

# General Specifications

Model SC202G (S)  
2-wire transmitter  
for Conductivity or Resistivity

EXA  
CE

Fieldbuses are based on highly reliable bi-directional communications between "smart" field devices and HOST systems. Next to a wide range of data each smart device can provide their status which is essential for adequate control and maintenance. The famous EXA sensor diagnostics will provide asset management facilities for those who operate and maintain the plant.

"The advent of Fieldbus technology had made possible a wide range of new capabilities throughout every level of the control system that had not previously been possible or fully explored".

Yokogawa has implemented three leading process Fieldbus technologies in their 202 series: HART®, Foundation Fieldbus H1 and Profibus PA. All transmitters are provided with the important and widely used Device Description files that provide information on parameters and other data in each device, as well as the ability to include algorithmic relationships such as calibrations.

Flexibility, reliability and low maintenance are among the benefits provided by the EXA SC202 conductivity analyzer. Designed to meet the particular requirements of measuring conductivity and resistivity in the modern industrial environment, it contains many features to ensure the best precision whatever the application.

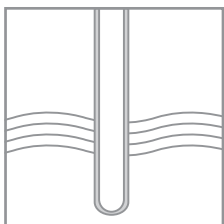
The transmitter is housed in a robust IP65 field mountable case and combined with the easy and clear LCD makes the SC202 a complete industrial transmitter. The logbook can be used to record events like calibrations and diagnostic messages. A wide variety of temperature compensation possibilities (NaCl according to IEC 746-3, manual TC, preprogrammed matrices and a free programmable 5x5 matrix), provide a high-accuracy measurement with a minimum effort. The addition of a USP<645> pure water monitoring feature also makes the SC202 suitable for the pharmaceutical industry



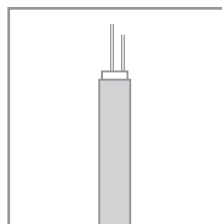
## Features

- Universal conductivity/resistivity, software switchable
- On-line sensor checking
- Event logbook in software
- Matrix temperature compensation for pure water applications
- Password protection for all levels of software
- Intrinsically safe version and non-incendive versions
- Pharmaceutical pure water monitoring (USP<645>)
- Autoranging from 0.01  $\mu\text{S}\times\text{C.C}$  to 200mSx.C.C.
- Intrinsically safe version <EEx> II 2(1)G EEx ib[ia] IICT4/T6.

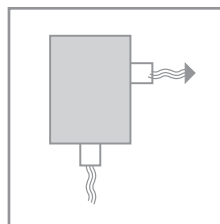
## System Configuration



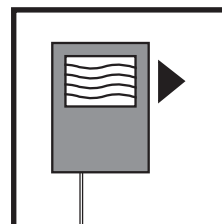
Sensors



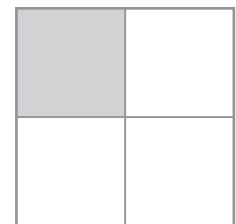
Cables



Fittings



Transmitters



Accessories

## Fieldbus

Field devices in general are becoming smarter, operations more complex and hold more information about themselves and the process. Higher communication data rates are important in handling this additional information without undue delays. Fieldbuses such as Foundation Fieldbus and Profibus PA (at 31.25 kbps) provides this capability, which is also ample for measurement values such as conductivity/resistivity, concentration and temperatures. With the SC202 it becomes possible to keep plant records up-to-date and accurate as the SC202 keeps a logbook and will therefore provide you with all this information necessary. Calibration and validation are becoming increasingly important, both because some products, like pharmaceuticals demand it. The logbook of the SC202 also holds invaluable information in the later investigation of production problems. Fieldbuses have brought major benefits to all aspects of process automation. The technology is now mature and well accepted by major end users in process and utilities markets. The Profibus PA and Foundation Fieldbus protocols use the European Standard EN50170. The physical layer is defined according to IEC 1158-2, which can also be used for intrinsically safe applications.

