcode is 123
1 = Passcode is 111  6 = Passcode is 957
2 = Passcode is 333  7 = Passcode is 331
3 = Passcode is 777  8 = Passcode is 546
4 = Passcode is 888  9 = Passcode is 847

Explanation:
In some cases a protection of operation level is wanted. In this way unauthorized access to any of the 3 levels can be blocked by a simple passcode. When a passcode is selected for an operation level, access to that level can only be obtained after entering the passcode. The display will show a message *PASS* to indicate the entry of the passcode.

NOTE:
For the Maintenance and Commissioning level the passcode entry is always requested when entering from the measure mode.
- For the Service level the passcode entry is requested after pushing the YES-key.
- When the Service level protection is activated, the passcode cannot be changed by unauthorized persons.

Default: 0.0.0.
No Passcode protection.

7-16. Restore default setting
ACCESS-CODE : 55 (see § 7-2)
DISPLAY : ERASE

Adjustment: YES Erase all programmed values and replace them by defaults.
NO Keep all programmed values as before.

Explanation:
This entry is provided to make it possible to start from the default values given by Yokogawa and thus erase all previously programmed information.

WARNING:
Do not use this code without proper authority as all settings and programmed functions will be lost!!

WARNING
Do not enter service codes that are not mentioned in this booklet.
8. CLASSIFICATION

8-1. Cenelec

1 conductivity sensor with integral temperature sensor such as (but not limited to) SC41-SP34, SC41-SP24, SC41-EP14, SC41-EP04. These are all passive sensor to be regarded as "simple apparatus" i.e. devices which comply with clause 1.3 of EN 50014.

Ex-classification: EEx ib [ia] II C T4

ZONE 0 or 1

Zone 1

Non Hazardous Area

Connecting cables such as (but not limited to): WU40-LH18, WU40-LH2, WU40-LH5

Vout = 14.4 V max.
Iout = 72.8 mA max.
C ext = 1300 nF max.
L ext = 8.0 mH max.

BASEEFA Nr. Ex 89C2379

Connecting cables such as (but not limited to):

WU40-LH18, WU40-LH2, WU40-LH5

Vout = 14.4 V max.
Iout = 72.8 mA max.
C ext = 1300 nF max.
L ext = 8.0 mH max.

BASEEFA Nr. Ex 89C2379

Certified Barrier with electronic current limitation and the following characteristics:

V max. out = 31.5 V, I max. out = 35 mA, P max. out = 1.1 W

Type: Yokogawa Bard 400 (BASEEFA Cert. Ex 84B2257x)

Any shunt zenerdiode safety barrier certified by BASEEFA or any EEC approved certification body to [EEx ia] II C or [EEx ib] II C where the output current is limited by a resistor “R” directly in the output line such as that I max. out = V max. out / R and not exceeding the following characteristics:

V max. out = 28 V, I max. out = 93.3 mA and P max. out = 8.66 W.

Such as (but not limited to):

Type: MTL 728
MTL 788 (BASEEFA Cert. Ex 832452)
MTL 788 R
Stahl 8981/31-280/085/00 (P.T.B. Cert. Ex-78/2007X)

Any shunt zenerdiode safety barrier or supply unit or isolated repeater certified by BASEEFA or any EEC approved certification body to [EEx ib] II C or [EEx ib] II C where the output current is limited in a different way and not exceeding the following characteristics:

V max. out = 22 V and I max. out = 85 mA

Such as (but not limited to):

Type: Camille Bauer Sineax 84-2B1-511
Sineax 89-2B1-511 (P.T.B. Cert. Ex-81/2044X)
8-2. FM

NON HAZARDOUS LOCATION

FMRC-Approved Barrier

31.5 V\text{max}
4-20 mA

To be installed in accordance with ANSI/RP 12.6 and NEC requirements
Maximum safe area voltage should not exceed 250 V\text{max}

HAZARDOUS LOCATION

Class I, Division I, Groups ABCD
Vmax = 31.5 V
Imax = 93.3 mA
Ci = 5 nF
Li = 16.5 µH

1 conductivity sensor with integral temperature sensor such as (but not limited to):
SC41-SP34
SC49-PP08
SC41-SP24
SC41-EP14
SC41-EP04
These are all passive sensors to be regarded as “simple apparatus” i.e. devices which do neither store nor generate voltage over 1.2 V, currents over 0.1 A, power over 25 W or energy over 20 mJ

connecting cables such as (but not limited to):
WU40-LH18 WU40-LH2
WU40-LH5
10 meter Maximum

Control Drawing for EXA 200 instruments

IM 12D7B2-E-H
9. CHANGE FROM CONDUCTIVITY TO RESISTIVITY MEASUREMENT

The EXA SC200 can be used for both conductivity and resistivity measurement. As delivered the instrument is set for conductivity measurement.

