



## 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 UKAS 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.

EN ISO 9001:2000



Cert. No. Q 05907

EN 29001 (ISO 9001)



Lenno, Italy – Cert. No. 9/90A

Stonehouse, U.K.



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 Technical Publications 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.

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# 1 Safety

## 1.1 Operator Liability

Before using this equipment in corrosive or abrasive environments, or with corrosive or abrasive fluids, the operator must verify that the materials of manufacture are suitable for the application. If requested, ABB will assist in this assessment but will not accept liability for the selection of materials.

Operators must observe all applicable national and plant regulations with regard to installation, testing and repair of this equipment.

## 1.2 Personnel

This equipment must be installed, commissioned and maintained by trained personnel who are authorized by the plant operator. These personnel must have read and understood this manual and must comply with its instructions.

## 1.3 Transport and Storage

Care must be taken during transportation of the device to ensure that it is not damaged. Special care must be taken to avoid excessive vibration and physical shock.

The equipment must not be transported or stored in such a way that it becomes contaminated by moisture or other potentially damaging contaminants.

Check the equipment thoroughly after transportation and storage and before installation. Any damage must be reported to the supplier or the shipper before installation.

## 1.4 Electrical Installation

Electrical installation must be performed only by authorized and competent personnel. Careful observation of the electrical connection information supplied in this manual is required before commencing installation.

## 2 Design and Function

### 2.1 General

ABB supply complete thermometer assemblies ready for immediate installation into the plant. ABB also supply spare parts and temperature accessories.

On receipt of a thermometer assembly, unpack it and check that all the ordered items and documentation are available before installation.

Take care to ensure that thermometer assembly is not damaged by rough or careless handling.

### 2.2 Thermocouples

Where thermocouples are supplied without a local transmitter, the thermocouple and the measuring circuit must be connected using suitable compensating cable. This cable must be of the correct type for the thermocouple and be connected with the correct polarity.

Route cables at least 500 mm (19.7 in.) away from power cables, preferably in a specifically designated signal tray. Twisted and shielded cables prevent unwanted signal interference.

Thermocouple signals may be isolated or the negative pole may be earthed at the measurement end. It is important to know which of these is the case when considering the likelihood of earth loops in the signal system. Typically, thermocouple systems are supplied isolated unless an earthed system is requested.

### 2.3 Resistance Thermometers

Where a resistance thermometer is supplied without a local transmitter, the thermometer and the measuring circuit must be connected using standard instrumentation cable of no less than 1.5 mm<sup>2</sup> (0.06 in<sup>2</sup>). Use a 4-wire circuit to eliminate the resistive effects of the connecting cables. Where a 4-wire circuit is impractical, a 3-wire circuit may be used with some (unpredictable) degradation in system accuracy.

Route cables at least 500 mm (19.7 in.) away from power cables, preferably in a specifically designated signal tray. Twisted and shielded cables prevent unwanted signal interference.

Ensure that the circuit current is kept as low as possible (typically 0.1 to 1 mA) to prevent self heating of the system.

### 2.4 Thermometer with Head-mounted Transmitter

Many of the potential problems detailed above can be avoided by using a head-mounted transmitter. This device converts the raw temperature signal into an industry-standard plant instrumentation signal as close to the point of measurement as is practically possible. Observe the following precautions when using these systems.

- Head temperature must not exceed the maximum operating temperature for the transmitter.
- Supply voltage must be within the limits specified for the transmitter.
- Output signal protection must be in accordance with the industry and plant standards for the signal type.

### 3 Installation

#### 3.1 Thermal Conduction Errors

A potential exists for error in the reading of the medium under test where there is a large thermal gradient between the medium and the external environment. Conduction of heat along a thermowell can produce a significant offset in the temperature experienced at the sensor. To avoid this, the thermowell must be 6 to 8 times longer than its tip diameter for use in liquids, and 10 to 15 times longer than its tip diameter for gases. In small-bore pipelines, install the equipment as shown in Fig. 3.1.

