

# General Specifications

Model DO202G  
2-wire Dissolved Oxygen Transmitter



GS 12J05C01-01E

Flexibility, reliability and low maintenance are among the benefits provided by the EXA DO202 2-wire Dissolved Oxygen transmitter. Designed to meet the exacting requirements of Dissolved Oxygen analysis in the modern industrial environment, it contains many features to ensure the best precision whatever the application.

The DO202 is housed in a rugged IP65 enclosure and is a loop powered 2-wire transmitter to combine safe and simple wiring, installation and commissioning with the advanced functionality of the YOKOGAWA EXA microprocessor analyzer family.

The DO202 is a SMART transmitter. Digital communication is done either through HART® protocol superimposed on the 4- 20 mA current or completely digital through Fieldbus communication: Fieldbus Foundation.

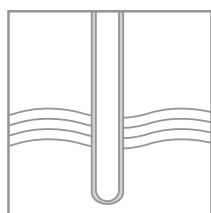
This SMART functionality allows the transmission of up to four process variables, information stored in the logbook, diagnostic data and remote configuration of the analyzer.

Yokogawa has developed drivers for PC configuration and maintenance software for different platforms like PRM, AMS and Pactware. The necessary drivers for PACTWARE can be downloaded free of charge from the website [www.yokogawa.com/eu](http://www.yokogawa.com/eu)

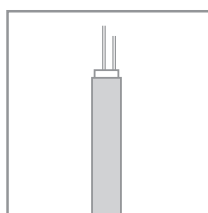
The DO202 transmitter is a universal Dissolved Oxygen Transmitter that accepts both galvanic sensors like DO30 and Polarographic sensors like OXYGOLD and OXYFERM that are used primarily in the Biotech industries. In combination with the OXYGOLD G the analyzer can accurately measure concentrations down to 1 ppb ( $\mu\text{g/L}$ ).

For high precision the DO202 offers automatic temperature compensation for both % saturation and ppm/ppb measurements; manual salinity compensation for analysis in saline water and manual pressure compensation for accurate analysis at high elevations or in reactors with high static pressure like production fermenters.

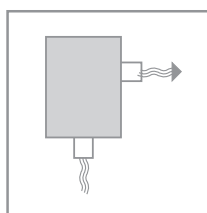
## System Configuration



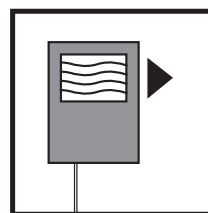
Sensors



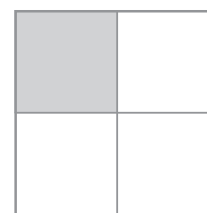
Cables



Fittings



Transmitters



Accessories



## Features

- Universal input accepts Galvanic and Polarographic sensors and various temperature compensating elements (Pt1000, 22k NTC)
- HART® communication standard with 4-20 mA loop powered model
- Fieldbus models for Foundation Fieldbus
- PROFIBUS models for PROFIBUS-PA
- Wide measuring range including ppb, ppm and % saturation
- Recommended sensors model DO30(G) , PB30, OXYFERM, OXYGOLD (for ppb measurement)
- Automatic temperature compensation from 0°C up to 100°C

## General Specifications

### Common specifications for all models

#### A. Input specifications

: The DO202 accepts output from membrane covered Dissolved Oxygen sensors. These sensors can be Galvanic type, where the sensor generates its own driving voltage or Polarographic type, where the sensor uses external driving voltage from the transmitter. The input range is 0-50  $\mu$ A for Galvanic sensors and 0- 1  $\mu$ A for Polarographic sensors. For temperature compensation the DO202 accepts Pt1000 RTD (DO30 sensor) and 22k NTC elements (OXYFERM and OXYGOLD sensors).

#### B. Measuring range

- Dissolved Oxygen
  - : 0 - 50 ppm (mg Oxygen per kg water);
  - 0 - 1999 ppb (mg Oxygen per 1000 kg water) and 0 - 600 % Saturation of Air in Water.
- Temperature : -20 to 150°C (-4 to 302°F).

#### C. Temperature compensation

: Automatic using Pt1000 or 22k NTC or manual. Range 0 - 100°C. (32 to 212 °F)

**D. Calibration** : Semi-automatic one or two point calibration in air or in water using solubility tables of ISO 5814. The influence of pressure and salinity is taken into account when these specifications are entered. Also a two point manual calibration is possible.

