User's Manual

Model SC202G-F Conductivity and Resistivity Transmitter

EXA

CE

YOKOGAWA ◆

IM 12D7B3-02E-H
1st Edition

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PREFACE

WARNING

Electric discharge
The EXA analyzer contains devices that can be damaged by electrostatic discharge. When servicing this equipment, please observe proper procedures to prevent such damage. Replacement components should be shipped in conductive packaging. Repair work should be done at grounded workstations using grounded soldering irons and wrist straps to avoid electrostatic discharge.

Installation and wiring
The EXA analyzer should only be used with equipment that meets the relevant international and regional standards. Yokogawa accepts no responsibility for the misuse of this unit.

CAUTION

The instrument is packed carefully with shock absorbing materials, nevertheless, the instrument may be damaged or broken if subjected to strong shock, such as if the instrument is dropped. Handle with care.

Although the instrument has a weatherproof construction, the transmitter can be harmed if it becomes submerged in water or becomes excessively wet.

Do not use an abrasive or solvent in cleaning the instrument.

Notice
The contents of this manual are subject to change without notice. Yokogawa is not responsible for damage to the instrument, poor performance of the instrument or losses resulting from such, if the problems are caused by:
- Improper operation by the user.
- Use of the instrument in improper applications.
- Use of the instrument in an improper environment or improper utility program.
- Repair or modification of the related instrument by an engineer not authorized by Yokogawa.

Warranty and service
Yokogawa products and parts are guaranteed free from defects in workmanship and material under normal use and service for a period of (typically) 12 months from the date of shipment from the manufacturer. Individual sales organizations can deviate from the typical warranty period, and the conditions of sale relating to the original purchase order should be consulted. Damage caused by wear and tear, inadequate maintenance, corrosion, or by the effects of chemical processes are excluded from this warranty coverage.

In the event of warranty claim, the defective goods should be sent (freight paid) to the service department of the relevant sales organization for repair or replacement (at Yokogawa discretion). The following information must be included in the letter accompanying the returned goods:
- Part number, model code and serial number
- Original purchase order and date
- Length of time in service and a description of the process
- Description of the fault, and the circumstances of failure
- Process/environmental conditions that may be related to the installation failure of the device
- A statement whether warranty or non-warranty service is requested
- Complete shipping and billing instructions for return of material, plus the name and phone number of a contact person who can be reached for further information.

Returned goods that have been in contact with process fluids must be decontaminated/disinfected before shipment. Goods should carry a certificate to this effect, for the health and safety of our employees. Material safety data sheets should also be included for all components of the processes to which the equipment has been exposed.

CONFIGURATION CHECKLIST FOR SC202

Primary choices	default	alternatives	reference on page	menu
Measurement	**Conductivity**	Resistivity	5.8- 5.9	SC 01
Temperature unit	**Celsius**	Fahrenheit	5.10- 5.11	SC 11
Sensor				
Cell constant	**0.1 /cm**	any value between 0.08 and 50	5.8-5.9, 6.1- 6.3	SC 03
Sensor type	**2-electrode**	4- electrode	5.8- 5.9	SC 02
Temperature compensator	**Pt1000**	Ni100, Pt100, 8k55, Pb36	5.10-5.11	SC 10
Temperature compensation	NaCl in water	fixed T.C., matrix	5.12, 5.13, 5.5	SC 20- 28; "temp"
USP functionality	inactive	Fail if USP limits are exceeded	9.1, 9.2, 5.17	SC 57
Calibration temperature	inactive	adjustment +/- 15 °C	5.11	SC 12
ZERO calibration	inactive	adjustment +/-1 µS/cm	5.9	SC 04
Diagnostics	hard alarm on all errors	hard or soft choices	5.17	SC 53
Cell fouling alarm	active	except E13 inactive	5.9	SC 05
Password protection	inactive	password for different levels	5.17	SC 52
Concentration units	inactive	linearization of output, w% on LCD	5.14 - 5.17	SC 31/35/55

1. Introduction And General Description

The Yokogawa EXA 202 is a 2-wire transmitter designed for industrial process monitoring, measurement and control applications. This user's manual contains the information needed to install, set up, operate and maintain the unit correctly. This manual also includes a basic troubleshooting guide to answer typical user questions.

Yokogawa can not be responsible for the performance of the EXA analyzer if these instructions are not followed.

1-1. Instrument check

Upon delivery, unpack the instrument carefully and inspect it to ensure that it was not damaged during shipment. If damage is found, retain the original packing materials (including the outer box) and then immediately notify the carrier and the relevant Yokogawa sales office.

Make sure the model number on the textplate affixed to the side of the instrument agrees with your order. Examples of textplates are shown below.

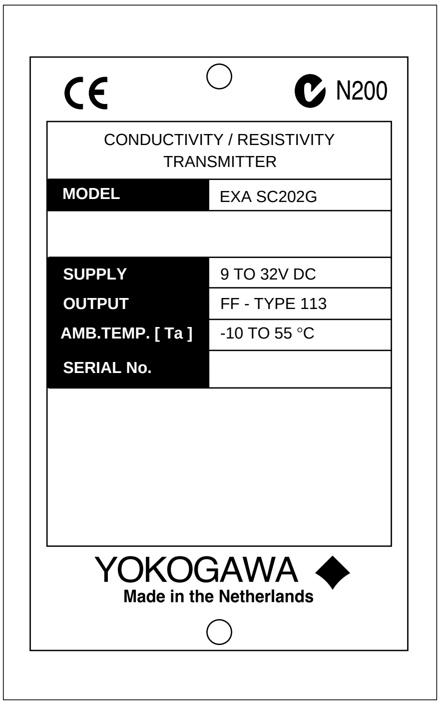


Figure 1-1. Textplate

note: The textplate will also contain the serial number and any relevant certification marks. Be sure to apply correct power to the unit. The first two characters of the serial number refers to the year and month of manufacturing. Check that all the parts are present, including mounting hardware, as specified in the option codes at the end of the model number. For a description of the model codes, refer to Chapter 2 of this manual under General Specifications.

Y= year		M= month	
2000	M	January	1
2001	N	February	2
2002	P	March	3
2003	R	April	4
....	..	....	..
2008	W	September	9
2009	X	October	O
2010	A	November	N
2011	B	December	D

Basic Parts List: Transmitter SC202
User's Manual
Optional mounting hardware when specified (See model code)

note: special grommett and if applicate option /T are packed in the terminal compartment, together with a second link for impedance selection.

1-2. Application

The EXA converter is intended to be used for continuous on-line measurement in industrial installations. The unit combines simple operation and microprocessor-based performance with advanced self-diagnostics and enhanced communications capability to meet the most advanced requirements. The measurement can be used as part of an automated process control system. It can also be used to indicate dangerous limits of a process, to monitor product quality, or to function as a simple controller for a dosing/neutralisation system.

Yokogawa designed the EXA analyzer to withstand harsh environments. The converter may be installed either indoors or outside because the IP65 (NEMA4X) housing and cabling glands ensure the unit is adequately protected. The flexible polycarbonate window on the front door of the EXA allows pushbutton access to the keypad, thus preserving the water and dust protection of the unit even during routine maintenance operations.
A variety of EXA hardware is optionally available to allow wall, pipe, or panel mounting. Selecting a proper installation site will permit ease of operation. Sensors should normally be mounted close to the converter in order to ensure easy calibration and peak performance. If the unit must be mounted remotely from the sensors, WF10 extension cable can be used up to a maximum of 30 metres (90 feet) with a BA10 junction box.

The EXA is delivered with a general purpose default setting for programmable items. (Default settings are listed in Chapter 5). While this initial configuration allows easy start-up, the configuration should be adjusted to suit each particular application. An example of an adjustable item is the type of temperature sensor used. The EXA can be adjusted for any one of five different types of temperature sensors.

To record such configuration adjustments, write changes in the space provided in Chapter 11 of this manual. Because the EXA is suitable for use as a monitor, a controller or an alarm instrument, program configuration possibilities are numerous.

Details provided in this user's manual are sufficient to operate the EXA with all Yokogawa sensor systems and a wide range of third-party commercially available probes. For best results, read this manual in conjunction with the corresponding sensor user's manual.

Yokogawa designed and built the EXA to meet the CE regulatory standards. The unit meets or exceeds stringent requirements of EN 61000-6-2 (Immunity), EN55022 Class A (Emission) without compromise, to assure the user of continued accurate performance in even the most demanding industrial installations.

2. GENERAL SPECIFICATIONS

2-1. Specifications

A. Input specifications : Two or four electrodes measurement with square wave excitation. Cell constants from 0.008 to 50 cm^{-1} WU40 sensor cable up to 20m. Up to 30m total using BA10 junction box and WF10 extension cable

B. Detection method : Frequency, read-pulse position and reference voltage are dynamically optimized.

C. Input ranges

- Conductivity : 0.000 µS/cm to 1999 mS/cm at 25 °C (77 °F) reference temperature.
  - Minimum : 0.2 µS x C at process temperature (underrange 0.000 µS/cm).
  - Maximum : 500 mS x C at process temperature (overrange 550 mS x C).
- Resistivity : 0.000 kΩ - 999 MΩ/C at 25 °C (77 °F) reference temperature.
  - Minimum : 0.002 kΩ/C at process temperature (underrange 0.000 kΩ x cm).
  - Maximum : 5 MΩ/C at process temperature (overrange 999 MΩ x cm).
- Temperature
  - Pt1000 : -20 to +250 °C (0 - 500 °F)
  - Pt100 and Ni100 : -20 to +200 °C (0 - 400 °F)
  - 8K55 NTC : -10 to +120 °C (10 - 250 °F)
  - Pb36 NTC : -20 to +120 °C (0 - 250 °F)

D. Output Span

- Conductivity : - min 0.01µS/cm
  : - max. 1999 mS/cm. (max 90% zero suppression)
- Resistivity : - min KΩxcm
  : - max. 999 MΩ x cm. (max 90% zero suppression)
- Temperature : Dependent on temp. sensor type:

Sensor type	min.	max.
Pt1000	25 °C (50 °F)	250 °C (500 °F)
Pt100, Ni100	25 °C (50 °F)	200 °C (400 °F)
Pb36, 8K55 NTC	25 °C (50 °F)	100 °C (200 °F)

The instrument is user programmable for linear or non-linear conductivity ranges.

E. Temperature compensation

: Automatic, for temperature ranges mentioned under C (inputs).

- Reference temp. : programmable from 0 to 100 °C or 30 to 210 °F (default 25 °C).

F. Compensation algorithm

- -NaCl : According IEC 746-3 NaCl tables (default).
- -T.C. : Two independent user programmable temperature coefficients, from -0.00% to 3.50% per °C (°F) by adjustment or calibration.
- - Matrix : : Conductivity as a function of concentration and temperature. Choice out of 5 preprogrammed matrices and a 25-point user-programmable matrix.

G. Logbook : Software record of important events and diagnostic data. Available through FF interface.

H. Display : Custom liquid crystal display, with a main display of 31/2 digits 12.5 mm high. Message display of 6 alphanumeric characters, 7 mm high. Warning flags and units (µS/cm, mS/cm, kΩ•cm and MΩ•cm) as appropriate.

I. Power supply : 9 to 32 VDC

J. Input isolation : 1000 VDC

K. Shipping Details : Package size w x h x d
290 x 225 x 170 mm.
11.5 x 8.9 x 6.7 in.
Packed weight approx. 2.5 kg (5lb).

2-2. Operating specifications

A. Performance : Conductivity
- Accuracy : ≤ 0.5 %

Performance : Resistivity
- Accuracy : ≤ 0.5 %

Performance : Temperature with Pt1000Ω, Ni100Ω and Pb36 NTC
- Accuracy : ≤ 0.3 °C

Performance : Temperature with PT100Ω and 8k55Ω
- Accuracy : ≤ 0.4 °C

Performance : Temperature compensation
- NaCl table : ≤ 1 %
- Matrix : ≤ 3 %
- Ambient influence : ≤ 0.05 %/°C
- Step response : 90 % (< 2 decades) in ≤ 7 seconds

B. Ambient operating temperature

: -10 to +55 oC (10 to 130 ºF) Excursions to -30 to +70 oC (-20 to 160 ºF) will not damage the instrument, specification maybe adversely affected
Drift < 500 ppm/°C

C. Storage temperature

: -30 to +70 oC (-20 to 160 ºF)

D. Humidity : 10 to 90% RH non-condensing

E. FF specification : Twisted 2-wire with shield.

F. Housing : Cast aluminium case with chemically resistant coating, cover with flexible polycarbonate window. Case color is off-white and cover is moss green. Cable entry is via two 1/2" polyamide glands. Cable terminals are provided for up to 2.5 mm2 finished wires. Weather resistant to IP65 and NEMA 4X standards. Pipe wall or panel mounting, using optional hardware.**G.**

Data protection : EEPROM for configuration and logbook, and lithium battery for clock.

H. Watchdog timer : Checks microprocessor

I. Automatic safeguard : Return to measuring mode when no keystroke is made for 10 min.

J. Operation protection : 3-digit programmable password.

K. Regulatory compliance
- EMC : meets council directive 89/336/EEC
- Emmission : meets EN 55022 Class A
- Immunity : meets EN 61000-6-2

L. DD specification

: The SC202 Device Description is available enabling communications.

2-3. Model and suffix codes

Model code	Suffix code	Option	Description
SC202G			Inductive Conductivity Transmitter General Purpose version
SC202S			Inductive Conductivity Transmitter Intrinsic Safe version
Type	-A		Milli-amp (+HART®) version
	-F		FOUNDATION® Fieldbus version
	-N		Non-Incendive Milli-amp (+HART®) version
	-B		Non-Incendive FOUNDATION® Fieldbus version
	-E		Always E
Options		/H	Hood for Sun Protection
		/U	Pipe & Wall mounting hardware
		/SCT	Stainless steel tagplate
		/Q	Calibration certificate
		/T	Turck Fieldbus connector

3. Installation And Wiring

3-1. Installation and dimensions

3-1-1. Installation site

The EXA converter is weatherproof and can be installed inside or outside. It should, however, be installed as close as possible to the sensor to avoid long cable runs between sensor and converter. In any case, the cable length should not exceed 30 mtr (100 feet). Select an installation site where:

- Mechanical vibrations and shocks are negligible
- No relay/power switches are in the direct environment
- Access is possible to the cable glands (see figure 3-1)
- The transmitter is not mounted in direct sunlight or severe weather conditions
- Maintenance procedures are possible (avoiding corrosive environments)

The ambient temperature and humidity of the installation environment must be within the limits of the instrument specifications. (See chapter 2).

3-1-2. Mounting methods

Refer to figures 3-2 and 3-3. Note that the EXA converter has universal mounting capabilities:

- Panel mounting using two (2) self-tapping screws
- Surface mounting on a plate (using bolts from the back)
- Wall mounting on a bracket (for example, on a solid wall)
- Pipe mounting using a bracket on a horizontal or vertical pipe (maximum pipe diameter 50 mm)

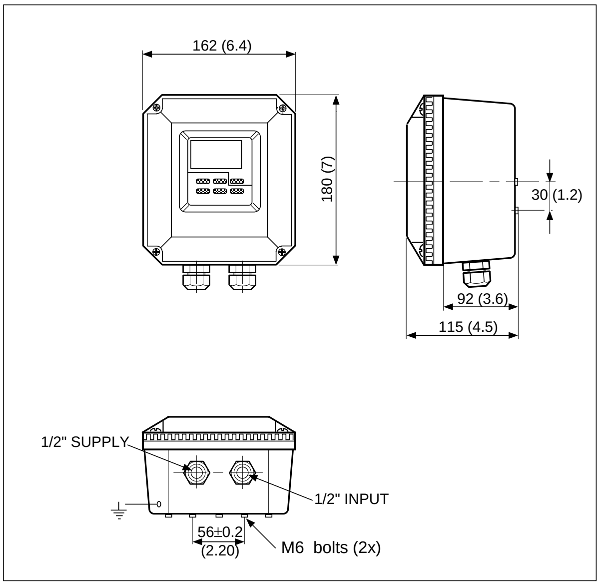


Fig. 3-1. Housing dimensions and layout of glands

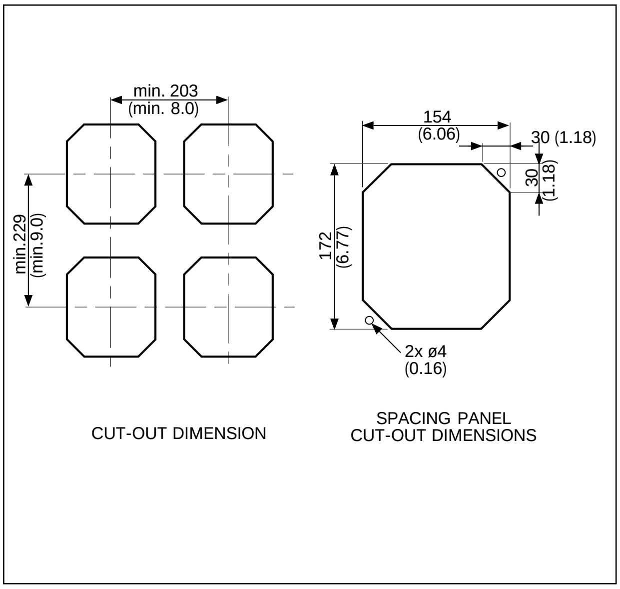


Fig. 3-2. Panel mounting diagram

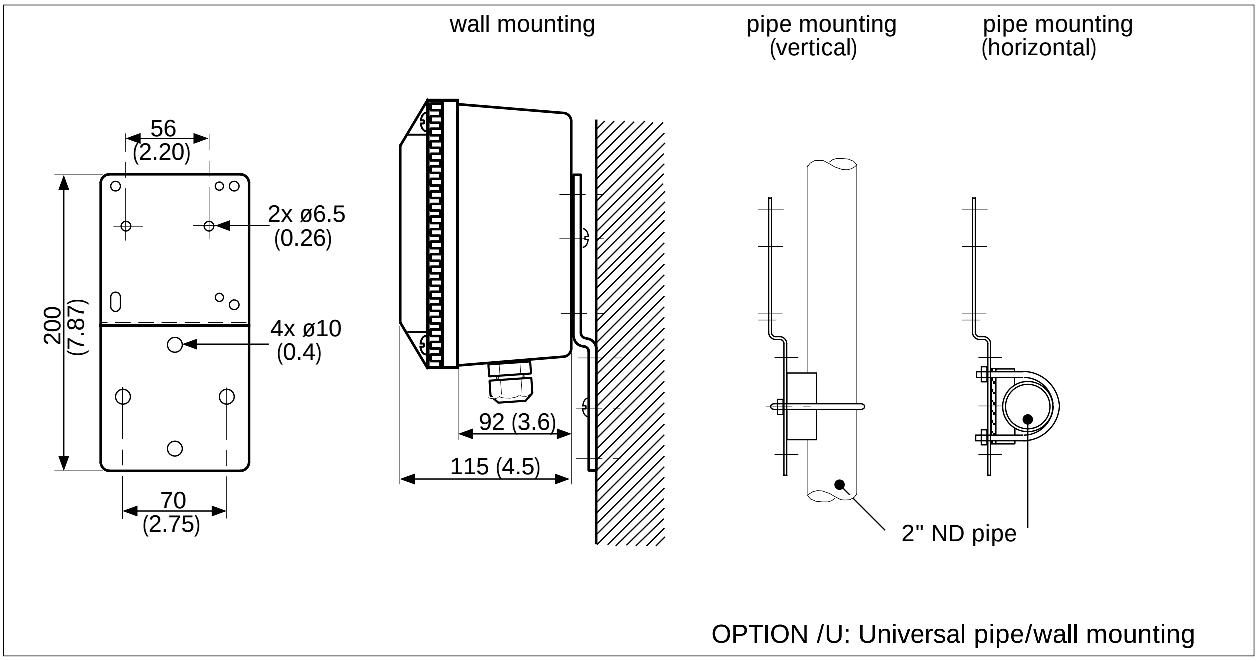


Figure 3-3. Wall and pipe mounting diagram

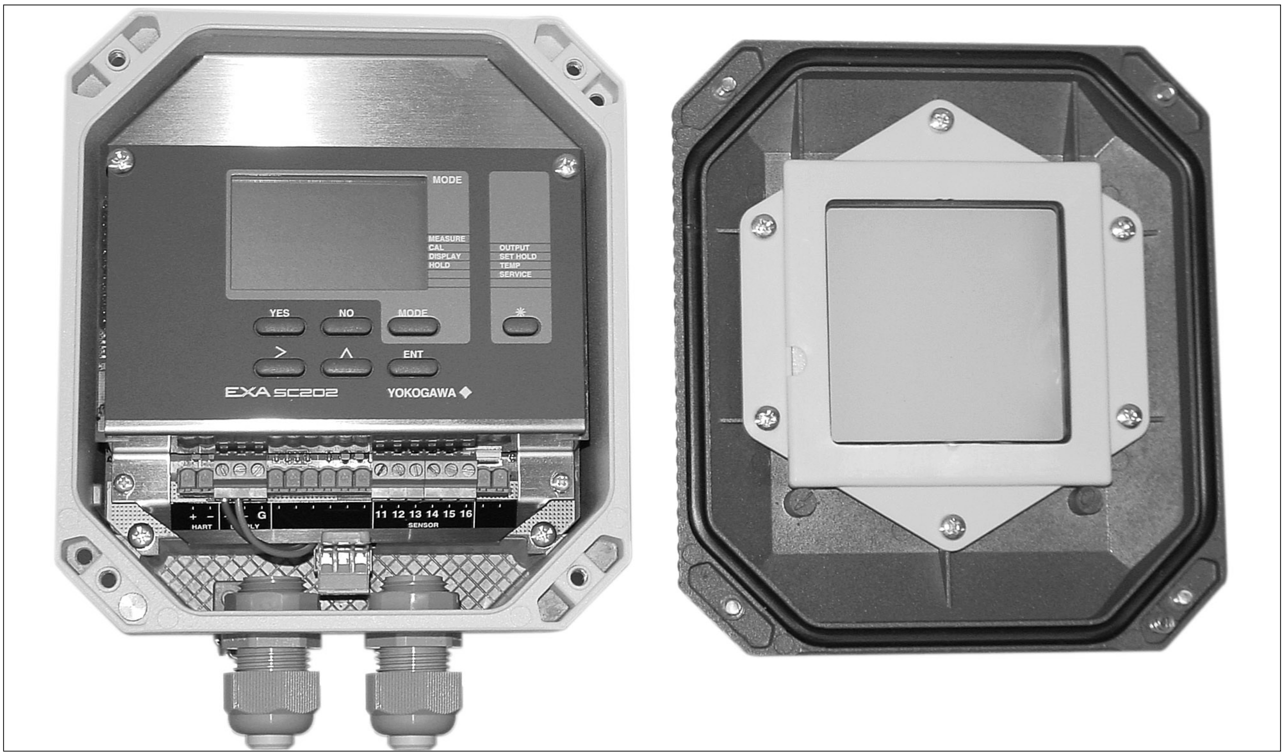


Figure 3-4. Internal view of EXA wiring compartment

3-2. Preparation

The Foundation Fieldbus® connections and the sensor connections should be made in accordance with figure 3-4 and 3-5. The terminals are of a plug in style for ease of mounting.

To open the EXA 202 for wiring:

1. Loosen the four frontplate screws and remove the cover.
2. The terminal strip is now visible.
3a. Connect the power supply. Use the gland on the left for this cable.
3b. Turck.
4. Connect the sensor input, using the gland on the right (see fig. 3-5). Switch on the power. Commission the instrument as required or use the default settings.
5. Replace the cover and secure frontplate with the four screws.
6. Connect the grounding terminals to protective earth.
7. The optional hose connection is used to guide the cables coming from an immersion fitting through a protective plastic tubing to the transmitter.

3-2-1. Cables, terminals and glands

The SC202 is equipped with terminals suitable for the connection of finished cables in the size range: 0.13 to 2.5 mm (26 to 14 AWG). The glands will form a tight seal on cables with an outside diameter in the range of 7 to 12 mm (9/32 to 15/32 inches).

