

ABB MEASUREMENT & ANALYTICS | DATA SHEET

AX410, AX411, AX416, AX450 and AX455

Single and dual input analyzers
for low level conductivity



Measurement made easy

More processing power,
higher performance

Cost effective

- select one or two conductivity inputs or combine conductivity and pH/Redox (ORP) in one analyzer
- integral PID controller (AX410)

Reduced installation cost

- easy access terminations; reduced panel space

High functionality at minimum cost

- conductivity, resistivity, difference, ratio, % passage, % rejection and inferred pH calculations

Expanded monitoring and control

- add-on option board provides a total of five alarm relays and four current outputs
- service logbook providing historical data

Energy saving

- high visibility, backlit display with auto switch-off function

Reduced yearly maintenance costs

- 30 V DC option negates the need for costly safety tests

Wide range of applicability

- water and waste water treatment
- power, pure water
- semiconductors
- chemicals
- pharmaceuticals
- pulp & paper

The AX400 series

The 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.

Models AX41x and AX45x enable continuous measurements of one or two low-level conductivity points with simultaneous local display and retransmission. The analyzers are used with ABB 2-electrode conductivity cells providing measurements with exceptional accuracy and performance.

Model AX45x analyzers are dedicated to United States Pharmacopoeia <645>.

AX400 Series analyzers are available for either wall-/pipe- or panel-mounting and are rated to IP65.

High functionality as standard

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

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

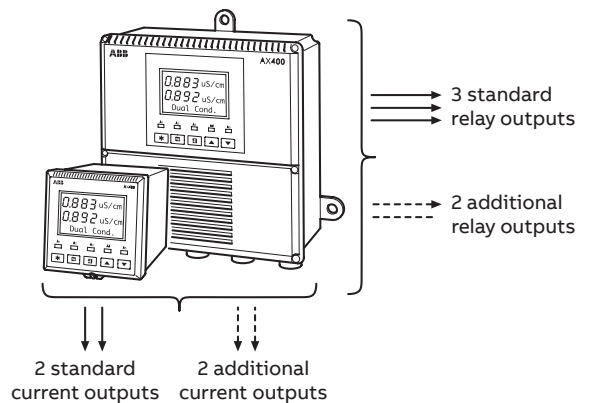
Innovative features such as a power saving display and a diagnostic current output option all contribute to low cost of ownership.

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 265 V AC operation. There are no inner switches to set.

They can also be provided for 24 V AC or 12 to 30 V DC supply and recognize automatically which of the two supplies is being used. 24 V 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.

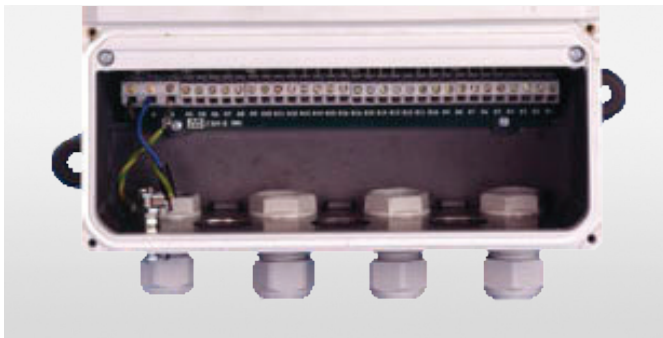
For conservation of energy, the backlight can be set to switch off automatically after 60 s of inactivity.



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 is opened.



AX400 termination chamber makes access easy

Single and dual input analyzers

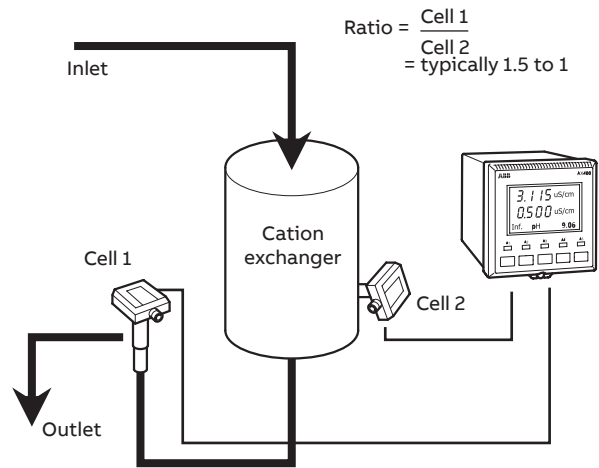
Both single and dual-input analyzers provide accurate measurement of low-level conductivity and can be configured for ranges in $\mu\text{S cm}^{-1}$, $\mu\text{S m}^{-1}$, mS cm^{-1} and mS m^{-1} .

