

- **Cost effective**
  - select one or two pH/Redox (ORP) inputs or combine pH/Redox (ORP) and conductivity in one analyzer
- **Reduced installation cost**
  - easy access terminations; reduced panel space
- **High functionality at minimum cost**
  - three alarms and two fully isolated current outputs
  - integral Water/Chemical sensor cleaner control
  - integral PID controller (AX460)
- **Expanded monitoring and control**
  - add-on option board provides a total of five alarm relays and four current outputs
  - service log-book providing historical data
- **On line assurance of reliability**
  - comprehensive sensor and instrument self-checking
- **Energy saving**
  - high visibility backlit display with auto switch-off function
- **Reduced yearly maintenance costs**
  - 12 to 30V DC option negates the need for costly safety tests
- **Wide range of applicability**
  - water and wastewater treatment
  - power, pure water
  - semiconductors
  - chemicals
  - pharmaceuticals
  - pulp & paper



More processing power, higher performance

## The AX400 Series

AX400 analyzers incorporate the latest technology to provide highly reliable, flexible, feature-packed devices that satisfy a diverse range of process monitoring and control applications. The complete range encompasses solutions for pH/Redox (ORP), conductivity and dissolved oxygen.

AX46x analyzers enable continuous measurements of one or two pH or Redox (ORP) points with simultaneous local display and retransmission. AX46x is used with glass, enamel and antimony pH electrodes and metal Redox sensors, providing measurements with exceptional accuracy and performance.

AX400 Series analyzers are available for either wall-/pipe- or panel-mounting and are rated to IP66/NEMA 4X.

## High Functionality as Standard

All versions are supplied with two, fully isolated current outputs as standard, that can be assigned to the measured parameter, sample temperature or any appropriate calculated variables.

Three programmable relay set points are available that can also be assigned as required.

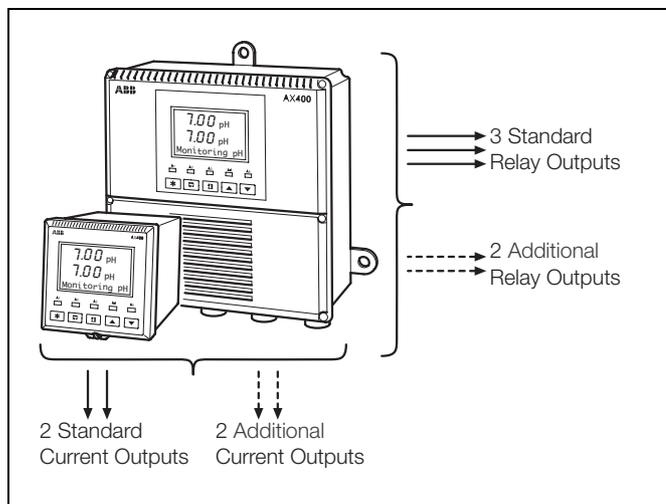
Innovative features such as power-saving display and a diagnostic current output option all contribute to a low cost of ownership.

## Plug-and-Produce Expanded Control

An advanced function card provides an additional two current outputs and two further alarm relays that can be assigned to either measured values or sample temperature.

ABB Plug-and-Produce software automatically reconfigures the analyzer if an option board is added later. No user programming is necessary.

A real-time clock and logbook are also included making the full-facility versions extremely powerful and versatile.



AX400 Outputs

## Significantly Reduced Maintenance Costs

The AX400 analyzers are supplied as standard for 85 to 265V AC operation. There are no inner switches to set.

They can also be provided for 24V AC or 12 to 30V DC supply and recognize automatically which of the two supplies is being used. 24V DC operation reduces maintenance costs significantly by negating the need for costly, yearly safety tests to ensure compliance with safety procedures.

## Energy Saving Display

The backlit display has been designed to operate in all types of environments and shows both the measured parameter(s) and, on a separate 16-character display line, diagnostic and computed information.

On dual-input analyzers both measured parameters are displayed simultaneously.

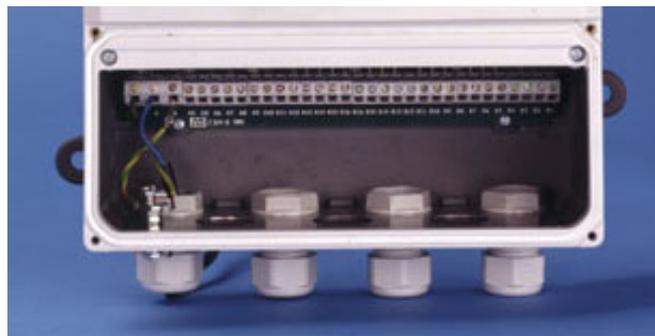
For conservation of energy, the backlight can be set to switch off automatically after 60s of inactivity.



Backlight Can Be Set to Switch-off When Inactive

## Easy-Access Installation Terminals

Easy access to the terminations ensures rapid and cost-effective installation. The wall-/pipe-mount version has been designed to ensure that cable connection is simple and convenient. Ingress protection of the electronics section is retained even when the terminal compartment cover is opened.

