User's Manual

FLXA202 / FLXA21 2-Wire Analyzer Operation of ISC

IM 12A01A03-33EN

YOKOGAWA
Yokogawa Electric Corporation

IM 12A01A03-33EN
2nd Edition

Introduction

Thank you for purchasing the FLXA™202/FLXA™21 2-Wire Analyzer.

Please read the following respective documents before installing and using the FLXA202/FLXA21.

When the FLXA21 with the output of FOUNDATION Fieldbus or PROFIBUS PA Communication is used, please refer to the User's Manual, IM 12A01A02-71E or IM 12A01A02-72E, too.

The related documents are as follows.

General Specifications

Contents	Document number	Note
FLXA202 2-wire Analyzer	GS 12A01A03-01EN	For FLXA202. Online manual
FLXA21 2-wire Analyzer	GS 12A01A02-01E	For FLXA21. Online manual
FLXA21 2-wire Analyzer FOUNDATION Fieldbus Communication	GS 12A01A02-71E	For FLXA21. Online manual
FLXA21 2-wire Analyzer PROFIBUS PA Communication	GS 12A01A02-72E	For FLXA21. Online manual

* the "E" or "EN" in the document number is the language code.

User's Manual

Contents	Document number	Note
FLXA202/FLXA21 2-wire Analyzer Start-up Manual	IM 12A01A02-12E	Attached to the product
FLXA202/FLXA21 2-wire Analyzer Safety Precautions	IM 12A01A02-20E	For intrinsic safety, nonincendive and Type n. Attached to the product
FLXA202/FLXA21 2-wire Analyzer Installation and Wiring	IM 12A01A03-01EN	Online manual
FLXA202/FLXA21 2-wire Analyzer Operation of pH/ORP	IM 12A01A03-31EN	For pH/ORP (-P1) selection Online manual
FLXA202/FLXA21 2-wire Analyzer Operation of SC	IM 12A01A03-32EN	For Conductivity (SC) (-C1) selection Online manual
FLXA202/FLXA21 2-wire Analyzer Operation of ISC	IM 12A01A03-33EN	For Inductive conductivity (ISC) (-C5) selection Online manual (This manual)
FLXA202/FLXA21 2-wire Analyzer Operation of DO	IM 12A01A03-34EN	For Dissolved oxygen (DO) (-D1) selection Online manual
FLXA202 2-wire Analyzer Operation of SENCOM SA-pH/ORP	IM 12A01A03-36EN	For pH/ORP of SENCOM SA (-S5) selection Online manual
FLXA202 2-wire Analyzer Operation of SENCOM SA-SC	IM 12A01A03-37EN	For Conductivity (SC) of SENCOM SA (-S5) selection Online manual
FLXA21 2-wire Analyzer FOUNDATION Fieldbus Communication	IM 12A01A02-71E	For FLXA21, output "-F" Online manual
FLXA21 2-wire Analyzer PROFIBUS PA Communication	IM 12A01A02-72E	For FLXA21, output "-P" Online manual

* The "E" or "EN" in the document number is the language code.

Note: Please read the Safety Precautions (IM 12A01A02-20E) before using the product.
The Safety Precautions includes Control Drawings of intrinsic safety, nonincendive and Type n that describes specific condition for using FLXA202/FLXA21 in hazardous/classified location.

An exclusive User's Manual might be attached to the products whose suffix codes or option codes contain the code "Z" (made to customers' specifications). Please read it along with this manual.

Technical Information

Contents	Document number	Note
FLXA202 2-wire Analyzer Selection Guide for Intrinsic Safety type Associated Apparatus	TI 12A01A02-42EN	Online manual
FLXA202/FLXA21 2-Wire Analyzer HART Communication	TI 12A01A02-60E	Online manual

* The "E" or "EN" in the document number is the language code.

You can download the latest documents from our website. Scan QR code.

http://www.yokogawa.com/an/flxa202/download/

Read corresponding user's manual for details about sensors or other related products.

■ Notes on Handling User's Manuals

- Please hand over the user's manuals to your end users so that they can keep the user's manuals on hand for convenient reference.
- Please read the information thoroughly before using the product.
- The purpose of these user's manuals is not to warrant that the product is well suited to any particular purpose but rather to describe the functional details of the product.
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■ Drawing Conventions

Some drawings may be partially emphasized, simplified, or omitted, for the convenience of description.

Some screen images depicted in the user's manual may have different display positions or character types (e.g., the upper / lower case). Also note that some of the images contained in this user's manual are display examples.

■ Composition of this User's Manual

The FLXA202/FLXA21 2-Wire Analyzer offers following measurements:
pH/ORP (oxidation-reduction potential), conductivity (SC), inductive conductivity (ISC), dissolved oxygen (DO), pH/ORP with SA11 SENCOM™ Smart Adapter, SC with SA11 SENCOM Smart Adapter.

This document explains inductive conductivity (ISC) measurement operation, configuration and calibration.
For other common instruction such as installation, see the reference user's manual as shown in the next table.

Model	1st input code	Contents	Document number
FLXA202　FLXA21	All	Start-up Manual	IM 12A01A02-12E
FLXA202　FLXA21		Safety Precautions	IM 12A01A02-20E
FLXA202　FLXA21		Installation and Wiring	IM 12A01A03-01EN
FLXA202　FLXA21	-C5	Operation of ISC	IM 12A01A03-33EN (This manual)

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FLXA202 / FLXA21
2-Wire Analyzer
Operation of ISC

IM 12A01A03-33EN 2nd Edition

CONTENTS

1. OPERATION OF ISC (Inductive Conductivity)

This chapter describes the screen operations of ISC, the object to be measured. Further details of screen operations can also be found in 1.2 Screen Operation in IM 12A01A03-01EN.

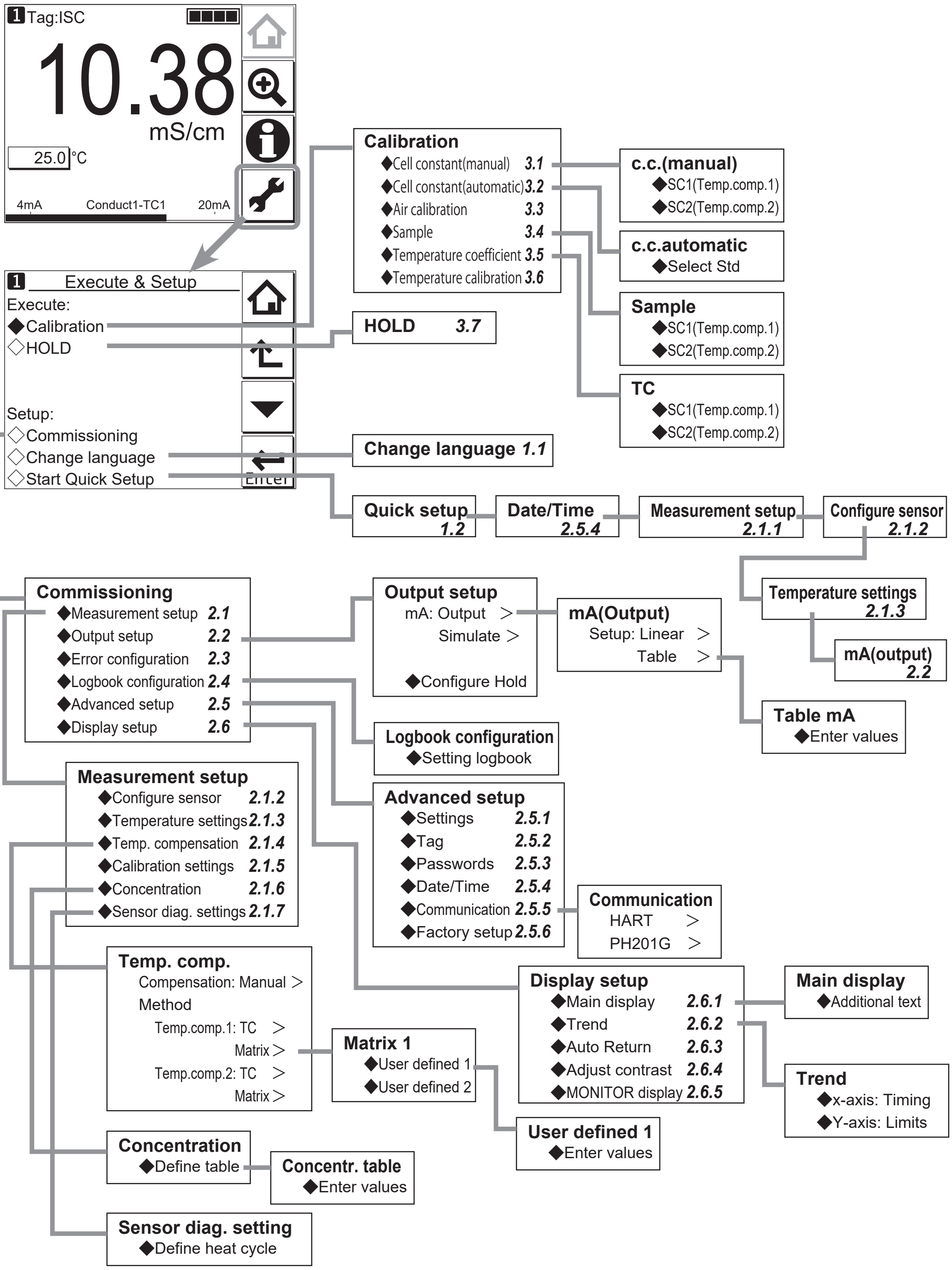


Figure 1.1 **Menu structure of ISC (the number after the item refers to the relevant section)**

1.1 Change language

The screen is set to display English at factory shipment; if you wish to use the FLXA202/FLXA21 in another language, first select a language as described in 2.7 Operation in IM 12A01A03-01EN.

1.2 Quick setup

The Quick setup screen is used to set up the basic items you want to set up first, such as the date/time and sensor settings. The detailed settings are described in 2. COMMISSIONING OF ISC (Inductive Conductivity).

You may leave the Quick setup now and return to it later; however, it is recommended to perform the quick setup first.

Each time the FLXA202/FLXA21 is started up, this screen is displayed. If it is not necessary to change the setup, press No or .

NOTE

When no operation is performed for 10 minutes or 60 minutes (depending on the setting of “Auto Return”), the display except Trend display automatically changes to the Monitor display (or to the Main display when the MONITOR display is disabled).

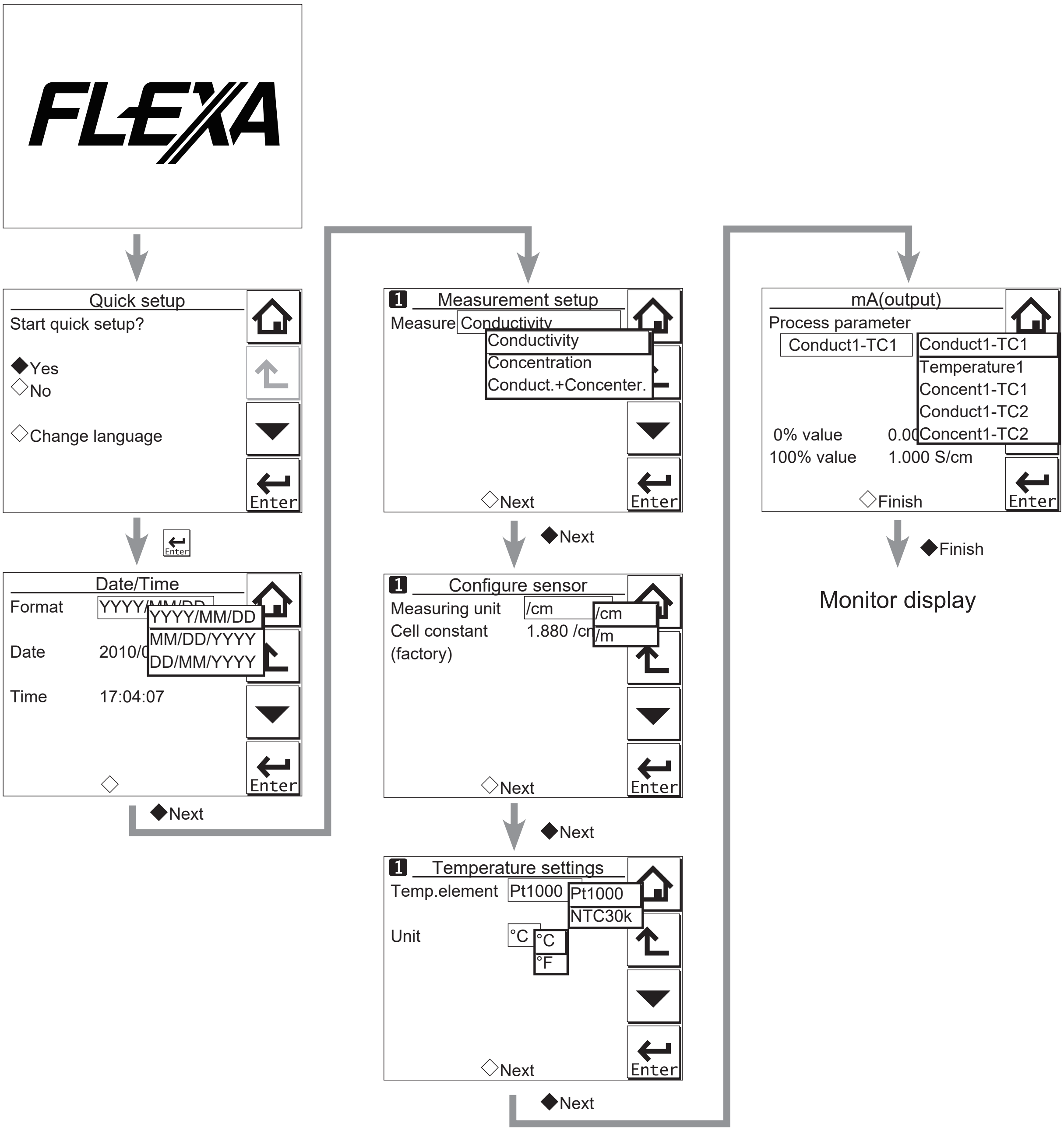


Figure 1.2 Quick setup

■ Date/Time

The date display format can be selected from among the three types.