One of the features of smart field devices is their ability to detect faults, either in the device electronics or in an associated sensor. Using a fieldbus system, such faults are reported in the device status byte in every message (assuming that communication is still possible!). For HART®, it is still useful to follow the convention of indicating fault conditions by setting the analogue output current to a value which is recognisably beyond the normal operating range (including the small amount of linear over-range commonly allowed). If it is still alive, the current output value is set to an appropriate value with the intention that a host system should be able to set alarm thresholds just outside the normal 4 to 20 mA range, to indicate measurement out-of-range, and to set further alarm thresholds to indicate a fault condition.

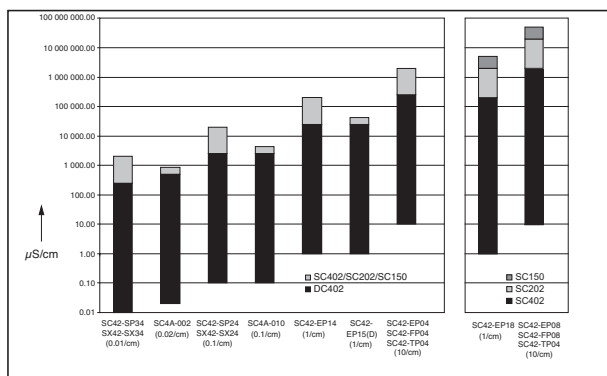
The SC202 follows the NAMUR Recommendation NE43 (18.01.1994) which suggests the following:

- Valid measurement range from 3.8 mA to 20.5 mA.
- Fault indicated by  $\leq 3.6$  mA or  $\geq 21.0$  mA. (burn)

### DD specification and other support files

The SC202G(S) Device Description (DD) files are available enabling communications compatible HOST devices (and HHT for HART®). Other files to support AMS, PRM and PDM are available as well. For more information contact your local Yokogawa sales offices.

## Accurate Conductivity Measurement



Measuring range as function of the cell constant

### Electrode selection

In order to make precise conductivity measurements, there are a number of prerequisites. Most important is the selection of suitable sensors. Special attention should be paid to the choice of the sensors

to ensure compatibility with both the chemical composition and the specific conductivity of the fluid to be measured. The installation of the sensor is also very important for a correct measurement. Other Yokogawa specification sheets cover the choice of sensors and holders, and any Yokogawa sales office can provide expert advice.

**Note:** With 2-electrode systems, polarization may decrease the conductivity value at higher concentrations. Applications using highly conductive fluids, inductive conductivity measurement should be considered as an alternative because of lower maintenance requirements.

## Process Temperature Compensation

As conductivity is a temperature dependant measurement, it is of great importance to determine the influence of the temperature. In general, the conductivity will change 2% per degree celsius. Therefore selecting a good temperature compensation method is imperative. Yokogawa has implemented several temperature compensation methods to fulfill this need.

### Automatic, according to NaCl tables (IEC-746-3 tables)

From the factory, the SC202G(S) is configured for non-linear temperature compensation according NaCl tables which will give accuracy in most measurements including Ultra Oure Water. In this case no site adjustments are required. For applications where NaCl compensation is not sufficient, other compensation possibilities are presented below.

### Matrix

The SC202G(S) is equipped with a matrix type algorithm (conductivity as a function of concentration and temperature) for accurate temperature compensation in various applications. Applications in Power Generation the following choices can be made:

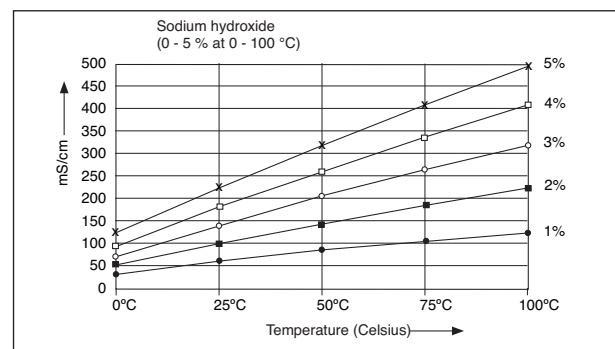
- HCl (cation) compensation (0 - 80°C)
- Ammonia compensation (0 - 80°C)
- Morpholine compensation (0 - 80°C)

For higher conductivity ranges the choices are:

- HCl (1 - 5 %, 0 - 60°C)
- NaOH (1 - 5 %, 0 - 100°C)
- 25 points (5 x 5) user programmable matrix.

