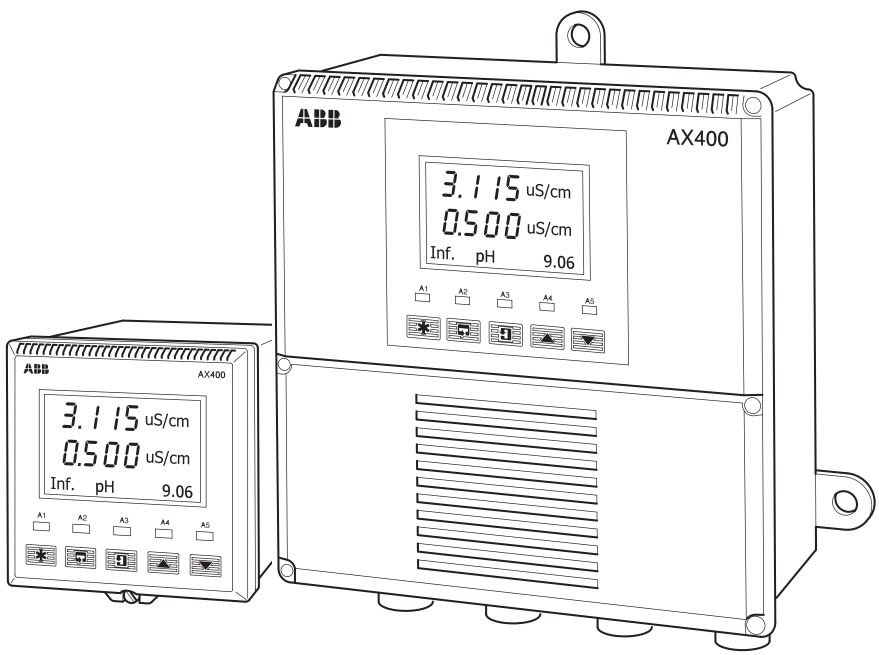
AX400 Series

User Guide

Models AX410 and AX411 Single and Dual Input Conductivity Analyzers

Incorporating Models AX450 and AX455 To Meet United States Pharmacopeia (USP 645) Regulations



ABB

ABB

The Company

We are an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The NAMAS Calibration Laboratory No. 0255 is just one of the ten flow calibration plants operated by the Company, and is indicative of our dedication to quality and accuracy.

BS EN ISO 9001:1994

Cert. No. Q05907

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

Stonehouse, U.K.

0255

Use of Instructions

Warning.
An instruction that draws attention to the risk of injury or death.

Note.
Clarification of an instruction or additional information.

Caution.
An instruction that draws attention to the risk of damage to the product, process or surroundings.

Information.
Further reference for more detailed information or technical details.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of the Marketing Communications Department.

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

CONTENTS

1 INTRODUCTION

The AX410 single input and AX411 dual input conductivity analyzers have been designed for continuous monitoring and control of conductivity.

The AX450 single input and AX455 dual input conductivity analyzers have been designed to meet United States Pharmacopeia (USP 645) requirements for continuous monitoring and control of conductivity.

It is available in wall-/pipe-mount or panel-mount versions and can be used with either one or two sensors, each with a temperature input channel. When used with two sensors, readings can be compared to produce a range of extrapolated values.

When making temperature compensated measurements, the sample temperature is sensed by a resistance thermometer (Pt100 or Pt1000) mounted in the measuring cell.

Analyzer operation and programming are performed using five tactile membrane keys on the front panel. Programmed functions are protected from unauthorized **Alt**eration by a five-digit security code.

Analyzer Model Number	Description of Analyzer	Sensor A	Sensor B
AX410	Single Input Conductivity (0 to 10,000 µS/cm)	Conductivity	Not Applicable
AX411	Dual Input Conductivity (0 to 10,000 µS/cm)	Conductivity	Conductivity
AX416	Dual Input Conductivity and pH/Redox(ORP)	Conductivity	pH/Redox(ORP)
AX450	Single Input Conductivity (USP)	Conductivity	Not Applicable
AX455	Dual Input Conductivity (USP)	Conductivity	Conductivity
AX460	Single Input pH/Redox(ORP)	pH/Redox(ORP)	Not Applicable
AX466	Dual Input pH/Redox(ORP)	pH/Redox(ORP)	pH/Redox(ORP)

Table 1.1 AX400 Series Analyzer Options

2 OPERATION

2.1 Powering Up the Analyzer

⚠ **Caution.** Ensure all connections are made correctly, especially to the earth stud – see Section 6.3.

1) Ensure the input sensors are connected correctly.

2) Switch on the power supply to the analyzer. A start-up screen is displayed while internal checks are performed, then the conductivity measurement readings screen (Operating Page) is displayed as conductivity measuring operation starts.

2.2 Displays and Controls

The display comprises two rows of $4\frac{1}{2}$ digit, 7-segment digital displays, which show the actual values of the measured parameters and alarm set points, and a 6-character dot matrix display showing the associated units. The lower display line is a 16-character dot matrix display showing the programming information.

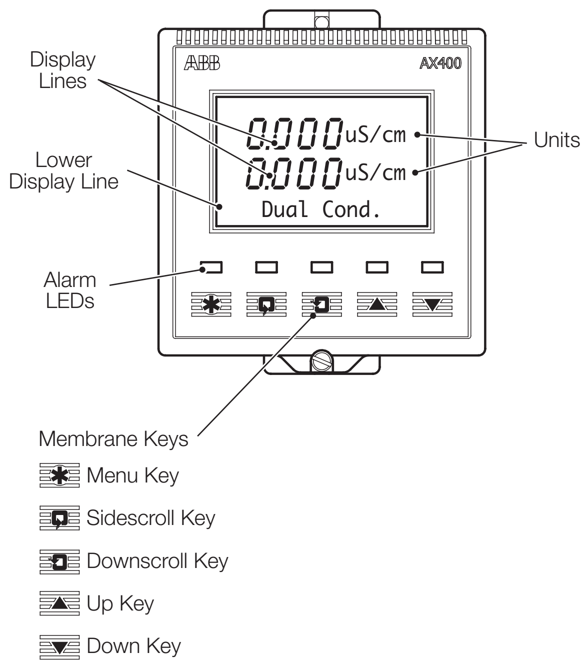


Fig. 2.1 Location of Controls and Displays

2.2.1 Key Functions

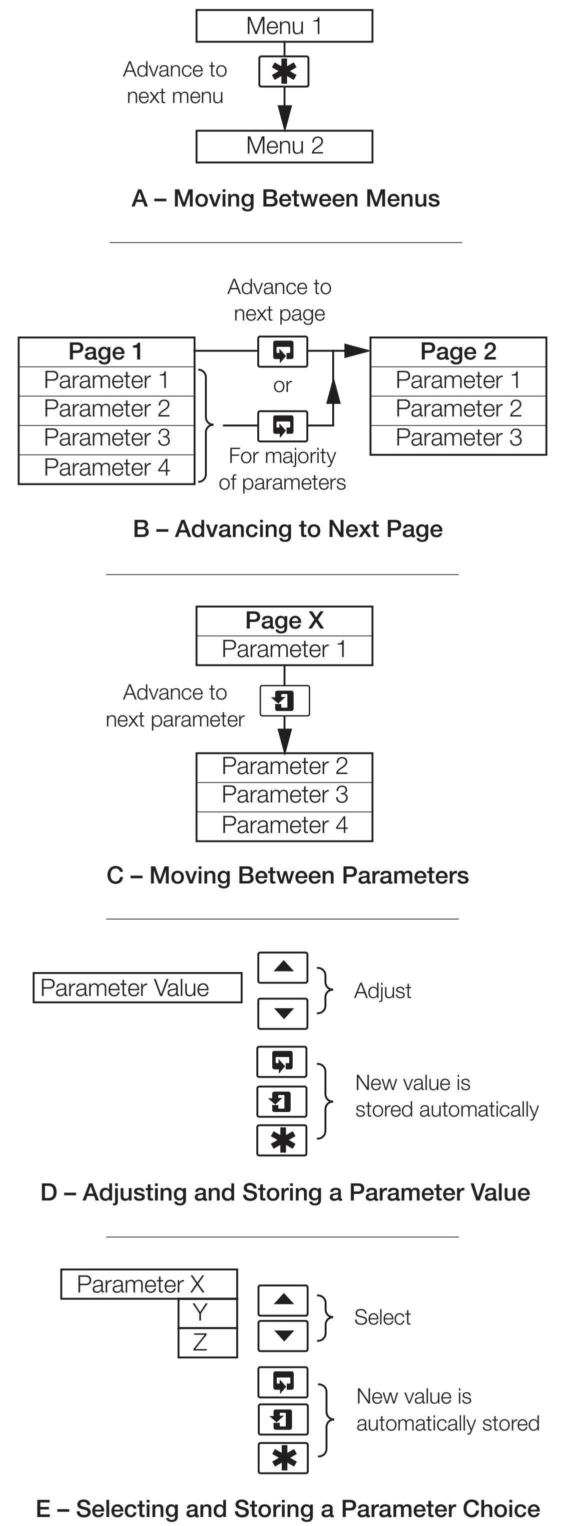


Fig. 2.2 Membrane Key Functions

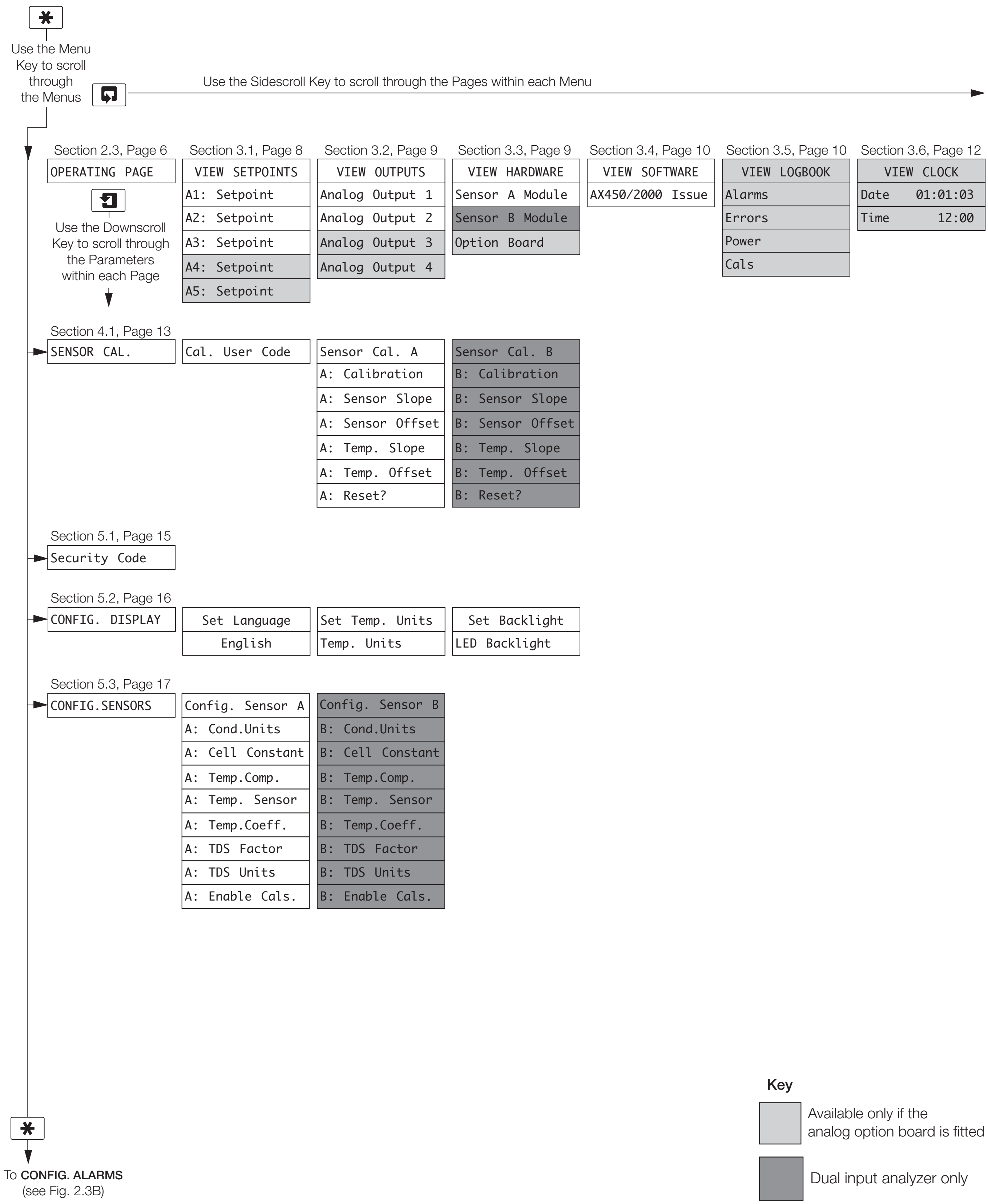


Fig. 2.3A Overall Programming Chart

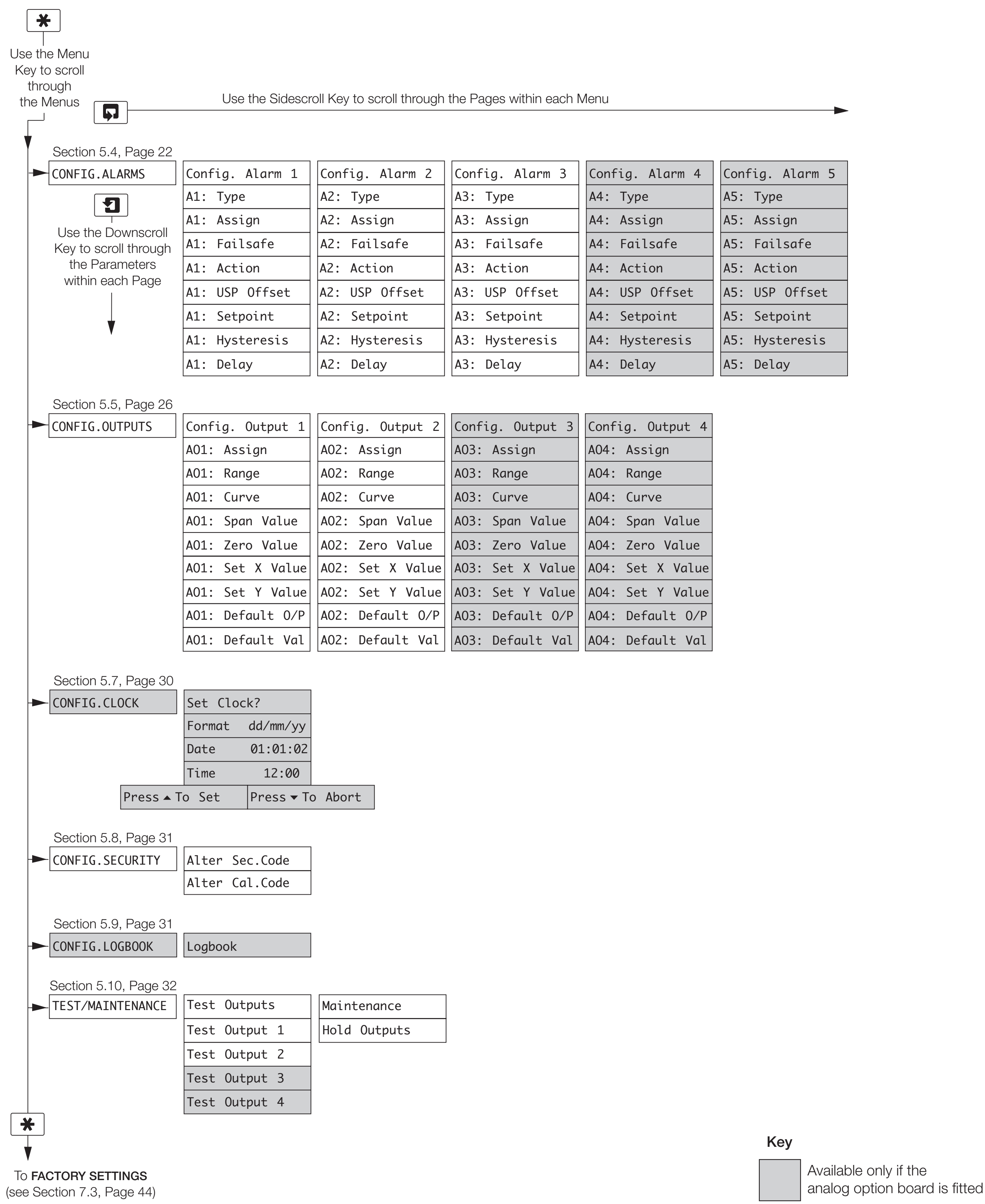
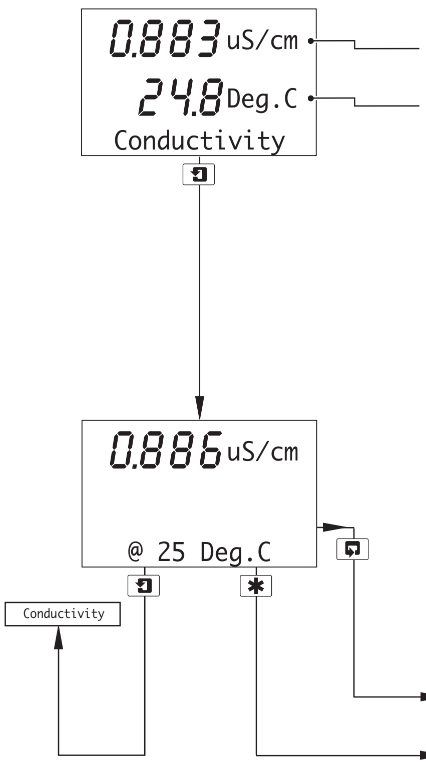


Fig. 2.3B Overall Programming Chart

2.3 Operating Page

2.3.1 Single Input Conductivity



Measured Values
Conductivity.

Temperature.

Notes.

1) The displayed conductivity and temperature readings are the actual measured values of the sample.

2) AX450 analyzers only – if **A: Cond.Units** is set to **USP645** in the **CONFIG. SENSORS** page (see Section 5.3), the displayed conductivity reading is the uncompensated conductivity value of the sample i.e. its value at the displayed temperature.

Temperature Compensated Conductivity Value – AX450 Analyzers Only

Notes.

1) This screen is displayed only if **A: Cond.Units** is set to **USP645** in the **CONFIG. SENSORS** page – see Section 5.3.

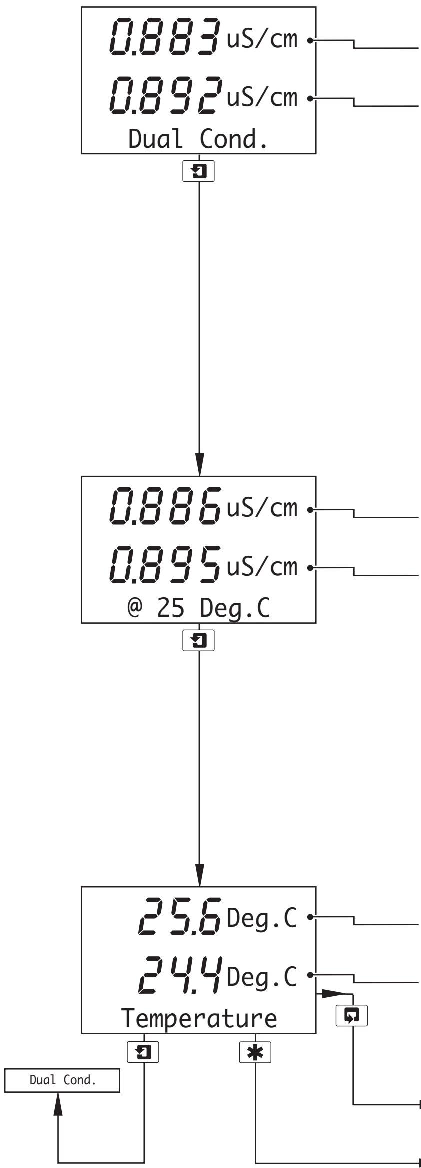
2) The displayed reading is the temperature compensated conductivity value i.e. the value it would be at a sample temperature of 25°C (77°F)

VIEW SETPOINTS — See Section 3.1.

SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

…2.3 Operating Page

2.3.2 Dual Input Conductivity



Measured Conductivity
Sensor A.

Sensor B.

Notes.

1) **Dual Cond.** is displayed only if **Signal Calc.** is set to **No Calculation** in the **CONFIG. SENSORS** page – see Section 5.3. See below for an explanation of calculations.