Enter the date or time of day by using the numerical keys.

For details, see 2.5.4 Date/Time.

■ Measurement setup

Select a suitable measurement parameter from among those displayed and set it up.

Measurement parameter setup can be made only when “ISC” is selected on the Sensor setup screen.

For details, see 2.1.1 Measurement.

■ Configure sensor

The measurement units can also be selected from among "/cm" and "/m".

The cell constant (factory default) is determined by factory calibration made during manufacturing.

The cell constant is indicated on the sensor. If a new sensor is used, the cell constant indicated here should be changed. When this value is changed, the real cell constant will also be changed.

For details, see 2.1.2 Configure sensor.

■ Temperature settings

Select a suitable temperature element from among those displayed and set it up.

Celsius (ºC) or Fahrenheit (ºF) temperature scale can be selected.

For details, see 2.1.3 Temperature settings.

■ mA (output)

Select an appropriate process parameter from among those displayed and set it. The mA output has been set to 0 – 500 μS/cm or 0 to 20 Ω cm at factory shipment. If a high resolution is required in a consistent measurement process, set this parameter to a value suitable for the process.

For details, see 2.2 Output setup.

1.3 Main display and Monitor display

Pressing [home] changes the screen to the Main display shown in Figure 1.3.

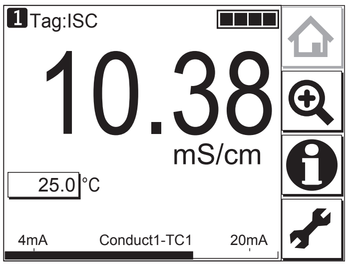


Figure 1.3 Example of main display

On the Main display, pressing [ ] of the 2nd or 3rd display item causes the 1st display item to be replaced by the selected item.

NOTE

Measured values to be displayed in the 1st to 3rd display items depend on the user definition (see 2.6.1 Main display). In the default condition, the 1st display item is conductivity, the 2nd display item is temperature, and the 3rd display item is empty.

When the MONITOR display is enabled (see 2.6.5 MONITOR display), pressing the 1st display item on the home display or the main display changes the display to the Monitor display with the enlarged font of the measured value.

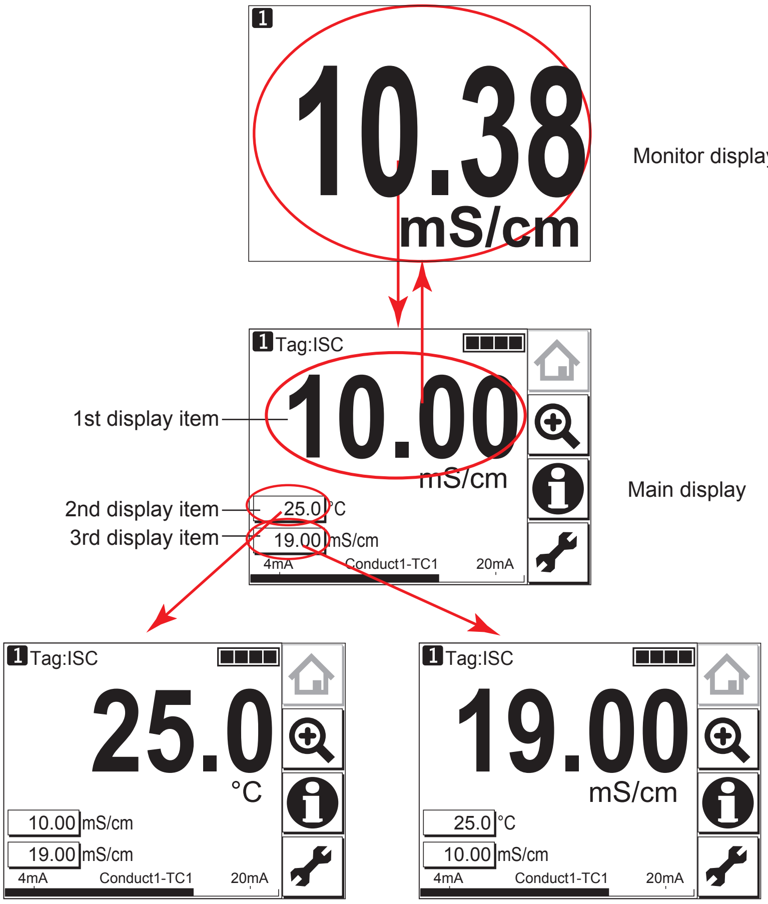
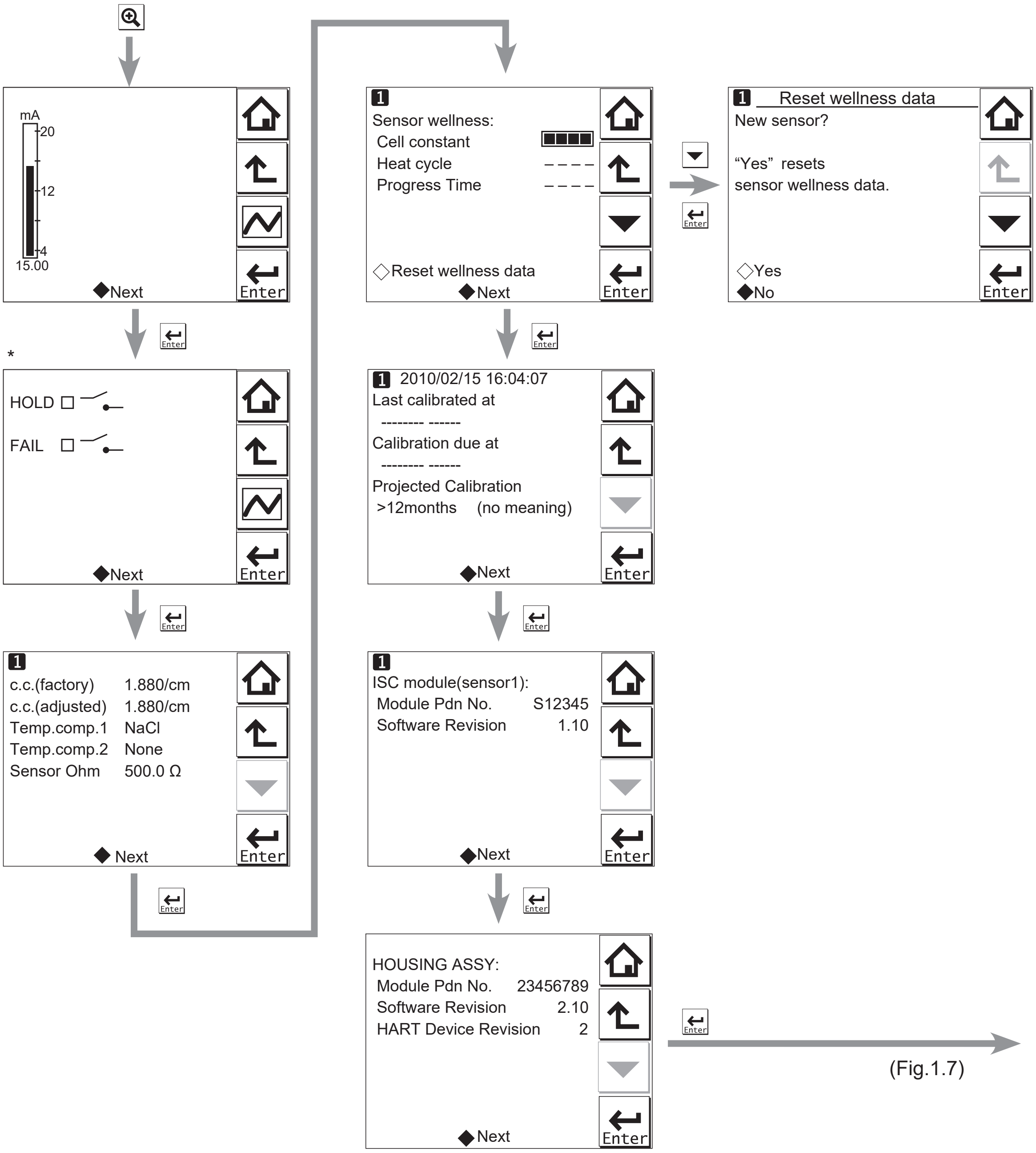


Figure 1.4 Change display

1.4 Zooming in on details

Pressing  on the Main display allows you to check detailed instrument information (instrument information such as setup, sensor diagnosis, calibration, and module productions number) through a transition of screens as shown in Figure 1.5.

In case of trouble, when you contact your nearest Yokogawa service center, please inform us of the module and FLXA202/FLXA21 software revision displayed on the Detail screen and other display information as well as the module productions number indicated on the nameplate attached to the instrument.



*: This screen is displayed only if the PH201G distributor is used and "PH201G" is selected in communication setup.

Figure 1.5 Detail display

■ Current output mA

= current output in mA. The range and function of this mA output can be set in Commissioning → Output setup → mA.

For details, see 2.2 Output setup.

■ Contact status

This screen is displayed only if the PH201G distributor is used and "PH201G" is selected in communication setup.

■ c.c. (factory)

This parameter displays the cell constant (factory setting).

The cell constant (factory setting) is determined by factory calibration made during sensor manufacturing. This value can be set in Commissioning → Measurement setup → Sensor setup.

The cell constant is indicated on the sensor or cable label.

■ c.c. (adjusted)

This parameter displays the cell constant (adjusted).

The cell constant (adjusted) is a cell constant that has been calibrated and is set by calibration action.

When the system's cell constant is adjusted on-line by calibration using a process solution or buffer solution, a new cell constant is logged here. The difference between this value and the default value set at factory shipment will not be large. If there is a large difference between them, check whether the sensor is broken or contaminated.

■ Temp. comp. 1

This parameter shows the temperature compensation method for 1st measurement. The setting is made in Commissioning → Measurement setup → Temp. comp.

■ Temp. comp. 2

This parameter shows the temperature compensation method for 2nd measurement. The setting is made in Commissioning → Measurement setup → Temp. comp.

2nd measurement does not imply that two measurements can be made individually, but it means that two types of compensation methods can be configured, which enables two phases to be monitored accurately in the same process. An example is monitoring the switching between process and washing solutions.

■ Sensor Ohm

This parameter represents the non-compensated resistance of the sensor.

■ Sensor wellness

At the Sensor wellness window, the soundness of a module is displayed. A larger number of ■ in each gauge indicates that the parameter concerned is sound. A gauge is indicated for only those parameters whose sensor wellness setting is "enabled," while a bar (----) is displayed if the sensor wellness setting is "disabled."

Sensor wellness setup can be made in Commissioning → Measurement setup → Sensor diag. settings. For details, see 2.1.7 Sensor diagnostic settings

The "Reset wellness data" button can reset wellness data.

When a sensor is exchanged or replaced, sensor wellness data should be reset.

NOTE

When a sensor is replaced, the replacement can be recorded manually into a logbook. (Refer to the Figure 1.7.)

■ Last calibrated

= date on which the last sensor calibration was performed. The displayed value of the Zero is the result of this calibration. The displayed value of Slope was calibrated on this date only if the last calibration was a 2-point calibration.

■ Calibration due

= the date when the calibration must be done next according to the settings of the calibration interval. The calibration intervals are set in Commissioning → Measurement setup → Calibration settings → Limits and timing.

■ Projected replacement

The projected maintenance function predicts the date when the sensor unit will need cleaning or recalibrating for maintaining measurement accuracy. The function checks the cleanliness of the sensor by monitoring the cell constant after calibration. Clean the sensor before the predicted date.

The function predicts the dates when the cell constant will cross the upper or lower limits and displays the predicted date with the status (the status is displayed in parentheses).

As shown in Figure 1.6, the date is predicted based on the intersection point of the upper or lower limits and the extrapolated line of the values obtained by the least squares method.

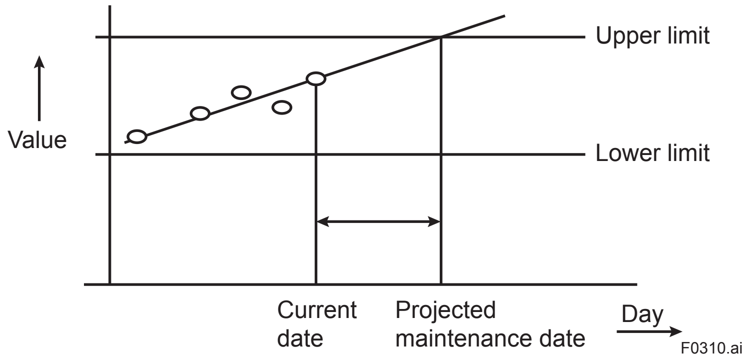


Figure 1.6

The status shows the certainty of the projected maintenance date in terms of the correlation coefficient R. Tables 1.1 and 1.2 show respective display patterns.

