

# General Specifications

Model EXA ISC402G  
Converter for  
inductive conductivity



The model EXA ISC402G inductive conductivity mains powered converter is designed for use with the model ISC40 sensor. This revolutionary conductivity measuring system features  $\pm 0,5\%$  accuracy over a very wide range of conductivity values (1 to 2.000.000  $\mu\text{S}/\text{cm}$ ) and process temperatures (-20 to 140°C/0 to 280°F) without changing cell constant or the need for recalibration.

The EXA ISC402G converter is suited to applications in which the concentration of acid, alkali or salt solution is measured for process control purposes. The power supply can be from most AC or DC sources. The four separate supply options make it an universal unit. Operating parameters are stored in non-volatile memory, so there is no danger when power drops occur. The instrument has a 'watchdog' timer which will always return it to the normal operating status after power has been removed. The unit can linearise the output range in concentration units and offers the potential for a coefficient "matrix" temperature compensation depending on the process composition. The EXA ISC402G also features auto zeroing to eliminate traditional temperature and long term drift caused by magnetic offset between the two toroids.

The Model ISC40 sensor is a rugged steel-backed sensor encapsulated with the highest quality engineering plastic known today (Victrex PEEK) for long service life in both abrasive and chemically corrosive processes.


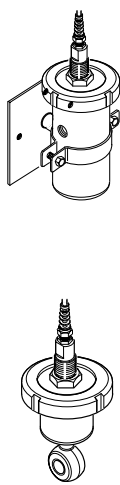

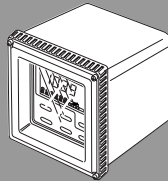
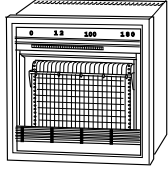
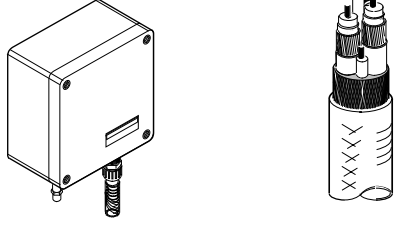
The stainless steel mounting thread and the Viton gasket allow safe and reliable installation. The long insertion depth allows for installation of the sensor either by a bulkhead mounting through a flange or tank wall, or by using one of the process adaptor kits (e.g. for flow-through or immersion service). The large bore, greater than 17 mm (11/16 in), gives long-term stability, preventing measuring errors caused by coating or plugging. The large bore also offers fast response even at low flow rates.



## FEATURES

- Accurate between 0.5  $\mu\text{S}/\text{cm}$  and 2 S/cm (2.000.000  $\mu\text{S}/\text{cm}$  with just one sensor and without recalibration).
- Auto-ranging display for best resolution.
- Four fully programmable SPDT contact outputs.
- Two fully configurable mA outputs.
- Output can be linearised to concentration units easily.
- Standard NaCl or Programmable TC temperature compensation.
- "Matrix Temperature compensation" for selected non-linear process solutions.
- RS485 communications and logbook facility in Windows® environment with PC402 software package.
- Universal mounting (wall, pipe and panel) and universal power supply (100/115/230 V AC or 24 V DC).

## SYSTEM CONFIGURATION

<p>Sensors</p> 	<p>Flow fitting and subassembly</p> 	<p>Immersion fitting</p> 	<p>Transmitters</p> 	<p>Receivers</p> 
			<p>Connecting equipment</p> 	

## MEASUREMENT PRINCIPLE

Unlike 2- or 4-electrode conductivity systems, the EXA ISC402G analyses the conductivity without any contact between electrodes and process fluid. The measurement is based on inductive coupling of 2 ring transformers (Toroids) by the liquid.

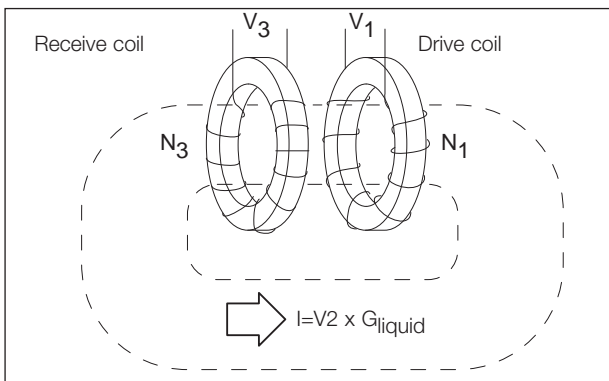
The EXA ISC402G supplies a reference voltage ( $V_1$ ) at a high frequency to the "drive coil". The core of this coil is of a high permeability magnetic material, and a strong magnetic field is generated in the toroid.