**E. Logbook** : Software record of important events and diagnostic data. Available through digital communication.

#### F. Transmission Signals

: Isolated output of 4-20 mA DC, Burn up (21 mA) or Burn down (3.6 mA when HART comm. non-used, 3.9 mA when HART comm. used) or pulse of 21 mA to signal failure.

**G. Display** : Custom liquid crystal display, with a main display of 3 1/2 digits 12.5 mm high. Message display of 6 alphanumeric characters, 7 mm high.

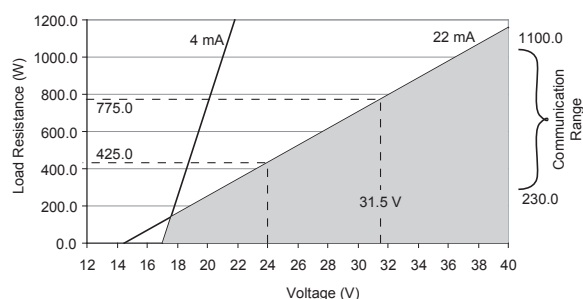
**H. Power supply** : Nominal 24 volt DC loop powered system

DO202G-A : up to 40 volts

DO202G-F, -P: 9-24, 9-17.5 (FISCO) VDC / 26.0 mA

**Note:** The transmitter contains a switched power supply. The transmitter requires a minimum power voltage in order to work correctly, which is dependant

on the load. Please refer to figures 2-1 and 2-2 for the correct power supply.



**Figure 2-1. Supply voltage/ load diagram**

**I. Input isolation** : 1000 VDC

#### J. Shipping details

Package size : W x H x H, 290 x 300 x 290 mm  
(11.5 x 11.8 x 11.5 inch)  
Packed weight : approx. 2.5 kg (5lb)

### Performance specifications

#### A. Performance in ppm mode

- Linearity :  $\pm 0.05$  ppm or  $\pm 0.8\%$  FS, whichever is greater
- Repeatability :  $\pm 0.05$  ppm or  $\pm 0.8\%$  FS, whichever is greater
- Accuracy :  $\pm 0.05$  ppm or  $\pm 0.8\%$  FS, whichever is greater

#### B. Performance in ppb mode

- Linearity :  $\pm 1$  ppb or  $\pm 0.8\%$  FS, whichever is greater
- Repeatability :  $\pm 1$  ppb or  $\pm 0.8\%$  FS, whichever is greater
- Accuracy :  $\pm 1$  ppb or  $\pm 0.8\%$  FS, whichever is greater

#### C. Performance in Temperature

- Linearity :  $\pm 0.3^\circ\text{C}$
- Repeatability :  $\pm 0.1^\circ\text{C}$
- Accuracy :  $\pm 0.3^\circ\text{C}$

#### Note on performance specifications:

The specifications are at reference temperature and with simulated inputs, because the DO202 can be used with many different sensors with their unique characteristics.

The following tolerance is added to above performance.

mA output tolerance :  $\pm 0.02$  mA of "4 - 20 mA"

#### D. Ambient temperature

: Operating temperature -10 to 55°C  
(10 to 130°F)  
; Storage temperature -30 to 70°C  
(-20 to 160°F)

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

**F. Housing** : Cast aluminum housing with chemically resistant coating, cover with flexible polycarbonate window. Case color is off-white with moss green cover. Cable entry is through two polyamide cable glands. Cable glands are provided for wiring up to 2.5 mm.

**G. Environmental protection**

: IP65, NEMA 4X, Type 3S.

**H. Mounting**

: Pipe, wall or panel mounting using optional hardware.

**I. Data protection**: EEPROM for configuration;  
Lithium battery for clock.**J. Watchdog timer**

: checks microprocessor functionality.

**K. Autoreturn**

: The transmitter returns into measuring mode automatically when no keystroke is made for 10 minutes.