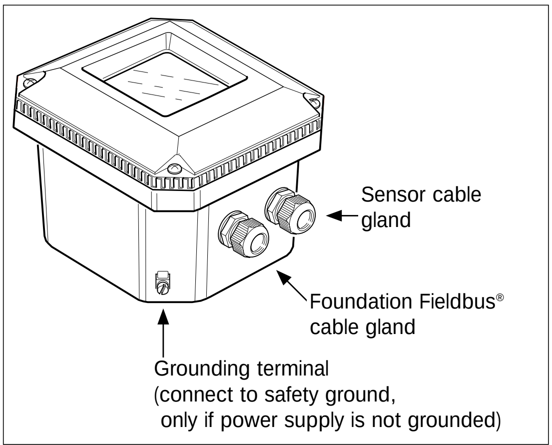


Figure 3-5. Glands to be used for cabling

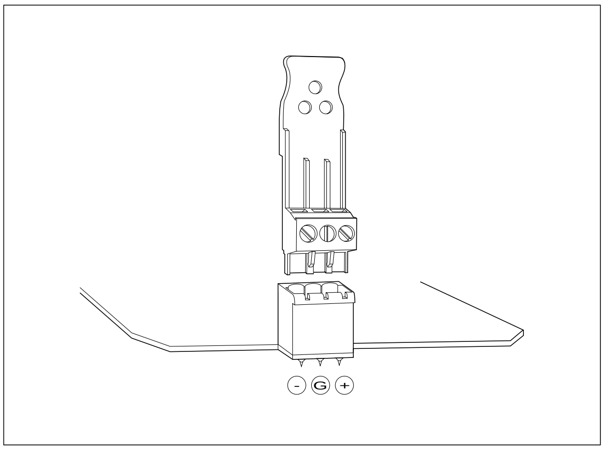


Figure 3-6. Pinhead connector

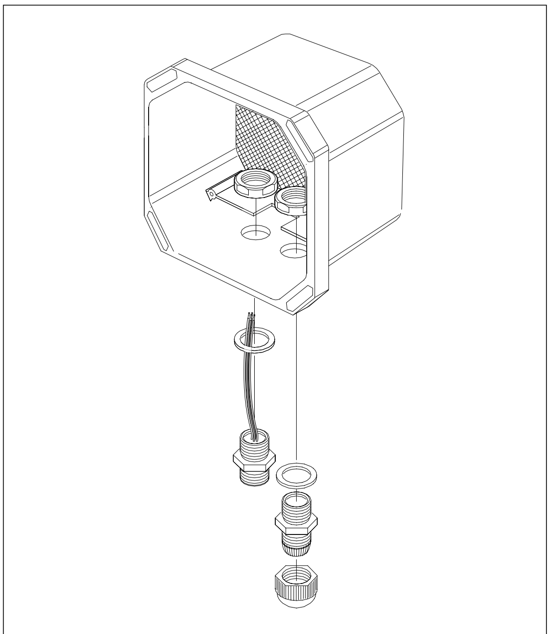


Figure 3-7. Option /T, Turck connector

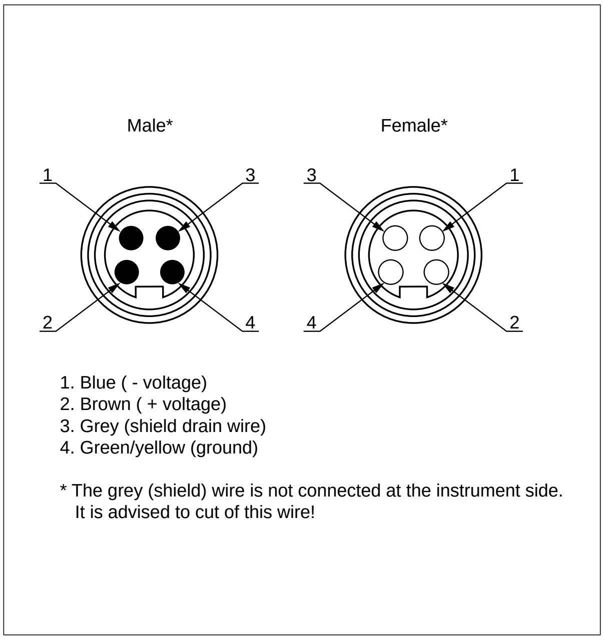


Figure 3-8. Turck connector pin numbers

3-3. Wiring of sensors

3-3-1. General precautions

Generally, transmission of signals from SC sensors is at a low voltage and current level. Thus a lot of care must be taken to avoid interference. Before connecting sensor cables to the transmitter make sure that following conditions are met:

– the sensor cables are not mounted in tracks together with high voltage and or power switching cables
– only standard sensor cables or extension cable are used
– the transmitter is mounted within the distance of the sensor cables (max. 10 m) up to 20m WF10 extension cable.
– the setup is kept flexible for easy insertion and retraction of the sensors in the fitting.

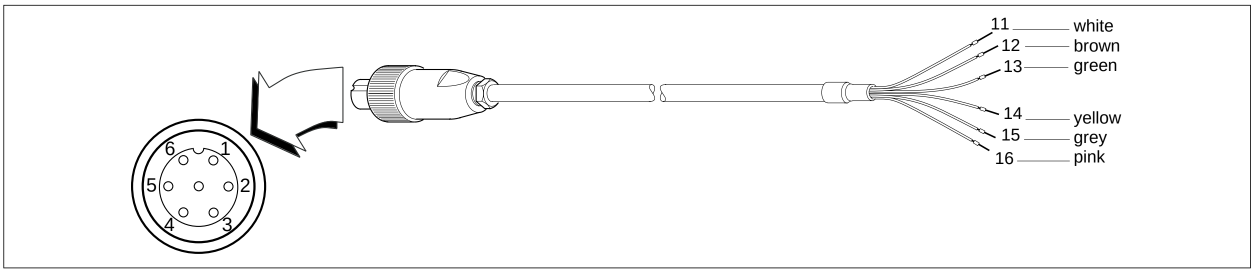


Fig. 3-7. Connection diagrams

3-4. Sensor wiring

Refer to figure 3-9, which includes drawings that outline sensor wiring.

The EXA SC202 can be used with a wide range of commercially available sensor types if provided with shielded cables, both from Yokogawa and other manufacturers. The sensor systems from Yokogawa fall into two categories, the ones that use fixed cables and the ones with separate cables.

To connect sensors with fixed cables, simply match the terminal numbers in the instrument with the identification numbers on the cable ends.

The separate sensors and the WU40-LH□□ cables are also numbered, but the numbers do not always match with the terminal numbers in the instrument. Figure 3-9 indicates how to connect the different sensor types.

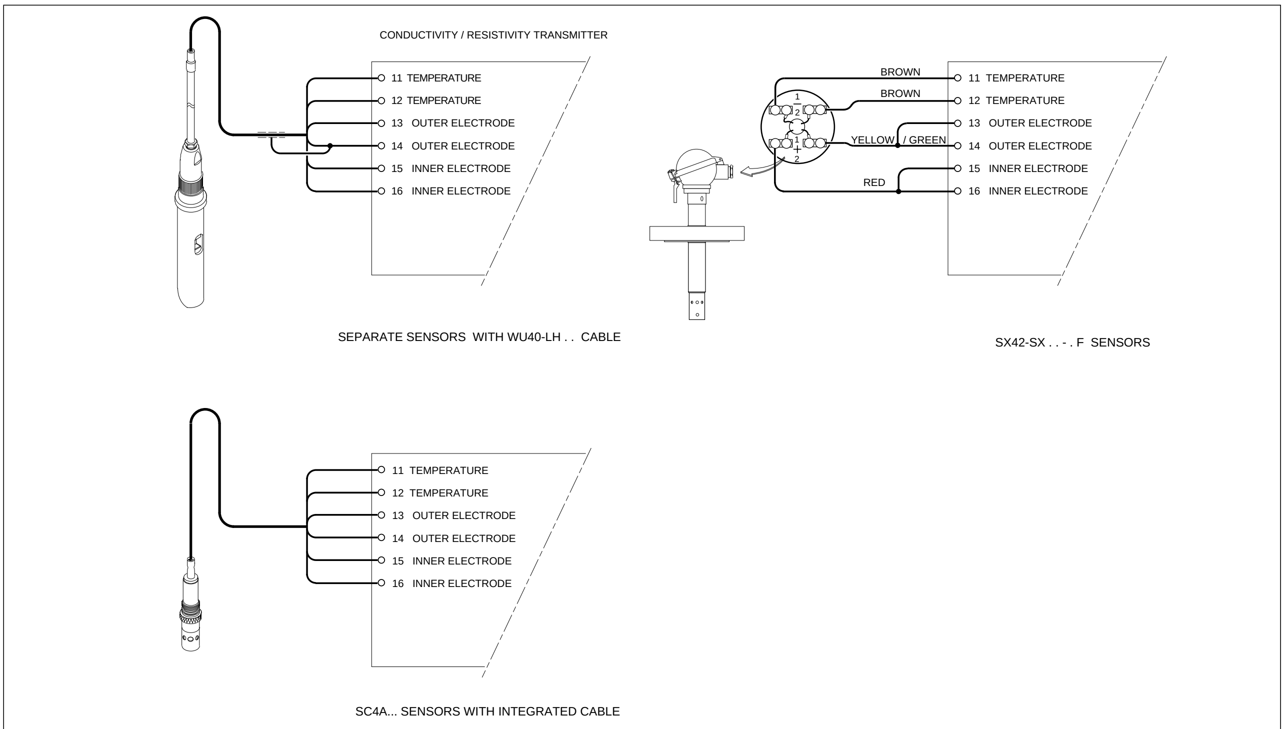


Figure 3-9. Sensor wiring diagrams

3-5. Other sensor systems

To connect other sensor systems, follow the general pattern of the terminal connections as listed below:

11 and 12 : Always used for temperature compensation resistor input.
13 and 14 : Normally used for the outer electrode
15 and 16 : Used for inner electrode

In case a 4-electrode measuring system will be used, 14 and 16 should be used for the current electrodes.
Please ensure that shielded cabling will be used.
In figure 3-10 this is shown in a schematic way.

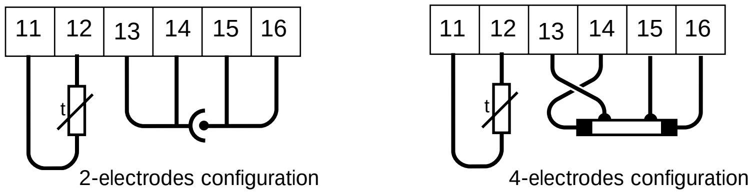


Figure 3-10. Connection diagram for other sensors

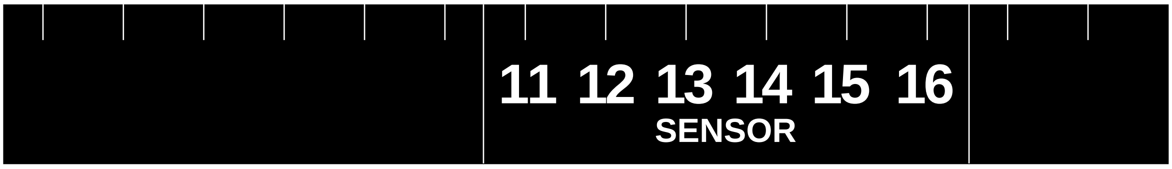


Fig. 3-11. Terminal indentification label

3-6. Sensor connection using junction box and extension cable

Where a convenient installation is not possible using the standard cables between sensors and converter, a junction box and extension cable may be used. The Yokogawa BA10 junction box and the WF10 extension cable should be used. These items are manufactured to a very high standard and are necessary to ensure that the specifications of the system can be met. The total cable length should not exceed 30 metres (e.g. 10 m fixed cable and 20 m extension cable).

note: Numbers 17 of both WF10 and BA10 do not need to be used.

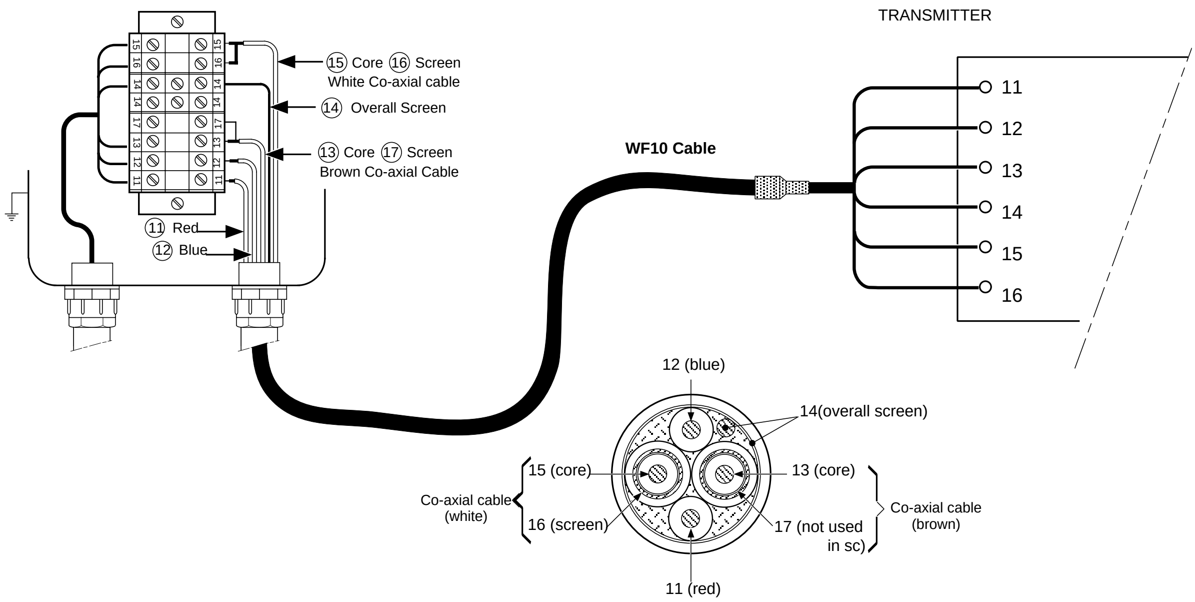


Fig. 3-12. Connection of WF10 extension cable and BA10 junction box

note: See page 3-10 for termination for WF10 cable in combination with EXA SC

Extension cable may be purchased in bulk quantities, cut to length. Then it is necessary to terminate the cable as shown below.

Termination procedure for WF10 cable.
1. Slide 3 cm of heat shrink tube (9 x 1.5) over the cable end to be terminated.
2. Strip 9 cm of the outer (black) insulating material, taking care not to cut or damage internal cores.

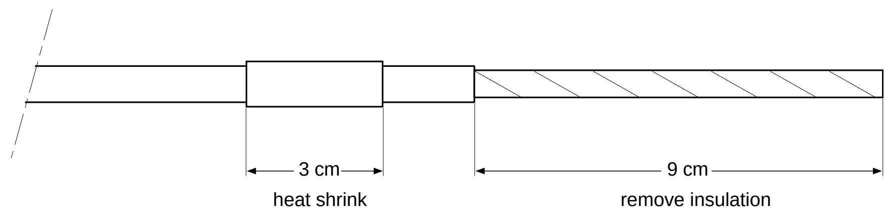


Fig. 3-13a.

3. Remove loose copper screening, and cut off the cotton packing threads as short as possible.
4. Strip insulation from the last 3 cm of the brown, and the white coaxial cores.

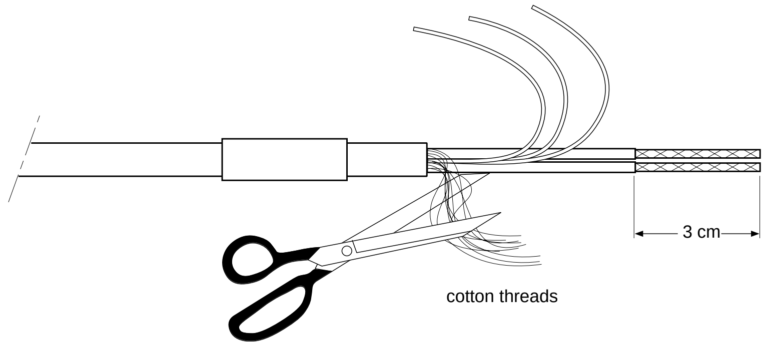


Fig. 3-13b.

5. Extract the coaxial cores from the braid, and trim off the black (low-noise) screening material as short as possible.
6. Insulate the overall screen and drain wire (14) and the 2 coaxial screens with suitable plastic tubing.
7. Strip and terminate all ends with suitable (crimp) terminals and identify with numbers as shown.

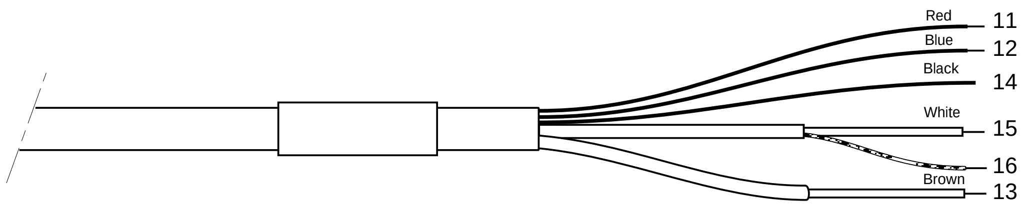


Fig. 3-13c.

8. Finally shrink the overall heat shrink tube into position.

4. Operation; Display Functions And Setting

4-1. Operator interface

This section provides a survey of the operation of the EXA operator interface. The basic procedures for obtaining access to the three levels of operation are described briefly. For a step-by-step guide to data entry, refer to the relevant section of this user's manual. Figure 4-1 shows the EXA operator interface.

LEVEL 1: Maintenance

These functions are accessible by pushbutton through a flexible front cover window. The functions make up the normal day-to-day operations that an operator may be required to complete. Adjustment of the display and routine calibration are among the features accessible in this way. (See table 4-1).

LEVEL 2: Commissioning

A second menu is exposed when the EXA front cover is removed and the display board is revealed. Users gain access to this menu by pressing the button marked * in the lower right of the display board. This menu is used to set the temperature compensation method. It also gives access to the service menu. (See table 4-1).

LEVEL 3: Service

For more advanced configuration selections, press the button marked * , then press “NO” repeatedly until you reach SERV (service). Now push the “Yes” button. Selecting and entering “Service Code” numbers in the commissioning menu provide access to the more advanced functions. An explanation of the Service Codes is listed in chapter 5 and an overview table is shown in chapter 11.

Table 4-1. Operations overview

	Routine	Function	Chapter
Maintenance	CALIB	Calibration with a standard solution or sample	6
	DISPLAY 1&2	Read auxiliary data or set message display	4
Commissioning	TEMP 1 & 2	Select method of temperature compensation	5
Service (Access to coded entries from the commissioning level)	SERVICE	Fine tune the specialized functions of the analyser	5

note: All three levels may be separately protected by a password. See Service Code 52 in chapter 5 Service Code table for details on setting passwords.

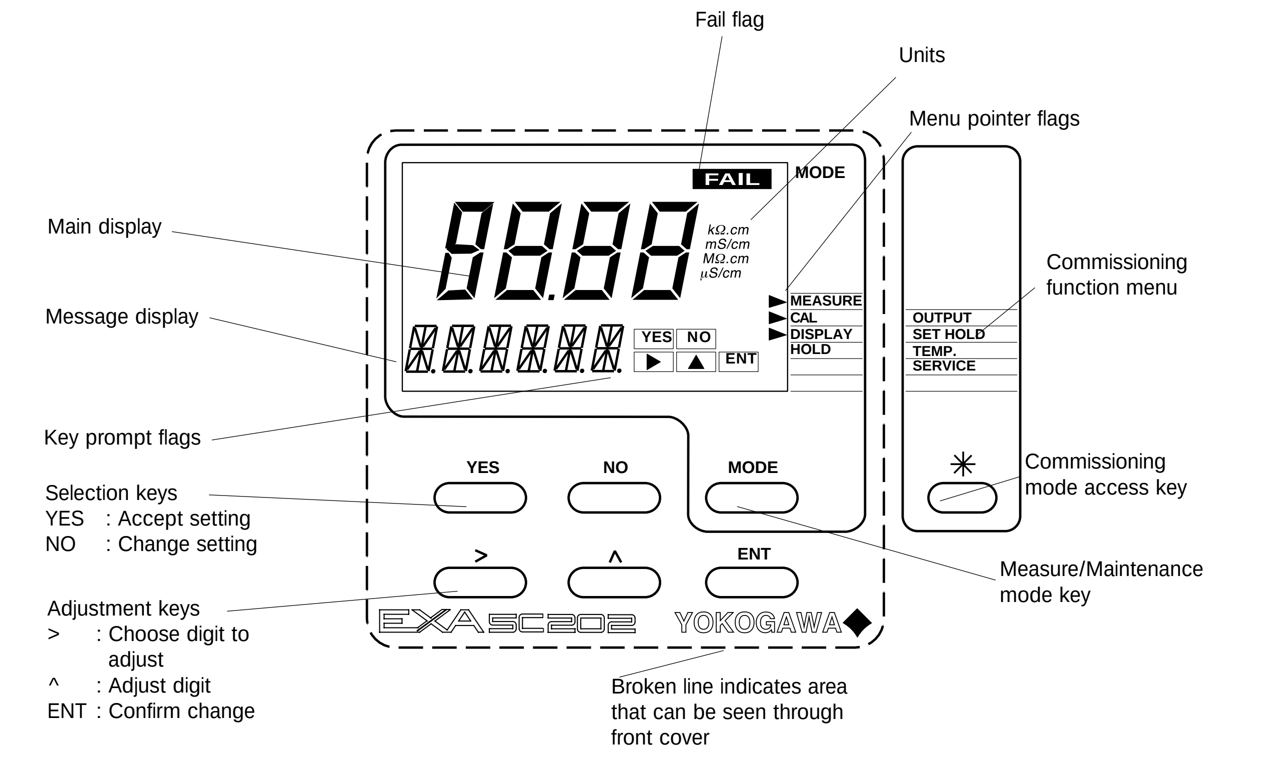


Figure 4-1. SC202 operator interface

4-2. Explanation of operating keys

MODE key This key toggles between the measuring and maintenance modes. Press once to obtain access to the maintenance function menu.

CALIB
DISP 1
DISP 2 - (Only when second temp. compensation enabled)

Press again to return to the measuring mode.

YES/NO keys These are used to select choices from the menu.

YES is used to accept a menu selection.
NO is used to reject a selection, or to move ahead to the next option.

DATA ENTRY keys (▶ ▲ ENT)

▶ is used as a “cursor” key. Each press on this key moves the cursor or flashing digit one place to the right. This is used to select the digit to be changed when entering numerical data.

▲ is used to change the value of a selected digit. Each press on this key increases the value by one unit. The value can not be decreased, so in order to obtain a lower value, increase past nine to zero, then increase to the required number.

ENT When the required value has been set using the ▶ and ▲ keys, press ENT to confirm the data entry. Please note that the EXA does not register any change of data until the ENT key is pressed.

✳ key This is the commissioning mode key. It is used to obtain access to the commissioning menu. This can only be done with the cover removed or opened. Once this button has been used to initiate the commissioning menu, follow the prompts and use the other keys as described above.

4-3. Setting passcodes

4-3-1. Passcode protection

In Service Code 52, passcode protection can be set for each one of the three operating levels, individually. This procedure should be completed after the initial commissioning (setup) of the instrument. The passcodes should then be recorded safely for future reference.

When passcodes have been set, the following additional steps are introduced to the configuration and programming operations:

Maintenance

Press MODE key. The display shows 000 and *PASS*
Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Maintenance Mode

Commissioning

Press * key. The display shows 000 and *PASS*
Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Commissioning Mode.

Service

From the commissioning menu, select *Service by pressing YES key. The display shows 000 and *PASS*
Enter a 3-digit passcode as set in Service Code 52 to obtain access to the Service Mode.

note: See Service Code 52 for the setting of passcodes.