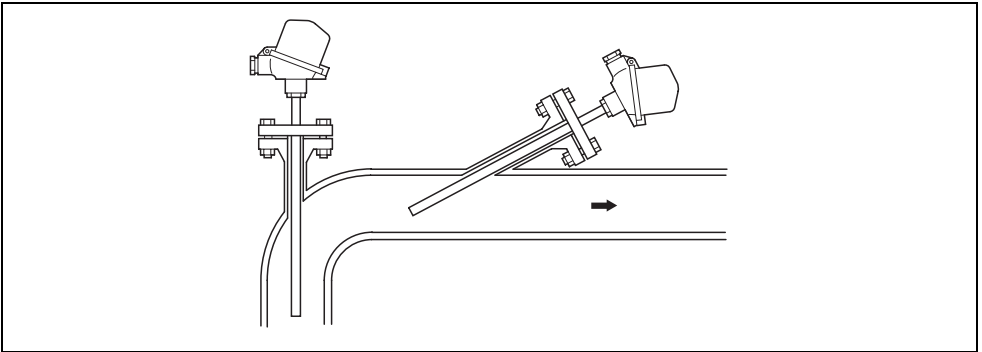


Fig. 3.1 Installation in Small-bore Pipelines

#### 3.2 Preferred Installation Position

When measuring temperatures of fluids flowing in pipelines, best results are obtained when the measuring tip is positioned within the middle third of the pipeline – see Fig. 3.2. This should be regarded as best practice but is less important when installing the equipment in a heavily lagged pipeline.

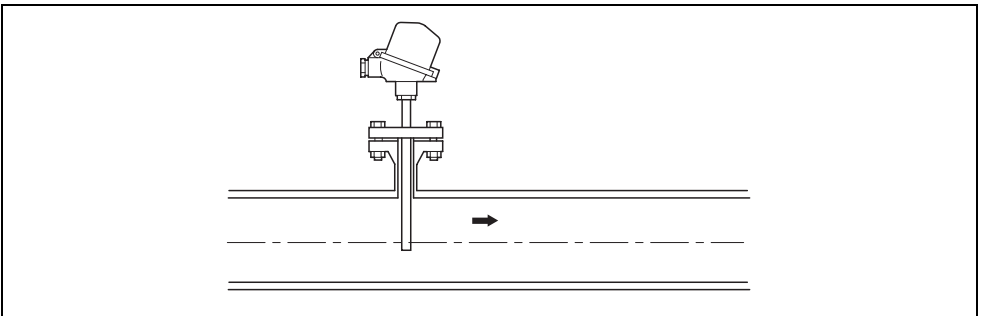


Fig. 3.2 Preferred Installation Position

### 3.3 Cable Connections – Table 3.1

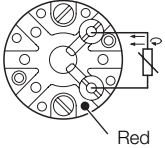
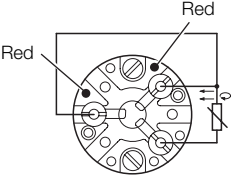
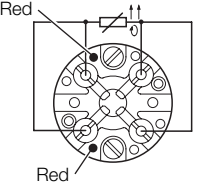
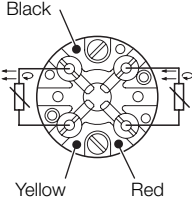
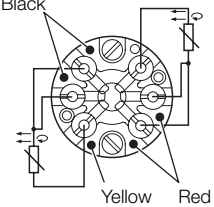
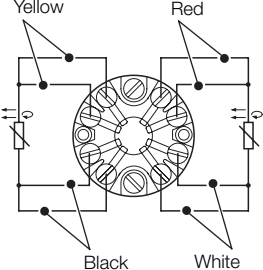
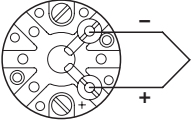
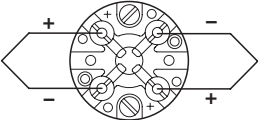
In accordance with EN60751 (IEC60751)		
Single		
<p><b>2-wire Circuit</b></p> 	<p><b>3-wire Circuit</b></p> 	<p><b>4-wire Circuit</b></p> 
Dual		
<p><b>2-wire Circuit</b></p> 	<p><b>3-wire Circuit</b></p> 	<p><b>4-wire Circuit</b></p> 
In accordance with EN60584		
<p><b>Single</b></p> 	<p><b>Dual</b></p> 	