2) The displayed conductivity readings are the actual values of the sample.

3) AX455 analyzers only – If **Cond.Units** for a sensor is set to **USP645** in the **CONFIG. SENSORS** page (see Section 5.3), the displayed conductivity reading for that sensor is the uncompensated conductivity value of the sample i.e. its value at its measured temperature (see below).

Temperature Compensated Conductivity – AX455 Analyzers Only
Sensor A.

Sensor B.

Notes.

1) This screen is displayed only if **Cond.Units** for either or both sensors is set to **USP645** in the **CONFIG. SENSORS** page – see Section 5.3.

2) If **Cond.Units** for a sensor is set to **USP645** in the **CONFIG. SENSORS** page (see Section 5.3), the displayed conductivity reading for that sensor is the temperature compensated value i.e. the value it would be at a sample temperature of 25°C (77°F).

Measured Temperature
Sensor A.

Sensor B.

Note. The displayed temperature readings are the actual values of the sample.

VIEW SETPOINTS — See Section 3.1.

SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

Calculations

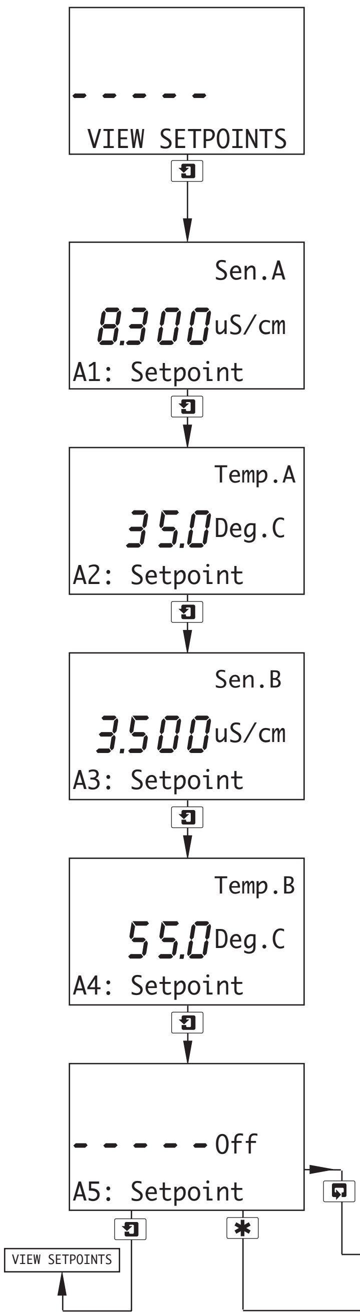
A range of computed dual conductivity readings can be displayed, each showing the result of a calculation performed by the analyzer. In each case, the type of calculation is shown on the lower display line, followed by the result of the calculation.

Calculations performed are:

Difference	=	A – B
% Rejection	=	(1–B/A) x 100
% Passage	=	B/A x 100
Ratio	=	A/B
Inferred pH	=	Uses an algorithm to calculate the pH value of the solution, inferred from its conductivity. See Appendix A3 for further information on inferred pH.

3 OPERATOR VIEWS

3.1 View Set Points



View Set Points
This page shows alarm set points. The value of each of the set points is shown, together with the name of the parameter it's assigned to.

Alarm assignments, set point values and relay/LED actions are programmable – see Section 5.4. Those shown are examples only.

Sensor A (Conductivity), Alarm 1 Set Point

Sensor A (Temperature), Alarm 2 Set Point

Sensor B (Conductivity), Alarm 3 Set Point – Dual input analyzers only

Sensor B (Temperature), Alarm 4 Set Point – Dual input analyzers only

Note. Alarm 4 is available only if the optional analog output board is fitted.

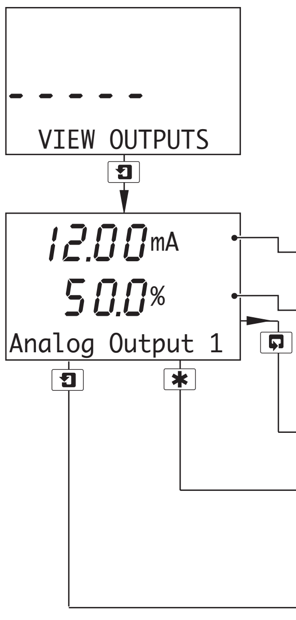
Alarm 5 Set Point

Note. Alarm 5 is available only if the optional analog output board is fitted.

VIEW OUTPUTS — Return to main menu.

SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

3.2 View Outputs



Theoretical Analog Output
There are up to four analog outputs, each showing information for one sensor:

✶ **Note.** Analog outputs 3 and 4 are available only if the optional analog output board is fitted.

Live current output value being retransmitted.

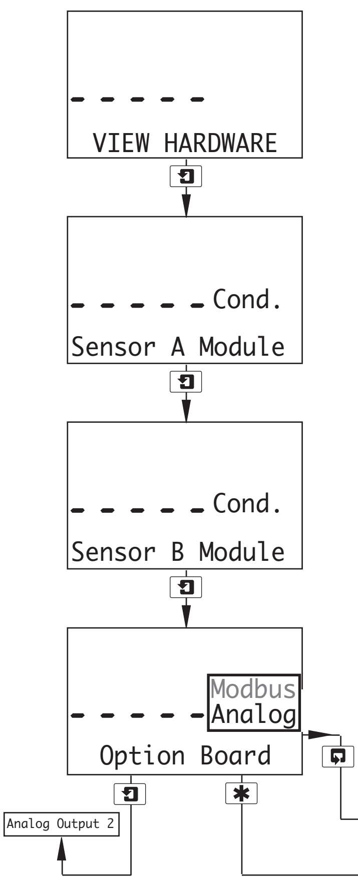
Current output shown as a percentage of full scale for the output range set in **CONFIG. OUPUTS** – see Section 5.5.

VIEW HARDWARE — See Section 3.3.

SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

Analog Output 2 — **Analog Output 2** – repeat for output 2 (and outputs 3 and 4 if optional analog output board fitted).

3.3 View Hardware



Sensor A Module
Shows the type of input board fitted to the analyzer for the Sensor A input.

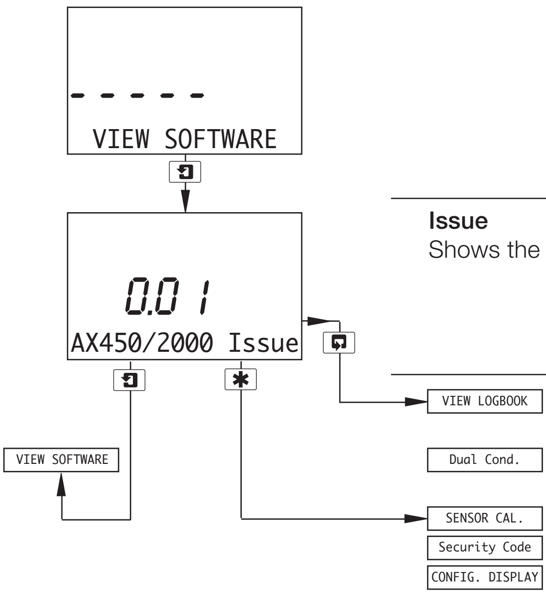
Sensor B Module – Dual input analyzers only
Shows the type of input board fitted to the analyzer for the Sensor B input.

Option Board
Shows the type of option board fitted to the analyzer (if applicable).

VIEW SOFTWARE — See Section 3.4.

SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

3.4 View Software



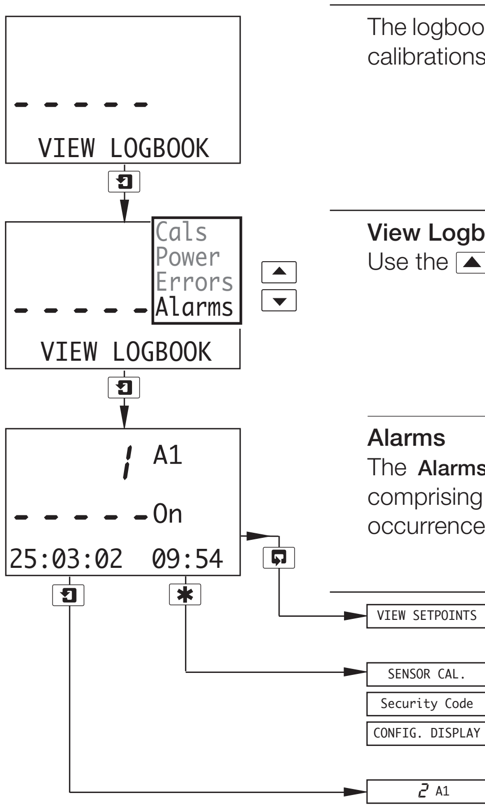
Issue
Shows the version number of the operating software.

Optional analog output board fitted ***and*** **Logbook** set to **On** in the **CONFIG. LOGBOOK** page (Section 5.9) – see Section 3.5.
Operating Page (optional analog output board not fitted) – see Section 2.3.

Sensor calibration enabled – see Section 4.1.
Alter Sec. Code not set to zero – see Section 5.1.
Alter Sec. Code set to zero – see Section 5.2.

3.5 View Logbook

> ✶ **Note.** The **VIEW LOGBOOK** function is available only if the optional analog output board is fitted ***and*** **Logbook** is set to **On** in the **CONFIG. LOGBOOK** page.



The logbook stores data entries for alarm events, sensor errors, power failures and sensor calibrations.

View Logbook
Use the ▲ and ▼ keys to access the **Alarms** logbook.

Alarms
The **Alarms** logbook contains up to 10 entries, entry 1 being the most recent, each comprising an alarm number, alarm state (On or Off), and the date and time of the occurrence.

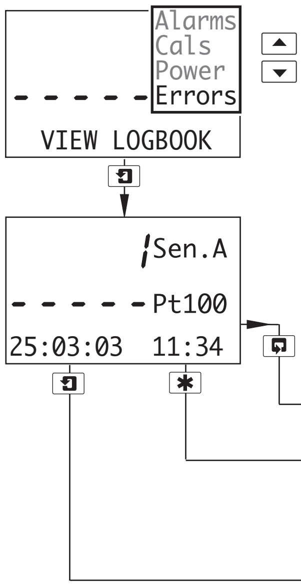
If optional analog input board fitted – see Section 3.6.

Sensor calibration enabled – see Section 4.1.
Alter Sec. Code not set to zero – see Section 5.1.
Alter Sec. Code set to zero – see Section 5.2.

Advance to entry 2 to 10.

✶ **Note.** If no more entries are stored, the display shows `No More Entries`.

…3.5 Logbook



View Logbook

Use the ▲ and ▼ keys to access the **Errors** logbook.

Errors

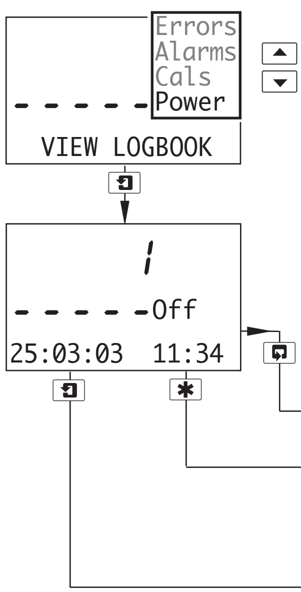
The **Errors** logbook contains up to 5 entries, entry 1 being the most recent, each comprising the sensor letter, error number, and the date and time of the occurrence, .

VIEW CLOCK — If optional analog input board fitted – see Section 3.6.

SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

2 Sen.A — Advance to entry 2 to 5.

Note. If no more entries are stored, the display shows `No More Entries`.



View Logbook

Use the ▲ and ▼ keys to access the **Power** logbook.

Power

The **Power** logbook contains up to 2 entries, entry 1 being the most recent, each comprising the power state (On or Off), and the date and time of the occurrence.

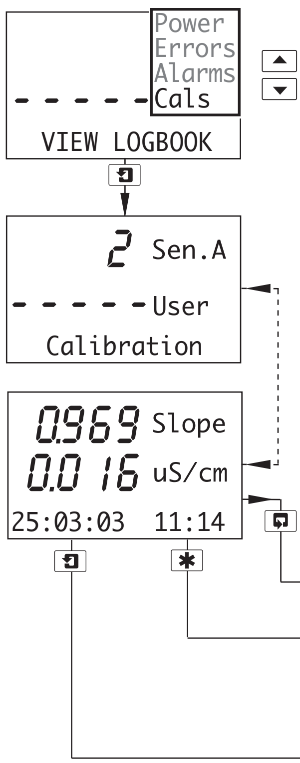
VIEW CLOCK — If optional analog input board fitted – see Section 3.6.

SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

2 — Advance to entry 2.

Note. If no more entries are stored, the display shows `No More Entries`.

...3.5 Logbook



View Logbook
Use the ▲ and ▼ keys to access the **Cals** logbook.

Calibration
The **Cals** logbook contains up to 5 entries, entry 1 being the most recent, each comprising 2 frames. Frame 1 contains the entry number and sensor letter and shows `User` to indicate a user performed calibration.

Frame 2 contains either the sensor % slope and sensor offset values for a conductivity calibration or the temperature % slope and temperature offset values for a temperature calibration, together with the date and time of the calibration.

VIEW CLOCK — If optional analog input board fitted – see Section 3.6.

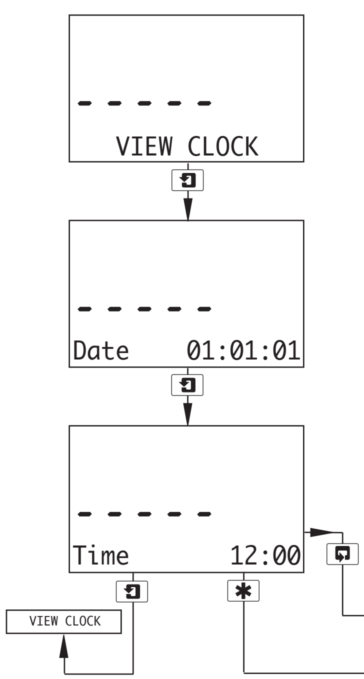
SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

2 Sen.A — Access entry 2 to 5.

Note. If no more entries are stored, the display shows `No More Entries`.

3.6 View Clock

Note. The **VIEW CLOCK** function is available only if the optional analog output board is fitted.



Date
Shows the current date.

Time
Shows the current time.

Dual Cond. — **Operating Page** – see Section 2.3.

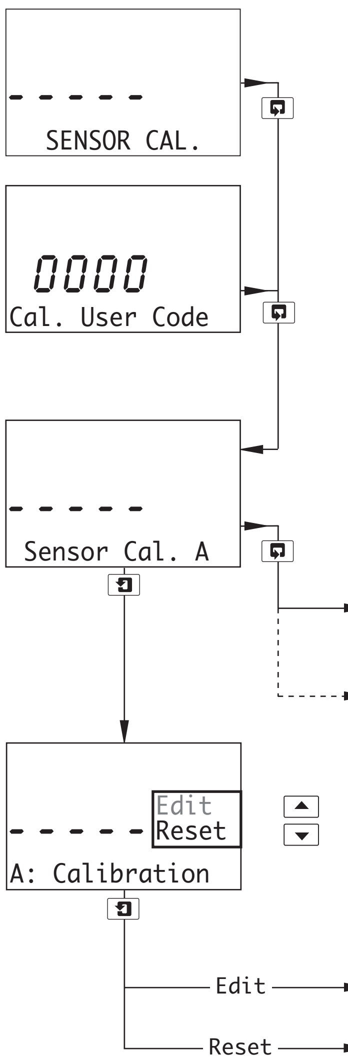
SENSOR CAL. — Sensor calibration enabled – see Section 4.1.
Security Code — **Alter Sec. Code** not set to zero – see Section 5.1.
CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

4 SETUP

4.1 Sensor Calibration

Notes.

- Sensor calibration is not usually required as the cell constant 'K' assigned to a cell is sufficiently accurate for most applications.
- TB2 cells are equipped with 2-wire temperature compensators therefore temperature errors can be expected in applications where the length of the connecting cable exceeds 10m. Carry out an situ temperature calibration to remove these errors.



Sensor Calibration

Note. Applicable only if **Enable Cals.** is set to **Yes** – see Section 5.3.

Sensor Calibration Security Code

Enter the required code number, between 0000 and 19999, to gain access to the sensor calibration procedure. If an incorrect value is entered, access to subsequent calibration pages is prevented and the display reverts to the **SENSOR CAL.** page.

Note. Applicable only if **Alter Cal. Code** is not set to zero – see Section 5.8.

Calibrate Sensor A

Sensor Cal. B — Sensor B calibration (dual input analyzers only) is identical to Sensor A calibration.

SENSOR CAL. — Single input analyzers only – return to main menu.

Edit or Reset Calibration

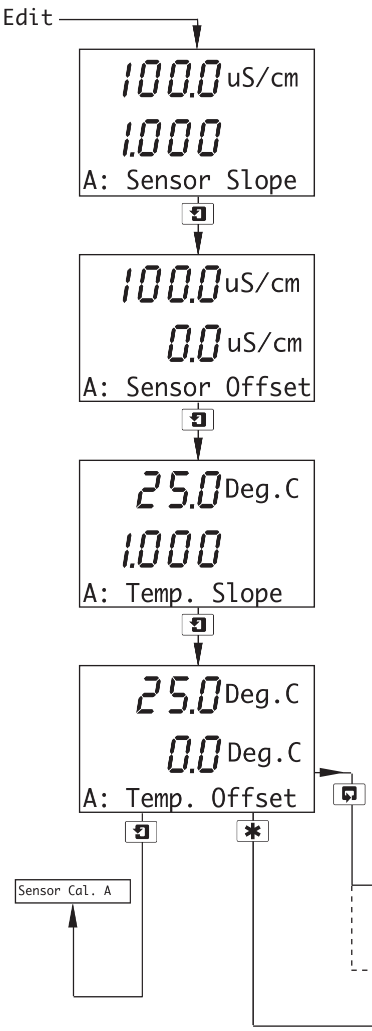
Select **Edit** to manually adjust the Slope and Offset values of the process and temperature sensors.

Select **Reset** to reset the sensor calibration data to the standard default settings:
Sensor and Temperature Slope = 1.000
Sensor and Temperature Offset = 0.0

A: Sensor Slope — **Edit** selected – continued on next page…

A: Reset? — **Reset** selected – continued on next page…

…4.1 Sensor Calibration



Sensor Slope
The upper display shows the measured conductivity. The lower display shows the process sensor slope.

Adjust the slope within the valid range 0.2000 to 5.000 until the conductivity reading is correct.

Sensor Offset
The upper display shows the measured conductivity. The lower display shows the process sensor offset.

Adjust the offset until the conductivity reading is correct.

Temperature Slope
The upper display shows the measured temperature. The lower display shows the temperature sensor slope.

Adjust the slope within the valid range 0.200 to 1.500 until the temperature reading is correct.

Temperature Offset
The upper display shows the measured temperature. The lower display shows the temperature sensor offset.

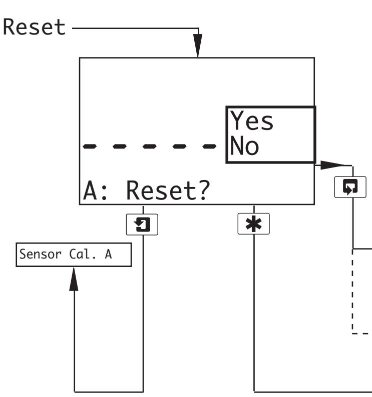
Adjust the offset within the valid range –40.0 to 40.0°C (–40.0 to 104.0°F) until the temperature reading is correct.

Sensor Cal. B — Sensor B calibration (dual input analyzers only) is identical to Sensor A calibration.

SENSOR CAL. — Single input analyzers only – return to main menu.

SECURITY CODE — **Alter Sec. Code** not set to zero – see Section 5.1.

CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.



Reset Calibration
Select **Yes** and press to reset the calibration data.
Select **No** and press to abort.

Sensor Cal. B — Sensor B calibration (dual input analyzers only) is identical to Sensor A calibration.

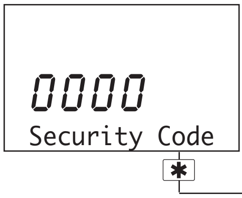
SENSOR CAL. — Single input analyzers only – return to main menu.

SECURITY CODE — **Alter Sec. Code** not set to zero – see Section 5.1.

CONFIG. DISPLAY — **Alter Sec. Code** set to zero – see Section 5.2.