Table 1.1 Display pattern of the projected maintenance date

Projected date	- -	0-1 month	1-3 months	3-6 months	6-12 months	Over 1 year

- - : cannot be predictable due to insufficient data

Table 1.2 Display pattern of the status

Status	(- - - - -) (R < 0.50)	(Poor) (0.50 ≤ R < 0.70)	(Reasonable) (0.70 ≤ R < 0.85)	(Excellent) (0.85 ≤ R < 1.00)

■ ISC module (sensor)

With this screen, you can check the module productions number and software revision of the installed module.

■ HOUSING ASSY

With this screen, you can check the module productions number, software revision, and HART device revision of the housing assembly.

■ Read logbook

The FLXA202/FLXA21 has two types of logbook per sensor to store history information on events, such as changed settings and calibrations.

By selecting one of the logbooks that you wish to check, you can retrieve and check this information. Storage of history information on each event in a logbook or which logbook to use for storage can be set up on the Configure logbook screen. For details, see 2.4 Logbook configuration

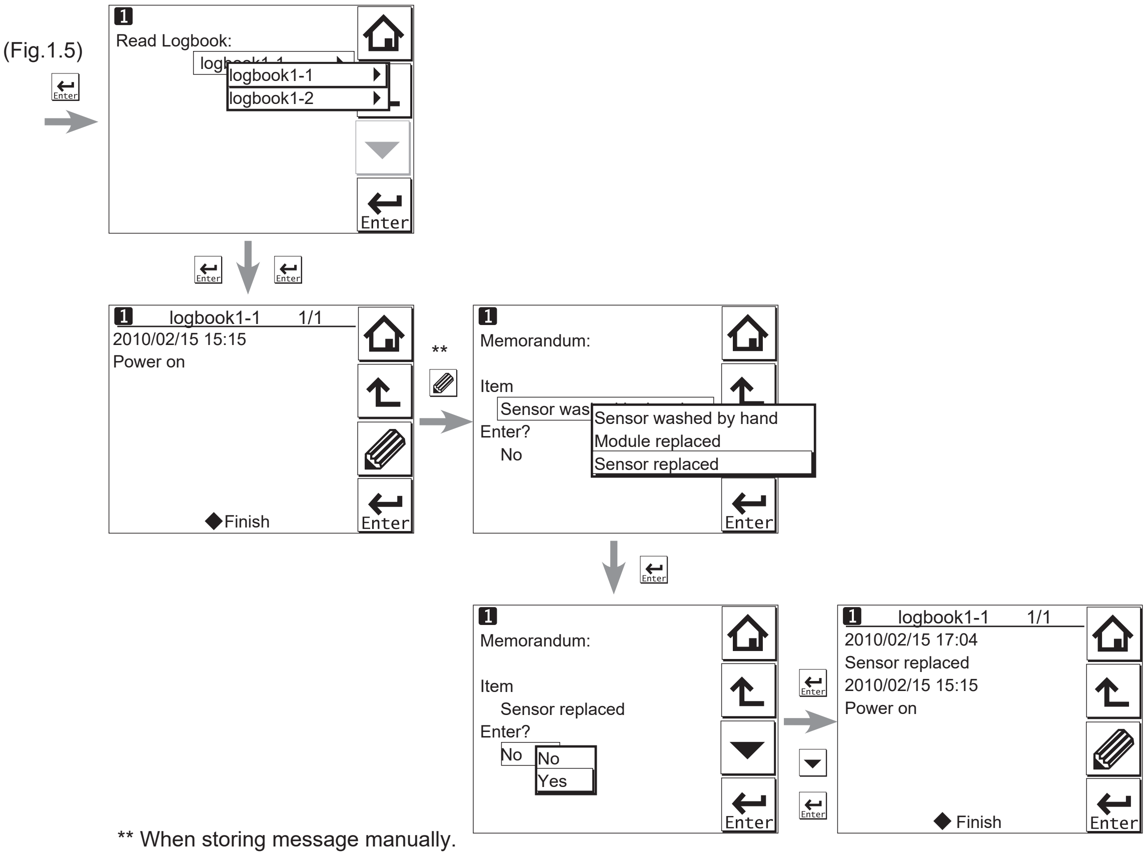
History information on events are automatically stored on the preset conditions.

In addition to this storing, following three messages can be manually stored in the logbook;

"Sensor washed by hand", "Module replaced", "Sensor replaced"

To store these messages, press and select one of three messages from the Item on the Memorandum screen. Its event date/time will be the time when a message is selected and entered.

When a password for Commissioning is set on the passwords' setup, pressing requires entering the password. (Refer to 2.5.3 Passwords)



** When storing message manually.

Figure 1.7 Detail display (continued)

1.5 Trend graphics

Pressing  on the Zoom display changes the display to a graphical mode in which the average measured value is shown on a time scale. The “Live” value is also digitally displayed in a text box. The time scale (X-axis) and the primary value scale (Y-axis) are set in the “DISPLAY SETUP” menu (2.6 Display setup).

The screen displays the trend of up to 41 averages of the measurement for each time interval. The FLXA202/FLXA21 samples the measurements every second. The trending graphic also shows the maximum and minimum measured values in that interval.

For example, if the time scale is set to 4 hours, then the trend is shown for 4 hours prior to the actual measurement. Each point on the trend line represents the average over 4×60×60/41 = 351 measurements (seconds).

NOTE

Updating the trend screen setup resets the current trend graph and starts a new one.

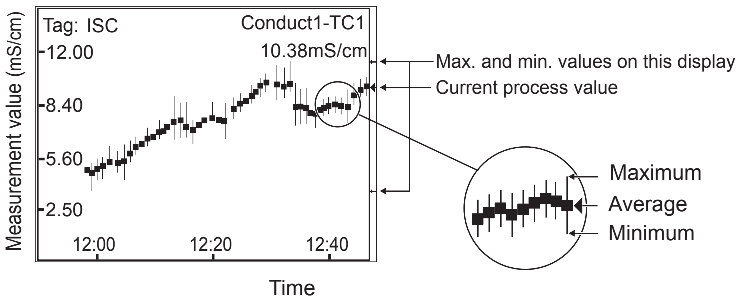


Figure 1.8 Trend screen

The 1st display item data on the Main display is shown as a graph. Touching any point on the display changes the display to the 2nd display item data (and to the 3rd display item data if set) and then returns to the Main display.

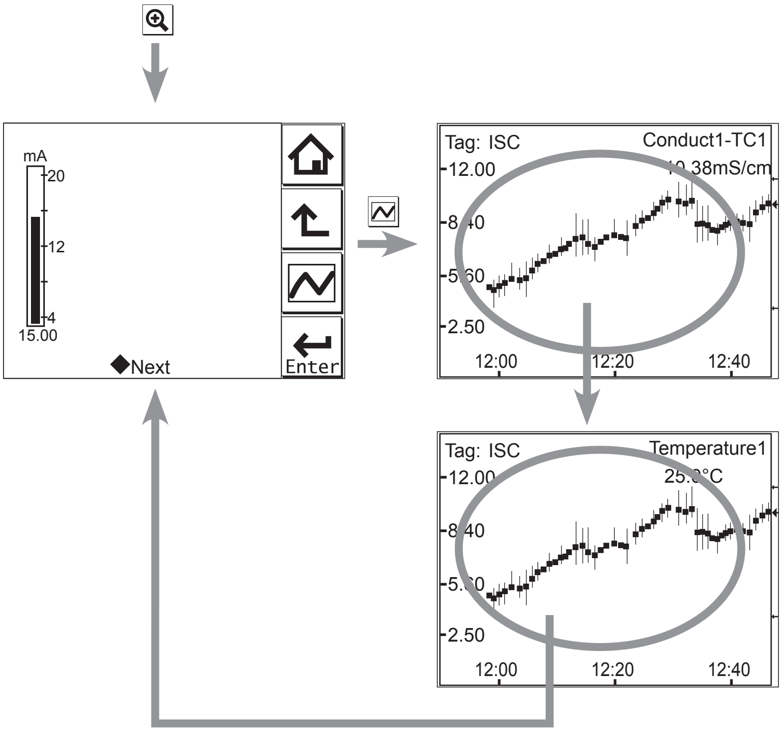


Figure 1.9 Trend graphics

1.6 Instrument status screen

In the  field of the Main display, the  (Warning) or  (Fault) sign appears according to the instrument status. Upon pressing the displayed button, detailed information of the relevant status appears. See 1.2 Screen Operation in IM 12A01A03-01EN.

1.7 Calibration and Commissioning

Allows you to calibrate and configure the instrument. These operations can be protected with a password.

For details on the password, refer to 2.5.3 Passwords.

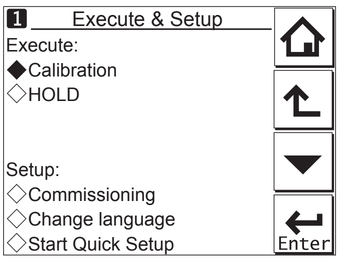


Figure 1.10 Execute & Setup

Pressing  changes the display to the Execute & Setup screen.

Browse through the menu items by pressing ▼ until you find the desired menu and then press Enter to enter that menu. It is also possible to enter a desired menu by pressing the ◇ symbol beside the menu item.

For calibration (HOLD), read 3. CALIBRATION OF ISC (Inductive Conductivity), and for commissioning, read 2. COMMISSIONING OF ISC (Inductive Conductivity)

2. COMMISSIONING OF ISC (Inductive Conductivity)

This chapter describes how to check and change settings from the Commissioning screen.

When you move to the Commissioning screen, the output is held.

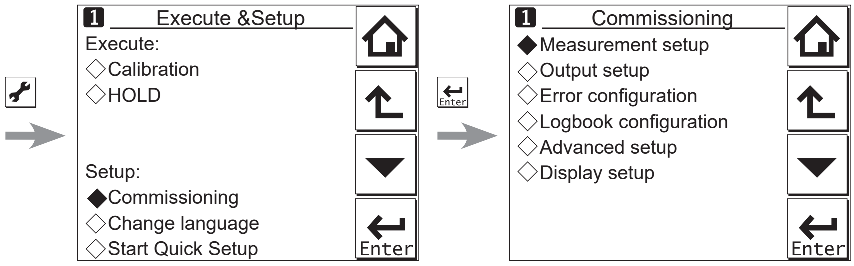


Figure 2.1 Commissioning screen

Operations in Commissioning can be password-protected. If you set up a password, always take a note of it. For details on setting a password, see 2.5.3 Passwords

Figure 2.1 shows the commissioning procedure. Before changing any parameters, read the relevant sections in this document and understand how the change of parameters affects the performance of this instrument. If you set a wrong value, return it to the default setting or value and then set it again.

On the first startup, the parameters are all default values configured at the factory. Check the parameters in Table 2.1 and change any of them if necessary depending on the sensors to be connected and the purpose of use.

Set “Measurement” first. Some measurement parameters and relevant options change accordingly. The underlined parameters in Table 2.1 are used for the quick setup.

You can download the default values and setting ranges from “User setting table of ISC”at http://www.yokogawa.com/an/flxa202/download/.

After confirming that the instrument operates normally with the parameters, print out the “User setting table of ISC” and write down these parameters in the column of User Settings.

All user parameters can also be saved in the instrument.

Select Commissioning → Advanced setup → Settings → Save user settings (see 2.5.1 Settings).

Table 2.1 Menu Structure and Default Values in "Commissioning"

Parameter					Ref. sect.
Measurement setup	Measurement				2.1.1
	Configure sensor	Measuring unit			2.1.2
		Cell constant (factory)			
	Temperature settings	Temp. element			2.1.3
	Temp. compensation	Compensation			2.1.4
		Reference temp.			
		Method			
	Calibration settings	Limits:	Air adjust		2.1.5
			c.c.		
		Timing:	Step Range		
			Stabilization time		
			Calib.interval		
	Concentration	Additional table			2.1.6
		Unit for table			
	Sensor diag. settings	Process time:			2.1.7
		Heat cycle:			
		Define heat cycle			
Output setup	mA				2.2
		Output	Process parameter		
			Setup		
			Linear	0 % value	
				100 % value	
			Table		
			Burn		
			Damping time		
		Simulate	Simulation perc.		
	Configure Hold				
Error configuration					2.3
Logbook configuration					2.4
Advanced setup	Settings				2.5.1
	Tag				2.5.2
	Passwords				2.5.3
	Date/Time				2.5.4
	Communication				2.5.5
		HART			
		PH201G			
	Factory setup				2.5.6
Display setup	Main display				2.6.1
	Trend				2.6.2
	Auto Return				2.6.3
	Adjust contrast				2.6.4
	MONITOR display				2.6.5

NOTE

All the parameters for the quick setup (underlined ones in Table 2.1) are crucial for measurement. If you change any of them, other parameters may be initialized. For the parameters that may initialize other values, see Appendix Reference material.

2.1 Measurement setup

This section describes how to set up various parameters relating to measurements.

Measurements are performed based on the measurement parameter setup.

2.1.1 Measurement

Select a measurement parameter from Conductivity, Concentration, and Conduct. + Concentr. The setting of the measurement parameter changes the menu structure in Error configuration, Display setup, etc. accordingly.