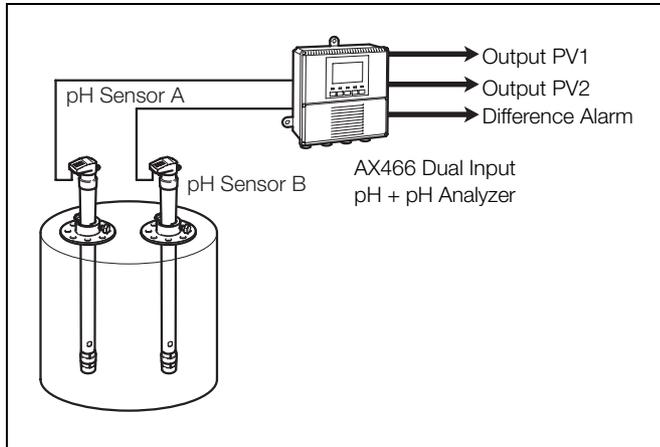


AX400 Termination Chamber Makes Access Easy

### Dual Input Measurement for Critical Duties

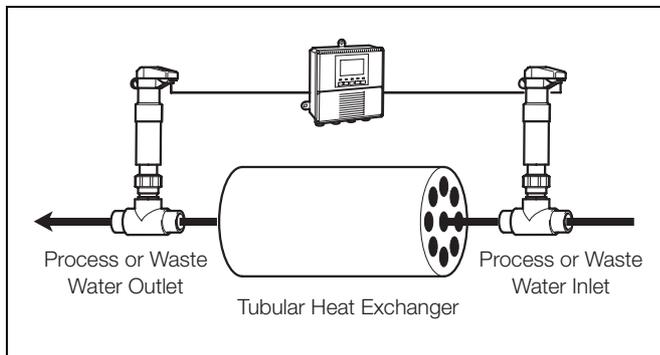
The AX400 enables two continuous measurements with simultaneous local display and retransmission. This capability provides an on-line validation of the process measurement.

Making two simultaneous measurements and configuring one of the set points as a difference alarm provides continuous on-line checking and early warning of an invalid measurement.



Dual-input Comparator for Critical Measurements

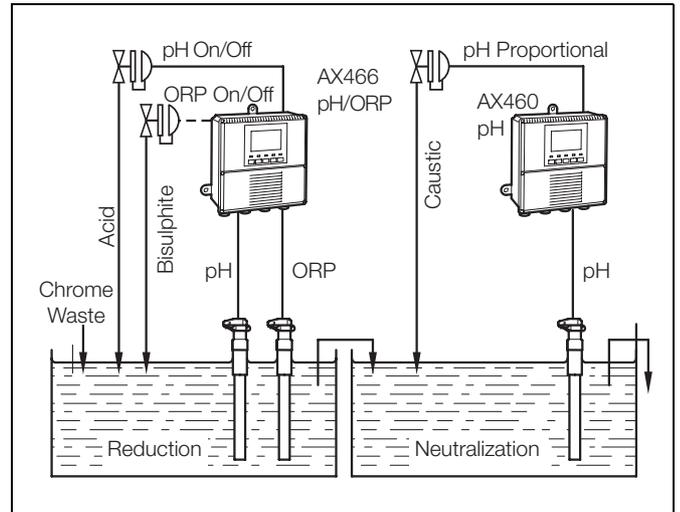
Detecting breakthrough of ammonia in a chiller unit is made possible with dual measurement. Comparison before and after the chiller ensures extremely rapid leakage detection, preventing damage to the system.



Ammonia Leakage Detection in a Chiller Unit

### Waste Treatment pH & Redox (ORP)

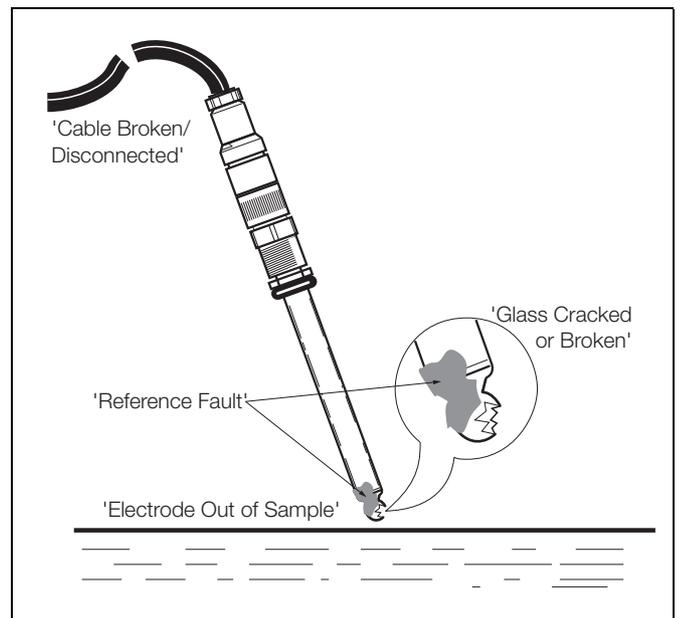
pH and Redox (ORP) are essential control parameters when removing toxic chromium ions from waste water in metal-finishing applications. Dual pH and Redox analyzers and integral control simplifies installation and reduces investment costs.



Waste Treatment pH and Redox (ORP)

### Just-in-Time Maintenance

One of the most vulnerable times for a pH electrode is during reintroduction into the line. If used with a solution earth rod, AX46x analyzers with advanced diagnostic facilities can detect sensor breakages as they occur. In addition, they can detect sensors out-of-process and several reference faults for fault diagnosis and reduced downtime.