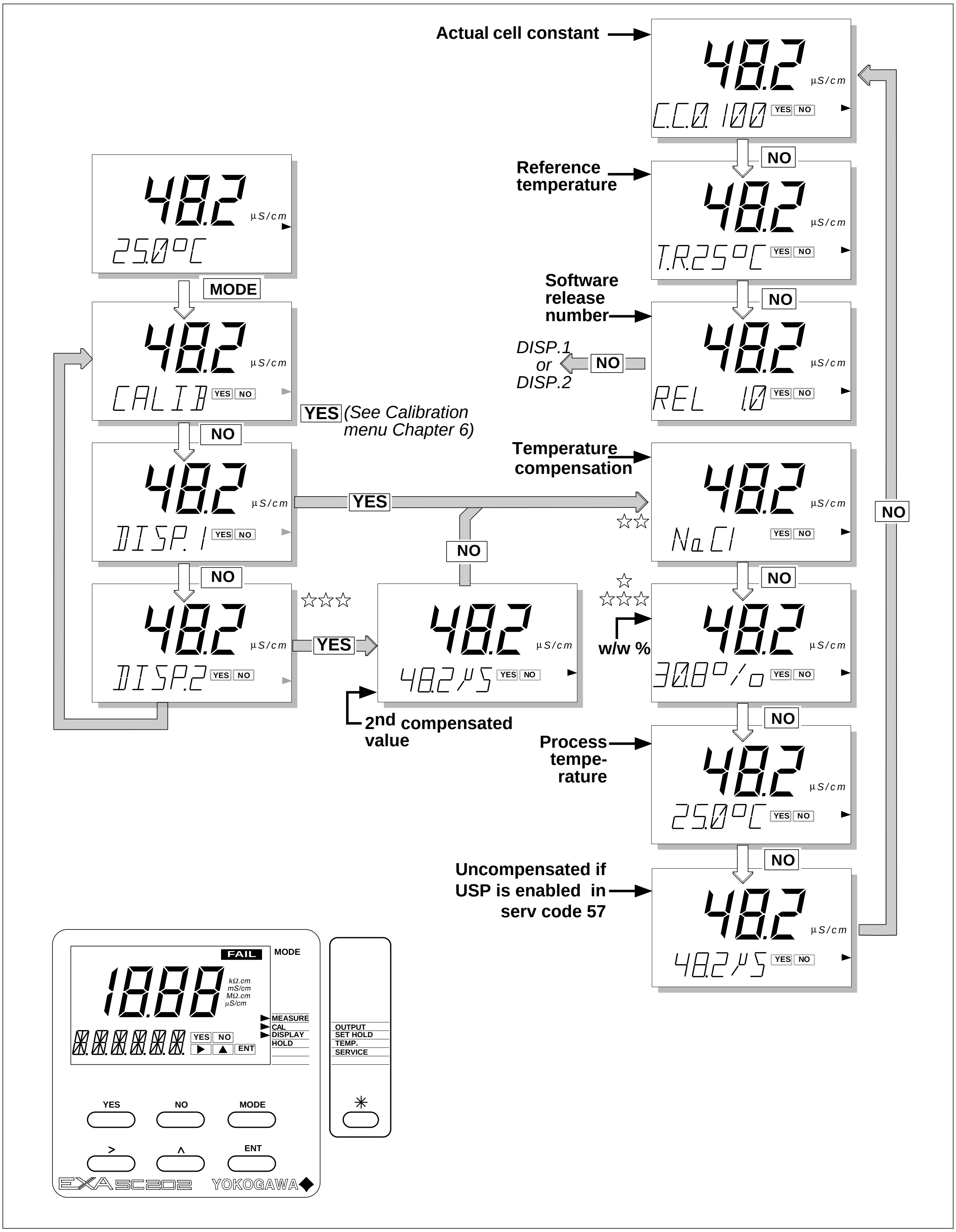
4-4. Display examples

The following pages show the sequence of button presses and screens displayed when working in some standard configurations. More or less options will be made available by the configuration of some service codes, or by choices made in the commissioning menu.

The following deviations are possible:

*	Item marked is omitted when switched off in commissioning mode.
**	Temperature compensation will be displayed dependent on chosen compensation method: NaCl, TC or matrix.
***	DISP.2 only appears if a 2nd (different) temperature compensation is set.
****	W/W % only appears if switched on in service code 55. In display 2 w/w % never appears.

Sequence for resistivity function is similar to this conductivity example.



5. Parameter setting

5-1. Maintenance mode

5-1-1. Introduction
Standard operation of the EXA instrument involves use of the Maintenance (or operating) mode to set up some of the parameters.

Access to the maintenance mode is available via the six keys that can be pressed through the flexible window in the instrument front cover. Press the “MODE” key once to enter this dialog mode.
(Note that at this stage the user will be prompted for a passcode when this has been previously set up in service code 52, section 5)

Calibrate : See “calibration” section 6.
Display setting : See “operation” section 4.5.

5-2. Commissioning mode

5-2-1. Introduction
In order to obtain peak performance from the EXA SC202, you must set it up for each custom application.

Temp1/2 : First and second temperature compensation methods and values. (see also section 5-2-4)
*NaCl is the default compensation and is used for neutral salt solutions.
Strong salt solutions and (ultra) pure water application.
*TC temperature coefficient compensation uses a linear temperature compensation factor.
This can be set by calibration or configuration.
*Matrix compensation is an extremely effective way of compensation.
Choose from standard matrix tables, or configure your own to exactly suit your process.
Service : This selection provides access to the service menu.

What follows are pictorial descriptions of typical frontplate pushbutton sequences for each parameter setting.
By following the simple YES/NO prompts and arrow keys, one can navigate through the service functions.

5-2-2. Temperature compensation

1. Why 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.
A coefficient (a) is introduced to express the amount of temperature influence in percent 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.

Table 5-1. NaCl-compensation according to IEC 746-3 with Tref = 25 °C

T	Kt	α	T	Kt	α	T	Kt	α
0	0.54	1.8	60	1.76	2.2	130	3.34	2.2
10	0.72	1.9	70	1.99	2.2	140	3.56	2.2
20	0.90	2.0	80	2.22	2.2	150	3.79	2.2
25	1.0	---	90	2.45	2.2	160	4.03	2.2
30	1.10	2.0	100	2.68	2.2	170	4.23	2.2
40	1.31	2.0	110	2.90	2.2	180	4.42	2.2
50	1.53	2.1	120	3.12	2.2	190	4.61	2.2
		200	4.78	2.2				

2. Standard temperature compensation

From the factory the EXA is 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.

A temperature compensation factor is derived from the following equation:

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

In which:

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

3. Manual temperature compensation

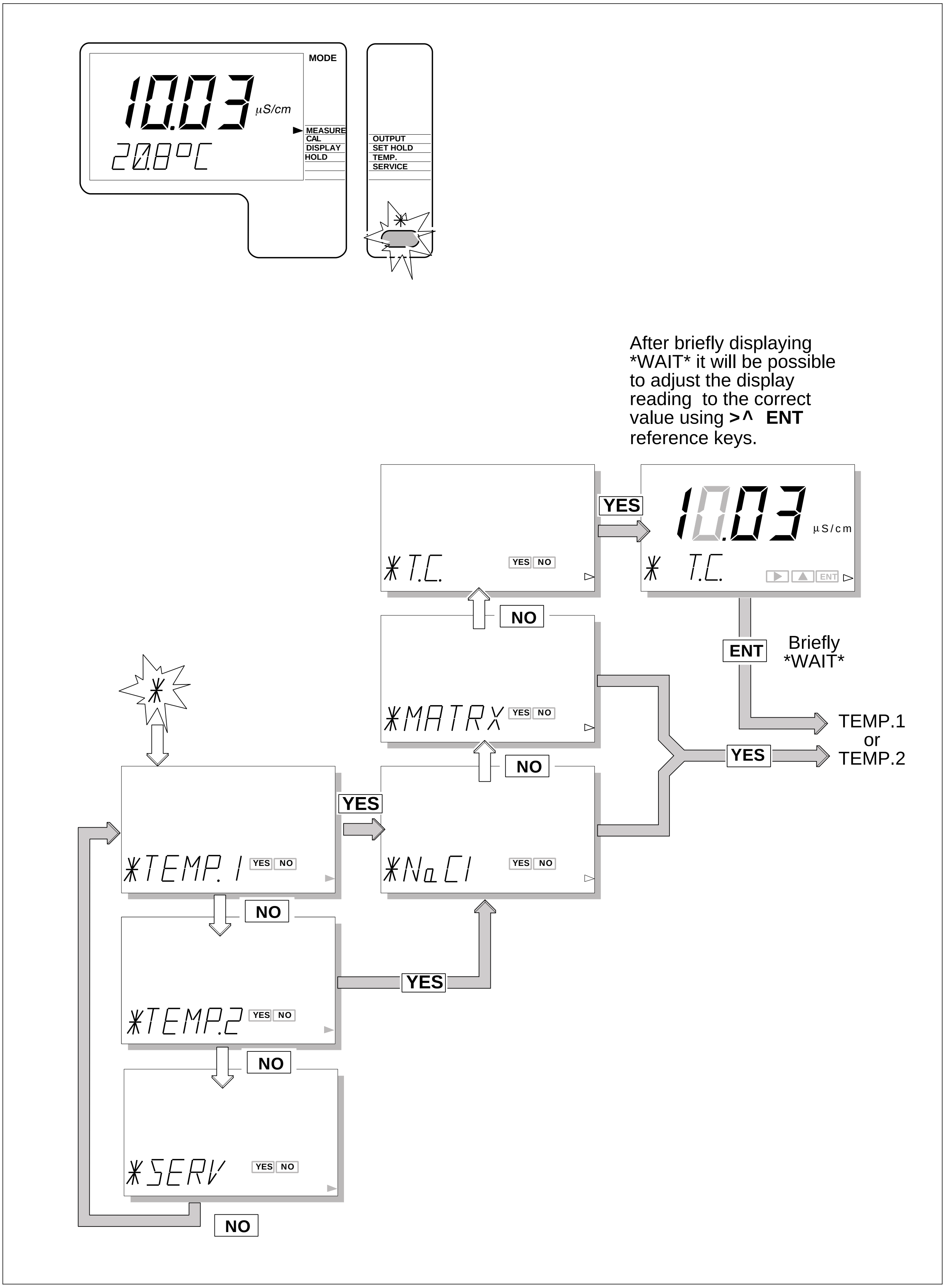
If the standard compensation function is found to be inaccurate for the sample to be measured, the converter can be set manually for a linear factor on site to match the application.
The procedure is as follows:

1. Take a representative sample of the process liquid to be measured.
2. Heat or cool this sample to the reference temperature of the converter (usually 25 °C).
3. Measure the conductivity of the sample with the EXA and note the value.
4. Bring the sample to the typical process temperature (to be measured with the EXA).
5. Adjust the display indication to the noted value at the reference temperature.
6. Check that the temperature compensation factor has been changed.
7. Insert the conductivity cell into the process again.

4. Other possibilities (section 5-4)

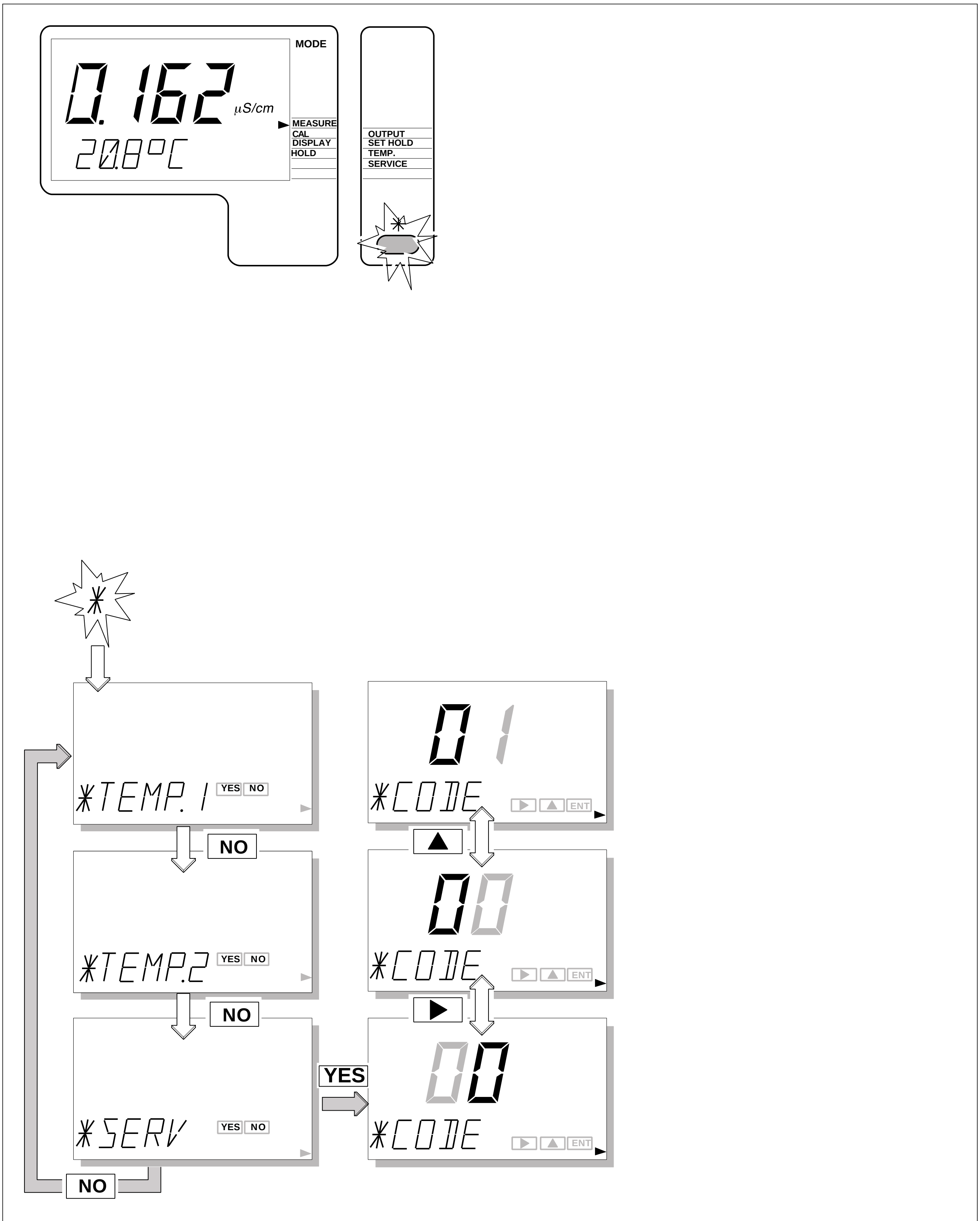
1. Enter calculated coefficient.
2. Enter matrix temperature compensation.

5-2-3. Temperature compensation selection



5-2-4. Service code

The figure below shows a typical button sequence to change a setting within the service menu. The specific settings are listed in numerical sequence on the following pages. On the page facing the setting tables are concise explanations of the purpose of the service codes.



5-3. Service Codes

5-3-1. Parameter specific functions

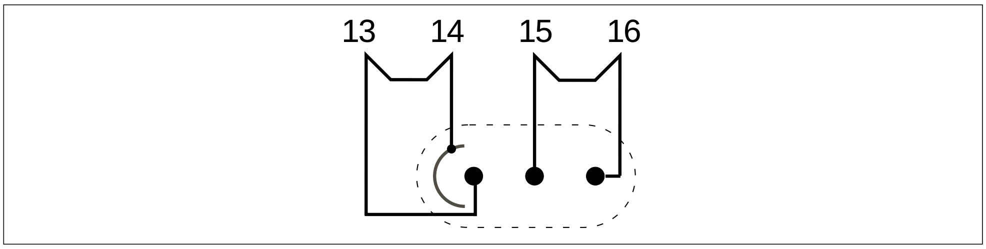
Code 1 SC/RES Choose the required parameter, either conductivity or resistivity. If the parameter is changed the instrument will go into reset to load parameter specific default values, followed by starting measurement. For all other service codes the instrument will return to commissioning mode after the service code setting is finished.

Code 2 4.ELEC Choose the required sensor type. Normally conductivity and/or resistivity measurements are done with 2-electrode type sensors. At high conductivity ranges, polarization of the electrodes may cause an error in conductivity measurement. For this reason 4-electrode type sensors may be necessary.

Code 3 0.10xC Enter the factory calibrated cellconstant mentioned on the textplate or on the fixed cable. This avoids the need for calibration. Any value between 0.008 and 50.0 /cm may be entered. The position of the decimal point can be changed when it is flashing.

*note: If the actual cell constant is changed after a calibration or if the entered cell constant differs from previous value, then the message “RESET?” will appear on the second line display. After pressing “YES” the entered value becomes the new calibrated cell constant. After pressing “NO” the update procedure of the cell constant entry is canceled.

Code 4 AIR To avoid cable influences on the measurement, a “zero” calibration with a dry sensor may be done. If a connection box (BA10) and extension cable (WF10) are used, “zero” calibration should be done including this connection equipment.
When using a 4-electrode sensor additional connections are required Temporarily interconnect terminals 13 to 14 and 15 to 16 before making the adjustment. This is necessary to eliminate the capacitive influence of the cables. The links should be removed after this step is completed.



Code 5 POL.CK The EXA SC202 has a polarization check capable of monitoring the signal from the cell for distortion from polarization errors. If there is a problem with the installation or the cell becomes fouled, this will trigger E1. For some applications very low conductivity and long cable runs, this error detection can cause false alarms during operation. Therefore this code offers the possibility to disable/enable this check.

5-3-2. Temperature measuring functions

Code 10 T.SENS Selection of the temperature sensor. The default selection is the Pt1000 sensor, which gives excellent precision with the two wire connections used. The other options give the flexibility to use a very wide range of other conductivity/resistivity sensors.

Code 11 T.UNIT Celsius or Fahrenheit temperature scales can be selected to suit the user’s preference.

Code 12 T.ADJ The calibration is a zero adjustment to allow for the cable resistance, which will obviously vary with length. The normal method is to immerse the sensor in a vessel with water in it, measure the temperature with an accurate thermometer, and adjust the reading for agreement

Code	Display	Function	Function detail	X	Y	Z	Default values	
Parameter specific functions								
01	*SC.RES	Select main parameter	Conductivity Resistivity	0 1			0	Cond.
02	*4-ELEC	Select 2/4-el system	2-Electrode measurement system 4-Electrode measurement system	0 1			0	2-El.
03	*0.10xC	Set cell constant	Press NO to step through choice of multiplying factors on the second display. 0.10xC 1.00xC 10.0xC 100.xC 0.01xC Press YES to select a factor Use >, ^, ENT keys to adjust MAIN digits				0.100 0.10xC 1.000	cm-1
04	*AIR *START *"WAIT" *END	Zero calibration	Zero calibration with dry cell connected Press YES to confirm selection Press YES to start, after briefly displaying "WAIT", *END will be displayed Press YES to return to commissioning mode					
05	*POL.CK	Polarization check	Polarization check off Polarization check on	0 1			1	On
06-09			Not used					

Code	**Display**	**Function**	**Function detail**	**X**	**Y**	**Z**	**Default values**	
Temperature measuring functions								
10	*T.SENS	Temperature sensor	Pt1000 Ni100 Pb36 Pt100 8k55	0 1 2 3 4			0	Pt1000
11	*T.UNIT	Display in °C or °F	°C °F	0 1			0	°C
12	*T.ADJ	Calibrate temperature	Adjust reading to allow for cable resistance. Use >, ^ , ENT keys to adjust value					None

.5-4. Temperature compensation functions

Code 20	T.R.°C	Choose a temperature to which the measured conductivity (or resistivity) value must be compensated. Normally 25°C is used, therefore this temperature is chosen as default value. The range for this setting is: 0 to 100 °C. If T.UNIT in code 11 is set to °F, the default value is 77°F and the range is 32 - 212°F.
Code 21	T.C.1/T.C.2	In addition to the procedure described in section 5-2-4 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 0.00 to 3.50 % per °C. In combination with reference temperature setting in code 20 a linear compensation function is obtained, suitable for all kinds of chemical solutions.
Code 22	MATRX	The EXA 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 EXA 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 adjustable matrix must be configured in code 23. Next the specific conductivity values at the different temperatures must be entered in codes 24 to 28.
Code 23	T1, T2, T3, T4 & T5 °C	Set the matrix compensation range. It is not necessary to enter equal temperature steps, but the values should increase from T1 to T5, otherwise the entrance will be refused. Example: 0, 10, 30, 60 and 100 °C are valid values for the T1....T5. The minimum span for the range (T5 - T1) is 25 °C.
Code 24-28	L1xT1 - L5xT5	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 (24 to 28). The table below shows a matrix entering example for 1 - 15% NaOH solution for a temperature range from 0 - 100 °C.

notes:

1. In chapter 11 a table is included 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.
3. Error code E4 occurs when two standard solutions have identical conductivity values at the same temperature within the temperature range.

Table 5-2. Example of user adjustable matrix

Matrix			Example	Example	Example	Example	Example
Code 23	Temperature	T1...T5	0 °C	25 °C	50 °C	75 °C	100 °C
Code 24	Solution 1 (1%)	L1	31 mS/cm	53 mS/cm	76 mS/cm	98 mS/cm	119 mS/cm
Code 25	Solution 2 (3%)	L2	86 mS/cm	145 mS/cm	207 mS/cm	264 mS/cm	318 mS/cm
Code 26	Solution 3 (6%)	L3	146 mS/cm	256 mS/cm	368 mS/cm	473 mS/cm	575 mS/cm
Code 27	Solution 4 (10%)	L4	195 mS/cm	359 mS/cm	528 mS/cm	692 mS/cm	847 mS/cm
Code 28	Solution 5 (15%)	L5	215 mS/cm	412 mS/cm	647 mS/cm	897 mS/cm	1134 mS/cm

Code	Display	Function	Function detail	X	Y	Z	Default values	
Temperature compensation functions								
20	*T.R.°C	Set reference temp.	Use >, ^, ENT keys to set value					25 °C
21	*T.C.1 *T.C.2	Set temp. coef. 1 Set temp. coef. 2	Adjust compensation factor if set to TC in section 5-2-5. Set value with >, ^, ENT keys Adjust compensation factor if set to TC in section 5-2-5. Set value with >, ^, ENT keys					2.1 % per °C 2.1 % per °C
22	*MATRX	Select matrix	Choose matrix if set to matrix comp. in section 5-2-5, using >, ^, ENT keys HCl (cation) pure water (0-80 °C) Ammonia pure water (0-80 °C) Morpholine pure water (0-80 °C) HCl (0-5 %, 0-60 °C) NaOH (0-5 %, 0-100 °C) User programmable matrix	 1 2 3 4 5 9			 1	 HCl
23	*T1 °C (°F) *T2.. *T3.. *T4.. *T5..	Set temp. range	Enter 1st (lowest) matrix temp. value Enter 2nd matrix temp. value Enter 3rd matrix temp. value Enter 4th matrix temp. value Enter 5th (highest) matrix temp. value					
24	*L1xT1 *L1xT2 .... *L1xT5	Enter conductivity values for lowest concentration	Value for T1 Value for T2 Value for T5					
25	*L2xT1	Concentration 2	Similar to code 24					
26	*L3xT1	Concentration 3	Similar to code 24					
27	*L4xT1	Concentration 4	Similar to code 24					
28	*L5xT1	Concentration 5	Similar to code 24					

5-5. mA output functions

Code 35 TABLE The table function allows the configuration of an output curve by 21 steps (intervals of 5%). Before entering all table values, the concentration values for the 0% and 100% should be set in service code 55. The intermediate points 5% to 95% are set automatically. The following example shows how the table may be configured to linearize the output with a mA curve.

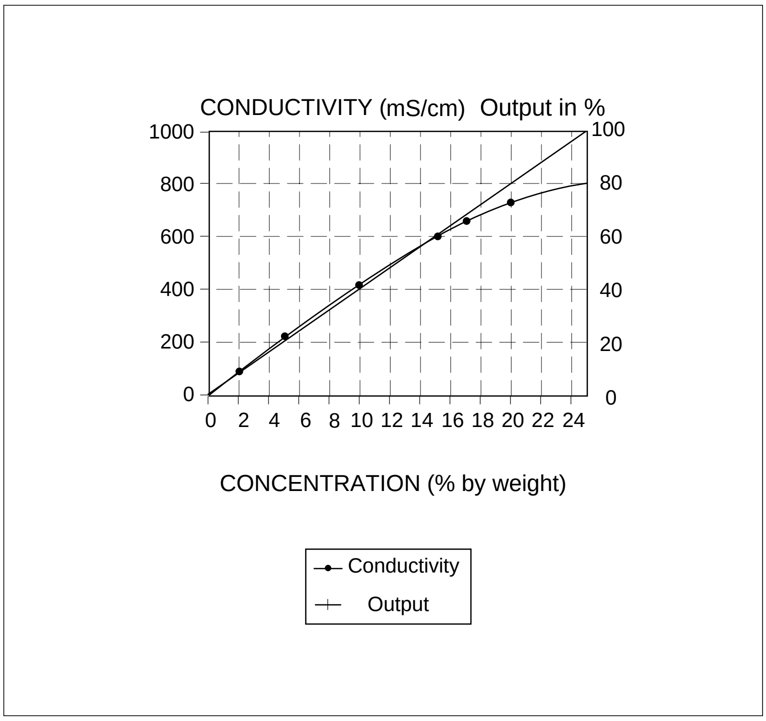


Fig. 5-1. Linearization of output, example: 0-25% Sulfuric acid

% Output	%H2SO4	mS/cm
0	**0** set in SC55	0
5	1.25	60
10	2.5	113
15	3.75	180
20	5	218
25	6.25	290
30	7.5	335
35	8.75	383
40	10	424
45	11.25	466
50	12.5	515
55	13.75	555
60	15	590
65	16.25	625
70	17.5	655
75	18.75	685
80	20	718
85	21.25	735
90	22.5	755
95	23.75	775
100	**25** set in SC55	791

Table 5-3.