**L. Password protection**

: All three levels can be protected by a user programmable 3 digit password

**M. EMC Conformity standards**  ,  **N200**EN 61326-1 Class A, Table 2  
(For use in industrial locations)  
EN 61326-2-3  
EN 61326-2-5 (Profibus communication may be influenced by strong electromagnetic field.)  
Korea Electromagnetic Conformity Standard**mA-HART® communication****A. Input**

: Two wire system 4-20 mA

**B. Power supply**: Nominal 24 volt DC loop powered system.

DO202G : up to 40 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 figure 2-2)

**C. Transmission**: Isolated output of 4 to 20 mA DC.**D. Signal**:Maximum load 425Ω at 24 VDC.  
(see figure 2-1)  
Burn to signal failure acc.  
NAMUR Recommendation NE43  
(18.01.1994)**E. Operating range** : 3.9 to 21mA**F. Communication**

: HART®, 1200 Baud, FSK modulated on 4 to 20 mA signal

**G. Configuration** : Local with 6 keys**H. Software** : Firmware based on Yokogawa stack.**I. Hardware** : Yokogawa HART® Modem F9197UB**J. Hand Terminal** : Rosemount HHT 275/375**K. Other control systems**:

Yokogawa PRM, Rosemount AMS, Siemens PDM

**L. Output span** :There are three output modes in which the output span can be freely selected: ppm (mg Oxygen per kg of water):  
0 - 50 ppm with minimum span of 1 ppm; ppb (mg Oxygen per 1000 kg of water): 0 - 1999 ppb with minimum span of 25 ppb and %

Saturation: 0 - 600 % with minimum span of 10 %

**M. Cable specification**

: 0.5 mm diameter or 24 AWG over maximum length of 1500 m

**N. DD specification**

: The DO202 Device Description is available enabling communications with the Handheld communicator and compatible devices.

**PROFIBUS-PA communications****A. Input signal**: Digital**B. Supply voltage**: 9 to 32 V DC**C. Operating current**: 26.0 mA**D. Operating values**: According to IEC 1158-2**E. Bus connection**

:Fieldbus interface based on IEC1158-2 according to FISCO-Model

**F. Power supply**: Power supply is achieved dependent on the application by means of segment coupler**G. Data transfer**: According to PROFIBUS- PA profile class B based on EN 50170 and DIN 19245 part 4**H. GSD file**: The actual file can be downloaded from [www.profibus.com](http://www.profibus.com) Configuration: Local with 6 keys**I. Software**: Firmware based on Siemens DPC31 stack.**J. Hardware**: PC- or PCMCIA-interfaces from Siemens**K. Other control**: Siemens PDM systems**L. Electrical connection**: Terminals acc. to IEC 1158-2**M. Fieldbus-cable-types**: Twisted and shielded two wire cable according to recommendation based on IEC 1158-2 Cable diameter: 6 to 12 mm (0.24 to 0.47 inch)**FOUNDATION FIELDBUS H1 communications****A. Input signal** : Digital**B. Supply voltage**: 9-32 V DC**C. Operating current**: 26.0 mA (base current)**D. Operating values**: According to IEC 1158-2**E. Bus connection**

: Fieldbus interface based on IEC 1158-2

according to FISCO model

**F. Power supply**: Power supply is achieved dependent on application by means of segment coupler**G. Data transfer** : FF specification Rev. 1.4 Basic device**H. Function blocks**: 3 x AI, Transducer, Resource**I. Files** : Actual file cCan be downloaded from our homepage**J. Configuration**: locally with 6 keys

- K. Software** : National Instruments:  
NI-FBUS configurator
- L. Hardware** : F-BUS interfaces from National  
Instruments (AT-FBUS, PCMA-  
FBUS)
- M. Other control systems**  
: YOKOGAWA PRM, DTM

### Operating Principles

The DO202 is designed to operate with membrane covered Dissolved Oxygen sensors. The sensor consists of a Cathode and an Anode. The membrane is stretched over the Cathode and the Oxygen molecules that diffuse from the process through the membrane to the cathode are oxidized by the cathode and converted into hydroxyl ions. ( $\text{OH}^-$ )

The current associated with this oxidation process is measured by the DO202 and converted in an output signal. This sensor current is proportional to the concentration of dissolved Oxygen in the process and dependent on the diffusion rate through the membrane.

This constant depends on the surface area of the cathode, on the type of membrane and on the thickness of the membrane and is therefore different for different types of sensors.

The voltage between Cathode and Anode is generated in two different ways and this determines the type of measurement:

#### 1) Polarographic measurement

Here the two electrodes are both made of a noble metal and an external DC voltage is applied to the electrodes. This voltage is approximately 675 mV. This polarization voltage is adjustable in DO202 to enable measurement with other membrane covered polarographic sensors.