5 PROGRAMMING

5.1 Security Code

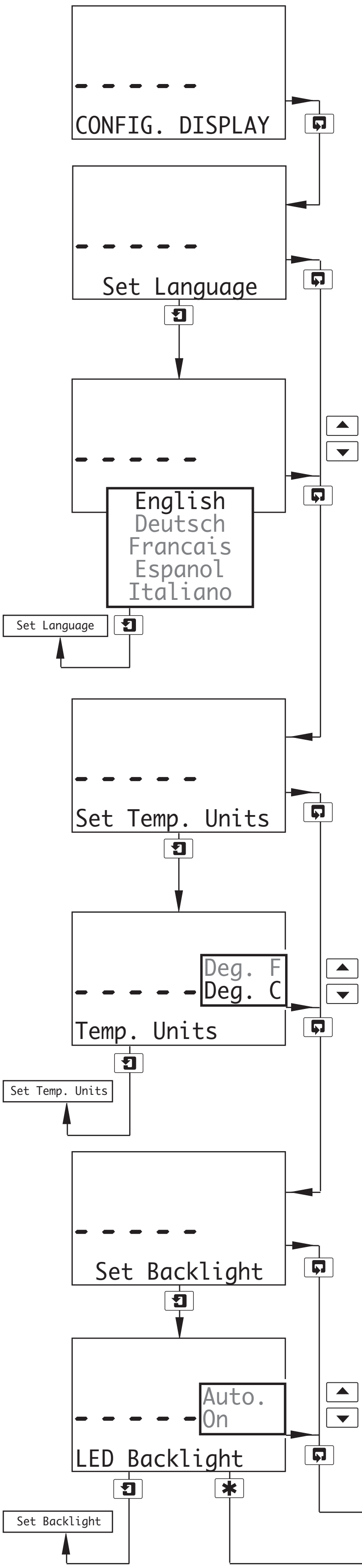


Enter the required code number, between 0000 and 19999, to gain access to the secure parameters. If an incorrect value is entered, access to subsequent programming pages is prevented and the display reverts to the **Operating Page** – see Section 2.3.

Note. This item is displayed only **Alter Sec. Code** not set to zero – see Section 5.8.

CONFIG. DISPLAY — See Section 5.2.

5.2 Configure Display



Set Language
Sets the language to be used on all displays.

Language Page
Use the ▲ and ▼ keys to select the required language.

Set Temperature Units

Temperature Units
Use the ▲ and ▼ keys to select the sample temperature display units.

Set Up Display Backlight

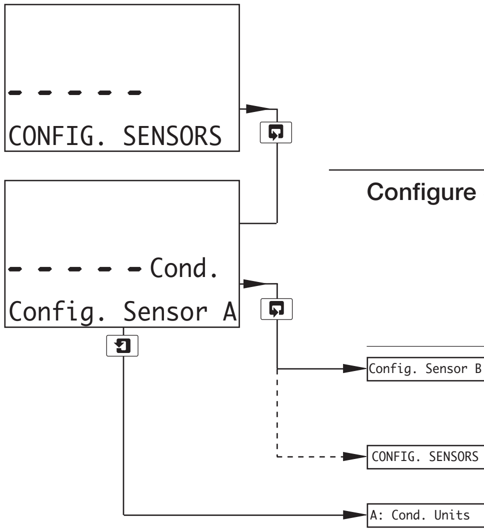
Backlight
Use the ▲ and ▼ keys to select the required backlight option:

- `Auto.` – Backlight comes on at each button press and switches off one minute after the last button press.
- `On` – Backlight is always on.

CONFIG. DISPLAY — Return to main menu.

CONFIG. SENSORS — See Section 5.3.

5.3 Configure Conductivity Sensors



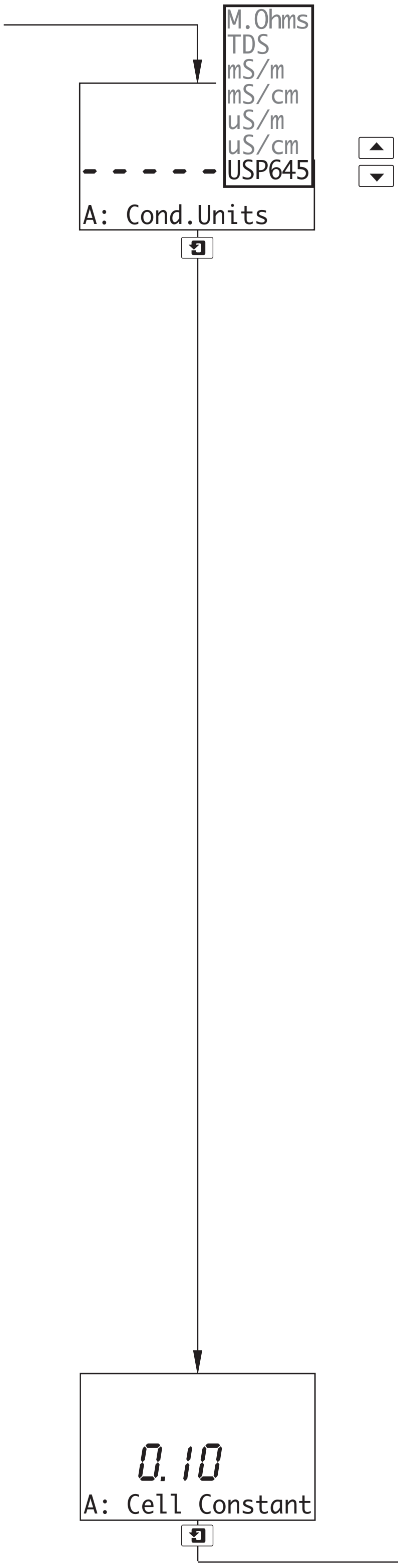
Configure Sensor A

Config. Sensor B – Sensor B configuration (dual input analyzers only) is identical to Sensor A configuration.

CONFIG. SENSORS – Single input analyzers only – return to main menu.

A: Cond. Units – Continued on next page…

…5.3 Configure Conductivity Sensors



Conductivity Units

Units can be programmed to suit the range and application. Select the required units, ensuring the range does not exceed the display limit of 10,000 µS cm^{-1}:

- `M.Ohms` – Megohms-cm
- `TDS` – Total Dissolved Solids (see Table 5.1)
- `mS/m` – MilliSiemens m^{-1} (0.1µS cm^{-1})
- `mS/cm` – MilliSiemens cm^{-1} (1000µS cm^{-1})
- `uS/m` – MicroSiemens m^{-1} (100µS cm^{-1})
- `uS/cm` – MicroSiemens cm^{-1}
- `USP645` – MicroSiemens cm^{-1}

(mS/m to USP645: see Table 5.2)

Note. USP645 available only on AX450 and AX455 analyzers.

Conductivity Cell Constant (K)	Maximum Conductivity Range (µS cm^{-1})	Maximum Effective TDS Range (ppm, mg/kg and mg/l)				
		TDS Factor (examples)				
		0.40	**0.50**	**0.60**	**0.70**	**0.80**
0.1	0 to 1,000	0 to 400	0 to 500	0 to 600	0 to 700	0 to 800
1.0	0 to 10,000	0 to 4,000	0 to 5,000	0 to 6,000	0 to 7,000	0 to 8,000

Table 5.1 TDS Range Limits for Different Cell Constants (K)

Conductivity Cell Constant (K)	Minimum Conductivity Range	Maximum Conductivity Range
0.01	0 to 0.1µS cm^{-1} 0 to 10.00µS m^{-1}	0 to 100.0µS cm^{-1} 0 to 10,000µS m^{-1}
0.05	0 to 0.5µS cm^{-1} 0 to 50.00µS m^{-1}	0 to 500.0µS cm^{-1} 0 to 10,000µS m^{-1}
0.10	0 to 1µS cm^{-1} 0 to 100µS m^{-1} 0 to 0.1mS m^{-1}	0 to 1,000µS cm^{-1} 0 to 10,000µS m^{-1} 0 to 100.0mS m^{-1}
1.00	0 to 10µS cm^{-1} 0 tpo 1,000µS m^{-1} 0 to 0.01mS cm^{-1} 0 to 1mS m^{-1}	0 to 10,000µS cm^{-1} 0 to 10,000µS m^{-1} 0 to 10mS cm^{-1} 0 to 1,000mS m^{-1}

Table 5.2 Conductivity Range Limits for Different Cell Constants (K)

Cell Constant

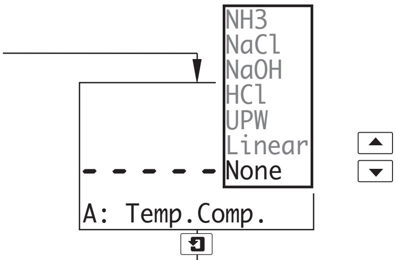
Enter the cell constant for the type of measuring cell used – see the relevant cell manual.

Note. If **A: Cond Units** is set to **USP645** (AX450 and AX455 analyzers only), the maximum cell constant is 0.10.

`A: Temp.Comp` AX410 and AX411 analyzers or **A: Cond Units** not set to **USP645** (AX450 and AX455 analyzers only) – continued on next page…

`A: Temp.Sensor` **A: Cond Units** set to **USP645** (AX450 and AX455 analyzers only) – continued on page 20.

…5.3 Configure Conductivity Sensors



Temperature Compensation
Select the type of temperature compensation required:

None – Select when raw conductivity measurement without temperature compensation is required.
Examples
- Water for injection (WFI) for US Pharmacopoeia (USP) applications.
- Purified water for USP applications.

Linear – Select for non-standard applications monitoring and when manual addition of temperature coefficient of unknown purity is required.

* UPW – Select when temperature effect of pure water only is required or when manual addition of temperature coefficient of unknown impurity to pure water temperature effect is required – see Note below.

* HCl – Select when temperature effect of pure water with trace acids is required
Examples
- Cation exchanger in-bed and outlet applications.
- Degassed cation conductivity applications.

* NaOH – Select when temperature effect of pure water with trace caustic is required
Example
- Inferred pH in caustic-dosed waters applications.

* NaCl – Select when temperature effect of pure water with trace salts is required
Examples
- General monitoring applications.
- Mixed-bed exchanger applications.
- Final polisher effluent applications.
- Cation exchanger inlet applications.
- Anion exchanger in-bed and outlet applications.
- Reverse osmosis applications.

* NH3 – Select when temperature effect of pure water with trace ammonia is required
Examples
- Ammonia-treated make-up and boiler feed water applications.
- Condenser sampling applications.
- Hot well sampling applications.
- Before-cation column applications.
- Inferred pH in ammonia-dosed waters applications.

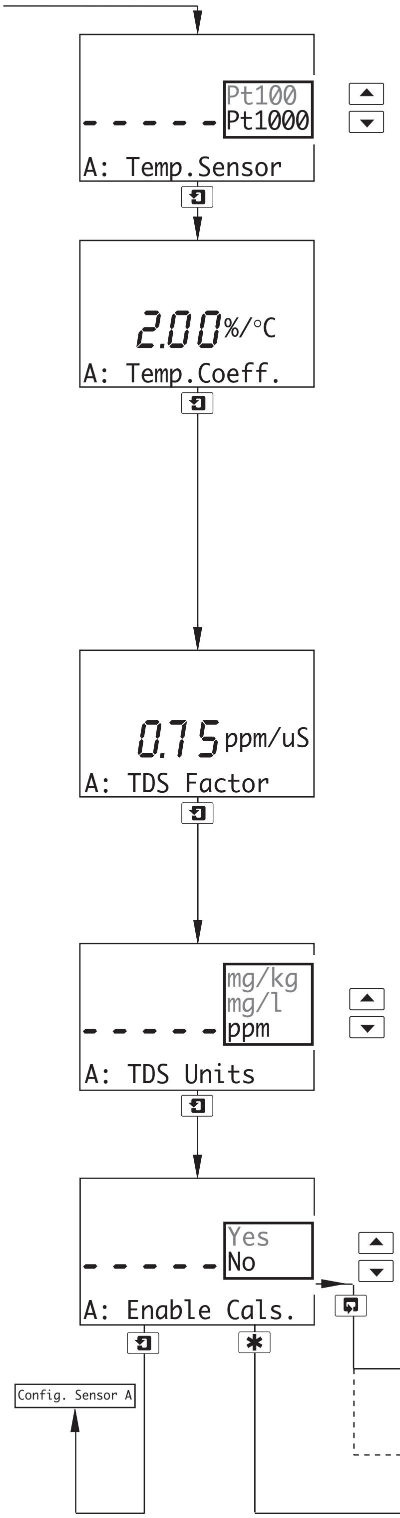
* Applicable only on conductivities up to 10μS cm^{-1}

Notes.
1) If **UPW** is selected, the temperature coefficient (α x 100) of the solution must be calculated if unknown – see Appendix A1.1.

2) Source data is based on IEC International Standard 65D/85/FD15

A: Temp.Sensor Continued on next page…

…5.3 Configure Conductivity Sensors



Temperature Sensor
Select the type of temperature sensor used, Pt100 or Pt1000.

Temperature Coefficient

Notes.

1) Displayed only if **Temp.Comp.** is set to **Linear** or **UPW** – see previous page.

2) If **A: Cond Units** is set to **USP645** (AX450 and AX455 analyzers only), the temperature coefficient is fixed automatically at 2.00%/°C.

Enter the temperature coefficient (α x 100) of the solution (0.01 to 5.0%/°C). If unknown, the temperature coefficient (α) of the solution must be calculated – see Appendix A1.1.

If the value has not yet been calculated, set it to 2%/°C provisionally.

TDS Factor

Note. Displayed only if **Cond.Units** is set to **TDS** – see page 15.

The TDS factor must be programmed to suit the particular application – see Appendix A2.

Enter the required TDS factor between 0.4 and 0.8.

For salinity applications, set the TDS factor to 0.5.

TDS Units

Note. Displayed only if **Cond.Units** is set to **TDS** – see page 15.

Select the TDS units (ppm, mg/l or mg/kg).

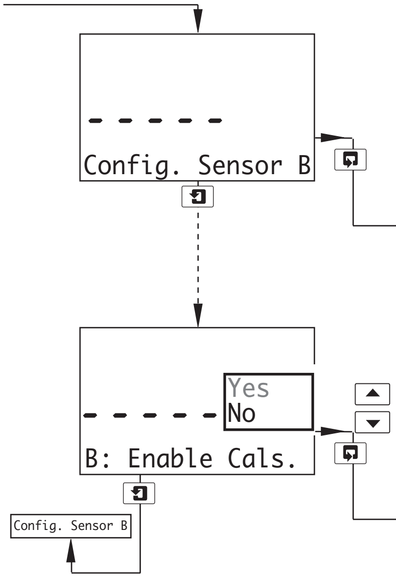
Enable Calibration
If Sensor Calibration is required, select **Yes**.
If **No** is selected the sensor calibration menus for Sensor A are disabled.

Config. Sensor B — Sensor B configuration (dual input analyzers only) is identical to Sensor A configuration.

CONFIG. SENSORS — Single input analyzers only – return to main menu.

CONFIG. ALARMS — See Section 5.4.

…5.3 Configure Conductivity Sensors

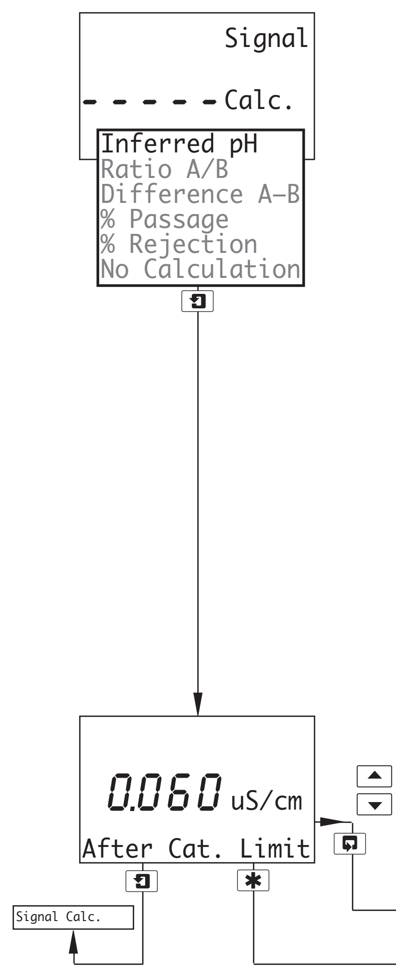


Configure Sensor B (dual input analyzers only)
Sensor B configuration is identical to Sensor A configuration.

`Signal Calc.` AX411 analyzers or **A: Cond.Units *or* B: Cond.Units** not set to **USP645** (AX455 analyzers only) – see below.

`CONFIG. SENSORS` **A: Cond.Units *and* B: Cond.Units** set to **USP645** (AX455 analyzers only) – return to main menu.

`CONFIG. SENSORS` Return to main menu.



Signal Calculation (dual input analyzers only)

Note. Sensor A and Sensor B units must be identical otherwise no calculations are performed and **No Calculation** and **Dissimilar Units** are displayed **Alt**ernately on the lower display line.

Calculations are performed using the inputs from both sensors. Select the required calculation from the following options:

`Inferred pH` – Calculates a pH value based on the conductivity readings (see Appendix A3 for further information on inferred pH).

Note. Inferred pH is available only if units for both Sensors A and B are set to **uS/cm** and temperature compensation for Sensor A is set to **NaOH** or **NH3**.

`Ratio A/B` – Calculates the ratio of the two conductivity inputs.
`Difference A-B` – Calculates the difference between the two conductivity inputs.
`% Passage` – Calculates the amount of conductivity as a percentage that passes through the cation exchange unit.
`% Rejection` – Calculates the amount of conductivity as a percentage that is absorbed in the cation exchange unit.
`No Calculation` – No calculation is performed and the conductivity readings are displayed directly.

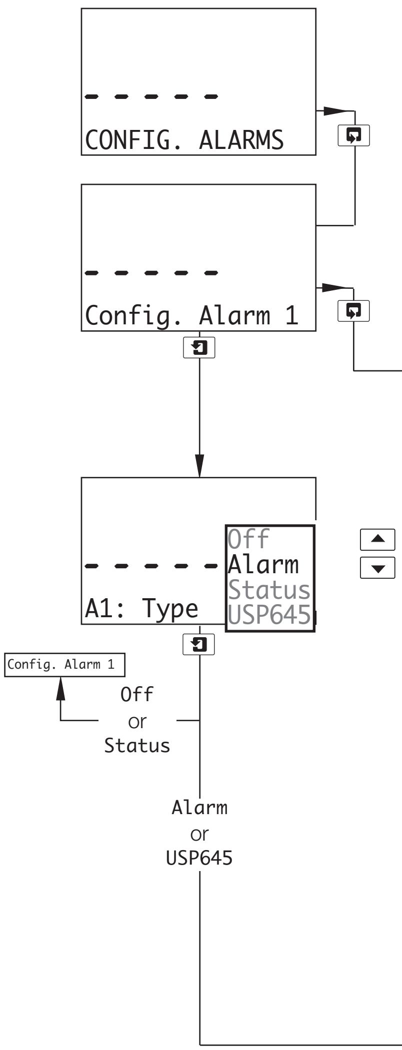
After-cation Limit
Set the required after-cation conductivity limit between 0.060 and 1.000 µS cm^{-1} in 0.001 steps.

Note. Applicable only if **Signal Calc.** is set to **Inferred pH**.

`CONFIG. SENSORS` Return to main menu.

`CONFIG. ALARMS` See Section 5.4.

5.4 Configure Alarms



Configure Alarm 1

`Config. Alarm 2` Alarm 2 (and Alarms 3 and 4 if optional analog output board is fitted) configuration is identical to Alarm 1.

Alarm 1 Type
Select the type of alarm required:

- `Off` – The alarm is disabled, the alarm LED is off and the relay is de-energized at all times.
- `Alarm` – The analyzer is configured using the **Assign** parameter (see next page) to generate an alarm in response to a specified sensor reading.
- `Status` – The analyzer alerts the operator to either a power failure or a condition that causes an error message to be displayed – see Table 8.1.
- `USP645` – The alarm set point is set automatically to the value in Table 5.3 that corresponds with the sample temperature and changes automatically with changes in sample temperature. If the sample temperature is *between* the values given in the table, the alarm set point is set to the value corresponding to the nearest *lower* temperature, e.g. if the sample temperature is 29°C (84.2°F), the alarm set point is set automatically to 1.3 µS/cm.

