User's Manual

Model ISC202G(S) Inductive Conductivity Transmitter

EXA

CE

YOKOGAWA

IM 12D8B3-E-E
7th Edition

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In this manual a sign appears if it concerns the ISC202G-A and ISC202GS-A/N

PREFACE

WARNING

Electric discharge

The EXA transmitter 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 transmitter 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.

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 transmitter 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 below.

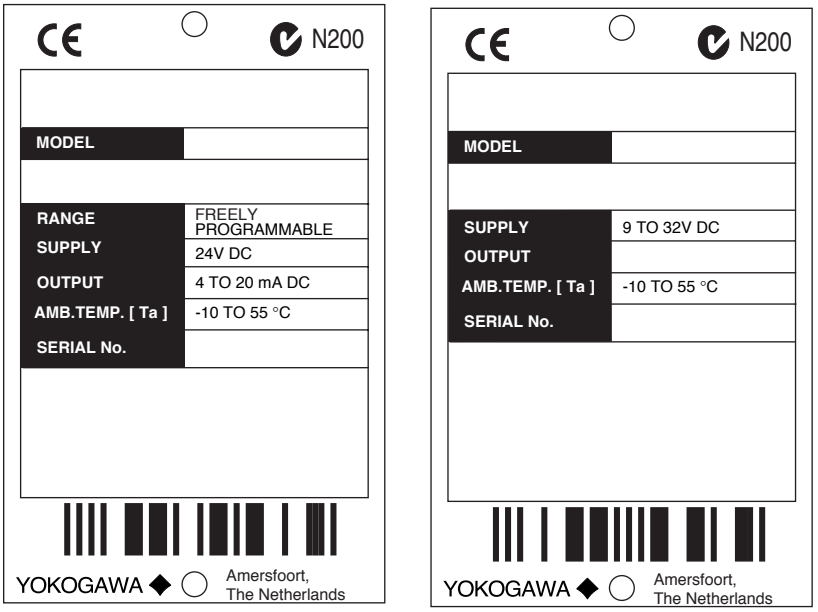


Figure 1-1. Nameplate

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 Section 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 ISC202
User's Manual Enlish
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/neutralization system.

Yokogawa designed the EXA transmitter 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 mtr (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 Section 5 and again in Section 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 two 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. To assure the user of continued accurate performance in even the most demanding industrial installations.

2. GENERAL SPECIFICATIONS
2-1. Specifications

A) Input specifications: One inductive conductivity sensor and one temperature sensor. Compatible with the ISC40 series with integrated temperature sensor.

B) Input range

- Conductivity:	0 to 1999 mS/cm at 25 °C (77 °F) reference temperature.
minimum:	1 µS/cm (at process temperature).
maximum:	3 S/cm (at process temperature).
- Temperature:	-30 to +150 ºC (-22 to 302 ºF).
- Cable length:	max. 60 mtr (200 feet) 10 mtr (35 feet) fixed sensor cable + 50 mtr (165 feet) WF10 extension cable. Influence of cable can be adjusted by doing an AIR CAL with the cable connected to a dry cell.

C) Functional specifications

Accuracy (under reference conditions):

- Conductivity	≤ 0.5 % ± 1.0 µS/cm
- Temperature	≤ 0.3ºC (0.6ºF)
- Temp.compensation	≤1 % for NaCl, ≤ 3 % for Matrix
- mA-Output circuits	≤ 0.02 mA.

D) Influence of:

- Ambient temperature	± 0.1% ± 0.05 µS/cm/ºC
- Step response	Õ8 seconds for 90% (2 decade step).

E) Indicating range:

- Main display	0 to 1999 mS/cm (1st compensation)
- Message display	0 to 1999 mS/cm (2nd compensation),Temperature -30 to 150 ºC (-22 to 302 ºF) Concentration 0 to 100.0% Temperature compensation methods NaCl, T.C., Matrix mA- Output (3.90 to 22.00 mA) Cell constant [cm^{-1}] Reference Temperature (ºC/ºF) Software Release.

mA F) Transmission signal:

- General	One milliampere output 4-20 mA DC, isolated from input, with a maximum load of 425 Ω (@ 24 VDC), see figure Supply voltage/Load diagram. This output can be configured for Conductivity, linear or conform a user programmable table.
- Status	Output signalling of failure can be selected to give 22 mA ± 0.05 mA (continuous or single pulse of 30 sec. at start of fault) or 3.90 mA ± 0.05 mA (continuous).
- Hold	Outputs may be set to hold the last or a fixed value during maintenance.

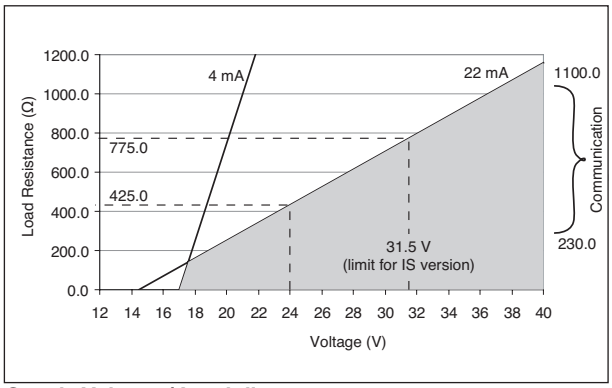
mA G) Transmission range:

- Conductivity	Minimum span 1 µS/cm and P 10% of high value (20mA) Maximum span 1999 mS/cm.

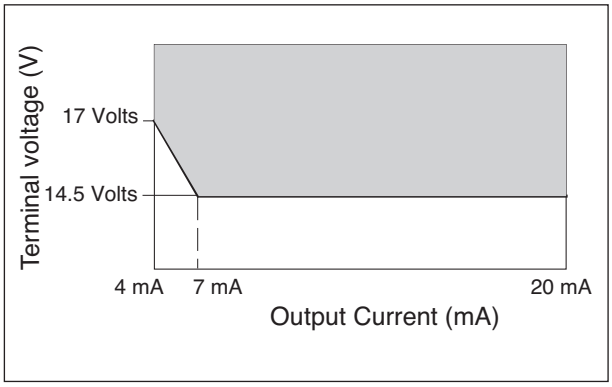
mA H) Serial Communication:

Bi-directional HART digital communication superimposed on the 4-20 mA signal.

I) DD specification The ISC202G(S) Device Description (DD) is available enabling communications with the hand held communicator and compatible devices. For more information contact your local Yokogawa sales offices.



Supply Voltage / Load diagram



Minimum terminal Voltage at the ISC202.

J) Temperature compensation:

- Sensor types:	30kΩ NTC or Pt1000.
- Automatic:	between -30 to 150 ºC (-22 to 302 ºF)
- Algorithm:	NaCl according to IEC 746-3 tables. Two T.C. settings possible between 0.00 to 3.50%/ºC Matrix: 8 selectable for concentrated solutions, 1 free programmable. Reference temperature adjustable between -30 to 150 ºC (-22 to 302 ºF).

K) Sensor diagnostics: Abnormal temperature (open, short), abnormal conductivity values (E5/E6 free programmable), e.g. dry cell, wiring problems.

L) Calibration: Manual, calibration Input pre-measured data (cell constant).

M) Logbook: Software record of important events and diagnostic data.

N) Display: Custom liquid crystal display.

- Main display:	$3^1/_2$ digits, 12.5 mm high, zero change included.
- Message display:	6 alphanumeric characters, 7 mm high.
- Special fields:	Flags for status indication : FAIL and HOLD.
- Measuring units:	µS/cm or mS/cm
- Key prompts:	YES, NO, >, ^, ENT, Menu pointer
- Keys:	6 keys operated through flexible window with tactile feedback. One hidden key behind the front cover.

O) Power supply: 24 VDC nominal
G-version 17-40 VDC
S-version 17-31.5 VDC

- Input Isolation: Maximum 1000 VDC

P) Housing: Cast aluminum case and cover both provided with chemically resistant coating (color: case off-white; cover moss-green).
Cover with flexible polycarbonate window. Weather protection: Rain and dust tight to IP65 (NEMA 4X).
Two polyamide glands 1/2".
Cable terminals for up to 2.5 mm^2.

Q) Mounting: Pipe, Wall or Panel.

R) Shipping details: Package 290 x 225 x 170 mm (w x h x d). Weight ± 2.5kg.

S) Environment and operational conditions:

- Ambient temp.: -10 to 55 ºC (+10 to +130 ºF)
  LCD operational temperature is specified -10 to 70 ºC (14 to 160 ºF)
  Excursions to -30 to +70 ºC will not damage the instrument.
- Storage temp.: -30 to +70 ºC (-20 to +160 ºF).
- Relative humidity: 10 to 90% Rh at 40 ºC ambient temperature, non condensing
- Data protection: EEPROM for configuration and logbook. Battery supported clock.
- Watchdog timer : Checks microprocessor.
- Automatic safeguard: Return to measurement after 10 minutes when no keystroke.

Operation protection: 3 digital pass codes (programmable).
Power down: No effect, reset to measurement.

T) HART specifications:

Minimum cable diameter: 0.51 mm, 24 AWG. Maximum cable length: 1500 m
Refer to standard HART specifications for more details.
See www.hartcomm.org

U) Regulatory compliance

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

V) 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
  KEMA 00ATEX1191 X
  II 2 (1) G
- 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
  ISC202S 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-ISC202S-00

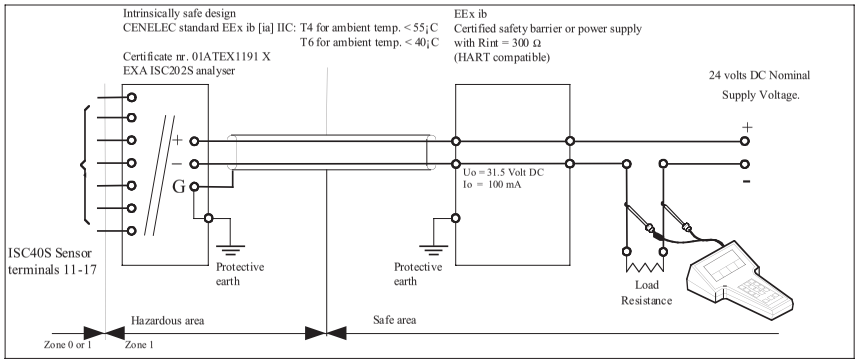
W) Non-Incendive

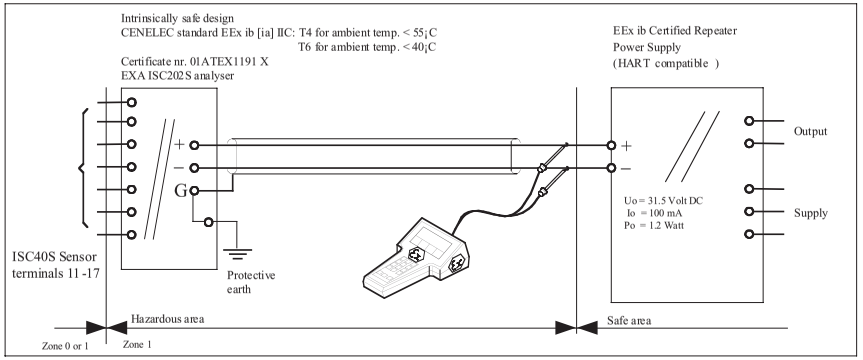
- FM : NI CL I, DIV 2, GP ABCD
  T4 for Ta -10 to 55 ºC
  T6 for Ta -10 to 40 ºC
  HAZ LOC per Control Drawing
  FF1-ISC202S-00
- CSA : NI CL I, DIV 2, GP ABCD
  T4 for Ta -10 to 55 ºC
  T6 for Ta -10 to 40 ºC
  Refer to Installation Drawing
  ISC202S CSA
- ATEX : EEx nA [L] IIC T4 for Ta -10 to 55 ºC
  EEx nA [L] IIC T6 for Ta -10 to 40 ºC
  KEMA 00ATEX1192 X
  II 3 G

2-2. Model and suffix codes

Model	Suffix Code	Option code	Description
ISC202G			Inductive Conductivity Transmitter, General Purpose version
Type	- A		Milli-amp (+HART) version
	- F		FOUNDATION ® Fieldbus version
	- P		Profibus PA version
	- E		Always E
Options		/H	Hood for Sun Protection
		/U	Pipe & Wall mounting hardware
		/SCT	Stainless steel tagplate
		/Q	Calibration certificate

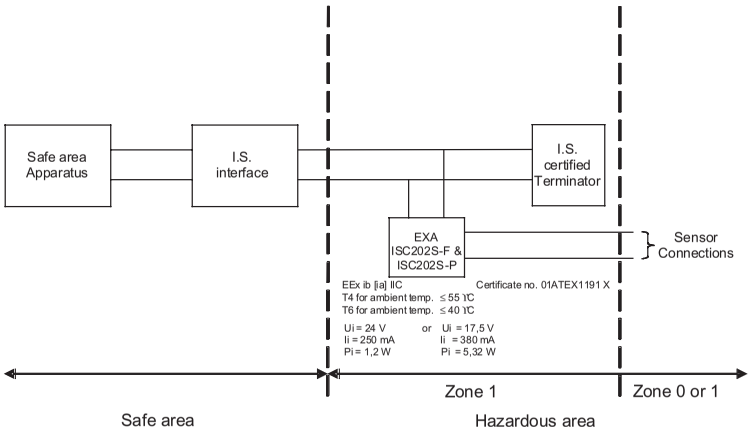
Model	Suffix Code	Option code	Description
ISC202S			Inductive Conductivity Transmitter, Intrinsic Safe version
Type	- A		Milli-amp (+HART) version
	- F		FOUNDATION ® Fieldbus version
	- P		Profibus PA version (Certificate Pending)
	- N		Non-Incendive Milli-amp (+HART) version
	- B		Non-Incendive FOUNDATION ® Fieldbus version
	- D		Non-Incendive Profibus PA version (Certificate Pending)
	- E		Always E
Options		/H	Hood for Sun Protection
		/U	Pipe & Wall mounting hardware
		/SCT	Stainless steel tagplate
		/Q	Calibration certificate





- Electrical data of the EXA ISC202S.
  - Supply and output circuit (terminals + and -):
    Maximum input voltage U_i = 31.5 V.
    Maximum input current I_i = 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 17):
    Maximum output voltage U_o = 14.4 V.
    Maximum output current I_o = 88 mA.
    Maximum allowed external capacitance C_o = 600nF (for EXA ISC202S-A), C_o = 3,5 F (for EXA ISC202S-N).
    Maximum allowed external inductance L_o = 4,5 mH (for EXA ISC202S-A), L_o = 10 mH (for EXA ISC202S-N),
- 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 ISC202S-A**
Title : Control Drawing ISC202S Cenelec	
Number : FF1-ISC202S-00	**Page : 1 of 10**
YOKOGAWA EUROPE B.V.	**Revision : 1.5**
	Date : 27/07/2004



〈 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 ISC202S-F & ISC202S-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 interna l inductance Li=2.6 µH.

- Sensor input circuit:
  Maximum output voltage Uo=14.4V; Maximum output current Io=88 mA
  Maximum allowed external capacitance:
  Co=600 nF (for EXA ISC202S-F & ISC202S-P),
  Co=3,5 F (for EXA ISC202S-B & ISC202S-D),
  Maximum allowed exte rnal inductance:
  Lo=4,5 mH (for EXA ISC202S-F & ISC202S-P),
  Lo=10 mH (for EXA ISC202S-B & ISC202S-D).