#### 2) Galvanic measurement

Here the cathode is made of a noble metal and the anode is made of a non-noble metal like lead. The galvanic voltage generated by this asymmetric set of electrodes is the driving force for the oxidation reaction.

Example: DO30 : Galvanic membrane covered DO sensor. The membrane is made of 50 micron TFA and the sensitivity is approximately 3.75  $\mu\text{A}$  in air saturated water.

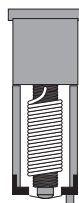


Figure 1: Galvanic DO sensor

### Display functions and ranges

The display continuously gives you all necessary information at a glance. The process values are shown in easy readable programmable units. Either mg/l, % saturation or ppm can be chosen.

The user-interface is simplified to a basic set of 6 keys accessible through the flexible window cover. It uses a simple step by step, question and answer style to communicate with the operator by giving messages on the second line of the display and indicating which keys are to be pressed in the display.

### Calibration

The DO202 can be calibrated for the sensor characteristics in various ways and the choice is a matter of convenience for the user.

#### 1. Air Calibration

The calibration in this mode is done with calibration gas. The most important calibration gas is ambient air. In air the sensitivity of the sensor is calibrated. In this mode the zero current of the sensor can also be calibrated using nitrogen as test gas. Most DO sensors require a very long time to reach their ZERO voltage and therefore it is recommended not to perform ZERO calibration, but only zero check.

#### 2. Water ( $\text{H}_2\text{O}$ ) Calibration

In this mode, calibration is done in water. The sensitivity of the sensor is calibrated with air saturated water. This saturation is done by blowing air in the water through a diffuser. The ZERO calibration in this  $\text{H}_2\text{O}$  CAL mode is done by dissolving sodium-bisulfite in the water. (Approximately 2 wt%). This sodiumbisulfite will remove all Oxygen from the water.

#### 3. Manual Calibration

Sometimes it is more convenient to perform a grab sample calibration. In this mode there are also two calibration points: SENS for the calibration of the sensitivity of the sensor. (This is a calibration point at high DO levels, for example in aerated water. Then table values can be used from ISO 5814.) And ZERO for the calibration of the zero current of the sensor. For this measurement normally a lab measurement is used as reference value in the ppb range of the sample.

### Salinity Compensation

ISO 5814 also describes the influence of salt in water on the solubility of air in water. This is an important parameter for the calibration of the DO sensor. The solubility decreases approximately 0,05 ppm with every ppt of salts. In the Automatic calibration mode the solubility tables of ISO 5814 are stored in memory and used to calibrate the sensitivity of the sensor. If the salinity (expressed in grams of salts per kg of water) is entered in the DO202, then accurate calibration is also achieved in salt water samples.

If this salinity compensation is not applied, then errors result in sensitivity calculations and in % saturation readings.

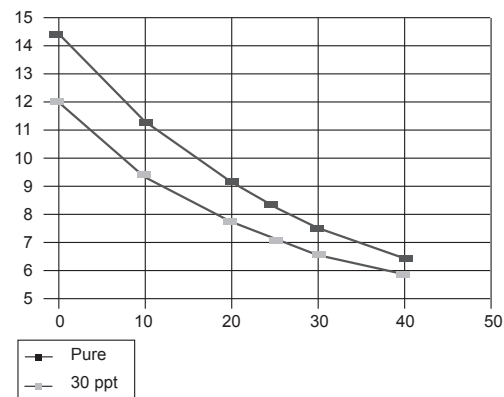


Figure 2: Solubility of air in water in ppm as function of temperature and salinity.

### Temperature Compensation

Temperature has a high influence on the sensitivity of the DO sensor and on the solubility of air in water. The first temperature effect is determined by the type of membrane in the DO sensor and may vary per sensor. DO30, OXYGOLD and OXYFERM sensors follow the same membrane characteristics that are programmed in DO202.

The second influence is defined in ISO 5814 and these characteristics are also programmed in DO202 to guarantee accurate measurement within the measuring range of the instrument.