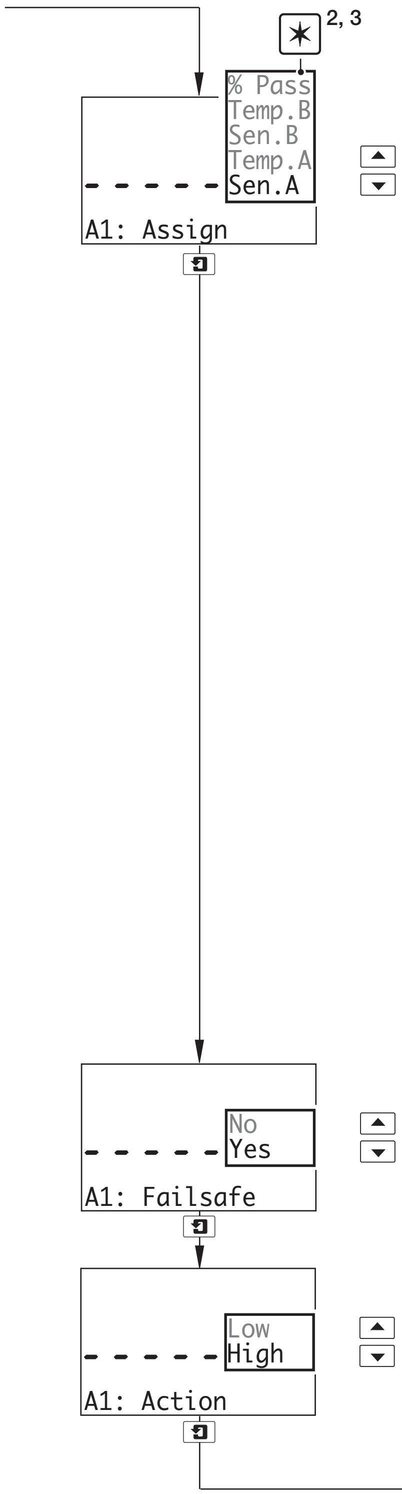
Note. The **USP645** alarm type is available only on AX450 and AX455 analyzers and only if **A: Cond.Units** is set to **USP645** – see Section 5.3.

`A1: Assign` Continued on next page…

Sample Temperature (°C)	Sample Temperature (°F)	USP645 Alarm Set Point Value (µS/cm)
0	32	0.6
5	41	0.8
10	50	0.9
15	59	1.0
20	68	1.1
25	77	1.3
30	86	1.4
35	95	1.5
40	104	1.7
45	113	1.8
50	122	1.9
55	131	2.1
60	140	2.2
65	149	2.4
70	158	2.5
75	167	2.7
80	176	2.7
85	185	2.7
90	194	2.7
95	203	2.9
100	212	3.1

Table 5.3 USP645 Alarm Set Point Values

…5.4 Configure Alarms



Alarm 1 Assign

When Alarm 1 Type is set to **Alarm**, this enables the alarm to alert the operator to one of two alarm conditions for a specified sensor:

`Temp.A` – The analyzer alerts the operator if the temperature of the process fluid measured by the selected sensor exceeds or drops below the value set in the **Alarm 1 Set Point** parameter (see next page), depending on the type of **Alarm 1 Action** selected – see below.

`Sen.A` – The analyzer alerts the operator if the conductivity of the process fluid measured by the selected sensor exceeds or drops below the value set in the **Alarm 1 Set Point** parameter (see next page), depending on the type of **Alarm 1 Action** selected – see below.

Notes.

1) Sensor B alarms and signal calculation are applicable only to dual input conductivity.

2) If **A1: Type** is set to **USP645**, the alarm is assignable only to **Sen.A** (or **Sen.B**. if dual input conductivity).

3) If **Signal Calc.** is set to any parameter other than **No Calculation** (see page 21), the display shows the selected parameter:
   - `% Pass` – **Signal Calc.** set to **% Passage**
   - `% Rej` – **Signal Calc.** set to **% Rejection**
   - `A – B` – **Signal Calc.** set to **Difference A – B**
   - `A/B` – **Signal Calc.** set to **Ratio A/B**
   - `pH` – **Signal Calc.** set to **Inferred pH** (see Appendix A3 for further information on inferred pH)

The analyzer alerts the operator if the value of the calculation exceeds or drops below the value set in the **Alarm 1 Set Point** parameter (see next page), depending on the type of **Alarm 1 Action** selected – see below.

Alarm 1 Failsafe

If failsafe action is required select **Yes**, otherwise select **No**.

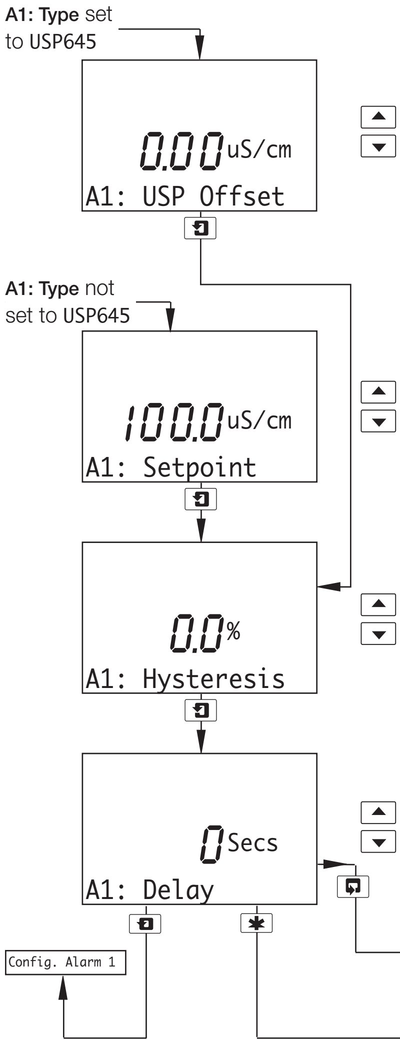
Alarm 1 Action

Select the alarm action required, **High** or **Low**.

`A1: USP Offset` **A1: Type** set to **USP645** (AX450 and AX455 analyzers only) – continued on next page…

`A1: Hysteresis` AX410 and AX411 analyzers or **A1: Type** not set to **USP645** (AX450 and AX455 analyzers only) – continued on next page…

…5.4 Configure Alarms



USP Offset

Enables the USP645 alarm set point value to be adjusted for increased process protection, i.e. the USP alarm set point value in Table 5.3 is offset by the amount entered (table value – offset value) to enable the alarm to be triggered early.

Note. The **USP Offset** parameter is available only on AX450 and AX455 analyzers and only if **A: Cond.Units** is set to **USP645** (see Section 5.3) and **A1: Type** is set to **USP645**.

Alarm 1 Set Point

The alarm 1 set point can be set to any value within the input range being displayed. Set the alarm set point to the required value – see table 5.2.

Alarm 1 Hysteresis

A differential set point can be defined between 0 and 5% of the alarm set point value. Set the required hysteresis, adjustable in steps of 0.1%.

Alarm 1 Delay

When an alarm condition occurs, the activation of the relays and LEDs is delayed for the specified time period. If the alarm clears within the period, the alarm is not activated. Set the required delay, in the range 0 to 60 seconds in steps of 1 second.

Config. Alarm 2 — Alarm 2 (and Alarms 3 and 4 if optional analog output board is fitted) configuration is identical to Alarm 1.

CONFIG. OUTPUTS — See Section 5.5.

…5.4 Configure Alarms

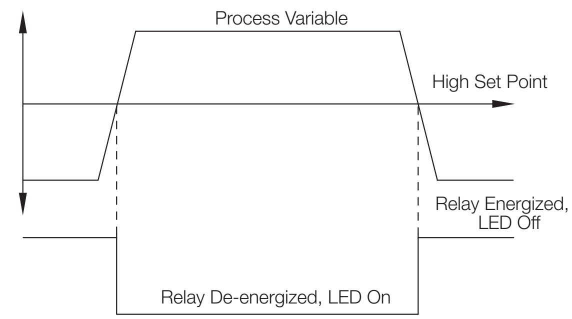


Fig. 5.1 High Failsafe Alarm without Hysteresis and Delay

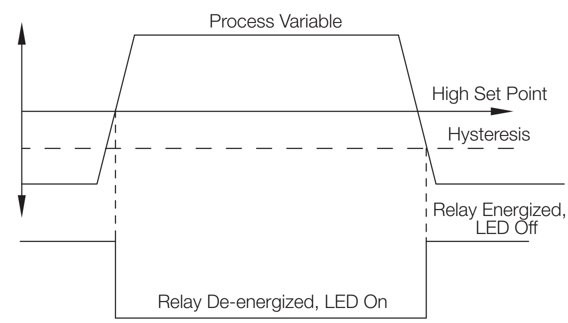


Fig. 5.2 High Failsafe Alarm with Hysteresis but no Delay

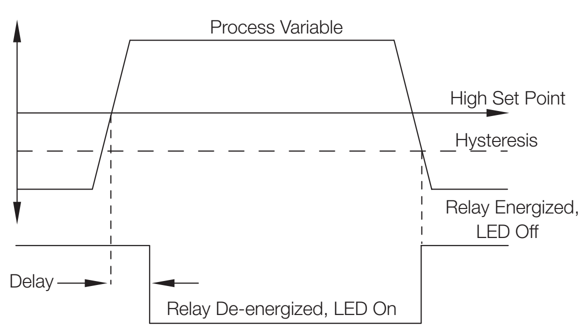


Fig. 5.3 High Failsafe Alarm with Hysteresis and Delay

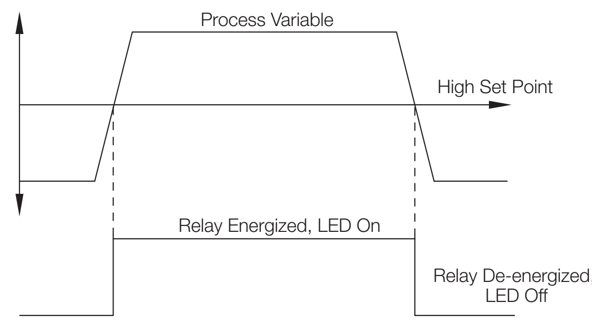


Fig. 5.4 High Non–Failsafe Alarm without Delay and Hysteresis

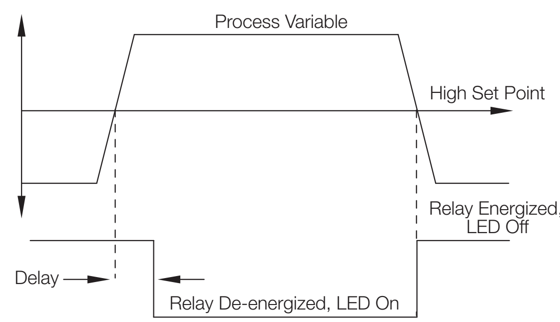
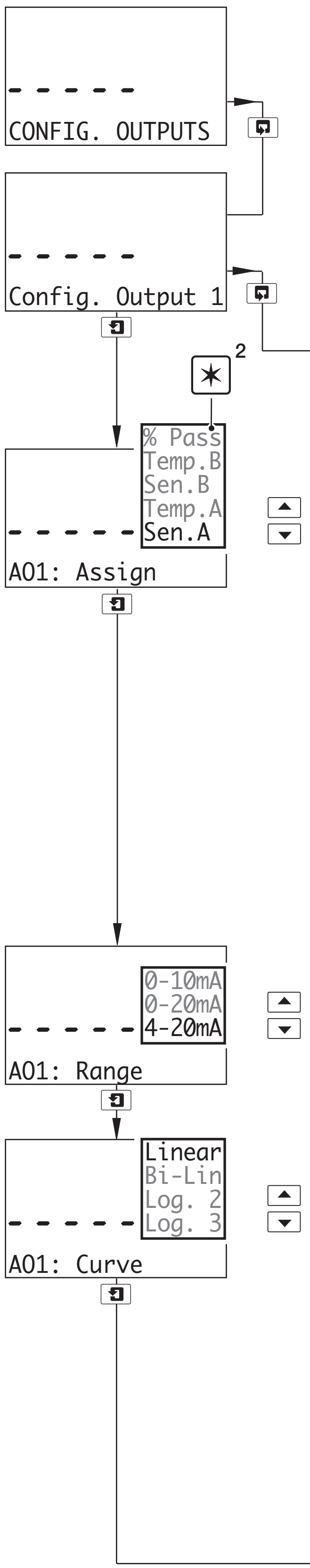


Fig. 5.5 High Failsafe Alarm with Delay but no Hysteresis

5.5 Configure Outputs



Configure Output 1

`Config. Output 2` Output 2 configuration (and Outputs 3 and 4 if optional analog output board is fitted) is identical to Output 1 configuration.

Assign

Select the sensor and analog output required:

- `Temp` – Temperature for the selected sensor
- `Sen` – Conductivity for the selected sensor

Notes.

1) Sensor B outputs and signal calculation are applicable only to dual input conductivity.

2) If **Signal Calc.** is set to any parameter other than **No Calculation** (see page 21), the display shows the selected parameter:
   - `% Pass` – **Signal Calc.** set to **% Passage**
   - `% Rej` – **Signal Calc.** set to **% Rejection**
   - `A – B` – |**Signal Calc.** set to **Difference A – B**
   - `A/B` – **Signal Calc.** set to **Ratio A/B**
   - `pH` – **Signal Calc.** set to **Inferred pH** (see Appendix A3 for further information on inferred pH)

Range

Set the analog output current range for the selected output.

Curve

Select the analog output scale required.

- `Linear` – Straight line between zero and span
- `Bi-Lin` – Bi-linear – see Fig. 5.6
- `Log. 2` – Logarithmic, 2-decades – see Fig. 5.7
- `Log. 3` – Logarithmic, 3-decades – see Fig. 5.8

Note. The curve is fixed to **Linear** if :

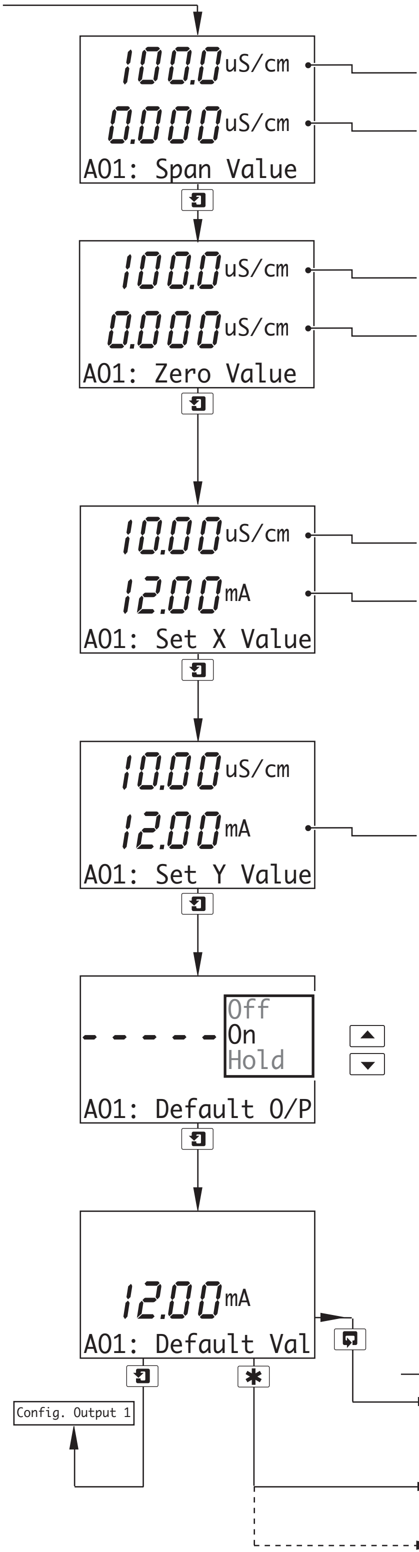
a) the analog output is assigned to temperature

or

b) the analog output is assigned to Sensor A or Sensor B (dual input conductivity only) **and Cond.Units** is set to **M_Ohms** (see Section 5.3).

`A01: Span Value` Continued on next page…

…5.5 Configure Outputs



Span Value
Span value – set the required span value.

Zero value.

Zero Value
Span value.

Zero value – set the required zero value – see Fig. 5.6.

Note. Applicable only if the **Curve** parameter is set to **Linear** or **Bi-Lin** – see opposite. When set to **Log. 2** and **Log. 3**, the zero value is set automatically.

Set Breakpoint X Value
Set the breakpoint value, which is the conductivity at which the breakpoint occurs.

Current at which the breakpoint occurs. This is Point B in Fig. 5.6.

Note. Applicable only if the **Curve** parameter is set to **Bi-Lin** – see opposite.

Set Breakpoint Y Value
Conductivity at which the breakpoint occurs.

Set the current at which the breakpoint occurs. This is Point C in Fig. 5.6.

Note. Applicable only if the **Curve** parameter is set to **Bi-Lin** – see opposite.

Default Output
Set the system reaction to failure:

- `Off` – Ignore failure and continue operation.
- `On` – Stop on failure. This drives the analog output to the level set in the **Default Val** parameter below.
- `Hold` – Hold the analog output at the value prior to the failure.

Default Value
The level to which the analog output is driven if a failure occurs.

Config. Output 2 — Output 2 configuration (and Outputs 3 and 4 if optional analog output board is fitted) is identical to Output 1 configuration.

CONFIG. CLOCK — If optional analog output board fitted – see Section 5.7.

CONFIG. SECURITY — If optional analog output board not fitted – see Section 5.8.

…5.5 Configure Outputs

Analog Output Assignment	Analog Output Span	Analog Output Zero
Conductivity	Programmable between 0.1% and 100% of conductivity span (Table 5.1)	Set automatically according to selected Analog Output Scale: `Linear` = Subject to a minimum range as per Table 5.2 `Bi-lin` = Subject to a minimum range as per Table 5.2 `Log. 2` = 1.0% of Analog Output Span `Log. 3` = 0.1% of Analog Output Span
If Conductivity Units = MΩ-cm	20.00 (maximum), 2.00 (minimum) (subject to minimum range of 1.00 MΩ-cm)	
Temperature (°C)	150 (maximum), –10 (minimum) (subject to minimum range of 20°C)	
Temperature (°F)	302 (maximum), 14 (minimum) (subject to minimum range of 36°F)	