Alternatively, the instrument can be set up for resistivity in MW-cm, total dissolved solids and salinity.

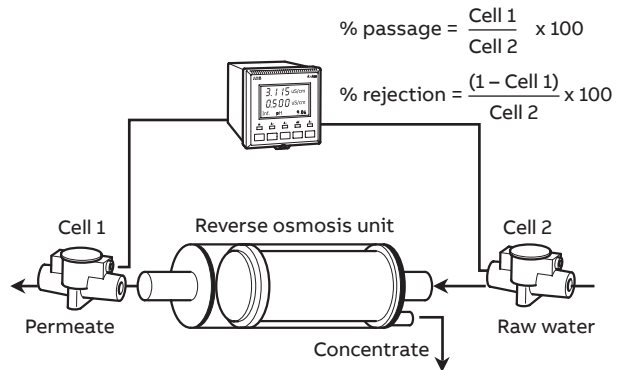
In addition, the dual-input analyzer calculates, displays and transmits:

- Ratio of cell 1 / cell 2
- Difference cell 1 – cell 2
- % Passage (cell 1 / cell 2) x 100
- % Rejection (1 – [cell 1 / cell 2]) x 100
- Inferred pH

These facilities are invaluable tools for demineralization and reverse osmosis and a host of industrial processes.



Cation exchanger

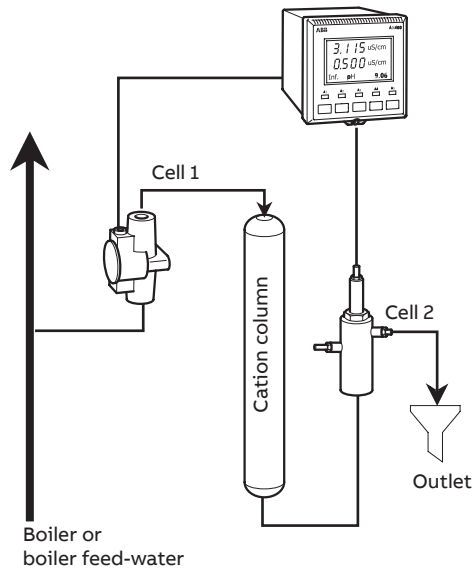


Reverse osmosis

Cation conductivity and inferred pH measurement

In low conductivity, ammoniated boiler waters, the AX411 analyzer can calculate an inferred pH measurement from the conductivity and a preset ammonia concentration. With this method, one AX411 provides cation conductivity, a direct output of pH, reduced cost and none of the maintenance associated with pH electrodes.

Self-monitoring of the validity of the pH measurement is achieved by checking that an after-cation conductivity value is sufficiently low. This measurement is provided by the second input of the AX411 analyzer. Alarm contacts can be configured for cation conductivity, invalid pH and exhausted resin.



Inferred pH with self-diagnostic alarm

AX410 integral P, PI and PID control

The single input AX410 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, depending upon the application.

Comprehensive temperature compensations

AX41x and AX45x conductivity analyzers provide true temperature compensation for all high-purity water applications:

- **Raw (uncompensated) conductivity**
 - USP<645> water for injection and purified water
- **NaCl**
 - General monitoring
 - Mixed-bed exchanger
 - Final polisher effluent
 - Cation exchanger inlet
 - Anion exchanger effluent
 - Reverse osmosis
- **HCl**
 - Cation exchanger outlet
 - Degassed cation conductivity
 - Semiconductor rinse and reclaim water
- **NH₃**
 - Ammonia-treated make-up and boiler feed water
 - Condenser sampling applications
 - Hot well sampling applications
 - Before-cation column applications
 - Inferred pH in ammonia-dosed waters
- **Ultra Pure Water (UPW)**
 - Temperature effect of pure water only
- **Linear**
 - Manual entry of temperature coefficient

‘Trim’ calibration

All ABB sensors are supplied pre-calibrated to exacting tolerances. This enables installation without the need for any further adjustment. The construction is robust and provides highly stable measurements over the sensor’s lifetime. The single-point calibration facility enables local adjustment where on-site validation is required.

