User's Manual

Model SC202G (S) Conductivity and Resistivity Transmitter

EXA

CE

YOKOGAWA ◆

IM 12D7B3-E-E
10th Edition

TABLE OF CONTENTS

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 IEC, American or Canadian 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
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
Range	**0-1000 µS/cm**	max. 1999 mS°C	5.3	"range"
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
Choices				
Communication	enabled	disable HART(R), PH201*B	5.19	SC 60- 62
Burn out	inactive	HI or LO output on fail	5.14- 5.15	SC 32
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
HOLD during maintenance	inactive	HOLD last value or fixed value	5.17, 5.3- 5.4	"hold", SC 50
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
Output in Concentration units	inactive	linearization of output, w% on LCD	5.14 - 5.17	SC 31/35/55

In this manual a sign appears if it concerns the SC202G J-A and SC202S-A/N.

1. INTRODUCTION AND GENERAL DESCRIPTION

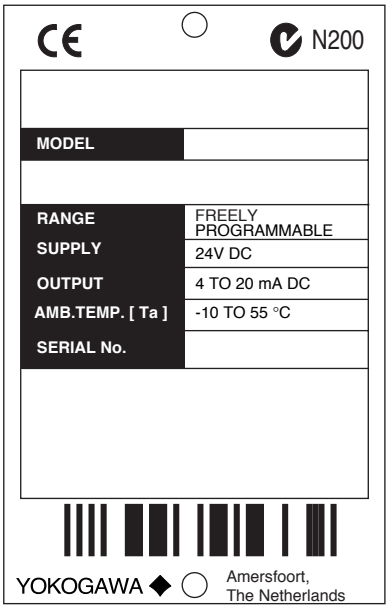
The Yokogawa EXA 202 is a 2-wire transmitter designed for industrial process monitoring, measurement and control applications. This user's manual contains the information needed to install, set up, operate and maintain the unit correctly. This manual also includes a basic troubleshooting guide to answer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

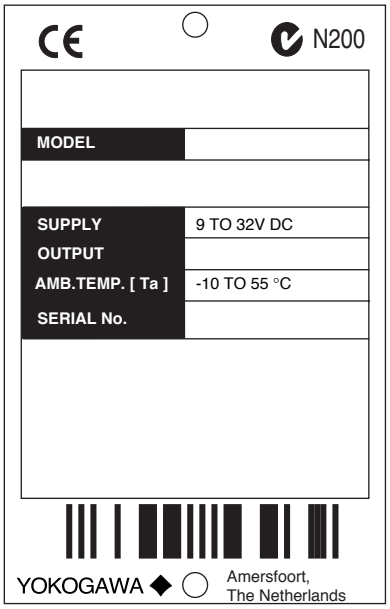
Yokogawa can not be responsible for the performance of the EXA analyzer if these instructions are not followed.

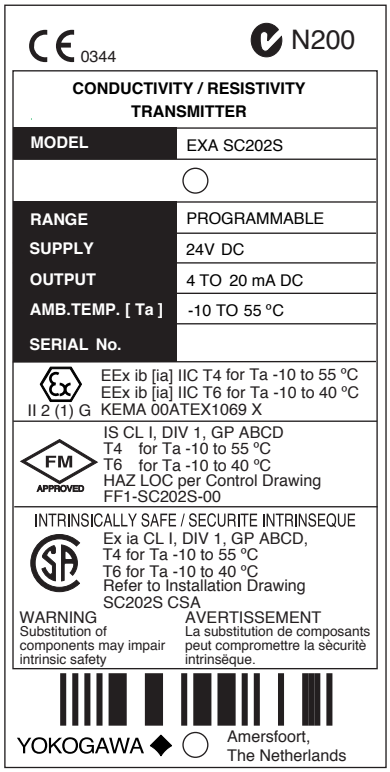
1-1. Instrument check

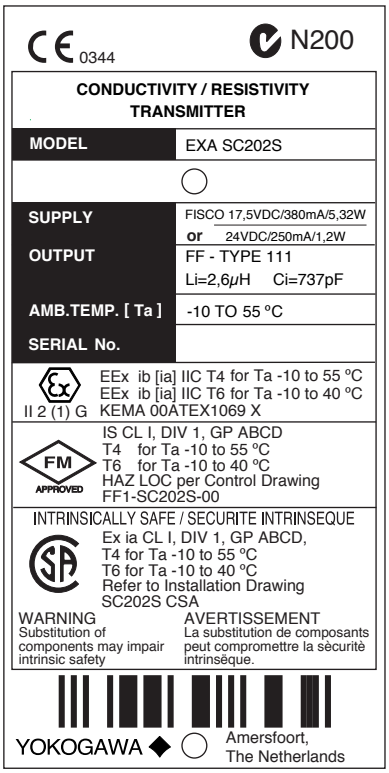
Upon delivery, unpack the instrument carefully and inspect it to ensure that it was not damaged during shipment. If damage is found, retain the original packing materials (including the outer box) and then immediately notify the carrier and the relevant Yokogawa sales office.

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









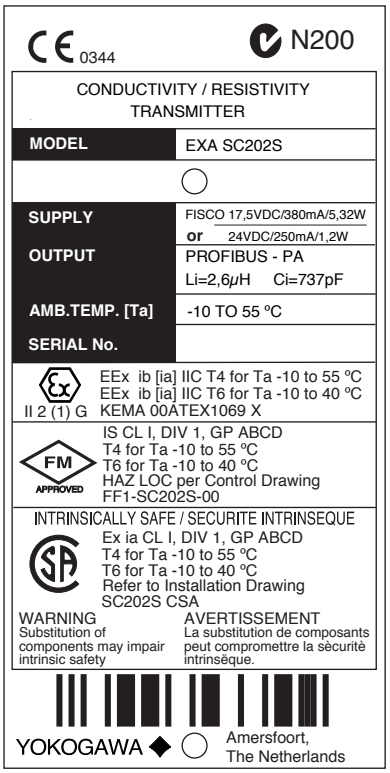


Figure 1-1. Nametplate

NOTE: The nameplate 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)

1-2. Application

The EXA transmitter 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 transmitter 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 transmitter 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 50 metres (150 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 and again in Chapter 11). 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 55082-2, EN55022 Class A 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 60m 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 ∧U - 999] U/C at 25 °C (77 °F) reference temperature.
  - Minimum : 0.002 ∧U/C at process temperature (underrange 0.000 kΩ x cm).
  - Maximum : 5] U/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)

mA D. Output Span

- Conductivity : - min 0.01µS/cm
  : - max. 1999 mS/cm. (max 90% zero suppression)
- Resistivity : - min 0.001kΩxcm
  : - max. 999] U 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 NTC, 8k55 NTC	25 °C (50 °F)	100 °C (200 °F)

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

mA E. Transmission Signal

: Isolated output of 4-20 mA DC . Maximum load 425 Ω. Burn up (22 mA) or Burn down (3.9 mA) or pulse of 22mA to signal failure. See Fig.2-1 and 2-2.

F. Temperature compensation

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

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

G. 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 function of concentration and temperature. Choice out of 5 preprogrammed matrixes and a 25-point user-programmable matrix.

H. Serial Communication

mA : Bi-directional according to HART digital communication super imposed on the 4-20mA signal.

I. Logbook : Software record of important events and diagnostic data. Available through HART interface.

J. Display : Custom liquid crystal display, with a main display of $3^1/_2$ digits 12.5 mm high. Message display of 6 alpha-numeric characters, 7 mm high. Warning flags and units (mS/cm, kΩ.cm, µS/cm and MΩ.cm) as appropriate.

K. Power supply : Nominal 24 volt DC loop powered system.

mA

SC202G ; up to 40 volts
SC202S : up to 31.5 volts

Note: The transmitter contains a switched power supply. The transmitter requires a minimum Power voltage in order to work correctly, which is dependant on the load. Please refer to figures 2-1 and 2-2 for the correct power supply.

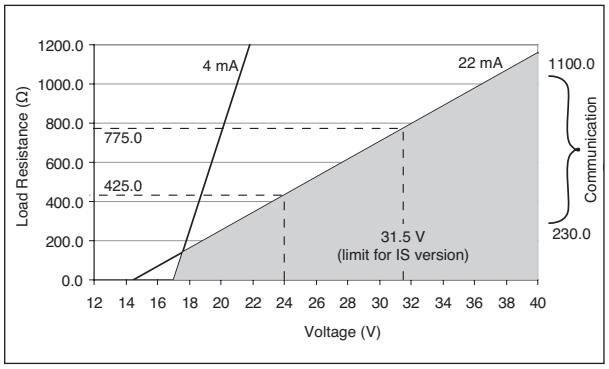


Fig. 2-1. Supply voltage/ load diagram

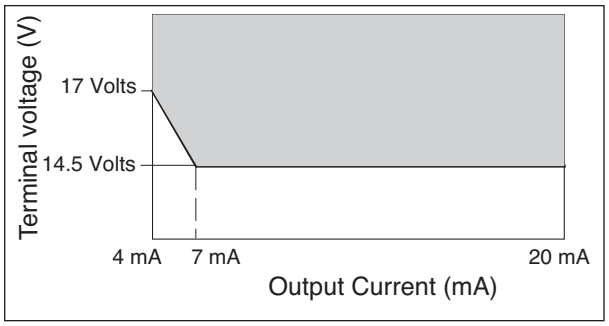


Fig. 2-2. Minimum terminal voltage at the SC202

L. Input isolation : 1000 VDC

M. 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 % ± 0.02 mA

Performance : Resistivity
- Accuracy : ≤ 0.5 % ± 0.02 mA

Performance : Temperature with Pt1000Ω, Ni100Ω and Pb36 NTC
- Accuracy : ≤ 0.3 °C ± 0.02 mA

Performance : Temperature with PT100Ω and 8k55Ω
- Accuracy : ≤ 0.4 °C ± 0.02 mA

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

C. Storage temperature
: -30 to +70 ◦C (-20 to 160 ºF)

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

mA **E. HART specification**
- Min. cable diameter : 0.51 mm, 24 AWG
- Max. cable length : 1500 m

Detailed information can be found at: www.hartcomm.org

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) Intrinsic safety

- ATEX : EEx ib [ia] IIC T4 for Ta -10 to 55 ºC
EEx ib [ia] IIC T6 for Ta -10 to 40 ºC
 II 2 (1) G
KEMA 00ATEX1069 X

- CSA : Ex ia CL I, DIV 1, GP ABCD,
T4 for Ta -10 to 55 ºC
T6 for Ta -10 to 40 ºC
Refer to Installation Drawing SC202S CSA

- FM : IS CL I, DIV 1, GP ABCD
T4 for Ta -10 to 55 ºC
T6 for Ta -10 to 40 ºC
HAZ LOC per Control Drawing FF1-SC202S-00

M) Non-Incendive

- FM : NI CL I, DIV 2, GP ABCD
T4 for Ta -10 to 55 ºC
T6 for Ta -10 to 40 ºC
HAZ LOC per Control Drawing FF1-SC202S-00

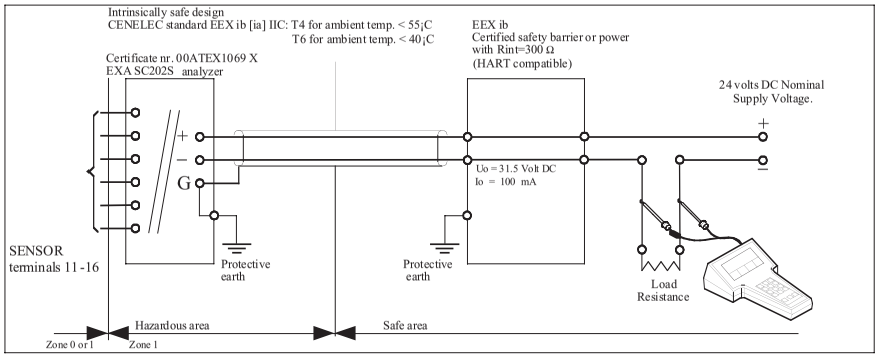
- CSA : NI CL I, DIV 2, GP ABCD
T4 for Ta -10 to 55 ºC
T6 for Ta -10 to 40 ºC
Refer to Installation Drawing SC202S CSA

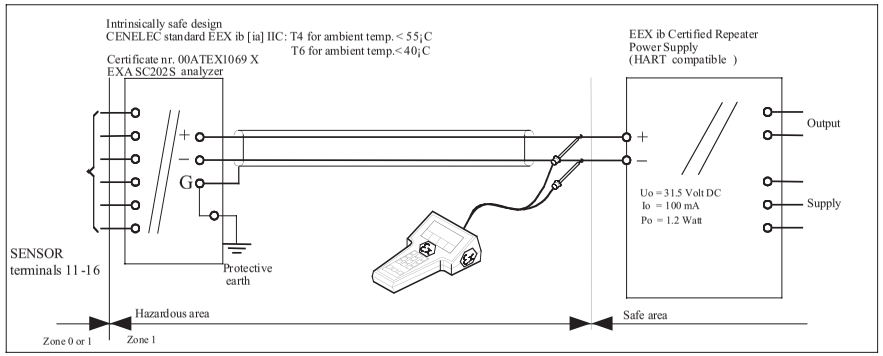
- ATEX : EEx nA [L] IIC T4 for Ta -10 to 55 ºC
EEx nA [L] IIC T6 for Ta -10 to 40 ºC
 II 3 G
KEMA 00ATEX1070 X

N. DD specification : The SC202 Device Description is available enabling communications with the Handheld Communicator (HCC) and compatible devices.

2-3. Model and suffix codes

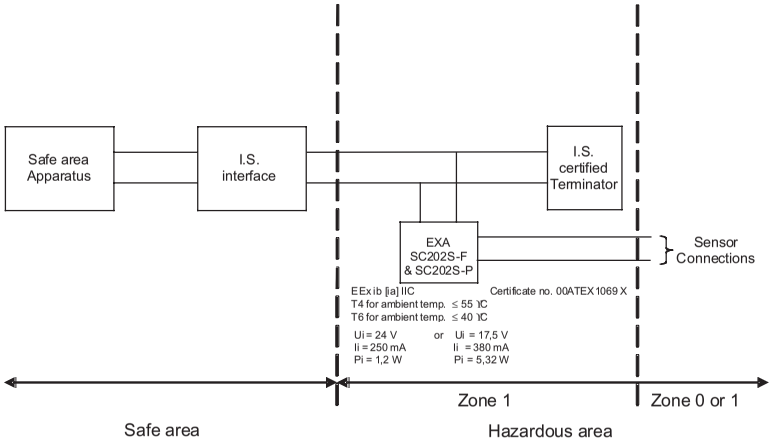
Model	Suffix Code	Option code	Description
SC202G			Conductivity Transmitter, General Purpose version
SC202S			Conductivity Transmitter, Intrinsic Safe version
Type	- A		Milli-amp (+HART) version
	- D		Non incendive profibus PA version
	- P		profibus PA version
	- F		FOUNDATION ® Fieldbus version
	- N		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





- Sensor(s) are of a passive type to be regarded as simple apparatus , devices which comply with clause 1.3 of the EN 50014.
- Electrical data of the EXA SC202S.
  - Supply and output circuit (terminals + and -):
    Maximum input voltage U_i = 31.5 V.
    Maximum input current I_i = 100 mA.
    Maximum input power Pi = 1.2 W
    Effective internal capacitance C_i = 22 nF.
    Effective internal inductance L_i = 22 µH.
  - Sensor input circuit (terminals 11 through 16):
    Maximum output voltage U_o = 14.4 V.
    Maximum output current I_o = 12.8 mA.
    Maximum allowed external capacitance C_o = 103 nF.
    Maximum allowed external inductance L_o = 200 mH.
- Barriers and power supply specification must not exceed the maximum values as shown in the diagram above. These safety descriptions cover most of the commonly used industry standard barriers, isolators and power supplies.
- The Hand Held Communicator must be of a ATEX certified intrinsically safe type in case it is used on the intrinsically safe circuit in the hazardous area or of a ATEX certified non-incendive type in case it is used in the non-incendive circuit in the hazardous area.

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-A**
Title : Control Drawing SC202S Cenelec	
Number : FF1-SC202S-00	**Page : 1 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004



〈 Sensor(s) are of a passive type to be regarded as 'simple apparatus', devices which comply with clause 1.3 of the EN 50014.