2.1.2 Configure sensor

This section describes how to configure the sensor to be connected.

● Measuring unit

Either /cm or /m can be chosen here.

The process values will be expressed in S/cm or S/m.

● Cell constant (factory)

The cell constant given at factory shipment is set.

When a new sensor is connected, set the new cell constant which is indicated on the sensor.

When a cell constant is changed, a calibrated cell constant (c.c. (adjusted)) will be the same value of the new cell constant (factory) after resetting an old one.

2.1.3 Temperature settings

Select the temperature element used for compensation from among Pt1000 or NTC30k. Select the same type as the temperature element that is actually connected.

Celsius (°C) or Fahrenheit (°F) temperature units are available. If the unit is changed, the following values are also recalculated automatically to the new unit:

- Manual temp.
- Reference temp.
- Temp. coefficient
- Temp. ranges in the matrix

2.1.4 Temperature compensation

● Temperature compensation

Two methods can be used: Automatic and Manual. Select Automatic when a temperature element is used or Manual when a manually set temperature is used.

NOTE

When Manual is selected on the Temperature compensation, a process temperature should be set in the “Manual temp.” A temperature shown on the Main display is this manually set temperature.

● Reference temperature

The temperature compensation function converts the measured conductivity value to that at the reference temperature. The reference temperature can be changed. The default value is 25ºC.

● Process temperature compensation

Select a temperature compensation method from among None, TC, NaCl, and Matrix. “None” does not perform the temperature compensation.

● TC

This method uses the linear compensation function.

For how to calculate a temperature coefficient of the compensation function, see ● Temperature compensation coefficient (TC) on page App-1.

● NaCl

This method uses the standard temperature compensation function with NaCl solution.

For details, see ● NaCl (standard temperature compensation) on page App-1.

● Matrix

This method uses the temperature compensation matrix, which is a table of the conductivity values at different temperatures and concentrations for a specific solution. The measured conductivity is compensated based on this matrix to the conductivity at the reference temperature.

Prepared matrixes and user-defined matrixes can be used. Two different user-defined matrixes are available.

For details, see ● Matrix on page App-3.

When the measured temperature or the precompensated conductivity is out of the range, the temperature compensation error (warning) will be issued. This is not a device error.

For more details, see ■ Temperature compensation error on page App-9.

Any two of these three methods can be set for conductivity measurement as “Temp.comp.1” and “Temp.comp.2”. The result of either method can be output or displayed (see 2.2 Output setup or 2.6 Display setup).

When “Measurement” is set to “Conduct. + Concentr.” for the Measurement, only one method can be set.

NOTE

The temperature compensation is not performed around zero. In this case, a warning may be issued.

2.1.5 Calibration settings

The screen flow differs depending on the combination of objects to be measured.

● Air adjust limit

Generally, air calibration is not required. To avoid the effects of the cable on the measurement of lower conductivities such as pure water, a “zero” calibration with a dry sensor may be done.

Perform a zero-calibration using a dry sensor to prevent the cable from affecting the measurement. If a terminal box (BA20) and extension cable (WF10) are used, perform the zero-calibration while they are connected.

As the calibration is performed in air, the resistivity is infinite (open connection). Higher conductivity values than the air adjust limit indicate that the cell is not in air or is still wet. To prevent wrong air calibrations, a limit must be given here.

NOTE

Perform a zero check for air calibration while the temperature compensation is set to NaCl.

- **c.c. high**

High limit of the cell constant expressed as a % of the nominal value. During calibration this value is used to check if the calibrated cell constant remains within reasonable limits.

- **c.c. low**

Low limit of the cell constant expressed as a % of the nominal value. During calibration this value is used to check if the calibrated cell constant remains within reasonable limits.

- **Step Range**

Set the range over which the stability of a measured value is checked. If variations of a measured value over the stabilization time are within this set value, the measured value is judged to have stabilized.

- **Stabilization time**

During calibration, the stability of the measurement is constantly monitored. When variations of the value are within a value set in Step Range over this stabilization time set here, the value is regarded as being stable. If the value does not stabilize within 10 minutes, calibration is aborted.

- **Calibration interval**

Set the interval in which a new calibration must take place. If the interval set here is exceeded, the instrument will be notified according to the setting in “Calib. time exceeded” in the error configuration.

2.1.6 Concentration

The “Concentration” can be set only when “Conduct. + Concentr.” or “Concentration” is selected for the Measurement in the Measurement setup menu.

The corresponding concentration given by a measured conductivity can be shown on the Main display.

- **Concentration table**

Concentration can be calculated by using the temperature compensation matrix or the additional concentration table.

  - **By using the temperature compensation matrix**

    Set the “Additional table” to “Disabled”. The concentration can be obtained from the temperature compensation matrix (based on the relation between the conductivity at the reference temperature and the concentration).

    Select Temp. compensation → Method, and then select Matrix. Next, choose a solution or User defined 1 or 2 (see 2.1.4 Temperature compensation). The concentration cannot be obtained by any other temperature compensation method (TC or NaCl).

  - **By using the additional concentration table**

    The additional concentration table indicates the relation between the conductivity and the concentration at the reference temperature. Set the “Additional table” to “Enabled”. The concentration can be obtained from the additional concentration table.

    After entering values, select “Yes” for “Check values?”. Values are interpolated into empty cells. If any mandatory cells are left blank, an error will be issued. An error message is also issued if there is any error in the concentration table.

    After completing entering values in the additional concentration table, set “Additional table” to “Enabled”.

● Unit for table

Select the concentration display units from among %, ppt *, ppm, and ppb. Changing the unit will not result in a re-calculation of the table. Reenter values in the additional concentration table.

*: Here ppt stands for parts per thousand ($1/10^3$), ppm: $1/10^6$, ppb: $1/10^9$.

2.1.7 Sensor diagnostic settings

This screen is used to set items relating to sensor diagnostics displayed on the screens invoked by pressing .

Gauges are displayed for only parameters that have been enabled in “Sensor diag. settings.”

Parameters set to Disable are provided with a bar display.

The setting parameters include Progress time and Heat cycle. It is also possible to set the “Bad limits” of the progress time and heat cycle and the “Heat cycle temp” and “Heat cycle time” of the heat cycle.

2.2 Output setup

The general procedure is to first define the function of the output, Output or Simulate. Then, set the process parameters associated with the output. On the Output, an output of measured value is selected. On the Simulate, a simulation value can be set.

And, the parameters for HOLD function can be set on this setting.

● Output

The output signal is a current value specified by the following parameters.

Process parameter

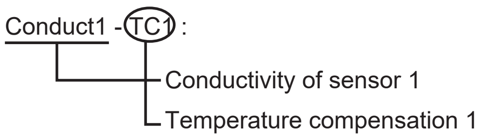
Available process parameters depend on the selected “Measurement” item in Measurement setup. Refer to Table 2.2.

The output of the selected process parameter is shown as a bar on the bottom of the Main display. And its parameter symbol (for example, Conduct1-TC1) is shown above the bar, too. When a selected process parameter is displayed as a measurement value, the top left number or character is turned to be white number or character on black background (for example, **1**).

(Refer to 1.2 Screen operation in IM 12A01A03-01EN)

Table 2.2 List of Process Parameters

Sensor	Measurement	Process Parameters
1	Conductivity	Conduct1-TC1
		Temperature1
		Conduct1-TC2
	Concentration	Conduct1-TC1
		Temperature1
		Concent1-TC2
	Conduct. + Concentr.	Conduct1-TC1
		Temperature1
		Concent1-TC2



Select the temperature compensation method is section 2.1.4.

Setup

Select one of the output methods: Linear and Table.

Linear: Set the 0% and 100% values.

Table: This allows the configuration of an output curve by 21 points (5% intervals). (The 0% and 100% values must be entered.)

Burn

Select the designated output in case of a fault from among Off, Low, and High. See 2.3 Error configurationto set the output.

Off: Output depends on the measured value.

Low: Output is fixed to 3.6 mA (when None is set in Communication setup)
Output is fixed to 3.9 mA (when HART or PH201G is selected in Communication setup)

High: Output is fixed to 22.0 mA.

Damping time

This is the time taken for a response to a step input change to reach 90% of the final value (attenuation time). Set this time in sec.

● Simulate

When this function is selected, an output of the instrument will be a fixed current value set in % of the output span. The output span range is -2.5% to 112.5% (3.6 mA to 22.0 mA).

When “Simulate” is selected, regardless of hold setting, the output is always simulated value.

■ Configure Hold

On the Configure Hold, settings are performed to hold of the mA output at a preset value. (Refer to 3.7 HOLD.) This is enabled only if “mA” is “Output.”

During the Commissioning or the Quick Setup, the mA output is automatically held. The preset value depends on a setting on the “Last or fixed”.

“Last”: The preset value is a value measured just before hold condition.

“Fixed”: The preset value is a value set in the “Fixed value mA”.
When the “Fixed” is selected, set a mA value in the “Fixed value mA”.

Selection on the “Hold during Calibration” decides to activate or deactivate the hold function automatically during calibration.

“Enabled”: Activation of the automatic hold function

“Disabled”: No automatic hold function

2.3 Error configuration

In Error configuration, configure the statuses of various error causes.

This allows the system to notify the user of the occurrence of an error according to the status categories in the Error configuration.

Select a status category from among Off, Warn. (Warning), and Fault.

“Fault” automatically performs burn-out. When Burn has been set to Off (2.2 Output setup), only the error message is displayed.

“Warn.” displays an error message.

When selecting PH201G in the communication setting, make sure that the “Fail contact” setting is appropriate.

The settable causes of errors are determined based on the settings of the Sensor setup and Measurement setup, and a status category is set to the causes displayed in the Errors 1/3 to 3/3 screens.

Table 2.3 Error configuration

Display item	Description	Default
Conductivity too high (or Concentration)	Conductivity or resistivity is lower than the minimum limit.	Warn.
Conductivity too low (or Concentration)	Conductivity or resistivity is higher than the maximum limit.	Warn.
Temperature too high	Measured process temperature is higher than the maximum limit.	Warn.
Temperature too low	Measured process temperature is lower than the minimum limit.	Warn.
Calibr. time exceeded	Calibration time exceeds the calibration interval (see 2.1.5 Calibration settings).	Off
Configuration error: 1st comp. matrix 2nd comp. matrix	The temperature compensation matrix is not defined properly (see 2.1.4 Temperature compensation).	Fault
Concentration table	The concentration table is not defined properly (see 2.1.6 Concentration).	Fault

CAUTION

If canceling an error configuration could be risky, do not cancel it as a dangerous situation may result.

NOTE

Use not Conductivity but (Conductivity x cell constant) to set the error limit for “Conductivity too high” and “Conductivity too low.”

NOTE

The temperature compensation is not performed around zero. In this case, a warning may be issued.

2.4 Logbook configuration

In “Logbook configuration,” the user configures information to be saved to a logbook or initializes the logbooks.

Logbooks are used to keep an electronic record of events such as error messages, calibrations, and programmed data changes. By referring to this log, users can, for instance, easily determine maintenance or replacement schedules.

In “Logbook configuration,” the user can select “Off,” “1-1,” or “1-2” for each item of interest to be logged. This can be done for items displayed on the Settings logbook 1/3 to 3/3 screens. Assigning 1-1 or 1-2 to each item allows information to be organized and logged in a logbook.

NOTE

Some events such as power-on are saved into the logbook “1-1”. This logbook may be full earlier. It is recommended that important information be saved into the logbook “1-2”.

For “Erase logbook”, a specified logbook “1-1” or “1-2” can be erased individually.

When the “Warn if logbook full” is set to “Yes”, a warning is given when the logbook come to near full (maximum 13 pages).

NOTE

When the logbook gets full, the oldest information is erased automatically.

2.5 Advanced setup

Advanced setup is used to set functions relating to matters other than measurements such as the selection of settings, tag setting, password setting for protecting calibration and commissioning operations, date setting, and communication setting.

(“Factory setup” is for service engineers only; there is no item to be set by the user.)

2.5.1 Settings

In “Settings,” select an item to be set as the default value from among “No action,” “Load factory settings,” “Save user settings,” and “Load user settings.”

When the default values are loaded, the instrument will be restarted. (In the case of “Save user settings,” it will not be restarted.)

The following parameters are not included in the defaults:

- Tag
- The contents of all logbooks

NOTE

When the “Save user setting” is only selected, save of the user-set parameters will start at once.

To avoid wrong selection, operation in this Settings must be done by , not by touching the menu message.

If you select “Load factory settings,” the instrument will be set to the default settings at factory shipment.

When this item is selected, a screen prompting whether to restart is displayed. If this is no problem, press “Yes.” Then the “Loading …” message appears and blinks and loading is started. When the factory settings have been loaded, the instrument will be restarted.

When “Save user settings” is selected, the current settings can be saved as the defaults. When this item is selected, the user settings will start to be saved immediately. After saving the parameters, press  or  to change the display because this save doesn’t have restart function.

If “Load user settings” is selected, the settings saved as user settings can be set as the defaults.

When this item is selected, a screen prompting whether to restart is displayed. If this is no problem, press “Yes.” Then the “Loading …” message appears and blinks and loading is started. When the user settings have been loaded, the instrument will be restarted.

2.5.2 Tag

A tag provides a symbolic reference to an instrument and is generally defined to be unique throughout the control system at one plant site. A tag can contain up to 12 alphanumeric characters. The default value is ISC or FLXA21-ISC.