Table 5.4 Analog Outputs

5.6 Output Functions

5.6.1 Bi-Linear Output – Fig. 5.6

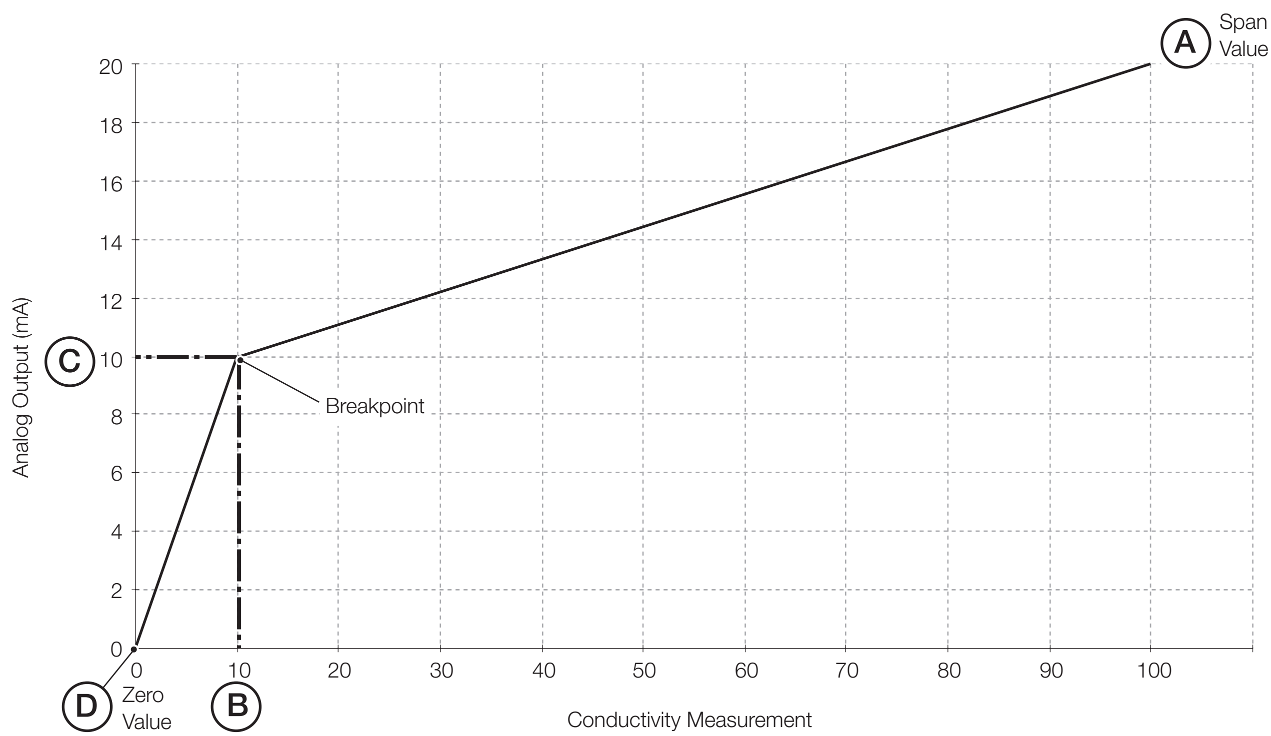


Fig. 5.6 Bi-Linear Output

…5.6 Output Functions

5.6.2 Logarithmic Output (2-decade) – Fig. 5.7

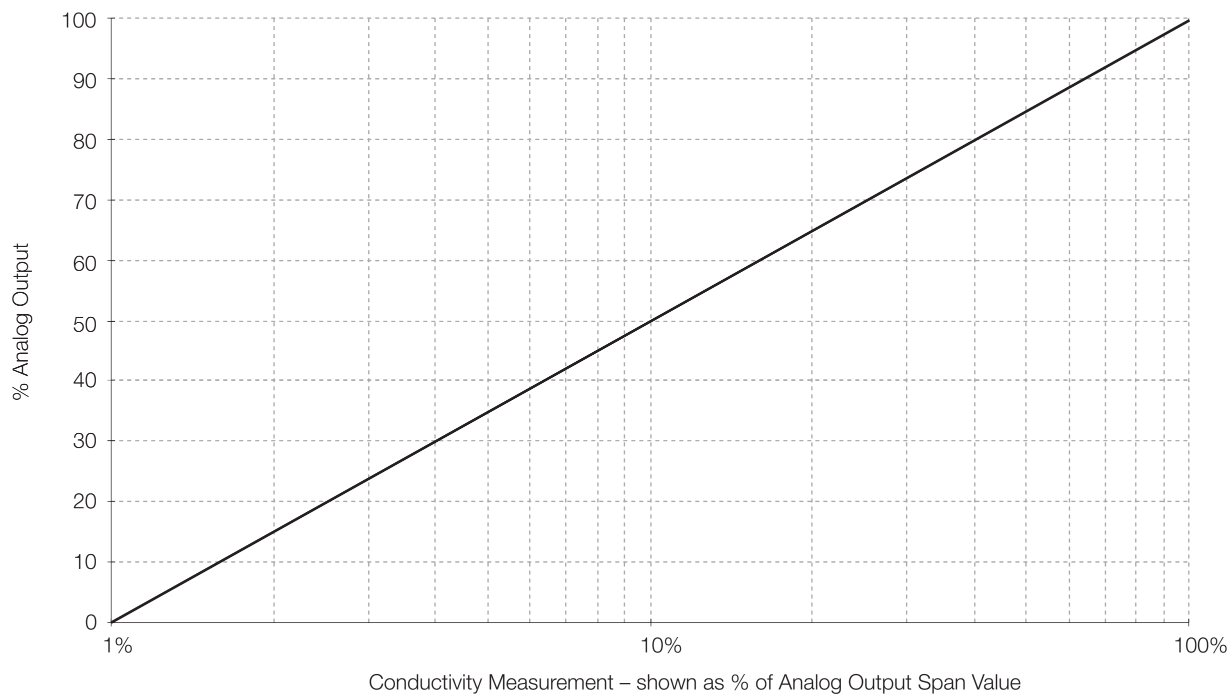


Fig. 5.7 Logarithmic Output (2-Decade)

5.6.3 Logarithmic Output (3-decade) – Fig. 5.8

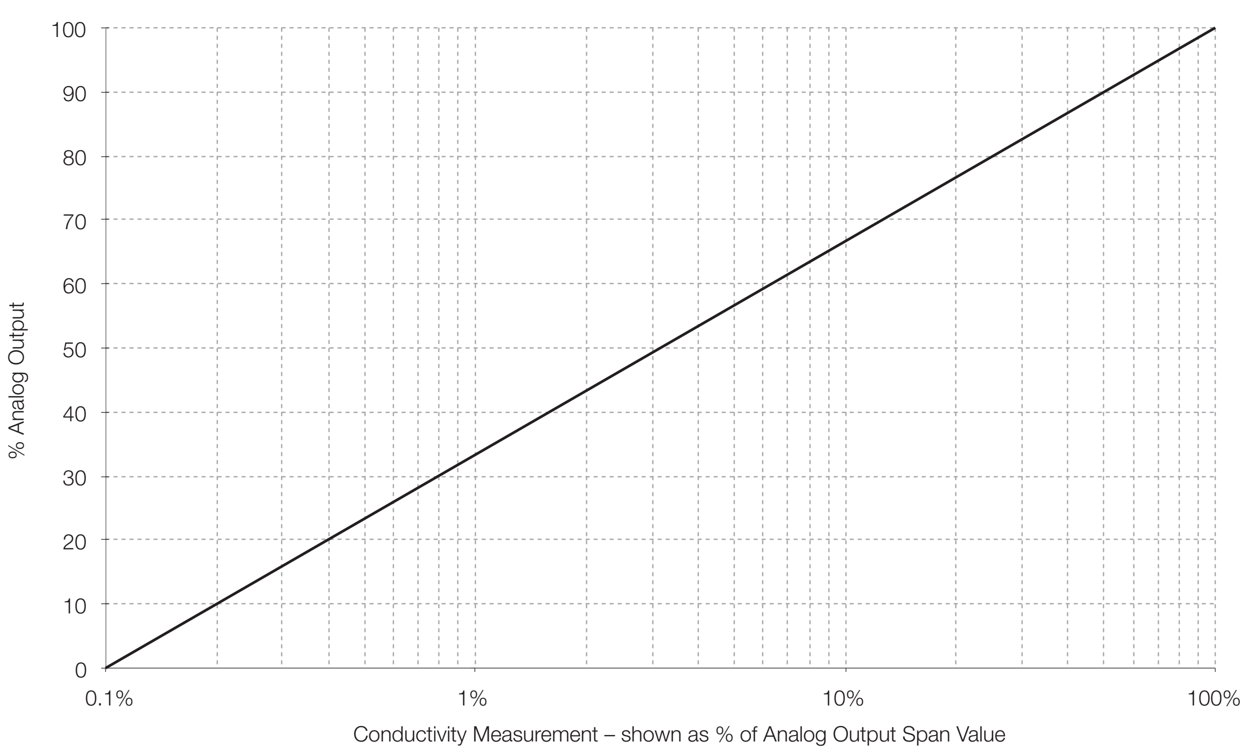
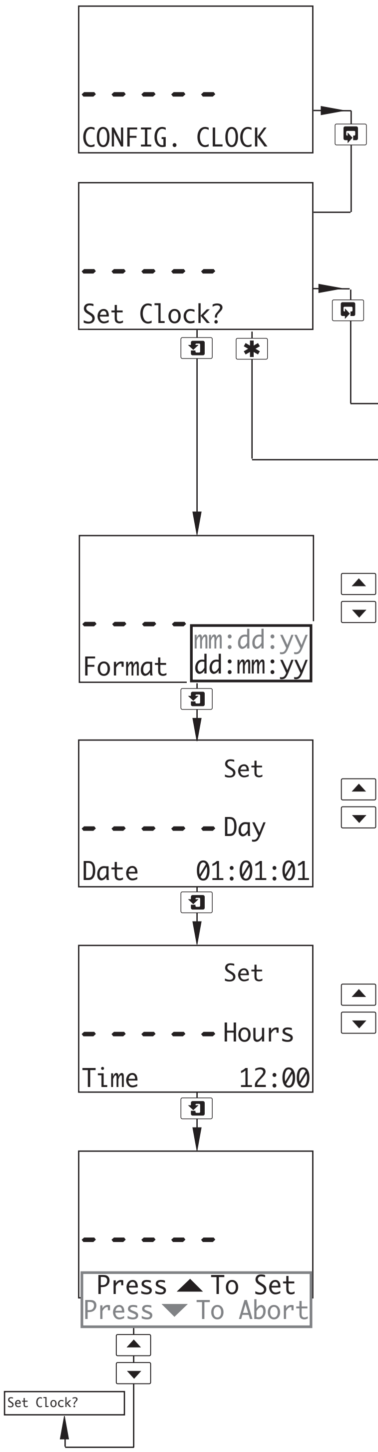


Fig. 5.8 Logarithmic Output (3-Decade)

5.7 Configure Clock

Note. The **Config. Clock** function is available only if the optional analog output board is fitted.



Set Clock
Set the system clock.

CONFIG. CLOCK Return to main menu.

CONFIG. SECURITY See Section 5.8.

Format
Select the required clock format.

Date
Set the date in the form dd:mm:yy.

Press [key] to move between the day, month and year fields.
Use the ▲ and ▼ keys to adjust each field.

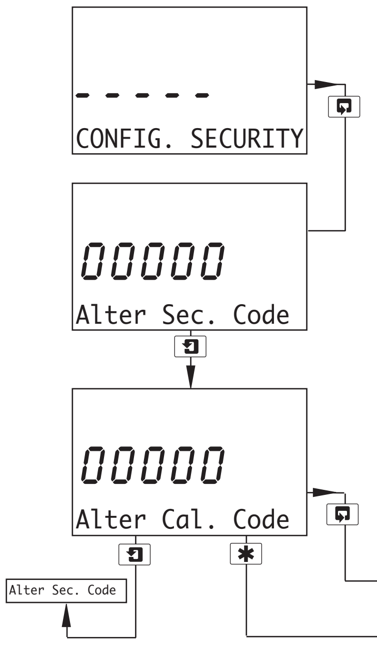
Time
Set the time in the form hh:mm.

Press [key] to move between hours and minute fields.
Use the ▲ and ▼ keys to adjust each field.

Press ▲ to Set and **Press ▼ to Abort** are shown alternately on the lower display line.

Press the appropriate key to set the clock or abort the changes.

5.8 Configure Security



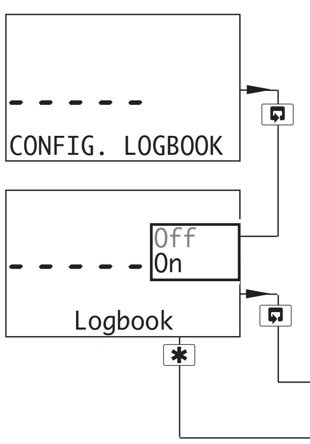
Alter Security Code
Set the security code to a value between 0000 and 19999.

Alter Calibration Code
Set the sensor calibration access code to a value between 0000 and 19999.

CONFIG. SECURITY Return to main menu.

CONFIG. LOGBOOK See Section 5.9.

5.9 Configure Logbook

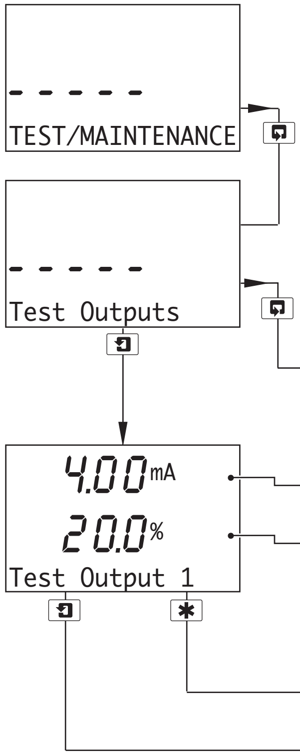


Configure Logbook
Use the ▲ and ▼ keys to to set the logbook **On** or **Off**.
If **Off** is selected, all data entries in the logbook are cleared.

CONFIG. LOGBOOK Return to main menu.

TEST/MAINTENANCE See Section 5.10.

5.10 Test Outputs and Maintenance



Test Outputs
Displays the output test details for the four channels. Test Output 1 only is shown; the remaining outputs are identical.

Note. Outputs 3 and 4 are available only if the optional analog output board is fitted.

`Maintenance` See below.

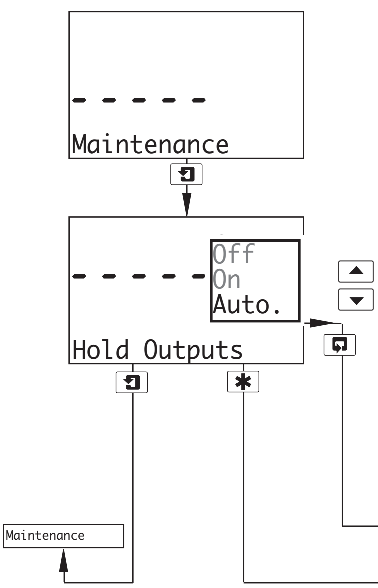
Test Output 1
The theoretical output current value.

Output current as a percentage of the full range current.

Use the ▲ and ▼ keys to adjust the displayed theoretical output current value to give the output required.

`FACTORY SETTINGS` See Section 7.3.

`Test Output 2` Test remaining outputs.



Maintenance

Hold Outputs
Enables the relay action and analog outputs to be maintained.

`Auto.` – Hold is released automatically after six hours.
`On` – Changes in relay action and analog outputs are inhibited.
`Off` – Changes in relay action and analog outputs are not inhibited.

Note. The LEDs flash while the analyzer is in Hold mode.

`TEST/MAINTENANCE` Return to main menu.

`CONFIG. SENSORS` See Section 7.3.

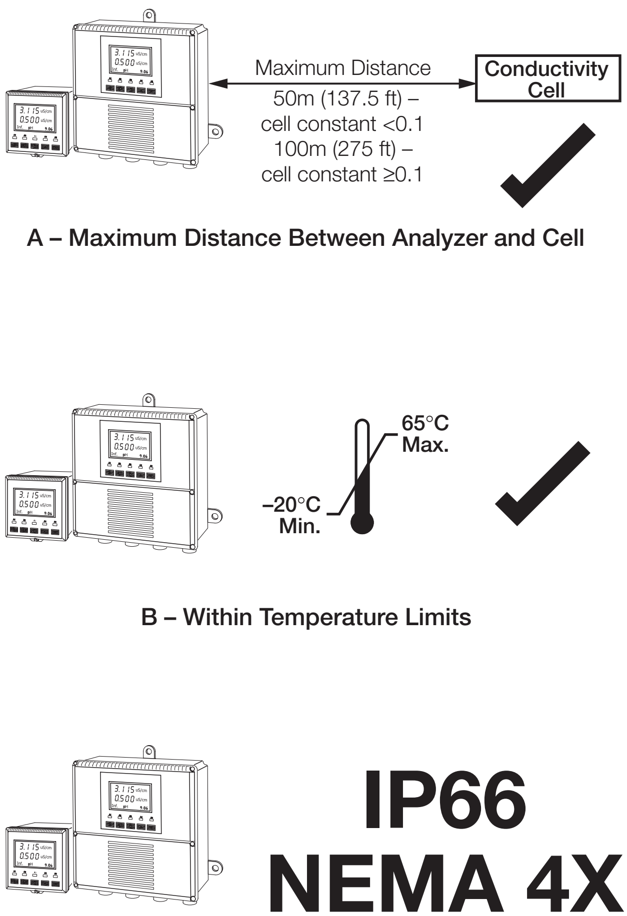
6 INSTALLATION

6.1 Siting Requirements

Caution.

- Mount in a location free from excessive vibration.
- Mount away from harmful vapours and/or dripping fluids.

Information. It is preferable to mount the analyzer at eye level, allowing an unrestricted view of the front panel displays and controls.