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

The magnetic field induces a voltage ( $V_2$ ) in this liquid winding. The induced current thus made to flow is proportional to this voltage and the conductance of the liquid "one turn winding" is according to Ohm's law.

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

There are 2 toroids mounted in the "doughnut" shaped sensor. The liquid also flows through the second toroid and therefore the liquid turn can be considered as a primary winding of the second ring transformer. The current in the liquid will create a magnetic field in the second toroid. The induced voltage ( $V_3$ ) being the result of this magnetic field can be measured as an output. The output voltage of this "receive coil" is therefore proportional to the specific conductivity of the process liquid.



**Inductive conductivity measurement principle**

## FUNCTIONAL DESCRIPTION

The EXA ISC402G is real time micro-controller operated conductivity-analysing system. It uses a dedicated micro-controller to control all functions necessary in such a system. The input and output functions are concentrated in the analogue section of the instrument. Even these functions are operated through special interfaces designed to minimise interference with the digital functions. All functions are executed separately.

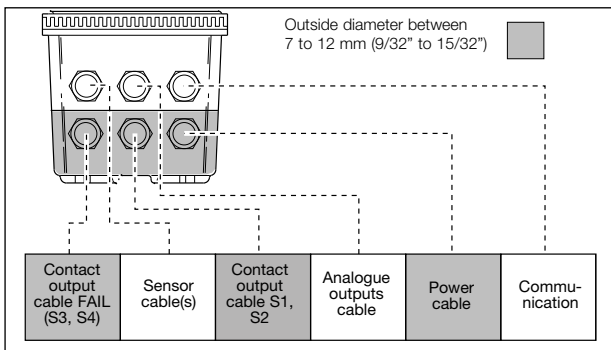
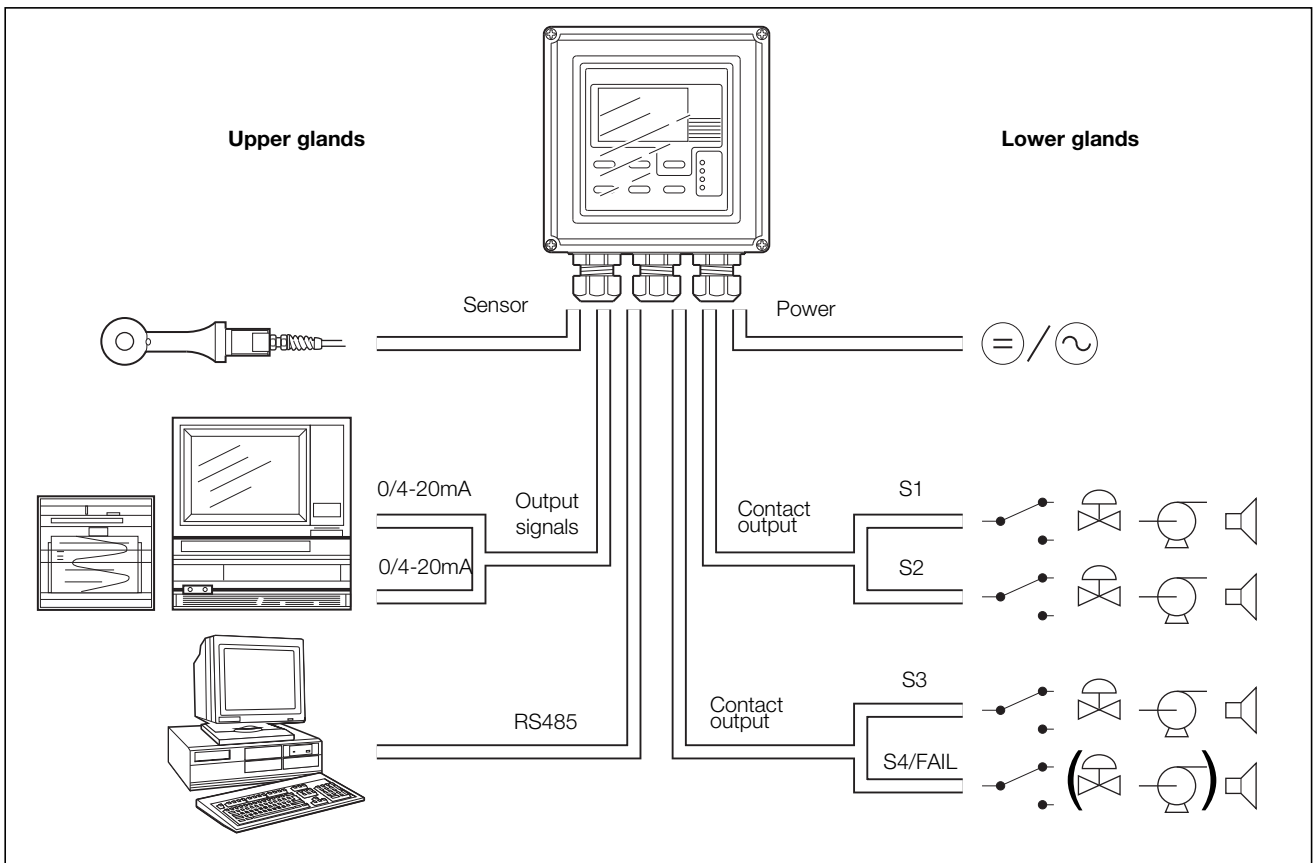
The user-interface is limited to a basic set of 6 keys accessible through the flexible window cover. The software is designed with the user in mind. It uses a simple 3 layer set-up to communicate with the operator by giving messages on the second line of the display area and indicating which keys are to be pressed in the display too. The keys are scanned continuously and the actions are taken immediately. An extensive system of checking values and parameters is implemented.