〈 Any I.S. interface may be used that meets the following 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 ISC202S-F** **Model EXA ISC202S-P**
Title : Control Drawing ISC202S Cenelec	
Number : FF1-ISC202S-00	**Page : 2 of 10**
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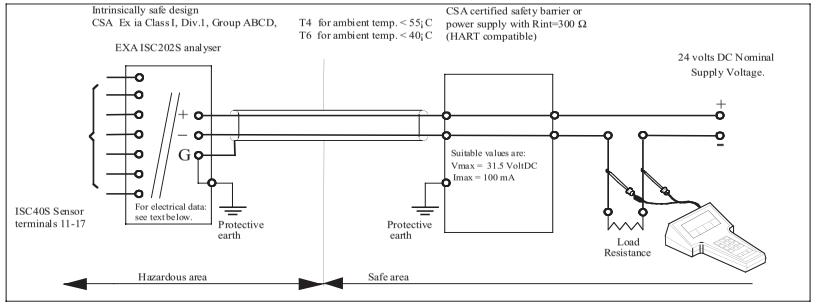
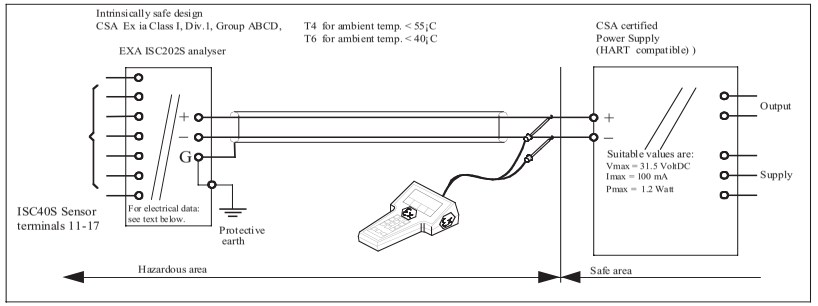
	Date : 27/07/2004





- Electrical data of the EXA ISC202S :

- 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 17):
  Maximum output voltage V_{oc} = 14.4 V.
  Maximum output current I_{sc} = 88 mA.
  Maximum allowed external capacitance C_a = 600 nF.
  Maximum allowed external inductance L_a = 4,5 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 17) is non-incendive having the parameters :
  Maximum output voltage V_{oc} = 14.4 V.
  Maximum output current I_{sc} = 88 mA.
  Maximum allowed external capacitance C_a = 3,5 F.
  Maximum allowed external inductance L_a = 10 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 ISC202S-A** **Model EXA ISC202S-N**
Title : Installation Drawing ISC202S CSA	
Number : FF1-ISC202S-00	**Page : 3 of 10**
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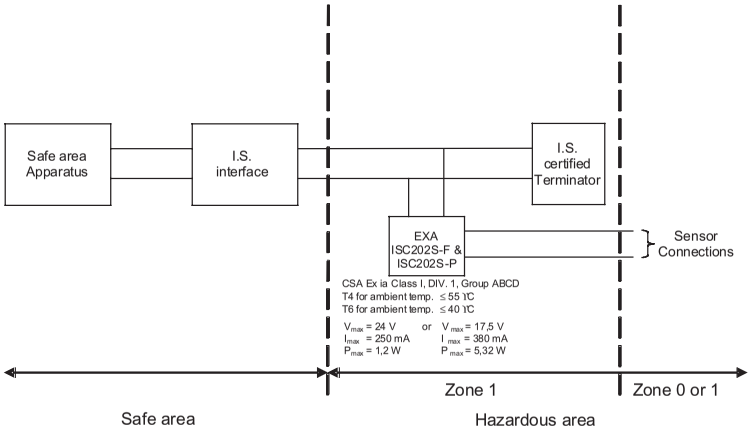

〈 Sensor(s) are a thermocouple, RTD's, passive resistive switch devices, or is CSA entity approved and meet connection requirements.

〈 Electrical data of the EXA ISC202S-F & ISC202S-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; Effective internal inductance Li=2.6 µH.

- Sensor input circuit:
  Maximum output voltage Voc=14.4 V; Maximum output current Isc=88 mA
  Maximum allowed external capacitance Ca=600 nF
  Maximum allowed external inductance La=4.5 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, Pa rt 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 .4 V; Maximum output current Isc=88 mA
Maximum allowed external capacitance Ca=3.5 F
Maximum allowed external inductance La=10 mH

Stamp Company :	**Stamp Certification Institute :**
Signature :	**Remarks :** **Model EXA ISC202S-F** **Model EXA ISC202S-B** **Model EXA ISC202S-P** **Model EXA ISC202S-D**
Title : Installation Drawing ISC202S CSA	
Number : FF1-ISC202S-00	**Page : 4 of 10**
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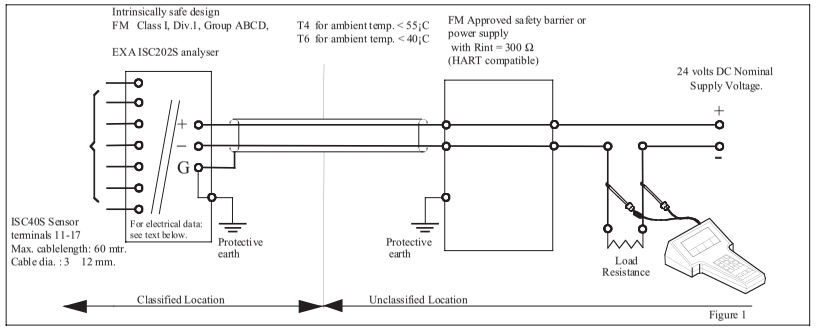

Figure 1

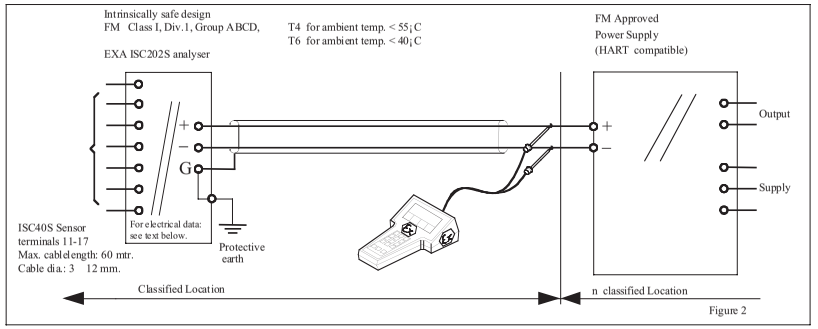

Figure 2

- Electrical data of the EXA ISC202S :
  - 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 17):
    Maximum output voltage V_t = 14.4 V.
    Maximum output current I_t = 88 mA.
    Maximum allowed external capacitance C_a = 600 nF.
    Maximum allowed external inductance L_a = 4,5 mH.
- If Hand Held Terminal (HHT) is not connected to the power supply lines of the EXA ISC202S (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 ISC202S (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 ISC202S-A** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing ISC202S-A (Intrinsic Safety)	
Number : FF1-ISC202S-00	**Page : 5 of 10**
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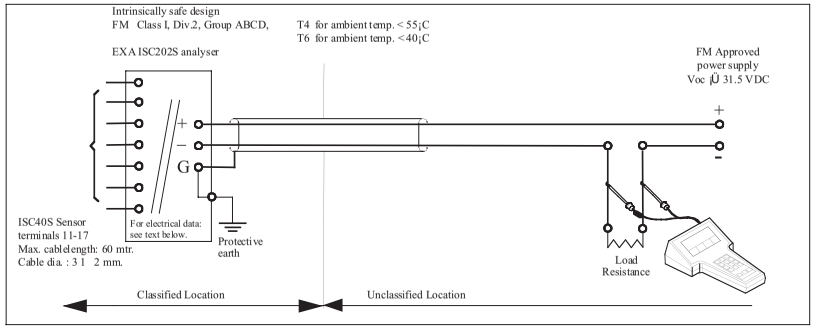

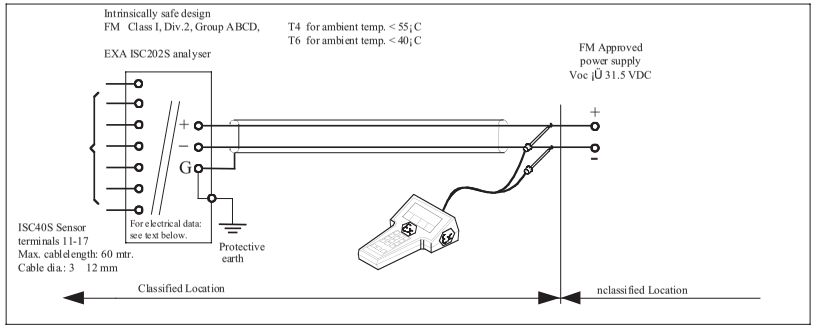

- Electrical data of the EXA ISC202S :
  - Supply circuit (terminals + and -):
    Maximum input voltage V_{max} = 31.5 V.
    Maximum input power Pi = 1.2 W
    Effective internal capacitance Ci = 22 nF
    Effective internal inductance Li = 22 H
  - Sensor input circuit (terminals 11 through 17):
    Maximum output voltage V_t = 14.4 V.
    Maximum output current I_t = 88 mA.
    Maximum allowed external capacitance C_a = 3,5 F.
    Maximum allowed external inductance L_a = 10 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 ISC202S-N** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing ISC202S-N (Non-incendive)	
Number : FF1-ISC202S-00	**Page : 6 of 10**
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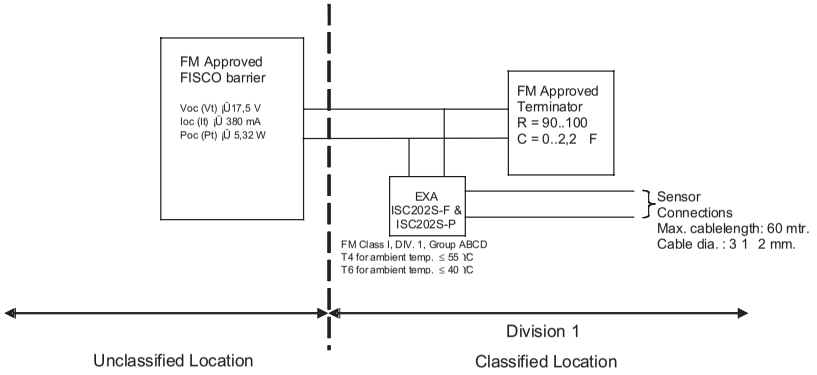

〈 Sensor(s) are of a passive type to be regarded as 'simple apparatus', devices which neither store nor generate voltages over 1.5 V, currents over 0.1 A, power over 25 mW or energy over 20 µJ, or are FM Approvals entity approved and meet connection requirements.

〈 Electrical data of the EXA ISC202S-F & ISC202S-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=88 mA; Ca=600 nF; La=4.5 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 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 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 vol tage (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 provid ede 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 followin g 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 ISC202S-F** **Model EXA ISC202S-P** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing ISC202S-F & ISC202S-P (Intrinsic safe Fisco concept)	
Number : FF1-ISC202S-00	**Page : 7of 10**
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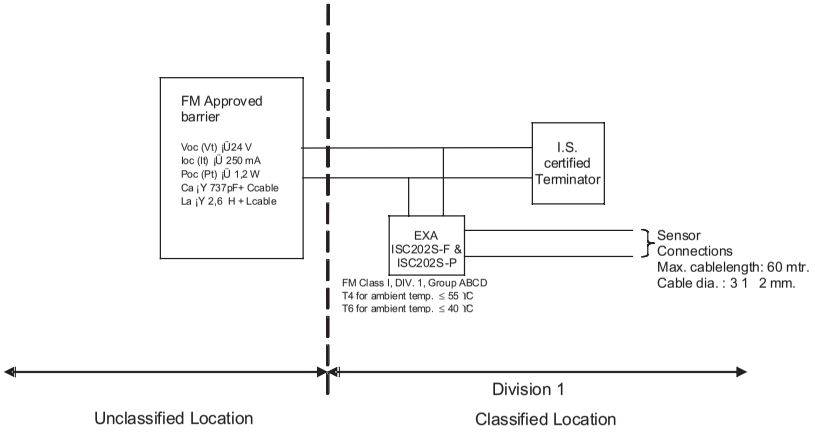

〈 Sensor(s) are of a passive type to be regarded as 'simple apparatus', devices which neither store nor generate voltages over 1. 5 V, currents over 0.1 A, power over 25 mW or energy over 20 µJ, or are FM Approvals entity approved and meet connection requirements.

〈 Electrical data of the EXA ISC202S-F & ISC202S-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= 737 pF; Effective internal inductance Li=2.6 µH.
- Sensor input circuit:
  Maximum output voltage Vt=14.4 V; Maximum output current It=88 mA
  Maximum allowed external capacitance Ca=600 nF
  Maximum allowed external inductance La=4.5 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 ISC202S-F** **Model EXA ISC202S-P** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing ISC202S-F & ISC202S-P (Intrinsic safe Entity concept)	
Number : FF1-ISC202S-00	**Page : 8 of 10**
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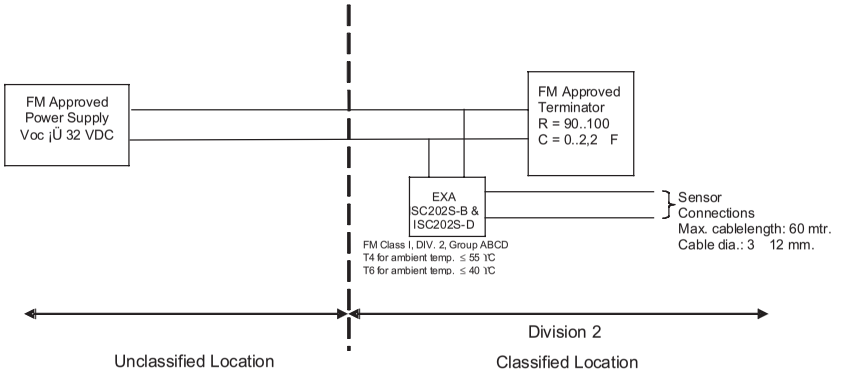
	Date : 27/07/2004



〈 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 ISC202S-B & ISC202S-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=88 mA; Ca=3,5 F; La=10 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 ISC202S-B** **Model EXA ISC202S-D** **No revision to drawing without prior FM Approval**
Title : FM Control Drawing ISC202S-B & ISC202S-D (Non-incendive Entity concept)	
Number : FF1-ISC202S-00	**Page : 10 of 10**
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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 mtr (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 section 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).