This matrix can easily be programmed from the service mode by entering 5 temperature points, followed by conductivity values for each concentration at the 5 temperatures.

### Temperature Coefficient (TC or a)



### Example of matrix temperature compensation

For many applications the TC will give an accurate temperature compensation. It is also possible to have a linear compensation with programmable coefficient. A second conductivity display with independent TC is possible.

At start-up a known temperature coefficient may be entered from the service mode, or the TC can be adjusted by calibration, using actual process solutions. The freely programmable reference temperature also contributes to a high accuracy measurement.

**USP<645> Monitoring**

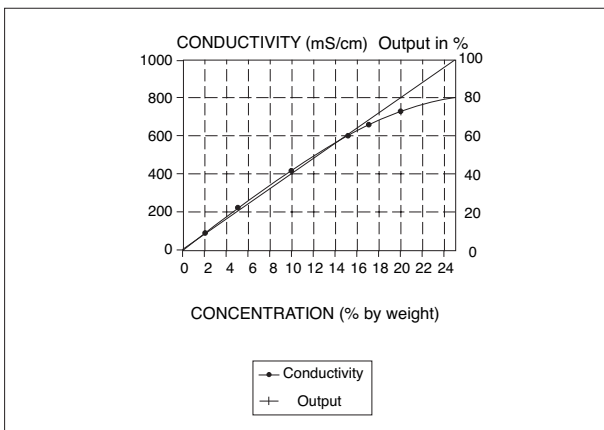
SC202G(S) monitors water quality according to the USP<645> directive (United States Pharmacopeia). Both compensated and uncompensated conductivity values can be read from the display, as can the solution temperature. There is an error message (E13) alarm to indicate that the USP<645> limit is exceeded. USP<645> determines a level of uncompensated conductivity for each temperature. The water must be below this level to be acceptable. This curve is preprogrammed into SC202G(S) and is used in the setpoint calculations.

**Converter design**

The transmitter uses advanced signal processing in order to minimize the effect of external influences such as polarization effects and cable resistance. This signal processing ensures that only changes in conductivity and temperature cause changes in the output.

**Concentration measurement**

Concentrations are determined according a 21 step concentration table. The table defines all conductivity values at 25°C and the corresponding concentration levels. The conductivity values at 25°C are determined by selecting the most applicable temperature compensation method. Below an example to measure the concentration of sulphuric acid.



**Linearization of output**

Example: 0-25% Sulphuric acid

Code Output	mA 4-20	Conc.	Example % H <sub>2</sub> SO <sub>4</sub>	Cond.	Example mS/cm
0	4.0		0.00		0
5	4.8		1.25		60
10	5.6		2.50		113
15	6.4		3.75		180
20	7.2		5.00		211
25	8.0		6.25		290
30	8.8		7.50		335
35	9.6		8.75		383
40	10.4		10.00		424
45	11.2		11.25		466
50	12.0		12.50		515
55	12.8		13.75		555
60	13.6		15.00		590
65	14.4		16.25		625
70	15.2		17.50		655
75	16.0		18.75		685
80	16.8		20.00		718
85	17.6		21.25		735
90	18.4		22.5		755
95	19.2		23.75		775
100	20.0		25.00		791

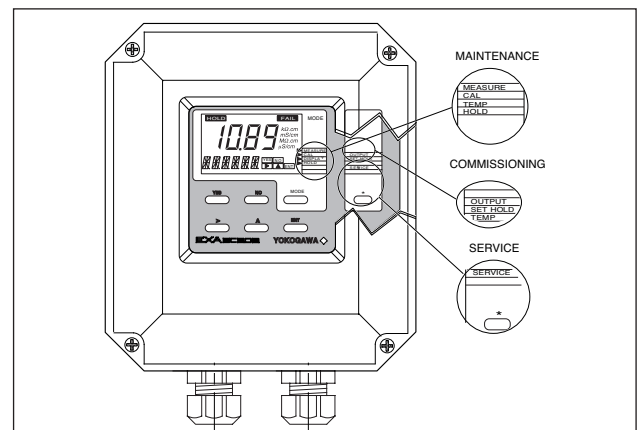
**Calibration**

It is maybe superfluous to say that the effect of incorrect calibrations are directly related to the measured conductivity value. Calibration of conductivity transmitters is in fact setting the slope or, the relation between the measured impedance and the Specific Conductivity (SC) value. This slope is expressed in cm<sup>-1</sup> and agrees with the Cell Constant of the sensor. All Yokogawa sensors are pre-calibrated during manufacturing according ASTM D1125 and this Cell Constant can be directly entered in the transmitter. Next, the transmitter offers the possibility to re-calibrate the sensor according ASTM D1125.