9-1. How to change from conductivity to resistivity measurement
- Remove the cover after loosening the 4 screws. Now you have access to the Display Board.
- Loosen the 4 screws that hold this board in place and remove it from the enclosure.
- On the upper back side of the Display Board are 5 blue jumpers. Change the spring jumper as shown in the figure. Make sure that center contact spring is securely hold to have good contact.

Within 15 seconds after the jumper change, the EXA SC200 will automatically load default data for resistivity measurement.

9-2. Resistivity measurement
As a resistivity measuring transmitter the EXA SC200 has the same function as described earlier in this manual.

The units mS/cm and µS/cm are replaced by kΩ·cm and MΩ·cm for resistivity measurement. If no unit is shown the unit is Ω·cm and can be changed in kΩ·cm by the key if the “.” is flashing. See range adjustment in section 4-2.

9-3. Maintenance of the transmitter
Calibration of the resistivity transmitter is done in the same way as described in section 5-1.

The calibration values can be calculated as follows:

- kΩ·cm = 1000 µS/cm
- Ω·cm = 1000 mS/cm

Example:
The 0.001 % NaCl-solution has a conductivity value of 21.4 µS/cm. In resistivity mode the value is 1000/21.4 = 46.7 kΩ·cm.

IM 12D7B2-E-H
10. SOFTWARE VERSION 3.0 COMPARED TO VERSIONS 1* AND 2*.

In 1994 the software of EXA SC200 has undergone a major update as result of user feedback. New features are made accessible by additional Service Codes to avoid programming conflicts with users of previous versions.

The new features are:

10-1. Cell constant
ACCESS-CODE : 05
DISPLAY : 1.00xC
Adjustments:
1. Select multiplying factor
2. Adjust the required cell constant
   1. Select multiplying factor with keys YES and NO.
   2. With keys > and ^ any cell constant between 0.01 and 50.0 cm⁻¹ can be selected.

Explanation:
1. Multiplying factor
   - The multiplying factor is confirmed after pressing the YES key.
   - Change multiplying factor to 1.0-10-10-0.01-0.1-1.0 by pressing NO key and confirm selection with YES key.
2. The value of the cell constant is indicated in the specifications of the cell and/or on its identification plate.

Adjust the required value of the cell after pressing the YES key to confirm the multiplying factor.
Select the digit to adjust with key > (digit flashes).
With ^ key the value of the selected digit can be changed.

Example: Cell constant = 0.00985
a. Select multiplying factor 0.01
b. Adjust the value to .985

10-2. Matrix compensation
ACCESS CODE : 13
Display : *MATR

Adjustment:
0 Only linear compensation (see access code 10)
1 HCl pure water (0 - 100 °C)/CATION
2 Ammonia
3 Morpholine in pure water
4 Hydrochloric Acid (1-5%)
5 Nitric Acid (1-5%)
9 User adjustable matrix (see access code 15)

NOTE:
Access to this routine is only possible when manually set temperature compensation factor (α) is selected in §4-4.

Explanation:
The SC200 is equipped with a matrix type algorithm for accurate temperature compensation in various applications. Select the range as close as possible to the actual temperature/concentration range. The SC200 will compensate by interpolation and extrapolation. Consequently, there is no need for a 100 % coverage.

If 9 is selected the temperature compensation range for the user adjustable matrix can be set in access code 15. In access codes 16 and 19 the specific conductivity values at 5 different temperatures is entered.
10-3. Matrix temperature compensation range

ACCESS CODE : 14
Display : °T1 °C

Adjustment: After selecting 9 in Access Code 13 the beginscale and endscale value of temperature compensation range of the users matrix can be adjusted using the keys . and ^.

Explanation:
In service codes 14 to 18 the SC200 transmitter can be fingerprinted to one particular application.
In access code 13 you have the possibility to adjust the compensation range.
After having access to this routine adjust the beginscale value of the compensation range. After entering the beginscale value the display indicates T5 °C and the endscale value can be adjusted. The temperatures T2, T3 and T4 are found proportionally.

Notes:
1. In defining the temperature compensation range, it is important to select T1 and T5 in such a way that the 5 reference temperatures are user friendly.
Example: T1 = 0 and T5 = 80 °C gives reference temperatures of 0, 20, 40, 60 and 80 °C.
2. The minimum span for the range is 50 °C (Error code 17 indicates a temperature range of less than 50 °C).