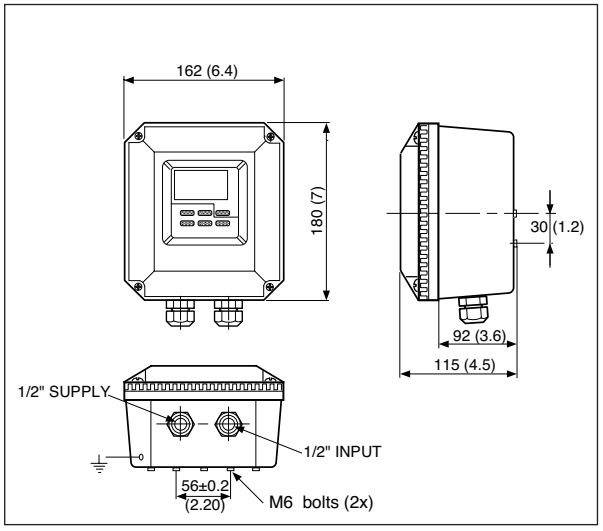


Fig. 3-1. Housing dimensions and layout of glands

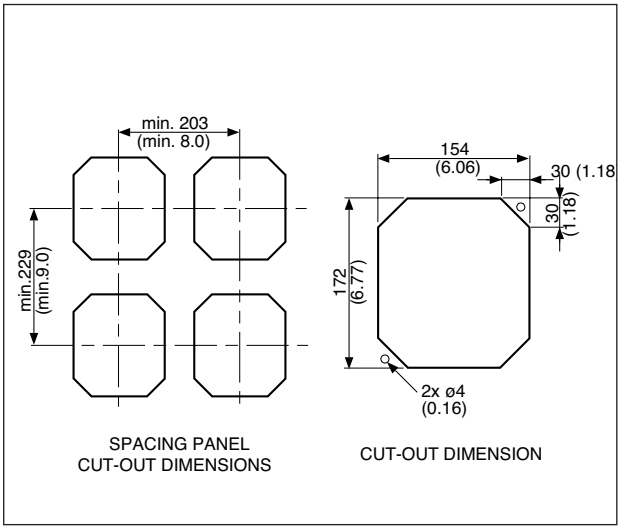


Fig. 3-2. Panel mounting diagram

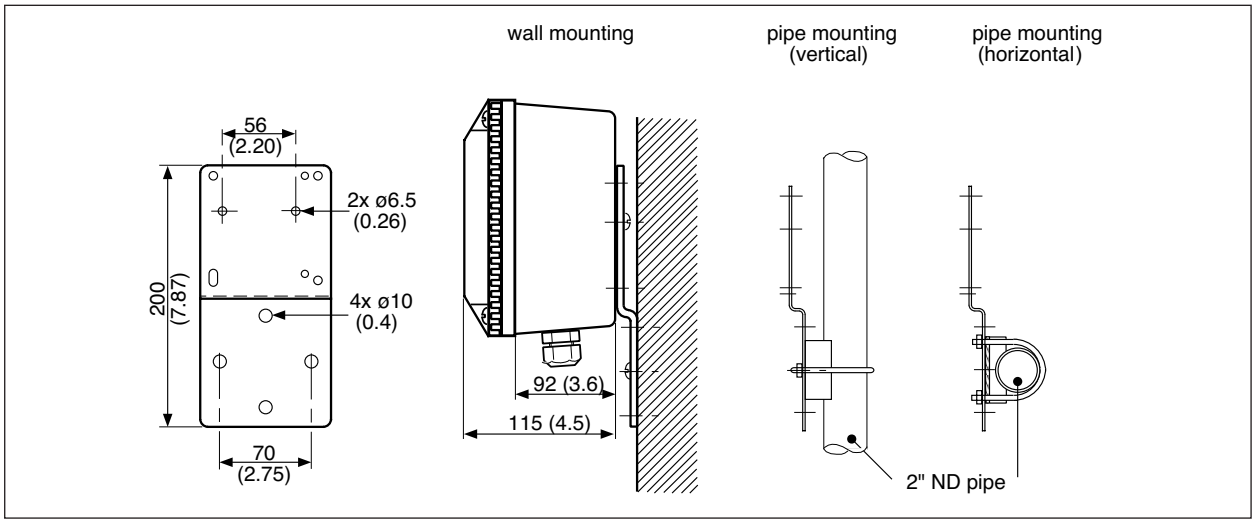


Figure 3-3. Wall and pipe mounting diagram

Figure 3-4. Internal view of EXA wiring compartment

mA 3-2. Preparation

The power/output connections and the sensor connections should be made in accordance with figure 3-5. . The terminals are of a plug in style for ease of mounting.

To open the EXA 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.

3-2-1. Cables, terminals and glands

The EXA 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).

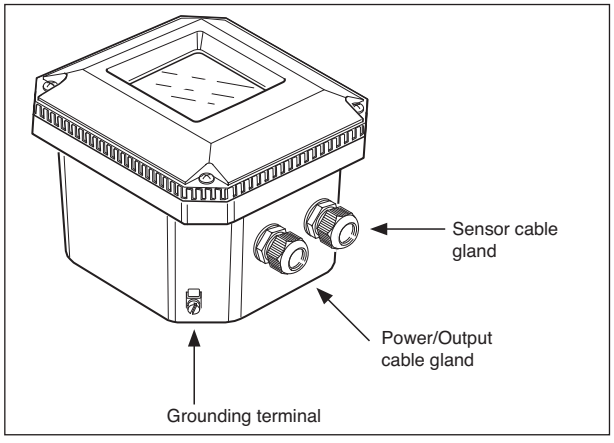


Figure 3-5. Glands to be used for cabling

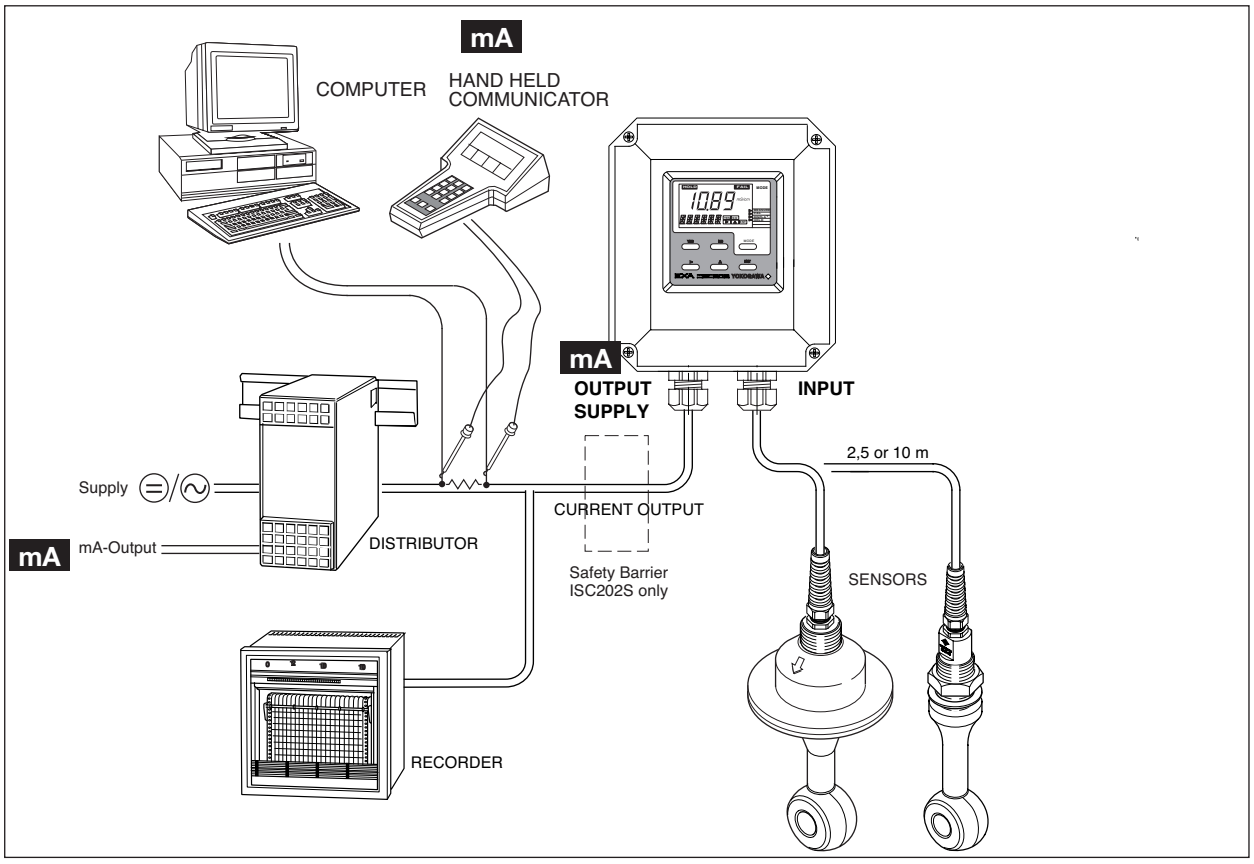


Figure 3-6. System configuration

3-3. Wiring of sensors

3-3-1. General precautions

Generally, transmission of signals from Inductive Conductivity 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 the 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

Make sure that the total of capacitances and inductances connected to the input terminals of the EXA ISC202S 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 ISC202S instrument can be mounted in Zone 1.
- The sensor 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 ISC202S 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 EXA ISC202S-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 the power supply

WARNING 3-4-1 General precautions

First make sure that the DC-power supply is according the specifications given.

DO NOT USE ALTERNATING CURRENT OR MAINS POWER SUPPLY! !

The cable leading to the distributor (power supply) or safety barrier transports power to an 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 mtr, or 1500 mtr 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 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 3-8.

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.

3-5. Sensor wiring
Refer to figure 3-7, which includes drawings that outline sensor wiring.

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

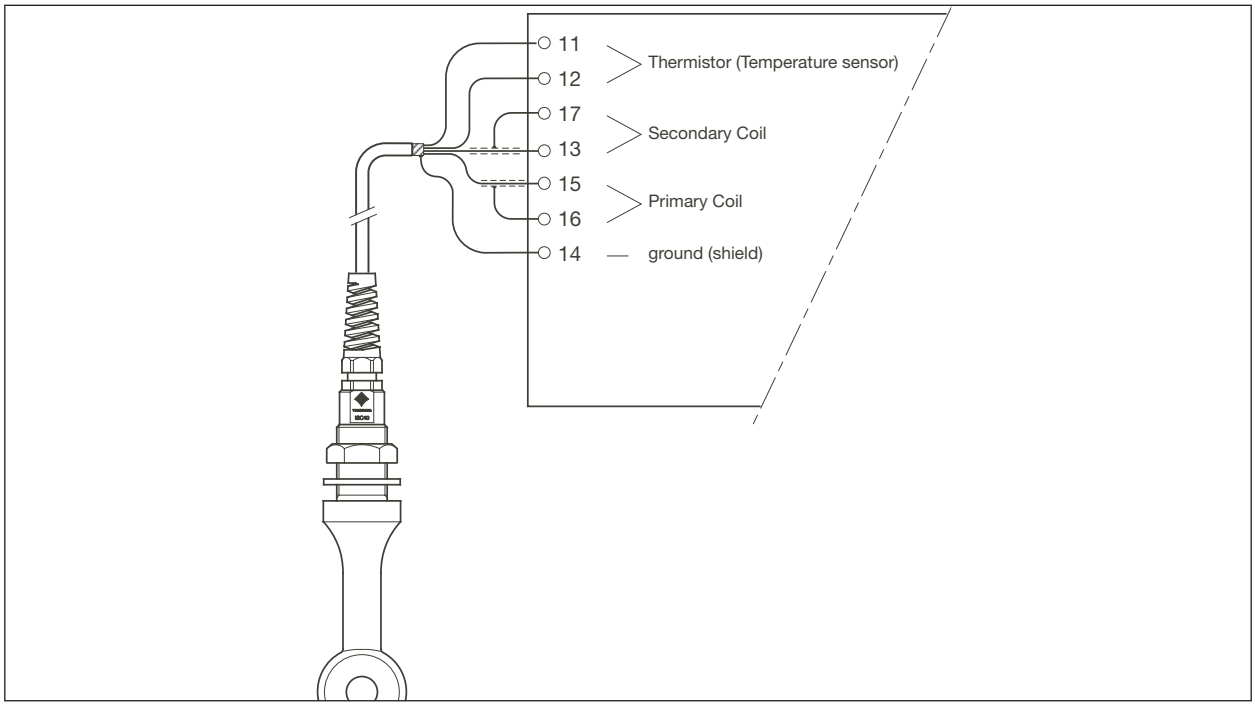


Figure 3-7. Sensor wiring diagrams

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 17 : Used for the secondary 'collector' coil.
15 and 16 : Used for the primary 'drive' coil.
14 : Overall screen

Figure 3-8. 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 mtr (e.g. 5 m fixed cable and 55 m extension cable).

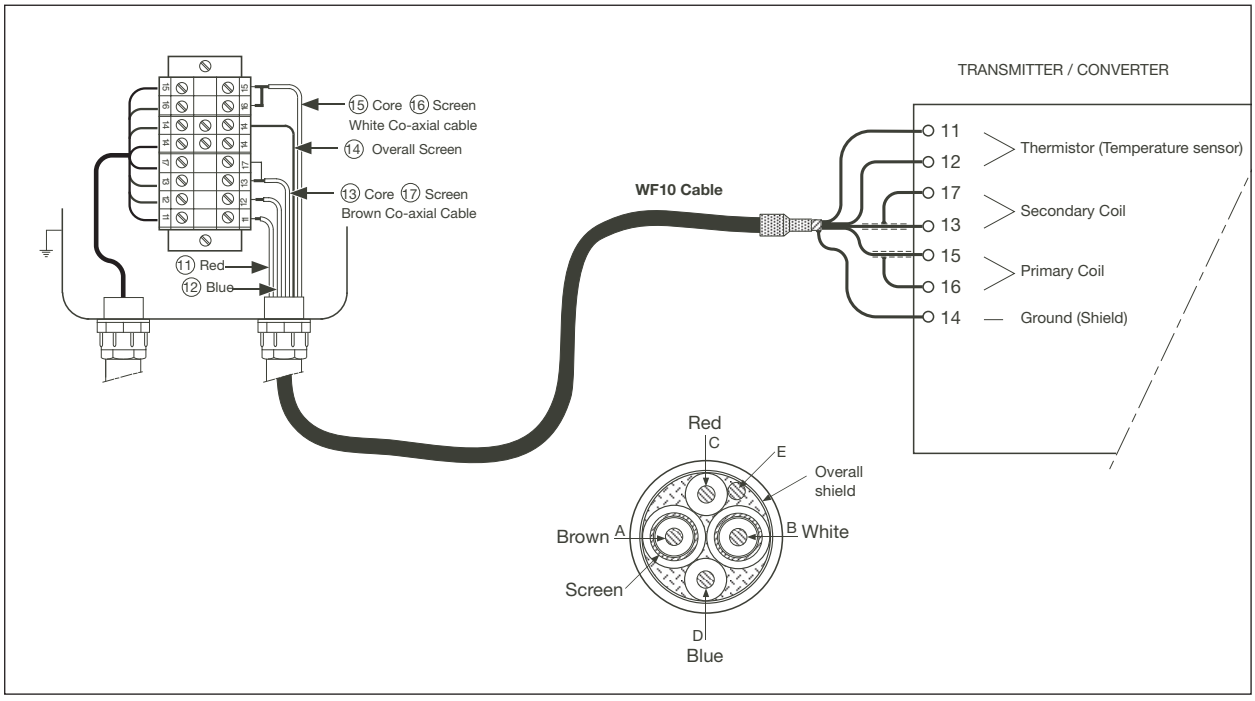
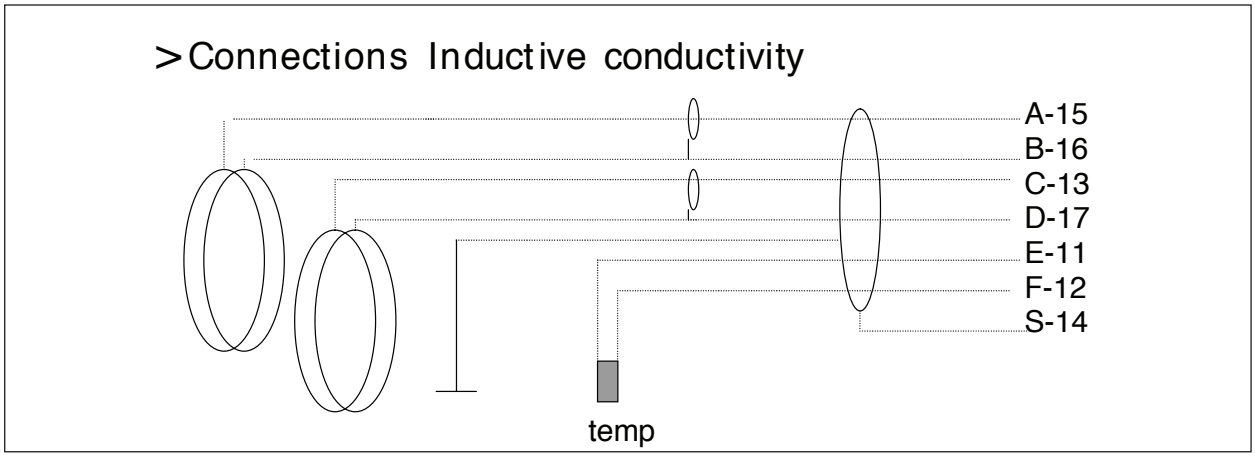


Fig. 3-9. Connection of WF10 extension cable and BA10/BP10 junction box



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.