〈 Electrical data of the EXA SC202S-F & SC202S-P:

- Supply and output circuit::
  Maximum input voltage Ui=24 V or Maximum input voltage Ui=17.5 V
  Maximum input current Ii=250 mA Maximum input current Ii=380 mA
  Maximum input power Pi=1.2 W Maximum input power Pi=5.32 W

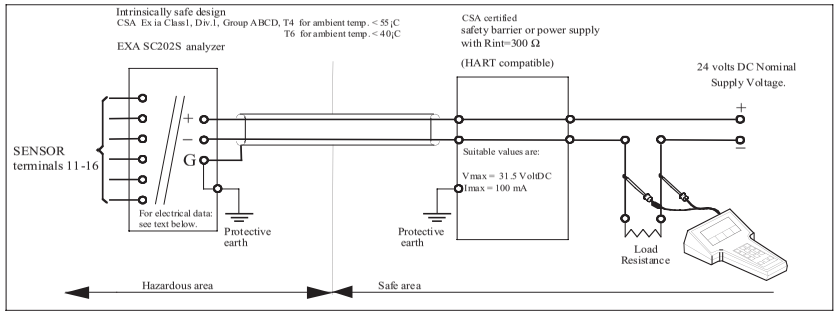
  Effective internal capacitance Ci=737 pF; Effective internal i nductance Li=2.6 µH.

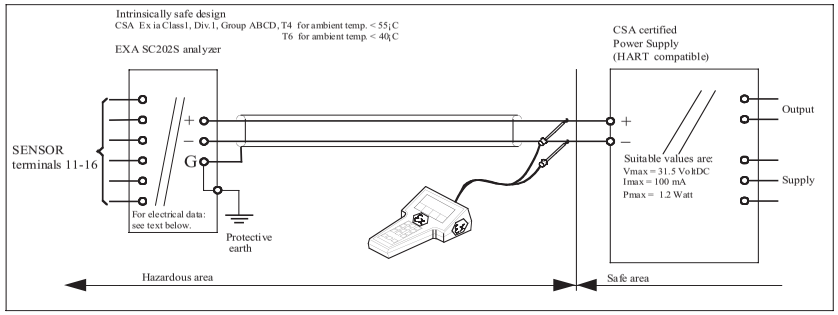
- Sensor input circuit:
  Maximum output voltage Uo=14.4V; Maximum output current Io=12.8 mA
  Maximum allowed external capacitance Co=103 nF
  Maximum allowed external inductance Lo=200 mH

〈 Any I.S. interface may be used that meets the follow ing requirements:
Uo ≤ 24 V or Uo ≤ 17.5 V
Io ≤ 250 mA Io ≤ 380mA
Po ≤ 1.2 W Po ≤ 5.32 W

Ca ? 737 pF + Ccable; La ? 2.6 µH + Lcable

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-F** **Model EXA SC202S-P**
Title : Control Drawing SC202S Cenelec	
Number : FF1-SC202S-00	**Page : 2 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004

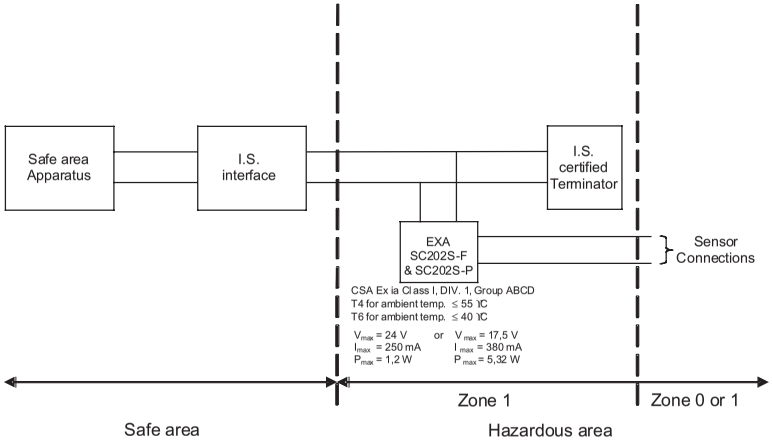




- Sensor is a thermocouples, RTD s, passive resistive switch devices, or is CSA entity approved and meet connection requirements.
- Electrical data of the EXA SC202S :

  - Supply and output circuit (terminals + and -)
  Maximum input voltage V_{max} = 31.5 V.
  Maximum input current I_{max} = 100 mA.
  Maximum input power P_{max} = 1.2 W.
  Effective internal capacitance C_i = 22 nF.
  Effective internal inductance L_i = 22 µH.
  - Sensor input circuit (terminals 11 through 16):
  Maximum output voltage V_{oc} = 14.4 V.
  Maximum output current I_{sc} = 12.8 mA.
  Maximum allowed external capacitance C_a = 103 nF.
  Maximum allowed external inductance L_a = 200 mH.
- Barriers and power supply should be CSA certified. The specifications must not exceed the maximum values as shown in the diagram above. Installation should be in accordance with Canadian Electrical Code, Part I or CEC, Part I.
  Maximum safe area voltage should not exceed 250 V_{RMS}.
  For Class I, Div. 2, Group ABCD the CSA certified barrier is not required, and the Sensor input circuit (terminals 11 through 16) is non-incendive having the parameters :
  Maximum output voltage V_{oc} = 14.4 V.
  Maximum output current I_{sc} = 12.8 mA.
  Maximum allowed external capacitance C_a = 1.4 µF.
  Maximum allowed external inductance L_a = 900 mH.
- The Hand Held Communicator must be of a CSA certified intrinsically safe type in case it is used on the intrinsically safe circuit in the hazardous area, or of a CSA certified non-incendive type in case it is used on the non-incendive circuit in the hazardous area.

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-A** **Model EXA SC202S-N**
Title : Installation Drawing SC202S CSA	
Number : FF1-SC202S-00	**Page : 3 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004



〈 Sensor(s) are a thermocouple, RTD's, passive resistive switch devices, or is CSA entity approved and meet connection requirements.

〈 Electrical data of the EXA SC202S-F & SC202S-P :

- Supply and output circuit::
  Maximum input voltage Vmax=24 V or Maximum input voltage Vmax=17.5 V
  Maximum input current Imax=250 mA Maximum input current Imax=380 mA
  Maximum input power Pmax=1.2 W Maximum input power Pmax=5.32 W

  Effective internal capacitance Ci=737 pF; E ffective internal inductance Li=2.6 µH.

- Sensor input circuit:
  Maximum output voltage Voc=14.4V; Maximum output current Isc=12.8 mA
  Maximum allowed external capacitance Ca=103 nF
  Maximum allowed external inductance La=200 mH

〈 Any CSA approved I.S. interface may be used that meets the following requirements:
Vmax ≤ 24 V or Vmax ≤ 17.5 V
Imax ≤ 250 mA Imax ≤ 380mA
Pmax ≤ 1.2 W Pmax ≤ 5.32 W

Ca ? 737 pF + Ccable; La ? 2.6 µH + Lcable

Installation should be in accordance with Canadian Electrical Code, Par t I or CEC, Part I.
Maximum safe area voltage should not exceed 250 Vrms.

For Class I, Div. 2, Group ABCD the CSA approved I.S. interface is not required, and the sensor input circuit is non-incendive having the parameters:
Maximum output voltage Voc=14.4V; Maximum output current Isc=12.8 mA
Maximum allowed external capacitance Ca=1.4 µF
Maximum allowed external inductance La=900 mH

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-F** **Model EXA SC202S-B** **Model EXA SC202S-P** **Model EXA SC202S-D**
Title : Installation Drawing SC202S CSA	
Number : FF1-SC202S-00	**Page : 4 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004

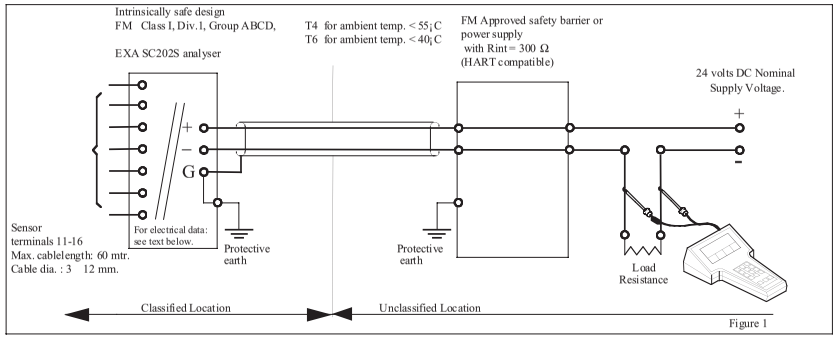


Figure 1

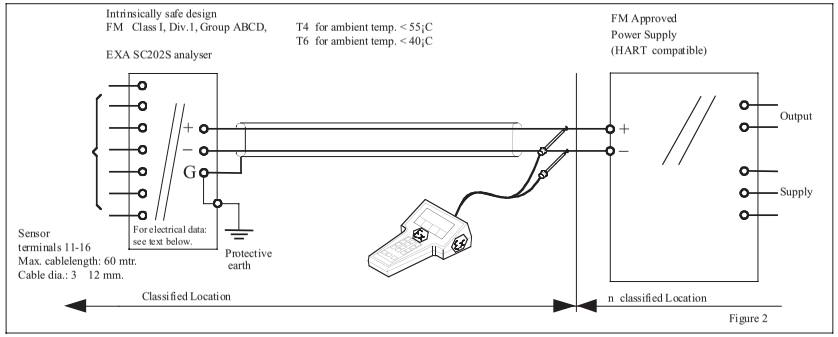


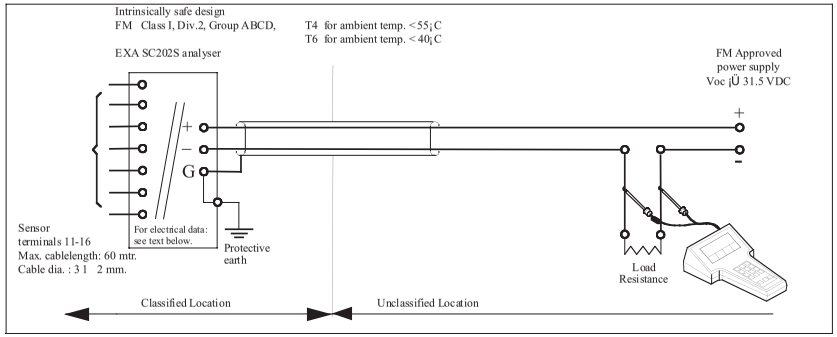
Figure 2

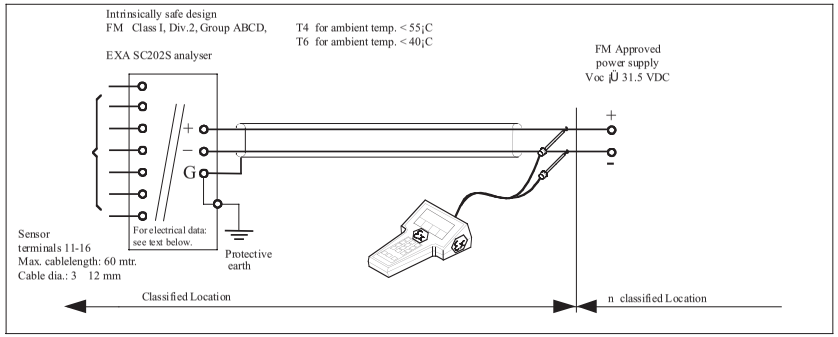
- Electrical data of the EXA SC202S :
  - Supply circuit (terminals + and -):
    Maximum input voltage V_{max} = 31.5 V.
    Maximum input current I_{max} = 100 mA.
    Maximum input power P_i = 1.2 W.
    Effective internal capacitance C_i = 22 nF.
    Effective internal inductance L_i = 22 µH.
  - Sensor input circuit (terminals 11 through 16):
    Maximum output voltage V_t = 14.4 V.
    Maximum output current I_t = 12.8 mA.
    Maximum allowed external capacitance C_a = 103 nF.
    Maximum allowed external inductance L_a = 200 mH.
- If Hand Held Terminal (HHT) is not connected to the power supply lines of the EXA SC202S (see figure 1):
  Any FM Approved barrier or power supply may be used that meets the following requirements.
  V_{oc} or $V_t \leq$ 31.5 V; I_{sc} or $I_t \leq$ 100 mA; $C_a \geq$ 22nF + C_{cable} ; $L_a \geq$ 22µH + L_{cable}
  If HHT is connected to the power supply lines of the EXA SC202S (see figure 2):
  The Hand Held Terminal must be FM Approved. Refer to the manufacturers control drawing of the HHT and the barrier/power supply to determine the cable parameters.
  (V_{oc} or V_t) + $V_{HHT} \leq$ 31.5 V; (I_{sc} or I_t) + $I_{HHT} \leq$ 100 mA; $C_a \geq$ 22nF + C_{cable}+ C_{HHT} ; $L_a \geq$ 22µH + L_{cable}+ L_{HHT}

  When installing this equipment, follow the manufacturer s installation drawing.
  Installation should be in accordance with ANSI/ISA RP 12.06.01 Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations and the National Electrical Code (ANSI/NFPA 70).
  Control equipment connected to the barrier/power supply must not use or generate more than 250 Vrms or Vdc.
- Resistance between Intrinsically Safe Ground and earth ground must be less than 1.0 Ohm.

WARNING
- Substitution of components may impair Intrinsic Safety
- To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing or read, understand and adhere to the manufacturer s live maintenance procedures.

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-A** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing SC202S-A (Intrinsic Safety)	
Number : FF1-SC202S-00	**Page : 5 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004

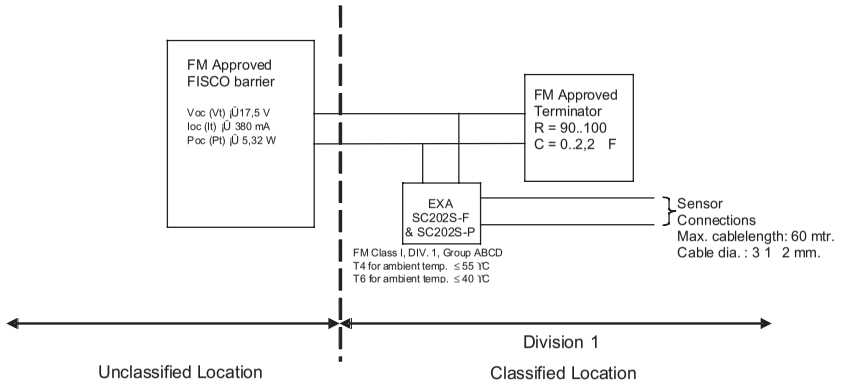




- Electrical data of the EXA SC202S :
  - Supply circuit (terminals + and -):
    Maximum input voltage V_{max} = 31.5 V.
    Maximum input power Pi = 1.2 W
    Effective internal capacitance Ci = 22 nF
    Effective internal inductance Li = 22 H
  - Sensor input circuit (terminals 11 through 16):
    Maximum output voltage V_t = 14.4 V.
    Maximum output current I_t = 12.8 mA.
    Maximum allowed external capacitance C_a = 1,4 F.
    Maximum allowed external inductance L_a = 900 mH.
- The Hand Held Terminal must be FM Approved in case it is used in the classified location.
  When installing this equipment, follow the manufacturers installation drawing. Installation shall be in accordance with Article 501.4(B) of the National Electrical Code (ANSI/NFPA 79).
  Nonincendive field wiring may be installed in accordance with Article 501.4(B)(3)
- Grounding shall be in accordance with Article 250 of the National Electrical code

WARNING
- Substitution of components may impair suitability for Division 2
- Do not remove or replace while circuit is live unless area is know to be non-hazardous
- Explosion Hazard — Do not disconnect equipment unless area is know to be non-hazardous
- Do not reset circuit breaker unless power has been removed from the equipment or the area is know to be non-hazardous

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-N** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing SC202S-N (Non-incendive)	
Number : FF1-SC202S-00	**Page : 6 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004



〈 Sensor(s) are of a passive type to be regarded as 'simple apparatus', devices which neither store nor generate voltages over 1.5 V, currents over 0.1 A, power over 25 mW or energy over 20 µJ, or are FM Approvals entity approved and meet connection requirements.

〈 Electrical data of the EXA SC202S-F & SC202S-P:
- Supply circuit: Vmax=17,5 V; Imax=380 mA; Pi=5,32 W; Ci=737 pF; Li=2.6 µH.
- Sensor input circuit: Vt=14.4 V; It=12.8 mA; Ca=103 nF; La=200 mH

〈 Any FM Approved FISCO barrier may be used that meets the following requirements:
Voc or Vt ≤ 17,5 V; Ioc or It ≤ 380 mA; Poc or Pt ≤ 5,32 W
When installing this equipment, follow the manufacturer s installation drawing.
Installation should be in accordance with ANSI/ISA RP 1 2.06.01 Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations and the National Electrical Code (ANSI/NFPA 70).
Associated apparatus connected to the FISCO barrier must not use or generate more than 250 Vrms or Vdc.

〈 Resistance between FISCO Intrinsically Safe Ground and earth ground must be less than 1.0 Ohm.