Code	Display	Function	Function detail	X	Y	Z	Default values
Output table for concentration							
35	*TABLE *0% *5% *10% *95% *100%	Output table for concentration	Linearization table for concentration in 5% steps. The measured value is set in the main display using the >, ^, ENT keys, for each of the 5% interval steps. Where a value is not known, that value may be skipped, and a linear interpolation will take place.				

5-6. User interface

Code 50	*RET.	When Auto return is enabled, the converter returns to the measuring mode from anywhere in the configuration menus, when no button is pressed during the set time interval of 10 minutes.
Code 52	*PASS	Passcodes can be set on any or all of the access levels, to restrict access to the instrument configuration.
Code 53	*Err01	Error message configuration. Two different types of failure mode can be set. Hard fail gives a steady FAIL flag in the display. Soft fail gives a flashing FAIL flag in the display. A good example is the dry sensor for a soft fail.
Code 54	*E5.LIM & *E6.LIM	Limits can be set for shorted and open measurement. Dependent on the main parameter chosen in code 01, the EXA will ask for a resistivity or conductivity value to be set (value to be set is the uncompensated conductivity/resistivity value).
Code 55	*%	The 0% and 100% table values are set here to be used in the concentration table of service code 35. The 19 intermediate values are calculated and set according evenly distribution.
Code 56	*DISP	The display resolution is default set to autoranging for conductivity reading. If a fixed display reading is needed, a choice can be made out of 7 possibilities. For resistivity the default reading is fixed to xx.xx MΩ.cm.
Code 57	*USP	Automatic checking for compliance with the water purity standard set in USP (United States Pharmacopeia). For more detailed description see chapter 9.

5-7. Logbook setup

Code 62	*ERASE	Erase logbook function to clear the recorded data for a fresh start. This may be desirable when re-commissioning an instrument that has been out of service for a while.

5-8. General

Code 70	*LOAD	The load defaults code allows the instrument to be set to the default (factory) setting with a single operation. This can be useful when wanting to change from one application to another.

Code	Display	Function	Function detail	X	Y	Z	Default values	
User interface								
50	*RET	Auto return	Auto return to measuring mode Off	0				
			Auto return to measuring mode On	1			1	On
51			Not used					
52	*PASS	Passcode	Maintenance passcode Off	0			0.0.0	Off
		Note # = 0 - 9, where	Maintenance passcode On	#				
			Commissioning passcode Off		0			Off
		1=111, 2=333, 3=777	Commissioning passcode On		#			
		4=888, 5=123, 6=957	Service passcode Off			0		Off
		7=331, 8=546, 9=847	Service passcode On			#		
53	*Err.01	Error setting	Polarization too high Soft/Hard	0/1			1	Hard
	*Err.05		Shorted measurement Soft/Hard	0/1			1	Hard
	*Err.06		Open measurement Soft/Hard	0/1			1	Hard
	*Err.07		Temperature sensor open Soft/Hard	0/1			1	Hard
	*Err.08		Temp. sensor shorted Soft/Hard	0/1			1	Hard
	*Err.13.		USP limit exceeded Soft/Hard	0/1			0	Soft
54	*E5.LIM	E5 limit setting	Maximum conductivity value				250	mS
			(Minimum resistivity value)				0.004	kΩ
	*E6.LIM	E6 limit setting	Minimum conductivity value				1.000	µS
			(Maximum resistivity value)				1.000	MΩ
55	*%	Display mA in w/w%	mA-range displayed in w/w% off	0				Off
			mA-range displayed in w/w% on	1				
	*0%		Set 0% output value in w/w%					
	*100%		Set 100% output value in w/w%					
56	*DISP	Display resolution	Auto ranging display		0		0	Auto
			Display fixed to X.XXX µS/cm or MΩ.cm	1				
			Display fixed to XX.XX µS/cm or MΩ.cm	2				
			Display fixed to XXX.X µS/cm or MΩ.cm	3				
			Display fixed to X.XXX mS/cm or kΩ.cm	4				
			Display fixed to XX.XX mS/cm or kΩ.cm	5				
			Display fixed to XXX.X mS/cm or kΩ.cm	6				
			Display fixed to XXXX mS/cm or kΩ.cm	7				
57	*USP	USP setting	Disable the E13 (USP limit exceeded)	0			0	Off
			Enable the E13 (USP limit exceeded)	1				

Code	Display	Function	Function detail	X	Y	Z	Default values	
Communication								
62	*ERASE	Erase logbook	Press YES to clear logbook data					

Code	Display	Function	Function detail	X	Y	Z	Default values	
General								
70	*LOAD	Load defaults	Reset configuration to default values					

6. Calibration

6-1 When is calibration necessary?

Calibration of conductivity/resistivity instruments is normally not required, since Yokogawa delivers a wide range of sensors, which are factory calibrated traceable to OIML standards. The cell constant values are normally indicated on the top of the sensor or on the integral cable. These values can be entered directly in service code 03 (section 5-3-1). If the cell has been subjected to abrasion (erosion or coating) calibration may be necessary. In the next section two examples are given. Alternatively calibration may be carried out with a simulator to check the electronics only.

note: During calibration the temperature compensation is still active. This means that the readings are referred to the reference temperature as chosen in service code 20 (section 5-3-4, default 25 °C).
Calibration is normally carried out by measuring a solution with a known conductivity value at a known temperature. The measured value is adjusted in the calibration mode. On the next pages the handling sequence for this action is visualized. Calibration solutions can be made up in a laboratory. An amount of salt is dissolved in water to give a precise concentration with the temperature stabilized to the adjusted reference temperature of the instrument (default 25 °C). The conductivity of the solution is taken from literature tables or the table on this page.

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

note: The standard instrument used as a reference must be accurate and based on an identical temperature compensation algorithm. Therefore the Model SC82 Personal Conductivity Meter of Yokogawa is recommended.

Typical calibration solutions.
The table shows some typical conductivity values for sodium-chloride (NaCl) solutions which can be made up in a laboratory.

Table 6-1. NaCl values at 25 °C

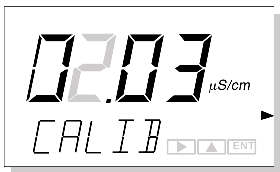
Weight %	mg/kg	Conductivity
0.001	10	21.4 µS/cm
0.003	30	64.0 µS/cm
0.005	50	106 µS/cm
0.01	100	210 µS/cm
0.03	300	617 µS/cm
0.05	500	1.03 mS/cm
0.1	1000	1.99 mS/cm
0.3	3000	5.69 mS/cm
0.5	5000	9.48 mS/cm
1	10000	17.6 mS/cm
3	30000	48.6 mS/cm
5	50000	81.0 mS/cm
10	100000	140 mS/cm

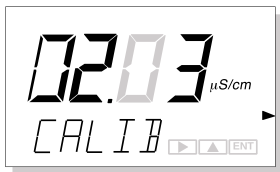
note:
For resistivity measurement the standard resistivity units of the calibration solution can be calculated as follows:
R = 1000/G (kΩ.cm if G = µS/cm)

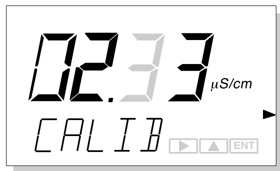
Example:
0.001% weight
R = 1000/21.4 = 46.7 kΩ.cm

6-2. Calibration procedure

Press the **MODE** key.
The legend CALIB appears, and the **YES/NO** key prompt flags flash.







Put the sensor in standard solution. Press **YES**.

Set the value using the **>**,**∧**, **ENT** key.

Select the flashing digit with the **>** key.
Increase its value by pressing the **∧** key

When the correct value is displayed, press **ENT** to enter the change.

After briefing displaying WAIT, the CAL.END message appears.

The calibration is now complete. Put the sensor back in the process and press **YES.**

The cell constant is automatically updated after the calibration and the new value can be read on the display as described in section 4.5.

The calculation is as follows: Cell constant in /cm= (Conductivity of calibration solution in mS/cm) x (Cell resistance in kOhm)

Comparing this calibrated cell constant with the initial nominal cell constant in service code 03 gives a good indication of the stability of the sensor. If the calibrated cell constant differs more than 20% from the nominal cell constant error E3 is displayed.

7. Maintenance

7-1. Periodic maintenance for the EXA 202 converter

The EXA transmitter requires very little periodic maintenance. The housing is sealed to IP65 (NEMA 4X) standards, and remains closed in normal operation. Users are required only to make sure the front window is kept clean in order to permit a clear view of the display and allow proper operation of the pushbuttons. If the window becomes soiled, clean it using a soft damp cloth or soft tissue. To deal with more stubborn stains, a neutral detergent may be used.

note: Never used harsh chemicals or solvents. In the event that the window becomes heavily stained or scratched, refer to the parts list (Chapter 10) for replacement part numbers.

When you must open the front cover and/or glands, make sure that the seals are clean and correctly fitted when the unit is reassembled in order to maintain the housing's weatherproof integrity against water and water vapour. The measurement otherwise may be prone to problems caused by exposure of the circuitry to condensation (see page 10-1).

The EXA instrument contains a lithium cell to support the clock function when the power is switched off. This cell needs to be replaced at 5 yearly intervals (or when discharged). Contact your nearest Yokogawa service centre for spare parts and instructions.

7-2. Periodic maintenance of the sensor

note: Maintenance advice listed here is intentionally general in nature. Sensor maintenance is highly application specific.

In general conductivity/resistivity measurements do not need much periodic maintenance. If the EXA indicates an error in the measurement or in the calibration, some action may be needed (ref. chapter 8 trouble-shooting). In case the sensor has become fouled an insulating layer may be formed on the surface of the electrodes and consequently, an apparent increase in cell constant may occur, giving a measuring error. This error is:

$$2 \times \frac{Rv}{Rcel} \times 100\ \%$$

where:
Rv = the resistance of the fouling layer
Rcel = the cell resistance

note: Resistance due to fouling or to polarization does not effect the accuracy and operation of a 4-electrode conductivity measuring system. If an apparent increase in cell constant occurs cleaning the cell will restore accurate measurement.

Cleaning methods
1. For normal applications hot water with domestic washing-up liquid added will be effective.
2. For lime, hydroxides, etc., a 5 ...10% solution of hydrochloric acid is recommended.
3. Organic foulings (oils, fats, etc.) can be easily removed with acetone.
4. For algae, bacteria or moulds, use a solution of domestic bleach (hypochlorite).

* Never use hydrochloric acid and bleaching liquid simultaneously. The very poisonous chlorine gas will result.

8. Troubleshooting

The EXA SC202 is a microprocessor-based analyzer that performs continuous self-diagnostics to verify that it is working correctly. Error messages resulting from faults in the microprocessor systems itself are few. Incorrect programming by the user can be corrected according to the limits set in the following text.

In addition, the EXA SC202 also checks the sensor to establish whether it is still functioning within specified limits.

What follows is a brief outline of some of the EXA SC202 troubleshooting procedures, followed by a detailed table of error codes with possible causes and remedies.

8-1. Diagnostics

8-1-1. Off-line checks

The EXA SC202 transmitter incorporates a diagnostic check of the adjusted cell constant value at calibration. If the adjusted value stays within 80 - 120 % of the nominal value set in service code 03, it is accepted. Otherwise, the unit generates an error (E3). With a FF communication package it is possible to scroll the calibration data in a logbook function.

The EXA also checks the temperature compensation factor while performing manual temperature compensation as described in section 5.2.5. If the TC factor stays within 0.00% to 3.50% per °C, it is accepted. Otherwise, E2 will be displayed.

8-1-2. On-line checks

The EXA performs several on-line checks to optimize the measurement and to indicate a fault due to the fouling or polarization of the connected sensor. The fault will be indicated by the activation of the FAIL flag in the display.

During measurement the EXA adjusts the measuring frequency to give the best conditions for the actual value being measured. At low conductivity there is a risk of error due to the capacitive effects of the cable and the cell. These are reduced by using a low measuring frequency. At high conductivity the capacitive effects become negligible and errors are more likely to be caused by polarization or fouling of the cell. These errors are decreased by increasing the measuring frequency.

At all values the EXA checks the signal from the cell to search for distortion which is typical of capacitive or polarization errors. If the difference between pulse front and pulse rear is > 20% an error E1 will be displayed and the FAIL flag in the display is activated. In service code 05 it is possible to turn this check on and off.

9. USP WATER PURITY MONITORING

9-1. What is USP ?

USP stands for United States Pharmacopeia and it is responsible for issuing guidelines for the pharmaceutical industry. Implementing these guidelines is highly recommended for companies wishing to market drugs in the US. This means that USP is important for pharmaceutical companies worldwide. USP recently issued: - USP - recommendations for conductivity measurement. This new USP, aims at the replacement of 5 antiquated laboratory tests by simple conductivity analysis.

9-2. What is conductivity measurement according to USP?

Life would be easy, if the limits for the conductivity of injection water were set to be 1.3 µS/cm at a reference temperature of 25°C. However, the committee (PHRMA WQC) who made the USP recommendations, could not agree on a simple Sodium Chloride model for water quality determination. Instead, they chose a Chloride-Ammonia conductivity-pH model in water atmospherically equilibrated (CO2) at 25 °C.

The objective of the WQC was to find an easy way to establish the water quality, so on-line analysis at process temperature was a necessary requirement. However, if it is not possible to choose one temperature response model to work to, then it is also not possible to choose one temperature compensation algorithm.

We as a manufacturer of analytical equipment do not want to go into the details of whether the limiting conductivity values for water quality are based on the Chloride model or the Ammonia model. Our job is to develop on-line analyzers that make it simple for our customers to meet the water quality that is specified as “stage 1: Conductivity Limit as a Function of Temperature.”

If the water exceeds the limits of stage 1, then it can still be acceptable, but requires the customer to proceed to Stage 2, and possibly Stage 3, to validate the water quality. It is our objective to assure that our customers do not exceed the limits in stage 1 to avoid them having to carry out the complicated laboratory checks in Stages 2 and 3.

9-3. USP in the SC202

1. In SC202 we have defined an Error Code: E13. This is independent of what range the customer is measuring or what temperature compensation method he is using for water quality monitoring. When the display shows E13, then the water quality exceeds the USP limits, and the FAIL flag on the display is activated to signal that the system needs urgent attention.

2. We have introduced uncompensated conductivity in the DISPLAY menu. In the LCD display the user can read the temperature and the raw conductivity to compare his water quality with the USP table.

3. We have kept all the EXA functionality: It is even possible to have the Display readings in resistivity units. Most users will have very good water quality and in the resistivity mode they will have better resolution on the recorder or DCS. The readings are simply the reciprocal values of the conductivity values.

9-4. Setting up SC202 for USP

First enable USP in service code 57. Change the setting from 0 (default) to 1 (enabled).

This activates uncompensated conductivity in the display menu. The E13 feature is also enabled. For E13 the FAIL flag is triggered when the uncompensated conductivity exceeds the relevant value in the graph.

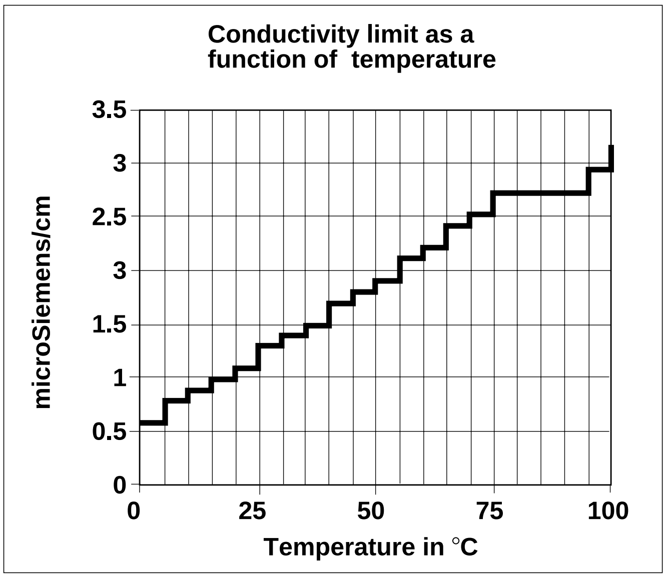


Fig. 9-1.

10. Spare Parts

Table 10-1. Itemized parts list

Item No.	Description	Part no.
1	Cover assembly including window, gasket and fixing screws	K1542JZ
2	Window	K1542JN
3	Terminals (block of 3)	K1544PF
4	Terminals (block of 5)	K1544PG
5	Case assembly EXA 202 Fielbus board	K1544KD
6	Gland set (one gland including seal and backing nut)	K1500AU
7	Text plate (general purpose version only)	K1544GD
8	Pin header (Internal FF connector)	K1544FA
9	Lithium cell (battery)	K1543AJ
10	Eeprom with latest SC202G software	K1544BJ
Options		
/T	Turck connector	K1544FN
/U	Pipe and wall mounting hardware	K1142KW
/PM	Panel mounting hardware	K1141KR
/SCT	Stainless steel tag plate	K1143ST

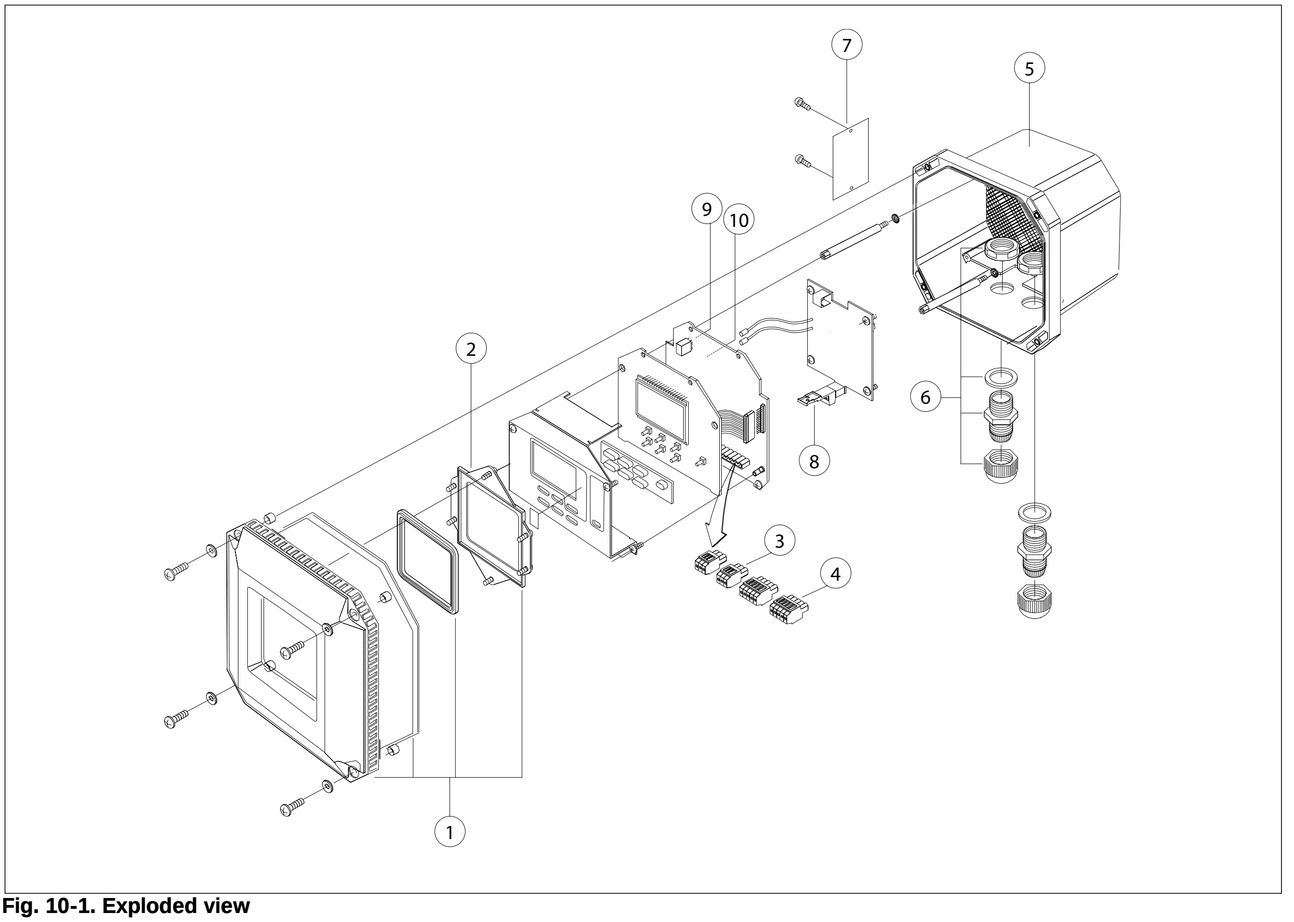


Fig. 10-1. Exploded view

11. Appendix

11-1. User setting for non-linear output table (code 31and 35)

Concentration table output						
Code Output	%	S/cm	%	S/cm	%	S/cm
0						
5						
10						
15						
20						
25						
30						
35						
40						
45						
50						
55						
60						
65						
70						
75						
80						
85						
90						
95						
100						

11-2. User entered matrix data (code 23 to 28)

Medium:			**T1 data**	**T2 data**	**T3 data**	**T4 data**	**T5 data**
Code 23	Temperature	T1...T5					
Code 24	Solution 1	L1					
Code 25	Solution 2	L2					
Code 26	Solution 3	L3					
Code 27	Solution 4	L4					
Code 28	Solution 5	L5					

Medium:			**T1 data**	**T2 data**	**T3 data**	**T4 data**	**T5 data**
Code 23	Temperature	T1...T5					
Code 24	Solution 1	L1					
Code 25	Solution 2	L2					
Code 26	Solution 3	L3					
Code 27	Solution 4	L4					
Code 28	Solution 5	L5					

11-3. Matrix data table (user selectable in code 22)

Matrix, Solution	Temp (°C)	Data 1	Data 2	Data 3	Data 4	Data 5
HCL-p (cation)		0 ppb	4 ppb	10 ppb	20 ppb	100ppb
selection 1	0	0.0116 µS	0.0228 µS	0.0472 µS	0.0911µS	0.450 µS
	10	0.0230 µS	0.0352 µS	0.0631 µS	0.116 µS	0.565 µS
	20	0.0419 µS	0.0550 µS	0.0844 µS	0.145 µS	0.677 µS
	30	0.0710 µS	0.085 µS	0.115 µS	0.179 µS	0.787 µS
	40	0.1135 µS	0.129 µS	0.159 µS	0.225 µS	0.897 µS
	50	0.173 µS	0.190 µS	0.220 µS	0.286 µS	1.008 µS
	60	0.251 µS	0.271 µS	0.302 µS	0.366 µS	1.123 µS
	70	0.350 µS	0.375 µS	0.406 µS	0.469 µS	1.244 µS
	80	0.471 µS	0.502 µS	0.533 µS	0.595 µS	1.373 µS
Ammonia-p		0 ppb	2 ppb	5 ppb	10 ppb	50 ppb
selection 2	0	0.0116 µS	0.0229 µS	0.0502 µS	0.0966µS	0.423 µS
	10	0.0230 µS	0.0337 µS	0.0651 µS	0.122 µS	0.535 µS
	20	0.0419 µS	0.0512 µS	0.0842 µS	0.150 µS	0.648 µS
	30	0.0710 µS	0.0788 µS	0.111 µS	0.181 µS	0.758 µS
	40	0.113 µS	0.120 µS	0.149 µS	0.221 µS	0.866 µS
	50	0.173 µS	0.178 µS	0.203 µS	0.273 µS	0.974 µS
	60	0.251 µS	0.256 µS	0.278 µS	0.344 µS	1.090 µS
	70	0.350 µS	0.356 µS	0.377 µS	0.439 µS	1.225 µS
	80	0.471 µS	0.479 µS	0.501 µS	0.563 µS	1.393 µS
Morpholine-p		0 ppb	20 ppb	50 ppb	100 ppb	500 ppb
selection 3	0	0.0116 µS	0.0272 µS	0.0565 µS	0.0963µS	0.288 µS
	10	0.0230 µS	0.0402 µS	0.0807 µS	0.139 µS	0.431 µS
	20	0.0419 µS	0.0584 µS	0.108 µS	0.185 µS	0.592 µS
	30	0.0710 µS	0.0851 µS	0.140 µS	0.235 µS	0.763 µS
	40	0.113 µS	0.124 µS	0.181 µS	0.289 µS	0.938 µS
	50	0.173 µS	0.181 µS	0.234 µS	0.351 µS	1.12 µS
	60	0.251 µS	0.257 µS	0.306 µS	0.427 µS	1.31 µS
	70	0.350 µS	0.357 µS	0.403 µS	0.526 µS	1.52 µS
	80	0.471 µS	0.481 µS	0.528 µS	0.654 µS	1.77 µS
Hydrochloric Acid		1%	2%	3%	4%	5%
selection 4	0	65 mS	125 mS	179 mS	229 mS	273 mS
	15	91 mS	173 mS	248 mS	317 mS	379 mS
	30	114 mS	217 mS	313 mS	401 mS	477 mS
	45	135 mS	260 mS	370 mS	474 mS	565 mS
	60	159 mS	301 mS	430 mS	549 mS	666 mS
Sodium Hydroxide		1%	2%	3%	4%	5%
selection 5	0	31 mS	61 mS	86 mS	105 mS	127 mS
	25	53 mS	101 mS	145 mS	185 mS	223 mS
	50	76 mS	141 mS	207 mS	268 mS	319 mS
	75	97.5 mS	182 mS	264 mS	339 mS	408 mS
	100	119 mS	223 mS	318 mS	410 mS	495 mS

11-4. Sensor Selection

11-4-1. General
The inputs of the EXA transmitter are freely programmable for ease of installation. Standard 2-electrode type sensors with a cell constant of 0.100/cm and a Pt1000 temperature sensor, need no special programming. The EXA indicates a fault with a signal in the display field if there is a mismatch of sensors in the connection.