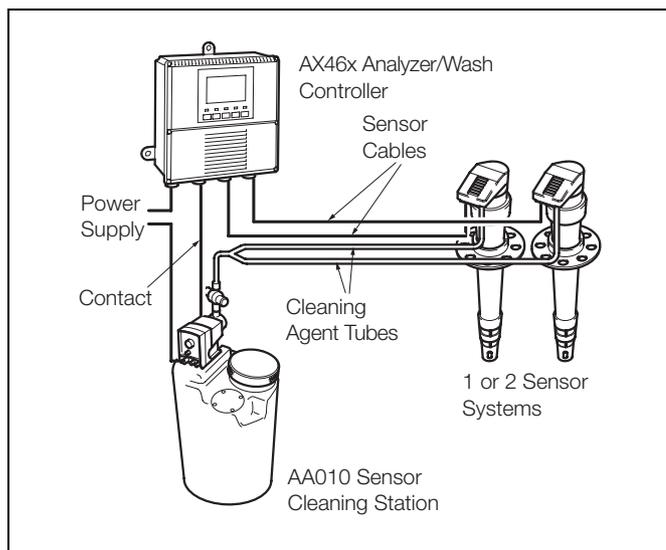
Just-in-Time Maintenance

### Reduced Maintenance Through In-line Cleaning

Many installed pH sensors benefit from regular cleaning. When carried out manually, this can be laborious and costly – so is often ignored. Advanced AX400 pH analyzers make it possible to automate sensor cleaning by using a programmable wash-timer contact to activate a cleaning agent valve or pump.

Pulsed water-wash and jet-wash chemical clean actions are standard, user-selectable functions. The frequency and duration of the wash can be tuned to meet the requirements of the application.

For chemical cleaning a 60 liter (13 gallon) sensor cleaning station can be supplied (model no. AA0010), complete with delivery pump and low level alarm. Chemical cleaning has proved particularly successful on potable drinking water plants where manganese and iron in the sample can create unacceptably high levels of maintenance. Effective cleaning reduces cost of ownership.



Efficient Auto-cleaning Control for One or Two Sensor Systems

### Combined Conductivity and pH

The AX416 version measures conductivity and pH with the same analyzer. The option board provides the capability to retransmit pH, conductivity and both sample temperatures. Five programmable alarms can be assigned to suit the needs of the application, enabling even the most demanding requirements to be met.



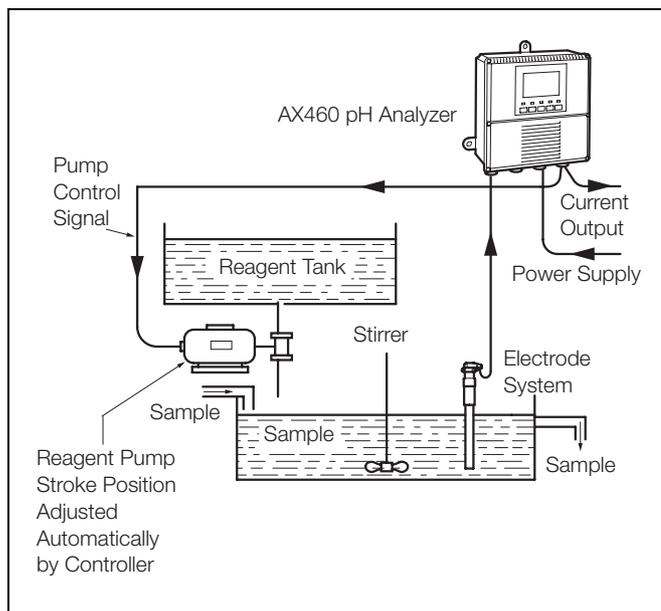
Simultaneous Conductivity and pH Measurement

### AX460 Integral P, PI and PID Control

The single input AX460 analyzers incorporate three-term PID Control, offering three modes of sophisticated control: analog, pulse length (time proportional) and pulse frequency. These are supplied as standard and can be operated in direct- or reverse-acting mode, dependent upon the application.

### Auto/Manual and Bumpless Transfer

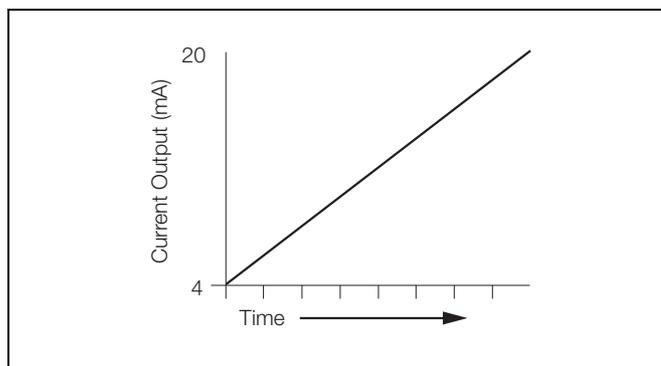
An auto/manual feature is incorporated for rapid manual access to the control functions. The controller facilitates bumpless transfer between manual and auto modes, providing the measured variable is within the proportional band and some integral action time has been programmed.