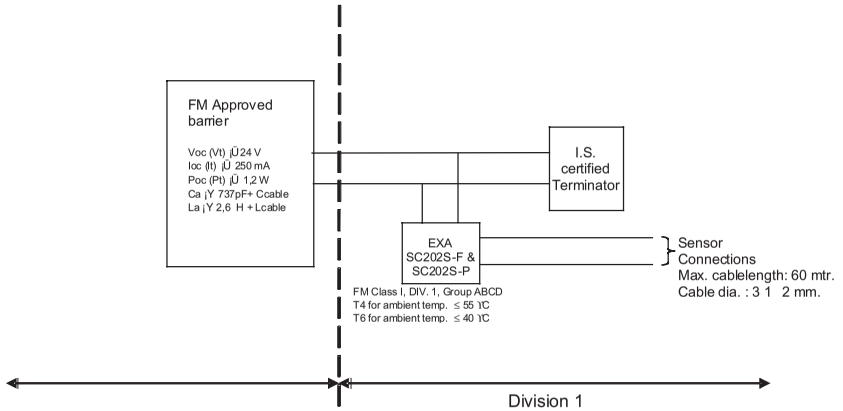
〈 The FISCO concept allows the interconnection of several I.S. apparatus not specifically examined in such combination. The criterion for such interconnection is that the volt age (Vmax), the current (Imax) and the power (Pi) which I.S. apparatus can receive and remain intrinsically safe, considering faults, must be equal to or greater that the voltage (Voc, Vt), the current (Ioc, It) and the power (Poc, Pt) which can be provide de by the FM approved FISCO barrier. In addition, the maximum unprotected residual capacitance (Ci) and inductance (Li) of each apparatus (other than the terminator) connected to the Fieldbus must be less than or equal to 5nF and 10 H respectively.

〈 In each I.S. Fieldbus segment only one active source, normally the FM Approved FISCO barrier, is allowed to provide the necessary power for the Fieldbus system. All other equipment connected to the bus cable has to be passive (not providing energy to the system) , except to a leakage current of 50 A for each connected device. Seperately powered equipment needs a galvanic isolation to insure that the I.S. Fieldbus circuit remains passive.

〈 The cable used to interconnect the devices needs to comply with the following parameters:
Loop resistance R : 15 1 50 /km; Inductance per unit length L : 0,4 1 mH/km
Capacitance per unit length C : 80 200 nF/km
(C = C line/line + 0,5 C line/screen if both line are floating)
(C = C line/line + C line/screen if the screen is connected to one line)
Length of spur cable: max. 30 m
Length of trunk cable: max. 1 km
Length of splice : max. 1 m

WARNING
- Substitution of components may impair Intrinsic Safety
- To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing or read, understand and adhere to the manufacturer s live maintenance procedures.

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-F** **Model EXA SC202S-P** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing SC202S-F & SC202S-P (Intrinsic safe Fisco concept)	
Number : FF1-SC202S-00	**Page : 7of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004



〈 Sensor(s) are of a passive type to be regarded as 'simple apparatus', devices which neither store nor generate voltages over 1. 5 V, currents over 0.1 A, power over 25 mW or energy over 20 µJ, or are FM Approvals entity approved and meet connection requirements.

〈 Electrical data of the EXA SC202S -F & SC202S-P :
- Supply circuit:
  Maximum input voltage Vmax=24 V
  Maximum input current Imax=250 mA
  Maximum input power Pi=1.2 W
  Effective internal capacitance Ci=73 7 pF; Effective internal inductance Li=2.6 µH.
- Sensor input circuit:
  Maximum output voltage Vt=14.4 V; Maximum output current It= 12.8 mA
  Maximum allowed external capacitance Ca= 103 nF
  Maximum allowed external inductance La= 200 mH

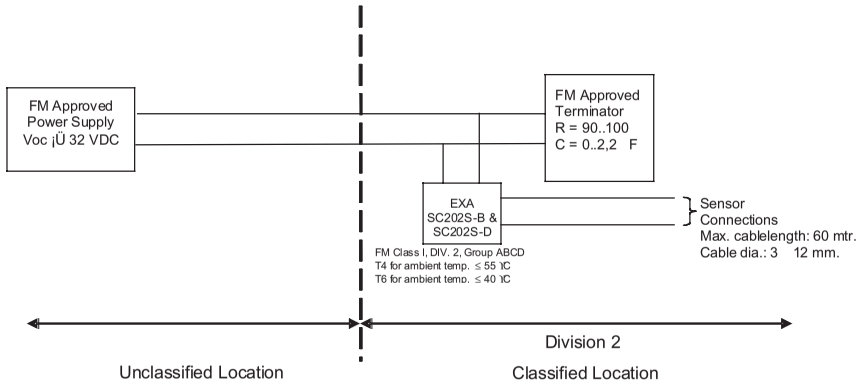
〈 Any FM Approved barrier may be used that meets the following requirements:
Voc or Vt ≤ 24 V
Ioc or It ≤ 250 mA
Poc or Pt ≤ 1.2 W
Ca ? 737 pF + Ccable; La ? 2.6 µH + Lcable

When installing this equipment, follow the manufacturer s installation drawing.
Installation should be in accordance with ANSI/ISA RP 12.06.01 Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations and the National Electrical Code (ANSI/NFPA 70).
Associated apparatus connected to the barrier must not use or generate more than 250 Vrms or Vdc.

〈 Resistance between Intrinsically Safe Ground and earth ground must be less than 1.0 Ohm.

WARNING
- Substitution of components may impair Intrinsic Safety
- To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing or read, understand and adhere to the manufacturer s live maintenance procedures.

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-F** **Model EXA SC202S-P** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing SC202S-F & SC202S-P (Intrinsic safe Entity concept)	
Number : FF1-SC202S-00	**Page : 8 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004



〈 Sensor(s) are of a passive type to be regarded as 'simple apparatus', devices which neither store nor generate voltages over 1.5 V, currents over 0.1 A, power over 25 mW or energy over 20 µJ, or are FM Approvals entity approved and meet connection requirements.

〈 Electrical data of the EXA SC202S-B & SC202S-D:
- Supply circuit: Vmax=32 V; Pi=1.2 W; Ci= 737 pF; Li= 2.6 H
- Sensor input circuit: Vt=14.4 V; It=12.8 mA; Ca=1.4 F; La=900 mH

When installing this equipment, follow the manufacturers installation drawing.
Installation shall be in accordance with Article 501.4(B) of the National Electrical Code (ANSI/NFPA 79).
Nonincendive field wiring may be installed in accordance with Article 501.4(B)(3)

〈 Grounding shall be in accordance with Article 250 of the National Electrical code.

WARNING
- Substitution of components may impair suitability for Division 2.
- Do not remove or replace while circuit is live unless area is know to be non -hazardous
- Explosion Hazard —Do not disconnect equipment unless area is know to be non -hazardous
- Do not reset circuit breaker unless power has been removed from the equipment or the area is know to be non - hazardous

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA SC202S-B** **Model EXA SC202S-D** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing SC202S-B & SC202S-D (Non-incendive Entity concept)	
Number : FF1-SC202S-00	**Page : 10 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 2.4**
	Date : 26/07/2004

3. INSTALLATION AND WIRING

3-1. Installation and dimensions

3-1-1. Installation site

The EXA transmitter 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 transmitter. In any case, the cable length should not exceed 60 meters (200 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 transmitter 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)

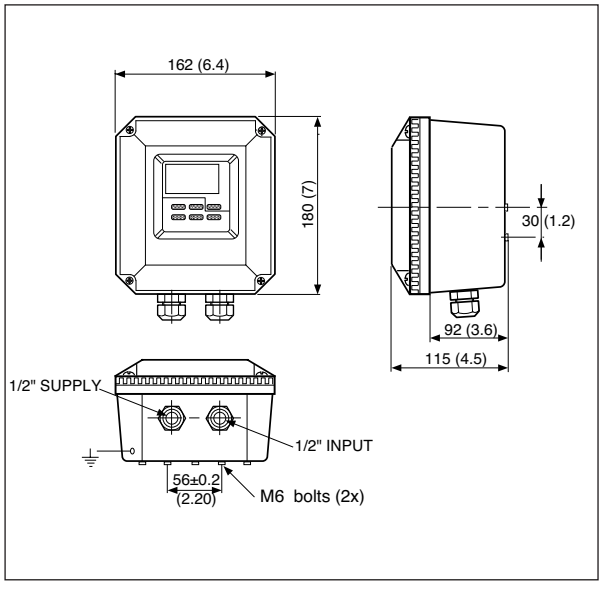


Fig. 3-1. Housing dimensions and layout of glands

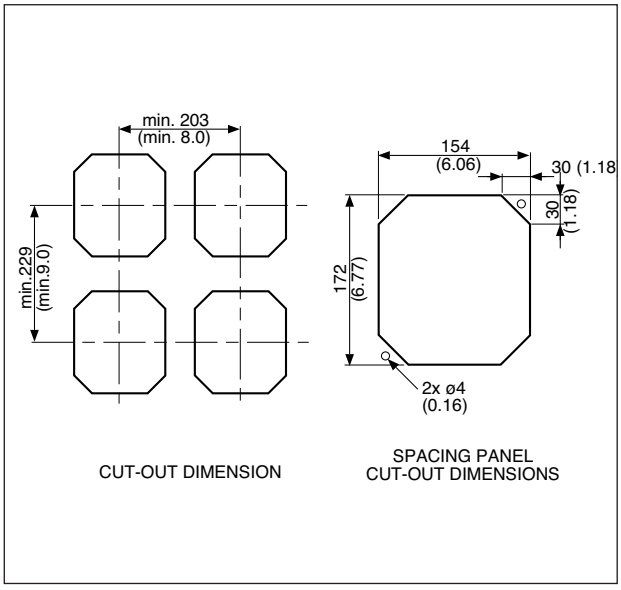


Fig. 3-2. Panel mounting diagram

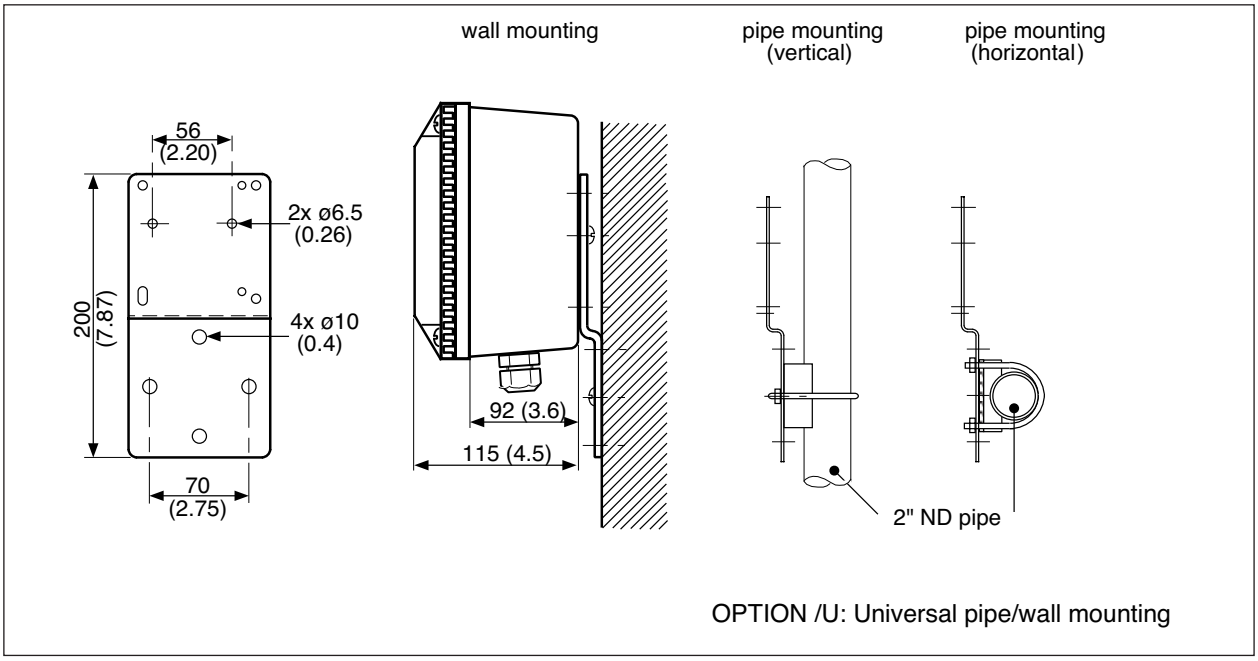


Figure 3-3. Wall and pipe mounting diagram

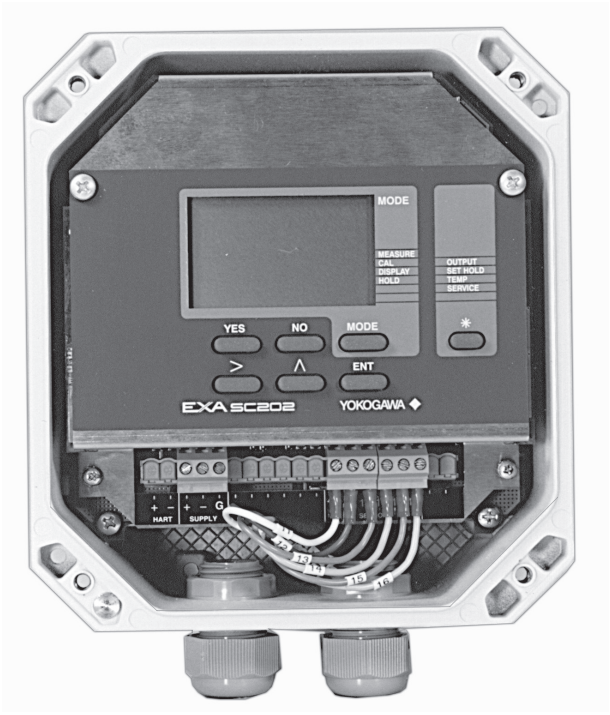


Figure 3-4. Internal view of EXA wiring compartment

mA

3-2. Preparation

Refer to figure 3-4. The power/output connections and the sensor connections should be made in accordance with the diagram on page 3-6. 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.
3. Connect the power supply. Use the gland on the left for this cable.
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).

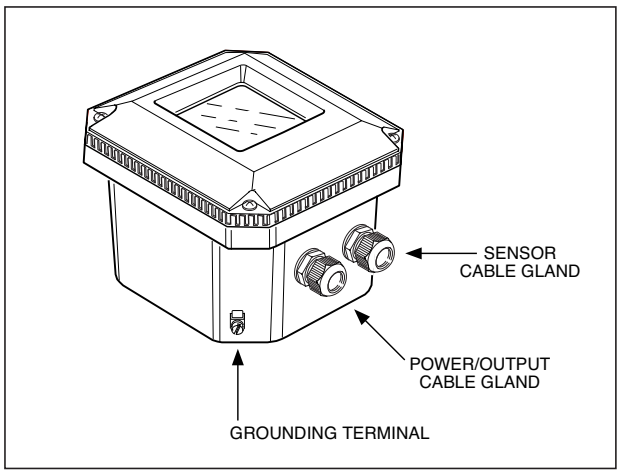


Figure 3-5. Glands to be used for cabling

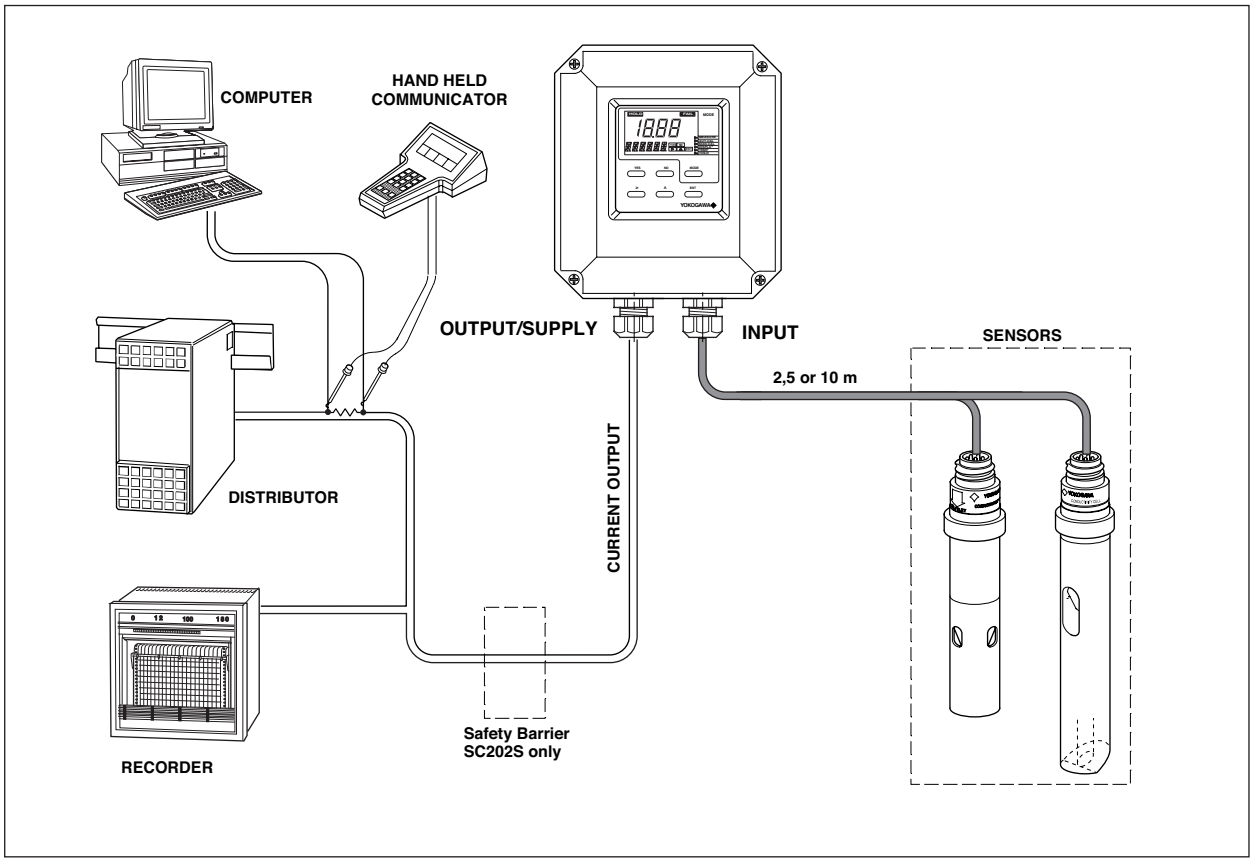


Figure 3-6. System configuration

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 50m WF10 extension cable.
– the setup is kept flexible for easy insertion and retraction of the sensors in the fitting.