11-4-2. Sensor selection
The EXA SC202 is pre/programmed to accept standard 2-electrode sensors with a Pt1000 temperature sensor. The EXA is universally compatible with all 2- and 4-electrode type of sensors with a cell constant within the range of 0.008/cm to 50.0/cm.

11-4-3. Selecting a temperature sensor
The EXA SC202 reaches its highest accuracy when used with a Pt1000 temperature sensor. This may influence the choice of the conductivity/resistivity sensor, as in most cases the temperature sensor is integrated in the conductivity/resistivity sensor.

11-5. Setup for other functions

- Diagnostic checks
  Polarization check and checks on the calibrated cell constant and the adjusted Temperature Coefficient, are included in the EXA SC202.

- Logbook
  In combination with the communications link, a “logbook” is available to keep an electronic record of events such as error messages, calibrations and programmed data changes. By reference to this log, users can for instance easily determine maintenance or replacement schedules.

note: On the pages 11-4 & 11-5 a reference list for the configuration of the SC202 is shown.

11.6. User setting table

	FUNCTION	SETTING DEFAULTS		USER SETTINGS	
Parameter specific functions					
01	*SC.RES	0	SC		
02	*4-Elec	0	2-Elec.		
03	*0.10xC	0.10xC 1.000	Factor /cm		
04	*AIR				
05	*POL.C.K	1	On		
Temperature measuring functions					
10	*T.SENS	0	Pt1000		
11	*T.UNIT	0	°C		
12	*T.ADJ		None		
Temperature compensation functions					
20	*T.R.°C	25	°C		
21	*T.C.1 *T.C.2	2.1 2.1	%/°C %/°C		
22	*MATRX		None, see 5-2-5		
23	*T1°C	T. range	See sep. table, 11-2		
24	*L1xT1	Cond. C1	See sep. table, 11-2		
25	*L2xT1	Cond. C2	See sep. table, 11-2		
26	*L3xT1	Cond. C3	See sep. table, 11-2		
27	*L4xT1	Cond. C4	See sep. table, 11-2		
28	*L5xT1	Cond. C5	See sep. table, 11-2		
Concentration table					
35	*TABL1	21 pt table	see code 31, 11-1		

11-7. Error codes

	FUNCTION	SETTING DEFAULTS		USER SETTINGS		
User Interface						
50	*RET	1	on			
52	*PASS	0.0.0	all off			
53	*Err.01	1	hard fail			
	*Err.05	1	hard fail			
	*Err.06	1	hard fail			
	*Err.07	1	hard fail			
	*Err.08	1	hard fail			
	*Err.13	0	soft fail			
54	*E5.LIM	250	mS			
		(0.004)	kΩ.			
	*E6.LIM	1.000	µS			
		(1.0)	MΩ.			
55	*0 %	0	Off			
	100%	100.0				
56	*DISP	0	Auto ranging (SC)			
		(2)	(xx.xxMΩ.cm) (RES)			
57	*USP	0	off			

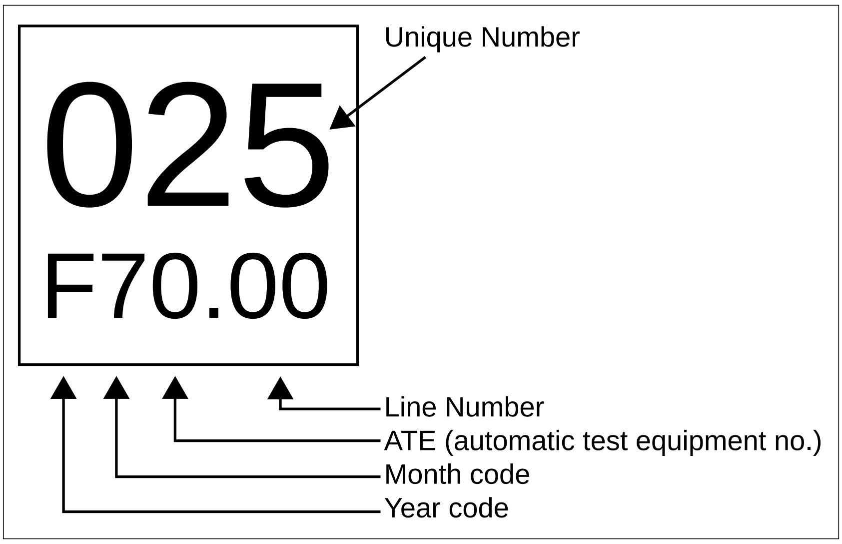
Code	Error description	Possible cause	Suggested remedy
E1	Polarization detected on cell	Sensor surface fouled Conductivity too high	Clean sensor Replace sensor
E2	Temperature coefficient out of limits (0-3.5%/ºC)	Incorrect field calibration of TC	Re-adjust Set calculated TC
E3	Calibration out of limits	Calibrated value differs more than +/- 20 % of nominal value programmed in code 03.	Check for correct sensor Check for correct unit (µS/cm, mS/cm, kΩ.cm or MΩ.cm) Repeat calibration
E4	Matrix compensation error	Wrong data entered in 5x5 matrix	Re-program
E5	Conductivity too high or resistivity too low (Limits set in service code 54)	Incorrect wiring Internal leakage of sensor Defective cable	Check wiring (3-6) Replace sensor Replace cable
E6	Conductivity too low or resistivity too high (Limits set in service code 54)	Dry sensor Incorrect wiring Defective cable	Immerse sensor Check wiring (3-6) Replace cable
E7	Temperature sensor open (Pt1000 : T > 250°C or 500°F) (Pt100/Ni100 : T > 200°C or 400°F) (8k55 : T < -10°C or 10°F) (PB36 : T < -20°C or 0°F)	Process temperature too high or too low Wrong sensor programmed Incorrect wiring	Check process Check model code sensor Check connections and cable
E8	Temperature sensor shorted (Pt1000/Pt100/Ni100 : T < -20°C or 0°F) (8k55/PB36 : T > 120°C or 250°F)	Process temperature too high or too low Wrong sensor programmed Incorrect wiring	Check process Check model code sensor Check connections and cable
E9	Air set impossible	Too high zero due to cable capacitance	Replace cable
E10	EEPROM write failure	Fault in electronics	Try again, if unsuccessful contact Yokogawa
E13	USP limit exceeded	Poor water quality	Check ion exchangers
E15	Cable resistance influence to temperature exceeds +/- 15°C	Cable resistance too high Corroded contacts Wrong sensor programmed	Check cable Clean and reterminate Reprogram
E18	Table values make no sense	Wrong data programmed	Reprogram
E19	Programmed values outside acceptable limits	Incorrect configuration by user	Reprogram
E20	All programmed data lost	Fault in electronics Very severe interference	Contact Yokogawa
E21	Checksum error	Software problem	Contact Yokogawa

12. Test Certificate

Test Certificate	**EXA Series Model SC202 Inductive Conductivity Transmitter**

1. Introduction

This inspection procedure applies to the model SC202 Conductivity converter. There is a serial number, unique to the instrument, which is stored in non-volatile memory. Each time the converter is powered up, the serial number is shown in the display. An example is shown below, for details see the Users manual:



2. General Inspection

Final testing begins with a visual inspection of the unit to ensure that all the relevant parts are present and correctly fitted.

3. Safety Test

The (-) minus and the external ground terminal of the housing are connected to a Voltage generator (100 VDC). The measured impedance value should be over 9.5 MW.

Terminal 14 and the external ground terminal of the housing are connected to a Voltage generator (500 VAC RMS) for 1 minute. The leakage current should remain below 12 mA.

4.1 Accuracy Testing

Our automated testing facility checks the resistivity input accuracy of the instrument using a calibrated ISC40 sensor and a variable resistor (decade resistor box).

4.1.1 Accuracy Testing of all supported temperature elements

Our automated testing facility checks the input accuracy of the instrument using a calibrated variable resistor (decade resistor box) to simulate the resistance of all temperature elements.
Overall Accuracy Test

This test can be performed by the end-user to check the overall accuracy of the instrument. The data specified on the Test certificate are results of the overall accuracy test performed during production and can be reproduced by performing similar tests with the following test equipment:

1. A variable resistor (resistor decade box 1) to simulate the temperate element. All tests are performed simulating 25ºC (77 ºF).
2. A second variable resistor (box 2) to simulate the conductivity. Recommended is a resistor decade box in steps of 1 W, between 2 W and 1200 kW. (accuracy 0.1%)
3. A fixed resistor of 300 W to simulate the mA-output load.
4. Screened cable to connect the input signals (a WU20 cable with a length of 2 metres is preferred)
5. A stabilised voltage supply unit : nominal 24 Volt DC
6. A current meter for DC currents up to 25 mA, resolution 1uA, accuracy 0.1%

Connect the SC202 as shown in Figure 1. Set box 1 to simulate 25 ºC
(1097,3 W for PT1000, 30 kW for NTC).

Before starting the actual test, the SC202 and peripheral testing equipment has to be connected to the power supply for at least 5 minutes, to assure the instrument is warmed up properly.

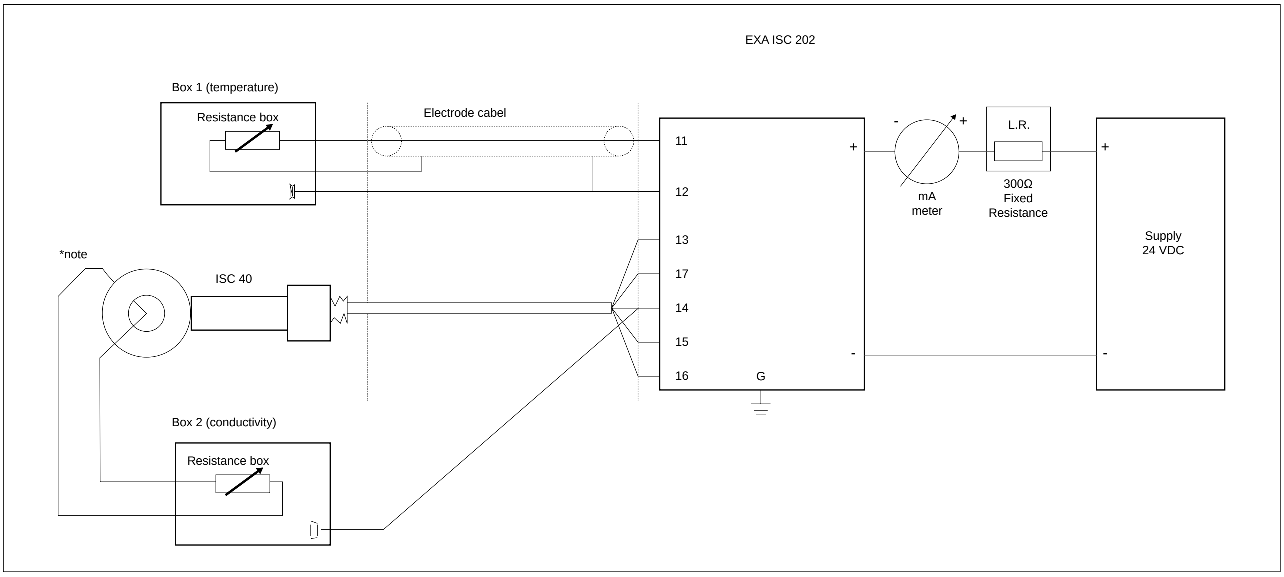


Figure 1. Connection diagram for the overall accuracy test

The tolerances specified relate to the performance of the SC202 with calibrated purpose built test equipment under controlled test conditions (humidity, ambient temperature). Note that these accuracy's are only reproducible when performed with similar test equipment under similar test conditions. Under other conditions, the accuracy and linearity of the test equipment will be different. The display may show values, which differ as much as 1% from those measured under controlled conditions.

4.2 Accuracy test mA output circuit

Our automated testing facility checks the output accuracy of the instrument with simulated mA-output values.

TABLE OF CONTENTS

1. INTRODUCTION

The second part of this manual describes only those topics that are required for operation of the fieldbus communications.

2 Safety Precautions

- For the protection and safety of the operator and the instrument or the system including the instrument, please be sure to follow the instructions on safety described in this manual when handling this instrument.
  In case the instrument is handled in contradiction to these instructions, Yokogawa does not guarantee safety.
- For the intrinsically safe equipment and explosionproof equipment, in case the instrument is not restored to its original condition after any repair or modification undertaken by the customer, intrinsically safe construction or explosionproof construction is damaged and may cause dangerous condition. Please contact Yokogawa for any repair or modification required to the instrument.
- The following safety symbol marks are used in this Manual:

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

IMPORTANT

Indicates that operating the hardware or software in this manner may damage it or lead to system failure.

NOTE

Draws attention to information essential for understanding the operation and features.

WARNING

- Instrument installed in the process is under pressure. Never loosen or tighten the process connector bolts as it may cause dangerous spouting of process fluid.
- During draining condensate or venting gas in transmitter pressure-detector section, take appropriate care to avoid contact with the skin, eyes or body, or inhalation of vapors, if the accumulated process fluid may be toxic or otherwise harmful.
  Since draining condensate or bleeding off gas gives the pressure measurement distur-bance, this should not be done when the loop is in operation.
- If the accumulated process fluid may be toxic or otherwise harmful, take appropriate care to avoid contact with the body, or inhalation of vapors even after dismounting the instrument from process line for maintenance.

CAUTION

This instrument is tested and certified as intrinsically safe type or explosionproof type. Please note that the construction of the instrument, installation, external wiring, maintenance or repair is strictly restricted, and non-observance or negligence of these restriction would result dangerous condition.

3. ABOUT FIELDBUS

3.1 Outline

Fieldbus is a bi-directional digital communication protocol for field devices, which offers an advancement implementation technologies for process control systems and is widely employed by numerous field devices.

EXA Series Fieldbus communication type employs the specification standardized by The Fieldbus Foundation, and provides interoperability between Yokogawa devices and those produced by other manufacturers. Fieldbus comes with software consisting of three AI function blocks, providing the means to implement flexible instrumentation system.

For information on other features, engineering, design, construction work, startup and maintenance of Fieldbus, refer to "Fieldbus Technical Information" ((http://www.yokogawa.com/fieldbus/tutorial.html)).

3.2 Internal Structure of EXA

The EXA contains two virtual field devices (VFD) that share the following functions.

3.2.1 System/network Management VFD

- Sets node addresses and Phisical Device tags (PD Tag) necessary for communication.
- Controls the execution of function blocks.
- Manages operation parameters and communication resources (Virtual Communication Relationship: VCR).

3.2.2 Function Block VFD

(1)Resource block

- Manages the status of EXA hardware.
- Automatically informs the host of any detected faults or other problems.

(2)Transducer block

- Converts sensor output to process values and transfers to AI function block by channels.

(3)AI1, AI2, AI3 function block

- Conditions raw data from the Transducer block.
- Outputs conditioned process values
- Carries out scaling, damping and square root extraction.

3.3 LOGICAL STRUCTURE OF EACH BLOCK

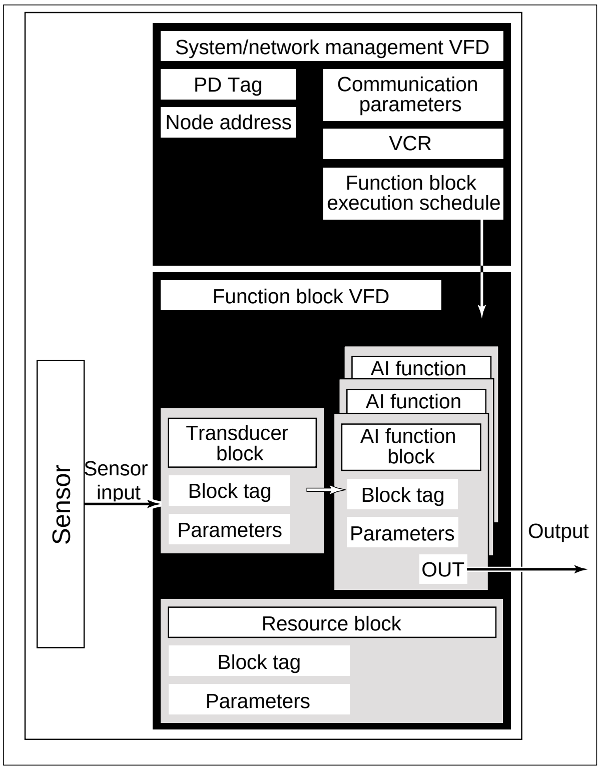


Figure 3.1 Logical Structure of Each Block

Setting of various parameters, node addresses, and PD Tags shown in Figure 3.1 is required before starting operation.

3.4 Wiring System Configuration

The number of devices that can be connected to a single bus and the cable length vary depending on system design. When constructing systems, both the basic and overall design must be carefully considered to allow device performance to be fully exhibited.

4. GETTING STARTED

Fieldbus is fully dependent upon digital communication protocol and differs in operation from conventional 4 to 20 mA transmission communication protocol. It is recommended that novice users use field devices in accordance with the procedures described in this section. The procedures assume that field devices will be set up on a bench or an instrument shop.

4.1 Connection of Devices

The following instruments are required for use with Fieldbus devices:

- **Power supply:**
  Fieldbus requires a dedicated power supply. It is recommended that current capacity be well over the total value of the maximum current consumed by all devices (including the host). Conventional DC current cannot be used as is.

- **Terminator:**
  Fieldbus requires two terminators. Refer to the supplier for details of terminators that are attached to the host.

- **Field devices:**
  Connect EXA Fieldbus communication type.
  Two or more EXA devices or other devices can be connected.

- **Host:**
  Used for accessing field devices. A dedicated host (such as DCS) is used for an instrumentation line while dedicated communication tools are used for experimental purposes. For operation of the host, refer to the instruction manual for each host. No details of the host are explained in the rest of this material.

- **Cable:**
  Used for connecting devices. Refer to "Fieldbus Technical Information" (TI 38K3A01-01E) for details of instrumentation cabling.
  Fieldbus uses twisted pair wires. To meet the Electro Magnetic Interference standards a shielded twisted pair is obligated.

Refer to Yokogawa when making arrangements to purchase the recommended equipment.

Connect the devices as shown in Figure 4.1. Connect the terminators at both ends of the trunk, with a minimum length of the spur laid for connection.

The polarity of signal and power must be maintained.

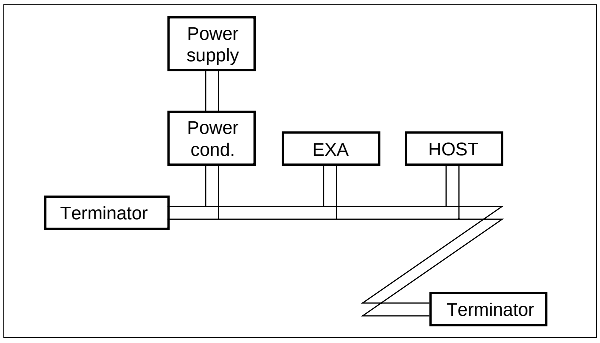


Figure 4.1 Cabling

NOTE

Before using a Fieldbus configuration tool other than the existing host, confirm it does not affect the loop functionality in which all devices are already installed in operation. Disconnect the relevant control loop from the bus if necessary.

IMPORTANT

Connecting a Fieldbus configuration tool to a loop with its existing host may cause communication data scrambles resulting in a functional disorder or a system failure.

4.2 Host Setting

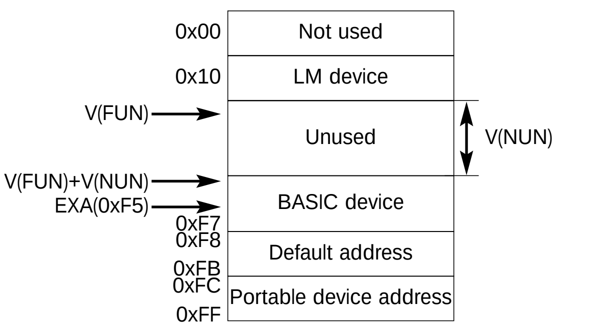
To activate Fieldbus, the following settings are required for the host.

IMPORTANT

Do not turn off the power immediately after setting. When the parameters are saved to the EEPROM, the redundant processing is executed for an improvement of reliability. If the power is turned off within 60 seconds after setting is made, the modified parameters are not saved and the settings may return to the original values.

Table 4.1 Operation Parameters

Symbol	Parameter	Description and Settings
V (ST)	Slot-Time	Set 4 or greater value.
V (MID)	Minimum-Inter-PDU-Delay	Set 4 or greater value.
V (MRD)	Maximum-Reply-Delay	Set so that V (MRD) 3 V (ST) is 12 or greater
V (FUN)	First-Unpolled-Node	Indicate the address next to the address range used by the host. Set 0x15 or greater.
V (NUN)	Number-of-consecutive-Unpolled-Node	Unused address range. EXA address is factory-set to 0xF5. Set this address to be within the range of the BASIC device in Figure 4.2.



Note 1: LM device: with bus control function (Link Master function)
Note 2: BASIC device: without bus control function

Figure 4.2 Available Address Range

4.3 Bus Power ON

Turn on the power of the host and the bus. First all segments of the display are lit, then the display begins to operate. If the indicator is not lit, check the polarity of the power supply.

Using the host device display function, check that the EXA is in operation on the bus.
Unless otherwise specified, the following settings are in effect when shipped from the factory.

PD tag: SC1001
Node address: 245 (hexadecimal F5)
Device ID: 5945430831xxxxxxxx (xxxxxxxx = a total of 8 alphanumeric characters)

If no EXA is detected, check the available address range and the polarity of the power supply. If the node address and PD tag are not specified when ordering, default value is factory set. If two or more EXA's are connected at a time with default value, only one EXA will be detected from the host as EXA's have the same initial address.
Separately connect each EXA and set a different address for each.

4.4 Integration of DD

If the host supports DD (Device Description), the DD of the EXA needs to be installed. Check if host has the following directory under its default DD directory.

594543\0831
(594543 is the manufacturer number of Yokogawa Electric Corporation, and 0831 is the EXA device number, respectively.)
If this directory is not found, DD of EXA has not been included. Create the above directory and copy the DD file (0m0n.ffo,0m0n.sym) (m, n is a numeral) (to be supplied separately) into the directory.

Once the DD is installed in the directory, the name and attribute of all parameters of the EXA are displayed.

Off-line configuration is possible by using Capability file (0M0N00.CFF).

4.5 Reading the Parameters

To read EXA parameters, select the AI1 block of the EXA from the host screen and read the OUT parameter. The current process value is displayed. Check that MODE_BLOCK of the function block and resource block is set to AUTO.