A – Maximum Distance Between Analyzer and Cell

B – Within Temperature Limits

C – Within Environmental Limits

Fig. 6.1 Siting Requirements

6.2 Mounting

6.2.1 Wall-/Pipe-mount Analyzers – Figs. 6.2 and 6.3

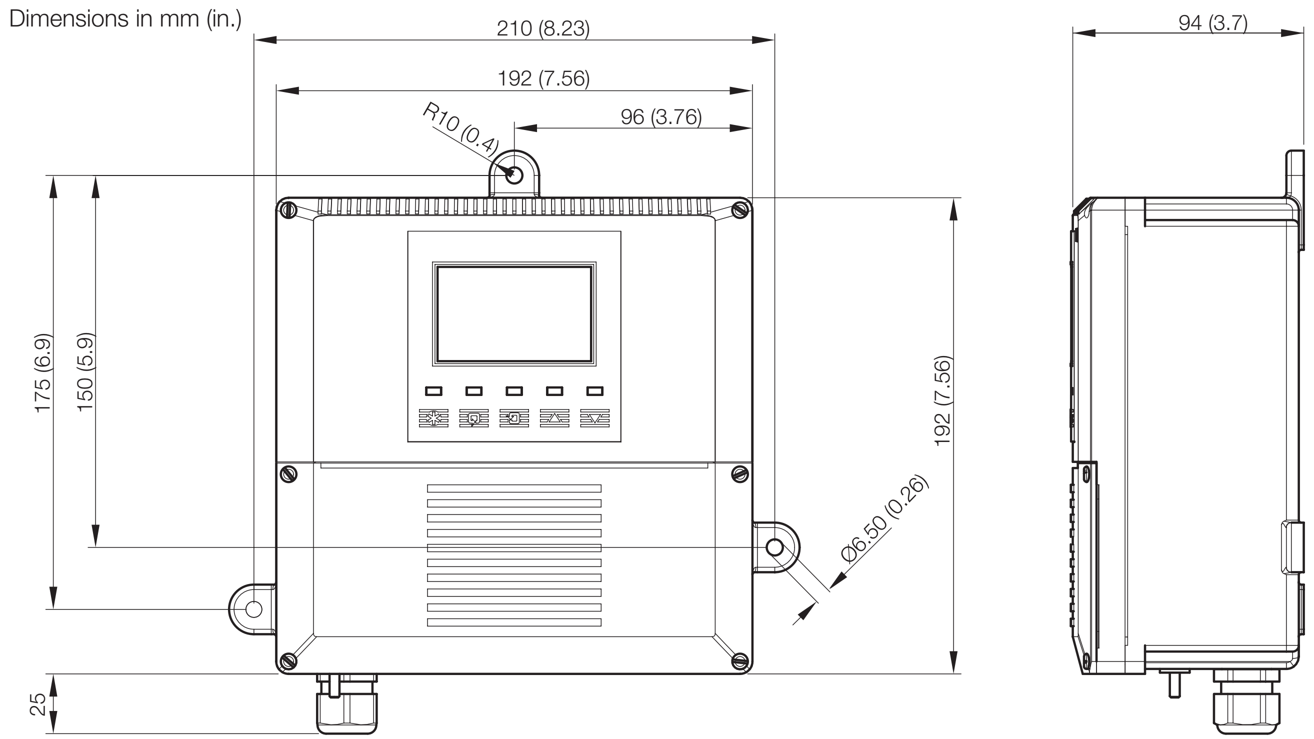


Fig. 6.2 Overall Dimensions

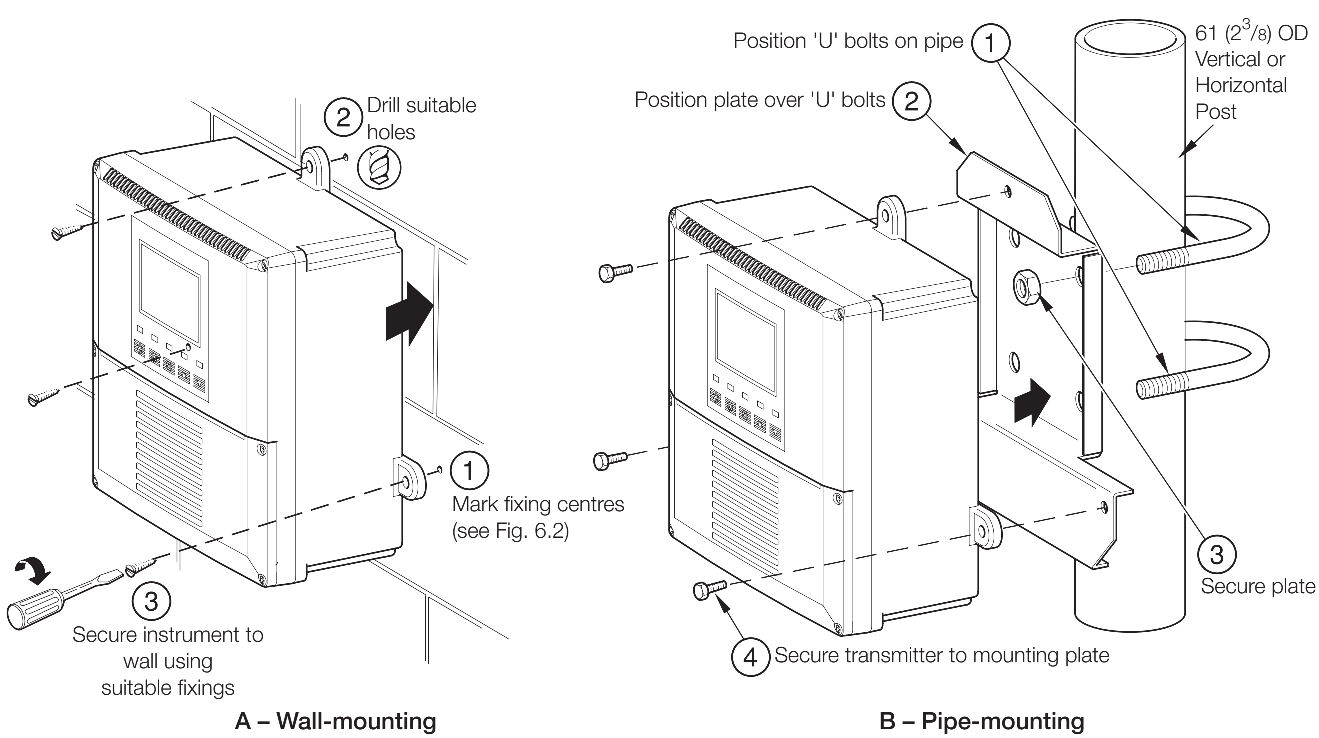


Fig. 6.3 Wall-/Pipe-mounting

…6.2 Mounting

6.2.2 Panel-mount Analyzers – Figs. 6.4 and 6.5

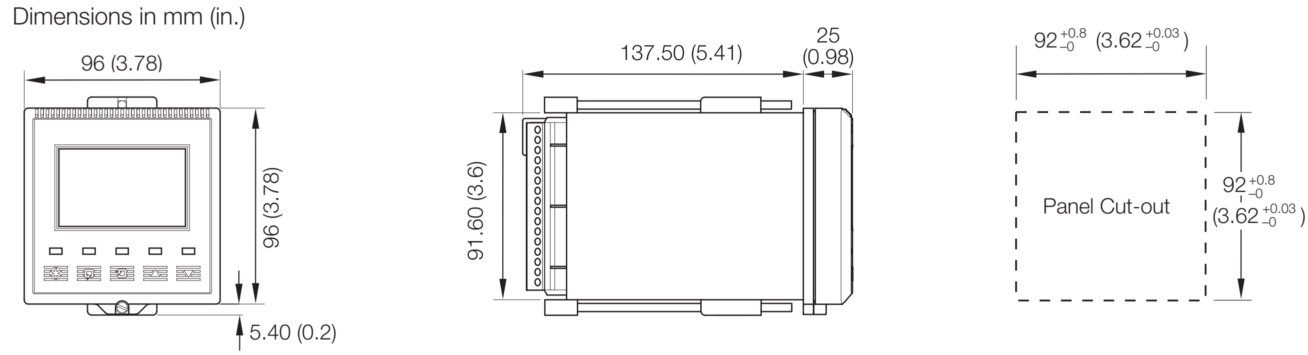
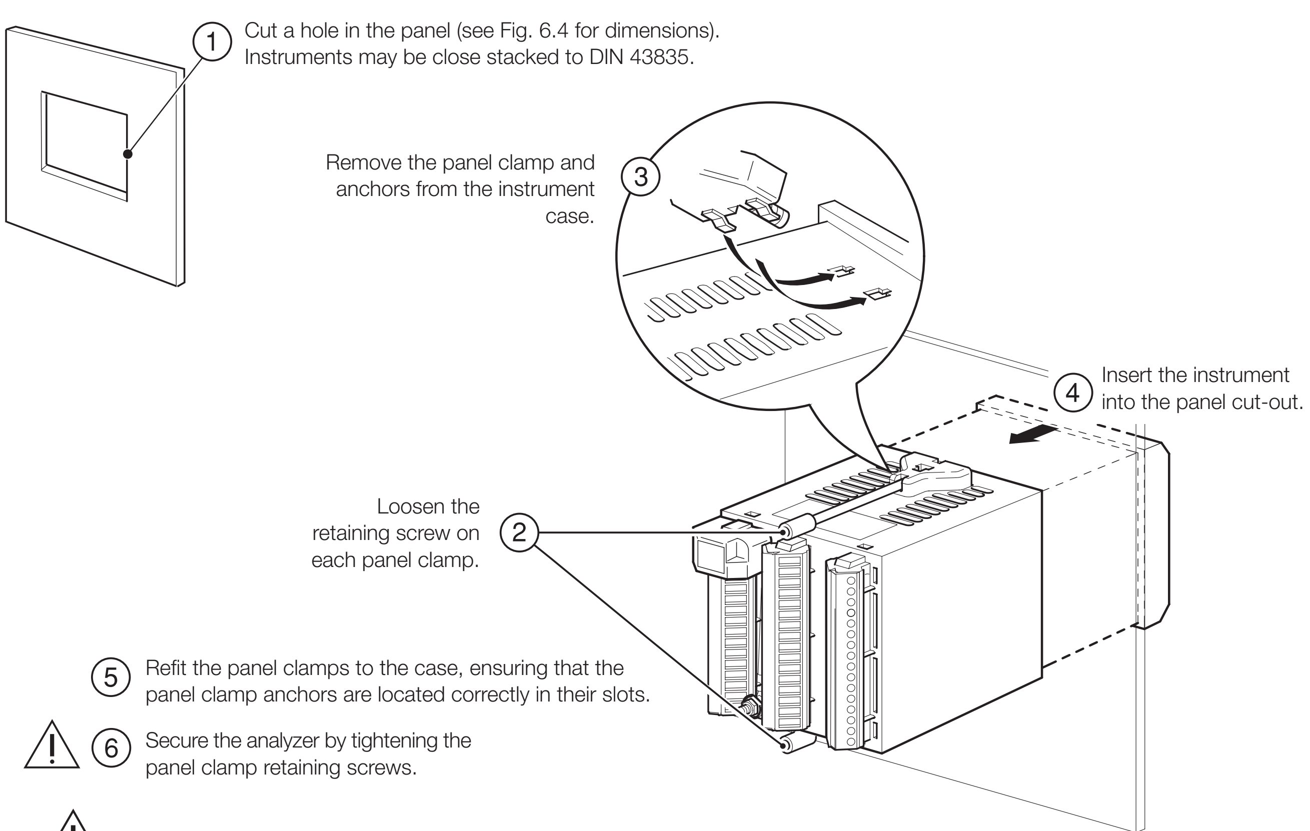


Fig. 6.4 Overall Dimensions



Caution. The clamp must fit flat on the analyzer casing. If the clamp is bowed, the securing screw is overtight and sealing problems may occur.

Fig. 6.5 Panel-mounting

6.3 Connections, General

Warning. The power supply earth (ground) **must** be connected to ensure safety to personnel, reduction of the effects of RFI interference and correct operation of the power supply interference filter.

Caution. The metal braid in the conductivity cell connecting cable **must not** be earthed, or allowed to touch earthed components, and must be cut back to the insulation at the conductivity cell end.

Information.

- **Earthing (grounding)** – stud terminal(s) is fitted to the analyzer case for bus-bar earth (ground) connection – see Fig. 6.8 (wall-/pipe-mount analyzers) or Fig. 6.10 (panel-mount analyzers).
- **Cable lengths** – the integral cable may be extended using a suitable junction box, but the total cable length must not exceed 50m (137.5 ft) for cells with a constant of <0.1 or 100m (275 ft) for cells with a constant of ≥0.1.
- **Cable routing** – always route signal output/conductivity cell cable leads and mains-carrying/relay cables separately, ideally in earthed metal conduit. Use twisted pair output leads or screened cable with the screen connected to the case earth stud.

  Ensure that the cables enter the analyzer through the glands nearest the appropriate screw terminals and are short and direct. Do not tuck excess cable into the terminal compartment.
- **Cable glands & conduit fittings** – ensure that the NEMA4X/IP66 rating is not compromised when using cable glands, conduit fittings and blanking plugs/bungs (M20 holes). The M20 glands accept cable of between 5 and 9mm (0.2 and 0.35 in.) diameter.
- **Relays** –the relay contacts are voltage-free and must be appropriately connected in series with the power supply and the alarm/control device which they are to actuate. Ensure that the contact rating is not exceeded. Refer also to Section 6.3.1 for relay contact protection details when the relays are to be used for switching loads.
- **Analog output** – Do not exceed the maximum load specification for the selected analog output range.

  Since the analog output is isolated, the –ve terminal **must** be connected to earth (ground) if connecting to the isolated input of another device.

…6.3 Connections, General

6.3.1 Relay Contact Protection and Interference Suppression – Fig. 6.6

If the relays are used to switch loads on and off, the relay contacts can become eroded due to arcing. Arcing also generates radio frequency interference (RFI) which can result in analyzer malfunctions and incorrect readings. To minimize the effects of RFI, arc suppression components are required; resistor/capacitor networks for a.c. applications or diodes for d.c. applications. These components can be connected either across the load or directly across the relay contacts. The RFI components must be fitted to the relay terminal block along with the supply and load wires – see Fig 6.6.

For **AC applications** the value of the resistor/capacitor network depends on the load current and inductance that is switched. Initially, fit a 100R/0.022µF RC suppressor unit (part no. B9303) as shown in Fig. 6.6A. If the analyzer malfunctions (locks up, display goes blank, resets etc.) the value of the RC network is too low for suppression and an **Alt**ernative value must be used. If the correct value cannot be obtained, contact the manufacturer of the switched device for details on the RC unit required.

For **DC applications** fit a diode as shown in Fig. 6.6B. For general applications use an IN5406 type (600V peak inverse voltage at 3A – part no. B7363).

Note. For reliable switching the minimum voltage must be greater than 12V and the minimum current greater than 100mA.

A – AC Applications

B – DC Applications

Fig. 6.6 Relay Contact Protection

…6.3 Connections, General

6.3.2 Cable Entry Knockouts, Wall-/Pipe-mount Analyzer – Fig. 6.7

The analyzer is supplied with 7 cable glands, one fitted and six to be fitted, as required, by the user – see Fig. 6.7.

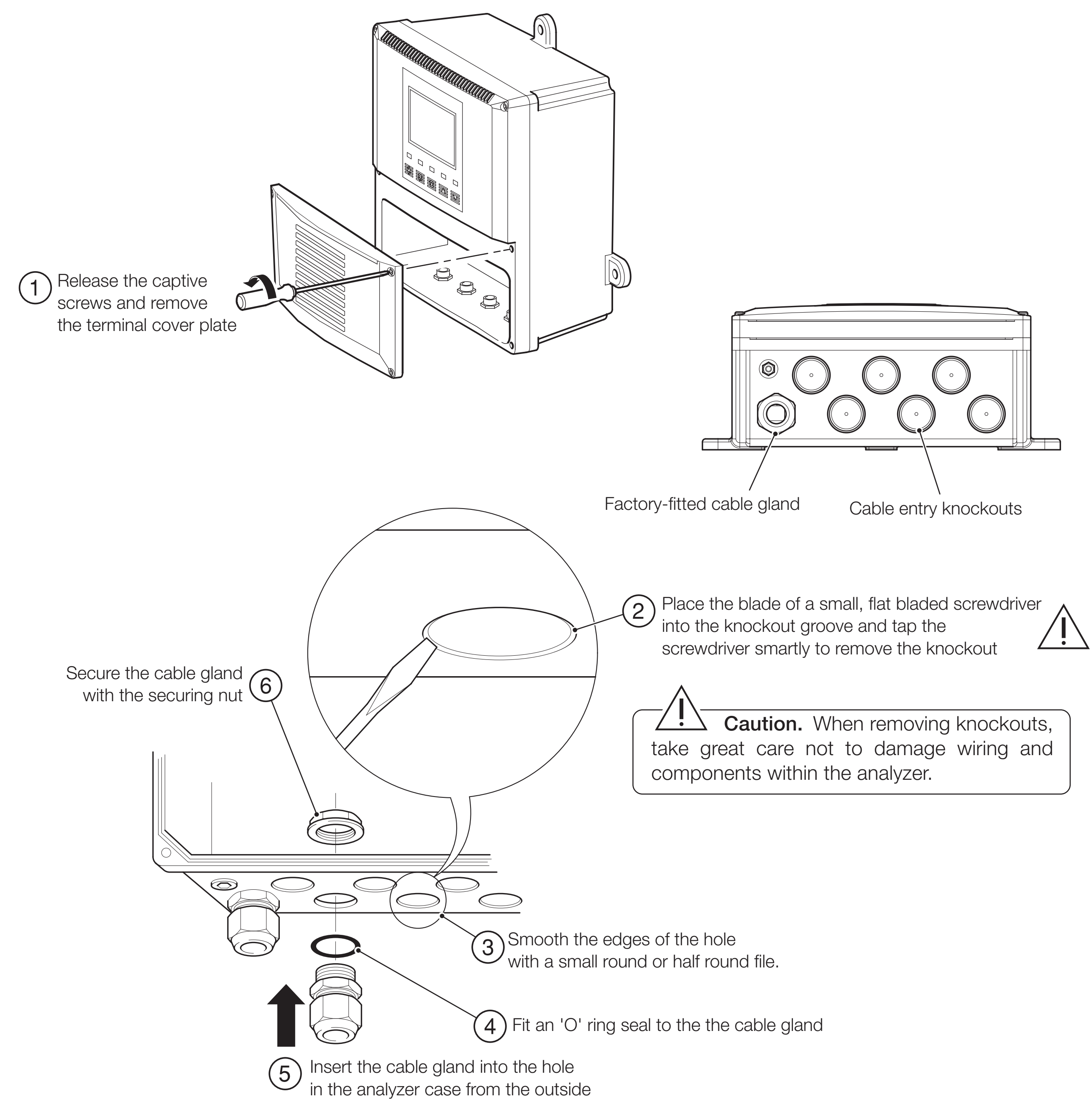


Fig. 6.7 Cable Entry Knockouts, Wall-/Pipe-mount Analyzer

Warning. Before making any connections, ensure that the power supply, any high voltage-operated control circuits and high common mode voltages are switched off.

6.4 Wall-/Pipe-mount Analyzer Connections

6.4.1 Access to Terminals – Fig. 6.8

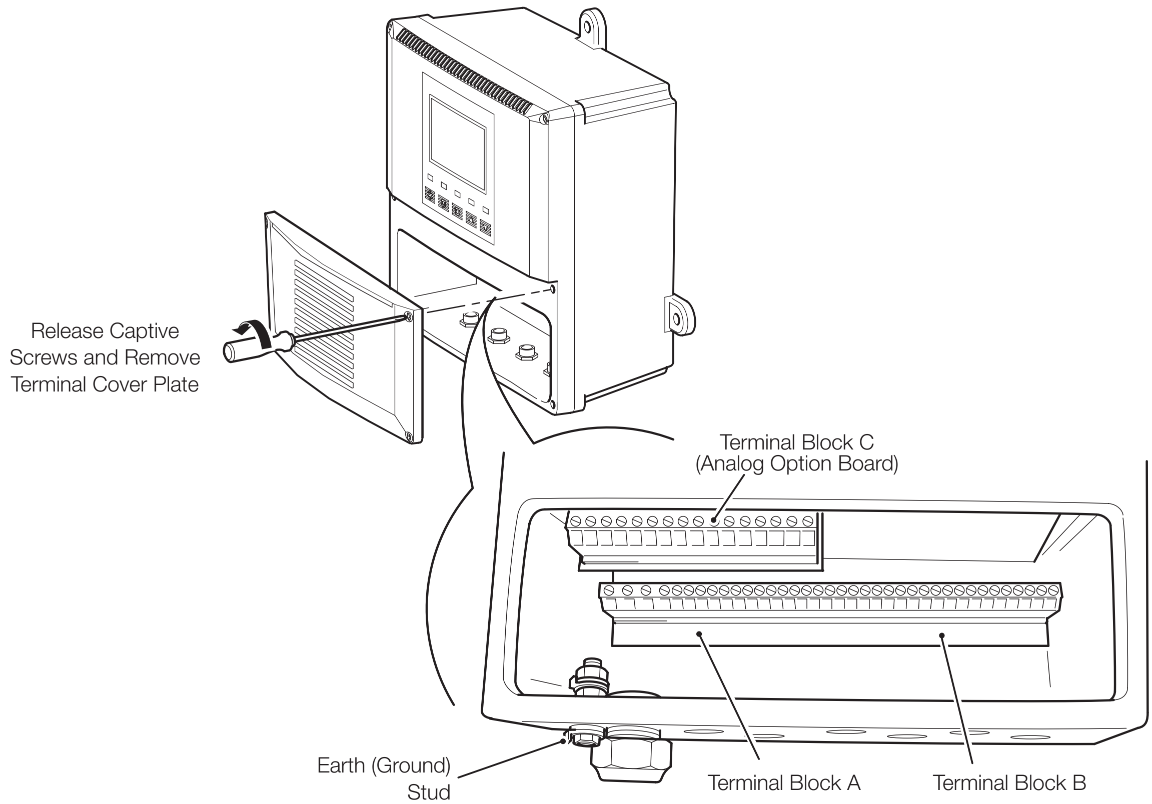
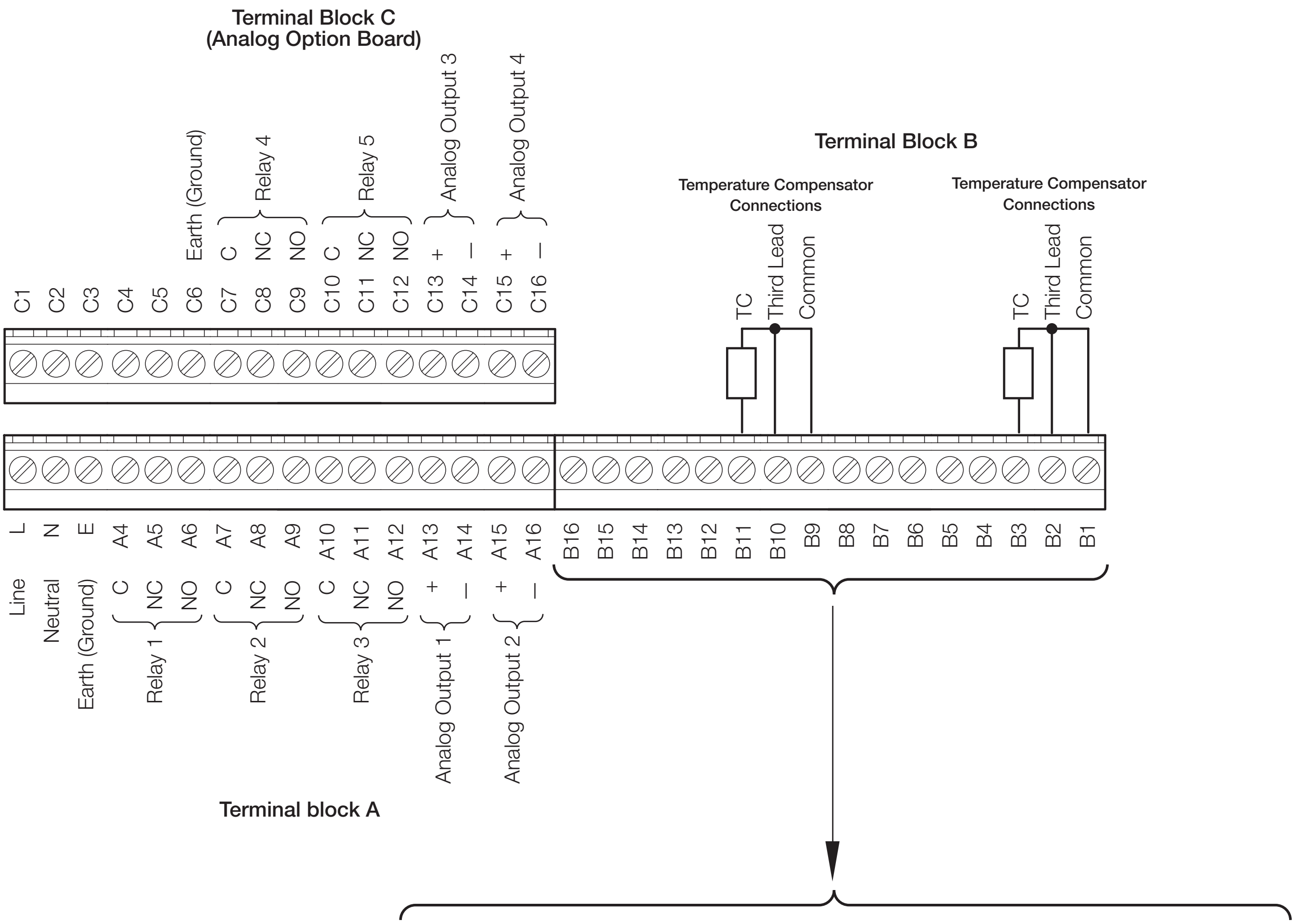


Fig. 6.8 Access to Terminals, Wall-/Pipe-mount Analyzer

…6.4 Wall-/Pipe-mount Analyzer Connections

6.4.2 Connections – Fig. 6.9



Terminal Block B		
Sensor B*	Sensor A	Conductivity Cell Connections
1	9	TC Common, Link B1 to B2 (Dual Conductivity Only) / B9 to B10**
2	10	TC Third Lead
3	11	TC
4	12	Screen
5	13	Cell (Cell Electrode)
6	14	Cell (Earth Electrode)
7	15	Not Used
8	16	Not Used

* Dual Conductivity Only
** When a 2-wire Pt100, Pt1000 or 'balco 3k' temperature compensator is fitted.
TC = Temperature Compensator.