3-3-2. Additional precautions for installations in hazardous areas - Intrinsic safe

Make sure that the total of capacitances and inductances connected to the input terminals of the EXA SC202S do not exceed the limits given in the certificate.
This sets a limit to the cable and extensions used.

– The intrinsic safe version of the EXA 202 instrument can be mounted in Zone 1.
– The sensors can be installed in Zone 0 or Zone 1 if a safety barrier according to the limits given in the system certificate is used.
– Ensure that the total of capacitances and inductances connected to the terminals of the EXA SC202 do not exceed the limits given in the certificate of the safety barrier or distributor.
– The cable used should preferably have a BLUE colour or marking on the outside.
– Installation for (sensors in Zone 0 or 1):
  Generally, the distributor with input/output isolation has no external earth connection. If there is an earth connection on the distributor and the external connection of the transmitter is connected to “protective” earth, the shield of the 2-wire cable may NOT be connected to “protective” earth at the distributor too.

3-3-3. Installation in: Hazardous Area-Non-Incendive

The SC202S-N may be installed in a Category 3/ Zone 2/ Div.2 area without the use of safety barriers. Maximum permissible supply voltage 31.5V

3-4. Wiring of power supply

3-4-1. General precautions

Do not activate the power supply yet. First make sure that the DC-power supply is according to the specifications given.

mA WARNING DO NOT USE ALTERNATING CURRENT OR MAINS POWER SUPPLY! !

The cable leading to the distributor (power supply) or safety barrier transports power to and output signal from the transmitter. Use a two conductor shielded cable with a size of at least 1.25 mm^2 and an outside diameter of 7 to 12 mm. The cable gland supplied with the instrument accepts these diameters. The maximum length of the cable is 2000 metre, or 1500 metres when using the communications. This ensures the minimum operating voltage for the instrument.

Grounding:

- If the transmitter is mounted on a grounded surface (e.g. a metal frame fixed in the soil) the shield of the 2-wire cable may NOT be connected to ground at the distributor.
- If the transmitter is mounted on a non-conducting surface (e.g. a brick wall) it is recommended to ground the shield of the 2-wire cable at the distributor end.

3-4-2. Connection of the power supply

The terminal strip is accessed as was described in section 3-2-1. Use the left-hand gland to insert the supply/
output cable to the transmitter. Connect the supply to the terminals marked +, - and G as is indicated in figures 3-11.

mA 3-4-3. Switching the instrument on

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

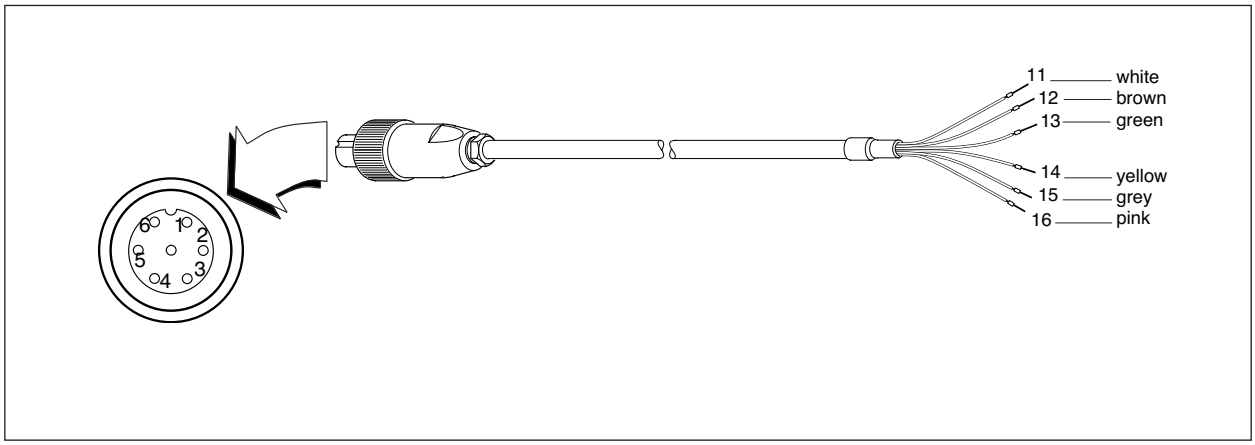


Fig. 3-7. Connection diagrams

3-5. 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-LHhh 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.

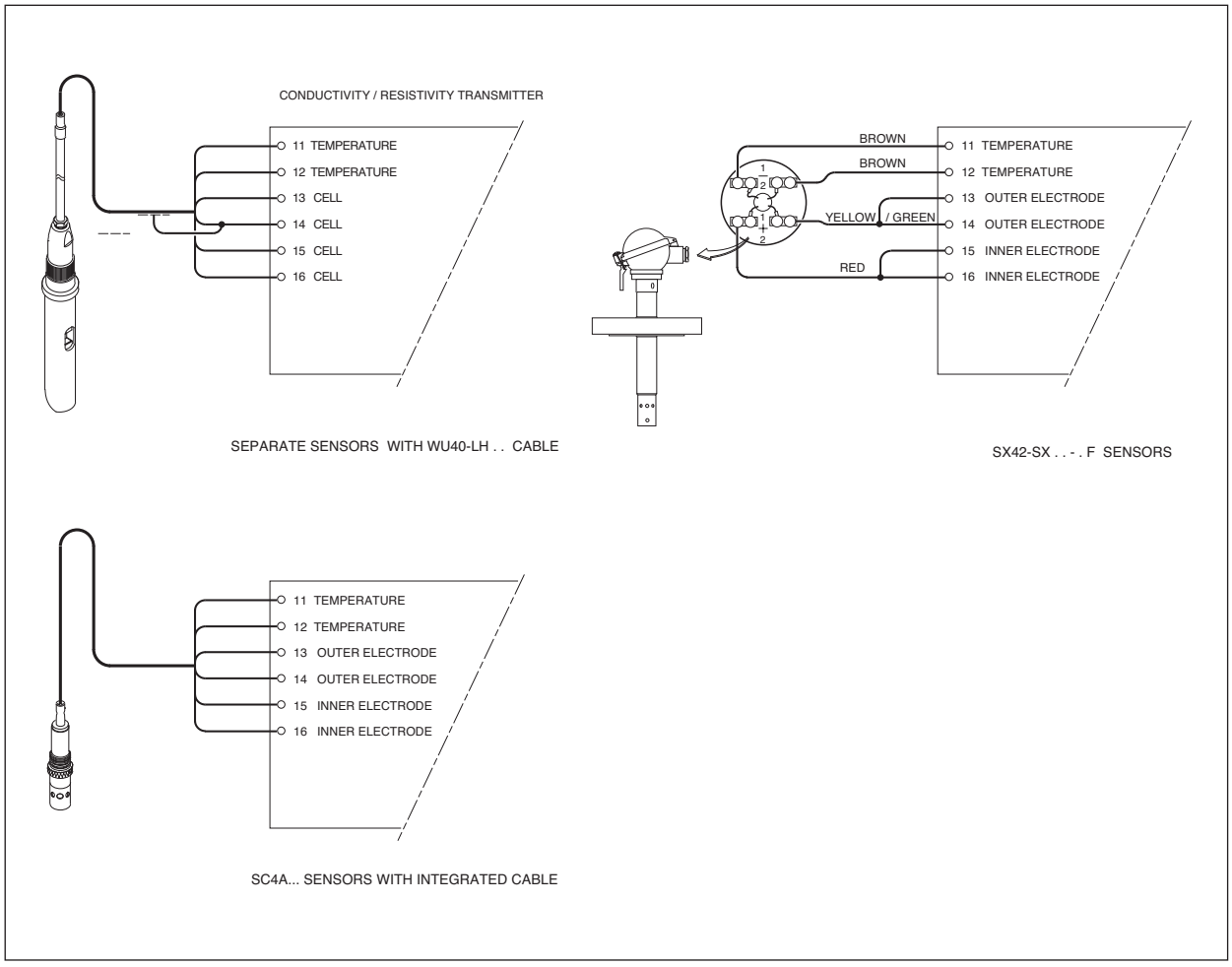


Figure 3-9. Sensor wiring diagrams

3-7. 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.

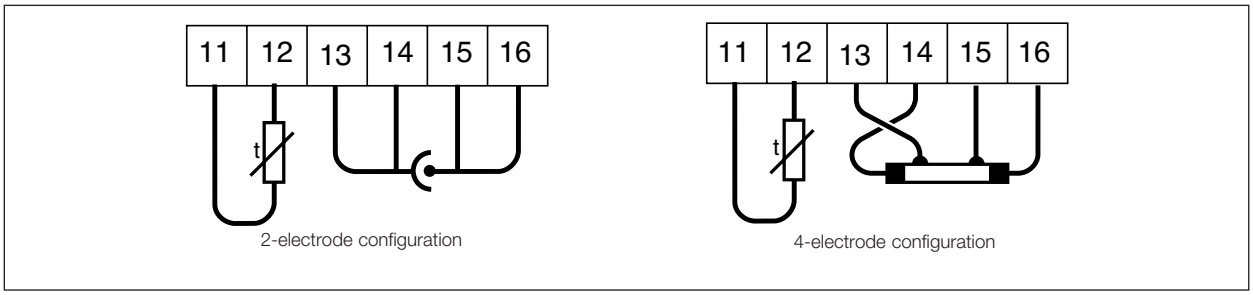


Figure 3-10. Connection diagram for other sensors

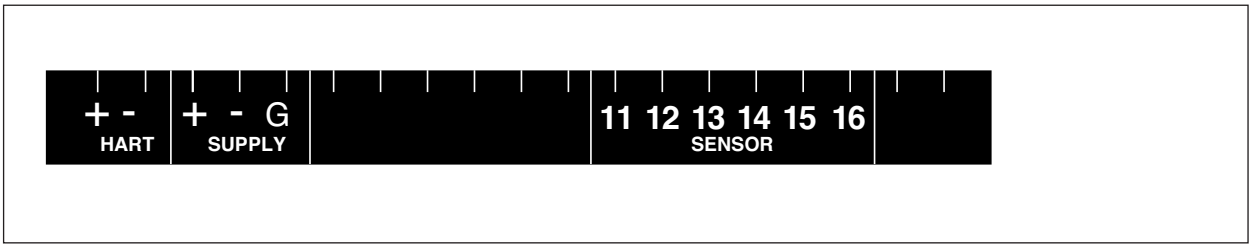


Figure 3-11. Terminal identification label

3-7-1. Sensor cable connections using junction box (BA10) and extension cable (WF10)

Where a convenient installation is not possible using the standard cables between sensors and transmitter, 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 are not compromised. The total cable length should not exceed
60 metres (e.g. 5 m fixed cable and 55 m extension cable).

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

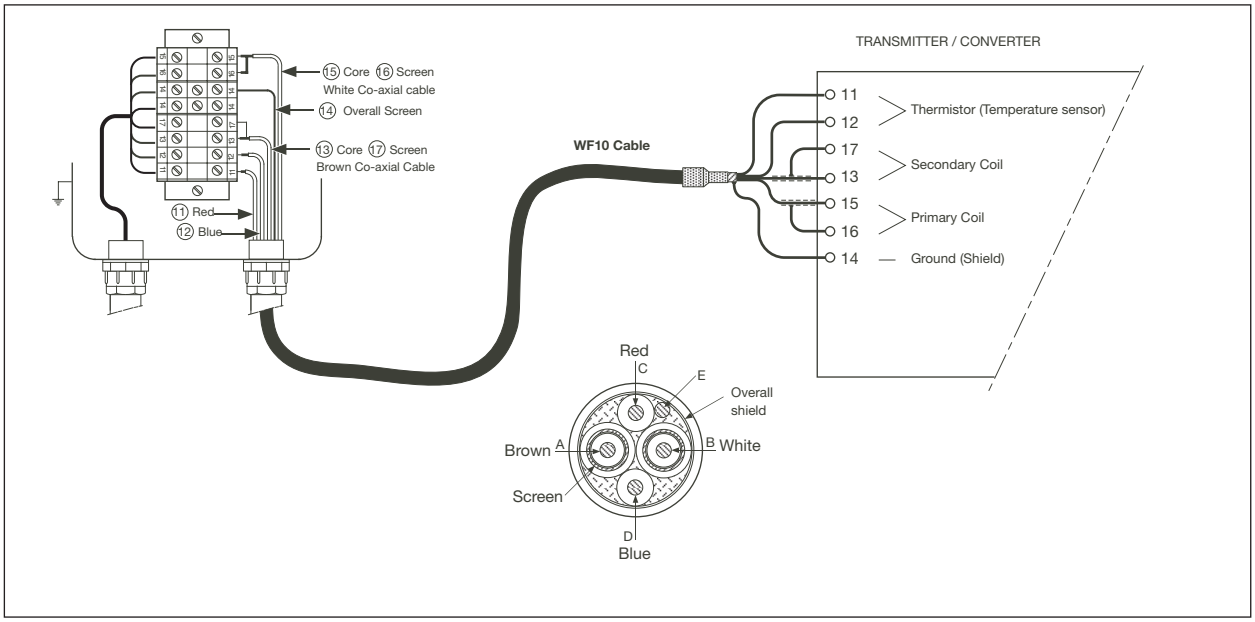
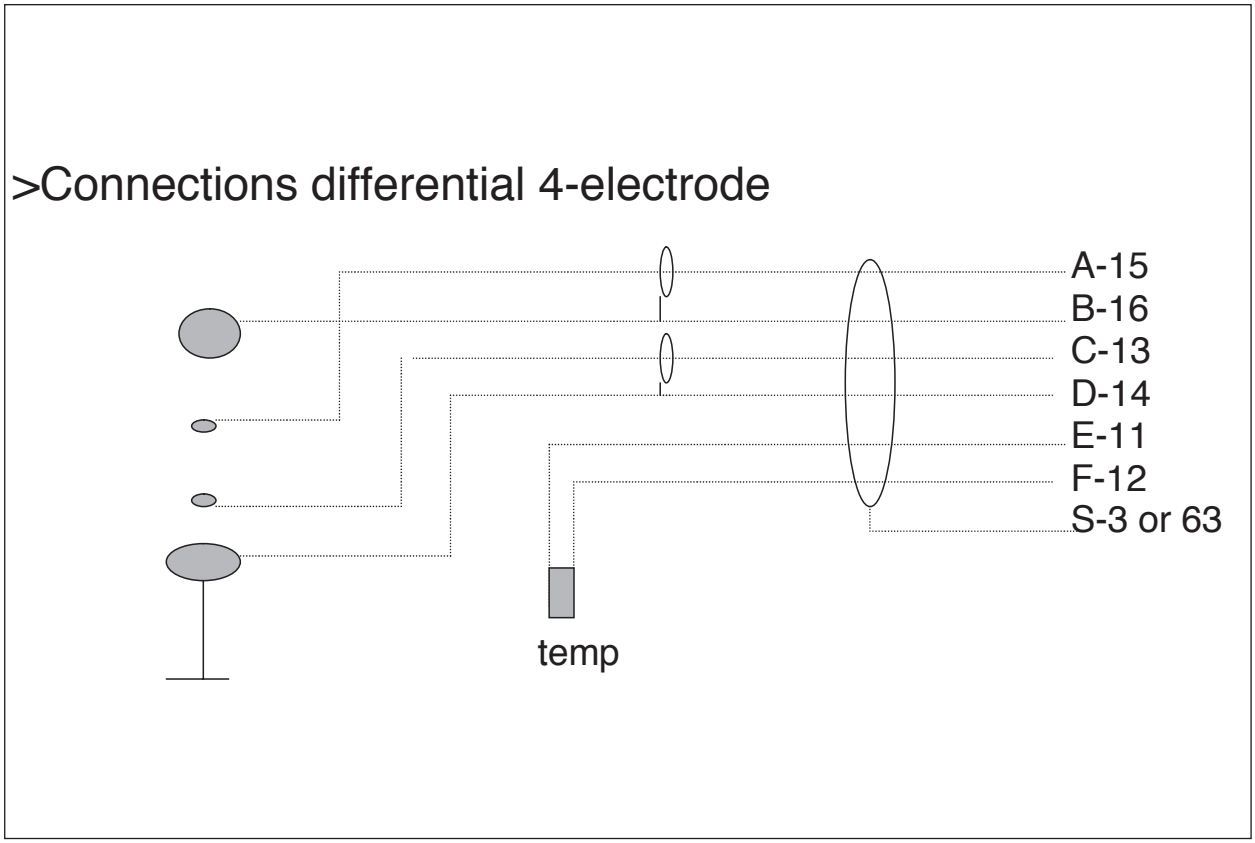


Fig. 3-12. Connection of WF10 extension cable and BA10/BP10 junction box

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.