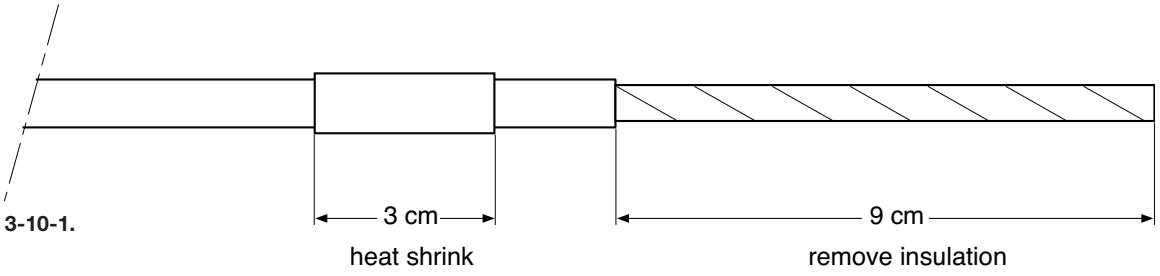


Fig. 3-10-1.

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.

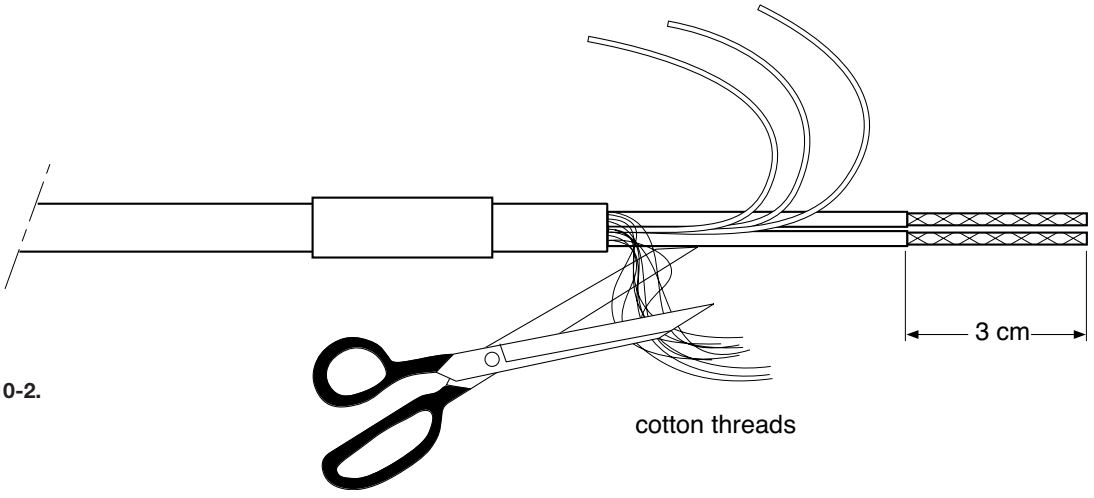


Fig. 3-10-2.

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.

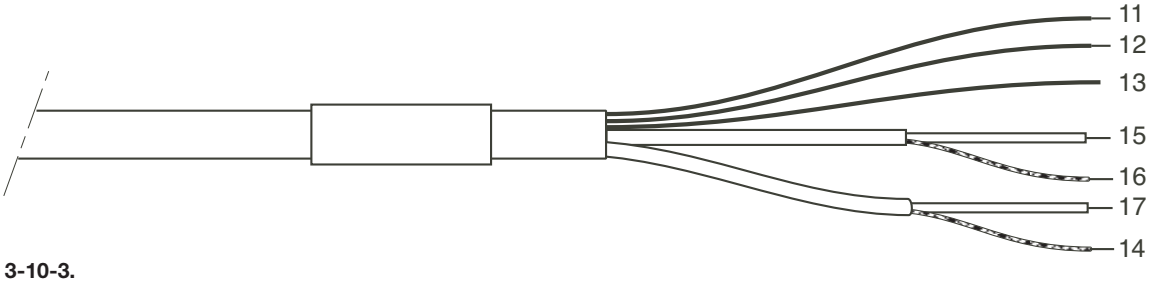


Fig. 3-10-3.

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	Section
Maintenance	CALIB	Calibration with a standard solution or sample	6
	DISPLAY 1&2	Read auxiliary data or set message display	4, 5
	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

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.

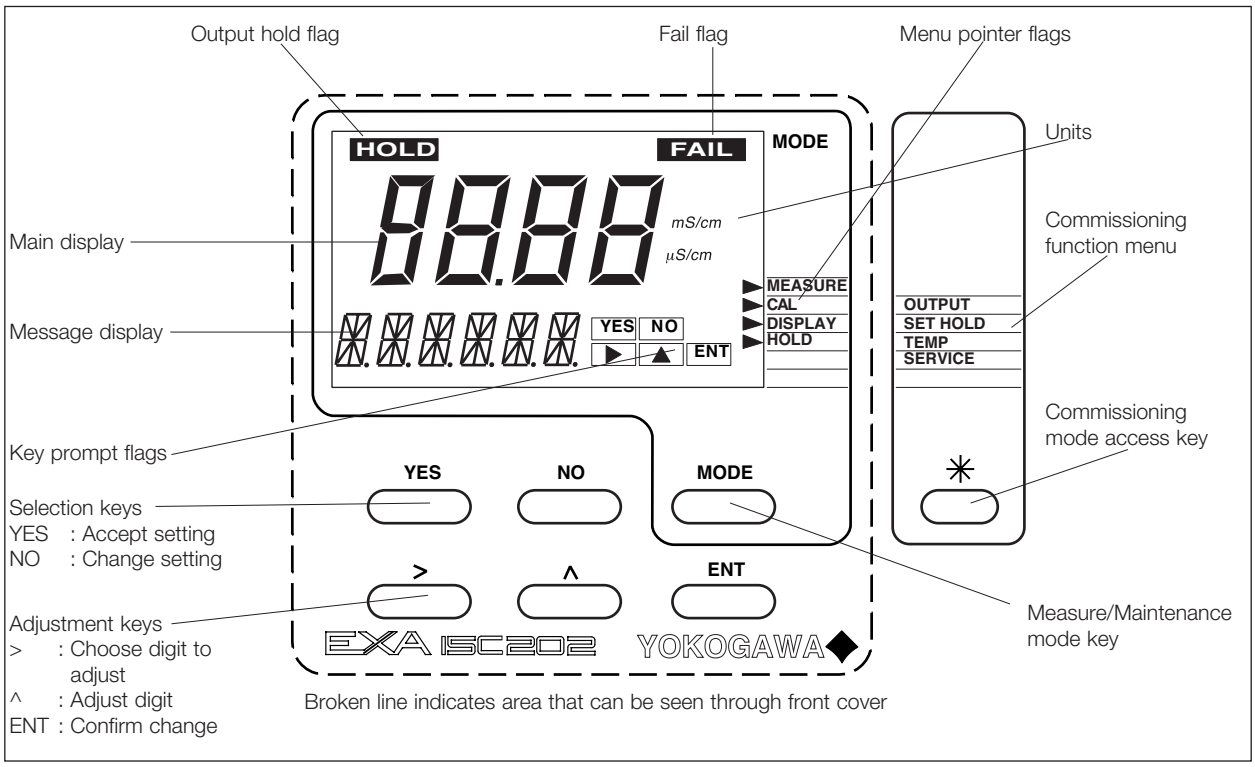


Figure 4-1. ISC202 operator interface

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, section 5.2)
HOLD - (only when enabled, section 5.2)

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 ▶ ▲ 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 the passcode protection for each one of the three operating 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.

5. Parameter setting

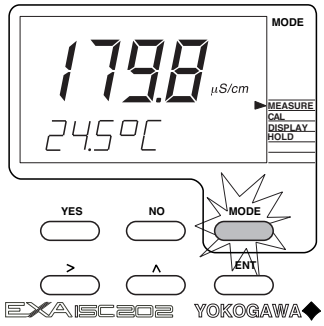
5-1. Maintenance mode

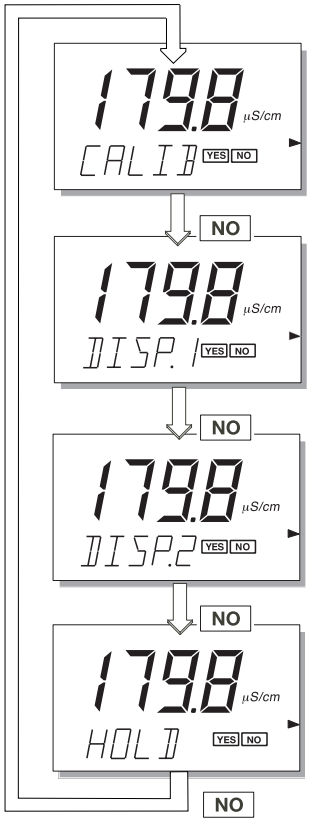
5-1-1. Introduction

Standard operation of the EXA transmitter 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 5-6)

Calibrate : See 'calibration' section 6.
Display setting : See 'operation' section 5-1-3, 5-1-4
Hold : Manually switch on/off 'hold' (when enabled in commissioning menu see section 5-2-2)





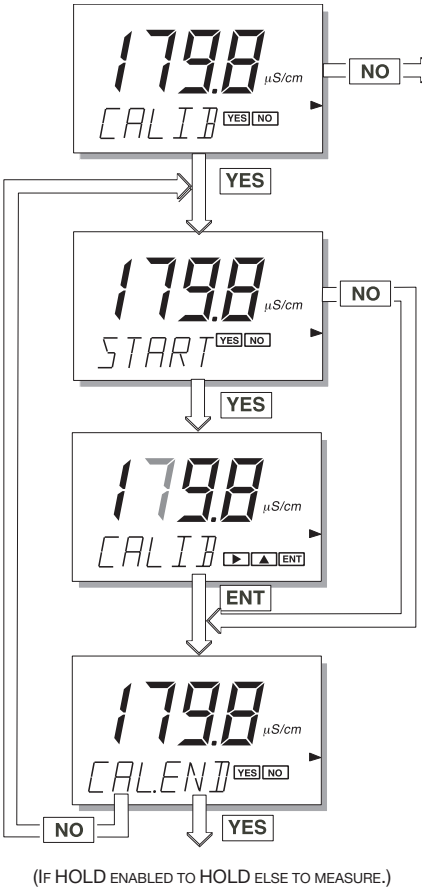
Press the **MODE** key

Only if enabled in commissioning mode section 5-2

mA

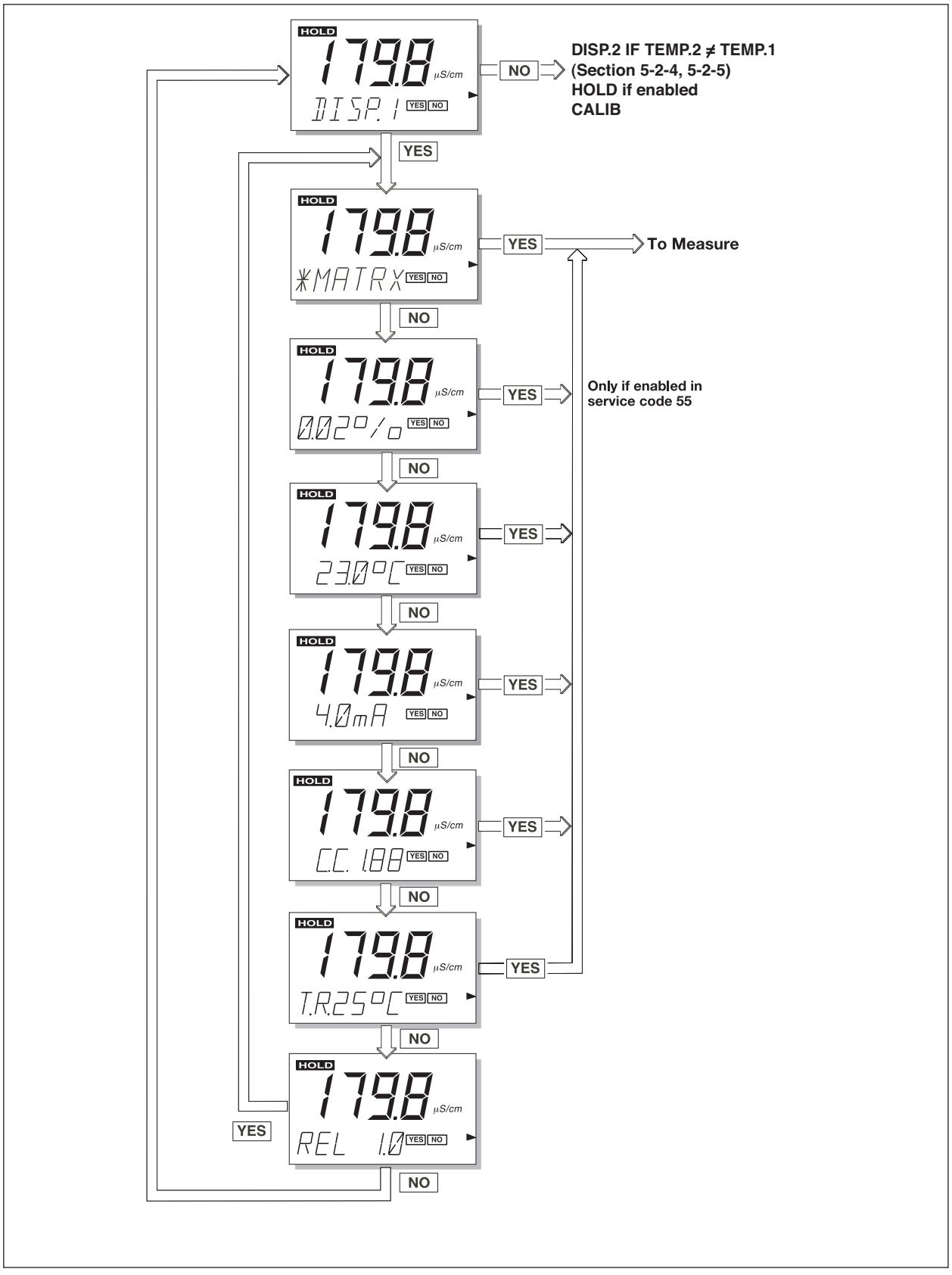
Only if enabled in commissioning mode section 5-2

5-1-2. Manual calibration to determine the cell constant (C.C.)