Fig. 6.9 Connections, Wall-/Pipe-mount Analyzer

Warning. Before making any connections, ensure that the power supply, any high voltage-operated control circuits and high common mode voltages are switched off.

6.5 Panel-mount Analyzer Connections

6.5.1 Access to Terminals – Fig. 6.10

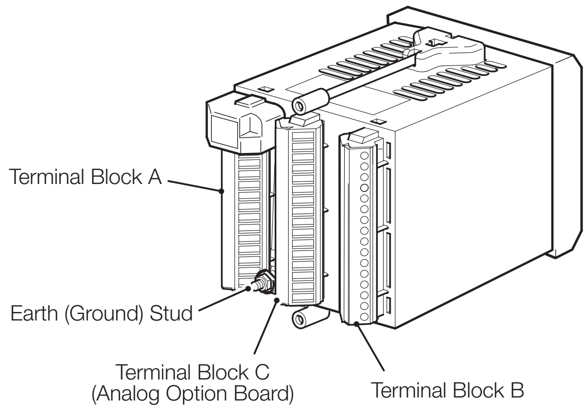
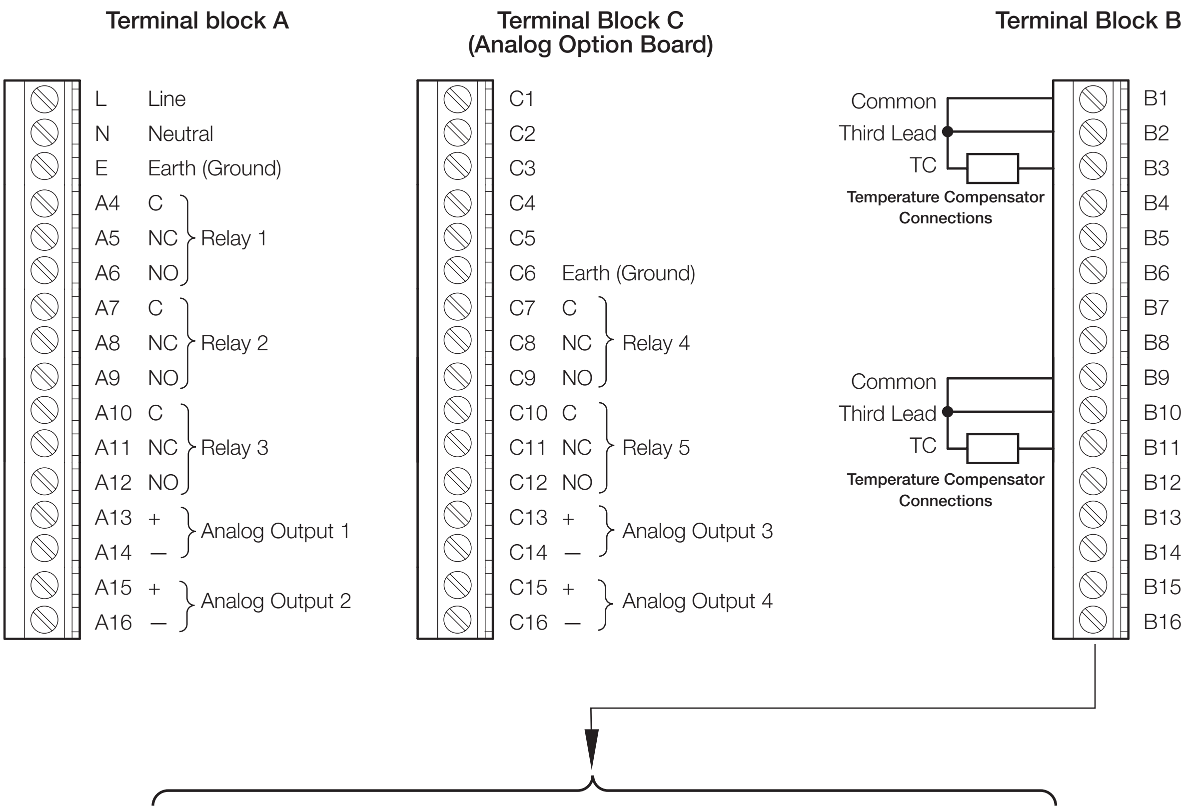


Fig. 6.10 Access to Terminals, Panel-mount Analyzers

…6.5 Panel-mount Analyzer Connections

6.5.2 Connections – Fig. 6.11



Terminal Block B		
Sensor B*	Sensor A	Conductivity Cell Connections
1	9	TC Common, Link B1 to B2 (Dual Conductivity Only) / B9 to B10**
2	10	TC Third Lead
3	11	TC
4	12	Screen
5	13	Cell (Cell Electrode)
6	14	Cell (Earth Electrode)
7	15	Not Used
8	16	Not Used

* Dual Conductivity Only
** When a 2-wire Pt100, Pt1000 or 'balco 3k' temperature compensator is fitted.
TC = Temperature Compensator.

Fig. 6.11 Connections, Panel-mount Analyzers

7 CALIBRATION

> ✶ **Notes.**
> - The analyzer is calibrated by the Company prior to dispatch and routine recalibration is not necessary. High stability components are used in the analyzer's input circuitry and, once calibrated, the Analog to Digital converter chip self-compensates for zero and span drift. It is therefore unlikely that the calibration will change over time. It is not advisable to attempt recalibration unless the input board has been replaced or the calibration tampered with.
> - Prior to attempting recalibration, test the analyzer's accuracy using suitably calibrated test equipment – see Sections 7.2 and 7.3.

7.1 Equipment Required

a) Decade resistance box (conductivity cell input simulator): 0 to 10kΩ (in increments of 0.1Ω), accuracy ±0.1%.

b) Decade resistance box (Pt100/Pt1000 temperature input simulator): 0 to 1kΩ (in increments of 0.01Ω), accuracy ±0.1%.

c) Digital milliammeter (current output measurement): 0 to 20mA.

> ✶ **Note.** Resistance boxes have an inherent residual resistance which may range from a few mΩ up to 1Ω. This value must be taken into account when simulating input levels, as should the overall tolerance of the resistors within the boxes.

7.2 Preparation

a) Switch off the supply and disconnect the conductivity cell(s), temperature compensator(s) and current output(s) from the analyzer's terminal blocks.

b) Sensor A:
   1) Link terminals B9 and B10.
   2) Link terminal B12 to the Case Earth Stud – see Fig. 6.8.
   3) Connect the 0 to 10kΩ decade resistance box to terminals B13 and B14 to simulate the conductivity cell. Connect the decade box earth to the Case Earth Stud.
   4) Connect the 0 to 1kΩ decade resistance box to terminals B11 and B9 to simulate the Pt100/Pt1000.

   Sensor B (dual input conductivity only):
   1) Link terminals B1 and B2.
   2) Link terminal B4 to the Case Earth Stud – see Fig. 6.8.
   3) Connect the 0 to 10kΩ decade resistance box to terminals B5 and B6 to simulate the conductivity cell. Connect the decade box earth to the Case Earth Stud.
   4) Connect the 0 to 1kΩ decade resistance box to terminals B3 and B1 to simulate the Pt100/Pt1000.

c) Connect the milliammeter to the analog output terminals.

d) Switch on the supply and allow ten minutes for the circuits to stabilize.

d) Select the **FACTORY SETTINGS** page and carry out Section 7.3.

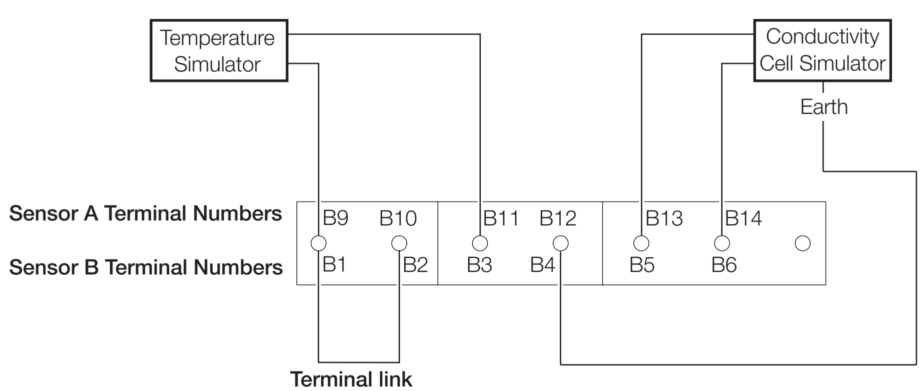


Fig. 7.1 Analyzer Terminal Links and Decade Resistance Box Connections

7.3 Factory Settings

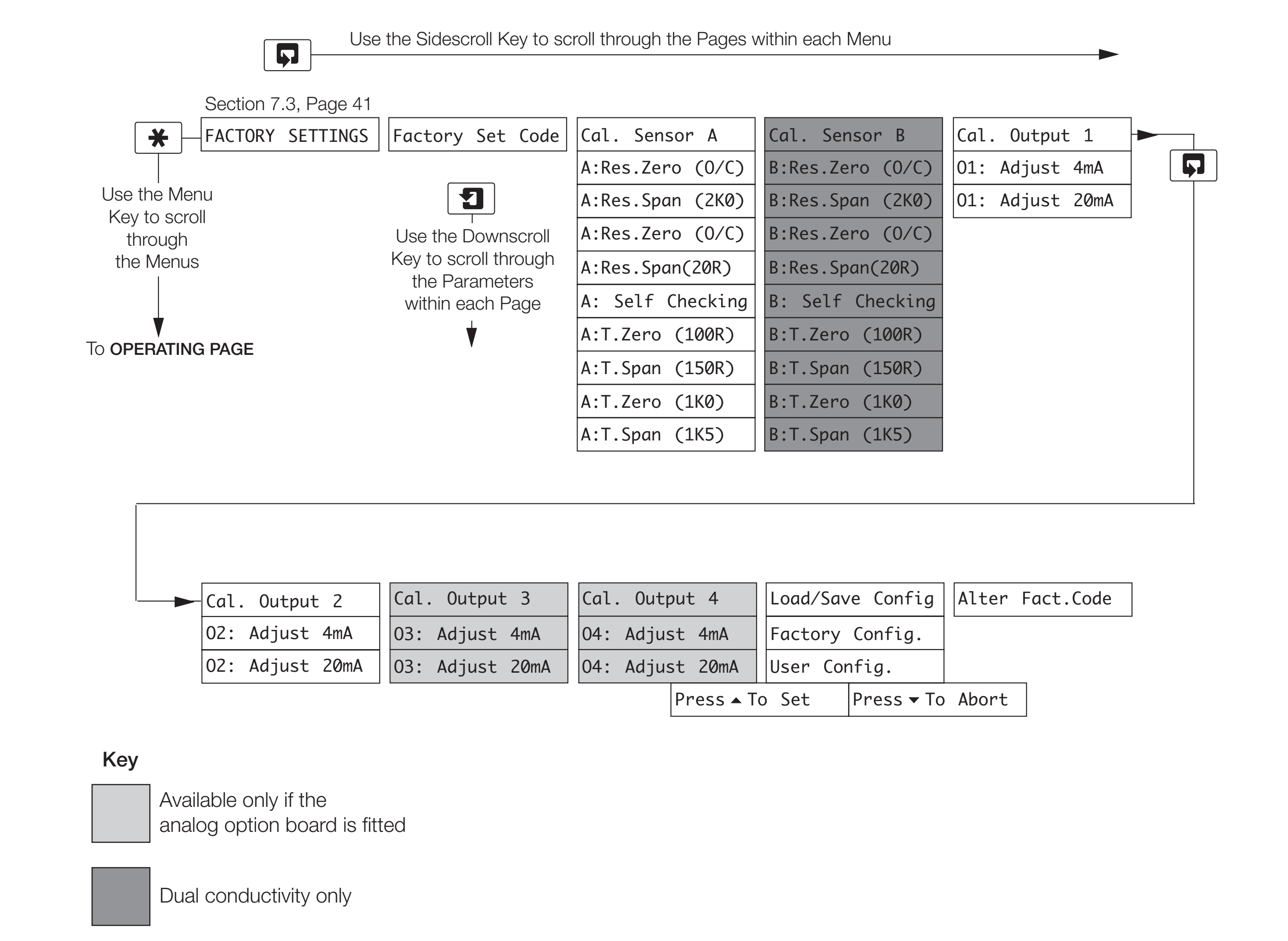
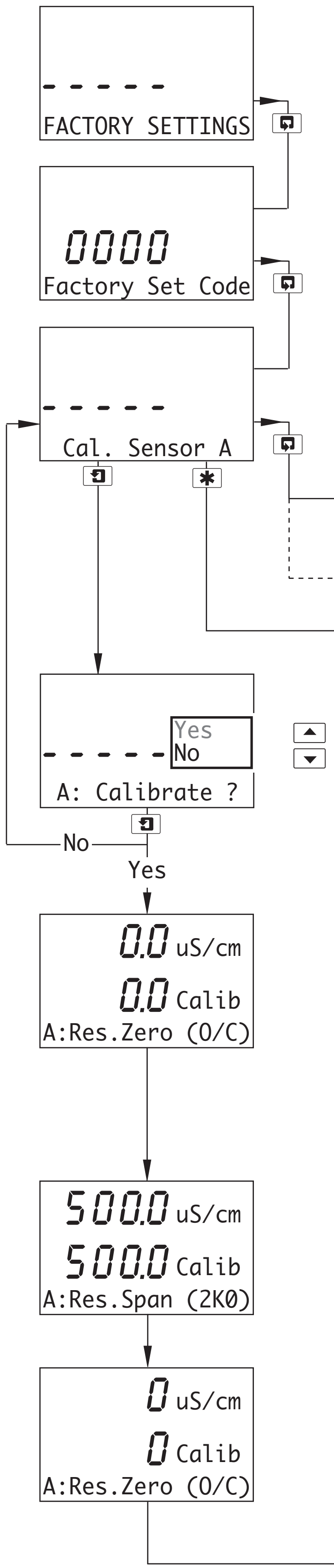


Fig. 7.2 Overall Factory Settings Chart

…7.3 Factory Settings



Factory Settings Access Code
Enter the required code number, between 0000 and 19999, to gain access to the factory settings. If an incorrect value is entered, access to subsequent parameters is prevented and the display reverts to the top of the **Factory Settings Page**.

Calibrate Sensor A

Note. The values in the display lines for sensor calibration are shown only as examples – the actual values obtained will differ.

Cal. Sensor B — Sensor B calibration (dual input analyzers only) is identical to Sensor A calibration.

Cal. Output 1 — Single input analyzers only – see page 43.

Dual Cond. — Return to **Operating Page**.

Calibrate Sensor A ?
If calibration is required select **Yes** otherwise select **No**.

Note. To abort calibration, press the key again at any time before calibration is complete – see next page.

Resistance Zero (Open Circuit)
Open circuit the cell simulator.

The display advances automatically to the next step once a stable and valid value is recorded.

Note. The upper 6-segment display shows the measured conductivity. Once the signal is within range the lower 6-segment display shows the same value and **Calib** is displayed to indicate that calibration is in progress.

Resistance Span (2k0)
Set the cell simulator to 2kΩ

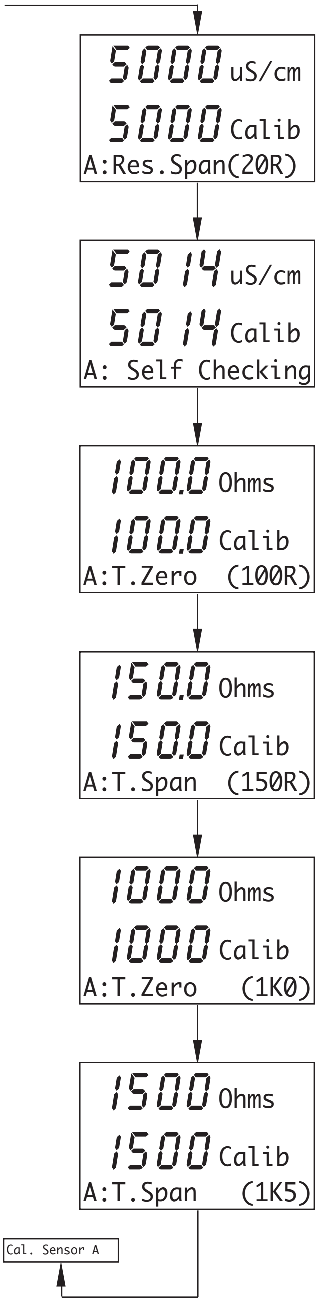
The display advances automatically to the next step once a stable and valid value is recorded.

Resistance Zero (Open Circuit)
Open circuit the cell simulator.

The display advances automatically to the next step once a stable and valid value is recorded.

A: Res.Vref — Continued on next page…

…7.3 Factory Settings



Resistance Span (20R0)
Set the cell simulator to 20Ω

The display advances automatically to the next step once a stable and valid value is recorded.

Self Checking
The analyzer calibrates the internal reference resistance automatically.

The display advances automatically to the next step once a stable and valid value is recorded.

Temperature Zero (100R)
Set the temperature simulator to 100Ω

The display advances automatically to the next step once a stable and valid value is recorded.

Temperature Span (150R)
Set the temperature simulator to 150Ω

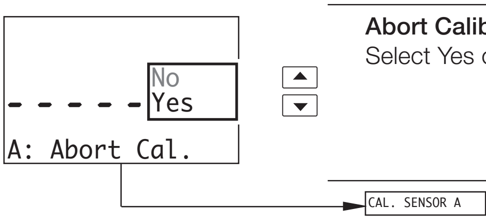
The display advances automatically to the next step once a stable and valid value is recorded.

Temperature Zero (1k0)
Set the temperature simulator to 1000Ω

The display advances automatically to the next step once a stable and valid value is recorded.

Temperature Span (1k5)
Set the temperature simulator to 1500Ω

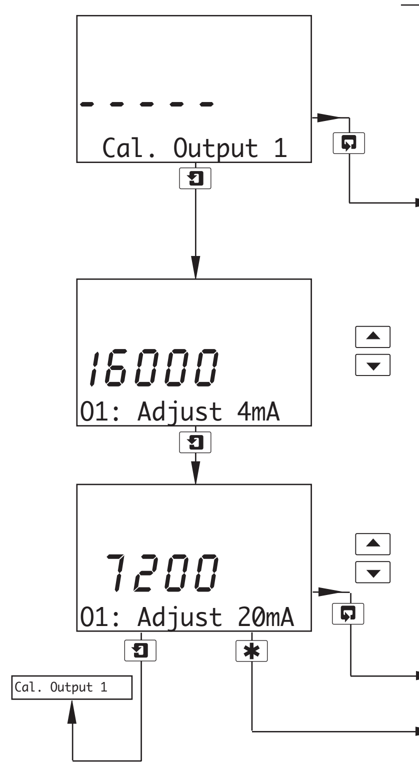
The display returns automatically to **Cal. Sensor A** once a stable and valid value is recorded.



Abort Calibration
Select Yes or No

Yes selected – the display returns to the **Calibrate Sensor A** page.
No selected – calibration continues.