From the outside the ISC402G looks and works just as a normal conductivity transmitter. Access can be restricted with the simple use of a password to those functions that are needed for daily operation of the converter, ensuring security in normal operation. Traditional transmitters feature simplicity and ISC402G offers the same simplicity. The processing power of the microprocessor makes it possible to have a much higher level of functionality and flexibility.

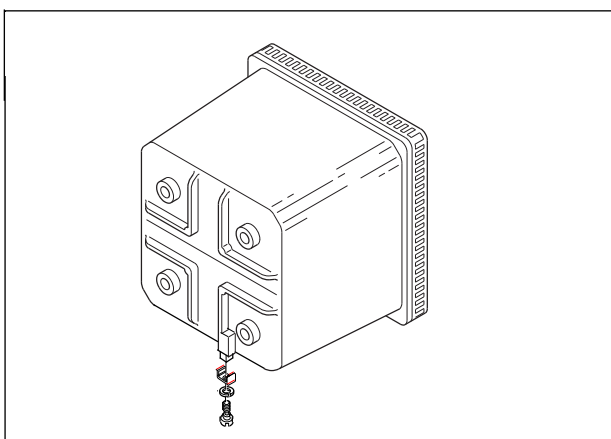
The power of the microprocessor is used for:

- Diagnostic functions to increase the dependability of the instrument.
- A self-tuning preamplifier to increase the rangeability to cover almost all conductivity applications.
- Input/output flexibility to offer the user solutions to compatibility problems and to non-linearity characteristics of some electrolytes.
- Auto zeroing to ensure long term stability
- Sophisticated temperature compensation to achieve temperature independent readings for even the most difficult processes like Sulphuric Acid and Sodium Hydroxide.

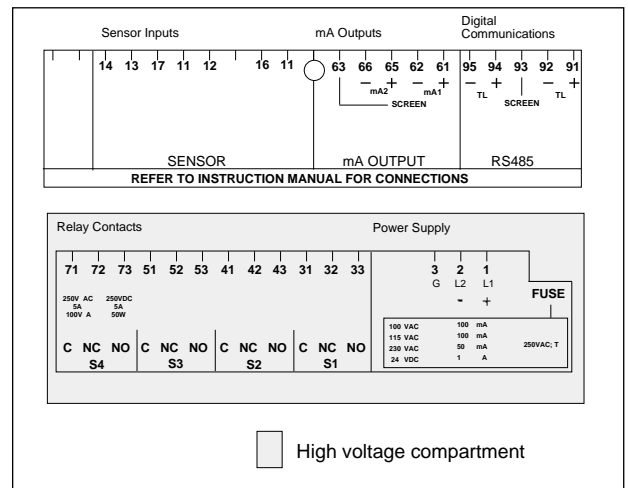
### SYSTEM CONFIGURATION



Glands to be used for cabling



Grounding



Terminal lay-out

**SPECIFICATIONS**

**General specifications**

- A. Input specifications : Yokogawa ISC40 inductive conductivity sensor.  
With integral temperature sensor YSI thermistor or PT1000 Ω.
- B. Measuring range : Conductivity 0 to 1999 mS/cm [at 25 °C (77°F) reference temperature].  
Min. conductivity : 0.5 µS/cm at process temperature  
Max. conductivity : 3000 mS/cm at process temperature  
Temperature : -20 to 140°C (0 to 280°F).

- C. Indicating range  
Main display : 0.0 µS/cm to 1999 mS/cm.  
Message display : -20 to 140°C (0 to 280°F); 0 to 199,9%.