The tag is displayed at the top of the main display.

2.5.3 Passwords

Calibration and commissioning operations can be separately protected by each password. To protect execute operations, enter a password in Execute's input field. To protect commissioning operations, enter a password in Commissioning's input field. By default, both input fields are empty. When a password input field is empty, operation is not password-protected. A password can contain up to 8 characters.

When you set a password, always take a note of it.

When a password is set, input of the password is necessary to enter the password-protected operation. After inputting the password, the display will change to an operator ID input display. When an operator ID is input, its operation is recorded into a logbook. The input of an operator ID is not necessary to enter the operation. An operator ID can contain up to 4 characters.

2.5.4 Date/Time

The Logbooks and trend graphs use the clock/calendar as a reference. The current date and time is set here. The time display format can be selected from among three types.

2.5.5 Communication

Select a communication parameter from None, HART, or PH201G in Communication setup. The burn down current is 3.9 mA when HART or PH201G is selected, and 3.6 mA when None is selected.

NOTE

To make the change of "Communication" valid, turn off the power supply once, and reboot.

In the case of "None," there is not the problem even if you do not change it as "HART" of default value except that the burn down current is different.

■ HART

Select this menu when HART communication (HART 5) is made.

In the HART setup screen, specify the network address and set up parameters for SV, TV, and FV.

(PV is linked with the "process parameter" setting in "Output settings" and cannot be changed here.)

● Network address

For 1-to-1 communication, leave the default value [0] unchanged. For multi-drop where multiple HART devices are connected on a bus, set addresses in 1 to 15. In this case, the mA output will be fixed to 4 mA.

● PV

PV is a parameter selected for analog output; it cannot be changed here.

● SV, TV, FV

The SV, TV, and FV parameters are items that the user must set up. Selectable items differ depending on the sensor type in "Sensor setup" and settings in "Measurement setup."

If blank is selected for a parameter, items below that parameter must all be set to blank. If an item is blank, those below it cannot be set to a status other than blank.

For more information on HART communication, see the Technical Information (TI 12A01A02-60E).

■ PH201G

Select this menu if the PH201G distributor is connected to the instrument.

In the PH201G setup screen, make settings for “Hold contact,” and “Fail contact.”

● Hold contact

Select Disabled or Enabled.

When this item is enabled, the output will be held according to the setting of “Hold type” on the Hold setup screen.

● Fail contact

Select a status from among “Fail + Warn,” “Fail only,” and “Disabled.”

This setting depends on the error configuration. See 2.3 Error configuration

“Fail” corresponds to “Fault.”

2.5.6 Factory setup

For “Factory setup,” there is no item to be set by the user.

NOTE

This menu is for service engineers only. This section is protected by a password. Attempting to change data in the factory adjustment menu without the proper instructions and equipment could result in corruption of the instrument setup and damage the performance of the unit.

2.6 Display setup

This screen is used to make various settings relating to screen display.

NOTE

Settable items differ depending on settings in “Measurement setup.”

2.6.1 Main display

Three measurement values can be set to display on the Main display as a primary value (1st line), a second value (2nd line) and a third value (3rd line) respectively.

On the “Additional text”, a text of up to 12 alphanumeric characters can be assigned to each measurement value.

Additional texts are displayed on the Main display, and are useful for identifying measurements. In some cases, not all 12 characters can be displayed due to the letters; check the texts displayed on the Main display after setting. If a part of the text is missing, adjust the number of characters.

2.6.2 Trend

This screen is used to make settings for the Trend Graph Screen.

Set the process parameters to be displayed for each trend. They can be set for the 1st to 3rd trends. When all three process parameters are set “Empty”, there is no trend display (no trend button).

- **X-axis: Timing**

  Select the X-axis timing's time span on the trend graph display from a list.

- **Y-axis: Limits**

  Set the Y-axis high and low limits on the trend graph display on a Trend screen basis.

NOTE

Updating the trend display setup resets the current trend graph and starts a new one.

2.6.3 Auto Return

When no operation is performed for the time set in "Auto Return", the display returns to the Monitor display (or to the Main display when the MONITOR display is disabled) and the analyzer returns to a normal measuring mode. (When the Trend display is selected, the Auto Return doesn't work.)

Select the time from among Disable, 10 min, and 60 min. When the Auto Return function is not used, select "Disable."

NOTE

A default is "10 min". When maintenance like a calibration that may take much time is performed, "60 min" or "Disable" is recommended to be selected.

2.6.4 Adjust contrast

The LCD screen contrast can be adjusted.

Pressing the ▲▼ keys adjusts the contrast in 11 levels from +5 to –5 (including the default value of "0").

2.6.5 MONITOR display

Select "Enable" so that the Monitor display becomes available. A default is "Enable".

During Hold condition and a warning/fault condition, the Main display is displayed to indicate the condition.

3. CALIBRATION OF ISC (Inductive Conductivity)

Inductive conductivity meters must be calibrated after being installed in a measurement location or moved to a different location.

Inductive conductivity meters do not generally need to be calibrated repetitively if they have been calibrated once before the start of use. If the cell is severely contaminated or has been subject to abrasion (possibly during cleaning), calibration may be necessary.

Execute air calibration first, if needed.

When using solutions, manual, automatic, and sample calibrations are available.

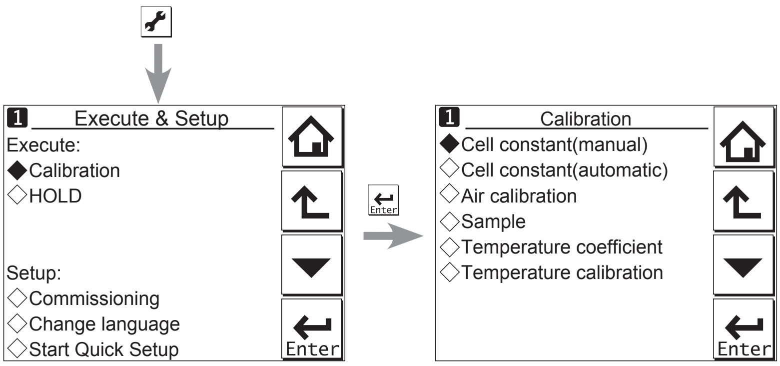


Figure 3.1 Calibration

NOTE

A default is “10 min” for “Auto Return”. When maintenance like a calibration that may take much time is performed, “60 min” or “Disable” is recommended to be selected. (Refer to 2.6.3 Auto Return)

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

- **“Cell constant (manual)”, “Cell constant (automatic)**

A calibration solution can be prepared in the laboratory. A salt solution is prepared with a known precise concentration. The temperature is stabilized to the reference temperature of the instrument (usually 25°C). The actual conductivity of the solution is taken from literature data. The typical calibration solutions include NaCl and KCl; see Appendix Reference material. To calibrate the instrument, the sensor is removed from a process and suspended in the solution, the conductivity value from the literature data is then entered and the calibration routine completed.

Make sure the sensor does not touch the sides of the container (see Figure 3.2).

- **“Sample calibration”**

This calibration uses a process solution. In this method, the conductivity of the process solution under measurement is measured with a standard instrument. In this case, care must be taken to make the measurement at the reference temperature since differences in the type of temperature compensation of the instruments may cause an error. With this method, it is not necessary to remove the sensor from the process. Because the sensor is immersed in the process, errors caused by the installation characteristics are compensated for.

NOTE

The standard instrument to be used in calibration with a process solution should always be accurate. Yokogawa recommends that the Model SC72 pocket conductivity meter be used for this purpose.

Where temperature compensation 1 (SC1) and temperature compensation 2 (SC2) have been configured, the configured temperature compensation is effective even during calibration. Therefore, the reading is the value converted to a conductivity value at the reference temperature set in Temperature settings.

There are temperature compensation 1 (SC1) and temperature compensation 2 (SC2), but this does not mean that calibration is required twice. It means that either SC1 or SC2 temperature compensation should be selected and calibration should be made once to obtain the cell constant. The cell constant after calibration can be checked on the Detail screen.

NOTE

When a sensor is exchanged or replaced, sensor wellness data should be reset.

When a sensor is replaced, the replacement can be recorded manually into a logbook. (Refer to the Figure 1.8.)

● Cell constant

The center value of the cell constant of the ISC40 sensor is 1.88 cm^{-1}. The nominal cell constants of individual sensors are indicated on the cable markers and the actual installation can change this factor. If there is less than 30 mm spacing between a sensor and holder, in-situ calibration is necessary to meet the specified accuracies.

- If the sensor is installed in the stainless steel standard holder ISC40FFJ-S, the cell constant is reduced by approximately 7%; enter a value 7% smaller than the value on the marker of the sensor cable.
- If the sensor is installed in the polypropylene standard holder ISC40FFJ-P, the cell constant is increased by approximately 1%; enter a value 1% greater than the value on the sensor cable marker.
- If the sensor is installed in piping that is long in the axial direction with the cross section as shown in Figure 3.3, the cell constant of the sensor installed in the piping (reference data for a design center value of 1.88 cm^{-1}) is as shown in Figure 3.3. A value obtained by multiplying the value on the sensor cable marker and a value read from Figure 3.3 should be entered.

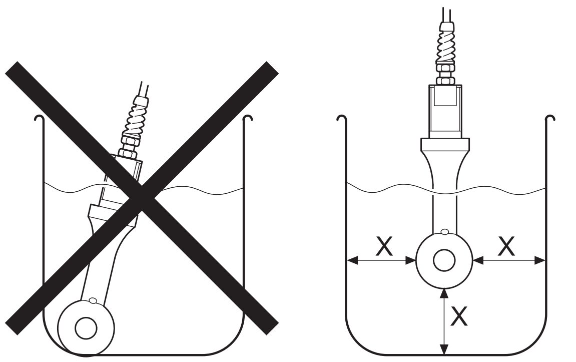


Figure 3.2 Sensor in calibration solution

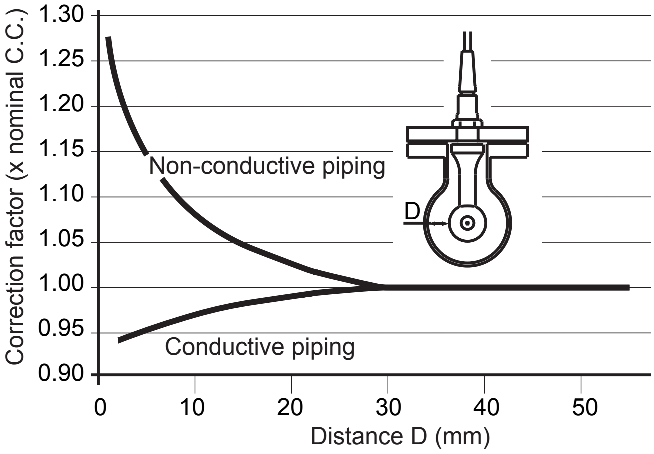


Figure 3.3 Relationship between the distance from the sensor to side wall and the cell constant

3.1 Cell constant (manual)

The intention of this calibration routine is to fine-tune a sensor for which only the nominal cell constant is known, or to recalibrate a sensor that has been changed (or damaged) during operation. Choose the 1st or 2nd temperature compensation to suit the calibration solution used. The solution with an appropriate precision should be prepared or purchased. Allow the sensor to reach stable readings for both temperature and conductivity before adjusting to the value of the corresponding calibration solution.

The cell constant of the calibrated sensor should also be set up here.

3.2 Cell constant (automatic)

This routine is built around the test method described in International Recommendation No. 56 of OIML (Organisation Internationale de Metrologie Legale). It allows the direct use of the solutions prescribed in the test method, automatically selecting the appropriate temperature compensation. The look-up table is used to find an appropriate conductivity reading for the measured temperature.

3.3 Air calibration

Execute air calibration first, if needed.

With the clean dry cell in open air, the reading should be zero. The air cal compensates for excess cable capacitance, and gives a better accuracy at low readings. This should be done when a sensor is installed or replaced. After some time in service, a dirty sensor may well show a high zero offset because of fouling. Clean the sensor and try again. Moreover, air calibration should be made in an environment free of electromagnetic interference.

Wait for the sensor to dry because air cal must be made with no current flow in the sensor, that is, the sensor must be dried while being exposed to air.

NOTE

The temperature compensation should be set to NaCl when confirming zero during air calibration.

NOTE

The temperature compensation is not performed around zero. In this case, a warning may be issued.

Not being wet, the sensor measures the conductivity of air, which is close to zero. Because zero conductivity is out of the range for temperature compensation (this range is based on the temperature and conductivity of solutions and is preset to 0.033 μS/cm at 20°C), a warning may be issued. This is not a device error.

The conductivity of air is zero and it does not have a temperature coefficient. Execute zero calibration regardless of the warning.

3.4 Sample

With the sensor in situ, a sample can be taken for laboratory analysis. Sample calibration records the time and reading, and holds these in memory until the analysis has been completed. The laboratory data can then be entered regardless of the current process value, without the need for calculations.

When sample calibration is made with temperature compensation activated, the types of temperature compensation for laboratory analysis equipment should be matched. Use of a different type of temperature compensation between equipment causes an error. The standard conductivity meter to be used should always be based on the accurate and same temperature compensation calculation method. Yokogawa recommends that the Model SC82 pocket conductivity meter be used for this purpose.

Press [Take Sample] to record a collected sample value in memory. Re-enter the Sample Cal. screen and press [Start calibration] to perform a sample calibration. This updates the recorded data.