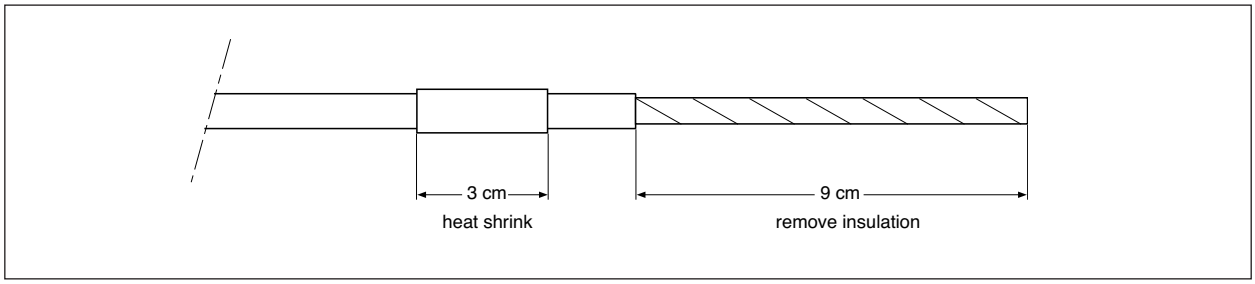


Fig. 3-13a.

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.

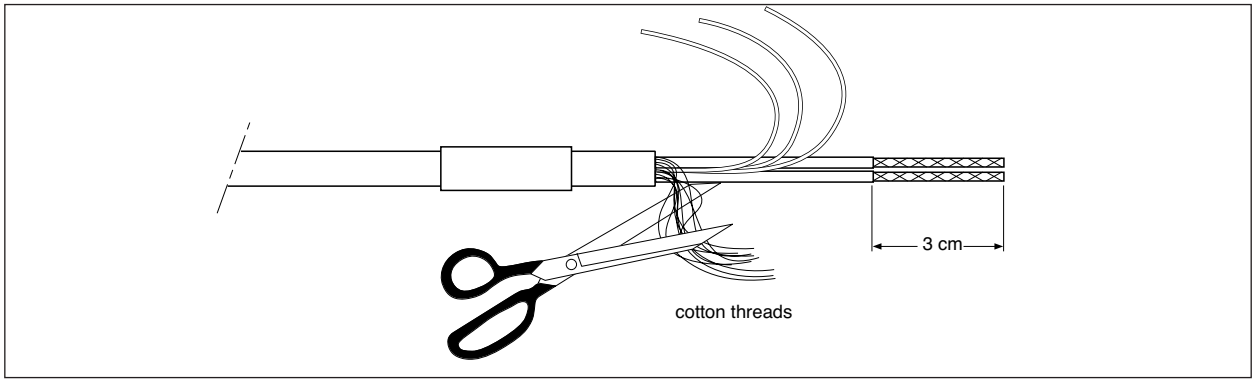


Fig. 3-13b.

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.

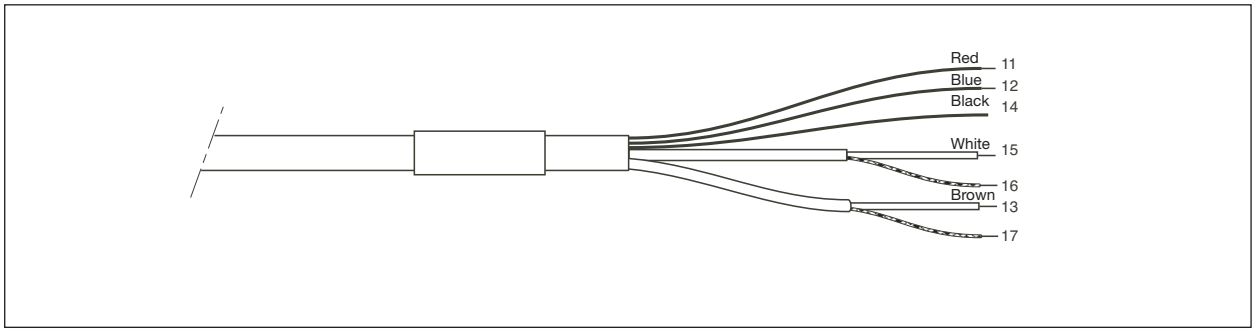


Fig. 3-13c.

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

4. OPERATION; DISPLAY FUNCTIONS AND SETTING

4-1. Operator interface

This section provides an overview 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 such values as the output ranges and hold features. 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 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
	HOLD	Switch hold on/off (when activated)	5
Commissioning	OUTPUT	Adjust the output range	5
	SET HOLD	Activate the hold function	5
	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 transmitter	5

mA

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.

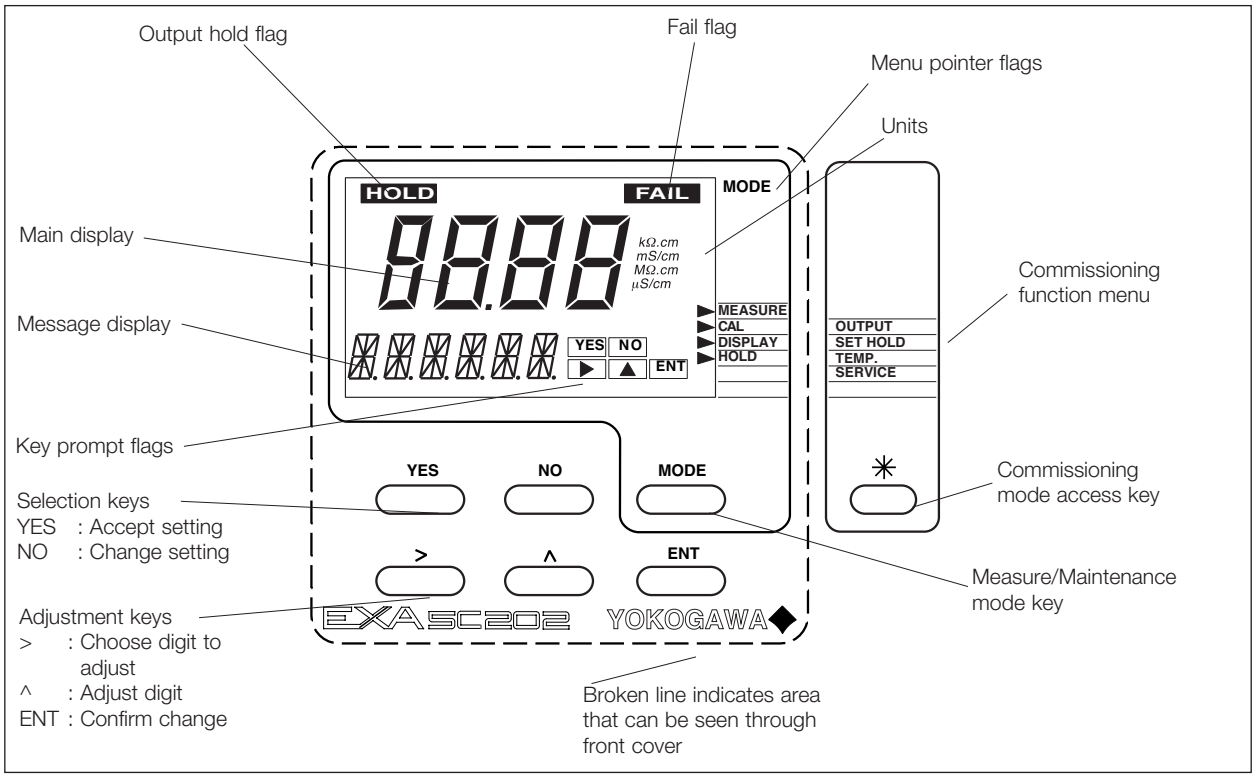


Figure 4-1. SC202 operator interface

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)
HOLD - (only when enabled)

Press again to return to the measuring mode (press twice when hold is activated).

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 (mA) ▶ ▲ 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, EXA users can set passcode protection for each one of the three operating levels, or for any one or two of the three levels. 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.

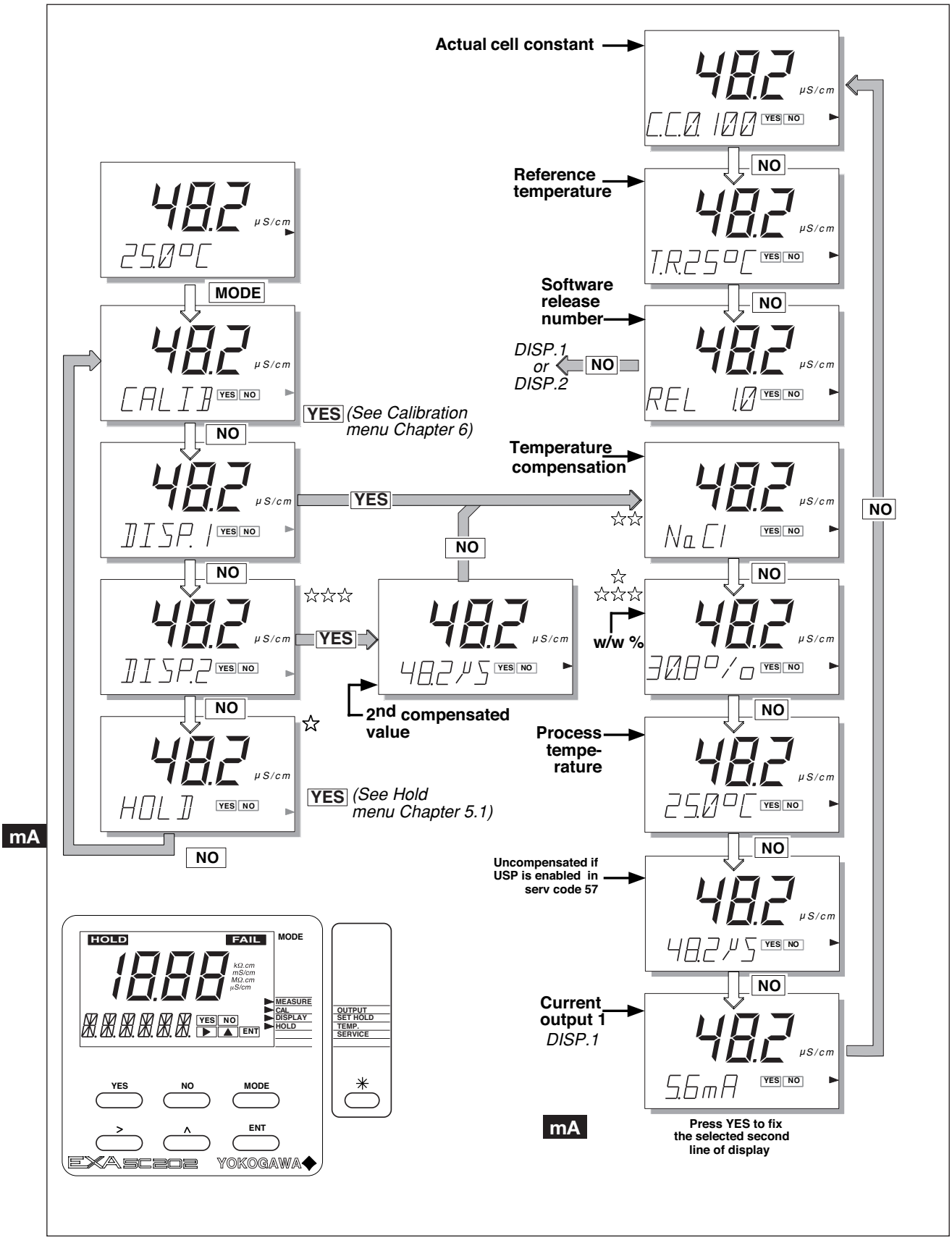
** Temperature compensation will be displayed dependent on chosen compensation method: NaCl, TC or matrix.

*** 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.

4-5. Display functions

Sequence for resistivity function is similar to this conductivity example.



5. PARAMETER SETTING

5-1. Maintenance mode

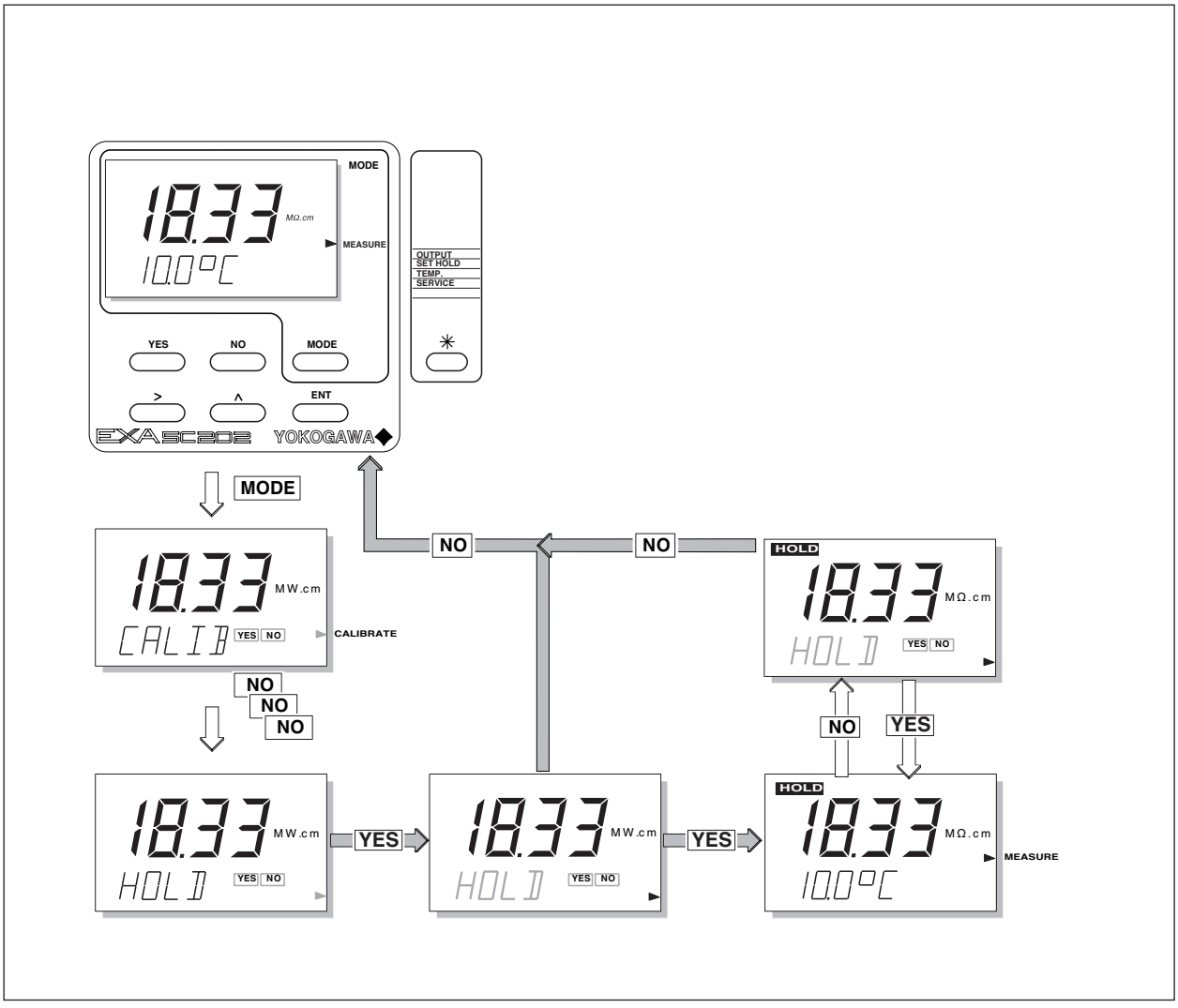
5-1-1. Introduction

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 where this has been previously set up in service code 52, section 5)

Calibrate : See “calibration” section 6.
Display setting : See “operation” section 4.
Hold : Manually switch on/off “hold” (when enabled in commissioning menu). See adjustment procedure 5-2-3.

mA 5-1-2. Manual activation of Hold



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.