AX460 – Integral P, PI, and PID Control

### Current Output Proportional Control

In this case, the control signal is provided by the 4 to 20mA output of the AX460 analyzers rather than using the alarm/control contacts. The magnitude of the current output changes in proportion to the deviation from set point. This method is used generally with motorized valves or when controlling the speed of dosing pumps with a 4 to 20mA proportional input.

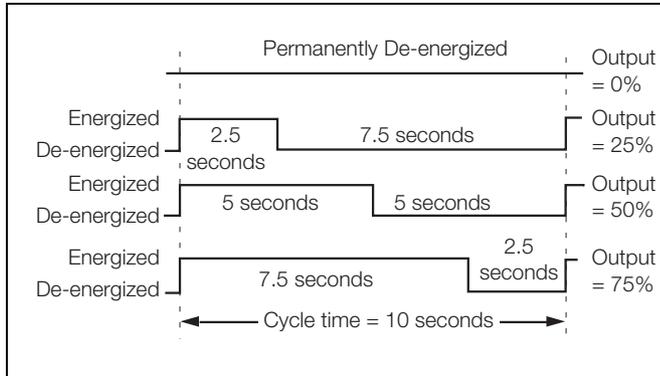


Current Acting Control

### Time Proportioning Control (Pulse Length)

With time proportioning control, the AX460 analyzer's control signal output is in pulses, the duration of which changes in proportion to the system error. The pulses are delivered by varying the length of time that the alarm/control contact is activated.

Time Proportioning Control is used generally to control dosing by low-cost solenoid valves or metering pumps and is also known as pulse-length proportional or Mark Space control.



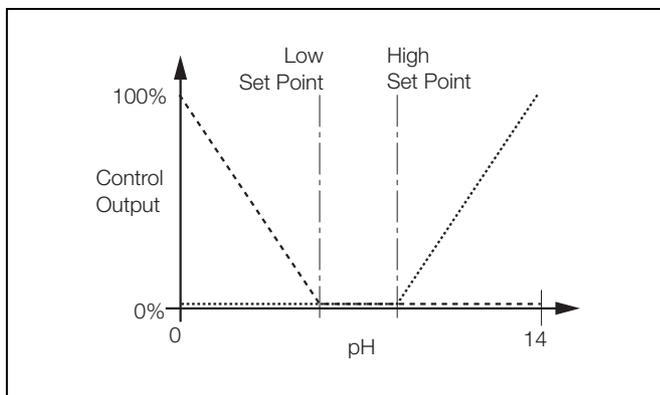
Time Proportioning Control

### Bi-directional Control

As well as single set point control for both acid and base addition, the AX460 analyzer can be configured with independent controllers.

To avoid control overlap, a minimum of 0.5pH difference (or deadband) between the set points is essential. The difference between the set points varies depending upon the application.

Control of each set point can be configured independently as either P or PI control in this mode. The setting of proportional band or integral action can also be different for each set point.



Bi-directional Control

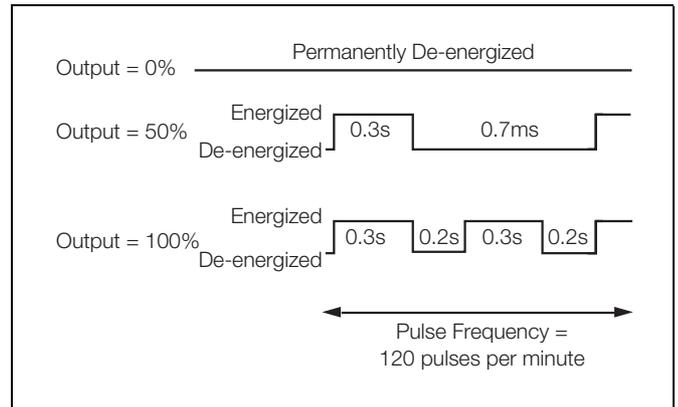
### Pulse-frequency Proportional Control

Impulse pumps dosing chemical reagents are controlled easily by the AX460 analyzer's pulse-frequency proportional control output. In this case, the pulse length of the alarm/control contact is fixed and the frequency of the delivered pulses increases in proportion to the system error, as set by the proportional band. Diaphragm metering pumps must have a remote pulse input capability in order to utilize this function.

Pulse-frequency control in the AX460 analyzer operates by pulsing a relay on for 300ms and off for a period of time determined by the pulse frequency. The pulse frequency (PFR) is adjustable between 1 and 120 pulses per minute. The greater the difference between the measured variable and the set point the greater the pulse frequency.

#### Example

If the pulse frequency is set at 120 pulses per minute and the percentage output is 100% then the pulse rate is 2 pulses per second. If the percentage output is reduced to 50%, the pulse rate falls to one pulse per second.



Pulse-frequency Proportional Control

### Power Failure Recovery

In the event of a power failure the user can configure the control mode to be Auto, Manual or Last. This optimizes control conditions on power-up to ensure rapid recovery of process control.