3.5 Temperature coefficient

Simply input the solution conductivity at the reference temperature (TR) after allowing the sensor to stabilize at elevated temperatures. The FLXA202/FLXA21 will calculate the temperature coefficient for you. The ideal temperature for this calibration is the normal process value (TP). This calibration is enabled if the Temperature Compensation is set to “TC.” (Refer to 2.1.4 Temperature compensation)

3.6 Temperature calibration

In order to make the most accurate measurements, it is important to have a precise temperature measurement. This affects the display of temperature, and the output signal (when used). More important, however, is the temperature compensation, and calibration accuracy. The temperature of the sensor system should be measured independently with a high precision thermometer. The value of “Measured temperature” should then be adjusted to agree with the reading (zero offset calibration only). For best accuracy, this should be done as near to the normal operating temperature as possible.

3.7 HOLD

The FLXA202/FLXA21 has a function to hold the mA output at a preset value (default: “Last”).

Use this menu to hold the output.

For the settings, see ■ Configure Hold on page 2-7.

During commissioning or quick setup, the output is automatically held.

Setting “Hold during Calibration” to “Disabled” deactivates the hold function during calibration.

Press  to select Execute: HOLD and then choose Manual Hold ON or Manual Hold OFF. This allows you to set up manual hold.

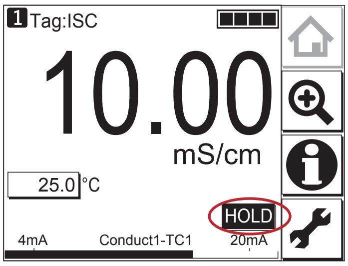


Figure 3.4 Example of the display with the manual hold enabled

To cancel manual hold, press the lit HOLD section on the Main display.

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Appendix Reference material

Temperature compensation

The conductivity of a solution is very dependent on 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 like solution composition, concentration and temperature range. A coefficient (α) is introduced 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 an accurate measure of concentration or purity.

NaCl (standard temperature compensation)

The FLXA202/FLXA21 has the default temperature compensation function based on a sodium chloride (NaCl) solution. This function can be used for various applications and is compatible with the NaCl compensation function of typical laboratory or portable instruments.

Table 1 NaCl compensation according to IEC 60746-3 with Tref. = 25°C

Temperature (°C)	Ratio*	Temperature compensation coefficient (%/°C)
0	0.54	1.8
10	0.72	1.9
20	0.90	2.0
25	1.00	—
30	1.10	2.0
40	1.31	2.0
50	1.53	2.1
60	1.76	2.2
70	1.99	2.2
80	2.22	2.2
90	2.45	2.2

Temperature (°C)	Ratio*	Temperature compensation coefficient (%/°C)
100	2.68	2.2
110	2.90	2.2
120	3.12	2.2
130	3.34	2.2
140	3.56	2.2
150	3.79	2.2
160	4.03	2.2
170	4.23	2.2
180	4.42	2.2
190	4.61	2.2
200	4.78	2.2

*: The ratio of the conductivity at respective temperatures to the conductivity at the reference temperature.

Temperature compensation coefficient (TC)

Set the temperature compensation coefficient based on the degree of influence of temperature on the conductivity (%/°C).

If the temperature compensation coefficient of the sample solution is known from laboratory experiments or has been previously determined, enter the value.

The setting range is between 0.00 and 10.0%. By combining with the reference temperature setting, a linear compensation function can be obtained. This is applicable to all kinds of chemical solution.

<Configure calculated temperature coefficient (TC).>

Follow routing

Commissioning >> Measurement setup >> Temp.compensation >> T.C.

Enter the temperature coefficient calculated from the following formula:

A. Calculation of temperature coefficient factor (With known conductivity at reference temperature).

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

α = Temperature compensation factor in %/°C
T = Measured temperature in °C
K_t = Conductivity at T
T_{ref} = Reference temperature
K_{ref} = Conductivity at T_{ref}

B. Calculation of temperature coefficient factor (with two known conductivity values at different temperatures)

Measure the conductivity of the liquid at two temperatures, one below the reference and above the reference temperature with the temperature coefficient set to 0,00%/°C and use the following equation to calculate a temperature coefficient (α).

$$K_{ref} = \frac{K_T}{1+\alpha(T - T_{ref})}$$

$$K_{ref} = \frac{K_1}{1+\alpha(T_1 - T_{ref})} = \frac{K_2}{1+\alpha(T_2 - T_{ref})}$$

$$K_1(1 + \alpha(T_2 - T_{ref})) = K_2(1 + \alpha(T_1 - T_{ref}))$$

$$K_1 \cdot \alpha(T_2 - T_{ref}) - K_2 \cdot \alpha(T_1 - T_{ref}) = K_2 - K_1$$

$$\alpha = \frac{K_2 - K_1}{K_1(T_2 - T_{ref}) - K_2(T_1 - T_{ref})}$$

Where T_1, T_2: liquid temperature (°C)
K_1: conductivity at T_1 (°C)
K_2: conductivity at T_2 (°C)

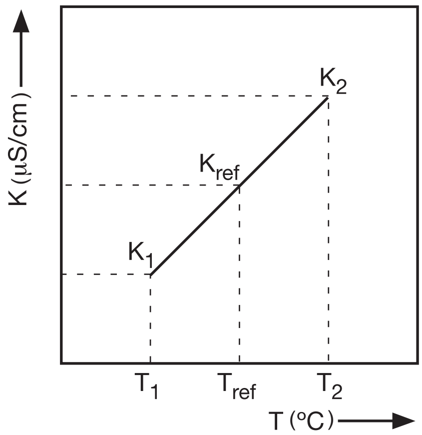


Figure 1 Conductivity

<Calculation example>

Calculate the temperature coefficient of a liquid from the following data.

Conductivity 124.5 µS/cm at a liquid temperature of 18.0 °C and a conductivity 147.6 µS/cm at a liquid temperature of 31.0 °C.

Substituting the data in the above formula gives the following result.

$$\alpha = \frac{147.6 - 124.5}{124.5x(31.0 - 25) - 147.6x(18.0 - 25)} \text{ x } 100 = 1.298 \text{ \%/°C}$$

Set the temperature coefficient in the FLXA202/FLXA21 converter.

When the temperature coefficient already set is accurate, the conductivity to be displayed must be constant regardless of liquid temperature. The following check will make sure that the temperature coefficient already set is accurate.

If, when the liquid temperature is lowered, a larger conductivity value is indicated, the temperature coefficient already set is too small.

The opposite also applies. If a smaller conductivity value is indicated, the temperature coefficient already set is too large. In either case, change the temperature coefficient so that the conductivity no longer changes.

● Matrix

Matrix means temperature compensation with the temperature compensation matrix.

The temperature compensation matrix is a table of conductivity values at different temperatures and concentrations.

Ready-made matrixes and user-defined matrixes are available.

<Ready-made matrixes>

Ready-made temperature compensation matrixes are available for common inorganic acids and bases.

Table 2 Ready-made temperature compensation matrixes

Select matrix	Compound to be measured	Concentration	Temperature	Details
Sulfuric acid 1..5%	H_2SO_4	1 to 5%	0 to 100˚C	Table A
Sulfuric acid 0..27%	H_2SO_4	0 to 27%	-1.1 to 98.9˚C	Table B
Sulfuric acid 39..85%	H_2SO_4	39 to 85%	-17.8 to 115.6˚C	Table C
Sulfuric acid 93..100%	H_2SO_4	93 to 100%	10 to 90˚C	Table D
HCl 1..5%	HCl	1 to 5%	0 to 60˚C	Table E
HCl 0..18%	HCl	0 to 18.2%	-10 to 65˚C	Table F
HCl 24..44%	HCl	23.7 to 43.8%	-20 to 65˚C	Table G
HNO_3 1..5%	HNO_3	1 to 5%	0 to 80˚C	Table H
HNO_3 0..25%	HNO_3	0 to 24.80%	0 to 80˚C	Table I
HNO_3 35..88%	HNO_3	35.0 to 87.7%	-16 to 60˚C	Table J
NaOH 1..5%	NaOH	1 to 5%	0 to 100˚C	Table K
NaOH 0..15%	NaOH	0 to 15%	0 to 100˚C	Table L
NaOH 25..50%	NaOH	25 to 50%	0 to 80˚C	Table M

The ready-made temperature compensation matrixes are listed in Table A to M where temperatures are in the column and concentrations are in the rows.

Table A Sulfuric acid 1..5% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 1.0 %	Solution 2 1.5 %	Solution 3 2.0 %	Solution 4 2.5 %	Solution 5 3.0 %	Solution 6 3.3 %	Solution 7 3.7 %	Solution 8 4.0 %	Solution 9 4.5 %	Solut. Max. 5.0 %
Tmin.	0 °C	0.0338	0.0487	0.0635	0.0793	0.0950	0.105	0.115	0.124	0.139	0.154
2.	10 °C	0.0391	0.0571	0.0750	0.0931	0.111	0.123	0.134	0.146	0.163	0.180
3.	20 °C	0.0444	0.0655	0.0865	0.107	0.127	0.141	0.154	0.167	0.186	0.205
4.	30 °C	0.0491	0.0727	0.0963	0.119	0.141	0.156	0.172	0.186	0.207	0.228
5.	40 °C	0.0533	0.0789	0.104	0.129	0.154	0.170	0.187	0.203	0.226	0.249
6.	50 °C	0.0575	0.0850	0.113	0.139	0.166	0.184	0.202	0.220	0.245	0.270
7.	63 °C	0.0606	0.0899	0.119	0.148	0.177	0.196	0.216	0.235	0.262	0.289
8.	75 °C	0.0637	0.0949	0.126	0.157	0.189	0.209	0.229	0.249	0.278	0.307
9.	88 °C	0.0659	0.0988	0.132	0.165	0.197	0.218	0.240	0.261	0.291	0.322
Tmax.	100 °C	0.0680	0.103	0.138	0.172	0.206	0.228	0.251	0.273	0.305	0.336
Tref.	25.0 °C	0.0470	0.0697	0.0923	0.114	0.135	0.149	0.164	0.178	0.198	0.218

Table B Sulfuric acid 0..27% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 0 %	Solution 2 5 %	Solution 3 8 %	Solution 4 12 %	Solution 5 14 %	Solution 6 17 %	Solution 7 20 %	Solution 8 22 %	Solution 9 24 %	Solut. Max. 27 %
Tmin.	-1.1 °C	0	0.1496	0.2330	0.3275	0.3695	0.4225	0.4640	0.4850	0.5005	0.5140
2.	10.0 °C	0	0.1813	0.3845	0.4030	0.4355	0.5210	0.5725	0.5980	0.6160	0.6340
3.	21.1 °C	0	0.2102	0.3330	0.4740	0.5335	0.6145	0.6805	0.7140	0.7385	0.7625
4.	32.2 °C	0	0.2351	0.3740	0.5360	0.6070	0.7030	0.7810	0.8225	0.8540	0.8860
5.	43.3 °C	0	0.2574	0.4130	0.5945	0.6735	0.7835	0.8755	0.9250	0.9635	1.0050
6.	54.4 °C	0	0.2674	0.4450	0.6455	0.7315	0.8533	0.9600	1.0190	1.0660	1.1180
7.	60.0 °C	0	0.2853	0.4600	0.6670	0.7570	0.8860	0.9980	1.0600	1.1110	1.1700
8.	71.1 °C	0	0.3007	0.4860	0.7070	0.8060	0.9470	1.0710	1.1400	1.1970	1.2640
9.	87.8 °C	0	0.3217	0.5210	0.7605	0.8665	1.0250	1.1630	1.2420	1.3100	1.3940
Tmax.	98.9 °C	0	0.3335	0.5420	0.7885	0.9025	1.0650	1.2160	1.3020	1.3760	1.4690
Tref.	25.0 °C	0	0.2190	0.3470	0.4960	0.5590	0.6450	0.7160	0.7520	0.7790	0.8060

Table C Sulfuric acid 39..85% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 39 %	Solution 2 44 %	Solution 3 50 %	Solution 4 55 %	Solution 5 60 %	Solution 6 65 %	Solution 7 70 %	Solution 8 75 %	Solution 9 80 %	Solut. Max. 85 %
Tmin.	-17.8 °C	0.2775	0.2500	0.2125	0.1770	0.1385	0.1020	0.0710	0.0435	0.0140	0
2.	4.4 °C	0.5225	0.4695	0.4000	0.3265	0.2750	0.2105	0.1500	0.0990	0.0655	0.0610
3.	21.1 °C	0.7220	0.6590	0.5700	0.4670	0.3950	0.3085	0.2315	0.1650	0.1200	0.1100
4.	32.2 °C	0.8600	0.7895	0.6870	0.5715	0.4870	0.3850	0.2950	0.2190	0.1655	0.1530
5.	43.3 °C	0.9225	0.9190	0.8080	0.6770	0.5830	0.4670	0.3640	0.2785	0.2190	0.2040
6.	54.4 °C	1.1250	1.0510	0.9305	0.7825	0.6770	0.5505	0.4400	0.3475	0.2825	0.2620
7.	65.6 °C	1.2490	1.1760	1.0530	0.8950	0.7810	0.6430	0.5220	0.4210	0.3495	0.3255
8.	82.2 °C	1.4340	1.3670	1.2370	1.0640	0.9390	0.7900	0.6570	0.5430	0.4620	0.4315
9.	98.9 °C	1.5950	1.5400	1.4150	1.2350	1.1000	0.9370	0.7960	0.6750	0.5880	0.5450
Tmax.	115.6 °C	1.7350	1.6920	1.5660	1.4250	1.2600	1.0910	0.9345	0.8110	0.7190	0.6630
Tref.	25.0 °C	0.7700	0.7050	0.6110	0.5040	0.4270	0.3350	0.2530	0.1840	0.1360	0.1250