**Three Level Operation**

The EXA SC202G(S) converter uses a 3-level operating system to take full advantage of the microprocessor while retaining the traditional simplicity of analog converters. Advanced functions are separated from conventional operation to avoid confusion. They can be activated as required for each individual application.

1. The normal maintenance functions are accessible through the flexible window by pushing the keys underneath.
2. Functions required to commission the instrument are hidden to discourage unauthorized tampering. The front cover is removed to reveal the commissioning menu and the hidden access key (marked ★).
3. Specialized functions can be adjusted via the SERVICE menu. In this case access is by using "service codes."



**Three level operation**

**MAINTENANCE level**

- Use : Normal operation and checking
- How : Simple operation by dialog through the closed front cover
- Example : Read secondary data displays

**COMMISSIONING level**

- Use : For normal commissioning
- How : Removal of the front cover reveals the access key and second menu
- Example : Output range setting

**SERVICE level**

- Use : Only for specialized functions
- How : Through special service code entries
- Example : Selecting process compensation

With this 3-level user-friendly approach, the instrument can be operated by anyone. Commissioning is straight-forward and needs no calibration equipment compared to analog instruments. Special functions available via access codes are invisible during normal operation. All three levels can be separately protected against unauthorized access by a password system using a three digit code.

## General Specifications

**A. Input specifications** : Two or four electrodes measurement with square wave excitation. Cell constants from 0.008 to 50 cm<sup>-1</sup>. WU40 sensor cable up to 20 mtr. Up to 60 mtr. total using BA10 junction box and WF10 extension cable.

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

### C. Input ranges

- Conductivity (display) : 0.000  $\mu$ S/cm to 1999 mS/cm at reference temperature (compensated value).
  - Minimum : 1  $\mu$ S x C. at process temperature (underrange 0.000  $\mu$ S/cm).
  - Maximum : 200 mS x C. at process temperature (overrange 500 mS x C.).
- Resistivity (display) : 0.000 k $\Omega$ -cm to 999 M $\Omega$ -cm at reference temperature (compensated value).
  - Minimum : 5  $\Omega$  / C.C. at process temperature (underrange 2  $\Omega$  x cm).
  - Maximum : 1 M $\Omega$  / C.C. at process temperature (overrange 999 M $\Omega$  x cm).
- Temperature
  - Pt1000 : -20 to 250°C (0 to 500 °F)
  - Pt100 and Ni100 : -20 to 200°C (0 to 400 °F)
  - 8K55 NTC : -10 to 120°C (10 to 250 °F)
  - Pb36 NTC : -20 to 120°C (0 to 250 °F)

**C. Temperature compensation** : Automatic, for temperature ranges mentioned under C (inputs). Reference temperature programmable from 0 to 100°C or 30 to 210 °F (default 25°C).

### D. Compensation algorithm

- NaCl : According IEC 746-3 NaCl tables (default).
- T.C. : Two independent user programmable temperature coefficients, from 0 to 3.5 % per °C (°F) by adjustment or calibration.
- Matrix : Conductivity as a function of concentration and temperature. Choice out of 5 preprogrammed matrices and a 25-point user-programmable matrix.

**E. Logbook** : Software record of important events and diagnostic data.

**F. Display** : Custom liquid crystal display, with a main display of 3<sup>1/2</sup> digits 12.5 mm high. Message display of 6 alphanumeric characters, 7 mm high. Warning flags and units (mS/cm, k $\Omega$ -cm,  $\mu$ S/cm and M $\Omega$ -cm) as appropriate.

**G. Input isolation** : 1000 VDC

**H. Cable and terminals** : The SC202 is equipped with terminals suitable for the connection of finished cables in the size range: 0.13 to 2.5 mm (26 to 14 AWG).