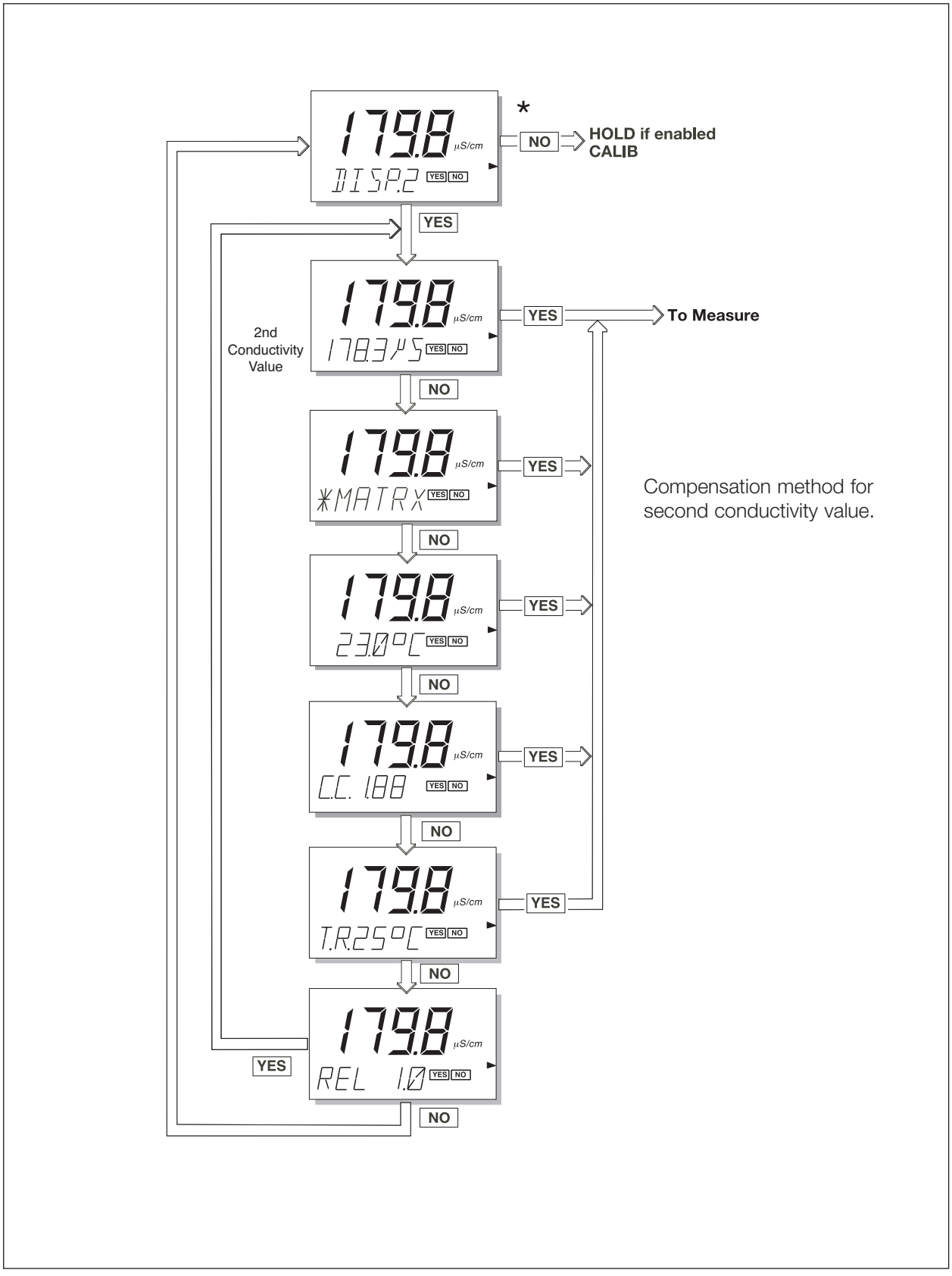


Enter the Conductivity value of the sample at reference temperature

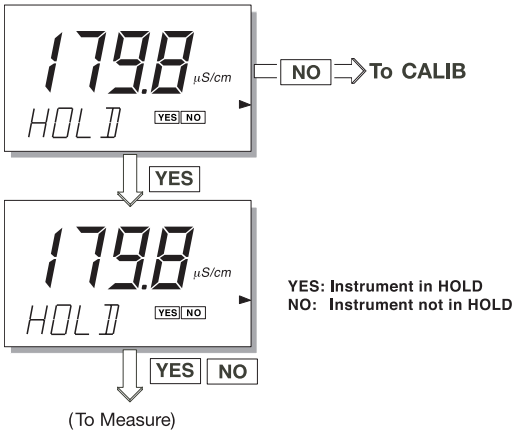
5-1-3. Second Line display. Referring to the first compensated conductivity.



5-1-4. Second Line display. Referring to the second compensated conductivity.



mA 5-1-5. Manual activation of HOLD



This option is only available if HOLD is enabled in Section 5-2.

5-2. Commissioning mode

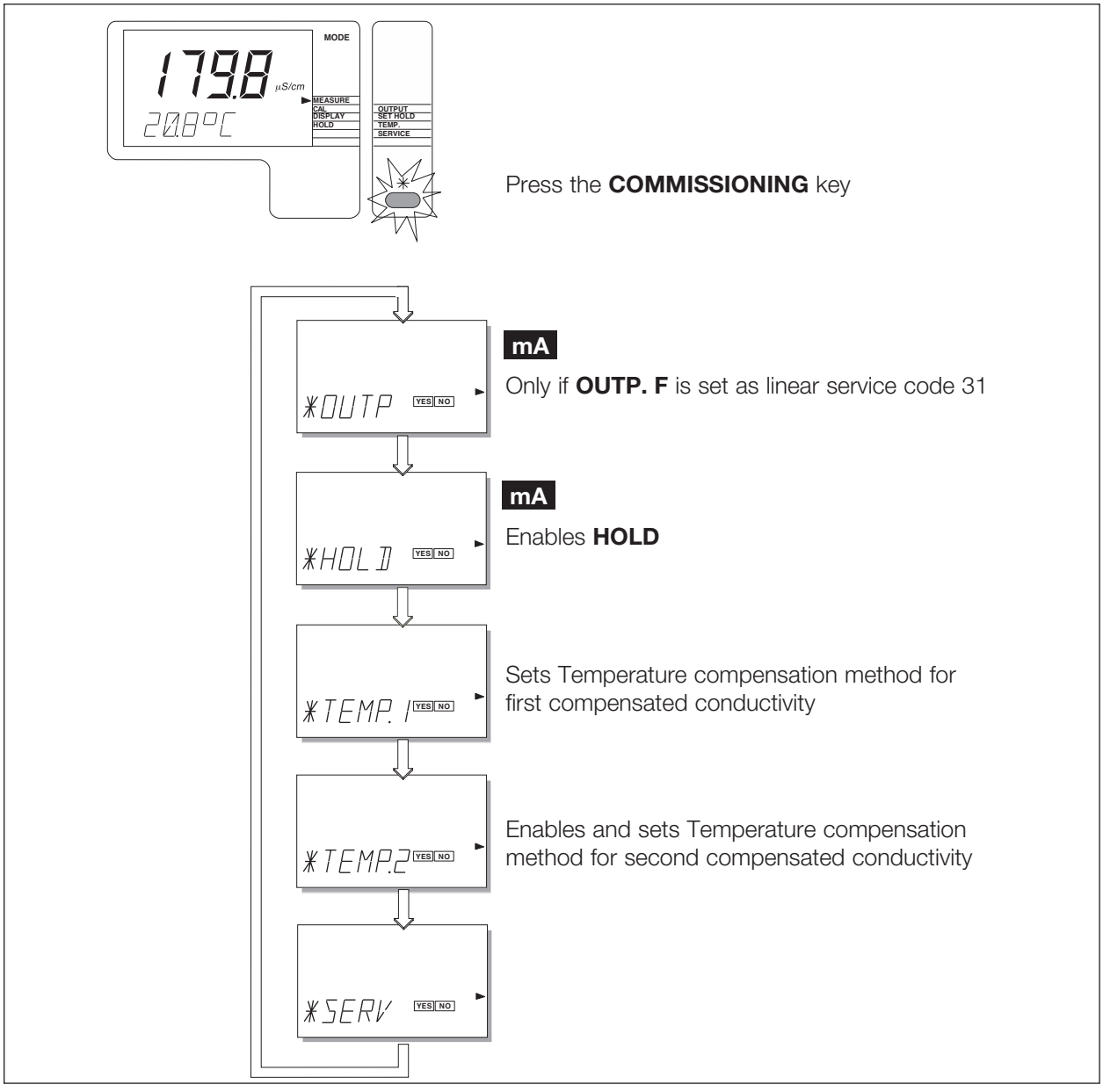
In order to obtain peak performance from the EXA ISC202, you must set it up for each custom application.

mA Output ranges : mA output is set as default to 0-1000 mS/cm.
For enhanced resolution in more stable measuring processes, it may be desirable to select for example 0-100 µS/cm range.

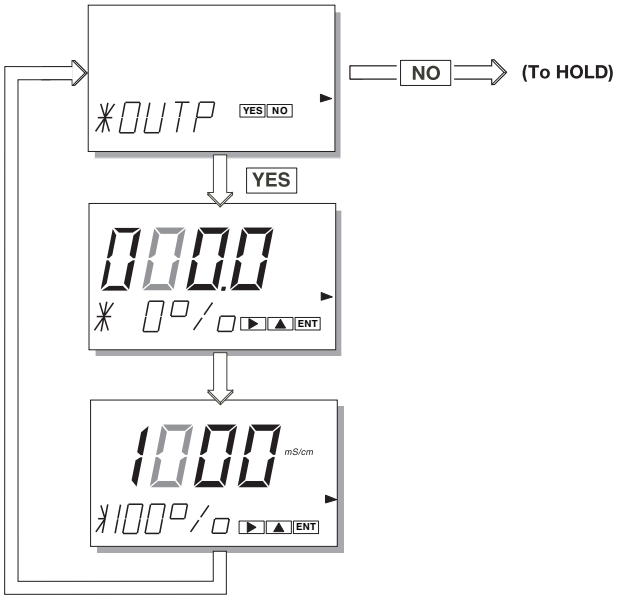
mA Hold : The EXA ISC202 transmitter has the ability to 'HOLD' the output during maintenance periods. This parameter should be set up to hold the last measured value, or a fixed value to suit the process (Section 5-2-2).

Temp1/2 : First/second temperature compensation types and values (see section 5-2-4 and 5-2-5).
* NaCl is used for neutral salt solutions. Strong solutions of salts are compensated, as are process waters, pure, and ultrapure water.
* TC temperature coefficient compensation uses a linear temperature compensation factor. This can be set by calibration (section 5) or configuration (service code 21).
* MATRIX compensation is an extremely effective way of compensation. Choose from standard matrix tables, or configure your own to exactly suit your process.
The default setting for TEMP1 and TEMP2 is NaCl. TEMP2 is enabled when it is not equal to TEMP1.

Service : This selection provides access to the service menu.

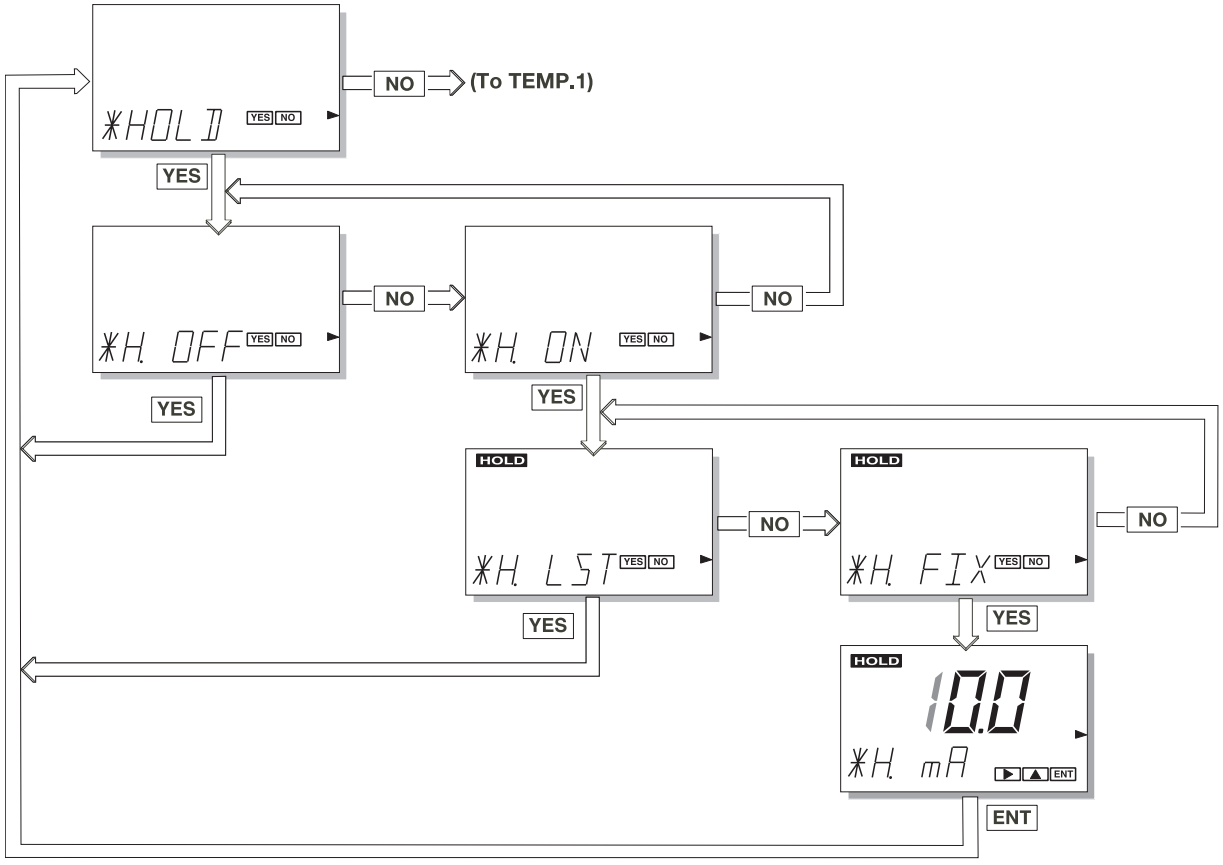


mA 5-2-1. Linear output (Range)



Note: 0% corresponds to 4 mA
100% corresponds to 20 mA

mA 5-2-2. HOLD



Here HOLD is enabled/disabled.

When enabled:

- The analyser's output will be set to HOLD when entering Maintenance-, Commissioning- or Service menu.
- Up on exiting one of the menus, the user is asked if HOLD should remain activated.
- Manual Hold will become available in "maintenance Mode" (to manually set the analyser's output in HOLD)

5-2-3. Temperature compensation

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 per °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.

1 Standard temperature compensation (NaCl)
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.

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				

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

2-A. Calculation of Temperature Coefficient Factor (α)
(With known conductivity at reference temperature).