4.6 Continuous Record of Values

If the host has a function of continuously recording the indications, use this function to list the indications (values). Depending on the host being used, it may be necessary to set the schedule of Publish (the function that transmits the indication on a periodic basis).

4.7 Generation of Alarm

If the host is allowed to receive alarms, generation of an alarm can be attempted from EXA. In this case, set the reception of alarms on the host side. EXA's VCR-7 is factory-set for this purpose. For practical purposes, all alarms are placed in a disabled status; for this reason, it is recommended that you first use one of these alarms on a trial basis. Set the value of link object-3 (index 30002) as “0, 299, 0, 6, 0”. Refer to section 5.6.1 Link Object for details.

Since the L0_PRI parameter (index 4029) of the AI1 block is set to “0”, try setting this value to “3”. Select the Write function from the host in operation, specify an index or variable name, and write “3” to it.

The L0_LIM parameter (index 4030) of the AI1 block determines the limit at which the lower bound alarm for the process value is given. In usual cases, a very small value is set to this limit. Set a value higher than the current process value, a lower bound alarm is raised. Check that the alarm can be received at the host. When the alarm is confirmed, transmission of the alarm is suspended.

The above-mentioned items are a description of the simple procedure to be carried out until EXA is connected to Fieldbus. In order to take full advantage of the performance and functionality of the device, it is recommended that it be read together with Chapter 5, which describes how to use the EXA.

5. CONFIGURATION

This chapter contains information on how to adapt the function and performance of the EXA to suit specific applications. Because two or more devices are connected to Fieldbus, settings including the requirements of all devices need to be determined. Practically, the following steps must be taken.

(1) Network design
Determines the devices to be connected to Fieldbus and checks the capacity of the power supply.

(2) Network definition
Determines the tag and node addresses for all devices.

(3) Definition of combining function blocks
Determines the method for combination between each function block.

(4) Setting tags and addresses
Sets the PD Tag and node addresses one by one for each device.

(5) Communication setting
Sets the link between communication parameters and function blocks.

(6) Block setting
Sets the parameters for function blocks.

The following section describes each step of the procedure in the order given. Using a dedicated configuration tool allows the procedure to be significantly simplified. This section describes the procedure to be assigned for a host which has relatively simple functions.

5.1 Network Design

Select the devices to be connected to the Fieldbus network. The following instruments are necessary for operation of Fieldbus.

- **Power supply**

  Fieldbus requires a dedicated power supply. It is recommended that current capacity be well over the total value of the maximum current consumed by all devices (including the host). Conventional DC current cannot be used as is. A power conditioner is reguired.

- **Terminator**

  Fieldbus requires two terminators. Refer to the supplier for details of terminators that are attached to the host.

- **Field devices**

  Connect the field devices necessary for instrumentation. EXA has passed the interoperability test conducted by The Fieldbus Foundation. In order to properly start Fieldbus, it is recommended that the devices used satisfy the requirements of the above test.

- **Host**

  Used for accessing field devices. A minimum of one device with bus control function is needed.

- **Cable**

  Used for connecting devices. Refer to “Fieldbus Technical Information” for details of instrumentation cabling. Provide a cable sufficiently long to connect all devices. For field branch cabling, use terminal boards or a connection box as required.

First, check the capacity of the power supply. The power supply capacity must be greater than the sum of the maximum current consumed by all devices to be connected to Fieldbus. The maximum current consumed (power supply voltage 9 V to 32 V) for EXA is 23 mA. The cable must have the spur in a minimum length with terminators installed at both ends of the trunk.

5.2 Network Definition

Before connection of devices with Fieldbus, define the Fieldbus network. Allocate PD Tag and node addresses to all devices (excluding such passive devices as terminators).

The PD Tag is the same as the conventional one used for the device. Up to 32 alphanumeric characters may be used for definition. Use a hyphen as a delimiter as required.

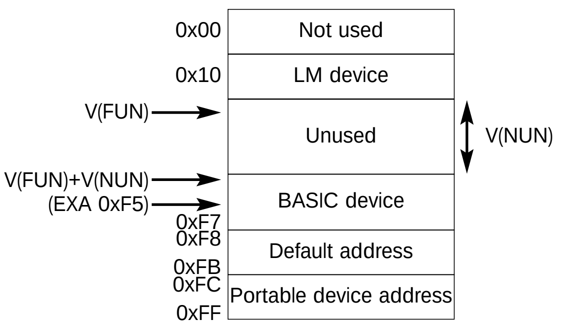
The node address is used to specify devices for communication purposes. Because data is too long for a PD Tag, the host uses the node address in place of the PD Tag for communication.
A range of 16 to 247 (or hexadecimal 0x10 to 0xF7) can be set.

Addresses of devices with Link Master capabilities are set in a low address range smaller than V(FUN). Addresses of basic devices are set in a higher range bigger than V(FUN) + V(NUN).
Specify the adress range used by setting the following two parameters in the LM-device:

Table 5.1 Parameters for Setting Address Range

Symbol	Parameters	Description
V (FUN)	First-Unpolled-Node	Indicates the address next to the address range used for the host or other LM device.
V (NUN)	Number-of-consecutive-Unpolled-Nodes	Unused address range

The devices within the address range written as “Unused” in Figure 5.1 cannot be used on a Fieldbus. For other address ranges, the range is periodically checked to identify when a new device is connected. Care must be taken not to allow the address range to become wider, which can lead to exhaustive consumption of Fieldbus communication performance.



Note 1: LM device: with bus control function (Link Master function)
Note 2: BASIC device: without bus control function

Figure 5.1 Available Range of Node Addresses

To ensure stable operation of Fieldbus, determine the operation parameters and set them to the LM devices. While the parameters in Table 5.2 are to be set, the worst-case values of all the devices to be connected to the same Fieldbus must be used. Refer to the specification of each device for details. Table 5.2 lists EXA specification values.

Table 5.2 Operation Parameter Values of the EXA to be Set to LM Devices

Symbol	Parameters	Description and Settings
V (ST)	Slot-Time	Indicates the time necessary for immediate reply of the device. Unit of time is in octets (256 µs). Set maximum specification for all devices. For EXA, set a value of 4 or greater.
V (MID)	Minimum-Inter-PDU-Delay	Minimum value of communication data intervals. Unit of time is in octets (256 µs). Set the maximum specification for all devices. For EXA, set a value of 4 or greater.
V (MRD)	Maximum-Reply-Delay	The worst case time elapsed until a reply is recorded. The unit is Slot-time; set the value so that V (MRD) 3V (ST) is the maximum value of the specification for all devices. For EXA, the setting must be a value of 12 or greater.

5.3 Definition of Combining Function Blocks

The input/output parameters for function blocks are combined. For the EXA, three AI blocks output parameter (OUT) and PID block are subject to combination. They are combined with the input of the control block as necessary. Practically, setting is written to the EXA link object with reference to “Block setting” in Section 5.6 for details. It is also possible to read values from the host at proper intervals instead of connecting the EXA block output to other blocks.

The combined blocks need to be executed synchronously with other blocks on the communications schedule. In this case, change the EXA schedule according to the following table. Enclosed values in the table are factory-settings.

Table 5.3 Execution Schedule of the EXA Function Blocks

Index	Parameters	Setting (Enclosed is factory-setting)
269 (SM)	MACROCYCLE_ DURATION	Cycle (MACROCYCLE) period of control or measurement. Unit is 1/32 ms. (32000 = 1 s)
276 (SM)	FB_START_ENTRY.1	AI1 block startup time. Elapsed time from the start of MACROCYCLE specified in 1/32 ms. (0 = 0 s)
277 (SM)	FB_START_ENTRY.2	AI2 block startup time. Elapsed time from the start of MACROCYCLE specified in 1/32 ms. (10666 = 0.33 s)
278 (SM)	FB_START_ENTRY.3	AI3 block startup time. Elapsed time from the start of MACROCYCLE specified in 1/32 ms. (21332 = 0.66 s)
279 (SM)	FB_START_ENTRY.4	Not used.

A maximum of 100 ms is taken for execution of an AI block. Executions of AI blocks should be scheduled sequentially. In no case should two AI function blocks of the EXA be executed at the same time (execution time is overlapped). 100 ms after AI block execution start the out value is available for further processing.

Figure 5.3 shows an example of schedule based on the loop shown in Figure 5.2.

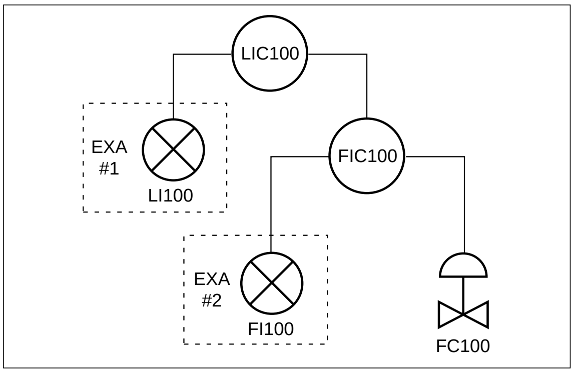


Figure 5.2 Example of Loop Connecting Function Block of Two EXA with Other Instruments

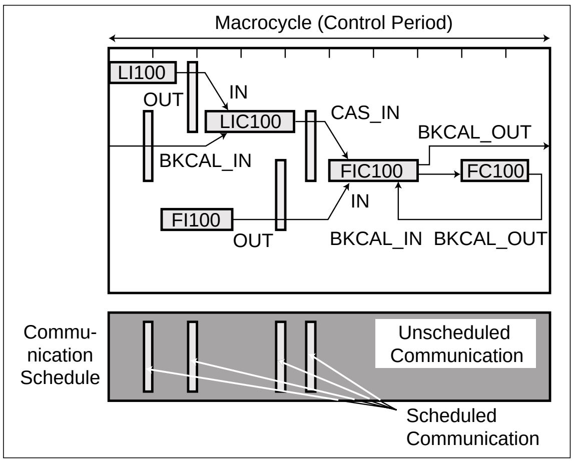


Figure 5.3 Function Block Schedule and Communication Schedule

When the macrocycle is set to more than 4 seconds, set the following intervals to be more than 1% of the macrocycle.

- Interval between “end of block execution” and “start of sending CD from LAS”
- Interval between “end of block execution” and “start of the next block execution”

5.4 Setting of Tags and Addresses

This section describes the steps in the procedure to set PD Tags and node addresses in the EXA. There are three states of Fieldbus devices as shown in Figure 5.4, and if the state is other than SM_OPERATIONAL state, no function block is executed. EXA must be transferred back to this state after a tag or address is changed.

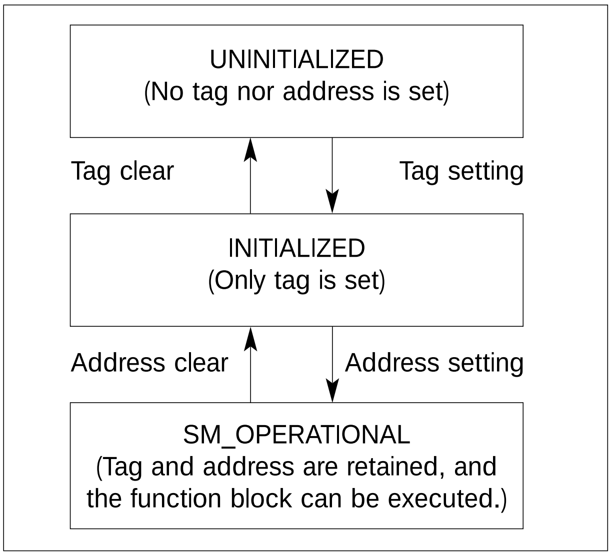


Figure 5.4 Status Transition by Setting PD Tag and Node Address

EXA has a PD Tag (PH1001) and node address (245, or hexadecimal F5) that are set upon shipment from the factory unless otherwise specified. To change only the node address, clear the address once and then set a new node address. To set the PD Tag, first clear the node address and clear the PD Tag, then set the PD Tag and node address again.

Devices whose node address was cleared will await the default address (randomly chosen from a range of 248 to 251, or from hexadecimal F8 to FB). At the same time, it is necessary to specify the device ID in order to correctly specify the device. The device ID of the EXA is 5945430831xxxxxxxx. (The xxxxxxxx at the end of the above device ID is a total of 8 alphanumeric characters.)

5.5 Communication Setting

To set the communication function, it is necessary to change the database residing in SM-VFD.

5.5.1 VCR Setting

Set VCR (Virtual Communication Relationship), which specifies the called party for communication and resources. EXA has 10 VCRs whose application can be changed, except for the first VCR, which is used for management.

EXA has VCRs of 3 types:

Publisher(-Subscriber) VCR
Publisher-Subscriber VCR's are designed to link Function Blocks. When a publishing Function Block runs, its output data is stored in the buffer of the Publisher VCR. Then the LAS (LM) sends a CD to this VCR to force it to transfer the data. Subscriber VCRs receive this data and gives this to the subscribing Function Blocks. Typical example is a linkage from an output of an Analog Input (AI) block to the process value input of the PID control block.

Publisher-Subscriber model is one-to-many one-way Communication. Subscribers are able to know whether data is updated since the last publish. This mechanism is important because Data Link Layer transfers data as scheduled regardless the publishing Function Block updates the data in the buffer.

(Client-)Server Model
Client-Server model is universal and used in many communication technologies. An application called "Client" requests another application called "Server" to do a specific action. When the Server finishes the requested action, its result is transferred back to the Client. It is an one-to-one two-way communication. Typical example is a human-machine interface (Client) to read data of a Function Block (Server). The Client sends a Read request to the Server and then the Server sends back the data to the Client. This communication is unscheduled and is handled during the unscheduled interval in the macrocycle. A Client may want to issue many requests at a time. A Client-Server VCR has a queue to store those requests and sends the requests one by one when the node has the token.

Source(-Sink) Model

A Source-Sink VCR is designed to broadcast messages. It is one-to-many one-way communication without any schedule. This model is sometimes called "Report Distribution Model." A Source VCR transfers a message in the queue to an assigned global address when the device has the token. Sink VCRs are set to the same global address and receive the same message from a Source. Foundation devices use this model for two specific purposes. One is to report alarms or events detected in the Source and the other is to transmit trends of Source Function Blocks. Alarms are acknowledged through a Client-Server VCR. It is desirable for an alarm logger to receive alarms from all devices with just one VCR. A Sink can receive messages from many Sources if the Sources are configured to send messages to the same global address.

A Source VCR transmits data without established connection. A Sink (QUU) VCR on another device can receive it if the Sink is configured so. A Publisher VCR transmits data when LAS requests so. An explicit connection is established from VCR(s) so that a Subscriber knows the format of published data.

Each VCR has the parameters listed in Table 5.4. Parameters must be changed together for each VCR because modification for each parameter may cause inconsistent operation.

Table 5.4 VCR Static Entry

Sub-index	Parameter	Description
1	FasArTypeAndRole	Indicates the type and role of communication (VCR). The following 3 types are used for EXA. 0x32: Server (Responds to requests from host.) 0x44: Source (Transmits alarm or trend.) 0x66: Publisher (Sends AI block output to other blocks.)
2	FasDllLocalAddr	Sets the local address to specify VCR in EXA. A range of 0x20 to 0xF7 in hexadecimal.
3	FasDllConfigured RemoteAddr	Sets the node address of the called party for communication and the address (DLSAP or DLCEP) used to specify VCR in that address. For DLSAP or DLCEP, a range of 0x20 to 0xF7 in hexadecimal is used. Addresses in Subindex 2 and 3 need to be set to the same contents of the VCR as the called party (local and remote are reversed).
4	FasDllSDAP	Specifies the quality of communication. Usually, one of the following types is set. 0x2B: Server 0x01: Source (Alert) 0x03: Source (Trend) 0x91: Publisher
5	FasDllMaxConfirm DelayOnConnect	To establish connection for communication, a maximum wait time for the called party's response is set in ms. Typical value is 60 seconds (60000).
6	FasDllMaxConfirm DelayOnData	For request of data, a maximum wait time for the called party's response is set in ms. Typical value is 60 seconds (60000).
7	FasDllMaxDlsduSize	Specifies maximum DL Service Data unit Size (DLSDU). Set 256 for Server and Trend VCR, and 64 for other VCRs.
8	FasDllResidual ActivitySupported	Specifies whether connection is monitored. Set TRUE (0xff) for Server. This parameter is not used for other communication.
9	FasDllTimelinessClass	Not used.

Sub-index	Parameter	Description
10	FasDllPublisherTime WindowSize	Not used.
11	FasDllPublisher SynchronizaingDlcep	Not used.
12	FasDllSubsriberTime WindowSize	Not used.
13	FasDllSubscriber SynchronizationDlcep	Not used.
14	FmsVfdId	Sets VFD for EXA to be used. 0x1: System/network management VFD 0x1234: Function block VFD
15	FmsMaxOutstanding ServiceCalling	Set 0 to Server. It is not used for other applications.
16	FmsMaxOutstanding ServiceCalled	Set 1 to Server. It is not used for other applications.
17	FmsFeatures Supported	Indicates the type of services in the application layer. In the EXA, it is automatically set according specific applications.

17 VCRs are factory-set as shown in the table below.

Table 5.5 VCR List

Index (SM)	VCR Number	Factory Setting
293	1	For system management (Fixed)
294	2	Server (LocalAddr = 0xF3)
295	3	Server (LocalAddr = 0xF4)
296	4	Server (LocalAddr = 0xF7)
297	5	Trend Source (LocalAddr = 0x07, Remote Address=0x111)
298	6	Publisher for AI1 (LocalAddr = 0x20)
299	7	Alert Source (LocalAddr = 0x07, Remote Address=0x110)
300	8	Server (LocalAddr = 0xF9)
301	9	Publisher for AI2 (LocalAddr = 0x21)
302	10	Publisher for AI3 (LocalAddr = 0x22)

5.5.2 Function Block Execution Control

According to the instructions given in Section 5.3, set the execution cycle of the function blocks and schedule of execution.

5.6 Block Setting

Set the parameter for function block VFD.

5.6.1 Link Object

Link object combines the data voluntarily sent by the function block with VCR. The EXA has 6 link objects. A single link object specifies one combination. Each link object has the parameters listed in Table 5.6. Parameters must be changed together for each VCR because the modifications made to each parameter may cause inconsistent operation.

Table 5.6 Link Object Parameters

Sub-index	Parameters	Description
1	LocalIndex	Sets the index of function block parameters to be combined; set “0” for Trend and Alert.
2	VcrNumber	Sets the index of VCR to be combined. If set to “0”, this link object is not used.
3	RemoteIndex	Not used in EXA. Set to “0”.
4	ServiceOperation	Set one of the following. Only one link object is used for Alert and/or Trend. 0: Undefined 2: Publisher 6: Alert 7: Trend
5	StaleCountLimit	Set the maximum number of consecutive stale input values which may be received before the input status is set to BAD. To avoid the unnecessary mode transition caused when the data is not correctly received by subscriber, set this parameter to “2” or more.

Set link objects as shown in Table 5.7.

Table 5.7 Factory-Settings of Link Objects (example)

Index	Link Object#	Factory Settings
30000	1	AI1.OUT → VCR#6
30001	2	Trend → VCR#5
30002	3	Alert → VCR#7
30003	4	AI2.OUT → VCR#9
30004	5	AI3.OUT → VCR#10
30005	6	Not used

5.6.2 Trend Object

It is possible to set the parameter so that the function block automatically transmits Trend. The EXA has three Trend objects, which are used for Trend in analog mode parameters. A single Trend object specifies the trend of one parameter.

Each Trend object has the parameters listed in Table 5.8. The first four parameters are the items to be set. Before writing to a Trend object, it is necessary to release the WRITE_LOCK parameter.

Table 5.8 Parameters for Trend Objects

Sub-index	Parameters	Description
1	Block Index	Sets the leading index of the function block that takes a trend.
2	Parameter Relative Index	Sets the index of parameters taking a trend by a value relative to the beginning of the function block. In the EXA AI block, the following three types of trends are possible. 7: PV 8: OUT 19: FIELD_VAL
3	Sample Type	Specifies how trends are taken. Choose one of the following 2 types: 1: Sampled upon execution of a function block. 2: The average value is sampled.
4	Sample Interval	Specifies sampling intervals in units of 1/32 ms. Set the integer multiple of the function block execution cycle.
5	Last Update	The last sampling time.
6 to 21	List of Status	16 samples of status.
21 to 37	List of Samples	16 samples of data.

Three trend objects are factory-set as shown Table 5.9.

Table 5.9 Trend Object are Factory-Set

Index	Parameters	Factory Settings
32000	TREND_FLT.1	Not used.
32001	TREND_FLT.2	Not used.
32002	TREND_FLT.3	Not used.

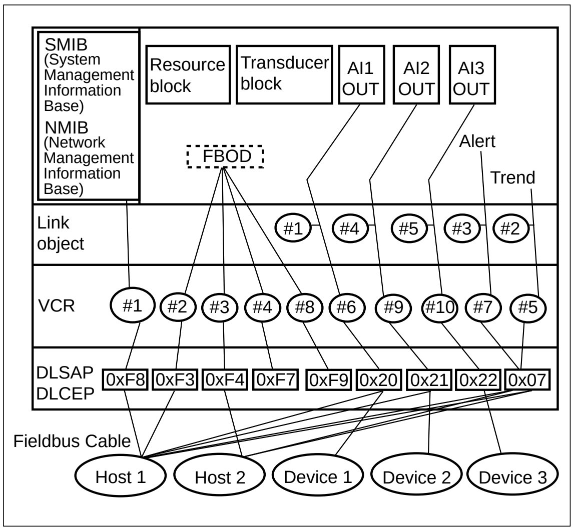


Figure 5.5 Example of Default Configuration

5.6.3 View Object

This is the object to form groups of parameters in a block. One advantage of forming groups of parameters is the reduction of load for data transaction. The EXA has four View Objects for each Resource block, Transducer block and AI1, AI2, AI3 function block, and each View Object has the parameters listed in Table 5.11 to 5.13.

Table 5.10 Purpose of Each View Object

	Description
VIEW_1	Set of dynamic parameters required by operator for plant operation. (PV, SV, OUT, Mode etc.)
VIEW_2	Set of static parameters which need to be shown to plant operator at once. (Range etc.)
VIEW_3	Set of all the dynamic parameters
VIEW_4	Set of static parameters for configuration or maintenance.