**Cable entry** : 2 cable glands 1/2" NPT. 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).

**J. Shipping details** : Package size w x h x d  
290 x 225 x 170 mm  
(11.5 x 8.9 x 6.7 inch)  
Packed weight approx. 2.5 kg (5lb)

**K. Housing** : Cast aluminum case with chemically resistant coating, cover with flexible polycarbonate window. Case color is off-white and cover is moss green. Cable entry is via two PG 13.5 polyamide glands. Cable terminals are provided for up to 2.5 mm<sup>2</sup> finished wires. Weather resistant to IP65 and NEMA 4X standards. Pipe, wall or panel mounting, using optional hardware.

## Operating Specifications

**A. Performance** : Conductivity  
- Accuracy :  $\leq 0.5\% \pm 0.02$  mA  
**Performance** : Resistivity  
- Accuracy :  $\leq 0.5\% \pm 0.02$  mA  
**Performance** : Temperature with Pt1000 $\Omega$ , Ni100 $\Omega$  and Pb36 NTC  
- Accuracy :  $\leq 0.3^\circ\text{C} \pm 0.02$  mA  
**Performance** : Temperature with PT100 $\Omega$  and 8K55 $\Omega$   
- Accuracy :  $\leq 0.4^\circ\text{C} \pm 0.02$  mA  
**Performance** : Temperature compensation  
- NaCl table :  $\leq 1\%$   
- Matrix :  $\leq 3\%$   
- Ambient influence :  $\leq 0.05\% / ^\circ\text{C}$   
- Step response : 90 % (< 2 decades) in  $\leq 7$  seconds

**B. Ambient operating temperature** : -10 to +55°C (10 to 130 °F)  
Drift < 500 ppm/°C  
Excursions to -30 to +70°C (-20 to 160 °F) will not damage the instrument, specification maybe adversely affected.

**C. Storage temp.** : -30 to +70°C (-20 to 160 °F)

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

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

**F. Watchdog timer** : Checks microprocessor

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

**H. Operation protection**

: 3-digit programmable password.

**J. Intrinsic safety**

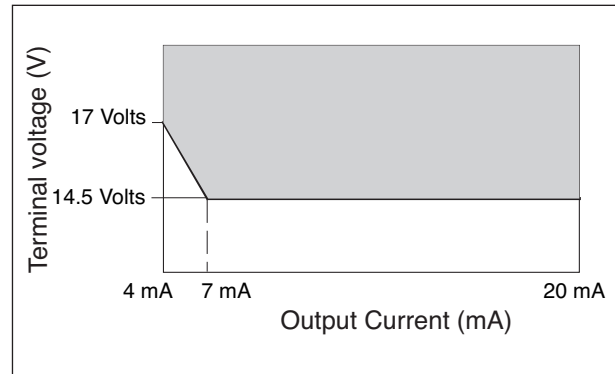
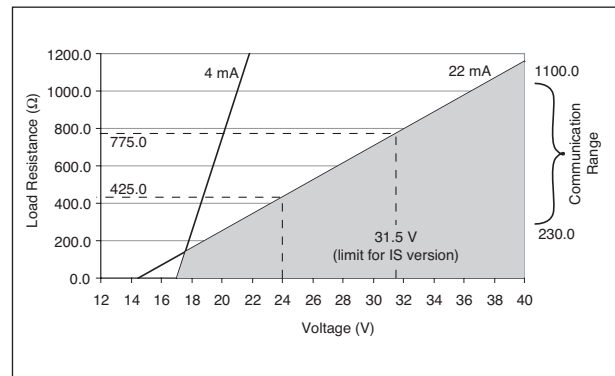
	⊕ II 2(1)G
- Cenelec ATEX	: EEx ib [ia] IIC T4 for Tamb. < 55°C
- Cenelec ATEX	: EEx ib [ia] IIC T6 for Tamb. < 40°C
- CSA	: Ex [ia] Class I, Div. 1, Group ABCD
- L96123-...	T4 for Tamb. < 55°C
	T6 for Tamb. < 40°C
- FM	: I.S. Class I, Div. 1, Group ABCD
- FMRC...	T4 for Tamb. < 55°C
	T6 for Tamb. < 40°C