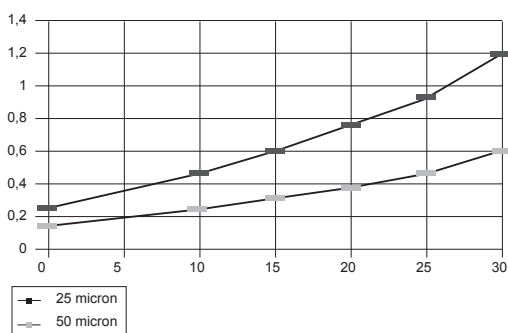


Figure 3: Sensitivity of DO30 sensor in  $\mu\text{A}$  as function of temperature and membrane thickness

### Pressure Compensation

The solubility of air in water is proportional to the pressure according to Henri's law. This pressure function is important for calibration of the DO sensors. The pressure influences the solubility in two ways:

#### 1. Barometric pressure

The barometric pressure varies with weather conditions and with altitude. Especially the altitude is an important variable that must be taken into account for accurate calibration. Examples can be found in ISO 5814. If the pressure is known, then this value can be entered in the DO202.

If the altitude is known, then it is best to calibrate using the manual calibration mode using the ISO 5814 tables found in the Instruction Manual.

#### 2. Static pressure

If the DO sensor is mounted near the bottom of a production fermenter or and the calibration is done while the water in the fermenter is aerated, then the static pressure must be entered in the DO202 to achieve accurate sensitivity calculations in the DO202.

### Output Signals

The basic DO202 transmitter offers HART® communication superimposed on the 4- 20 mA loop powered 2-wire line. The 4-20 mA can be scaled freely within the measuring range of the analyzer between 0- 600% of saturation and 0- 50 ppm oxygen and 0- 1999 ppb.

Through HART® the user has access to the other process variables:

- PV: User selected process value: ppm, ppb or % saturation
- SV: Temperature
- TV: % Saturation
- QV: sensor current

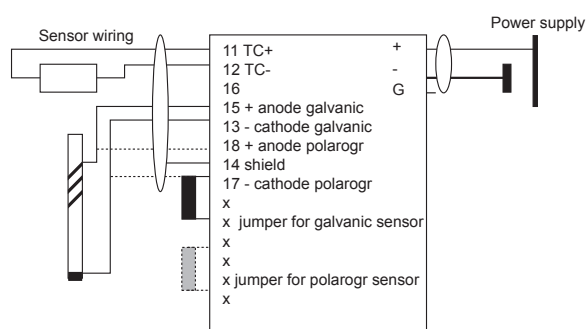
Each of these process variables can be decoded into current output or contact output through the HIM: Hart Interface Module. Yokogawa offers standard a HIM with two 0- 20 or 4- 20 mA outputs and three contact

outputs with 24 VDC power supply.

Full communication with the DO202 can be done through various brands of HART® Handheld terminals (HHT) or through Pactware. This program and the Yokogawa DTM library can be downloaded from YOKOGAWA or PACTWARE WEB sites free of charge by Yokogawa customers. Yokogawa recommends the use of MH-02 modem for HART®-RS232 conversion.

The Fieldbus Foundation model offers full digital communication between DO202 and the HOST computer. DO202 has passed the interoperability tests and is in addition tested with CENTUM and DELTA-V distributed control systems. For full information we refer to the WEB sites of the Fieldbus Foundation.

### Wiring



### Model and Suffix codes

[Style: S2]

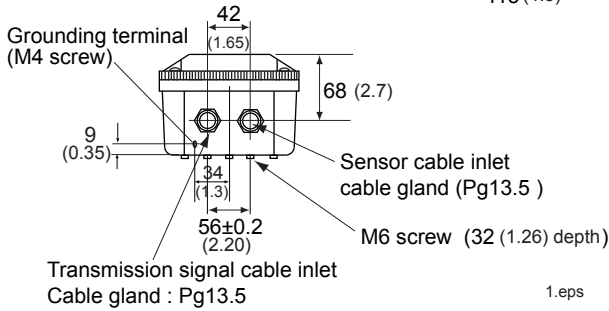
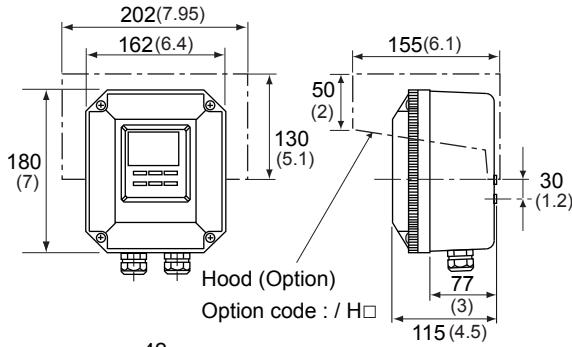
Model	Suffix Code	Option Code	Description
DO202G	-----	-----	2-wire Dissolved oxygen transmitter
Type	-A -P -F	----- ----- -----	mA with HART Profibus FF
Language	-E -J	----- -----	English Japanese
Options			
Mounting Hardware	/U		Pipe, Wall mounting bracket (Stainless steel)
	/PM		Panel mounting bracket (Stainless steel)
Hood	/H		Hood for sun protection (Carbon steel)
	/H2		Hood for sun protection (Stainless steel)
Tag Plate	/SCT		Stainless steel tag plate
Conduit Adapter	/AFTG		G 1/2
	/ANSI		1/2NPT
	/TB		Screw terminal (*1)
	/X1		Epoxy baked finish (*2)