Output ranges : mA output is set as default to 0-1 mS/cm or 0-19.99 MΩ.cm.
For enhanced resolution in more stable measuring processes, it may be desirable to select for example 5-10 µS/cm range.

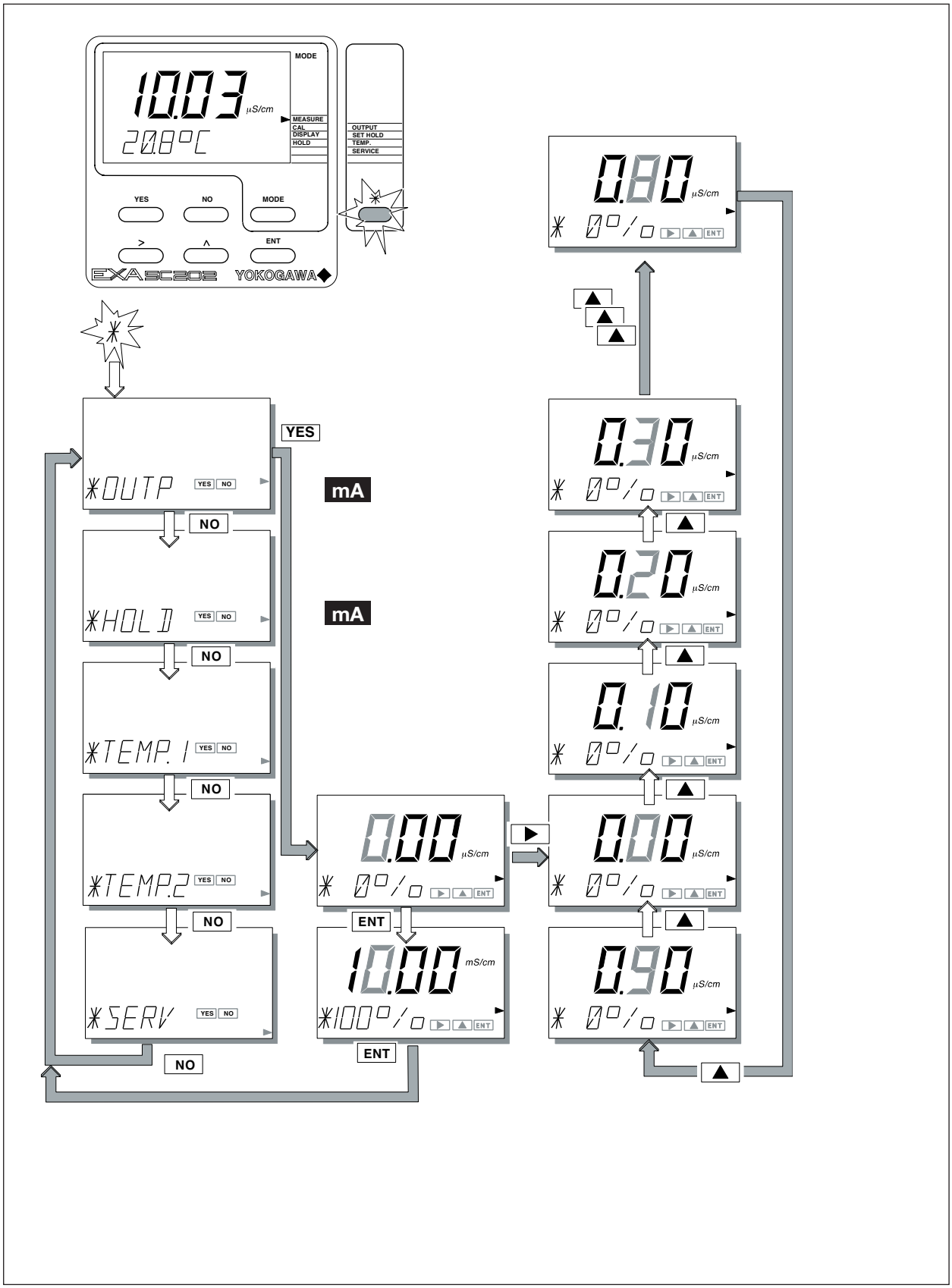
mA Hold : The EXA SC202 transmitter has the ability to "HOLD" the output during maintenance periods. This parameter should be set up to hold the last measured value, or a fixed value to suit the process.

Temp1/2 : First and second temperature compensation types and values. (see also section 5-2-4)
* NaCl is the default compensation and is used for neutral salt solutions. Strong solutions of salts are compensated, as are process waters and pure, and ultrapure water.
* 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.

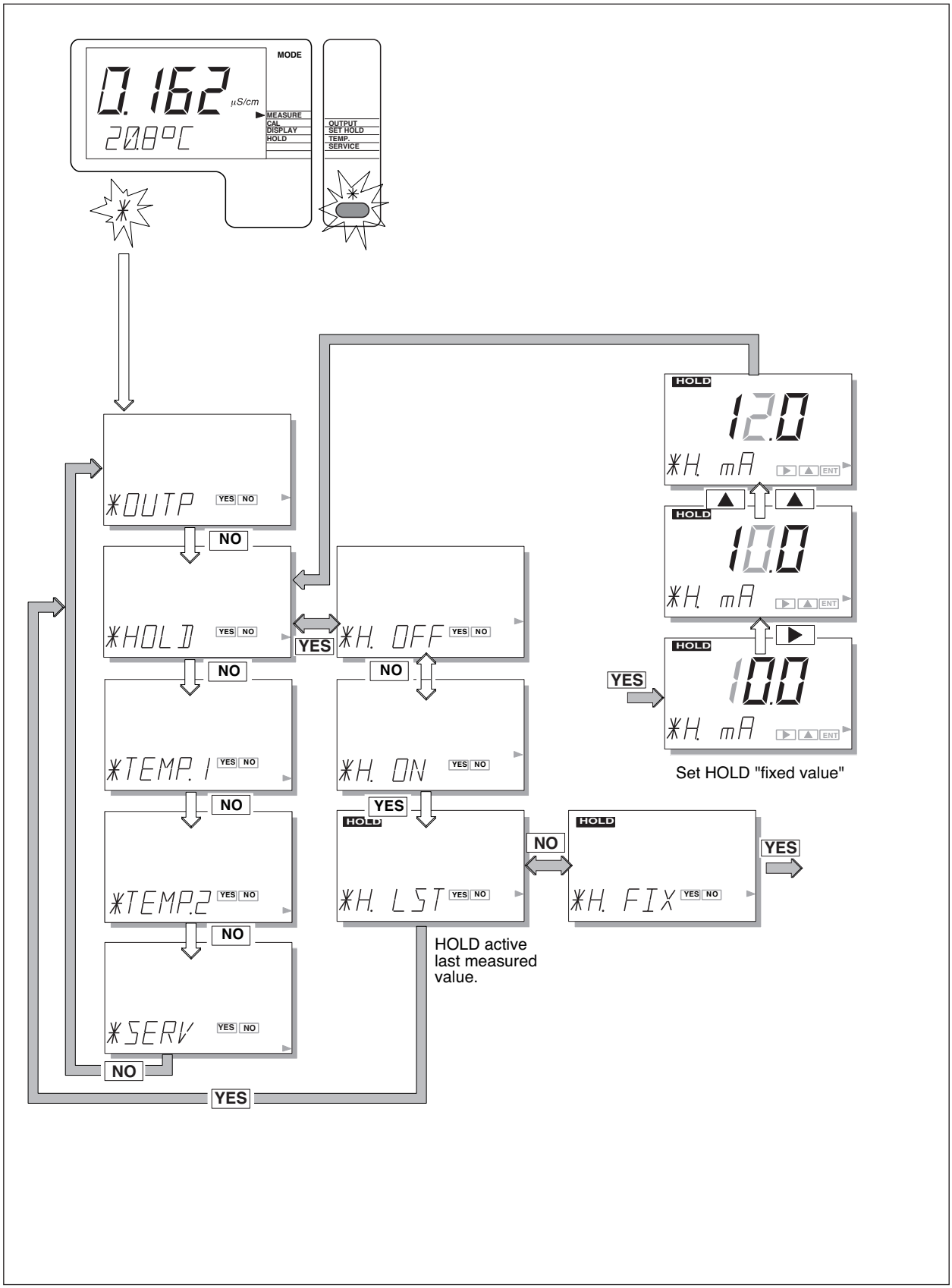
Service : This selection provides access to the service menu.

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

5-2-2. Range


MODE
10.03 µS/cm
20.8°C
MEASURE
CAL
DISPLAY
HOLD
OUTPUT
SET HOLD
TEMP.
SERVICE
YES
NO
MODE
>
^
ENT
EXA SC202
YOKOGAWA
*OUTP
*HOLD
*TEMP.1
*TEMP.2
*SERV
YES
NO
mA
mA
0.00 µS/cm
*0%
ENT
10.00 mS/cm
*100%
0.80 µS/cm
0.30 µS/cm
0.20 µS/cm
0.10 µS/cm
0.00 µS/cm
0.90 µS/cm

mA 5-2-3. HOLD


MODE
0.162
µS/cm
20.8°C
MEASURE
CAL
DISPLAY
HOLD
OUTPUT
SET HOLD
TEMP.
SERVICE
*OUTP
YES NO
NO
*HOLD
YES NO
YES
*H. OFF
YES NO
NO
*TEMP.1
YES NO
NO
*H. ON
YES NO
NO
*TEMP.2
YES NO
YES
HOLD
*H. LST
YES NO
NO
HOLD
*H. FIX
YES NO
YES
NO
*SERV
YES NO
NO
YES
HOLD
12.0
*H. mA
HOLD
10.0
*H. mA
HOLD
10.0
*H. mA
YES
Set HOLD "fixed value"
HOLD active
last measured
value.

5-2-4. 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 range. A coefficient (α) is introduced to express the amount of temperature influence in % change in conductivity/°C. In almost all applications this temperature influence must be compensated before the conductivity reading can be interpreted as an accurate measure of concentration or purity.

Table 5-1. NaCl-compensation according to IEC 746-3 with T_{ref} = 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

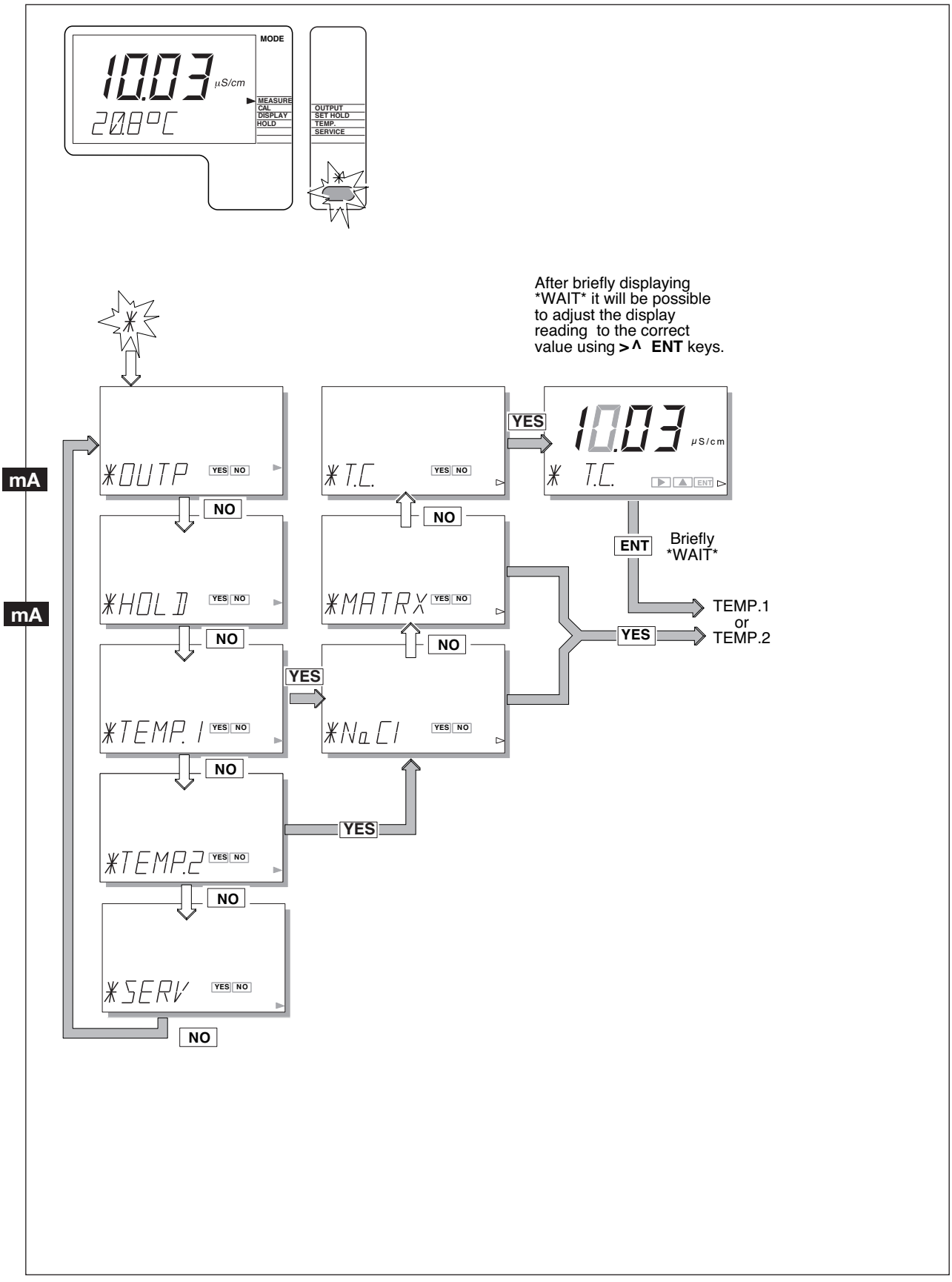
If the standard compensation function is found to be inaccurate for the sample to be measured, the transmitter can be set manually for a linear factor on site to match the application.
The procedure is as follows:

1. Take a representative sample of the process liquid to be measured.
2. Heat or cool this sample to the reference temperature of the transmitter (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)

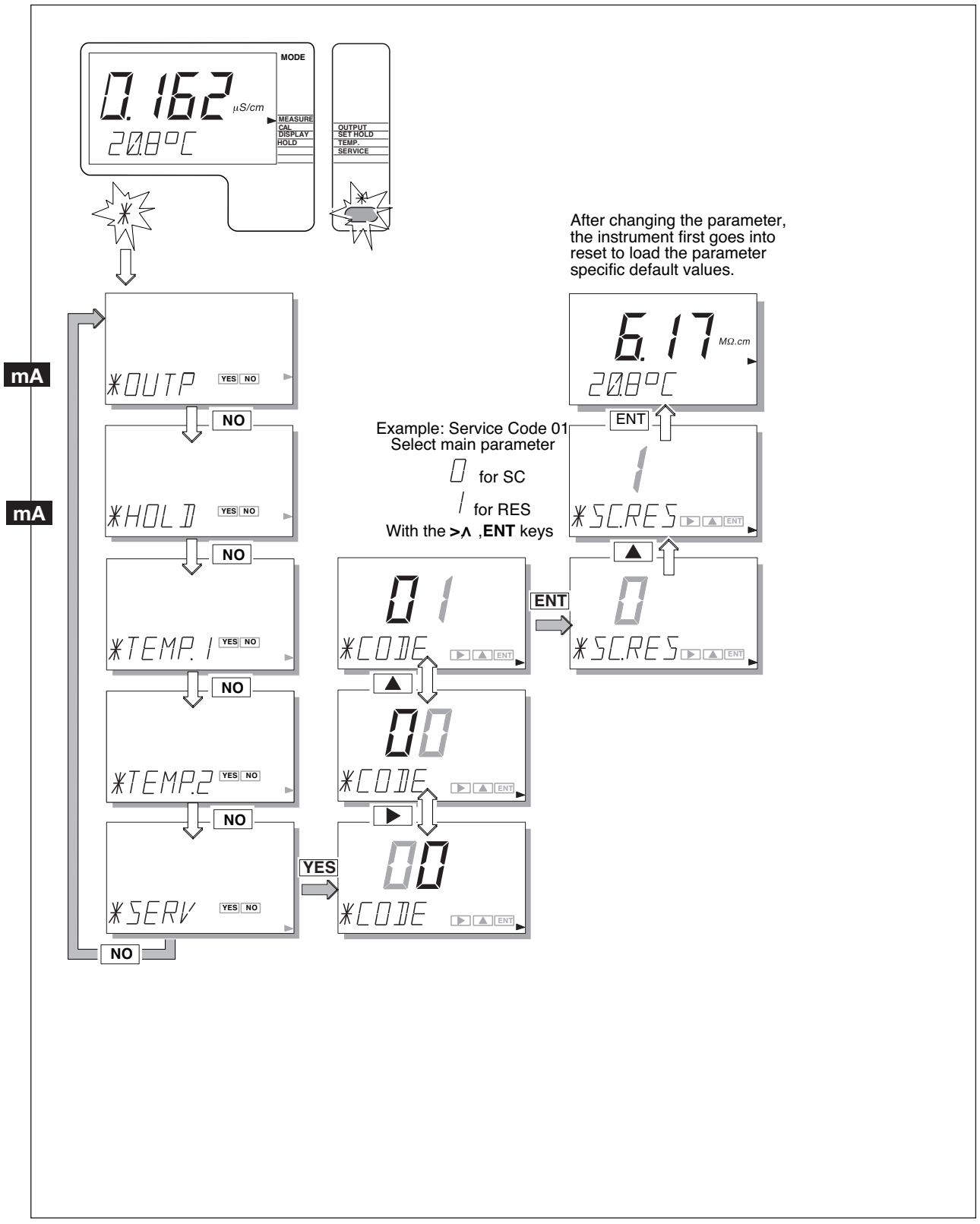
1. Enter calculated coefficient.
2. Enter matrix temperature compensation.