10-4. Matrix data

ACCESS CODE : 15, 16, 17, 18, 19
Display : *L1*T1

Adjustment: After adjusting the range in access code 14 it is necessary to fill the matrix.

Explanation:
In these access codes the specific conductivity values can be entered for 5 different concentrations of the process liquid; each one in one specific access code (15 to 19).
Adjust the conductivity value of the first solution at temperature T1 using keys > and ^.
Confirm the adjustment by pressing the ENT key. The display indication changes to “L1 xT2”. Now the conductivity value at temperature T2 can be adjusted. Continue this process until “SERV” is displayed and adjustment is finished.
Repeat the procedures for solutions 2 to 4 in access codes 16 to 19.

NOTES:
1. Use the table on page 42 to record your programmed values. It will make programming easy for duplicate systems or in case of data loss.
2. Each matrix column has to increase in conductivity value:
   L1 .Tx< L2.Tx< L3.Tx< L4.Tx< L5.Tx
3. Error code E4 occurs when two standard solutions have identical conductivity values at the same temperature within the temperature range.
10-5. Selection between "soft" or "hard" FAIL Situations
ACCESS CODE : 20
Display : *ERR.01

Adjustment:
NO   Error 01 is skipped; next error is shown
YES  0 = Soft alarm
     1 = Hard alarm
     Pressing ENTER confirms the selection

Explanation:
As described in chapter 6, the error codes marked with an asterisk(*) normally will trigger a number of actions.
If soft alarm action is selected, the FAIL message flag is flashing. The output functions will not go into BURN OUT position and the contact outputs continue to operate.
If hard alarm function is selected, the output goes into BURN OUT signal if programmed that way in Access Code 09: and the FAIL flag is shown in the display.

10-6. Selection between yes or no E6 Fail-message.
### 10-7 Matrix examples

<table>
<thead>
<tr>
<th>Matrix</th>
<th>example</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>CODE 14</td>
<td>TEMPERATURE</td>
<td>T1 ... T5</td>
</tr>
<tr>
<td>CODE 15</td>
<td>SOLUTION 1</td>
<td>L1</td>
</tr>
<tr>
<td>CODE 16</td>
<td>SOLUTION 2</td>
<td>L2</td>
</tr>
<tr>
<td>CODE 17</td>
<td>SOLUTION 3</td>
<td>L3</td>
</tr>
<tr>
<td>CODE 18</td>
<td>SOLUTION 4</td>
<td>L4</td>
</tr>
<tr>
<td>CODE 19</td>
<td>SOLUTION 5</td>
<td>L5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temp.</th>
<th>0 ppb</th>
<th>4 ppb</th>
<th>10 ppb</th>
<th>20 ppb</th>
<th>100 ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cation Conductivity µS/cm</td>
<td>1</td>
<td>0 25 50 75 100</td>
<td>0.00975 0.0559 0.1752 0.4092 0.7681</td>
<td>0.152 0.25 0.385 0.62 0.98</td>
<td>0.31 0.50 0.70 0.96 1.3</td>
</tr>
<tr>
<td>Ammonia Conductivity µS/cm</td>
<td>2</td>
<td>0 25 50 75 100</td>
<td>0.00975 0.0559 0.1752 0.4092 0.7681</td>
<td>0.122 0.25 0.41 0.65 1</td>
<td>0.23 0.50 0.80 1.13 1.52</td>
</tr>
<tr>
<td>Morpholine Conductivity µS/cm</td>
<td>3</td>
<td>0 25 50 75 100</td>
<td>0.00975 0.0559 0.1752 0.4092 0.7681</td>
<td>0.149 0.25 0.375 0.60 0.98</td>
<td>0.30 0.50 0.70 0.97 1.38</td>
</tr>
<tr>
<td>Hydrochloric Acid mS/cm 1-5%</td>
<td>4</td>
<td>0 15 30 45 60</td>
<td>65 91 114 135 159</td>
<td>125 173 217 260 301</td>
<td>179 248 313 370 430</td>
</tr>
<tr>
<td>Nitric Acid mS/cm 1-5%</td>
<td>5</td>
<td>0 20 40 60 80</td>
<td>39.5 57.4 81.4 99.9 127.8</td>
<td>76.1 108.5 148.1 180.8 217</td>
<td>113.4 161.4 215 260 299</td>
</tr>
</tbody>
</table>

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<thead>
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