## Specification

### pH/Redox (ORP) – AX460 and AX466

#### Inputs

- One or two\* pH or mV inputs and solution earth
- One or two\* temperature sensors
- Enables connection to glass or enamel pH and reference sensors and Redox (ORP) sensors

\*AX466 only

#### Input resistance

- Glass  $>1 \times 10^{13}\Omega$
- Reference  $1 \times 10^{13}\Omega$

#### Range

- 2 to 16pH or -1200 to +1200mV

#### Minimum span

- Any 2pH span or 100mV

#### Resolution

- 0.01pH

#### Accuracy

- 0.01pH

#### Temperature compensation modes

- Automatic or manual Nernstian compensation
  - Range -10 to 200°C (14 to 392°F)
- Process solution compensation with configurable coefficient
  - Range -10 to 200°C (14 to 392°F)
  - adjustable -0.05 to +0.02%/°C (-0.02 to +0.009%/°F)

#### Temperature sensor

- Programmable Pt100, Pt1000 or Balco 3kΩ

---

### Calibration Ranges

#### Check value (zero point)

- 0 to 14pH

#### Slope

- Between 40 and 105% (low limit user-configurable)

---

### Electrode Calibration Modes

#### Calibration with auto-stability checking

- Automatic 1 or 2 point calibration selectable from:

- ABB
- DIN
- Merck
- NIST
- US Tech

- 2 x user-defined buffer tables for manual entry,
- 2-point calibration or single-point process calibration

### Conductivity – AX416 Only

#### Range

- Programmable 0 to 0.5 to 0 to 10,000μS/cm (with various cell constants)

#### Minimum span

- 10 x cell constant

#### Maximum span

- 10,000 x cell constant

#### Units of measure

- μS/cm, μS/m, mS/cm, mS/m, MΩ-cm and TDS

#### Accuracy

- Better than ±0.01% of span (0 to 100μS/cm)
- Better than ±1% of reading (10,1000μS/cm)

#### Operating temperature range

- 10 to 200°C (14 to 392°F)

#### Temperature compensation

- 10 to 200°C (14 to 392°F)

#### Temperature coefficient

- Programmable 0 to 5%/°C and fixed temperature compensation curves (programmable) for acids, neutral salts and ammonia

#### Temperature sensor

- Programmable Pt100 or Pt1000

#### Reference Temperature

- 25°C (77°F)

---

### Display

#### Type

- Dual 5-digit, 7-segment backlit LCD

#### Information

- 16-character, single line dot-matrix

#### Energy-saving function

- Backlit LCD configurable as ON or Auto-Off after 60s

#### Logbook\*

- Electronic record of major process events and calibration data

#### Real-time clock\*

- Records time for logbook and auto-manual functions

\*Available if option board is fitted

---

## Relay Outputs – On/Off

### Number of relays

Three supplied as standard or five with option board fitted

### Number of set points

Three supplied as standard or five with option board fitted

### Set point adjustment

Configurable as normal or failsafe high/low or diagnostic alert

### Hysteresis of reading

Programmable 0 to 5% in 0.1% increments

### Delay

Programmable 0 to 60s in 1s intervals

### Relay contacts

Single-pole changeover

Rating 5A, 115/230V AC, 5A DC

### Insulation

2kV RMS contacts to earth/ground

---

## Analog Outputs

### Number of current outputs (fully isolated)

Two supplied as standard or four with option board fitted

### Output ranges

0 to 10mA, 0 to 20mA or 4 to 20mA

Analog output programmable to any value between 0 and 22mA to indicate system failure

### Accuracy

±0.25% FSD, ±0.5% of reading (whichever is the greater)

### Resolution

0.1% at 10mA, 0.05% at 20mA

### Maximum load resistance

750Ω at 20mA

### Configuration

Can be assigned to either measured variable or either sample temperature

---

## Digital Communications

### Communications

Profibus DP (with option board fitted)

## Control Function – AX460 Only

### Controller Type

P, PI, PID (configurable)

### Control Outputs

#### Output

Can be assigned a maximum of two relays, two analog outputs, or one of each

#### Analog

Current output control (0 to 100%)

#### Time proportioning cycle time

1.0 to 300.0s, programmable in increments of 0.1s

#### Pulse frequency

1 to 120 pulses per minute, programmable in increments of 1 pulse per minute

#### Controller action

Reverse, direct or bi-directional (programmable)

#### Proportional band

0.1 to 999.9%, programmable in increments of 0.1%

#### Integral action time (Integral reset)

1 to 7200s, programmable in increments of 1s (0 = Off)

#### Derivative

0.1 to 999.9s programmable in increments of 0.1s, available only for single set point control

#### Auto/Manual

User-programmable

---

## Access to Functions

### Direct keypad access

Measurement, maintenance, configuration, diagnostics and service functions

Performed without external equipment or internal jumpers

---

## Sensor Cleaning Function

### Configurable cleaning action relay contact

Continuous

Pulse in 1s on and off times

### Frequency

5 minutes to 24 hours, programmable in 15 minute increments up to 1 hour then in 1 hour increments for 1 to 24 hours

### Duration

15s to 10 minutes, programmable in 15s increments up to 1 minute then in 1 minute increments up to 10 minutes

### Recovery period

30s to 5 minutes, programmable in 30s increments

**Mechanical Data****Wall-/Pipe-mount versions**

IP66/NEMA4X

Dimensions 192mm high x 230mm wide x 94mm deep  
(7.56 in. high x 9.06 in. wide x 3.7 in. deep)

Weight 1kg (2.2 lb)