Table D Sulfuric acid 93..100% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min.	Solu-tion 2	Solu-tion 3	Solu-tion 4	Solu-tion 5	Solu-tion 6	Solu-tion 7	Solu-tion 8	Solu-tion 9	Solut. Max.
		93.0 %	**94.0 %**	**95.0 %**	**95.5 %**	**96.0 %**	**97.0 %**	**97.5 %**	**98.0 %**	**99.0 %**	**100.0 %**
Tmin.	**10 °C**	0.0860	0.0835	0.0800	0.0768	0.0735	0.0640	0.0563	0.0485	0.0225	0
2.	**20 °C**	0.1153	0.1143	0.1110	0.1086	0.1051	0.0961	0.0895	0.0812	0.0580	0.0085
3.	**25 °C**	0.1320	0.1310	0.1260	0.1230	0.1190	0.1090	0.1020	0.0920	0.0640	0.0105
4.	**30 °C**	0.1490	0.1467	0.1414	0.1375	0.1332	0.1220	0.1138	0.1035	0.0703	0.0125
5.	**40 °C**	0.1897	0.1860	0.1787	0.1739	0.1680	0.1520	0.1410	0.1295	0.0869	0.0171
6.	**50 °C**	0.2323	0.2275	0.2190	0.2124	0.2041	0.1833	0.1710	0.1574	0.1067	0.0219
7.	**60 °C**	0.2787	0.2715	0.2604	0.2530	0.2440	0.2200	0.2053	0.1884	0.1275	0.0279
8.	**70 °C**	0.3284	0.3196	0.3065	0.2970	0.2853	0.2594	0.2420	0.2255	0.1495	0.0240
9.	**80 °C**	0.3826	0.3714	0.3550	0.3450	0.3332	0.3015	0.2813	0.2570	0.1732	0.0404
Tmax.	**90 °C**	0.4390	0.4250	0.4050	0.3923	0.3775	0.3405	0.3175	0.2910	0.1975	0.0460
Tref.	**25.0 °C**	0.1320	0.1310	0.1260	0.1230	0.1190	0.1090	0.1020	0.0920	0.0640	0.0105

Table E HCl 1..5% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min.	Solu-tion 2	Solu-tion 3	Solu-tion 4	Solu-tion 5	Solu-tion 6	Solu-tion 7	Solu-tion 8	Solu-tion 9	Solut. Max.
		1.0 %	**1.5 %**	**2.0 %**	**2.5 %**	**3.0 %**	**3.3 %**	**3.7 %**	**4.0 %**	**4.5 %**	**5.0 %**
Tmin.	**0 °C**	0.0650	0.0950	0.125	0.152	0.179	0.196	0.213	0.229	0.251	0.273
2.	**5 °C**	0.0737	0.107	0.141	0.172	0.202	0.221	0.240	0.258	0.283	0.308
3.	**10 °C**	0.0823	0.120	0.157	0.191	0.225	0.246	0.267	0.288	0.316	0.344
4.	**15 °C**	0.0910	0.132	0.173	0.211	0.248	0.271	0.294	0.317	0.348	0.379
5.	**20 °C**	0.0987	0.143	0.188	0.229	0.270	0.295	0.320	0.345	0.378	0.412
6.	**30 °C**	0.114	0.166	0.217	0.265	0.313	0.342	0.372	0.401	0.439	0.477
7.	**38 °C**	0.125	0.182	0.239	0.290	0.342	0.373	0.406	0.438	0.479	0.521
8.	**45 °C**	0.135	0.198	0.260	0.315	0.370	0.404	0.440	0.474	0.520	0.565
9.	**53 °C**	0.147	0.214	0.281	0.340	0.400	0.437	0.475	0.512	0.564	0.616
Tmax.	**60 °C**	0.159	0.230	0.301	0.366	0.430	0.469	0.510	0.549	0.608	0.666
Tref.	**25.0 °C**	0.106	0.154	0.202	0.247	0.291	0.318	0.346	0.373	0.409	0.444

Table F HCl 0..18% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min.	Solu-tion 2	Solu-tion 3	Solu-tion 4	Solu-tion 5	Solu-tion 6	Solu-tion 7	Solu-tion 8	Solu-tion 9	Solut. Max.
		0 %	**3.65 %**	**5.48 %**	**7.30 %**	**9.12 %**	**11.0 %**	**12.8 %**	**14.6 %**	**16.4 %**	**18.2 %**
Tmin.	**-10 °C**	0	0.174	0.226	0.277	0.329	0.362	0.390	0.409	0.427	0.439
2.	**0 °C**	0	0.212	0.294	0.364	0.421	0.464	0.489	0.514	0.538	0.552
3.	**10 °C**	0	0.262	0.362	0.445	0.512	0.566	0.603	0.629	0.654	0.668
4.	**15 °C**	0	0.284	0.395	0.481	0.554	0.610	0.653	0.681	0.708	0.722
5.	**20 °C**	0	0.312	0.431	0.526	0.600	0.658	0.706	0.737	0.768	0.783
6.	**25 °C**	0	0.332	0.459	0.563	0.647	0.713	0.764	0.794	0.824	0.837
7.	**30 °C**	0	0.359	0.497	0.607	0.692	0.760	0.815	0.850	0.885	0.901
8.	**45 °C**	0	0.425	0.587	0.721	0.830	0.914	0.978	1.02	1.06	1.08
9.	**55 °C**	0	0.468	0.648	0.796	0.917	1.01	1.08	1.13	1.17	1.17
Tmax.	**65 °C**	0	0.509	0.705	0.867	1.00	1.10	1.18	1.23	1.28	1.31
Tref.	**25.0 °C**	0	0.332	0.459	0.563	0.647	0.713	0.764	0.794	0.824	0.837

Table G HCl 24..44% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 23.7 %	Solution 2 25.6 %	Solution 3 29.2 %	Solution 4 31.0 %	Solution 5 32.8 %	Solution 6 34.7 %	Solution 7 36.5 %	Solution 8 38.3 %	Solution 9 40.1 %	Solut. Max. 43.8 %
Tmin.	-20 °C	0.354	0.351	0.342	0.335	0.328	0.319	0.312	0.303	0.295	0.277
2.	0 °C	0.560	0.555	0.538	0.524	0.511	0.497	0.482	0.467	0.452	0.424
3.	10 °C	0.670	0.661	0.635	0.620	0.604	0.587	0.570	0.553	0.537	0.504
4.	15 °C	0.722	0.712	0.685	0.669	0.652	0.635	0.616	0.597	0.579	0.540
5.	20 °C	0.783	0.771	0.739	0.720	0.700	0.679	0.658	0.637	0.617	0.576
6.	25 °C	0.830	0.818	0.786	0.768	0.748	0.728	0.707	0.686	0.662	0.622
7.	30 °C	0.898	0.885	0.849	0.827	0.805	0.782	0.759	0.736	0.714	0.667
8.	45 °C	1.07	1.06	1.01	0.989	0.964	0.938	0.911	0.883	0.855	0.797
9.	55 °C	1.19	1.17	1.12	1.09	1.06	1.03	1.00	0.970	0.940	0.910
Tmax.	65 °C	1.30	1.28	1.23	1.20	1.17	1.14	1.11	1.08	1.05	1.02
Tref.	25.0 °C	0.830	0.818	0.786	0.768	0.748	0.728	0.707	0.686	0.662	0.622

Table H HNO_3 1..5% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 1.0%	Solution 2 1.5 %	Solution 3 2.0 %	Solution 4 2.5 %	Solution 5 3.0 %	Solution 6 3.3 %	Solution 7 3.7 %	Solution 8 4.0 %	Solution 9 4.5 %	Solut. Max. 5.0 %
Tmin.	0 °C	0.0395	0.0578	0.0761	0.0948	0.1134	0.1246	0.1360	0.1472	0.1634	0.1795
2.	10 °C	0.0485	0.0704	0.0923	0.1149	0.1374	0.1510	0.1650	0.1786	0.1987	0.2188
3.	15 °C	0.0529	0.0767	0.1004	0.1249	0.1494	0.1642	0.1795	0.1943	0.2163	0.2384
4.	20 °C	0.0574	0.0830	0.1085	0.1350	0.1614	0.1774	0.1940	0.2100	0.2340	0.2580
5.	30 °C	0.0694	0.0989	0.1283	0.1583	0.1882	0.2061	0.2246	0.2425	0.2683	0.2940
6.	40 °C	0.0814	0.1148	0.1481	0.1816	0.2150	0.2348	0.2552	0.2750	0.3025	0.3300
7.	50 °C	0.0907	0.1276	0.1645	0.2010	0.2375	0.2591	0.2814	0.3030	0.3333	0.3635
8.	60 °C	0.0999	0.1404	0.1808	0.2204	0.2600	0.2834	0.3076	0.3310	0.3640	0.3970
9.	70 °C	0.1139	0.1564	0.1989	0.2392	0.2795	0.3036	0.3284	0.3525	0.3875	0.4225
Tmax.	80 °C	0.1278	0.1724	0.2170	0.2580	0.2990	0.3238	0.3493	0.3740	0.4110	0.4480
Tref.	25.0 °C	0.0634	0.0909	0.1184	0.1466	0.1748	0.1918	0.2093	0.2263	0.2511	0.2760

Table I HNO_3 0..25% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 0 %	Solution 2 3.12 %	Solution 3 6.20 %	Solution 4 9.30 %	Solution 5 12.40 %	Solution 6 15.32 %	Solution 7 17.72 %	Solution 8 20.11 %	Solution 9 22.46 %	Solut. Max. 24.80 %
Tmin.	0 °C	0	0.1140	0.2259	0.3120	0.3980	0.4472	0.4854	0.5236	0.5498	0.5760
2.	18 °C	0	0.1606	0.3178	0.4345	0.5512	0.6062	0.6559	0.7055	0.7368	0.7680
3.	20 °C	0	0.1650	0.3215	0.4395	0.5575	0.6236	0.6742	0.7248	0.7568	0.7888
4.	25 °C	0	0.1780	0.3490	0.4760	0.6030	0.6655	0.7186	0.7717	0.8119	0.8520
5.	30 °C	0	0.1900	0.3665	0.5002	0.6339	0.7065	0.7619	0.8172	0.8555	0.8938
6.	40 °C	0	0.2110	0.4095	0.5588	0.7081	0.7860	0.8451	0.9042	0.9511	0.9980
7.	50 °C	0	0.2600	0.4507	0.6154	0.7801	0.8620	0.9239	0.9857	1.044	1.102
8.	60 °C	0	0.3100	0.4899	0.6699	0.8498	0.9345	0.9982	1.062	1.133	1.205
9.	70 °C	0	0.3330	0.5273	0.7223	0.9173	1.004	1.068	1.132	1.219	1.306
Tmax.	80 °C	0	0.3560	0.5660	0.7770	0.9826	1.069	1.133	1.198	1.302	1.407
Tref.	25.0 °C	0	0.1780	0.3490	0.4760	0.6030	0.6655	0.7186	0.7715	0.8119	0.8520

Table J HNO_3 35..88% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 35.0 %	Solution 2 37.2 %	Solution 3 43.3 %	Solution 4 49.6 %	Solution 5 55.8 %	Solution 6 62.0 %	Solution 7 75.0 %	Solution 8 76.6 %	Solution 9 82.0 %	Solut. Max. 87.7 %
Tmin.	-16 ˚C	0.412	0.400	0.368	0.334	0.288	0.254	0.163	0.147	0.089	0.044
2.	0 ˚C	0.576	0.555	0.507	0.456	0.404	0.352	0.227	0.208	0.128	0.060
3.	10 ˚C	0.678	0.666	0.614	0.555	0.493	0.438	0.268	0.246	0.153	0.069
4.	18 ˚C	0.770	0.754	0.700	0.634	0.565	0.506	0.300	0.277	0.172	0.077
5.	20 ˚C	0.786	0.776	0.721	0.654	0.583	0.512	0.310	0.290	0.175	0.079
6.	25 ˚C	0.842	0.831	0.784	0.714	0.636	0.559	0.340	0.315	0.185	0.081
7.	30 ˚C	0.895	0.886	0.827	0.754	0.672	0.590	0.370	0.335	0.190	0.083
8.	40 ˚C	1.001	0.995	0.938	0.858	0.774	0.690	0.430	0.375	0.200	0.087
9.	50 ˚C	1.105	1.095	1.038	0.958	0.874	0.790	0.485	0.415	0.210	0.091
Tmax.	60 ˚C	1.205	1.195	1.138	1.058	0.974	0.890	0.530	0.455	0.220	0.095
Tref.	25.0 ˚C	0.842	0.831	0.784	0.714	0.636	0.559	0.340	0.315	0.185	0.081