- D. Transmission signal : Two outputs, each 0/4-20 mA DC, maximum load 600 Ohm, isolated from input and communications. A common negative line is used for both outputs.  
- Output current in fault condition may be selected for 22 ±0.5 mA. as a warning.  
Both signals can be held (fixed or last value) during maintenance.  
- mA1 and mA2 can be configured for independent conductivity ranges.  
- mA2 can alternatively be used to give a temperature signal.

Serial communication : Bi-directional according to EIA-485 standard.  
Isolated from input and analogue signals.

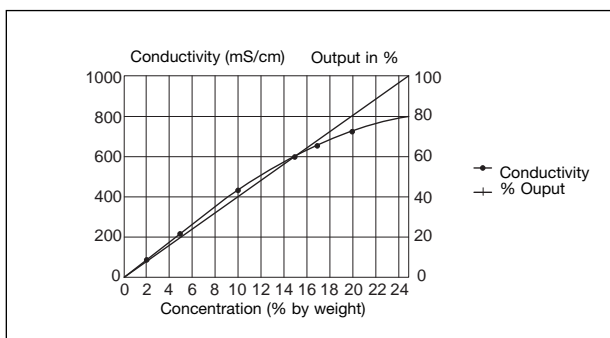
- E. Transmission range  
Conductivity : User programmable for linear/non-linear conductivity ranges.  
Minimum span : 100 µS/cm.  
Maximum span : 1999 mS/cm.  
Zero suppression : Upto 90% Fullscale.  
Temperature : Always linear and only on mA2.  
Minimum span : 10°C or 10°F  
Maximum span : 160°C or 280°F

- F. Contact Outputs  
General : All contacts are SPDT contacts  
LED indicators for all contacts (S1, S2 and S3 LED on when relay is powered),(S4 LED on when relay is not powered).  
Switch capacity : 100 VA maximum at 250 VAC, 5 A  
50 W maximum at 250 VDC, 5 A.  
Status : High of Low when used for process value (Conductivity or temperature)  
Pulsating for "soft fail" indicating that maintenance is required or ON for "hard fail" indicating that the diagnostics found a serious system error when used for FAIL function  
Parameter : Conductivity (S1..S4), Temperature (S1..S3), Fail (S4)  
Control functions : On/Off  
Proportional duty cycle control (range and period are programmable with min-max protection)  
Proportional frequency control (range and maximum pulse frequency are programmable)

**MODEL SPECIFICATION**

Model	Suffix Code	Option Code	Description
ISC402G			Inductive Conductivity Transmitter
	-E .....		Always E
Supply voltage	-1 .....		115 Volts 50/60 Hz
	-2 .....		230 Volts 50/60 Hz
	-4 .....		24 Volts DC
	-5 .....		100 Volts 50/60 Hz
Instr. manual	-E .....		English *
Options	/U .....		Pipe and wall mounting kit
	/PM .....		Panel Mounting kit
	/Q .....		Quality certificate
	/SCT.....		Stainless steel tag

\* For other languages contact your local sales office



**Linearisation of output**  
**Example: 0-25% Sulfuric acid**

Code Output	mA 4-20	Conc.	Example % H <sub>2</sub> SO <sub>4</sub>	Cond.	Example mS/cm
0	4		0		0
5	4.8		1.25		60
10	5.6		2.5		113
15	6.4		3.75		180
20	7.2		5		211
25	8		6.25		290
30	8.8		7.5		335
35	9.6		8.75		383
40	10.4		10		424
45	11.2		11.25		466
50	12		12.5		515
55	12.8		13.75		555
60	13.6		15		590
65	14.4		16.25		625
70	15.2		17.5		655
75	16		18.75		685
80	16.8		20		718
85	17.6		21.25		735
90	18.4		22.5		755
95	19.2		23.75		775
100	20.0		25		791

#### Programmable variables

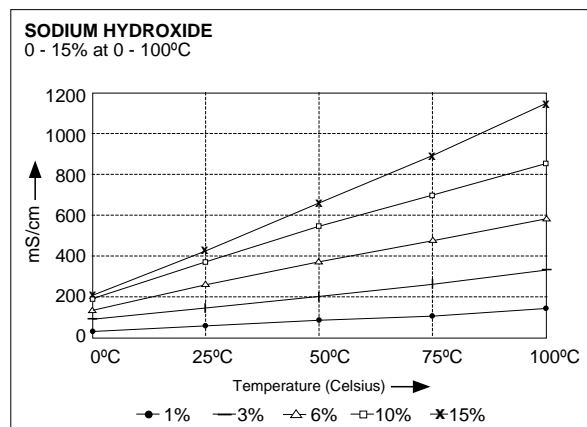
- G. Logbook : Hysteresis, delay time  
: For storing measuring/setup data
- H. Power supply Voltage : 100 VAC ( $\pm 15\%$ ), 50/60 Hz.  
: 115 VAC ( $\pm 15\%$ ), 50/60 Hz.  
: 230 VAC ( $\pm 15\%$ ), 50/60 Hz.  
: 24 VDC (-20% / +30%).
- I. Power consumption : Maximum 10 VA for AC version  
: Maximum 10 W for DC version