5-2-5. Temperature compensation selection



5-2-6. 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

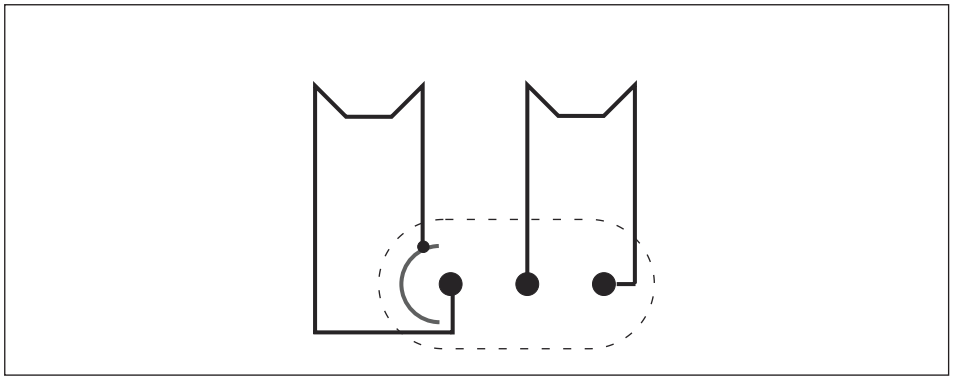
Code 1 SC/RES — Choose the required parameter, either conductivity or resistivity. If the parameter is changed the instrument will go into reset to load parameter specific default values, followed by starting measurement. For all other service codes the instrument will return to commissioning mode after 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 may be changed according the visual description in the right-handed page of section 5-2-2.

***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 nominal and 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 be used, “zero” calibration should be done including this connection equipment. When using a 4-electrode sensor additional connections are required temporarily Interconnect terminals 13 & 14 with each other and 15 & 16 with each other 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 application with 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.

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					

5-3-2. Temperature measuring functions

Code 10	T.SENS	Selection of the temperature compensation sensor. The default selection is the Pt1000 Ohm 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 user preference.
Code 12	T.ADJ	With the process temperature sensor at a stable known temperature, the temperature reading is adjusted in the main display to correspond. 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	
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
13-19			Not used					

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. Limitations for this setting are: 0 to 100 °C.
If T.UNIT in code 11 is set to °F, default value is 77°F and the limitations are 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	Set temp. coef. 1	Adjust compensation factor if set to TC in section 5-2-5. Set value with >, ^, ENT keys					2.1 % per °C
	*T.C.2	Set temp. coef. 2	Adjust compensation factor if set to TC in section 5-2-5. Set value with >, ^, ENT keys					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					
29			Not used					

mA 5-5. mA output functions

Code 31 OUTP.F For the SC202 the output may be chosen as linear to input, or configured in a 21 point table to a particular linearization. Enable the table setup in code 31, and configure the table in code 35.

Code 32 BURN Diagnostic error messages can signal a problem by sending the output signals upscale or downscale (21 mA or 3.6 mA). This is called upscale or downscale burnout, from the analogy with thermocouple failure signaling of a burned-out or open circuit sensor. The pulse burnout setting gives a 21 mA signal for the first 30 seconds of an alarm condition. After the "pulse" the signal returns to normal. This allows a latching alarm unit to record the error. In the case of the EXA the diagnostics are extensive and cover the whole range of possible sensor faults.

* Only when the HART communication is disabled the downscale output signal is 3.6 mA. When HART communication is enabled the output signal is 3.9 mA.

Code 35 TABLE The table function allows the configuration of an output curve by 21 steps (intervals of 5%). The following example shows how the table may be configured to linearize the output with a mA curve.

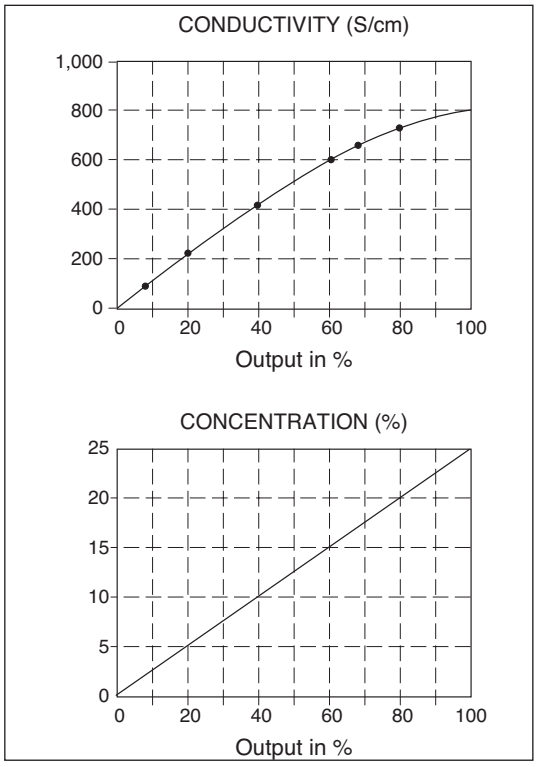


Fig. 5-1. Linearization of output
Example: 0-25% Sulfuric acid

Code Output	4-20 mA	% H_2SO_4 Service code 55	mS/cm Service code 35	Default mS/cm
0	4.0	0.00	0	0
5	4.8	1.25	60	50
10	5.6	2.50	113	100
15	6.4	3.75	180	150
20	7.2	5.00	218	200
25	8.0	6.25	290	250
30	8.8	7.50	335	300
35	9.6	8.75	383	350
40	10.4	10.00	424	400
45	11.2	11.25	466	450
50	12.0	12.50	515	500
55	12.8	13.75	555	550
60	13.6	15.00	590	600
65	14.4	16.25	625	650
70	15.2	17.50	655	700
75	16.0	18.75	685	750
80	16.8	20.00	718	800
85	17.6	21.25	735	850
90	18.4	22.50	755	900
95	19.2	23.75	775	950
100	20.0	25.00	791	1000

Table 5-3.

Concentration Output function is done in de following order:

- Set OUTP.F. (Service Code 31) to table
- Set the Concentration range in % (Service Code 55)
- Set table values (%output and Conductivity values) in TABLE (Service Code 35)

mA

Code	Display	Function	Function detail	X	Y	Z	Default values	
mA Outputs								
30			Not used					
31	*OUTP.F	mA output functions	Linear Table	0 1			0	Linear
32	*BURN	Burn function	No burnout Burnout downscale Burnout upscale Pulse burnout	0 1 2 3			0	No Burn.
33, 34			Not used					
35	*TABLE *0% *5% *10% *95% *100%	Output table for mA	Linearization table for mA 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.					
36-39			Not used					

5-6. User interface

Code 50	*RET.	When Auto return is enabled, the transmitter reverts 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. A fail signal is transmitted on the mA output when enabled in code 32. 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). * To disable the E5/E6 diagnostics the limit must be set to 0 (zero).
Code 55	*%	For some applications the measured parameter values may be (more or less) linear to concentration. For such applications it is not needed to enter an output table, but 0 and 100% concentration values directly can be set.
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.

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			(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				
58-59			Not used					

5-7. Communication setup

mA	Code 60	*COMM.	The settings should be adjusted to suit the communicating device connected to the output. The communication can be set to HART or to PH201*B distributor (for Japanese market only).
		*ADDR.	Select address 00 for point to point communication with 4-20mA transmission. Addresses 01 to 15 are used in multi-drop configuration (fixed 4mA output).
mA	Code 61	*HOUR *MINUT *SECND *YEAR *MONTH *DAY	The clock/calendar for the logbook is set for current date and time as reference.
	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 returned to the default set up with a single operation. This can be useful when wanting to change from one application to another.

5-9. Test and setup mode

Code 80	*TEST	The test mode is used to confirm the instrument setup. It is based on the factory setup procedure and can be used to check the QIC (factory generated Certificate). This test is described in the Quality Inspection Standard, see chapter 12.

NOTE : Attempting to change data in service code, 80 and above without the proper instructions and equipment, can result in corruption of the instrument setup, and will impair the performance of the unit.

	Code	Display	Function	Function detail	X	Y	Z	Default values	
	Communication								
mA	60	*COMM.	Communication	Set communication Off	0			1.0	On
				Set communication On	1				
				Set communication PH201*B On	2				
				Communication write enable		0			Write
				Communication write protect		1			enable
		*ADDR.	Network address	Set address 00 to 15				00	
mA	61	*HOUR *MINUT *SECND *YEAR *MONTH *DAY	Clock setup	Adjust to current date and time using >, ^ and ENT keys					
	62	*ERASE	Erase logbook	Press YES to clear logbook data					
	63-69			Not used					

Code	Display	Function	Function detail	X	Y	Z	Default values	
General								
70	*LOAD	Load defaults	Reset configuration to default values					
71-79			Not used					

Code	Display	Function	Function detail	X	Y	Z	Default values	
Test and setup mode								
80	*TEST	Test and setup	Built in test functions as detailed in QIS and Service Manual					

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 NIST 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.

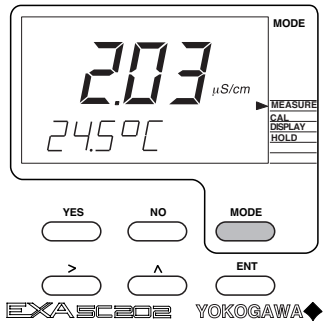
Table 6-1. NaCl values at 25 °C

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.

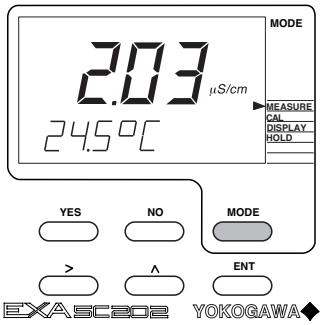
The calibration is now complete. Put the sensor back in the process and press **YES.**

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.

6-3. Calibration with HOLD active



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.**

HOLD will be displayed. Press **NO** to turn off HOLD and return to the measuring mode.

7. MAINTENANCE

7-1. Periodic maintenance for the EXA 202 transmitter

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 HART 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.

The following error message table gives a list of possible problems that can be indicated by the EXA.

Table 8-1. Error Codes

Code	Error description	Possible cause	Suggested remedy
E1	Polarization detected on cell	Sensor surface fouled Conductivity too high	Clean sensor and calibrate 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 (3-5) 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 (3-5) 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
mA E17	Output span too small	Incorrect configuration by user	Reprogram
mA 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

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 mA Output and 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. In the example mentioned above the contact will close at an uncompensated resistivity of 1/1.76 µS/cm. = 0.568 MΩ.cm.

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.

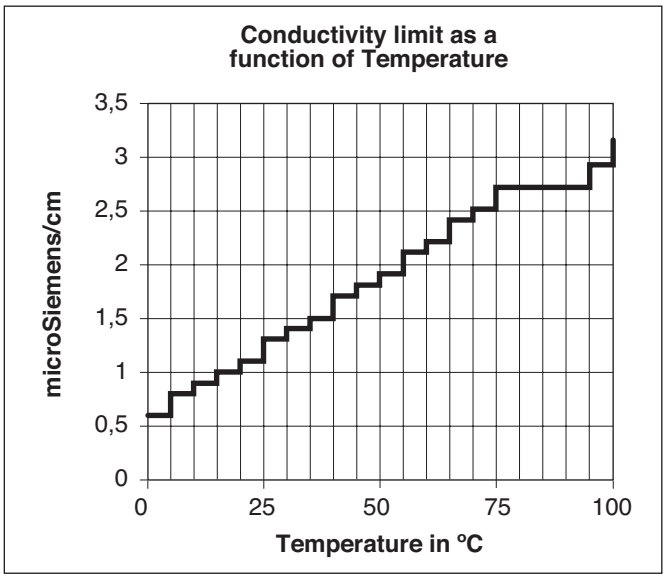


Fig. 9-1.

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
3a	Internal works assembly (general purpose)	K1544DJ
3b	Internal works assembly (intrinsically safe)	K1544DK
4	Digital (display) board	K1544DB
5a	Analogue (input) board (general purpose)	K1544SK
5b	Analogue (input) board (intrinsically safe)	K1544SE
6	Ribbon cable	K1544PH
7	EPROM	K1544BJ
8	Lithium cell (battery)	K1543AJ
9	Terminals (block of 3)	K1544PF
10	Housing	K1542JL
11	Gland set (one gland including seal and backing nut)	K1500AU
Options		
/U	Pipe and wall mounting hardware	K1542KW
/SCT	Stainless steel tag plate	K1544ST
/H	Hood for sun protection	K1542KG

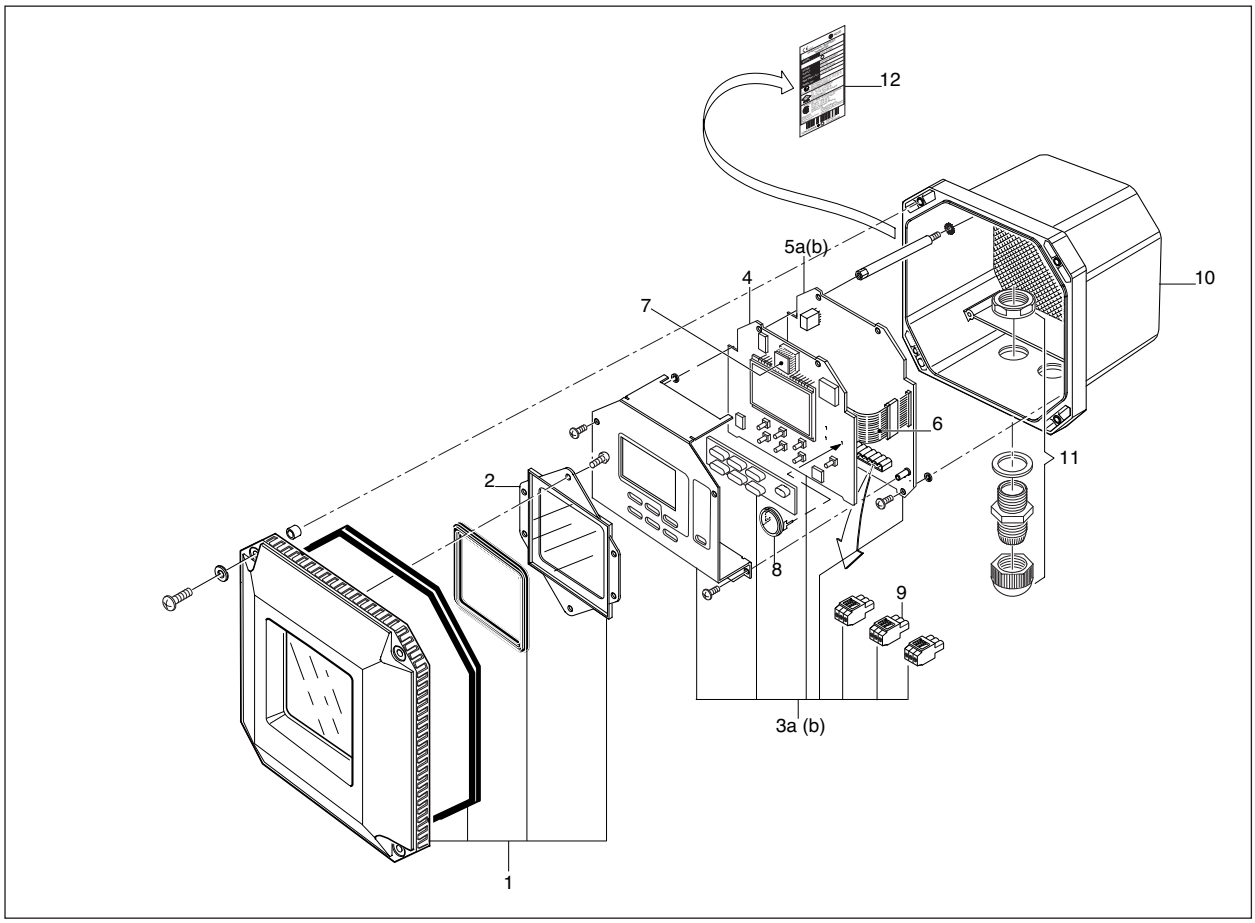


Fig. 10-1. Exploded view

11. APPENDIX

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

Output signal value							
%	mA						
Output	4-20						
0	4						
5	4.8						
10	5.6						
15	6.4						
20	7.2						
25	8						
30	8.8						
35	9.6						
40	10.4						
45	11.2						
50	12						
55	12.8						
60	13.6						
65	14.4						
70	15.2						
75	16						
80	16.8						
85	17.6						
90	18.4						
95	19.2						
100	20.0						

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

mA

- Current Outputs
  Transmission signals for the measured parameters can be set up in service codes 30-39.