**K. Non- Incendive:**

	⊕ II 3(1)G
- Cenelec ATEX	: EEx na [L] IIC T4 for Tamb. < 55°C
- Cenelec ATEX	: EEx na [L] IIC T6 for Tamb. < 40°C
- CSA	: Class I, Div. 2, Group ABCD
- L96123-...	T4 for Tamb. < 55°C
	T6 for Tamb. < 40°C
- FM	: N.I. Class I, Div. 2, Group ABCD
- FMRC...	T4 for Tamb. < 55°C
	T6 for Tamb. < 40°C

**L. Regulatory compliance**

- EMC	: meets council directive 89/336/EEC
- Emission	: meets EN55022 class A
- Immunity	: meets EN61000-6-2
- ATEX	: meets directive 94/9/EC

**Fig. 1 minimum terminal voltage at the SC202****Fig. 2 HART® supply voltage/ load diagram****HART® Communications****Input** : Two-wire system, 4-20 mA**Power supply** : Nominal 24 volt DC loop powered system.

SC202G : up to 40 volts

SC202S : up to 31.5 volts

**Note:** The transmitter contains a switched power supply, drawing its energy from the 0-4 mA section of the signal. Consequently the 17 volt limit is applied at 4 mA. The characteristic of the unit is such that above about 7 mA on the output, the terminal voltage can drop to 14.5 volts without problem. (see fig. 1)

**Transmission** : Isolated output of 4 to 20 mA DC.

**Signal** Maximum load 425 Ω. (see fig. 2)  
Burn to signal failure acc. NAMUR Recommendation NE43 (18.01.1994)

**Operating range** : 3.6 to 21mA**Communication** : HART®, 1200 Baud, FSK modulated on 4 to 20 mA signal**Bus connection** : Intrinsic safe EN 50020 according ATEX non incendive EN 50021**Configuration** : Local with 6 keys**Software** : Firmware based on Yokogawa stack.**Hardware** : JSP HART® Modem model MH-02**Hand Terminal** : Rosemount HHT 275**Other control systems** : Yokogawa PRM, Rosemount AMS, Siemens PDM,**Output span**

- Conductivity : min 0.01μS/cm, max. 1999 mS/cm. (max 90% zero suppression)
  - Resistivity : min 0.001kΩ·cm, max. 999 MΩ·cm. (max 90% zero suppression)
- The instrument is user programmable for linear or non-linear conductivity ranges.

**Cable specification**

- Min. cable diameter : 0.51 mm, 24 AWG
  - Max. cable length : 1500 m
- (Detailed information can be found at: [www.hartcomm.org](http://www.hartcomm.org))

**DD specification**

: The SC202 Device Description is available enabling communications with the Handheld communicator and compatible devices.

**PROFIBUS-PA Communications**

<b>Input signal</b>	: Digital
<b>Supply voltage</b>	: 9 to 32 VDC
<b>Operating current</b>	: 24.5 mA
<b>Operating values</b>	: According to IEC 1158-2
<b>Bus connection</b>	: Fieldbus interface based on IEC 1158-2 according to FISCO-Model
<b>Power supply</b>	: Power supply is achieved dependant on the application by means of segment coupler
<b>Data transfer</b>	: According to PROFIBUS- PA profile class B based on EN 50170 and DIN 19245 part 4
<b>GSD file</b>	: The actual file can be downloaded from <a href="http://www.profibus.com">www.profibus.com</a>
<b>Configuration</b>	: Local with 6 keys
<b>Software</b>	: Firmware based on Siemens DPC31 stack.
<b>Hardware</b>	: PC- or PCMCIA-interfaces from Siemens)
<b>Other control systems</b>	: Siemens PDM
<b>Electrical connection</b>	: Terminals acc. to IEC 1158-2
<b>Fieldbus-cable-types</b>	: Twisted and shielded two wire cable according to recommendation based on IEC 1158-2
<b>Cable diameter</b>	: 6 to 12mm(0.24 to 0.47 inch)