#### Functional specifications

- A. Performance  
Linearity error :  $\leq 0.3\% \pm 0.5 \mu\text{S/cm} \pm 0.02 \text{ mA}$   
Repeatability error :  $\leq 0.2\% \pm 0.5 \mu\text{S/cm} \pm 0.02 \text{ mA}$   
Accuracy error :  $\leq 0.5\% \pm 0.5 \mu\text{S/cm} \pm 0.02 \text{ mA}$   
Ambient temperature :  $\leq 0.05\%/^{\circ}\text{C}$   
Step response :  $\leq 3$  seconds for 90%
- B. Temperature  
Range : -10 and 130°C  
: (10 to 270°F).  
Accuracy :  $\leq 0.2^{\circ}\text{C} \pm 0.02 \text{ mA}$   
Reference Temp. : Adjustable 0 to 100°C  
: (30 to 210°F)  
Compensation (algorithm) : User selectable  
NaCl : According to IEC 746-3 tables.  
TC : -9.99% to 9.99% per °C (°F)  
: By adjustment or calibration.  
Specific process : User selectable/configurable matrix  
: with conductivity function of  
: concentration and temperature (25  
: points)
- C. Sensor diagnostics : Abnormal temperature  
: Abnormal value.

#### Environment and operational conditions

- A. Ambient operating temperature  
: -10 to +55 °C (10 to 131 °F)  
: Excursions to -30 °C (-20 °F) do not  
: influence the current output function,  
: and excursions to +70 °C (160 °F)  
: are acceptable too.
- B. Storage Temperature : -30 to 70°C (-20 to 160°F)
- C. Relative humidity : 10 to 90%.
- D. Weather protection : Rain and dust tight to IP 65  
: (NEMA 4X).
- E. Data protection : Non volatile memory (EEPROM)  
: Backup for logbook  
: Battery powered Date/Time backup.
- F. Watchdog timer : Checks microprocessor.
- G. Automatic safeguard : Continues measurement if no key is  
: pushed for 10 minutes.
- H. Voltage supply interruption  
: At the nominal voltage  
: - Less than 50 ms, no effect  
: - Greater than 50 ms, reset.
- I. Power down : No effect, reset to measurement.
- J. Operation protection : 3 digit pass code.



#### Matrix to temperature compensation

#### Construction

- A. Display : Custom liquid crystal display.  
Main display : 3n digit, 12.5 mm high.  
Message display : 6 alphanumeric characters,  
: 7 mm high.  
Special fields : Flags for status indication  
: HOLD, Hold output signal condition  
: FAIL, Fault condition  
Measuring units :  $\mu\text{S/cm}$ ;  $\text{mS/cm}$ .  
Key prompts : YES, NO, >, ^, ENT. Menu pointer (▶).
- B. Keys : 6 keys operated through flexible  
: window with tactile feedback and one  
: hidden key behind the front cover.
- C. Relay status indication : 4 red LED's.
- D. Housing  
Material : Cast aluminium with epoxy coated  
: case.  
: Polycarbonate cover with stainless  
: steel screws and inserts.  
Window : Flexible Poly-carbonate.  
Colour : Cover, Moss green  
: Case, Off-white.  
Cable entries : Six polyamide glands 1.1".  
Cable terminals : For up to 2.5 mm finished wires.
- E. Mounting : Pipe and Wall or Panel
- F. Shipping details  
Package (w x h x d) : 290 x 225 x 170 mm  
: (11.5 x 8.9 x 6.7 in).  
Weight : approximately 2.5 kg (5 lb).

#### Regulatory compliance

- A. EMC : meets council directive  
: 89/336/ EEC  
Emission : meets EN55022 Class A  
Immunity : meets EN50082-2  
Low voltage : meets council directive  
: 73/23/EEC  
Installation : Designed for installation conforming  
: to IEC 1010-1.  
: Category II.

## ALARMS AND CONTROL FUNCTIONS

The EXA ISC402G features four S.P.D.T. relay contacts to accommodate several functions.

### Process alarm

The contact is switched when the process value reaches a pre-set limit. This can be either a high or a low limit.

Adjustable parameters:  
 Setpoint for the process value  
 Hysteresis of the switching action  
 Delay time of the relay (0.1-200 sec)

### Proportional duty cycle control

The contact is used to control the time a solenoid feed valve is opened. The proportional control is achieved by opening and closing the valve and varying the ratio of on to off time. Below the setpoint the valve is always closed, and beyond the proportional range, always open, as shown in the diagram on the right.