Combined conductivity and pH

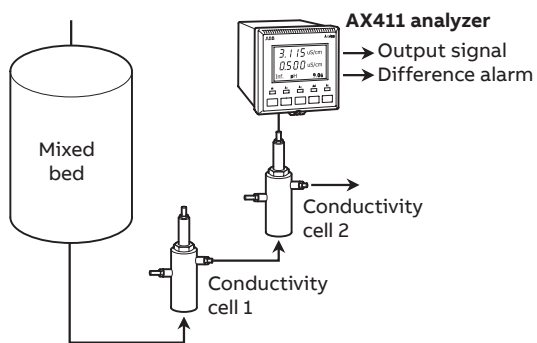
The AX416 version measures conductivity and pH with the same analyzer. The option board provides the capability to retransmit pH, conductivity and both sample temperatures. Five programmable alarms can be assigned to suit the needs of the application, enabling even the most demanding requirements to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



Simultaneous conductivity and pH measurement

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.



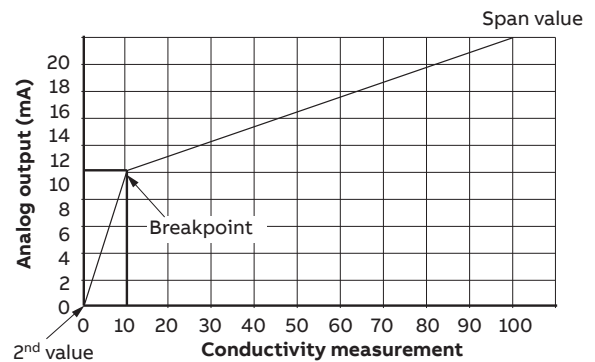
Dual input comparator for critical measurements

AX41x configurable current outputs

The analyzer's current outputs are fully galvanically isolated and configurable as 4 to 20 mA, 0 to 20 mA or 0 to 10 mA. In addition, AX400 conductivity analyzers offer the user a choice in how the current output is configured:

- Linear
- 2-decade logarithmic
- 3-decade logarithmic
- Bi-linear with configurable break-point
- User-configurable between 0.1 and 100 % of total span

Bi-linear and logarithmic ranges effectively provide a split output facility. General monitoring is covered with the lower range while still supplying excellent discrimination during high level excursions, such as during an alarm state.



Bi-linear output maximizes sensitivity over the critical range

AX450 and AX455 USP <645> conductivity

AX450 and AX455 analyzers have been developed specifically with the guidance of major leading pharmaceutical manufacturers to produce a system fully compliant to USP<645>.

The US Pharmacopoeia has replaced the off-line qualitative test of water impurities, such as chloride, with a composite in-line Stage 1 Test based on conductivity.

Certification

To conform to USP<645> the accuracies of the instrument display and the sensor's cell constant are assured below specified limits. Each AX450 or AX455 analyzer and model 2278 cell is supplied with a traceable test certificate.

Revalidation facility

ABB provides a revalidation facility for the 2278 conductivity cell where the cell can be returned periodically for re-certification of the cell constant. This quick turnaround facility fulfills the stringent certification requirements of today's pharmaceutical industry.

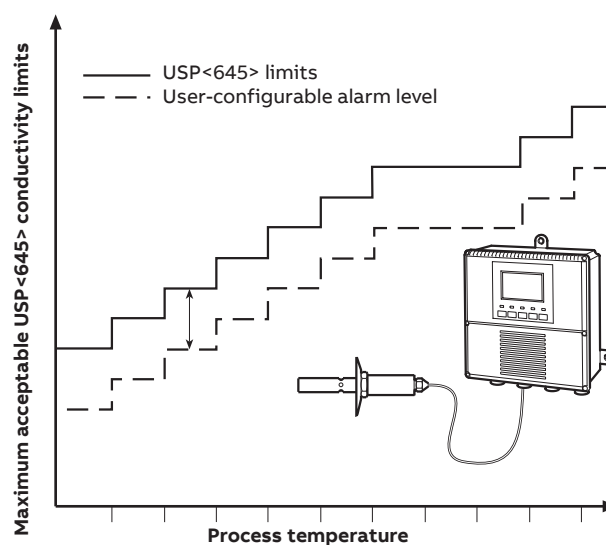
Recording USP<645>

Two standard current outputs, or four (optional), enable both conductivity and temperature to be recorded externally as a permanent record of compliance.