**Panel-mount versions**

IP66/NEMA4X (front only)

Dimensions 96mm x 96mm x 162mm deep  
(3.78 in. x 3.78 in. x 6.38 in. deep)

Weight 0.6kg (1.32 lb)

**Cable Entry Types**

Standard	5 or 7 x M20 cable glands
North American	7 x knockouts suitable for 1/2 in. Hubble gland

---

**Power Supply****Voltage requirements**

85 to 265V AC 50/60 Hz

24V AC or 12 to 30V DC (optional)

**Power consumption**

&lt;10VA

**Insulation**

Mains to earth (line to ground) 2kV RMS

**Environmental Data****Operating temperature limits**

-20 to 65°C (-4 to 149°F)

**Storage temperature limits**

-25 to 75°C (-13 to 167°F)

**Operating humidity limits**Up to 95%RH non condensing

---

**EMC****Emissions and immunity**

Meets requirements of:

EN61326 (for an industrial environment)

EN50081-2

EN50082-2

**Hazardous area approvals**

GENELEC ATEX IIG EEx n IIC T4 Pending

FM non-incendive Class I Div. 2 Groups A to D Pending

CSA non-incendive Class I Div. 2 Groups A to D Pending

---

**Safety****General safety**

EN61010-1

Overvoltage Class II on inputs and outputs

Pollution category 2

---

**Languages****Languages configurable:**

English

French

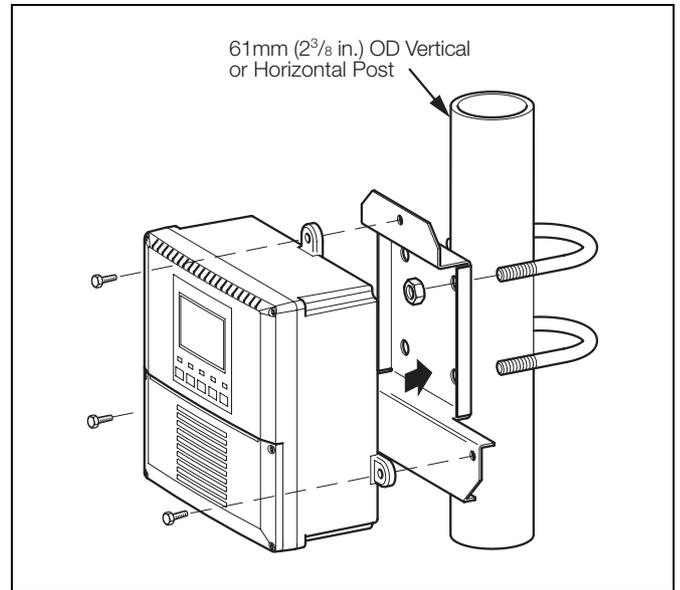
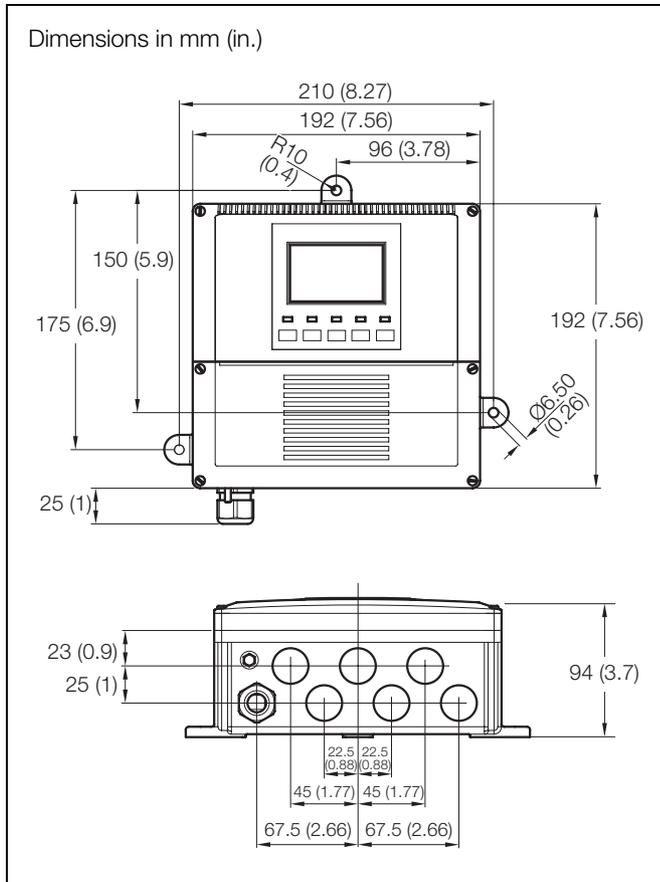
German