Adjustable parameters:  
 Setpoint for the process value  
 Proportional range for control  
 Total period of the duty cycle (5-100 sec)

### Proportional pulse frequency control

The contact is used to control a pulse driven feed pump. The proportional control is given by adjusting the frequency of the pulses, which in turn varies the speed of the pump.

Adjustable parameters:  
 Setpoint for the process value  
 Proportional range for control  
 Maximum frequency of the pulses (50-120 per minute)

### Malfunction indication

The fourth contact is by default set to function as an alarm, indicating that the EXA has found a fault in the measuring loop. If the self diagnostics of the EXA indicate a fault or error, the FAIL contact will be switched. In most cases this will be caused by a malfunction of the measuring loop. The FAIL contact is also closed when the power is removed.

The "FAIL" contact may also be configured as a fourth process alarm.

### Communications

The EXA ISC402G is equipped with RS485 communication facility. The communication lines are isolated from the input and output signals.

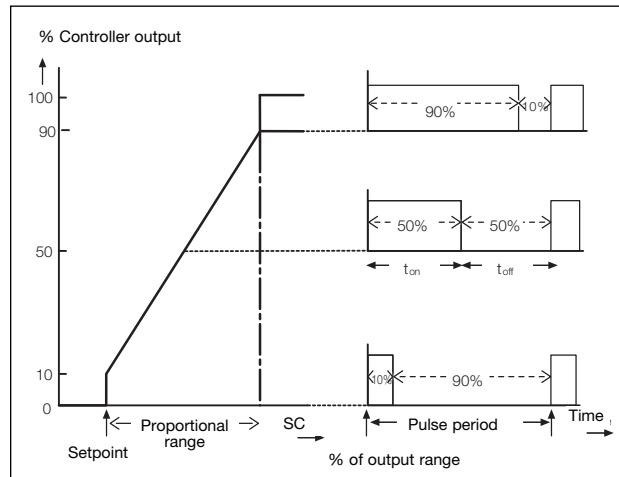
Communication speed is selectable from 1200, 2400, 4800, 9600, baud. The format is also selectable for even, odd, and no parity.

The full facilities of the ISC402G are available over the two way communication link.

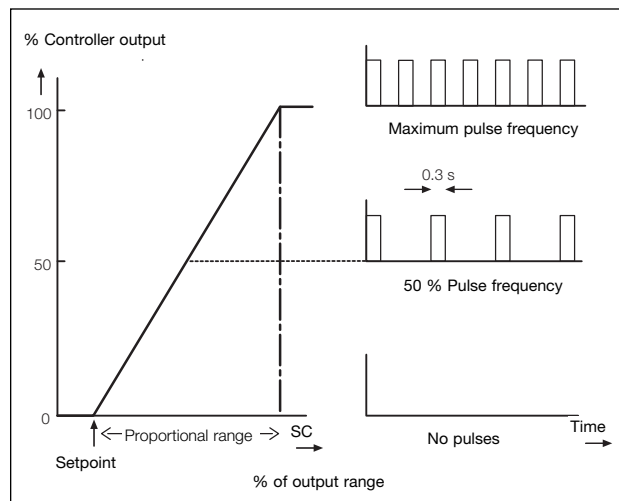
### Logbook

In combination with the communication facility, there is a logbook feature. This is a software record of events, calibrations, alarms and the like. The choice of what is recorded is for the user to decide, and a total of approximately 100 events may be stored. New additions are made by overwriting the oldest entry, once 100 entries have been exceeded.

Access is only via the RS485 link, and a software package is available to support these features. This may be ordered from Yokogawa under the part number PC402.



**Duty cycle control**



**Pulse frequency control**

## INSTALLATION AND WIRING

### Installation site

The converter is a rain-tight type, and can be installed inside or outside. It should, however, be installed as close as possible to the sensors to avoid long cable lengths between sensors and transmitter.

Select an installation site where:

- Mechanical vibrations and shocks are negligible.
  - No relay/power switches are in the direct environment.
  - The transmitter is not mounted in direct sunlight and severe weather conditions.
  - Maintenance activities are possible (no corrosive atmospheres).
- The ambient temperature and humidity of the installation environment must be within the limits of the instrument specifications.

### Mounting methods

The EXA ISC402G transmitter has universal mounting possibilities:

- Panel mounting using optional brackets.
- Surface mounting on a plate (by bolts from the back).
- Wall mounting on a bracket (e.g. thick brick wall).
- Pipe mounting using a bracket on a horizontal or vertical pipe (maximum diameter 50 mm).