Automatic stage 1 test

Maximum acceptable impurity levels are expressed by USP<645> as uncompensated conductivity at 5 °C (9 °F) increments. The Stage 1 test of PW and WFI requires both parameters to be checked against the set limits.

The Stage 1 conductivity / temperature limits are stored within the AX45X analyzer and can be activated on a limit alarm contact. The alarm can be configured to initiate at a safe working distance from the Stage 1 limit. This enables assurance of operation to Stage 1 without manual intervention.



Automatic USP<645> stage 1 test

Total USP<645> compliance

| Specification | USP requirement | Models AX450 and AX455 |
|----------------------------|--|--|
| Conductivity cell constant | Verified to within $\pm 2\%$ ✓ | Traceable verification to $\pm 2\%$ with certificate (normal accuracy $\pm 1\%$). Re-verifiable |
| Resolution of display | $0.1 \mu\text{S cm}^{-1}$ ✓ | $0.01 \mu\text{S cm}^{-1}$ |
| Instrument accuracy | $\pm 1.0\%$; $\pm 0.1 \mu\text{S cm}^{-1}$ ✓ | Max. $\pm 1.0\%$ of FSD. Min. $0.01 \mu\text{S cm}^{-1}$ to max. $0.1 \mu\text{S cm}^{-1}$ Traceable verification with certificate |
| Temperature compensation | Uncompensated ✓ | Uncompensated and compensated |
| Measurement range | 0.2 to $4 \mu\text{S cm}^{-1}$ ✓ | 0 to $1 \mu\text{S cm}^{-1}$ to 0 to $10 \mu\text{S cm}^{-1}$, fully user configurable |

Specification

Conductivity – AX41x and AX45x

Range

Programmable 0 to 0.5 to 0 to 10,000 $\mu\text{S cm}^{-1}$
(with various cell constants)

Minimum span

10 x cell constant

Maximum span

10,000 x cell constant

Units of measure

$\mu\text{S cm}^{-1}$, $\mu\text{S m}^{-1}$, mS cm^{-1} , mS m^{-1} , $\text{M}\Omega\text{-cm}$ and TDS

Accuracy

Better than $\pm 0.01\%$ of span (0 to 100 $\mu\text{S cm}^{-1}$)

Better than $\pm 1\%$ of reading (10,000 $\mu\text{S cm}^{-1}$)

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)

Calculated variables – AX411

| | |
|------------------------------|---|
| Ratio | 0 to 19,999 |
| Difference | 0 to 10,000 $\mu\text{S cm}^{-1}$ |
| Percent passage or rejection | 0 to 100.0 % |
| Total dissolved solids | 0 to 8,000 ppm |
| Inferred pH | 7.0 to 10.0pH (NH_3 -dosed systems) 7.0 to 11.0pH (NaOH -dosed systems)* |

pH /Redox (ORP) – AX416

Inputs

- pH or mV input and solution earth
- Temperature sensor Pt100, Pt1000 or Balco 3k
- Enables connection to glass or enamel pH and reference sensors and Redox (ORP) sensors

Input resistance

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

Range

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

Minimum span

Any 2 pH span or 100 mV

Resolution

0.01 pH

Accuracy

0.01 pH

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 3k Ω

Calibration ranges

Check value (zero point)

0 to 14 pH

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 one-point process calibration

* pH calculation according to the appendix in the VGB directive 450L, 1988.

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 60 s

Logbook*

Electronic record of major process events and calibration data

Real-time clock*

Records time for logbook and auto-manual functions

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 60 s in 1 s intervals

Relay contacts

Single-pole changeover

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

Insulation

2 kV RMS contacts to earth / ground

Analog outputs

Number of current outputs (fully isolated)

Two supplied as standard or four with option board fitted

Output range

- 0 to 10, 0 to 20 or 4 to 20 mA
- Analog output programmable to any value between 0 and 22 mA to indicate system failure

Accuracy

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

Resolution

0.1 % at 10 mA , 0.05 % at 20 mA

Maximum load resistance

750Ω at 20 mA

Configuration

Can be assigned to either measured variable or either sample temperature

Digital communications

Communications

Profibus DP (with option board fitted)

Control function – AX410 only

Controller type

P, PI, PID (configurable)

Control outputs

Analog

Current output control (0 to 100 %)

Time proportioning cycle time

1.0 to 300.0 s, programmable in increments of 0.1 s

Pulse frequency

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

Controller action

Direct or reverse

Proportional band

0.1 to 999.9 %, programmable in increments of 0.1 %

Integral action time (Integral reset)

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

Derivative

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

Auto / Manual

User-programmable

*Available if option board is fitted.