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

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

2-B. Calculation of Temperature Coefficient Factor (TC)
(with two known conductivity values at different temperatures)
Measure the conductivity of the liquid at two temperatures, one below the reference and above the reference temperature with the temperature coefficient set to 0.00% per °C and use the following equation to calculate a temperature coefficient (α).

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

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

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

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

$$\alpha = \frac{K_2 - K_1}{K_1 (T_2 - T_{ref}) - K_2 (T_1 - T_{ref})} \times 100\%$$

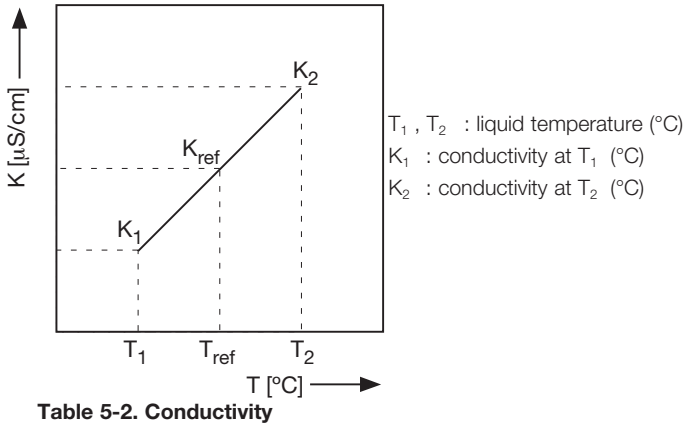


Table 5-2. Conductivity

Calculation example
Calculate the temperature co-efficient of a liquid from the following data.
Conductivity 124.5 µS/cm at a liquid temperature of 18.0 °C and a conductivity 147.6 µS/cm at a liquid temperature of 31.0 °C.

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

mA

$$\alpha = \frac{147.6 - 124.5}{124.5(31.0 - 25) - 147.6(18.0 - 25)} \times 100\% = 1.298\%/\,^{\circ}C$$

Set the temperature coefficient in the EXA transmitter.

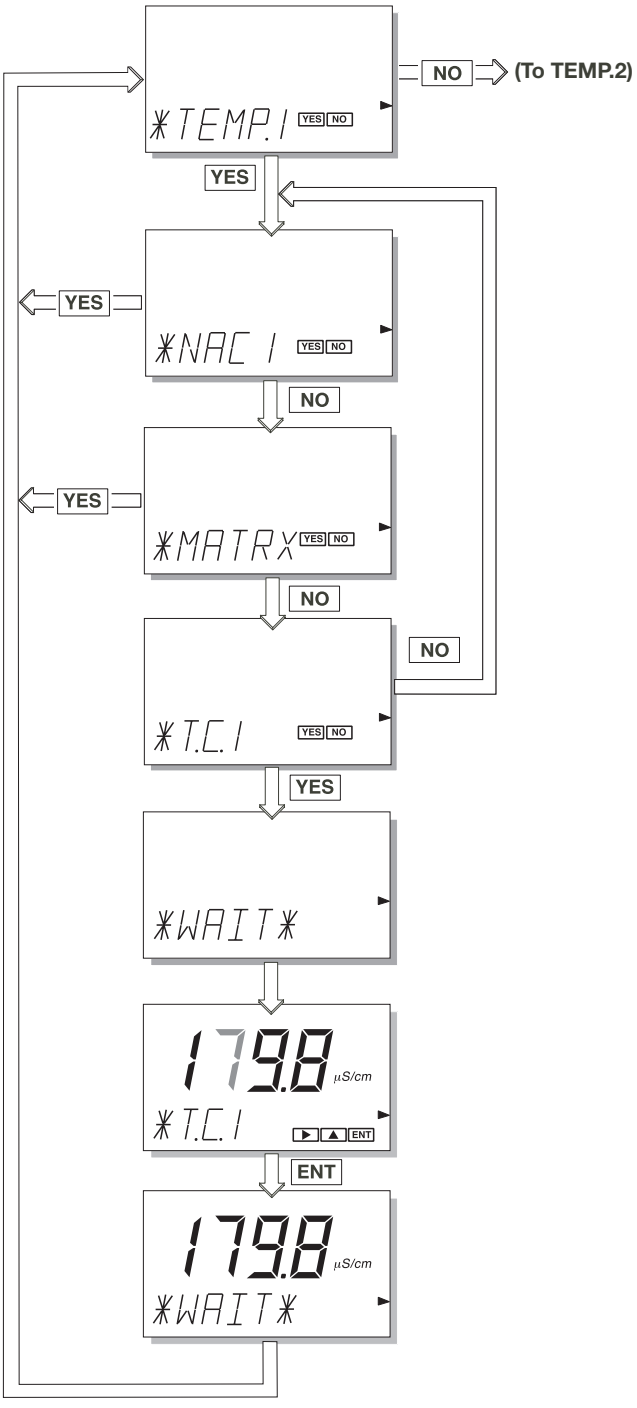
2-C. Checking
When the temperature coefficient already set is accurate, the conductivity to be displayed must be constant regardless of liquid temperature. The following check will make sure that the temperature coefficient already set is accurate.
If, when the liquid temperature is lowered, a larger conductivity value is indicated, the temperature coefficient already set is too small.
The opposite also applies. If a smaller conductivity value is indicated, the temperature coefficient already set is too large. In either case, change the temperature coefficient so that the conductivity no longer changes.

3. Matrix compensation
The compensation matrix is a table of temperature and conductivity values at differing concentrations. These values are used to calculate the temperature compensation applicable for a particular solution. Choose the component that you will be measuring in your application, and where appropriate the concentration range. EXA will do the rest.

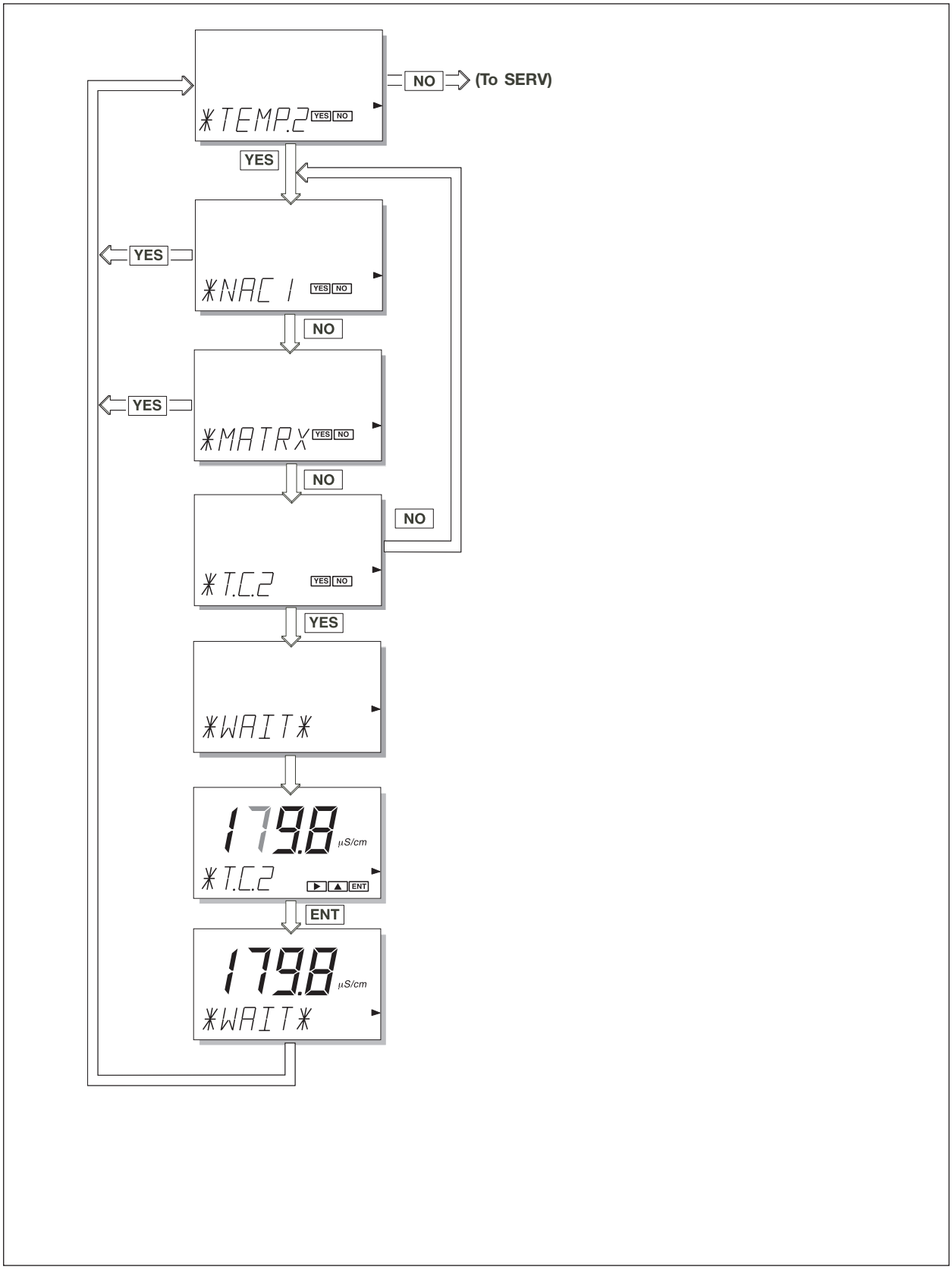
4. Manual temperature compensation (Section 5-2-4 and 5-2-5)
If the standard compensation function is found to be inaccurate for the sample to be measured, the transmitter can be set manually for a linear factor on site to match the application.
The procedure is as follows:
1. Take a representative sample 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.

5. Other possibilities (section 5-3)
1. Enter calculated coefficient.
2. Enter matrix temperature compensation.

5-2-4. Temperature compensation for first conductivity value



5-2-5. Temperature Compensation for second conductivity value



5-3. Service Codes

5-3-1. Parameter specific functions

Code 3	C.C.	Enter the factory calibrated cellconstant mentioned on the textplate or on the fixed cable. This avoids the need for calibration. Any value between 0.2 and 50.0/cm may be entered.
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.

5-3-2. Temperature measuring functions

Code 10	T.SENS	Selection of the temperature compensation sensor. The default selection is the 30k NTC sensor, which gives excellent precision with the two wire connections used. The other option gives the flexibility to use a very wide range of other conductivity/inductive 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	
Parameter specific functions								
03	*C.C.	Set cell constant	Use ▶ ▲ ENT keys to set value				1.88	/cm
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					

Code	Display	Function	Function detail	X	Y	Z	Default values	
Temperature measuring functions								
10	*T.SENS	Temperature sensor	30k NTC Pt1000	0 1			0	30k NTC
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. Set value relative to current temperature Use ▶ ▲ ENT keys to adjust value				0.0	ºC

5-3-3. 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: -30 to 150 °C.
If T.UNIT in code 11 is set to °F, default value is 77°F and the limitations are -22 - 302°F.

Code 21 T.C.1/T.C.2 — In addition to the procedure described in section 5-2-4 and 5-2-5 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. Matrix data is exeplified in Appendix 11-3

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 ºC are valid values for the T1....T5. The minimum span for the range (T5 - T1) is 25 °C. The valid range for a temperature value is -30º to 150ºC.

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 0.5 - 5% H_2SO_4 solution for a temperature range from 0 - 100 °C. Conductivity range from 0.0 µS/cm to 1999 mS/cm.

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. Default of user adjustable matrix

			T1	**T2**	**T3**	**T4**	**T5**
			0 °C	25 °C	50 °C	75 °C	100 °C
Code 24	Solution 1	L1	33.8 mS/cm	47.0 mS/cm	57.5 mS/cm	63.7 mS/cm	68.0 mS/cm
Code 25	Solution 2	L2	63.5 mS/cm	92.3 mS/cm	112.5 mS/cm	126.0 mS/cm	137.5 mS/cm
Code 26	Solution 3	L3	95.0 mS/cm	135.3 mS/cm	166.0 mS/cm	188.5 mS/cm	206.0 mS/cm
Code 27	Solution 4	L4	124.5 mS/cm	178.0 mS/cm	220.0 mS/cm	249.0 mS/cm	273.0 mS/cm
Code 28	Solution 5	L5	154.0 mS/cm	218.0 mS/cm	270.0 mS/cm	307.0 mS/cm	336.0 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					2.10 % 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					2.10 % per °C
22	*MATRx	Select matrix	Choose matrix if set to matrix comp. in section 5-2-5, using ▶ ▲ ENT keys H_2SO_4, 0 -100ºC, 0.5 - 5% H_2SO_4, 0 -100ºC, 2.5 - 25% HCl, 0 - 60ºC, 0.5 - 5% HCl, 0 - 60ºC, 1 - 20% HNO_3, 0 - 80ºC, 0.5 - 5% HNO_3, 0 -80ºC, 2.5 - 25% NaOH, 0 -100ºC, 0.5 - 5% NaOH, 0 -100ºC, 0.5 - 15% User programmable matrix	 1 2 3 4 5 6 7 8 9			1	H_2SO_4
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 5-3-4. mA output functions

Code 31 OUTP.F For the ISC202 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.

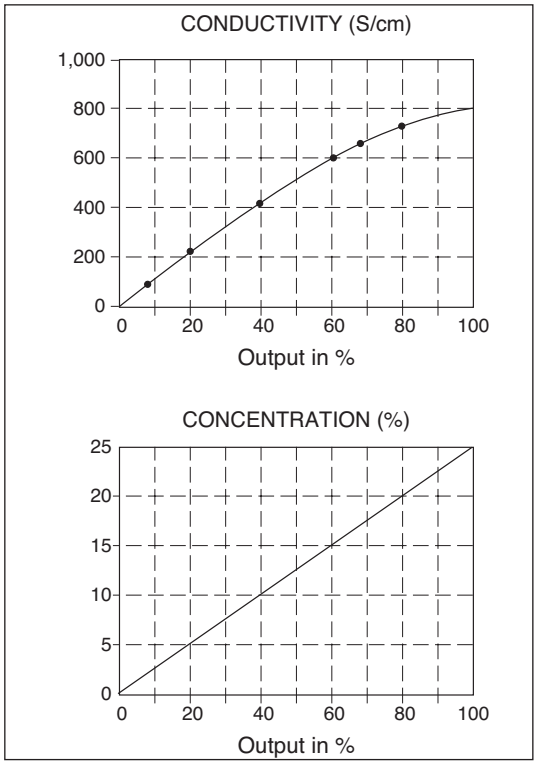


Fig. 5-1. Linearization of output
Example: 0-25% Sulfuric acid

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	Linearisation 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.					
36-49			Not used					

5-3-5. 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	*Err05	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. E5 (High) is default set to 3 S and must be in the range of 0.10 S to 9.99 S. E6 (Low) is default set to 5 µS and must be in the range of 0.00 µS to 99.9 µS. * to disable the E5/E6 diagnostics the limit must be set to 0 (zero).
Code 55	*%	Linear weight percentage. 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 5 possibilities.

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.05	Error setting	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
54	*E5.L S	E5 limit setting	Maximum conductivity value				3	S
	*E6.LIM	E6 limit setting	Minimum conductivity value				5	µS
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 XXX.X µS/cm	3				
			Display fixed to X.XXX mS/cm	4				
			Display fixed to XX.XX mS/cm	5				
			Display fixed to XXX.X mS/cm	6				
			Display fixed to XXXX mS/cm	7				
57-59			Not used					

5-3-6. 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 PH 201*B distribution (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.

5-3-7. 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.