Table K NaOH 1..5% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 1.0 %	Solution 2 1.5 %	Solution 3 2.0 %	Solution 4 2.5 %	Solution 5 3.0 %	Solution 6 3.3 %	Solution 7 3.7 %	Solution 8 4.0 %	Solution 9 4.5 %	Solut. Max. 5.0 %
Tmin.	0 ˚C	0.0310	0.0460	0.0610	0.0735	0.0860	0.0923	0.0987	0.105	0.116	0.127
2.	10 ˚C	0.0398	0.0584	0.0770	0.0933	0.110	0.119	0.128	0.137	0.151	0.165
3.	20 ˚C	0.0486	0.0708	0.0930	0.113	0.133	0.145	0.157	0.169	0.186	0.204
4.	30 ˚C	0.0576	0.0833	0.109	0.133	0.157	0.172	0.187	0.202	0.222	0.242
5.	40 ˚C	0.0668	0.0959	0.125	0.154	0.182	0.200	0.217	0.235	0.258	0.281
6.	50 ˚C	0.0760	0.109	0.141	0.174	0.207	0.227	0.248	0.268	0.294	0.319
7.	63 ˚C	0.0868	0.124	0.162	0.199	0.236	0.258	0.281	0.304	0.334	0.364
8.	75 ˚C	0.0975	0.140	0.182	0.223	0.264	0.289	0.314	0.339	0.374	0.408
9.	88 ˚C	0.108	0.155	0.203	0.247	0.291	0.319	0.347	0.375	0.413	0.452
Tmax.	100 ˚C	0.119	0.171	0.223	0.271	0.318	0.348	0.380	0.410	0.453	0.495
Tref.	25.0 ˚C	0.0530	0.0770	0.101	0.123	0.145	0.158	0.172	0.185	0.204	0.223

Table L NaOH 0..15% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min. 0 %	Solution 2 1 %	Solution 3 3 %	Solution 4 4 %	Solution 5 5 %	Solution 6 6 %	Solution 7 8 %	Solution 8 10 %	Solution 9 12 %	Solut. Max. 15 %
Tmin.	0 ˚C	0	0.035	0.087	0.113	0.133	0.150	0.176	0.195	0.206	0.215
2.	10 ˚C	0	0.042	0.109	0.140	0.167	0.190	0.226	0.255	0.274	0.293
3.	18 ˚C	0	0.047	0.125	0.163	0.195	0.221	0.267	0.303	0.327	0.345
4.	25 ˚C	0	0.052	0.142	0.183	0.222	0.256	0.313	0.355	0.381	0.410
5.	30 ˚C	0	0.056	0.153	0.200	0.242	0.278	0.338	0.389	0.424	0.467
6.	40 ˚C	0	0.063	0.179	0.233	0.281	0.323	0.396	0.458	0.502	0.551
7.	50 ˚C	0	0.070	0.201	0.265	0.320	0.368	0.454	0.527	0.580	0.645
8.	60 ˚C	0	0.080	0.223	0.293	0.355	0.410	0.507	0.592	0.658	0.742
9.	80 ˚C	0	0.100	0.270	0.350	0.425	0.493	0.612	0.721	0.814	0.936
Tmax.	100 ˚C	0	0.119	0.315	0.407	0.495	0.574	0.717	0.850	0.967	1.130
Tref.	25.0 ˚C	0	0.052	0.142	0.183	0.222	0.256	0.313	0.355	0.381	0.410

Table M NaOH 25..50% (Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min.	Solu-tion 2	Solu-tion 3	Solu-tion 4	Solu-tion 5	Solu-tion 6	Solu-tion 7	Solu-tion 8	Solu-tion 9	Solut. Max.
		25 %	28 %	30 %	32 %	35 %	38 %	40 %	42 %	45 %	50 %
Tmin.	0 ˚C	0.140	0.100	0.075	0.060	0.040	0.024	0.017	0.012	0.010	0.007
2.	10 ˚C	0.212	0.174	0.148	0.124	0.094	0.074	0.063	0.053	0.038	0.025
3.	18 ˚C	0.270	0.232	0.207	0.184	0.153	0.131	0.120	0.105	0.090	0.078
4.	25 ˚C	0.352	0.313	0.289	0.266	0.233	0.207	0.194	0.180	0.162	0.146
5.	30 ˚C	0.411	0.372	0.347	0.323	0.291	0.264	0.248	0.233	0.214	0.195
6.	40 ˚C	0.528	0.489	0.463	0.440	0.405	0.373	0.354	0.337	0.317	0.293
7.	50 ˚C	0.645	0.605	0.580	0.556	0.520	0.482	0.460	0.441	0.420	0.390
8.	60 ˚C	0.796	0.766	0.746	0.724	0.694	0.660	0.639	0.623	0.604	0.570
9.	75 ˚C	1.023	1.007	0.995	0.980	0.955	0.925	0.908	0.893	0.873	0.839
Tmax.	80 ˚C	1.098	1.086	1.078	1.066	1.042	1.015	0.997	0.982	0.963	0.929
Tref.	25.0 ˚C	0.352	0.313	0.289	0.266	0.233	0.207	0.194	0.180	0.162	0.146

<User-defined matrixes>

The user-defined temperature compensation matrix is a matrix defined by users. Enter values as shown in Table 3. The gray areas must be entered.

Table 3 Example of user-defined matrix (Reference temperature (Tref.): 25.0 ˚C, Conductivity unit: S/cm)

Temp.ranges \ Solutions (Conc.)		Solut. Min.	Solut. Max.	Solu-tion 2	Solu-tion 3	Solu-tion 4	Solu-tion 5	Solu-tion 6	Solu-tion 7	Solu-tion 8	Solu-tion 9
		0 %	15 %	1 %	3 %	4 %	5 %	6 %	8 %	10 %	12 %
Tref.	(25.0 ˚C)	0.013	0.410	0.052	0.142	0.183	0.222	0.256	0.313	0.355	0.381
Tmin.	0 ˚C	0.009	0.215	0.035	0.087	0.113	0.133	0.150	0.176	0.195	0.206
Tmax.	100 ˚C	0.025	1.13	0.119	0.315	0.407	0.495	0.574	0.717	0.850	0.967
2.	10 ˚C	0.010	0.293	0.042	0.109	0.140	0.167	0.190	0.226	0.255	0.274
3.	18 ˚C	0.012	0.357	0.047	0.125	0.163	0.195	0.221	0.267	0.303	0.327
4.	25 ˚C	0.013	0.410	0.052	0.142	0.183	0.222	0.256	0.313	0.355	0.381
5.	30 ˚C	0.014	0.468	0.056	0.153	0.200	0.242	0.278	0.338	0.389	0.424
6.	40 ˚C	0.015	0.551	0.067	0.179	0.233	0.281	0.323	0.396	0.458	0.502
7.	50 ˚C	0.017	0.645	0.070	0.201	0.265	0.320	0.368	0.454	0.527	0.580
8.	60 ˚C	0.018	0.742	0.080	0.223	0.293	0.355	0.410	0.507	0.592	0.658
9.	80 ˚C	0.021	0.936	0.100	0.270	0.350	0.425	0.493	0.612	0.721	0.814

Note: This table is as shown on the screen. The gray areas must be entered.

Set the reference temperature in the Temp. comp. screen (default: 25.0°C).

Input concentration values in the Solution screen.

The values must be entered in ascending order from Solution (Min.) to Solution (Max.). Solution (Min.) and Solution (Max.) must be entered.

Input temperatures for compensation in the Temp. ranges screen.

Input the conductivity values* at respective temperatures in the Solution (Min.) screen and those in the Solution (Max.) screen. Input other values, if any, in the Solution n screen.

*: Enter the precompensated conductivity.

All cells of two user-defined matrixes are blank as a default. If any cells are not blank, clear them.

After entering all values, select “Check values?” to verify that there is no error.

This function checks if the matrix is consistently incremental or decremental. If any error is found, its location is specified.

If there is no error, the matrix is compensated linearly and the blanks of the table (if any) are filled. If some areas are left empty without running “Check values?”, a 1st/2nd comp. matrix error will be issued.

■ Temperature compensation error

The temperature compensation error (alarm) is issued in any of the following cases.

● TC

The error is issued when:

(measured temperature – reference temperature) < –90/compensation coefficient

The default of the temperature compensation coefficient is 2.10%/°C.

For example, when the reference temperature is 25°C, the temperature compensation coefficient is 2.10%/°C and the measured temperature is lower than –17.9°C, the error will be issued.

Temperature compensation is performed even while an alarm is being issued.

● Matrix

The error is issued when the temperature or the precompensated conductivity is out of the range of the temperature compensation matrix.

In this case, however, the temperature compensation is performed by extrapolation even while an alarm is being issued.

● All

When the conductivity is around zero, the temperature compensation error may be issued. In this case, the temperature compensation is not performed, and the precompensated conductivity is displayed.

Whether the conductivity is around zero or not is determined by the temperature and conductivity of solutions. For example, when the temperature is 20°C and the conductivity is lower than 0.033 μS/cm, the conductivity is determined to be around zero.

When measuring the conductivity around zero in air calibration or when the conductivity to be measured is around zero, an alarm may be issued.

NOTE

To display the precompensated conductivity, set the Method to “None”.

Select Measurement setup → Temp. compensation.

■ Calibration solutions for conductivity

The calibration (cell constant) of a sensor does not change unless the sensor is damaged.

It can also appear to change because of coating of the electrodes, or partial blockage.

It does not make sense to regularly recalibrate the FLXA202/FLXA21.

A calibration check, however, is another matter. When the objective is clearly defined as a diagnostic exercise a regular check can bring an extra level of security and confidence to the measurement.

Sensor damage, and/or coatings can be difficult to see and the calibration check can confirm their presence, by a deviation from the known solution conductivity. The remedial action should be to clean the sensor, and carefully check for blockage or damage (not simply to recalibrate).

Higher conductivity solutions should be used where possible. The lower the conductivity of the test solution, the easier it is to contaminate. Carbon dioxide from the air can be quickly absorbed to cause an error. All containers must be suitably clean, and all materials suitably pure. Outside of a well-equipped laboratory these conditions are hard to meet.

FLXA202/FLXA21 is programmed with the following table of conductivity of Potassium Chloride (KCl) solutions at 25°C. This is used in the Automatic Cell Constant setting calibration feature. (See 3.2 Cell constant (automatic) The table is derived from the Standards laid down in "International Recommendation No. 56 of the Organisation Internationale de Métrologie Legale".

Table 4 KCl values at 25 °C

mol/l	mg KCl/kg of solution	Conductivity
0.001	74.66	0.1469 mS/cm
0.002	149.32	0.2916 mS/cm
0.005	373.29	0.7182 mS/cm
0.01	745.263	1.4083 mS/cm
0.1	7419.13	12.852 mS/cm
1.0	71135.2	111.31 mS/cm

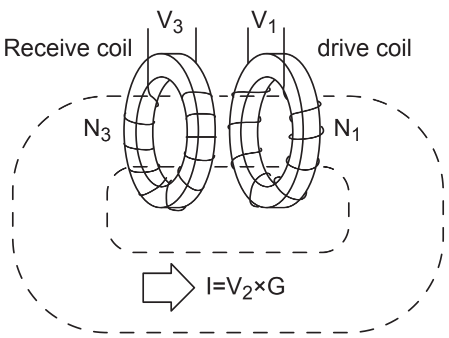
If it is more convenient, the user may make solutions from Sodium Chloride (NaCl or common table salt) with the help of the following relationship table. This table is derived from the IEC norm 60746-3.

Table 5 NaCl values at 25 °C

Weight %	mg/kg	Conductivity
0.001	10	21.4 µS/cm
0.003	30	64.0 µS/cm
0.005	50	106 µS/cm
0.01	100	210 µS/cm
0.03	300	617 µS/cm
0.05	500	1.03 mS/cm
0.1	1000	1.99 mS/cm
0.3	3000	5.69 mS/cm
0.5	5000	9.48 mS/cm
1	10000	17.6 mS/cm
3	30000	48.6 mS/cm
5	50000	81.0 mS/cm
10	100000	140 mS/cm

Measurement principle

Contrary to contact electrode conductivity, the EXA ISC Series analyses the conductivity with out any contact between electrodes and process fluid. The measurement is based on inductive coupling of 2 ring trans form ers (Toroids) by the liquid.



The converter supplies a reference volt age at a high frequency to the "drive coil". The core of this coil is of a high permeability mag net ic material, and a strong magnetic field is generated in the toroid.

The liquid passes through the hole in the toroid and can be considered as a "one turn" secondary winding.

The magnetic field will induce a voltage in this secondary winding. The induced cur rent in the liquid winding is proportional to this volt age and the conductance of the liquid "one turn winding" is according to Ohm's law.

The conductance (1/R) is proportional to the specific conductivity and a constant factor that is determined by the geometry of the sensor (length divided by surface area of the hole in the toroid) and the installation of the sensor.

There are 2 toroids mounted in the “dough nut” shaped sensor. The liquid also flows through the second toroid and therefore the liquid turn can be considered as a primary winding of the second ring transformer.

The current in the liquid will create a magnetic field in the second toroid. The induced voltage being the result of this magnetic field can be measured as an output.

The output voltage of this “receive coil” is therefore proportional to the specific conductivity of the process liquid.

■ Changing the settings

If any setting is accidentally changed, values to the right of the relevant arrow in Table 6 are all initialized.

Table 6 Parameters that initialize other values

Measurement ->	Output: Process parameter ->	Linear: 0% value, 100% value
		Table
		Communication: HART: PV
	Display setup: Main display	
	Trend Graph Screen ->	Y-axis (low, high)
	Communication: HART	
Configure sensor: Measuring unit ->	Display setup: Main display: unit	

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