**FOUNDATION Fieldbus H1 Communications**

<b>Input signal</b>	: Digital
<b>Supply voltage</b>	: 9 to 32 VDC
<b>Operating current</b>	: 24.5 mA (base current)
<b>Operating values</b>	: According to IEC 1158-2
<b>Bus connection</b>	: Fieldbus interface based on IEC 1158-2 according to FISCO-Model
<b>Power supply</b>	: Power supply is achieved dependant on the application by means of segment coupler
<b>Data transfer</b>	: FF Specification Rev. 1.4, Basic device
<b>Function blocks</b>	: 3xAI, Transducer, Resource
<b>Files</b>	: Actual file can be downloaded from our homepage
<b>Configuration</b>	: Local with 6 keys,
<b>Software</b>	: National Instruments, NI-FBUS configurator
<b>Hardware</b>	: FBUS-interfaces from National Instruments (AT-FBUS and PCMCIA FBUS)
<b>Other control systems</b>	: Yokogawa PRM, DMT

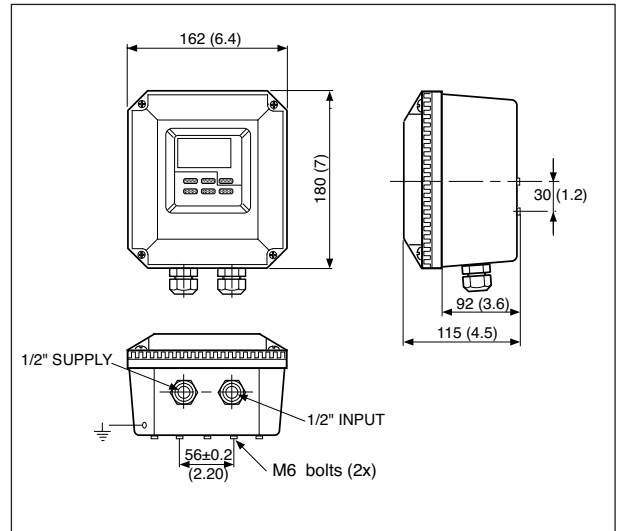
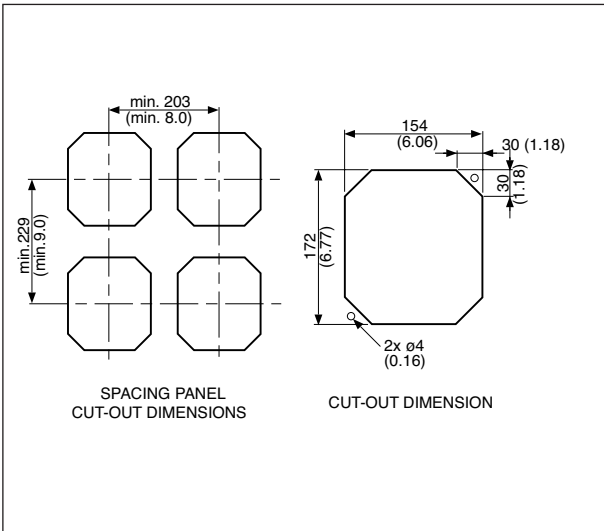
**Model and Suffix codes**

Model	Suffix Code	Option code	Description
SC202G			Conductivity transmitter, General Purpose version
Type	- A - F - P		Milli-amp (+HART®) version FOUNDATION® Fieldbus version Profibus PA version
	- E		Always E
Options		/H /U /SCT /Q	Hood for sun protection Pipe & Wall mounting hardware Stainless steel tagplate Calibration certificate

Model	Suffix Code	Option code	Description
SC202S			Conductivity transmitter, Intrinsic Safe version
Type	- A - F - P - N - B - D		Milli-amp (+HART®) version FOUNDATION® Fieldbus version Profibus PA version Non-Incendive Milli-amp (+HART®) version Non-Incendive FOUNDATION® Fieldbus version Non-Incendive Profibus PA version
	- E		Always E
Options*		/H /U /SCT	Hood for sun protection Pipe & Wall mounting hardware Stainless steel tagplate