	Code	Display	Function	Function detail	X	Y	Z	Default values	
	Communication								
mA	60	*COMM.	Communication	Set HART® communication off	0			1.0	On
				Set HART® communication on	1				
				Set communication PH 201*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 ▶ ▲ 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					

6. Calibration

6-1 When is calibration necessary?

Calibration of conductivity 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 directly can be entered 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 refered 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 visualised. 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 stabilised 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) and Potassium cholide (KCl) solutions which can be made up in a laboratory.

Table 6-1. NaCl values at 25 °C (IEC 746-3)

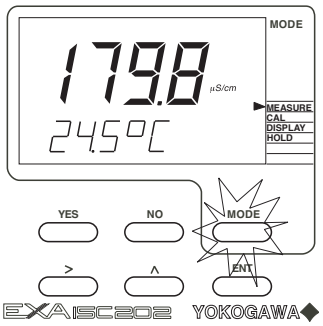
Weigth %	mg/kg	Conductivity
0.001	10	21.4 µS/cm
0.003	30	64.0 µS/cm
0.005	50	106 µS/cm
0.01	100	210 µS/cm
0.03	300	617 µS/cm
0.05	500	1.03 mS/cm
0.1	1000	1.99 mS/cm
0.3	3000	5.69 mS/cm
0.5	5000	9.48 mS/cm
1	10000	17.6 mS/cm
3	30000	48.6 mS/cm
5	50000	81.0 mS/cm
10	100000	140 mS/cm

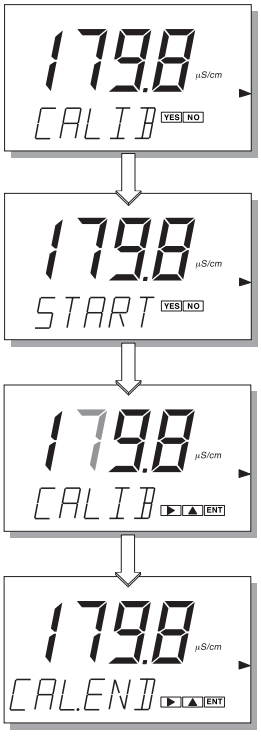
Table 6-2. KCl values at 25 °C

Weigth %	molal (m)	mg of KCl / kg of solution	Conductivity
0.3	0.001	74.66	0.1469 mS/cm
0.5	0.002	149.32	0.2916 mS/cm
1	0.005	373.29	0.7182 mS/cm
3	0.01	745.263	1.4083 mS/cm
5	0.1	7419.13	12.852 mS/cm
10	1.0	71135.2	111.31 mS/cm

The table is derived from the Standards laid down in 'International Recommendation No. 56 of the Organisation Internationale de Métrologie Legale'.

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 it's value by pressing the ▲ key
When the correct value is displayed,
press **ENT** to enter the change

After briefly 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 dislay as described in section 5-1-2. and 5-1-3.
If the calibrated cell constant is not within the range of 0.2 - 50.0 cm^{-1}, error E3 is displayed.

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 (Section 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.

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

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

In general conductivity 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. Section 8 trouble- shooting).

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. Trouble shooting

8-1. Introduction

The EXA ISC202 microprocessor based conductivity analyser continuously monitors the condition of all key components of the measuring system to ensure that measurement is dependable. If a fault is detected this is immediatly signalled. Errors are shown on the display with a code. Table shows the errors which can be detected and gives information to help locate the fault or identify the error. Faults detected while the instrument is on line can also be signalled by a burnout (section 5-5).

8-2. Self diagnostics of the conductivity sensor

During measurement the instrument adjusts the measuring parameters to give the best conditions for the actual value being measured. At all values the instrument checks the signal from the cell to search for distortion. If there is a problem with the installation of the cell and this becomes defective this will trigger an error message on the display possibly accompanied by a by a burnout signal (section 5-5).

8-3. Self diagnostics of the temperature sensor

The temperature sensor, which is normally built into the conductivity cell, is checked to detect damage or faulty connections.

8-4. Self diagnostics of the electronics

The microprosessor opertion is checked by a watchdog which initiates an electronic reset if the normal functions suffers severe interference. During reset the instrument checks the program and all stored data. If a fault is then detected an alarm is given.

8-5. Checking during operation

Whenever the instrument is being programmed or calibrated, data is checked and an error is shown when appropriate. Should this occur the new data is rejected and the instrument continues to work with the previuos settings.

9 Error messages and explanation

Code	Error description	Possible cause	Remedy
E2	Wrong temperature coefficient	Incorrect data entry	See section 5-2-3, 5-2-4, 5-2-5
E3	Calibration out of range (>factor 10)	Wrong unit (mS vs µS) Defective sensor Standard error	See section 6-1, 6-2 Replace sensor Check standard
E4*	Impossible program for Temperature Compensation	Incorrect data in 5*5 Matrix in code 24-28	See section 5-3-3
E5*	Conductivity too high	Incorrect wiring defective sensor	Check wiring Replace sensor
E6*	Conductivity too low	Sensor not submersed Sensor plugged Incorrect wiring Defective sensor	Check installation Clean sensor Check wiring Replace sensor
E7*	Temperature too high	If 30k NTC Temperature < -30° (-22°F) If Pt 1000 Temperature > 150° (302°F)	Check wiring Replace sensor
E8*	Temperature too low	If 30k NTC Temperature > 150° (302°F) If Pt 1000 Temperature < -30° (-22°F)	Check wiring Replace sensor
E9*	Impossible AIR SET	Too high ZERO	Replace sensor
E10*	EEPROM write failure	Software problem	Unplug the unit, try again call Yokogawa Service
E15	Impossible adjustment Temperature	Abnormal cable resistance	Check reference see section 5-3-2
E17	Outspan span too small Temperature compensation span too small	Max. zero suppression is 90% Min. temperature span is 50°C	See section 5-2-1 See section 5-2-4, 5-2-5, 5-3-3
E18	Impossible program for Output table	Incorrect data in code 04	See section 5-3-3
E19	Programmed values not accepted	Values exceed preset limits	Try again, read instructions
E20*	DATA LOST	Unauthorized programming Software problem	The unit has to be reinitialized Call Yokogawa
E21	Corrupted Eprom	Software failure	Call Yokogawa

10. Spare Parts

Table 10-1. Itemised 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)	K1544DV
4	Digital (display) board	K1544DU
5a	Main (input) board assembly (general purpose)	K1544TK
6	Ribbon cable	K1544PH
7	EPROM	K1544BM
8	Lithium cell (battery)	K1543AJ
9	Terminals (block of 3)	K1544PF
10	Housing mA version	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

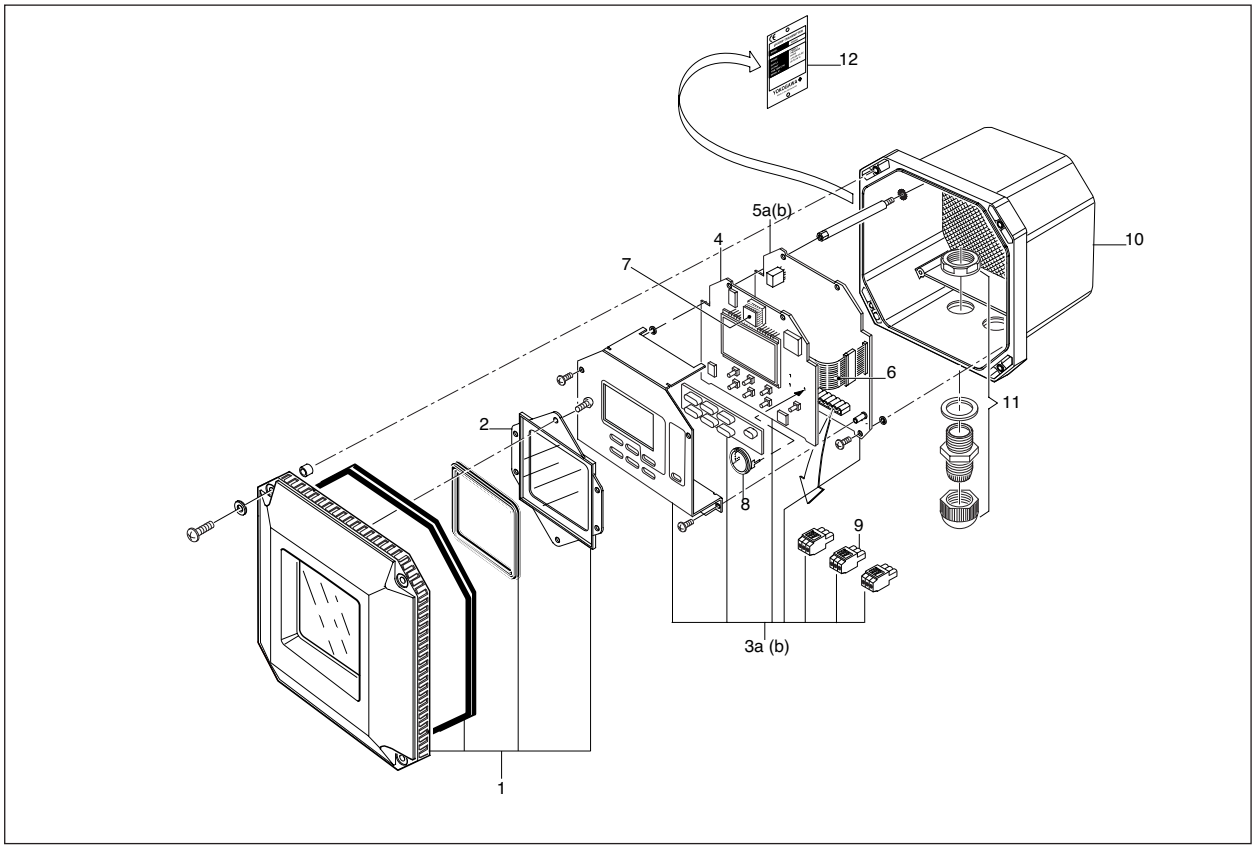


Fig. 10-1. Exploded view

mA 11 Appendix

11-1. User setting for non-linear output table (code 31, 35 and 36)

Output signal value

% Output	mA 4-20	%	S/cm	%	S/cm	%	S/cm
0	4.0						
5	4.8						
10	5.6						
15	6.4						
20	7.2						
25	8.0						
30	8.8						
35	9.6						
40	10.4						
45	11.2						
50	12.0						
55	12.8						
60	13.6						
65	14.4						
70	15.2						
75	16.0						
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
1. Sulfuric acid		1 %	2 %	3 %	4 %	5 %
H_2SO_4	0	33.8 mS	63.5 mS	95.0 mS	124.5 mS	154.0 mS
0.5 – 5 %	25	47.0 mS	92.3 mS	135.3 mS	178.0 mS	218.0 mS
	50	57.5 mS	112.5 mS	166.0 mS	220.0 mS	270.0 mS
	75	63.7 mS	126.0 mS	188.5 mS	249.0 mS	307.0 mS
	100	68.0 mS	137.5 mS	206.0 mS	273.0 mS	336.0 mS
2. Sulfuric acid		5 %	10 %	15 %	20 %	25 %
H_2SO_4	0	154.0 mS	292.0 mS	398.0 mS	475.0 mS	516.0 mS
2.5 - 25%	25	218.0 mS	424.0 mS	590.0 mS	718.0 mS	791.0 mS
	50	270.0 mS	534.0 mS	749.0 mS	929.0 mS	1043.0 mS
	75	307.0 mS	612.0 mS	871.0 mS	1094.0 mS	1251.0 mS
	100	336.0 mS	673.0 mS	963.0 mS	1221.0 mS	1418.0 mS
3. Hydrochloric acid		1 %	2 %	3 %	4 %	%
HCl	0	65 mS	125 mS	179 mS	229 mS	273 mS
0.5 - 5%	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
4. Hydrochloric acid		2 %	4 %	8 %	12 %	20 %
HCl	0	125.0 mS	229.0 mS	387.0 mS	479.0 mS	558.0 mS
1 – 20%	15	173.0 mS	317.0 mS	527.0 mS	650.0 mS	745.0 mS
	30	217.0 mS	401.0 mS	660.0 mS	820.0 mS	938.0 mS
	45	260.0 mS	474.0 mS	793.0 mS	985.0 mS	1130.0 mS
	60	301.0 mS	549.0 mS	919.0 mS	1146.0 mS	1315.0 mS
5. Nitric acid		1 %	2 %	3 %	4 %	5 %
HNO_3	0	39.5 mS	76.1 mS	113.4 mS	147.2 mS	179.5 mS
0.5 - 5%	20	57.4 mS	108.5 mS	161.4 mS	210.0 mS	258.0 mS
	40	81.4 mS	148.1 mS	215.0 mS	275.0 mS	330.0 mS
	60	99.9 mS	180.8 mS	260.0 mS	331.0 mS	397.0 mS
	80	127.8 mS	217.0 mS	299.0 mS	374.0 mS	448.0 mS
6. Nitric acid		5 %	10 %	15 %	20 %	25 %
HNO_3	0	179.5 mS	330.0 mS	448.0 mS	523.0 mS	575.0 mS
2.5 - 25%	20	258.0 mS	462.0 mS	616.0 mS	717.0 mS	794.0 mS
	40	330.0 mS	586.0 mS	778.0 mS	902.0 mS	1004.0 mS
	60	397.0 mS	696.0 mS	929.0 mS	1079.0 mS	1206.0 mS
	80	448.0 mS	795.0 mS	1075.0 mS	1263.0 mS	1426.0 mS
7. Sodium Hydroxide		1 %	2 %	3 %	4 %	5 %
NaOH	0	31.0 mS	61.0 mS	86.0 mS	105.0 mS	127.0 mS
0.5 - 5%	25	53.0 mS	101.0 mS	145.0 mS	185.0 mS	223.0 mS
	50	76.0 mS	141.0 mS	207.0 mS	268.0 mS	319.0 mS
	75	97.5 mS	182.0 mS	264.0 mS	339.0 mS	408.0 mS
	100	119.0 mS	223.0 mS	318.0 mS	410.0 mS	495.0 mS
8. Sodium Hydroxide		1 %	3 %	6 %	10 %	15 %
NaOH	0	31.0 mS	86.0 mS	146.0 mS	195.0 mS	215.0 mS
0.5 - 15%	25	53.0 mS	145.0 mS	256.0 mS	359.0 mS	412.0 mS
	50	76.0 mS	207.0 mS	368.0 mS	528.0 mS	647.0 mS
	75	97.5 mS	264.0 mS	473.0 mS	692.0 mS	897.0 mS
	100	119.0 mS	318.0 mS	575.0 mS	847.0 mS	1134.0 mS