...Specification

Access to functions

Direct keypad access

- Measurement, maintenance, configuration, diagnostics or service functions
- Performed without external equipment or internal jumpers

Sensor cleaning function – AX416 only

Configurable cleaning action relay contact

- Continuous
- Pulse in 1 s 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

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

Recovery period

30 s to 5 minutes, programmable in 30 s increments

Mechanical data

Wall- / Pipe-mount versions

- IP65 (not evaluated under UL certification)
- Dimensions 192 mm high x 230 mm wide x 94 mm deep (7.56 in. high x 9.06 in. wide x 3.7 in. deep)
- Weight 1 kg (2.2 lb.)

Panel-mount versions

- IP65 (front only)
- Dimensions 96 mm x 96 mm x 162 mm deep (3.78 in. x 3.78 in. x 6.38 in. deep)
- Weight 0.6 kg (1.32 lb.)

Cable entry types

| | |
|----------------|---|
| Standard | 5 or 7 x M20 cable glands |
| North American | 7 x knockouts suitable for ½ in. Hubble gland |

Power supply

Voltage requirements

- 100 to 240 V AC, 50 / 60 Hz (90 V min. to 264 V max. AC)
- 12 to 30 V DC

Power consumption

10 W

Insulation

Mains to earth (line to ground) 2 kV RMS

Environmental data

Operating temperature limits

–20 to 55 °C (–4 to 131 °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

Approvals, certification and safety

Safety approval

UL

CE mark

Covers EMC & LV Directives (including latest version EN 61010)

General safety

- EN61010-1
- Overvoltage Class II on inputs and outputs
- Pollution category 2

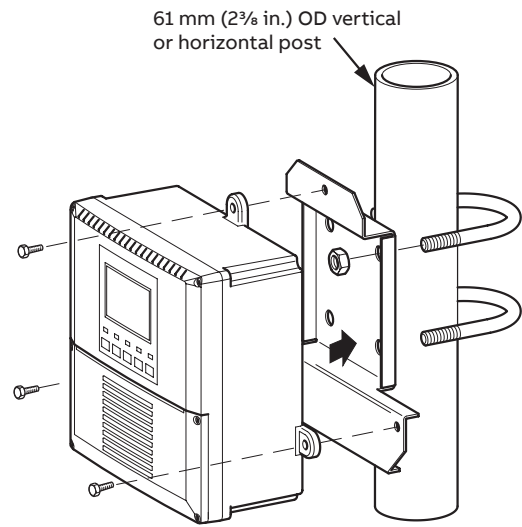
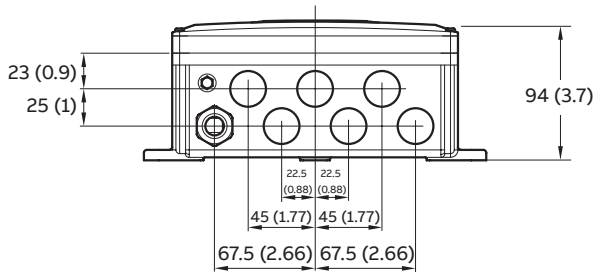
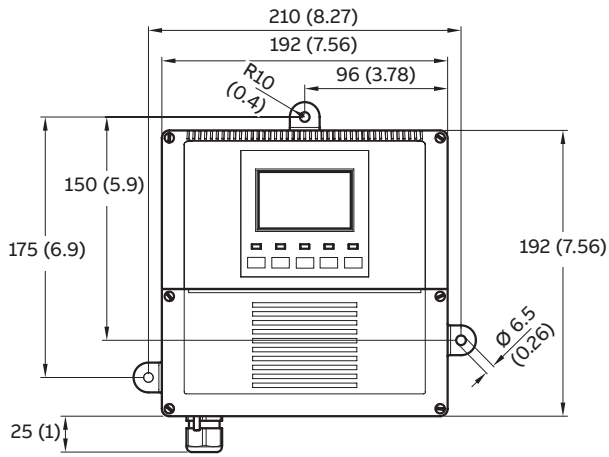
Languages