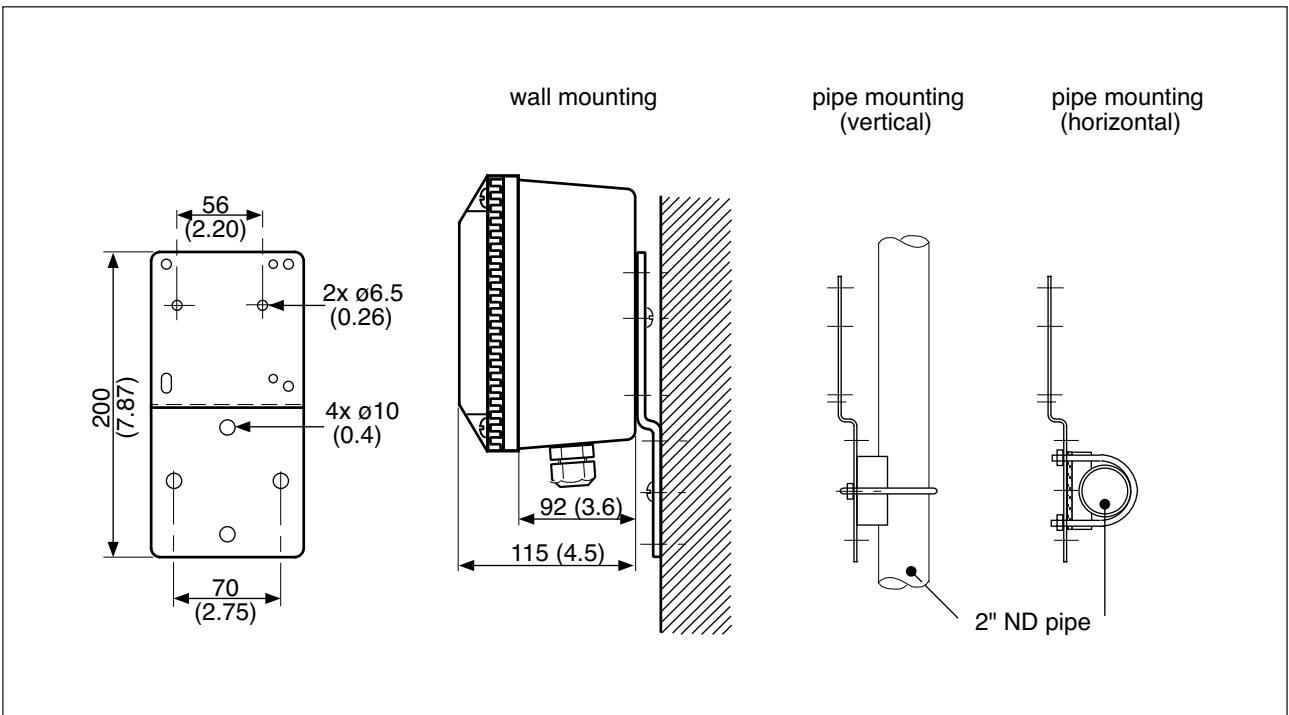
\* /Q: Quality Inspection certificate is always included with the product.

**Dimensions and mounting**



**Panel cut-out, spacing and mounting**

**Dimensions**



**Universal pipe/wall mounting**

## Spare parts SC202G

Part no.	Description
K1500AU	Gland set 1/2 inch for EXA's
K1542JC	Spare part flat cable
K1542JK	Cover for EXA200/202
K1542JL	Case assy for EXA200/202
K1542JN	Window assy for EXA200/202
K1542JZ	Cover assy for EXA200/202
K1542KG	/H for EXA200/202 (hood)
K1542KW	/U pipe/wall mounting for EXA
K1544BC	Nameplate for SC202G
K1544BJ	Eprom + latest software SC202G
K1544FA	Pin-header for HART®-FF interface
K1544KD	Case assy for EXA202 Fieldbus
K1544PF	Terminals, block of 3
K1544ST	/SCT for EXA200/202
MH-02	Sparepart HART® modem

## Spare parts SC202S

Part no.	Description
K1500AU	Gland set 1/2 inch for EXA's
K1542JK	Cover for EXA200/202
K1542KG	/H for EXA200/202 (hood)
K1542KW	/U pipe/wall mounting for EXA
K1544PF	Terminals, block of 3
K1544ST	/SCT for EXA200/202
MH-02	Sparepart HART® modem

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Fax (65)-241-2606  
[www.yokogawa.com/sing](http://www.yokogawa.com/sing)

Yokogawa has an extensive sales and distribution network. Please refer to the European website ([www.yokogawa.com/eu](http://www.yokogawa.com/eu)) to contact your nearest representative.



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