### Installation of the sensor

The ISC40 is a donut shaped sensor. Ideally, the process flows through the hole of the donut with the temperature compensator up-stream. For minimal obstruction of the flow and for accurate measurement without the need for calibration of the installation factor, the process should flow freely around the donut. This is effected by allowing a minimum distance of 25 mm (1 in) between donut and process piping (d).

The sensor is provided with a gasket and retaining nut. This allows "bulkhead mounting" in tank wall or standard flange through a hole of 27 mm (1.1 in) diameter (A). The insertion depth is 125 mm. Two flats are provided with wrench size 20 mm (0.8 in) to allow easy mounting and alignment of the sensor.

- For On-line mounting, adapters are available for standard 2" process connection (Gas thread, NPT, ANSI-flange, DIN-flange).
- For by-pass measurement, flow fittings are available in Polypropylene, Polyvinylidene Fluoride and Stainless Steel.
- For measurements in open ducts or vessels, an immersion fitting in CPVC is available.

For easy wiring the sensor should be located within 5 or 10m (16 or 32ft) from the transmitter using the integral sensor cabling (refer to Fig. 3).

Upto 40 metres of WF10 extension cable may be used with a BA10 junction box.

The installation factor of the ISC40 is the ratio of the measured conductivity at the sensor and the specific conductivity of the solution. The unit is  $\text{cm}^{-1}$  just as the cell constant of a contact electrode system. This factor is  $1.88 \text{ cm}^{-1}$  for the ISC40 if the sensor is installed with a minimum of 25 mm (1 in) of process fluid surrounding the donut.

Installed in an ISC40FF-S stainless steel flow cell, the factor is  $1.7 \text{ cm}^{-1}$ .

Installed in an ISC40FF-P polypropylene flow cell, the factor is  $1.88 \text{ cm}^{-1}$ .

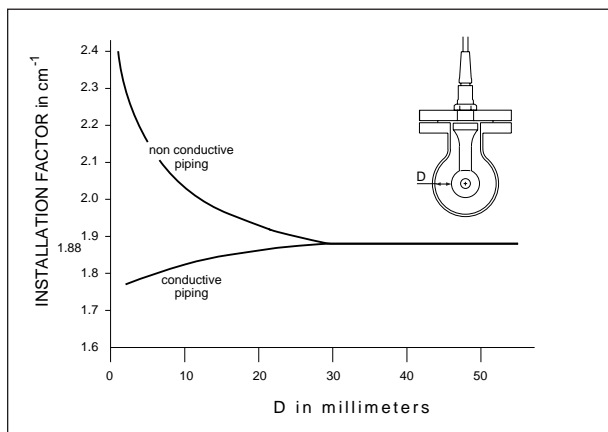
The factor may be estimated from table above for actual installations not using the standard flow assemblies.

### Wiring

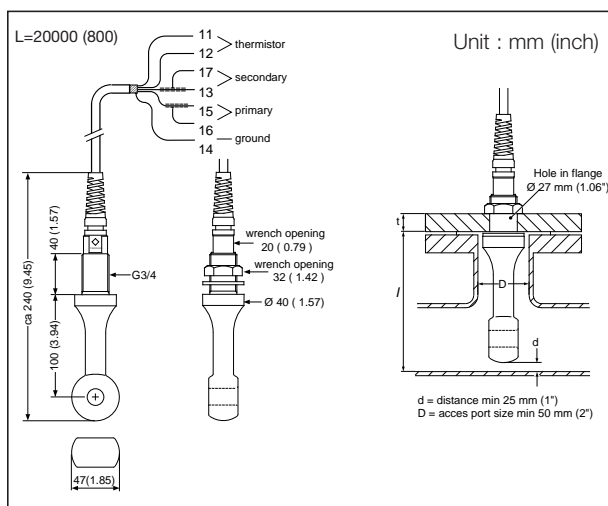
When wiring the converter, the following guidelines should be used for cable selection, in order to ensure the correct sealing of the cable glands and the correct operation of the terminals.

Overall cable diameter : - 7-11 mm (9/32"-15/32")

Conductor cross section : - 0.13 2 mm - 4.0 2 mm (26-12 AWG)