11-4. Configuration Checklist For ISC202

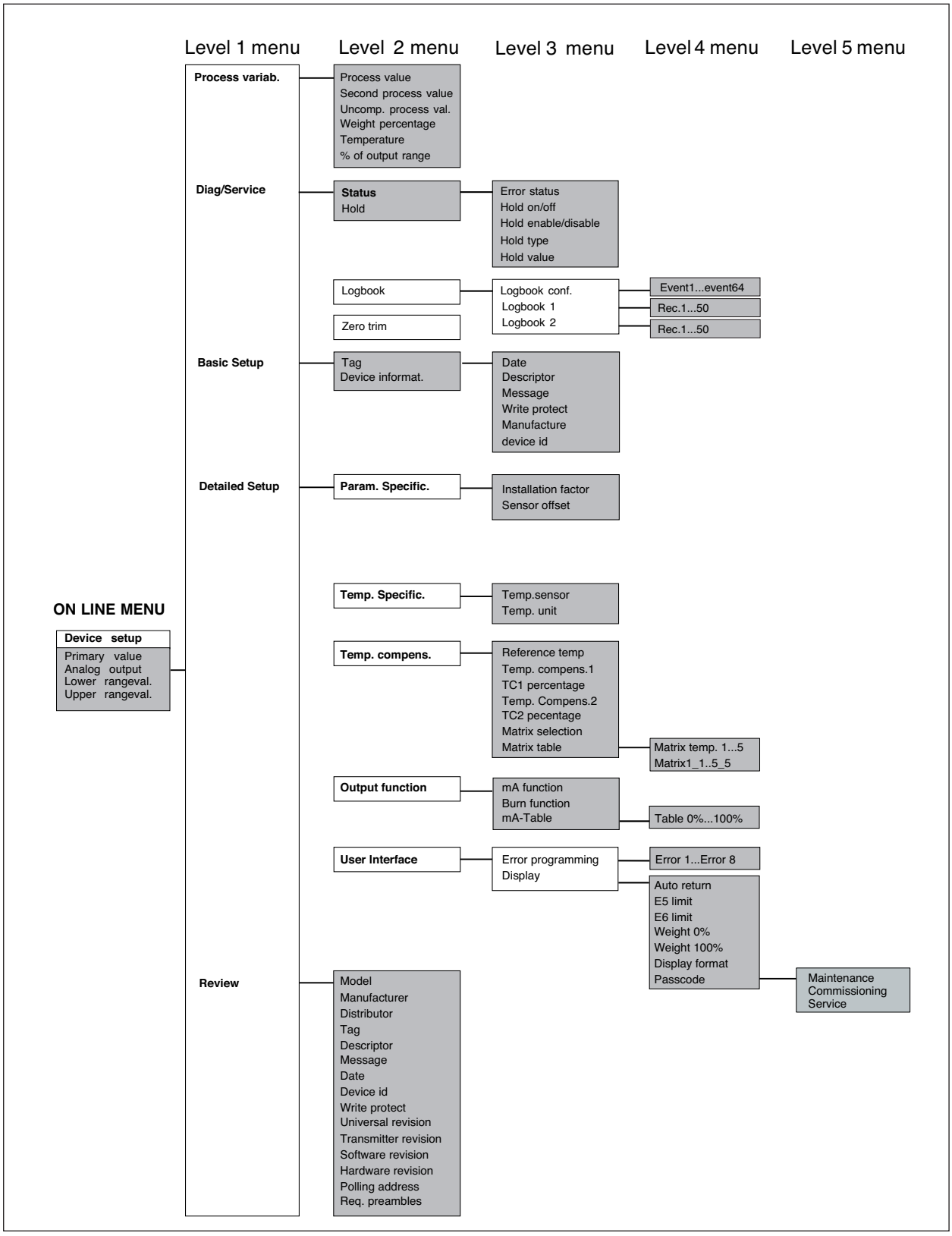
Primary choices	Defaults	Alternatives	Reference on page	Menu or Service code (SC)
Measurement	Conductivity			
1st Temp. compensation	NaCl in water	Fixed T.C., Matrix	5-2-3	'Commissioning'
2nd Temp. compensation	NaCl in water	Fixed T.C., Matrix (inactive)	5-2-4	'Commissioning'
2nd Line display	Process temp.	1st compensation method, Weight%, Output (mA), C.C., Ref. Temp., Software release, 2nd compensated Conductivity, 2nd compensation method	5-1-3/4	'Maintenance'
Range (Linear)	0-1000 mS/cm	0-1999 mS/cm	5-2-1	'Commissioning'
Temperature compensator	30k NTC	Pt 1000	5-3-2	SC 10
Temperature unit Sensor	Celsius (ºC)	Fahrenheit (ºF)	5-3-2	SC 11
cell constant	1.88 /cm	Any value between 0.2 and 19.99 /cm	5-3-1	SC 03
Communication	HART® enabled	disable HART®, PH201*B	5-7	SC 60
Burn out	inactive	HI or LO, Pulse burnout	5-5	SC 32
HOLD during maintenance	inactive	Hold last value or fixed value	5-2-2	'Commissioning'
Calibration temperature	inactive	Adjustment +/- 15ºC	5-3-2	SC 12
AIR (zero) calibration	inactive	Adjustment +/- 15 µS/cm	5-3-1	SC 04
C.C. Calibration	inactive	0.2 and 19.99 /cm	5-1-2	'Maintenance'
Diagnostics	Hard alarm (all errors)	Hard or soft choices	5-6	SC 53
Instrument Limit: E5 (high)	3S	E5 (High) 0.10 - 9.99 S	5-6	SC 54
Instrument Limit: E6 (low)	0.5 µS	E6 (Low) 0.00 - 99.9 µS	5.6	SC 54
Password protection	inactive	(In)active password for different levels	5-6	SC 52
Output in Concentration units	inactive	Linearization of output, Weight% on LCD	5-6	SC 55

11-5. Coded service settings (default)

	Code	Display	Default Values	Setting #1	Setting #2	Setting #3
	03	*C.C.	1.88 /cm			
	10	*T.SENS	0 : 30 kNTC			
	11	*T.UNIT	0 : ºC			
	12	*T.ADJ	0 ºC			
	20	*T.R. ºC	25ºC			
	21	*T.C.1	2.1% per ºC			
		*T.C.2	2.1% per ºC			
	22	*MATRx	1 : H2SO4			
mA	31	*OUTP.F	0: Linear			
	32	*BURN	0: No Burnout			
	50	*RET	1: On			
	52	*PASS	0.0.0.: off.off.off			
	53	*Err. 05	1 : HARD			
		*Err. 06	1 : HARD			
		*Err. 07	1 : HARD			
		*Err. 08	1 : HARD			
	54	*E5.L	3S			
		*E6.LIM	5µS			
mA		*OUTP	0% : 0µS			
			100% : 1000mS			
mA		*HOLD	disabled			
		*TEMP.1	NaCl			
		*TEMP.2	NaCl			
mA	60	*COMM.	1.0: On, write enable			

mA 11-6. 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 instruction manual and the on-line help structure.

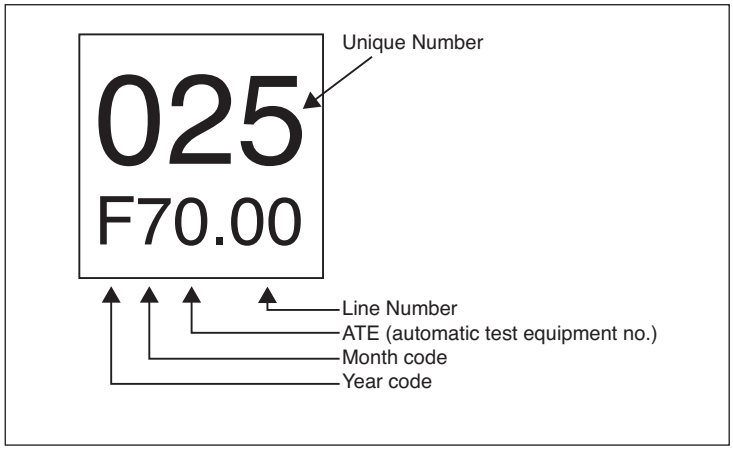


12. Test Certificate

Test Certificate — **EXA Series**
Model ISC202
Inductive Conductivity Transmitter

1. Introduction

This inspection procedure applies to the model ISC202 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.

Next the (+) plus, the (-) minus and terminals 12, 14,16 and 17 linked together. A load of 500VAC is placed over the interconnected terminals and the ground. During 10 seconds it is checked if the leak current is equal or less than 15 mA.

4.1 Accuracy Testing

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

4.2.1 Accuracy Testing of the Pt1000

Our automated testing facility checks the input accuracy of the instrument using a calibrated variable resistor (decade resistor box) to simulate the resistance of the Pt1000.

4.2.2 Accuracy Testing of the 30k NTC

Our automated testing facility checks the input accuracy of the instrument using a calibrated variable resistor (decade resistor box) to simulate the resistance of the 30k NTC.

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 125 Ω and 188 kΩ. (accuracy 0.1%)
3. A fixed resistor of 300 Ω to simulate the mA-output load.
4. An inductive conductivity sensor (ISC40)
5. An insulated wire with a length of approximately 1 mtr and a minimum cross-section of 0.75 mm^2 to be connected through the ISC40 to the box 2.
6. A stabilised voltage supply unit : nominal 24 Volt DC
7. A current meter for DC currents up to 25 mA, resolution 1µA, accuracy 0.1%

Connect the ISC202 as shown in Figure 1. Set box 1 to simulate 25ºC
(1097,3 Ω for Pt1000, 30 kΩ for NTC).

Before starting the actual test, the ISC202 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.

***note:** For low ohmic input values (box 2) it is necessary to compensate for the wiring resistance. The number of windings through the inductive sensor needs to be increased from 1 to 10. As a result the range will be extended by a factor 100. For the low ohmic input range (1.25Ω to 37.60 Ω) the value should be multiplied by hundred (e.g. 2.51 Ω becomes 251 Ω).

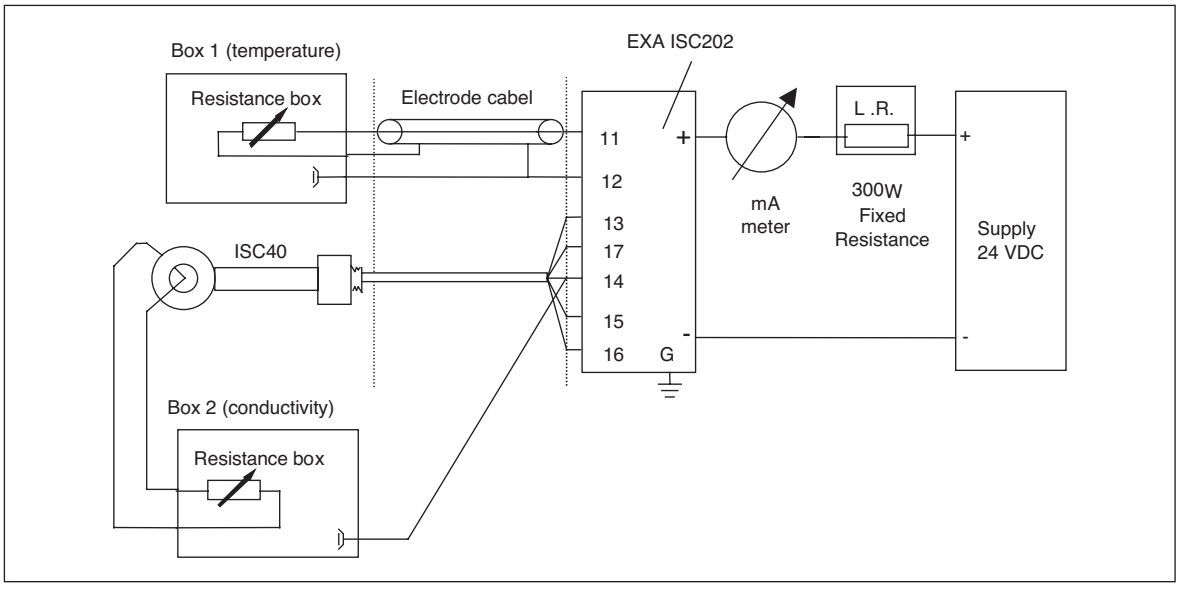


Figure 1. Connection diagram for the overall accuracy test

The tolerances specified relate to the performance of the ISC202 with a calibrated sensor and 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 sensor and 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 ISC202
Inductive Conductivity Transmitter

1. Instrument Description							
Model :	ISC202G-A-E/U			Serial No :	R2713022		
Order :	100007731001			Release Version :	1.1		
2. General Inspecton	OK						
3.1 Safety Test	OK			3.2 Communication Test	OK		

4.1 Accuracy Test (C.C. = 1.00cm^{-1})			
Input Ω	Display Ω	Tolerance Ω	Reading Ω
1.000	1.000	± 0.005	**0.997**
10.00	10.00	± 0.05	**9.99**
100.0	100.0	± 0.5	**99.9**
1.000k	1.000k	± 0.006k	**1.000 k**
10.00k	10.00k	± 0.15k	**10.01 k**
100.0k	100.0k	± 11.2k	**100.0 k**

4.2.1 Accuracy Test (Temp. Display with Pt1000 RTD)				4.2.2 Accuracy Test (Temp. Display 30k NTC sensor)			
Resistance Ω	Temp. °C	Tolerance °C	Reading °C	Resistance Ω	Temp. °C	Tolerance °C	Reading °C
960.9	-10	± 0.3	**-10.0**	158000	-10	± 0.2	**-10.0**
1097.3	25	± 0.3	**25.0**	30000	25	± 0.2	**25.0**
1232.4	60	± 0.3	**60.0**	7599	60	± 0.2	**60.0**
1385.0	100	± 0.3	**100.0**	2069	100	± 0.2	**100.0**
1498.2	130	± 0.3	**130.0**	903	130	± 0.2	**130.0**

4.3 Overall Accuracy Test (C.C.=1.88cm^{-1}; NaCl compensation; 30k NTC @ 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	± 1.00µ	**-0.215 µ**	4.00	± 0.02	**4.00**
188.0k	10.00µ	± 1.10µ	**9.82 µ**			
18.80k	100.0µ	± 2.0µ	**99.9 µ**			
3.760k	500µ	± 6µ	**500 µ**			
1.880k	1.000m	± 0.011m	**1.000 m**			
376.0	5.00m	± 0.05m	**5.00 m**			
188.0	10.00m	± 0.10m	**10.03 m**	4.16	± 0.02	**4.16**
37.60	50.0m	± 0.5m	**50.04 m**	4.80	± 0.02	**4.80**
18.80	100.0m	± 1.0m	**100.1 m**	5.60	± 0.04	**5.60**
7.52	250m	± 3m	**250 m**	8.00	± 0.07	**8.00**
3.76	500m	± 5m	**501 m**	12.00	± 0.10	**12.01**
2.51	749m	± 8m	**750 m**	15.98	± 0.15	**15.99**
1.88	1.000	± 0.010	**1.001**	20.00	± 0.18	**20.01**
1.25	1.504	± 0.015	**1.505**	20.50	± 0.02	**20.50**

5. Accuracy Test mA output circuit			Date	Ambient Temp	Rel. Humidity
Simulated Output mA	Tolerance mA	Actual Output mA	04-03-03	21.0 °C	28 %RH
4.0	± 0.02	**4.00**			
8.0	± 0.02	**8.00**			
12.0	± 0.02	**11.99**			
16.0	± 0.02	**15.99**			
20.0	± 0.02	**19.99**			

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11-7. Software revision History

11-7-1. Changes made by software release 1.1

- Optimized limits for calibration

11-7-2. Changes made by software release 1.2

- Extend c.c. to max. 50.0 /cm
- Extend temperature range in ISC to -30 ~ 150 ºC
- High limit cell constant increased to 50 /cm, to cover an ex-situ sensor
- Minimum output span decreased to 10 uS/cm
- First S/N: U3716000

11-7-3. Changes made by software release 1.3

- Create possibility to disable E5/E6 diagnostics by setting the E5/E6 limits to 0 (zero)

11-7-4. Changes made by software release 1.4

- Solved rare problem with 'Freezing' measurement
- Burn down output signal to 3.9 mA when HART communication is enabled. When disabled it is 3.6 mA
- Fixed rare HART communication failure

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