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

mA

- Communications
  The proprietary HART communication link allows remote configuration and data retrieval through the PC202 communication package. This is an excellent tool for the maintenance engineer, quality engineer or plant manager. Service codes 60 - 69 are used to set up the communications.

- 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	Factor		
		1.000	/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	2.1	%/°C		
	*T.C.2	2.1	%/°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		
mA outputs					
31	*OUTP.F	0	Linear S.C.		
32	*BURN	0	No Burn		
35	*TABL1	21 pt table	see code 31, 11-1		

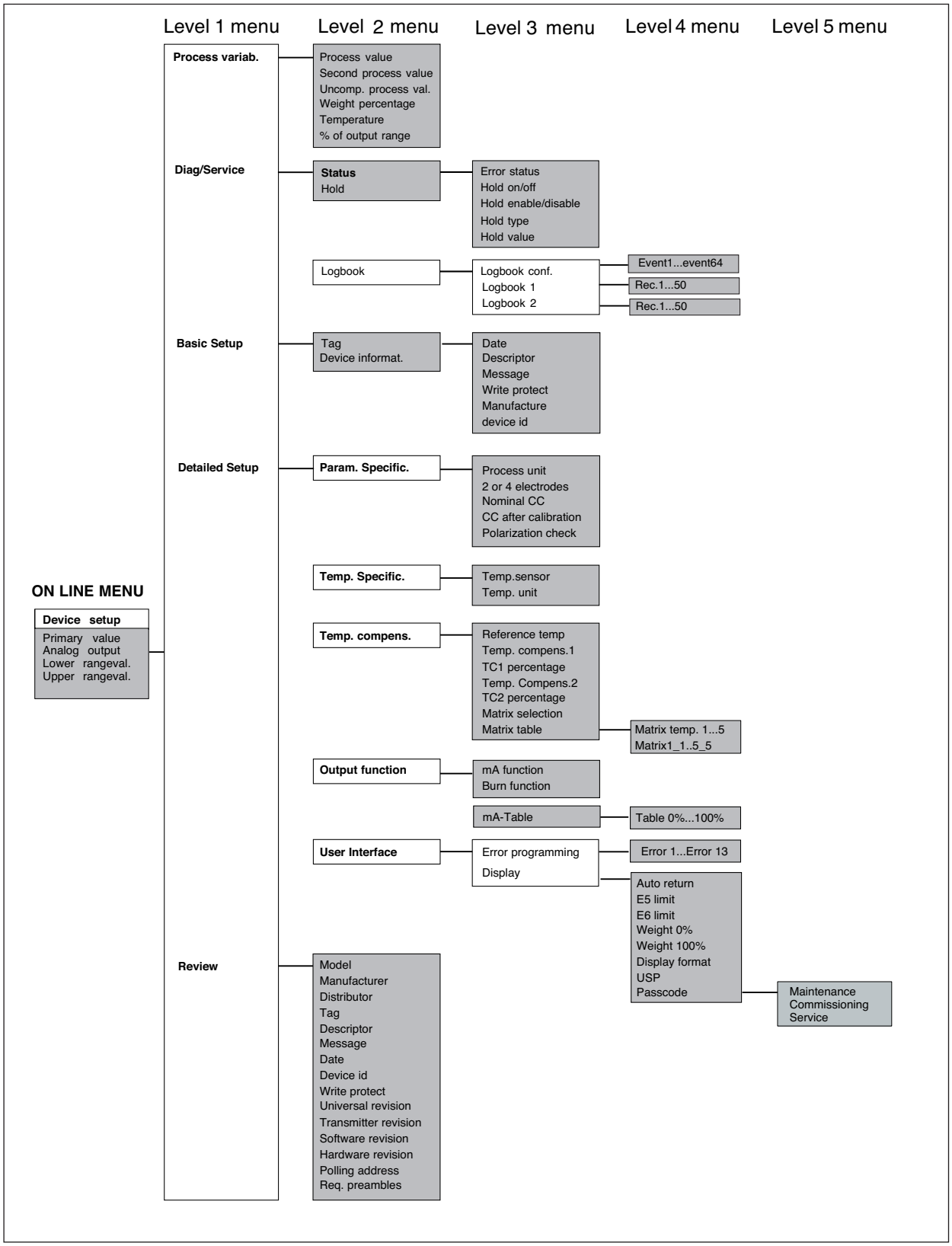
	FUNCTION	SETTING DEFAULTS		USER SETTINGS		
User Interface						
50	*RET	1	on			
52	*PASS	0.0.0	all off			
53	*Err.01	1	hard fail			
	*Err.05	1	hard fail			
	*Err.06	1	hard fail			
	*Err.07	1	hard fail			
	*Err.08	1	hard fail			
	*Err.13	0	soft fail			
54	*E5.LIM	250	mS			
		(0.004)	kΩ.			
	*E6.LIM	1.000	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			
Communication						
60	*COMM. *ADDR.	0.1 00	off/write prot. 00			
61	*HOUR					
62	*ERASE					
General						
70	*LOAD					
Test and setup mode						
80	*TEST					

11-7. Error codes

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
E17	Output span too small	Incorrect configuration by user	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

mA 11-8. Device Description (DD) menu structure

The Device Description (DD) is available from Yokogawa or the HART foundation. An example is shown below of the ON LINE menu structure. This manual makes no attempt to explain the operation of the Hand Held communicator (HHC). For detailed operating instructions, refer to the HHC user's manual and the on-line help structure.



11-9. Field Change Order

11-9-1 Changes made by software release 1.1
- PH201 communication added for Japanese market

11-9-2 Changes made by software release 1.2
- E20 is cleared after the programmed data was recovered

11-9-3 Changes made by software release 2.1
- Communication is default set to enabled / write enabled

11-9-4 Changes made by software release 2.2
- Minimal celconstant changed from 0,008cm^{-1} to 0,005cm^{-1}

11-9-5 Changes made by software release 2.3
- Default Temperature Compensation Matrix loaded,
  to prevent 'impossible' values after a loading all parameters from DCS

11-9-6 Changes made by software release 2.4
- Create possibility to disable E5/E6 diagnostics by setting the E5/E6 limits to 0 (zero)
- Burn down outputsignal changed to 3.9 mA when the HART communication is enabled.
  When disabled it is 3.6 mA
- Fixed rare HART communication failure

11-9-7 Changes made by software release 2.5
- Implementation of Burn low in combination with HART changed.
- Some minor improvements in HART communication.

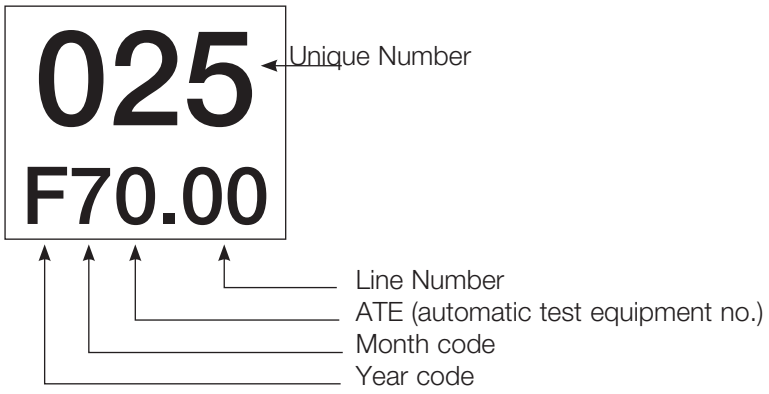
12.1 TEST CERTIFICATE

Test Certificate

EXA Series
Model SC202
Inductive Conductivity Transmitter

1. Introduction

This inspection procedure applies to the model SC202 Conductivity transmitter. There is a serial number, unique to the instrument, which is stored in non-volatile memory. Each time the transmitter 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 MΩ.

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 variable resistor (decade resistor box).

4.2 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.

4.3 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 Ω, between 2 Ω and 1200 kΩ. (accuracy 0.1%)
3. A fixed resistor of 300 U 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 1µA, accuracy 0.1%

Connect the SC202 as shown in Figure 1. Set box 1 to simulate 25 oC (1097,3 U for Pt1000).

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.

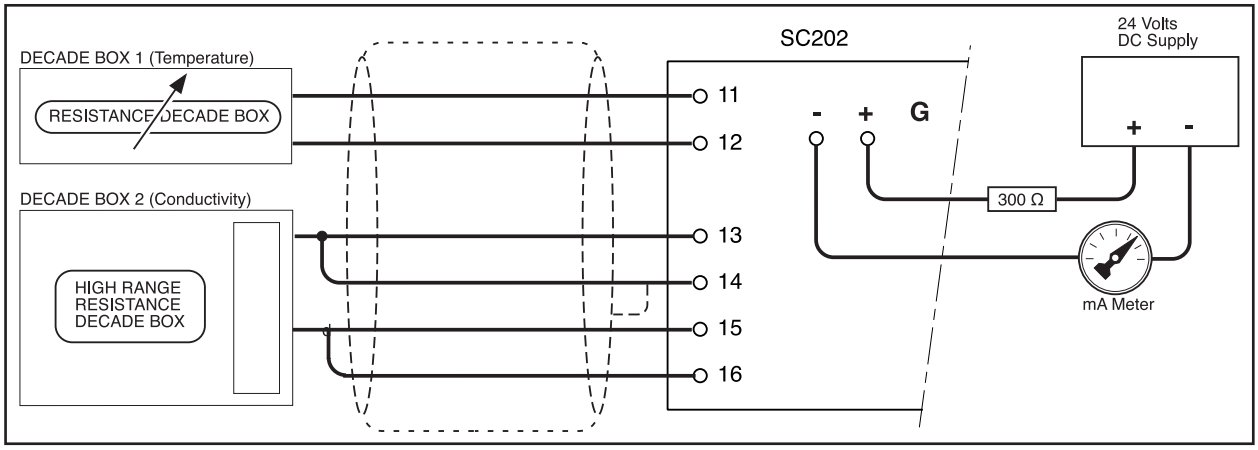


Figure 1. Connection diagram for the overall accuracy test

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.

5. Accuracy test mA output circuit

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

Test Certificate

EXA Series
Model SC202
Conductivity or Resistivity Transmitter

1. Instrument Description							
Model :	SC202G-F-E/U			Serial No :	P7113118		
Order :	100000193018			Release Version :	2.1		
2. General Inspecton	OK						
3.1 Insulation Test	OK			3.2 Communication Test	OK		

4.1 Accuracy Test (C.C. = 1.00cm^{-1})				4.2.1 Accuracy Test(Temp. Display with Ni 100 RTD)			
Input Ω	Display Ω	Tolerance Ω	Reading Ω	Resistance Ω	Temp. °C	Tolerance °C	Reading °C
100	0.100K	± 0.001k	**100.0**	94.6	-10	± 0.3	**-10.0**
1k	1.000k	± 0.005k	**1.001 k**	114.1	25	± 0.3	**25.1**
10k	10.00k	± 0.05k	**10.01 k**	145.0	75	± 0.3	**75.1**
100k	100.0k	± 0.5k	**100.0 k**	179.6	125	± 0.3	**124.9**
1M	1.000M	± 0.010M	**1.001 M**	231.8	190	± 0.3	**190.0**

4.2.2 Accuracy Test (Temp. Display with Pt100 RTD)				4.2.3 Accuracy Test(Temp. Display with Pb36 NTC sensor)			
Resistance Ω	Temp. °C	Tolerance °C	Reading °C	Resistance Ω	Temp. °C	Tolerance °C	Reading °C
96.1	-10	± 0.4	**-10.0**	9414.0	-10	± 0.3	**-10.0**
109.7	25	± 0.4	**24.9**	2179.0	25	± 0.3	**25.0**
129.0	75	± 0.4	**75.0**	278.9	90	± 0.3	**89.9**
147.9	125	± 0.4	**124.8**	215.6	100	± 0.3	**100.0**
172.2	190	± 0.4	**190.1**	168.4	110	± 0.3	**110.0**

4.2.4 Accuracy Test (Temp. Display with Pt1000 RTD)				4.2.5 Accuracy Test (Temp. Display 8k55 sensor)			
Resistance Ω	Temp. °C	Tolerance °C	Reading °C	Resistance Ω	Temp. °C	Tolerance °C	Reading °C
960.9	-10	± 0.3	**-10.0**	47000.0	-10	± 0.4	**-10.0**
1097.3	25	± 0.3	**25.0**	8550.0	25	± 0.4	**24.9**
1289.8	75	± 0.3	**75.0**	780.0	90	± 0.4	**90.0**
1479.4	125	± 0.3	**125.0**	577.0	100	± 0.4	**100.1**
1721.6	190	± 0.3	**190.0**	440.0	110	± 0.4	**110.0**
1904.6	240	± 0.3	**240.0**				

4.3 Overall Accuracy Test (C.C.=1.88cm^{-1}; NaCl compensation; Pt1000 @ T = 25± 0.3°C)						
Input Ω	Display S/cm	Tolerance S/cm	Reading S/cm	Nominal mA	Tolerance mA	Reading mA
Open	0.000µ	± 0.01µ	**0.001 µ**	4.00	± 0.02	**4.00**
1200k	5.00µ	± 0.05µ	**5.00 µ**			
50k	20.00µ	± 0.2µ	**20.0 µ**			
10k	100µ	± 1.0µ	**99.9 µ**			
2k	500µ	± 5µ	**500 µ**			
500	2.00m	± 0.02m	**2.00 m**	4.16	± 0.02	**4.15**
100	10.00m	± 0.10m	**10.00 m**	4.80	± 0.03	**4.79**
50	20.0m	± 0.2m	**20.0 m**	5.60	± 0.04	**5.60**
20	50.0m	± 0.5m	**50.0 m**	8.00	± 0.06	**8.00**
10	100m	± 1m	**100.1 m**	12.00	± 0.10	**12.00**
7	142.8m	± 1.4m	**142.8 m**	16.00	± 0.13	**15.42**
5	200m	± 2m	**200 m**	20.00	± 0.18	**19.99**
2	500m	± 5m	**497 m**	20.50	± 0.18	**20.50**

5. Accuracy Test mA output circuit			Date	Ambient Temp	Rel. Humidity
Simulated Output mA	Tolerance mA	Actual Output mA	**17-07-02**	**°C**	**%RH**
4.0	± 0.02	**4.00**			
8.0	± 0.02	**7.99**			
12.0	± 0.02	**12.00**			
16.0	± 0.02	**15.99**			
20.0	± 0.02	**20.00**			

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