Italian

Spanish

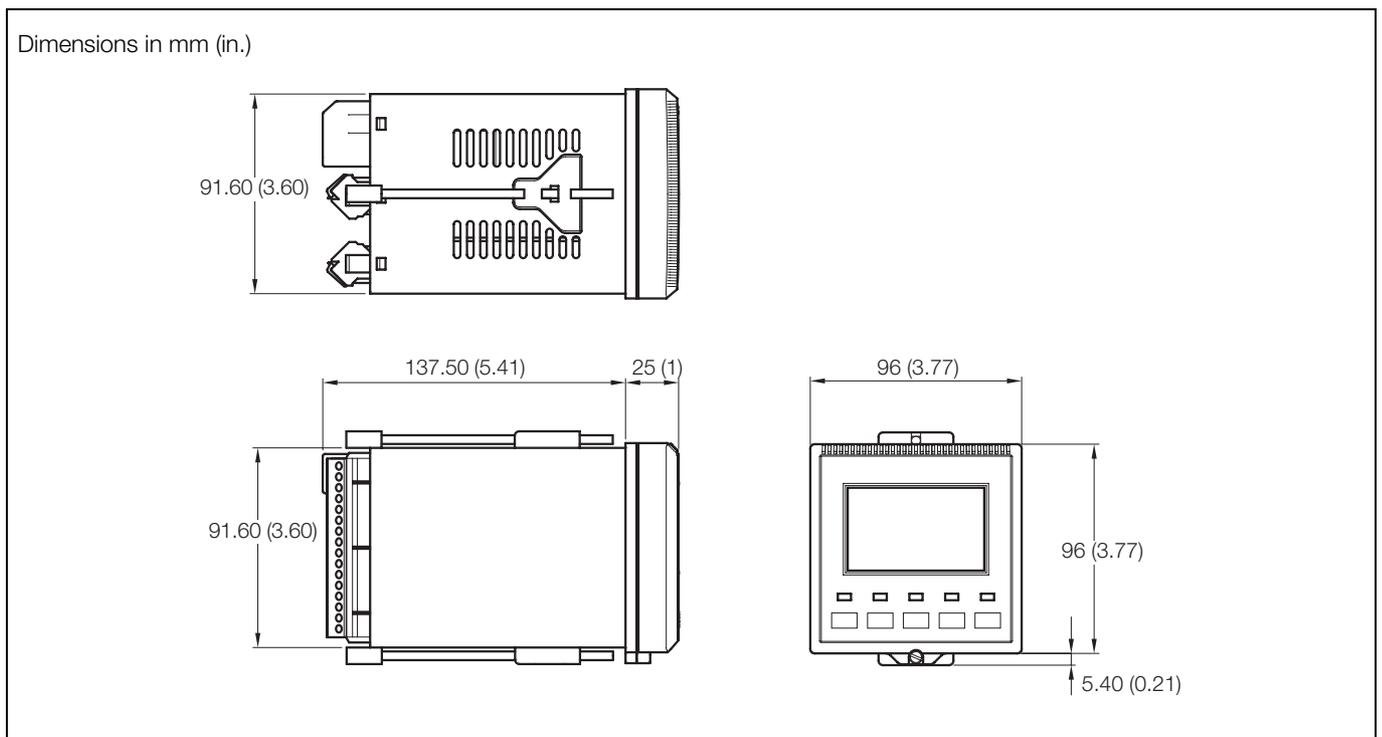
---

**Overall Dimensions**



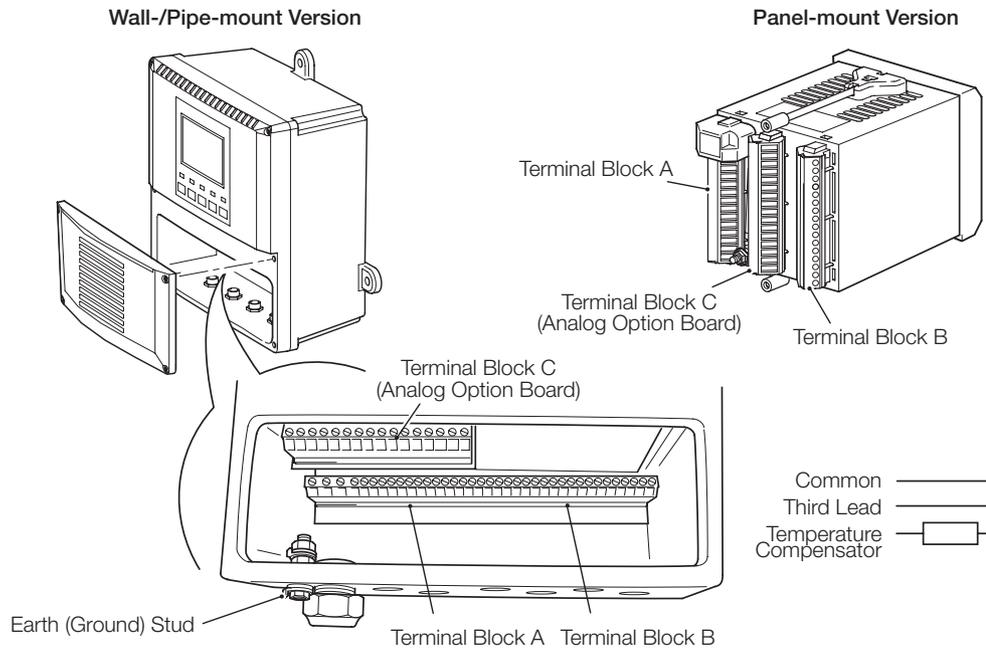
Pipe-mount Detail

Wall-/Pipe-mount Version

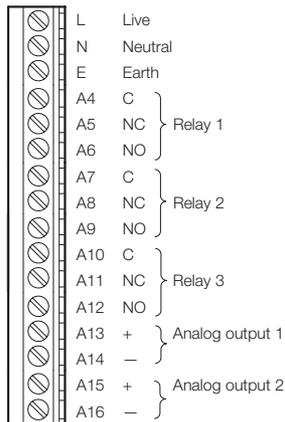


Panel-mount Version

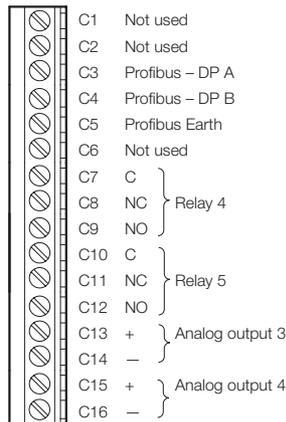
## Electrical Connections



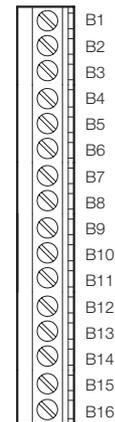
**Terminal block A**



**Terminal Block C (Analog Option Board)**



**Terminal Block B**  
(see table below)



Terminal Block B		pH/Redox (ORP) without Solution Earth‡	pH/Redox (ORP) with Solution Earth‡	Conductivity
Sensor B	Sensor A			
1	9	Temperature Compensator common* Link 1 & 2 / 9 & 10**	Temperature Compensator common* Link 1 & 2 / 9 & 10**	Temperature Compensator common Link 1 & 2 / 9 & 10**
2	10	Temperature Compensator third lead*	Temperature Compensator third lead*	Temperature Compensator third lead
3	11	Temperature Compensator*	Temperature Compensator*	Temperature Compensator
4	12	Not applicable	Reference Electrode	Screen
5	13	Not used	Not used	Cell (Cell Electrode)
6	14	Reference Electrode	Solution Earth‡	Cell (Earth Electrode)
7	15	Screen*	Screen*	Not used
8	16	Glass/Metal Electrode	Glass/Metal Electrode	Not used

\*If fitted.

\*\*When a 2-wire Pt100, Pt1000 or BALCO temperature compensator is fitted.

‡Solution Earth also referred to as Ground Rod.

Ordering Information

Single and Dual Input Analyzers for pH/Redox (ORP) and Conductivity Models AX460, AX466 & AX416	AX4	X	X	X	X	X	0	X
<b>First Process Variable (PV1)</b>								
Conductivity 0 to 10,000µS cm <sup>-1</sup> for 2-electrode sensors		1						
Conductivity 0 to 1,999mS cm <sup>-1</sup> for 4 electrode sensors		3						
Conductivity USP<645> for 2-electrode sensors		5						
pH/Redox (ORP)		6						
Dissolved Oxygen		8						
<b>Second Process Variable (PV2)*</b>								
No second process variable – select for PID control of PV1							0	
Conductivity 0 to 10,000µS cm <sup>-1</sup> for 2-electrode sensors							1	