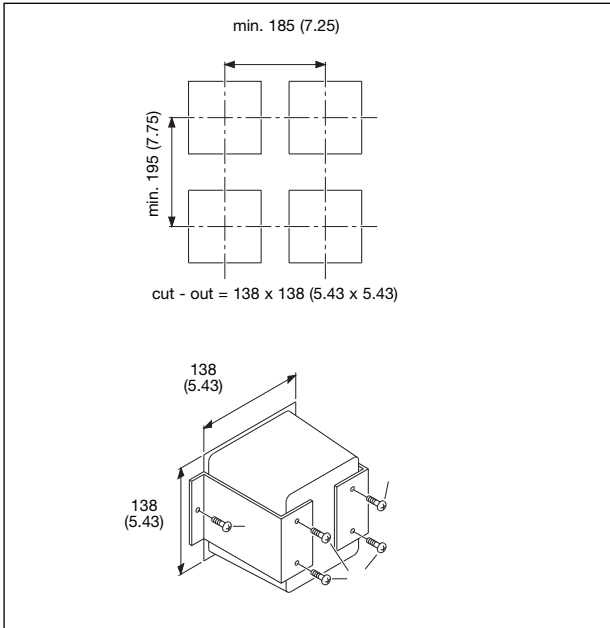


Installation factor as a function of free distance around donut

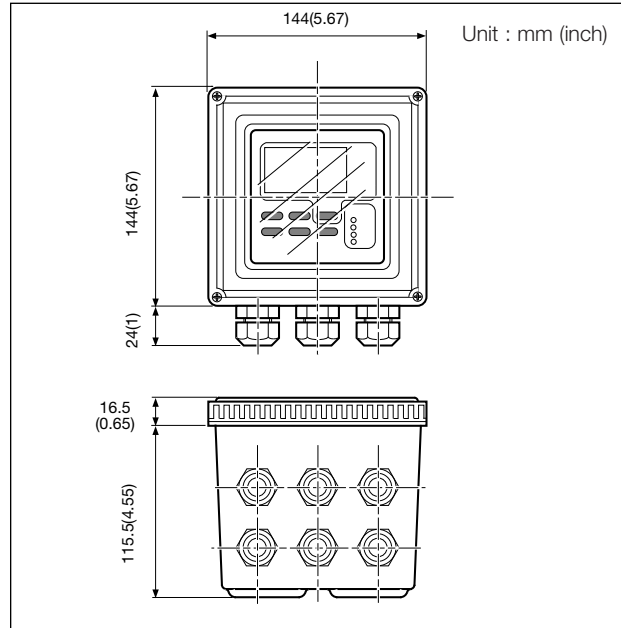


Dimensions and installation instructions bulk-head mounting

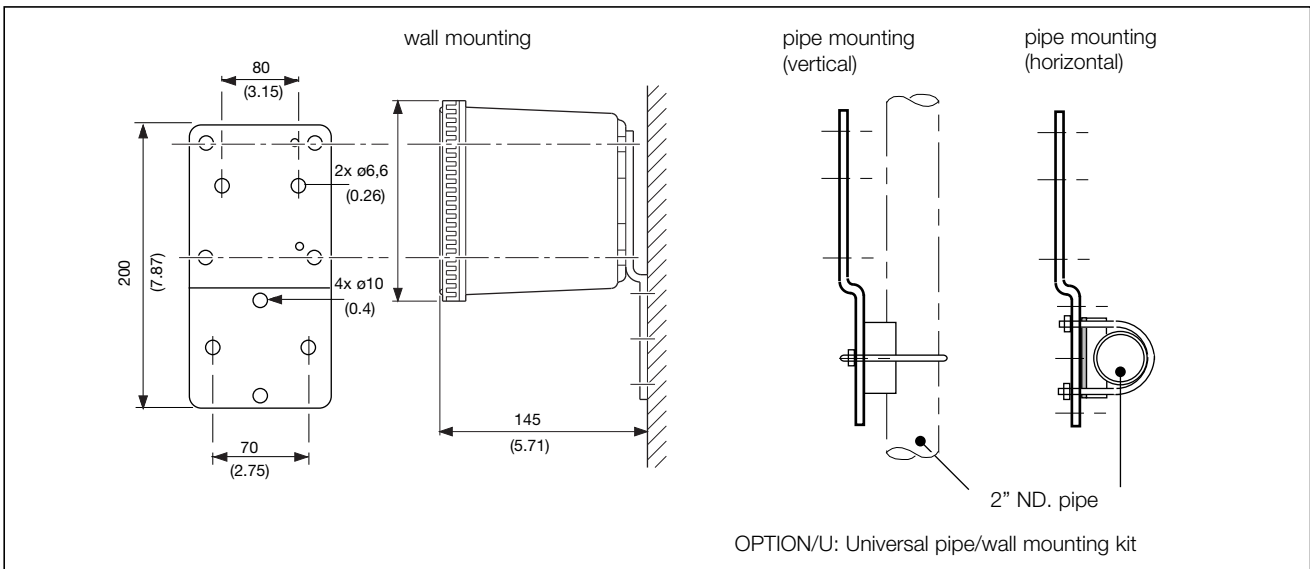
**DIMENSIONS AND MOUNTING**



**Panel cut-out and spacing**



**Dimensions**



**Universal pipe/wall mounting**

**YOKOGAWA** ◆

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