Languages configurable:

- English
- French
- German
- Italian
- Spanish

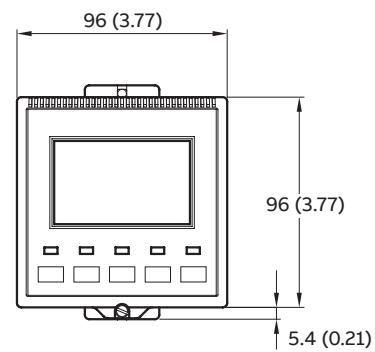
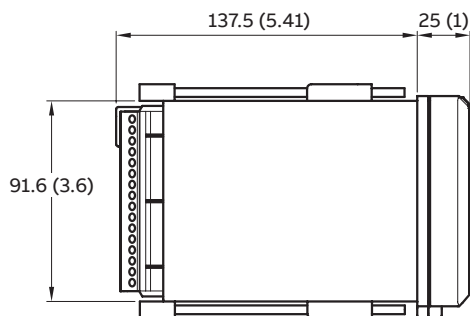
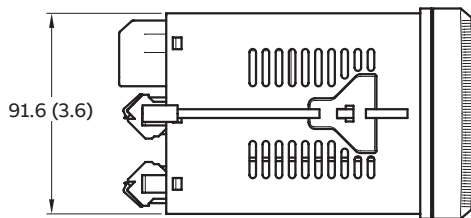
Overall dimensions

Dimensions in mm (in.)