Table 5.11 View Object for Resource Block

Relative Index	Parameter Mnemonic	VIEW _1	VIEW _2	VIEW _3	VIEW _4
1	ST_REV	2	2	2	2
2	TAG_DESC				
3	STRATEGY				2
4	ALERT_KEY				1
5	MODE_BLK	4		4	
6	BLOCK_ERR	2		2	
7	RS_STATE	1		1	
8	TEST_RW				
9	DD_RESOURCE				
10	MANUFAC_ID				4
11	DEV_TYPE				2
12	DEV_REV				1
13	DD_REV				1
14	GRANT_DENY		2		
15	HARD_TYPES				2
16	RESTART				
17	FEATURES				2
18	FEATURE_SEL		2		
19	CYCLE_TYPE				2
20	CYCLE_SEL		2		
21	MIN_CYCLE_T				4
22	MEMORY_SIZE				2
23	NV_CYCLE_T		4		
24	FREE_SPACE		4		
25	FREE_TIME	4		4	
26	SHED_RCAS		4		
27	SHED_ROUT		4		
28	FAULT_STATE	1		1	
29	SET_FSTATE				
30	CLR_FSTATE				
31	MAX_NOTIFY				1
32	LIM_NOTIFY		1		
33	CONFIRM_TIME		4		
34	WRITE_LOCK		1		
35	UPDATE_EVT				
36	BLOCK_ALM				
37	ALARM_SUM	8		8	
38	ACK_OPTION 2				2
39	WRITE_PRI				
40	WRITE_ALM				
41	ITK_VER				2
42	SOFT_REV				
43	SOFT_DESC				
44	SIM_ENABLE_MSG				
45	DEVICE_STATUS_1			4	
46	DEVICE_STATUS_2			4	
47	DEVICE_STATUS_3			4	
48	DEVICE_STATUS_4			4	
49	DEVICE_STATUS_5			4	
50	DEVICE_STATUS_6			4	
51	DEVICE_STATUS_7			4	
52	DEVICE_STATUS_8			4	
	TOTALS (# BYTES)	22	30	54	31

Table 5.12 View Object for Transducer Block

Realtive Index	Parameters Mnemonic	View 1	View 2	View 3	View 4
0	blk_data				
1	st_rev	2	2	2	2
2	tag_desc[32]				
3	strategy				2
4	alert_key				1
5	mode_blk	4		4	
6	block_err	2		2	
7	update_evt				
8	block_alm				
9	transducer_directory[2]				
10	transducer_type	2	2	2	2
11	xd_error	1		1	
12	collection_directory[7]				
13	primary_value_type		2		
14	primary_value	5		5	
15	primary_value_range				11
16	sensor_const				4
17	cal_point_hi		4		
18	cal_point_lo		4		
19	cal_min_span				4
20	sensor_cal_method				1
21	sensor_cal_date				8
22	secondary_value	5		5	
23	secondary_value_unit		2		
24	sensor_temp_comp				1
25	sensor_temp_man_value				
26	sensor_type_temp				2
27	sensor_connection_temp				1
28	sensor_type_cond				2
29	sensor_ohms				
30	xd_man_id[32]				
31	temperature_coeff				4
32	concentration	5		5	
33	tertiary_value	5		5	
34	reference_temperature				4
35	comp_method		1		1
36	comp_matrix_sel				1
37	tertiary_comp_method				1
38	tert_temperature_coeff				4
39	alarm_sum	8		8	
40	dev_alarm	4		4	
41	logbook1_reset				
42	logbook1_event				
43	logbook2_reset				
44	logbook2_event				
45	logbook_config[16]				16
46	test_1				
58	test_13				
TOTALS (# BYTES)		43	17	43	72

Table 5.13 View Object for AI1.AI2.AI3 Function Block

Relative Index	Parameter Mnemonic	VIEW 1	VIEW 2	VIEW 3	VIEW 4
1	ST_REV	2	2	2	2
2	TAG_DESC				
3	STRATEGY				2
4	ALERT_KEY				1
5	MODE_BLK	4		4	
6	BLOCK_ERR	2		2	
7	PV	5		5	
8	OUT	5		5	
9	SIMULATE				
10	XD_SCALE		11		
11	OUT_SCALE		11		
12	GRANT_DENY		2		
13	IO_OPTS				2
14	STATUS_OPTS				2
15	CHANNEL				2
16	L_TYPE				1
17	LOW_CUT				4
18	PV_FTIME				4
19	FIELD_VAL	5		5	
20	UPDATE_EVT				
21	BLOCK_ALM				
22	ALARM_SUM	8		8	
23	ACK_OPTION				2
24	ALARM_HYS				4
25	HI_HI_PRI				1
26	HI_HI_LIM				4
27	HI_PRI				1
28	HI_LIM				4
29	LO_PRI				1
30	LO_LIM				4
31	LO_LO_PRI				1
32	LO_LO_LIM				4
33	HI_HI_ALM				
34	HI_ALM				
35	LO_ALM				
36	LO_LO_ALM				
	TOTALS (# BYTES)	31	26	31	46

Table 5.14 Indexes of View for Each Block

	VIEW_1	VIEW_2	VIEW_3	VIEW_4
Resourse Block	40100	40101	40102	40103
Transducer Block	40200	40201	40202	40203
AI1 Function Block	40400	40401	40402	40403
AI2 Function Block	40410	40411	40412	40413
AI3 Function Block	40420	40421	40422	40423

5.6.4 Function Block Parameters

Function block parameters can be read from the host or can be set. For a list of the parameters of blocks held by the EXA, refer to "List of parameters for each block of the EXA" in Appendix 1. The following is a list of important parameters with a guide how to set them.

MODE_BLK:
This mode parameter is very important as it gives the state of the block. In O/S (Out_Of_Service) mode the block is out of operation. In this mode it is allowed to update parameters. Manual mode gives the operator the possibility to manually update a selected number of parameters (values, scaling e.g.) in order to test the system. In automatic mode the function block is executed and block parameters are automatically updated. Under normal operating circumstances, set the Auto mode for normal operation. Auto mode is the factory default.

Note:
The actual mode is changed by setting the target mode. When the resource block mode is set to OOS all function blocks in the VFD are set to OOS mode.

CHANNEL:
Transducer blocks convert raw signals into process values. The values are assigned to channels. For the EXA 202 SC three channels are available.
1: Conductivity/Resistivity, 2: Temperature,
3: Second Conductivity/Resistivity, 4: Concentration

XD_SCALE/OUT_SCALE:
Scaling information is used for two purposes. Display devices need to know the range for bar graphs and trending, as well as the units code. Control blocks need to know the range to use internally as percent of span, so that the tuning constants may remain dimensionless. This is converted back to a number with units by using the range of OUT_SCALE. The AI block has the parameter XD_SCALE to define the units expected from the transducer.

Transducer scaling (XD_SCALE) is applied to the value from the channel to produce the FIELD_VAL in percent. The XD_SCALE units code must match the channel units code (if one exists), or the block will remain in O/S mode after being configured. A block alarm for units mismatch will be generated.
If L_TYPE is set to Indirect or Ind Sqr Root, OUT_SCALE determines the conversion from FIELD_VAL to the output. PV and OUT always have identical scaling. OUT_SCALE provides scaling for PV. The PV is always the value that the block will place in OUT if the mode is Auto.

Table 5.15 Unit Index by XD_SCALE

SC	Index	Channel
°C	1001	2
°F	1002	2
Ω・cm	1295	1, 3
S/cm	1594	1, 3
%	1342	4

L_TYPE:
Specifies the operation function of the AI block. If set to “Direct”, the input delivered to CHANNEL is directly reflected on OUT. If set to “Indirect”, scaling by XD_SCALE and OUT_SCALE is carried out and is reflected on OUT. If set to “Indirect SQRT”, after scaling by XD_SCALE, the square root is extracted and the value scaled by OUT_SCALE is reflected on OUT.

Example:

Channel range is defined as 0 to 100 °C but °F units is required for HOST display.
Set the following parameters (figure 5.6):

XD_SCALE: EU@0% = 0 °C
EU@0% = 100 °C
Unit = °C
Decimal point = 2

OUT_SCALE: EU@0% = 32 °F
EU@0% = 212 °F
Unit = °F
Decimal point = 2

PV_FTIME:
Sets the time constant of the damping function within AI block (primary delay) in seconds.

Alarm Priority:
Indicates the priority of the process alarm. If a value of 3 or greater is set, an alarm is transmitted.
The factory default is 0.
Four types of alarm can be set:
HI_PRI, HI_HI_PRI, LO_PRI, and LO_LO_PRI.

Alarm Threshold:
Sets the threshold at which a process alarm is generated. The factory default setting is a value that does not generate an alarm.
Four types of alarm can be set:
HI_LIM, HI_HI_LIM, LO_LIM, and LO_LO_LIM.

Equations:

$$\text{FIELD\_VAL} = 100^* \frac{(\text{channel value - EU@0\%})}{(\text{EU@100\% - EU@0\%})}$$

Direct: PV = channel value

$$\text{Indirect: PV} = \text{EU@0\%} + \frac{\text{FIELD\_VAL}}{100} \quad (\text{EU@100\% - EU@0\%})$$

$$\text{Ind Sqr Root: PV} = \text{EU@0\%} + \frac{\text{sqrt FIELD\_VAL}}{100} \quad (\text{EU@100\% - EU@0\%})$$

Figure 5.6 Scaling applied to temperature conversion.

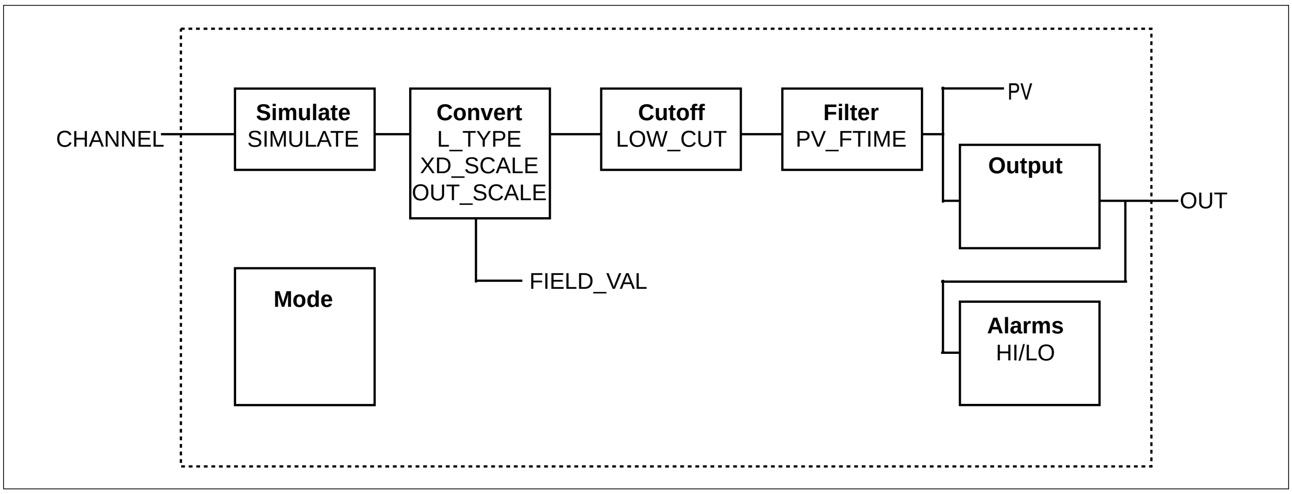
Equations:

$$\text{FIELD\_VAL} = 100 \frac{(\text{channel value - EU@0\%})}{(\text{EU@100\% - EU@0\%})} \qquad \text{[XD\_SCALE]}$$

Direct: PV = channel value

$$\text{Indirect: PV} = \text{EU@0\%} + \frac{\text{FIELD\_VAL}}{100} (\text{EU@100\% - EU@0\%}) \qquad \text{[OUT\_SCALE]}$$

$$\text{Ind Sqr Root: PV} = \text{EU@0\%} + \frac{\sqrt{(\text{FIELD\_VAL})}}{100} (\text{EU@100\% - EU@0\%}) \qquad \text{[OUT\_SCALE]}$$



6. IN-PROCESS OPERATION

This chapter describes the procedure performed when changing the operation of the function block of the EXA in process.

6.1 Mode Transition

When the function block mode is changed to Out_Of_Service, the function block pauses and a block alarm is issued.

When the function block mode is changed to Manual, the function block suspends updating of output values. In this case alone, it is possible to write a value to the OUT parameter of the block for output. Note that no parameter status can be changed.

6.2 Generation of Alarm

6.2.1 Indication of Alarm

Figure 6.1 Error Identification on Indicator

6.2.2 Alarms and Events

Following alarm or event can be reported by EXA as an alert if allowed.

Analog Alerts
(Generated when a process value exceeds threshold)

By AI1 Block	Hi-Hi Alarm, Hi Alarm, Low Alarm, Low-Low Alarm
By AI2 Block	Hi-Hi Alarm, Hi Alarm, Low Alarm, Low-Low Alarm
By AI3 Block	Hi-Hi Alarm, Hi Alarm, Low Alarm, Low-Low Alarm

Discrets Alerts
(Generated when an abnormal condition is detected)

By Resource Block	Block Alarm, Write Alarm
By Transducer Block	Block Alarm
By AI1 Block	Block Alarm
By AI2 Block	Block Alarm
By AI3 Block	Block Alarm

Update Alerts
(Generated when a important (restorable) parameter is updated)

By Resource Block	Update Event
By Transducer Block	Update Event
By AI1 Block	Update Event
By AI2 Block	Update Event
By AI3 Block	Update Event

An alert has following structure:

Table 6.2 Alert Object

Subindex			Parameter Name	Explanation
Analog Alert	Discrete Alert	Update Alert		
1	1	1	Block Index	Index of block from which alert is generated
2	2	2	Alert Key	Alert Key copied from the block
3	3	3	Standard Type	Type of the alert
4	4	4	Mfr Type	Alert Name identified by manufacturer specific DD
5	5	5	Message Type	Reason of alert notification
6	6	6	Priority	Priority of the alarm
7	7	7	Time Stamp	Time when this alert is first detected
8	8		Subcode	Enumerated cause of this alert
9	9		Value	Value of referenced data
10	10		Relative Index	Relative index of referenced data
		8	Static Revision	Value of static revision (ST_REV) of the block
11	11	9	Unit Index	Unit code of referenced data

6.3 Simulation Function

The simulation function simulates the input of a function block and lets it operate as if the data was received from the transducer block. It is possible to conduct testing for the downstream function blocks or alarm processes.

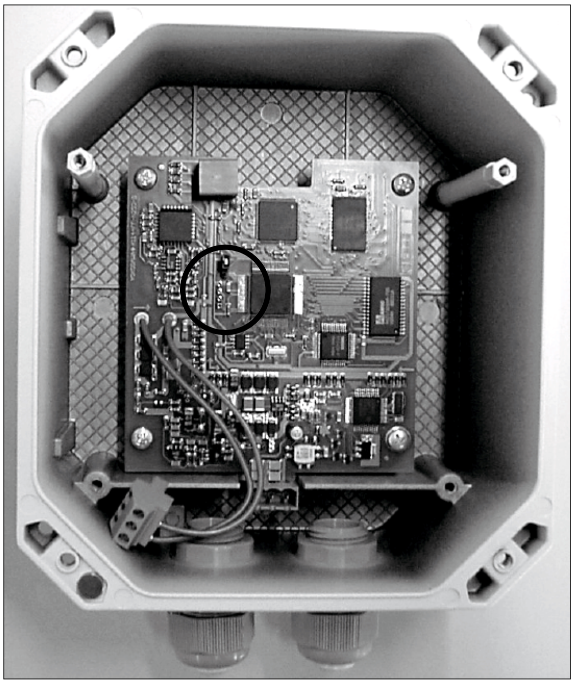
A SIMULATE_ENABLE switch is mounted on the FF PCB assembly. This is to prevent the accidental operation of this function. When this is switched on, simulation is enabled. (See Figure 6.2.) To initiate the same action from a remote terminal, if REMOTE LOOP TEST SWITCH is written to the SIM_ENABLE_MSG parameter (index 1044) of the resource block, the resulting action is the same as is taken when the above switch is on. Note that this parameter value is lost when the power is turned OFF. In simulation enabled status, an alarm is generated from the resource block, and other device alarms will be masked; for this reason the simulation must be disabled immediately after using this function.

The SIMULATE parameter of AI block consists of the elements listed in Table 6.3 below.

Table 6.3 SIMULATE Parameter

Sub-index	Parameters	Description
1	Simulate Status	Sets the data status to be simulated.
2	Simulate Value	Sets the value of the data to be simulated.
3	Transducer Status	Displays the data status from the transducer block. It cannot be changed.
4	Transducer Value	Displays the data value from the transducer block. It cannot be changed.
5	Simulate En/Disable	Controls the simulation function of this block. 1: Simulation disabled (standard) 2: Simulation started

When Simulate En/Disable in Table 6.3 above is set to 2, the applicable function block uses the simulation value set in this parameter instead of the data from the transducer block. This setting can be used for propagation of the status to the trailing blocks, generation of a process alarm, and as an operation test for trailing blocks.



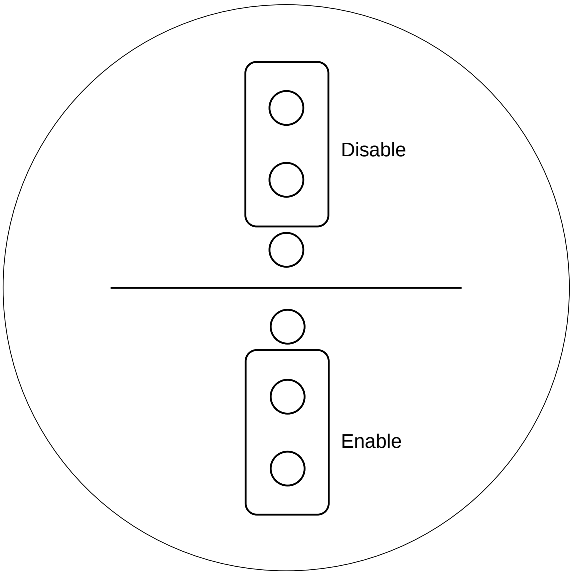


Figure 6.2 SIMULATE_ENABLE Switch Position

7. DEVICE STATUS

Device setting status and failures of EXA are indicated by using parameter DEVICE_STATUS_1, DEVICE_STATUS_2 and DEVICE_STATUS_3 (index 1045, 1046 and 1047) in Resource Block.

Table 7.1 Contents of DEVICE_STATUS_1, DEVICE_STATUS_2 and DEVICE_STATUS_3

Hexadecimal	DEVICE_STATUS_1 Display through DD
0x80000000	
0x40000000	
0x20000000	
0x10000000	
0x08000000	
0x04000000	
0x02000000	
0x01000000	
0x00800000	Sim.enable Jmpr On
0x00400000	RB in O/S mode
0x00200000	
0x00100000	
0x00080000	Fbus EEPROM error
0x00040000	
0x00020000	
0x00010000	
0x00008000	Link Obj.1 not open
0x00004000	Link Obj.2 not open
0x00002000	Link Obj.3 not open
0x00001000	Link Obj.4 not open
0x00000800	Link Obj.5 not open
0x00000400	Link Obj.6 not open
0x00000200	Link Obj.7 not open
0x00000100	Link Obj.8 not open
0x00000080	Link Obj.9 not open
0x00000040	Link Obj.10 not open
0x00000020	Link Obj.11 not open
0x00000010	Link Obj.12 not open
0x00000008	Link Obj.13 not open
0x00000004	Link Obj.14 not open
0x00000002	Link Obj.15 not open
0x00000001	Link Obj.16 not open

Hexadecimal	DEVICE_STATUS_2 Display through DD
0x80000000	
0x40000000	
0x20000000	
0x10000000	
0x08000000	
0x04000000	
0x02000000	
0x01000000	
0x00800000	
0x00400000	
0x00200000	
0x00100000	
0x00080000	FF interface checksum error
0x00040000	EXA checksum error (E21)
0x00020000	Hart communication failure
0x00010000	FF interface eeprom failure
0x00008000	EXA eeprom failure (E20)
0x00004000	mismatch between FF parameter and EXA parameter
0x00002000	
0x00001000	
0x00000800	
0x00000400	
0x00000200	
0x00000100	matrix error (E4)
0x00000080	concentration table error (E18)
0x00000040	conductivity exceeds usp limit (E13)
0x00000020	polarization detected (E1)
0x00000010	temperature compensation error (E2)
0x00000008	temperature sensor shorted (E8)
0x00000004	temperature sensor open (E7)
0x00000002	conductivity exceeds low limit (E6)
0x00000001	conductivity exceeds high limit (E5)

Hexadecimal	DEVICE_STATUS_3 Display through DD
0x80000000	
0x40000000	
0x20000000	
0x10000000	
0x08000000	Transducer Block is in O/S mode
0x04000000	
0x02000000	
0x01000000	
0x00800000	
0x00400000	
0x00200000	
0x00100000	
0x00080000	
0x00040000	
0x00020000	Simulation is enabled in AI3 Function Block
0x00010000	AI3 Function Block is in Manual mode
0x00008000	AI3 Function Block is in O/S mode
0x00004000	Simulation is enabled in AI2 Function Block
0x00002000	AI2 Function Block is in Manual mode
0x00001000	AI2 Function Block is in O/S mode
0x00000800	AI1 Function Block is not scheduled
0x00000400	Simulation is enabled in AI1 Function Block
0x00000200	AI1 Function Block is in Manual mode
0x00000100	AI1 Function Block is in O/S mode
0x00000080	
0x00000040	
0x00000020	
0x00000010	
0x00000008	
0x00000004	
0x00000002	
0x00000001	

APPENDIX 1. LIST OF PARAMETERS FOR EACH BLOCK OF THE EXA

Note: The Write Mode column contains the modes in which each parameter is write enabled.
O/S: Write enabled in O/S mode.
MAN: Write enabled in Man mode and O/S mode.
AUTO: Write enabled in Auto mode, Man mode, and O/S mode.

A1.1 Resource Block

Relative Index	Index	Parameter Name	Factory Default	Write Mode	Explanation
0	1000	Block Header	TAG:“RS”	Block Tag = O/S	Information on this block such as Block Tag, DD Revision, Execution Time etc.
1	1001	ST_REV	–	–	The revision level of the static data associated with the resource block. The revision value is incremented each time a static parameter value in this block is changed.
2	1002	TAG_DESC	Null	AUTO	The user description of the intended application of the block.
3	1003	STRATEGY	1	AUTO	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
4	1004	ALERT_KEY	1	AUTO	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
5	1005	MODE_BLK	AUTO	AUTO	The actual, target, permitted, and normal modes of the block.
6	1006	BLOCK_ERR	–	–	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
7	1007	RS_STATE	–	–	State of the resource block state machine.
8	1008	TEST_RW	Null	AUTO	Read/write test parameter-used only for conformance testing and simulation.
9	1009	DD_RESOURCE	Null	–	String identifying the tag of the resource which contains the Device Description for this resource.
10	1010	MANUFAC_ID	0x00594543	–	Manufacturer identification number-used by an interface device to locate the DD file for the resource.
11	1011	DEV_TYPE	3	–	Manufacturer’s model number associated with the resource-used by interface devices to locate the DD file for the resource.
12	1012	DEV_REV	1	–	Manufacturer revision number associated with the resource-used by an interface device to locate the DD file for the resource.
13	1013	DD_REV	1	–	Revision of the DD associated with the resource-used by an interface device to locate the DD file for the resource.
14	1014	GRANT_DENY	0	AUTO	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
15	1015	HARD_TYPES	Scalar input	–	The types of hardware available as channel numbers. bit0: Scalar input bit1: Scalar output bit2: Discrete input bit3: Discrete output
16	1016	RESTART	–	–	Allows a manual restart to be initiated. Several degrees of restart are possible. They are 1: Run, 2: Restart resource, 3: Restart with initial value specified in FF functional spec. (*1), and 4: Restart processor. *1: FF-891 Foundation TM Specification Function Block Application Process Part 2.
17	1017	FEATURES	Soft write lock supported Report supported	–	Used to show supported resource block options.
18	1018	FEATURE_SEL	Soft write lock supported Report supported	AUTO	Used to select resource block options defined in FEATURES. bit0: Scheduled bit1: Event driven bit2: Manufacturer specified
19	1019	CYCLE_TYPE	Scheduled	–	Identifies the block execution methods available for this resource.
20	1020	CYCLE_SEL	Scheduled	AUTO	Used to select the block execution method for this resource.

Relative Index	Index	Parameter Name	Factory Default	Write Mode	Explanation
21	1021	MIN_CYCLE_T	3200 (100ms)	–	Time duration of the shortest cycle interval of which the resource is capable.
22	1022	MEMORY_SIZE	0	–	Available configuration memory in the empty resource. To be checked before attempting a download.
23	1023	NV_CYCLE_T	0	–	Interval between writing copies of NV parameters to non-volatile memory. Zero means never.
24	1024	FREE_SPACE	0	–	Percent of memory available for further configuration. EXA has zero which means a preconfigured resource.
25	1025	FREE_TIME	0	–	Percent of the block processing time that is free to process additional blocks. EXA does not support this.
26	1026	SHED_RCAS	640000 (2S)	AUTO	Time duration at which to give up on computer writes to function block RCas locations. Supported only with PID function.
27	1027	SHED_ROUT	640000 (2S)	AUTO	Time duration at which to give up on computer writes to function block ROut locations. Supported only with PID function.
28	1028	FAULT_STATE	1	–	Condition set by loss of communication to an output block, failure promoted to an output block or a physical contact. When fail-safe condition is set, Then output function blocks will perform their FSAFE actions.
29	1029	SET_FSTATE	1	AUTO	Allows the fail-safe condition to be manually initiated by selecting Set.
30	1030	CLR_FSTATE	1	AUTO	Writing a Clear to this parameter will clear the device fail-safe state if the field condition, if any, has cleared.
31	1031	MAX_NOTIFY	3	–	Maximum number of unconfirmed notify messages possible.
32	1032	LIM_NOTIFY	3	AUTO	Maximum number of unconfirmed alert notify messages allowed.
33	1033	CONFIRM_TIM	5000 (ms)	AUTO	The minimum time between retries of alert reports.
34	1034	WRITE_LOCK	Not locked	AUTO	If set, no writes from anywhere are allowed, except to clear WRITE_LOCK. Block inputs will continue to be updated
35	1035	UPDATE_EVT	–	–	This alert is generated by any change to the static data.
36	1036	BLOCK_ALM	–	–	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
37	1037	ALARM_SUM	Enable	–	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
38	1038	ACK_OPTION	0xFFFF	AUTO	
39	1039	WRITE_PRI	0	AUTO	Priority of the alarm generated by clearing the write lock.
40	1040	WRITE_ALM	–	–	This alert is generated if the write lock parameter is cleared.
41	1041	ITK_VER	4	–	Version number of interoperability test by Fieldbus Foundation applied to EXA.
42	1042	SOFT_REV		–	EXA software revision number.
43	1043	SOFT_DESC		–	Yokogawa internal use.
44	1044	SIM_ENABLE_MSG	Null	AUTO	Software switch for simulation function.
45	1045	DEVICE_STATUS_1	0	–	Device status (VCR setting etc.)
46	1046	DEVICE_STATUS_2	0	–	Device status (failure or setting error etc.)
47	1047	DEVICE_STATUS_3	0	–	Device status (function block setting.)
48	1048	DEVICE_STATUS_4	0	–	Not used.
49	1049	DEVICE_STATUS_5	0	–	Not used.
50	1050	DEVICE_STATUS_6	0	–	Not used.
51	1051	DEVICE_STATUS_7	0	–	Not used.
52	1052	DEVICE_STATUS_8	0	–	Not used.