…7.3 Factory Settings



Calibrate Output 1

Note. When adjusting the 4 and 20mA outputs, the display reading is unimportant and is used only to indicate that the output is changing when the ▲ and ▼ keys are pressed.

Cal. Output 2 – See below.

Adjust 4mA

Use the ▲ and ▼ keys to set the milliammeter reading to 4mA.

Note. The analog output range selected in **Configure Outputs** (see Section 5.5) does not affect the reading.

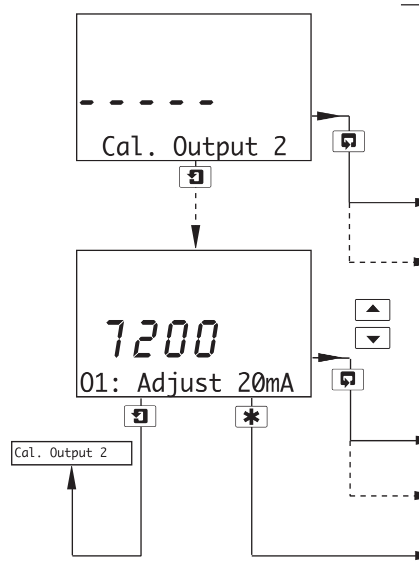
Adjust 20mA

Use the ▲ and ▼ keys to set the milliammeter reading to 20mA.

Note. The analog output range selected in **Configure Outputs** (see Section 5.5) does not affect the reading.

Cal. Output 2 – See below.

Dual Cond. – Return to **Operating Page**.



Calibrate Output 2

Note. Output 2 (and Outputs 3 and 4 if optional analog output board is fitted) calibration is identical to Output 1 calibration.

Cal. Output 3 – Optional analog output board fitted.

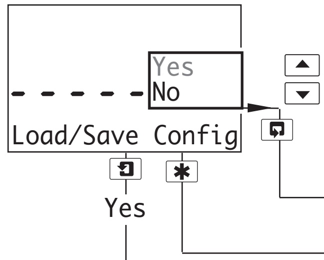
Load/Save Config – Optional analog output board not fitted – see page 44.

Cal. Output 3 – Optional analog output board fitted.

Load/Save Config – Optional analog output board not fitted – see page 44.

Dual Cond. – Return to **Operating Page**.

…7.3 Factory Settings



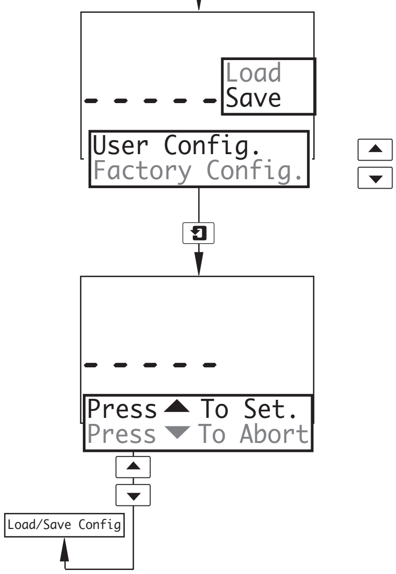
Load/Save Configuration

Select whether a configuration is to be loaded or saved.

Note. If **No** is selected, pressing the [enter] key has no effect.

`Alter Fact. Code` See below.

`Dual Cond.` Return to **Operating Page**.



Load User/Factory Configuration

Note. Applicable only if **Load/Save Config** is set to **Yes**.

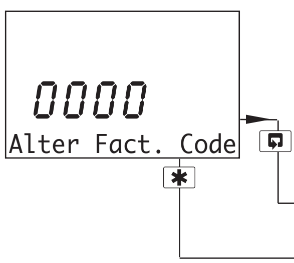
`Factory Config.`	–	resets all the parameters in the **Configuration Pages** to the Company Standard.
`Save User Config.`	–	saves the current configuration into memory.
`Load User Config.`	–	reads the saved user configuration into memory.

User Config. and **Factory Config.** are displayed alternately if a User Configuration has been saved previously. Use the ▲ and ▼ keys to make the required selection.

Note. **User Config.** is displayed only if a User Configuration has been saved previously.

Press ▲ to Set and **Press ▼ to Abort** are displayed alternately on the lower display line.

Press the appropriate key to load/save the configuration or abort the changes.



Alter Factory Code

Set the factory settings access code to a value between 0000 and 19999.

`FACTORY SETTINGS` Return to main menu.

`Dual Cond.` Return to **Operating Page**.

8 SIMPLE FAULT FINDING

8.1 Error Messages

If erroneous or unexpected results are obtained the fault may be indicated by an error message – see Table 8.1. However, some faults may cause problems with analyzer calibration or give discrepancies when compared with independent laboratory measurements.

Error Message	Possible Cause
A: FAULTY Pt100 A: FAULTY Pt1000	Temperature compensator/associated connections for Sensor A are either open circuit or short circuit.
B: FAULTY Pt100 B: FAULTY Pt1000	Temperature compensator/associated connections for Sensor B are either open circuit or short circuit.
BEFORE CAT. HIGH	The conductivity value before the cation exchange unit has exceeded 10µS/cm.
AFTER CAT. HIGH	The conductivity value after the cation exchange unit has exceeded the programmed limit.

Table 8.1 Error Messages

8.2 No Response to Conductivity Changes

The majority of problems are associated with the conductivity cell which must be cleaned as an initial check. It is also important that all program parameters have been set correctly and have not been **Alt**ered inadvertently – see Section 5.

If the above checks do not resolve the fault:

a) Check the analyzer responds to a resistance input. Disconnect the conductivity cell cable and connect a suitable resistance box directly to the analyzer input – see Section 6.4. Select the **CONFIG. SENSORS** page and and set **Temp.Comp.** to **None** – see Section 5.3. Check the analyzer displays the correct values as set on the resistance box – see Table 8.2 or use the expression:

$$R = \frac{K \times 10^6}{G}$$

Where: R = resistance
K = cell constant
G = conductivity

Failure to respond to the input indicates a fault with the analyzer which must be returned to the Company for repair. A response, but with incorrect readings, usually indicates an electrical calibration problem. Re-calibrate the analyzer as detailed in Section 7.3.

b) If the response in a) is correct, reconnect the conductivity cell cable and connect the resistance box to the cell end. Check the analyzer displays the correct values as set on the resistance box in this configuration.

If the analyzer passes check a) but fails check b), check the cable connections and condition. If the response for both checks is correct, replace the conductivity cell.

Conductivity µS cm^{-1} (G)	Cell Constant (K) 0.05	0.1	1.0
	Resistance (R)		
0.055	909.091kΩ	–	–
0.1	500kΩ	1MΩ	–
0.5	100kΩ	200kΩ	–
1	50kΩ	100kΩ	1MΩ
5	10kΩ	20kΩ	200kΩ
10	5kΩ	10kΩ	100kΩ
50	1kΩ	2kΩ	20kΩ
100	500Ω	1kΩ	10kΩ
500	100Ω	200Ω	2kΩ
1000	–	100Ω	1kΩ
5000	–	–	200Ω
10000	–	–	100Ω

Table 8.2 Conductivity Readings for Resistance Inputs

8.3 Checking the Temperature Input

Check the analyzer responds to a temperature input. Disconnect the Pt100/Pt1000 leads and connect a suitable resistance box directly to the analyzer inputs – see Section 6.4. Check the analyzer displays the correct values as set on the resistance box – see Table 8.3.

Incorrect readings usually indicate an electrical calibration problem. Re-calibrate the analyzer as detailed in Section 7.3.

Temperature °C	Input Resistance (Ω) Pt100	Pt1000
0	100.00	1000.00
10	103.90	1039.00
20	107.79	1077.90
25	109.73	1097.30
30	111.67	1116.70
40	115.54	1155.40
50	119.40	1194.00
60	123.24	1232.40
70	127.07	1270.70
80	130.89	1308.90
90	134.70	1347.00
100	138.50	1385.00
130.5	150.00	1500.00

Table 8.3 Temperature Readings for Resistance Inputs

APPENDIX A

A1 Automatic Temperature Compensation

The conductivities of electrolytic solutions are influenced considerably by temperature variations. Thus, when significant temperature fluctuations occur, it is general practice to correct automatically the measured, prevailing conductivity to the value that would apply if the solution temperature were 25°C, the internationally accepted standard.

Most commonplace, weak aqueous solutions have temperature coefficients of conductance of the order of 2% per °C (i.e. the conductivities of the solutions increase progressively by 2% per °C rise in temperature); at higher concentrations the coefficient tends to become less.

At low conductivity levels, approaching that of ultra-pure water, dissociation of the H_2O molecule takes place and it separates into the ions H^+ and OH^-. Since conduction occurs only in the presence of ions, there is a theoretical conductivity level for ultra-pure water which can be calculated mathematically. In practice, correlation between the calculated and actual measured conductivity of ultra-pure water is very good.

Fig. A1 shows the relationship between the theoretical conductivity for ultra-pure water and that of high purity water (ultra-pure water with a slight impurity), when plotted against temperature. The figure also illustrates how a small temperature variation considerably changes the conductivity. Subsequently, it is essential that this temperature effect is eliminated at conductivities approaching that of ultra-pure water, in order to ascertain whether a conductivity variation is due to a change in impurity level or in temperature.

For conductivity levels above 1µS cm^{-1}, the generally accepted expression relating conductivity and temperature is:

$$G_t = G_{25}\,[1 + \propto (t - 25)]$$

Where: G_t = conductivity at the temperature t°C

G_{25} = conductivity at the standard temperature (25°C)

$\propto$ = temperature coefficient per °C

At conductivities between 1µS cm^{-1} and 1,000µS cm^{-1}, $\propto$ lies generally between 0.015/°C and 0.025/°C. When making temperature compensated measurements, a conductivity analyzer must carry out the following computation to obtain G_{25}:

$$G_{25} = \frac{G_t}{[1 + \propto (t - 25)]}$$

However, for ultra-pure water conductivity measurement, this form of temperature compensation alone is unacceptable since considerable errors exist at temperatures other than 25°C.

At high purity water conductivity levels, the conductivity/temperature relationship is made up of two components: the first component, due to the impurities present, generally has a temperature coefficient of approximately 0.02/°C; and the second, which arises from the effect of the H^+ and OH^- ions, becomes predominant as the ultra-pure water level is approached.

Consequently, to achieve full automatic temperature compensation, the above two components must be compensated for separately according to the following expression:

$$G_{25} = \frac{G_t - G_{upw}}{[1 + \propto (t - 25)]} + 0.055$$

Where: G_t = conductivity at temperature t°C

G_{upw} = ultra-pure water conductivity at temperature t°C

$\propto$ = impurity temperature coefficient

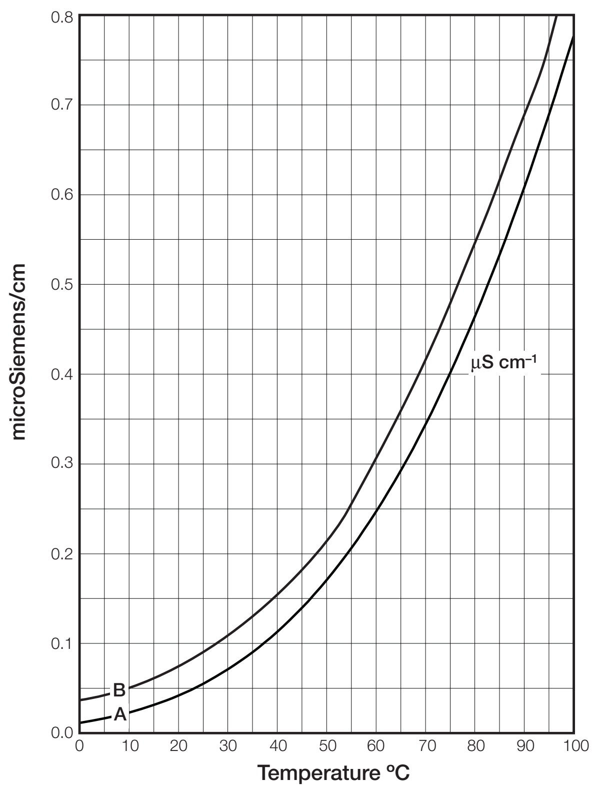
0.055 = conductivity in µS cm^{-1} of ultra-pure water at 25°C

The expression is simplified as follows:

$$G_{25} = \frac{G_{imp}}{[1 + \propto (t - 25)]} + 0.055$$

Where: G_{imp} = impurity conductivity at temperature t°C

The conductivity analyzer utilizes the computational ability of a microprocessor to achieve ultra-pure water temperature compensation using only a single platinum resistance thermometer and mathematically calculating the temperature compensation required to give the correct conductivity at the reference temperature.



Curve 'A' – Theoretical ultra pure water conductivity
Curve 'B' – High purity water conductivity (ultra pure water with slight impurity)

Fig. A.1 Ultra-pure Water Temperature Compensation

A1.1 Calculation of Temperature Coefficient

The temperature coefficient of a solution can be obtained experimentally by taking non-temperature compensated conductivity measurements at two temperatures and applying the following expression:

$$\propto = \frac{G_{t2} - G_{t1}}{G_{t1}(t_2 - 25) - G_{t2}(t_1 - 25)}$$

Where: G_{t2} = conductivity measurement at a temperature of t_2°C
G_{t1} = conductivity measurement at a temperature of t_1°C

One of these measurements could be made at the ambient temperature and the other obtained by heating the sample.

Temperature coefficient (%/°C) = ∝ x 100.

For ultra pure water applications the temperature compensation equation becomes,

$$\propto = \frac{G_{imp1} - G_{imp2}}{[G_{imp2}(t_1 - 25) - G_{imp1}(t_2 - 25)]}$$

Where: $G_{imp1} = G_{t1} - G_{upw1}$
$G_{imp2} = G_{t2} - G_{upw2}$

A2 Relationship Between Conductivity and Total Dissolved Solids (TDS) Measurement

The TDS factor (i.e. the relationship between conductivity (μS cm^{-1}) and TDS in p.p.m.) is totally dependent on the properties of the solution being measured.

In simple solutions where only one electrolyte is present, the conductivity/TDS ratio can easily be ascertained, e.g. 0.5 in the case of sodium chloride. However, in complex solutions where more than one electrolyte is present, the ratio is not easily calculated and can only be reliably determined by laboratory testing (e.g. precipitation and weighing). The ratio in these cases is found to vary between approximately 0.4 and 0.8, depending on the chemical constituents, and is constant only when the chemical ratios remain constant throughout a particular process.

In cases where the TDS factor cannot be determined easily, refer to the supplier of the particular chemical treatment being used.

A3 Inferred pH Derived from Differential Conductivity

Where cation resin columns are used to remove the effects on the conductivity measurement of alkaline and hydrazine chemical treatment on boilers, it is common practice to measure both before- (specific conductivity) and after-cation conductivity. The sensitivity of the conductivity measurement to chemical contaminants resulting from condenser leaks or poor boiler-feed make-up water is increased by passing the sample through the cation column. Both measurements can be made on one dual conductivity input analyzer.

If it is known that a sample contains only one impurity, e.g. ammonia, the conductivity measurement now becomes an indication of the concentration of that impurity. It is now possible to calculate the pH of the sample from the concentration data and the result is referred to as 'inferred pH'.

It is stressed that the inferred pH value is valid only if there are no other impurities present. To ensure this, the chemist looks at the after-cation conductivity (which is a sensitive method of detecting impurities in the sample) and only after establishing that it is low is the inferred pH value validated.

The dual input conductivity analyzer, when used to monitor direct and after-cation conductivities on a sample, automatically calculates the inferred pH for the most commonly used pH correction chemicals when programmed to do so. The user-configurable after-cation conductivity alarm is used to detect other impurities in the sample and can thus inform the user of the validity of the inferred pH value.

The maximum after-cation conductivity value is programmable between 0.060 and 1.000µS cm^{-1} dependent on local conditions. Values above this level generate an **AFTER CAT. HIGH** alarm and before-cation conductivity above 10.000µS cm^{-1} generates a **BEFORE CAT. HIGH** alarm.

> ✶ **Note.** Both conductivity inputs must be configured as µS cm^{-1} in order to calculate inferred pH.

The inferred pH feature can be used only in the following circumstances:

a) On steam raising plant.

b) For boiler chemical treatment such as ammonia, sodium hydroxide, and/or hydrazine. For this application, either **NH3** or **NaOH** temperature compensation must be selected – see Section 7.3.

> ✶ **Note.** Inferred pH measurement is inappropriate to chemical treatments such as phosphate, morpholine and quinhydrone.

c) Where the after-cation conductivity value is an insignificant value to the before-cation value, or is greater than 1.0µS cm^{-1}.

SPECIFICATION

Conductivity

Range
Programmable 0 to 0.5 to 0 to 10000µS/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 (10,000µS/cm)

Operating temperature range
–10 to 150°C (14 to 302°F)

Temperature compensation
–10 to 150°C (14 to 302°F)

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

Temperature sensor
Programmable Pt100 /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 (with option board)
Electronic record of major process events and calibration data

Real-time clock (with option board)
Records time for logbook and auto-manual functions

pH /Redox (ORP)

Inputs
1 or 2* pH or mV inputs and solution earth

1 or 2* temperature sensors

Enables connection to glass or enamel pH and reference sensors and Redox (ORP) sensors

*AX466 only

Input resistance
Glass > 1 x $10^{13}\Omega$

Reference 1 x $10^{13}\Omega$

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 150°C (14 to 302°F)

Process solution compensation with configurable coefficient
Range 0 to 100°C (32 to 212°F)

Temperature sensor
Programmable Pt100, Pt1000 & 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 or 2-point calibration or one-point process calibration

Set Points, Relays and Outputs

Number of set points
3 supplied as standard or 5 with option card fitted

Number of relays*
2 supplied as standard or 4 with option card fitted

Number of analog outputs* (fully isolated)
2 supplied as standard or 4 with option card fitted

Relay Outputs – On/Off

Number of relays
3 supplied as standard

5 with option card fitted

Set point adjustment
Fully 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

* For AX460 PID versions the control output can be assigned a max. of 2 relays, 2 analog outputs or 1 of each

Analog Outputs

Number of outputs (fully isolated)
2 outputs supplied as standard

4 outputs with option card fitted

Output current
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, ±5% of reading

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

Serial communications
Modbus serial data interface

Access to Functions

Direct keypad access
Measurement, maintenance, configuration, diagnostics or 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, fully configurable

Duration
15s to 10 minutes, fully configurable

Recovery period
30s to 5 minutes, fully configurable

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

N. 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
<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

CENELEC 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

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NOTES

PRODUCTS & CUSTOMER SUPPORT

Products

Automation Systems

- *for the following industries:*
  - Chemical & Pharmaceutical
  - Food & Beverage
  - Manufacturing
  - Metals and Minerals
  - Oil, Gas & Petrochemical
  - Pulp and Paper

Drives and Motors

- *AC and DC Drives, AC and DC Machines, AC motors to 1kV*
- *Drive systems*
- *Force Measurement*
- *Servo Drives*

Controllers & Recorders

- *Single and Multi-loop Controllers*
- *Circular Chart , Strip Chart and Paperless Recorders*
- *Paperless Recorders*
- *Process Indicators*

Flexible Automation

- *Industrial Robots and Robot Systems*

Flow Measurement

- *Electromagnetic Magnetic Flowmeters*
- *Mass Flow Meters*
- *Turbine Flowmeters*
- *Wedge Flow Elements*

Marine Systems & Turbochargers

- *Electrical Systems*
- *Marine Equipment*
- *Offshore Retrofit and Referbishment*

Process Analytics

- *Process Gas Analysis*
- *Systems Integration*

Transmitters

- *Pressure*
- *Temperature*
- *Level*
- *Interface Modules*

Valves, Actuators and Positioners

- *Control Valves*
- *Actuators*
- *Positioners*

Water, Gas & Industrial Analytics Instrumentation

- *pH, conductivity, and dissolved oxygen transmitters and sensors*
- *ammonia, nitrate, phosphate, silica, sodium, chloride, fluoride, dissolved oxygen and hydrazine analyzers.*
- *Zirconia oxygen analyzers, katharometers, hydrogen purity and purge-gas monitors, thermal conductivity.*

Customer Support

We provide a comprehensive after sales service via a Worldwide Service Organization. Contact one of the following offices for details on your nearest Service and Repair Centre.

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United States of America

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Fax: +1 (0) 755 883 4373

Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification. Periodic checks must be made on the equipment's condition.

In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of operating and maintenance records relating to the alleged faulty unit.

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