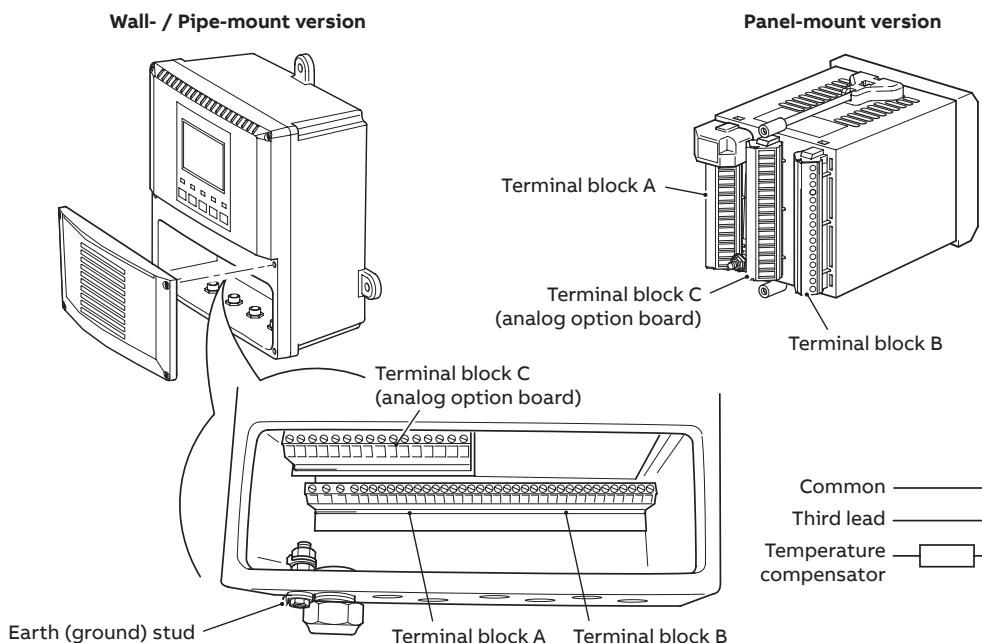
Pipe-mount detail

Wall- / Pipe-mount version

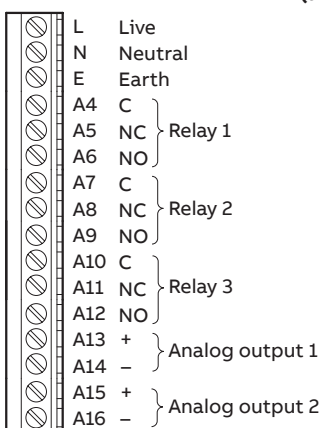


Panel-mount version

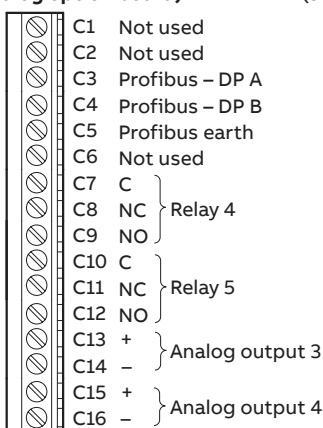
Electrical connections



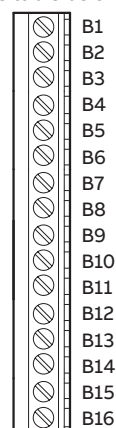
Terminal block A



Terminal block C (analog option board)



Terminal block B (see table below)



| Terminal block B | | Conductivity | pH/Redox (ORP) without solution earth‡ | pH/Redox (ORP) with solution earth‡ |
|------------------|----------|---|--|-------------------------------------|
| Sensor B | Sensor A | | | |
| 1 | 9 | Temperature compensator common Link 1 & 2 / 9 & 10** | Temperature compensator common* | Temperature compensator common* |
| 2 | 10 | Temperature compensator third lead | Temperature compensator third lead* | Temperature compensator third lead* |
| 3 | 11 | Temperature compensator | Temperature compensator* | Temperature compensator* |
| 4 | 12 | Screen | Not applicable | Reference electrode |
| 5 | 13 | Cell (cell electrode) | Not used | Not used |
| 6 | 14 | Cell (earth electrode) | Reference electrode | Solution earth‡ |
| 7 | 15 | Not used | Screen* | Screen* |
| 8 | 16 | Not used | Glass / Metal electrode | Glass / Metal electrode |

*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 conductivity and pH models AX410, AX411 and AX416 | AX4 | X | X | X | X | X | 0 | X |
|---|-----|---|---|---|---|---|---|---|
| First process variable (PV1) | | | | | | | | |
| Conductivity 0 to 10,000 $\mu\text{S cm}^{-1}$ for 2-electrode sensors | | 1 | | | | | | |
| Conductivity 0 to 1,999 mS cm^{-1} for 4-electrode sensors | | 3 | | | | | | |
| Conductivity USP<645> for 2-electrode sensors | | 5 | | | | | | |
| pH/Redox (ORP) | | 6 | | | | | | |
| Dissolved oxygen | | 8 | | | | | | |
| Second process variable (PV2)* | | | | | | | | |
| No second process variable – select for PID control of PV1 | | | 0 | | | | | |
| Conductivity 0 to 10,000 $\mu\text{S cm}^{-1}$ for 2-electrode sensors | | | 1 | | | | | |
| Conductivity 0 to 1,999 mS cm^{-1} for 4-electrode sensors** | | | 3 | | | | | |
| Conductivity USP<645> for 2-electrode sensors | | | 5 | | | | | |
| pH/Redox (ORP) | | | 6 | | | | | |
| Dissolved oxygen | | | 8 | | | | | |
| Enclosure types | | | | | | | | |
| Wall-mount IP65, general | | | | | | | | |
| Wall-mount – cable glands fitted | | | | 1 | | | | |
| Pipe-mount | | | | 2 | | | | |
| Wall-mount IP65, North American | | | | | | | | |
| Wall-mount | | | | | 6 | | | |
| Pipe-mount | | | | | 7 | | | |
| Panel-mount, universal | | | | | | | | |
| Panel-mount** | | | | | | 5 | | |
| Advanced functions and communications | | | | | | | | |
| 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 | |
| Power supply | | | | | | | | |
| 100 to 240 V AC 50 / 60 Hz | | | | | | | | 0 |
| 12 to 30 V DC | | | | | | | | 1 |
| Reserved | | | | | | | | |
| | | | | | | | | 0 |
| Manual | | | | | | | | |
| 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 (for example, AX416 is permissible, AX461 is not permissible).

** Profibus DP is not available in panel-mount housing when 0 to 1,999 mS/cm is selected as the second process variable (PV2).

Acknowledgements

PROFIBUS is a registered trademark of PROFIBUS and PROFINET International (PI).

Notes

Sales



Service



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