A1.2 AI BLOCK

Relative Index	Parameter Name	Factory Default	Write Mode	Explanation
0	Block Header	TAG: “AI1” or “AI2” or “AI3”	Block Tag = O/S	Information on this block such as Block Tag, DD Revision, Execution Time etc.
1	ST_REV	–	–	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
2	TAG_DESC	(blank)	AUTO	The user description of the intended application of the block.
3	STRATEGY	1	AUTO	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
4	ALERT_KEY	1	AUTO	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
5	MODE_BLK	AUTO	AUTO	The actual, target, permitted, and normal modes of the block.
6	BLOCK_ERR	–	–	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
7	PV	–	–	Either the primary analog value for use in executing the function, or a process value associated with it. May also be calculated from the READBACK value of an AO block.
8	OUT	–	Value= MAN	The primary analog value calculated as a result of executing the function.
9	SIMULATE	Disable	AUTO	Allows the transducer analog input or output to the block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status.
10	XD_SCALE	Specified at the time of order	O/S	The high and low scale values, engineering units code, and number of digits to the right of the decimal point used with the value obtained from the transducer for a specified channel. Refer to Table 5.15 for the unit available.
11	OUT_SCALE	Specified at the time of order	O/S	The high and low scale values, engineering units code, and number of digits to the right of the decimal point to be used in displaying the OUT parameter and parameters which have the same scaling as OUT.
12	GRANT_DENY	0	AUTO	Options for controlling access of host computers and local control panels to operating, tuning and alarm parameters of the block.
13	IO_OPTS	0	O/S	Options which the user may select to alter input and output block processing
14	STATUS_OPTS	Propagate Fault Forward	O/S	Options which the user may select in the block processing of status
15	CHANNEL	AI1: 1 AI2: 2	O/S	The number of the logical hardware channel that is connected to this I/O block. This information defines the transducer to be used going to or from the physical world.
16	L_TYPE	Specified at the	MAN	Deterines if the values passed by the transducer time of order block to the AI block may be used directly (Direct) or if the value is in different units and must be converted linearly (Indirect), or with square root (Ind Sqr Root), using the input range defined by the transducer and the associated output range.
17	LOW_CUT	Linear: 0% Square root: 10%	AUTO	Limit used in square root processing. A value of zero percent of scale is used in block processing if the transducer value falls below this limit, in % of scale. This feature may be used to eliminate noise near zero for a flow sensor.
18	PV_FTIME	2sec	AUTO	Time constant of a single exponential filter for the PV, in seconds.
19	FIELD_VAL	–	–	Raw value of the field device in percent of thePV range, with a status reflecting the Transducer condition, before signal characterization (L_TYPE) or filtering (PV_FTIME).
20	UPDATE_EVT	–	–	This alert is generated by any change to the static data.
21	BLOCK_ALM	–	–	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

Relative Index	Parameter Name	Factory Default	Write Mode	Explanation
22	ALARM_SUM	Enable	–	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
23	ACK_OPTION	0xFFFF	AUTO	Selection of whether alarms associated with the block will be automatically acknowledged.
24	ALARM_HYS	0.5%	AUTO	Amount the PV must return within the alarm limits before the alarm condition clears. Alarm Hysteresis is expressed as a percent of the PV span.
25	HI_HI_PRI	0	AUTO	Priority of the high high alarm.
26	HI_HI_LIM	+INF	AUTO	The setting for high high alarm in engineering units.
27	HI_PRI	0	AUTO	Priority of the high alarm.
28	HI_LIM	+INF	AUTO	The setting for high alarm in engineering units.
29	LO_PRI	0	AUTO	Priority of the low alarm.
30	LO_LIM	-INF	AUTO	The setting for the low alarm in engineering units.
31	LO_LO_PRI	0	AUTO	Priority of the low low alarm.
32	LO_LO_LIM	-INF	AUTO	The setting of the low low alarm in engineering units.
33	HI_HI_ALM	–	–	The status for high high alarm and its associated time stamp.
34	HI_ALM	–	–	The status for high alarm and its associated time stamp.
35	LO_ALM	–	–	The status of the low alarm and its associated time stamp.
36	LO_LO_ALM	–	–	The status of the low low alarm and its associated time stamp.

A1.3 TRANSDUCER BLOCK

Index	PARAMETERS NAME	Default	Valid Range	Description
2000	BLOCK HEADER	TAG: "TB"		General information about thefunction block
2001	ST_REV	-	-	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed
2002	TAG_DESC	" "		The user description of the intended application of the block
2003	STRATEGY	0		The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block
2004	ALERT_KEY	1		The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
2005	MODE_BLK	AUT_MODE		The actual, target, permitted, and normal modes of the block
2006	BLOCK_ERR	-		This parameter reflects the error status associated with a block. It is a bit-string, so that multiple errors can be shown
2007	UPDATE_EVT	-		The alert is generated by any change to the static data.
2008	BLOCK_ALM	-		The block alarm is used for all configuration error, hardware connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set Active status in Status attribute.
2009	TRANSDUCER _DIRECTORY			A directory that specifies the number and starting indices of the transducers.
2010	TRANSDUCER _TYPE	Conductivity Transmitter	conductivity	Conductivity transducer block
2011	XD_ERROR	-		The error code in transducer: No failure, Electronics failure, I/O failure, Mechanical failure
2012	COLLECTION_ DIRECTORY	-		A directory that specifies the number, starting indices and DD item Ids of the data collection in each transducer within a transducer block

Index	PARAMETERS NAME	Default	Valid Range	Description
2013	PRIMARY_VALUE _TYPE	conductivity, resistivity	conductivity, resistivity	Type of measurement represented by primary value
2014	PRIMARY_VALUE	-	0 to 2 S/cm	Primary value of the instrument is Conductivity
2015	PRIMARY_VALUE _RANGE	-	0 to 2 S/cm	The range of the instrument
2016	SENSOR_CONST	0	0.01 to 10 cm-1	The conductivity cell has a specific cell constant determined by the dimensions of the cell
2017	CAL_POINT_HI	2	0 to 2 S/cm	Highest calibration point
2018	CAL_POINT_LO	0	0 to 2 S/cm	Lower calibration point
2019	CAL_MIN_SPAN	0,0001	> 0,0001 S/cm	Minimum span between two calibration points
2020	SENSOR_CAL _METHOD	-	1point, 2point	
2021	SENSOR_CAL _DATE	-	till 2104	Date the sensor was last calibrated
2022	SECONDARY _VALUE	-	-30 to 140 ºC , -22 to 284ºF	Temperature value
2023	SECONDARY _VALUE_UNIT	ºC	ºC, ºF	Temperature unit
2024	SENSOR_TEMP _COMP	automatic	Off, manual, automatic	Select off when no temperature compensation is required. Select manual when no temperature element is available and the temperature is stable and select auto when a temperature element is available
2025	SENSOR_TEMP _MAN_VALUE	25	-30 to 140ºC , -20 to 280ºF	manual temperature value
2026	SENSOR_TYPE _TEMP	Pt1000	Pt1000, Pt100, 5k1, 3kBalco, 8k55, 350, NTC10k, 6k8	Temperature element used:
2027	SENSOR_ CONNECTION_ TEMP	2	2	Only 2-wire connections supported
2028	SENSOR_ TYPE_COND	contact 2 -electrode	2-electrode, 4-electrode	Either 2-electrode or 4-electrode contacting conductivity cell can be selected
2029	SENSOR_OHMS	-		Actual cell resistance
2030	XD_MAN_ID	" "		
2031	TEMPERATURE _COEFF	2.1	0 to 10%/ºC (%/ºF)	Process temperature compensation factor
		2032	CONCENTRATION	- Conductivity combined with temperature can be directly related to the concentration. Concentraion is expressed in percentage
2033	TERTIARY_VALUE	-	0 to 2 S/cm	Second compensated conductivity value
2034	REFERENCE_ TEMPERATURE	25	0 to 100 ºC	Conductivity can be process compensated to a standard reference temperature. Mostly 20∞C or 25∞C is used
2035	COMP_METHOD	NaCl	None, NaCl, TC, matrix	Method of process temperature compensation for the primary value
2036	COMP_MATRIX_SEL	HCl	HCl cation (0-80 °C), Ammonia (0-80 °C), Morpholine (0-80 °C), HCl (0-5%,0-60°C) NaOH (0-5%,0-100°C), User defined	When matrix compensation is required one can make a selection out of 4 predefined matrices and one user definable matrix
2037	TERTIARY_COMP _METHOD	None	None, NaCl, TC, matrix	Method of process temperature compensation for the second conductivity value
2038	TERT_TEMPERATURE _COEFF	2.1		Process temperature compensation factor for the second conductivity value

Index	PARAMETERS NAME	Default	Valid Range	Description
2039	ALARM_SUM	-		
2040	DEV_ALARM	-		Device Alarm is used to give the status of the analyser. See separate table for error messages
2041	LOGBOOK1_RESET	Idle	Idle, Reset	Reset the pointer to the first (oldest) event in logbook 1
2042	LOGBOOK1_EVENT	-		Event whereto the pointer is referenced. When parameter is read, the pointer is increased by one.
2043	LOGBOOK2_RESET	Idle	Idle, Reset	Reset the pointer to the first (oldest) event in logbook 2
2044	LOGBOOK2_EVENT	-		Event whereto the pointer is referenced. When parameter is read, the pointer is increased by one
2045	LOGBOOK_CONFIG[16]	-		Per event one can decide whether it should be logged and it which logbook (1 or 2) it should be logged
2046	TEST_1	-		
2047	TEST_2	-		
2048	TEST_3	-		
2049	TEST_4	-		
2050	TEST_5	-		
2051	TEST_6	-		
2052	TEST_7	-		
2053	TEST_8	-		
2054	TEST_9	-		
2055	TEST_10	-		
2056	TEST_11	-		
2057	TEST_12	-		
2058	TEST_13	-		

APPENDIX 2. APPLICATION, SETTING AND CHANGE OF BASIC PARAMETERS

A2.1 Applications and Selection of Basic Parameters

Setting Item (applicable parameters)	Summary
Tag No.	Sets PD Tag and each block tag. Up to 32 alphanumeric characters can be set for both tags. Refer to "Tag and address" in Section 5.4.
Calibration range setup (XD_SCALE)	Sets the range of input from the transducer block corresponding to the 0% and 100% points in operation within the AI1 function block. The calibrated range (0% and 100%) is the factory default setting. Sets the range unit number of decimals required.
Output scale setup (OUT_SCALE)	Sets the scale of output corresponding to the 0% and 100% points in operation within the AI1 function block. It is possible to set a unit and scale that differs from the calibration range. Sets the range unit and the number of decimals required.
Scale range and unit of built-in indicator setup (OUT_SCALE)	The range determined with the output scale becomes the scale and unit of the built-in indicator. Note: If a built-in indicator is available, the lower bound and the upper bound of the range (numeric string excluding the decimal point if it is included) may be set in a range from -19999 to 19999. Down to the third decimal position can be set.
Output mode setup (L_TYPE)	Selects the operation function of the AI function block. It may be chosen from among Direct, Indirect, and IndirectSQRT. Direct: The output of the transducer block is directly output only via filtering without scaling and square root extraction. Indirect: Output processed by proportion at the AI function block. IndirectSQRT: Output processed by square root extraction at the AI function block.
Output signal low cut mode setup (LOW_CUT)	If the output falls below the setting of this parameter, the output is set to Zero. It can be set individually with Direct, Indirect, and IndirectSQRT.
Damping time constant setup (PV_FTIME)	Sets the time constant of the damping (primary delay) function in the AI function block in seconds.
Simulation setup (SIMULATE)	Performs simulation of the AI function block. The input value and status for the calibration range can also be set. It is recommended that this parameter be used for loop checks and other purposes. Refer to "Simulation Function" in Section 6.3.

A2.2 Setting and Change of Basic Parameters

This section describes the procedure taken to set and change the parameters for each block. Obtaining access to each parameter differs depending on the configuration system used.
For details, refer to the instruction manual for each configuration system.

Access the block mode (MODE_BLK) of each block.

↓

Set the Target of block mode (MODE_BLK) to Auto, Man or O/S (*Note 2) according to the Write Mode of the parameter to be set or changed.

↓

When "actual mode" has changed (*Note 1), data associated with the function block can be maintenanced.

↓

back to Auto (*Note 2) .
Set the Target (*Note 1) of block mode

IMPORTANT

Do not turn the power OFF immediately after parameter setting. When the parameters are saved to the EEPROM, the redundant processing is executed for an improvement of reliability. Should the power be turned OFF within 60 seconds after setting of parameters, changed parameters are not saved and may return to their original values.

Note 1: Block mode consists of the following four modes that are controlled by the universal parameter that displays the running condition of each block.
- Target: Sets the operating condition of the block.
- Actual: Indicates the current operating condition.
- Permit: Indicates the operating condition that the block is allowed to take.
- Normal: Indicates the operating condition that the block will usually take.

Note 2: The following are the operating conditions which the individual blocks will take.

	AI Function Block	Transducer Block	Resource Block
Automatic (Auto)	Yes	Yes	Yes
Manual (Man)	Yes		
Out of Service (O/S)	Yes	Yes	Yes

Refer to the "List of parameters for each block of the EXA" for details of the Write Mode for each block.

A2.3 Setting the AI1 Function Block

The AI1 function block outputs the conductivity signals.

(1)Setting the calibration range

The channel (1) associated with the conductivity/resistivity value has a range of 0 to 1,999 S/cm. By default the 0% (Lower range limit) and the 100% (Upper range limit) are set accordingly. The unit is default set to S/cm. The unit should be changed to Ω.cm by changing from conductivity to resistivity mode. Select the correct unit or the block will remain in O/S mode. A block alarm for units mismatch will be generated.

(2)Setting the output scale

As explained in section 5.6.4. the OUT_SCALE can used to convert the channel's value to a different scale (e.g. mV converted to V or °C converted to °F). If the channel's unit (= XD_SCALE unit) is the same as the output unit DO NOT use scaling or let the OUT_SCALE have the same scaling as XD_SCALE. If L_TYPE is set to Indirect or Ind Sqr Root, OUT_SCALE determines the conversion from FIELD_VAL to the output. PV and OUT always have identical scaling. OUT_SCALE provides scaling for PV. The PV is always the value that the block will place in OUT if the mode is Auto.

For AI1 set L_TYPE to Direct

With the EXA, the channel values are displayed on the display indicator, independant of the scaling in the AI blocks.

(3)Setting the output mode

Access the L_TYPE parameter.
Set the output mode.

1: Direct	(Sensor output value)
2: Indirect	(Linear output value)
3: IndirectSQRT	(Square root extraction output value)

(4)Setting the damping time constant

Access the PV_FTIME parameter.
Set the damping time (in seconds).

(5)Simulation

By optionally setting the input value to the calibration range and status, perform simulation of the AI function block.

Access the Simulate Value parameter.
Set an optional input value.

↓

Access the Simulate Status parameter.
Set the status code.

↓

Access the Simulate En/Disable parameter.
Set whether Simulation is enabled or disabled.
2: Enabled
1: Disabled

If simulation is enabled, AI block uses Simulate Status and Simulate Value as the input, and if disabled, the AI block uses Transducer Status and Transducer Value as input.
Refer to Section 6.3 Simulation Function.

A2.4 Setting the AI2 Function Block

The AI2 function block outputs the temperature.

(1)Setting the temperature information

The channel of AI2 function block is default set to channel 2. This channel represents the temperature value in °C units or °F . The XD_SCALE unit should be set accordingly. The range of the channel is –20 to 140 °C (-20 to 280 °F)

Handling of scaling and mode parameters of the block is the same as AI1.

A2.5 Setting the AI3 Function Block

The AI3 function block outputs conductivity/resistivity that is compensated to the second compensation method.

(1)Setting the information

The channel of AI3 function block is set default to channel 3. This channel represents the second compensated conductivity value. The same sensor input value is used and compensated according a second temperature compensation method specified by TERTIARY_COMP_METHOD. The second temperature compensation method is set in 5-2-5. Temperature compensation method.

Handling of scaling and mode parameters of the block is the same as AI1.

A2.6 Setting Concentration to AI block

Channel 4 represents the concentration value. This value is obtained by using the concentration table (service code 35 and 55). By changing the channel of either AI block to channel 4, concentration can be used for scheduled communications.

The SC202 holds 4 channels and 3 AI blocks. Each AI block can be linked to a channel making 3 Process values available for scheduled communication.

Channel 1:	Conductivity / Resistivity (acc. COMP_METHOD)
Channel 2:	Temperature
Channel 3:	Conductivity / Resistivity (acc. TERTIARY_COMP_METHOD)
Channel 4:	Concentration (of first conductivity/resistivity value)

A2.7 Setting the Transducer Block

To access function specifics of the EXA of the transducer block, the DD (Device Description) for EXA needs to have been installed in the configuration tool used. For integration of DD, refer to “Integration of DD” in Section 4.4.

APPENDIX 3. OPERATION OF EACH PARAMETER IN FAILURE MODE

• Following table summarizes the value of EXA parameters when LCD display indicates an Alarm.

error description	**EXA display**	**dev_alarm**	**resource block**	**transducer block**			
			BLOCK_ERR	BLOCK_ERR	XD_ERROR	PV.status	SV.status
conductivity exceeds high limit	E5	0x80000000		INPUT_FAILURE _ERR	MECHANICAL _FAILURE	BAD, SENS _FAIL	
conductivity exceeds low limit	E6	0x40000000		INPUT_FAILURE _ERR	MECHANICAL _FAILURE	BAD, SENS _FAIL	
temperature sensor open	E7	0x20000000		INPUT_FAILURE _ERR	MECHANICAL _FAILURE	BAD, SENS _FAIL	BAD, SENS _FAIL
temperature sensor shorted	E8	0x10000000		INPUT_FAILURE _ERR	MECHANICAL _FAILURE	BAD, SENS _FAIL	BAD, SENS _FAIL
temperature compensation error	E2	0x08000000				BAD, NON_ SPECIFIC	
polarization detected	E1	0x04000000		INPUT_FAILURE _ERR		BAD, NON_ SPECIFIC	
conductivity exceeds usp limit	E13	0x02000000				BAD, NON_ SPECIFIC	
concentration table error	E18	0x01000000				BAD, CONFIG _ERR	
matrix error	E4	0x00800000				BAD, CONFIG _ERR	
not used		0x00400000					
not used		0x00200000					
not used		0x00100000					
not used		0x00080000					
not used		0x00040000					
mismatch between FF interface and EXA parameter		0x00020000		NEEDS_MAINT_	ELECTRONICS NOW_ERR	BAD, DEV _FAIL _FAILURE	BAD, DEV
EXA eeprom failure	E20	0x00010000		NEEDS_MAINT_ NOW_ERR	DATA_INTEGRITY _ERROR	BAD, DEV _FAIL	BAD, DEV _FAIL
FF interface eeprom failure		0x00008000	LOST_STATIC _ERR, LOST_ NV_ERR	NEEDS_MAINT_ NOW_ERR	DATA_INTEGRITY _ERROR	BAD, DEV _FAIL	BAD, DEV _FAIL
Hart communication failure		0x00004000		NEEDS_MAINT_ NOW_ERR	ELECTRONICS _FAILURE	BAD, DEV _FAIL	BAD, DEV _FAIL
EXA checksum error	E21	0x00002000			ELECTRONICS _FAILURE	BAD, DEV _FAIL	BAD, DEV _FAIL
FF interface checksum error		0x00001000					
resource block out of service		0x00000800	OUT_OF_ SERVICE_ERR			BAD, NON _SPECIFIC	BAD, NON _SPECIFIC
transducer block out of service		0x00000400		OUT_OF_ SERVICE_ERR		BAD, OUT_OF_ SERVICE	BAD, OUT_ OF_SERVICE
AI1 out of service		0x00000200					
AI1 in manual mode		0x00000100					
AI1 in simulation mode		0x00000080	SIMULATE_ ACTIVE_ERR				
AI1 not scheduled		0x00000040					
AI2 out of service		0x00000020					
AI2 in manual mode		0x00000010					
AI2 in simulation mode		0x00000008	SIMULATE_ ACTIVE_ERR				
AI3 out of service		0x00000004					
AI3 in manual mode		0x00000002					
AI3 in simulation mode		0x00000001	SIMULATE_ ACTIVE_ERR				

			channel = 1 (AI1)	channel = 2 (AI2)	channel = 3 (AI3)	channel = 4
	TV.status	CONCENTRATION.status	OUT.status	OUT.status	OUT.status	OUT.status
	BAD, SENS _FAIL	BAD, SENS_FAIL	BAD, SENS _FAIL		BAD, SENS_FAIL	BAD, SENS_FAIL
	BAD, SENS _FAIL	BAD, SENS_FAIL	BAD, SENS _FAIL		BAD, SENS_FAIL	BAD, SENS_FAIL
	BAD, SENS _FAIL	BAD, SENS_FAIL	BAD, SENS _FAIL	BAD, SENS_FAIL	BAD, SENS_FAIL	BAD, SENS_FAIL
	BAD, SENS _FAIL	BAD, SENS_FAIL	BAD, SENS _FAIL	BAD, SENS_FAIL	BAD, SENS_FAIL	BAD, SENS_FAIL
	BAD, NON _SPECIFIC	BAD, NON_SPECIFIC	BAD, NON_ SPECIFIC		BAD, NON_ SPECIFIC	BAD, NON_SPECIFIC
	BAD, NON _SPECIFIC	BAD, NON_SPECIFIC	BAD, NON_ SPECIFIC		BAD, NON_ SPECIFIC	BAD, NON_SPECIFIC
	BAD, NON _SPECIFIC	BAD, NON_SPECIFIC	BAD, NON_ SPECIFIC		BAD, NON_ SPECIFIC	BAD, NON_SPECIFIC
	BAD, CONFIG _ERR	BAD, CONFIG_ERR	BAD, CONFIG _ERR		BAD, CONFIG_ ERR	BAD, CONFIG_ERR
	BAD, CONFIG	BAD, CONFIG_ERR	BAD, CONFIG		BAD, CONFIG_	BAD, CONFIG_ERR
	_ERR		_ERR		ERR	
	BAD, DEVL _FAIL	_FAI	BAD, DEV	BAD, DEV_FAIL _FAIL	BAD, DEV_	BAD, DEV_FAIL FAIL
	BAD, DEV _FAIL		BAD, DEV _FAIL	BAD, DEV_FAIL	BAD, DEV_ FAIL	BAD, DEV_FAIL
	BAD, DEV _FAIL		BAD, DEV _FAIL	BAD, DEV_FAIL	BAD, DEV_ FAIL	BAD, DEV_FAIL
	BAD, DEV _FAIL		BAD, DEV _FAIL	BAD, DEV_FAIL	BAD, DEV_ FAIL	BAD, DEV_FAIL
	BAD, DEV _FAIL		BAD, DEV _FAIL	BAD, DEV_FAIL	BAD, DEV_ FAIL	BAD, DEV_FAIL
	BAD, NON_ SPECIFIC		BAD, NON _SPECIFIC	BAD, NON_ SPECIFIC	BAD, NON_ SPECIFIC	BAD, NON_SPECIFIC
	BAD, OUT_ OF_SERVICE		BAD, NON _SPECIFIC	BAD, NON_ SPECIFIC	BAD, NON_ SPECIFIC	BAD, NON_SPECIFIC
			BAD, OUT_OF _SERVICE			
				BAD, OUT_ OF_SERVICE		
					BAD, OUT_ OF_SERVICE	

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