\*1 It can be specified when the suffix code -A is selected.

\*2 The housing is coated with epoxy resin.

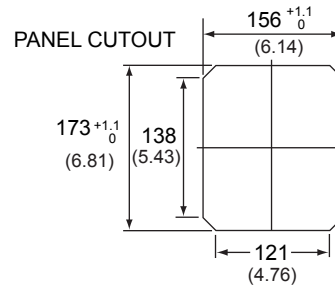
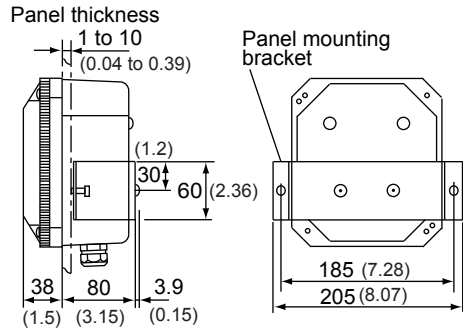
**Dimensions and mounting**

Unit: mm (inch)



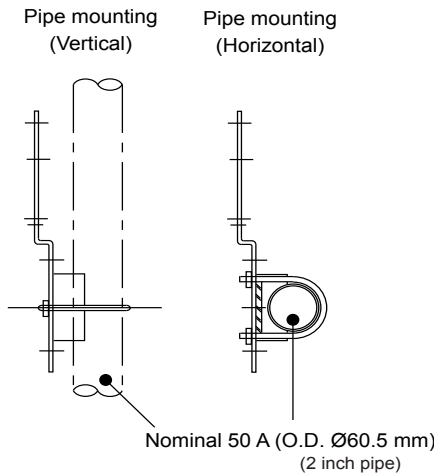
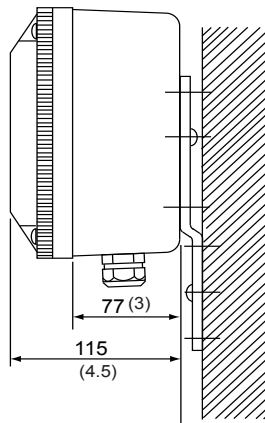
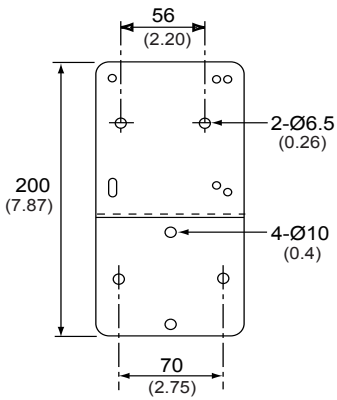
1.eps

**Panel Mounting (Option code: /PM)**



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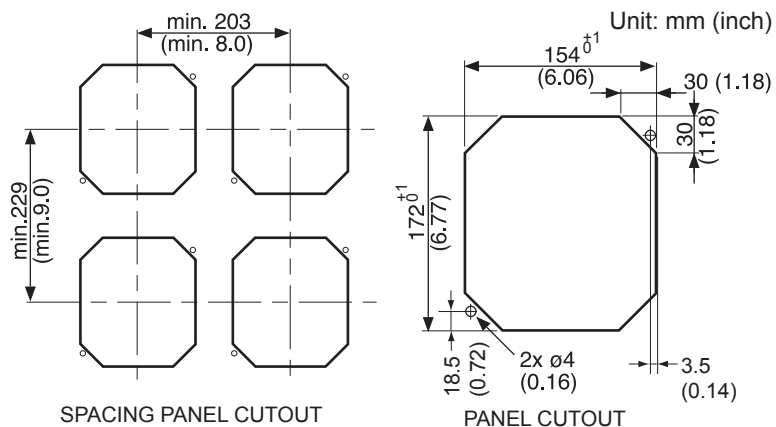
**Pipe/Wall Mounting (Option code: /U)**