Conductivity 0 to 1,999mS cm <sup>-1</sup> for 4-electrode sensors**							3	
Conductivity USP<645> for 2-electrode sensors							5	
pH/Redox (ORP)							6	
Dissolved Oxygen							8	
<b>Enclosure Types</b>								
<b>Wall-mount IP66/NEMA 4X, General</b>								
Wall-mount – cable glands fitted							1	
Pipe-mount							2	
<b>Wall-mount NEMA 4X/IP66, North American</b>								
Wall-mount							6	
Pipe-mount							7	
<b>Panel-mount, Universal</b>								
Panel-mount**							5	
<b>Advanced Functions &amp; Communications</b>								
Basic (2 current outputs + 3 relays)							0	
Advanced (4 current outputs + 5 relays + logbook)							1	
Profibus DP, basic (2 current outputs + 3 relays)**							2	
Profibus DP, advanced (4 current outputs + 5 relays + logbook)**							3	
<b>Power Supply</b>								
85 to 265V AC 45 to 65Hz							0	
24V AC/12 to 30V DC (auto-selection)							1	
Reserved								0
<b>Manual</b>								
English								1
French								2
Italian								3
German								4
Spanish								5

\* When ordering units with a second process variable (PV2) the code digit for PV2 in the order code number must be equal to, or greater than, the code digit for PV1, e.g. AX416 permissible, AX461 not permissible.

\*\* Profibus DP not available in panel-mount housing when 0 to 1,999mS/cm is selected as Second Process Variable (PV2).

## Single and Dual Input Analyzers for pH/Redox (ORP)

AX460, AX466 and AX416

---

ABB has Sales & Customer Support expertise  
in over 100 countries worldwide

[www.abb.com](http://www.abb.com)

The Company's policy is one of continuous product  
improvement and the right is reserved to modify the  
information contained herein without notice.

Printed in UK (02.09)

© ABB 2009



**ABB Limited**  
Oldends Lane, Stonehouse  
Gloucestershire  
GL10 3TA  
UK  
Tel: +44 (0)1453 826661  
Fax: +44 (0)1453 829671

**ABB Inc.**  
Analytical Instruments  
9716 S. Virginia St., Ste. E  
Reno, Nevada 89521  
USA  
Tel: +1 775 850 4800  
Fax: +1 775 850 4808