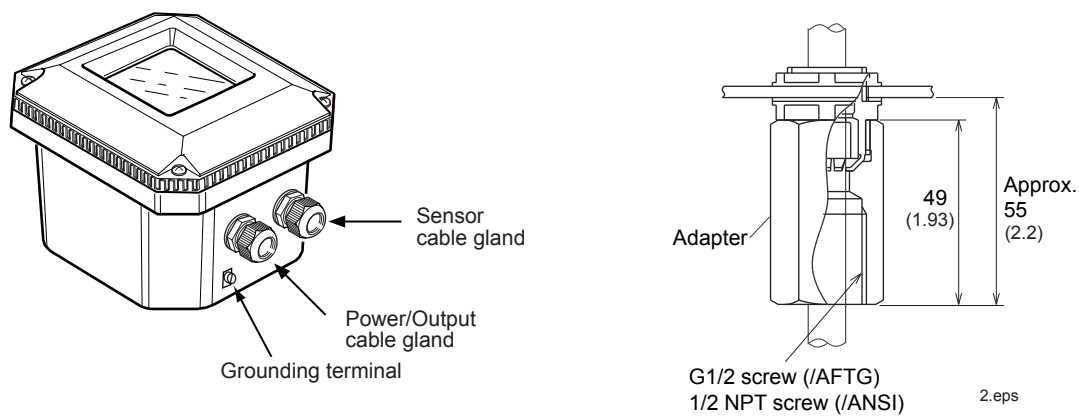
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## Panel Mounting using two self-tapping screws

Unit: mm (inch)



## Transmitter Housing and Conduit Adapter (Option code: /AFTG, /ANSI)



## Inquiry Specifications Sheet for DO202 Dissolved Oxygen Analyzer

For inquiries on the Yokogawa dissolved oxygen analyzer, please tick (✓) the appropriate box (□) and write down the relevant information in the blanks.

### 1. General

Name of your firm : \_\_\_\_\_  
 Person in charge : \_\_\_\_\_ Department : \_\_\_\_\_ (Phone No. \_\_\_\_\_)  
 Name of plant : \_\_\_\_\_  
 Measuring point : \_\_\_\_\_  
 Purpose of use :  Indication  Recording  Alarm  Control

### 2. Measurement Conditions

(1) Liquid temperature : \_\_\_\_\_ to \_\_\_\_\_, normal \_\_\_\_\_ [°C]  
 (2) Liquid pressure : \_\_\_\_\_ to \_\_\_\_\_, normal \_\_\_\_\_ [kPa]  
 (3) Flow speed : \_\_\_\_\_ to \_\_\_\_\_, normal \_\_\_\_\_ [m/s]  
 (4) Name of liquid to be measured : \_\_\_\_\_  
 (5) Components of liquid to be measured : \_\_\_\_\_  
 (6) Other conditions : \_\_\_\_\_

### 3. Installation Site

(1) Ambient temperature : \_\_\_\_\_  
 (2) Location :  Outdoors  Indoors \_\_\_\_\_  
 (3) Other information : \_\_\_\_\_

### 4. Requirements

(1) Measurement range :  0 to 50 mg/l  \_\_\_\_\_  
 (2) Transmission output :  4 to 20 mA DC  HART®  PROFIBUS-PA  FOUNDATION Fieldbus  
 (3) System component selection :  Sensor  Holder  Converter  Cleaning system  Calibration set  
 Parts set for maintenance  Terminal box  
 (4) Length of sensor cable :  3 m  5 m  10 m  15 m  20 m  
 (5) Type of holder :  Guide pipe  Submersion  Floating ball  Suspension  
 (6) Cleaning method :  No cleaning  Jet cleaning  
 (7) Other requirements :