Table 3.1 Thermometer Connections for Resistance Thermometers and Thermocouple Thermometers.

Where a head-mounted transmitter has been supplied, refer to the documentation supplied for that device.



### **3.4 Ceramic Thermowells**

Where a ceramic thermowell has been supplied for high temperature service, take special care to protect it from physical and thermal shock.

### **3.5 Thermowell Installation**

To prevent failure of the seal and leakage of process fluid when fitting thermowells to the plant, it is important to ensure that the correct nuts, bolts, studs and gaskets are used and that threads are tightened appropriately.

### **3.6 Use of Thermowells Under Changed Process Conditions**

Where an existing thermowell is to be used in a modified process or process conditions, take care to ensure that it is still suitable for the new service. Pay particular attention to the following:

- Corrosion and erosion resistance
- Temperature limitations
- Process connection rating and condition
- Wake frequency

### **3.7 Thermowells with Velocity Collars**

Velocity collars are used to shorten the unsupported length of the stem of a thermowell, thus changing its resonance frequency. To ensure the correct operation of a thermowell fitted with a velocity collar, a good fit between the collar and the wall of the fitting is essential. Therefore, machining of the standoff to achieve a tight sliding fit between the standoff wall and the velocity collar is required. Contact ABB for advice if there are any doubts regarding acceptable tolerances.

## **4 Maintenance**

### **4.1 Regular Inspection**

Inspect the equipment regularly for signs of wear and leakage. Electrical connections must be inspected for corrosion and loosening of connections due to vibration. External protection housings must be inspected for signs of corrosion that could lead to leakage.

### **4.2 Measurement Checking**

The best way to check the accuracy of a thermometer system is to remove it from service and check its operation in a calibration laboratory. If this is not possible, use a hand-held laboratory device to check the temperature seen by the thermometer system in situ.

Use plant standard signal sources to check the signal path from the thermometer to the rest of the plant.

Where a signal appears to operate correctly at the sensor but gives a false reading at the measuring system, ensure that no ground loops exist. Ground loops are eliminated either by completely isolating the system from ground or by ensuring that it is grounded in one place only.

Where an error occurs at installation or re-installation, ensure that the polarity and cable type are correct for the installation.

Where an error occurs over time during operation, check for ingress of moisture and/or other contaminants and check the mechanical state of cable connections.

## Appendix A Hazardous Areas

This Appendix contains important safety information regarding thermometers and thermocouples designed for use in hazardous areas according to EU-directive 94/9 EC (ATEX 100a).

### A.1 Designation

- Ex d
  - Resistance temperature detectors (RTD) and thermocouples (TC) provided with AG Series connection heads.
  - AG Series field housings.
- Ex n
  - Resistance temperature detectors (RTD) and thermocouples (TC) provided with connection heads.
  - Field housings.

### A.2 Additional Ex Marking

RTD and TC with appropriate thermowells or protection tubes for temperature measurement within group II category 2 (Ex d) or group II category 3 (Ex n).

Other RTD and TC as well as field housings.

## **A.3 Range of Application**

### **A.3.1 Category**

Series Ex d RTD, TC and field housings are devices of group II, category 2 as defined by EU directive 94/9/EC (ATEX 100a).

Series EEx de RTD, TC and field housings are devices of group II, category 2 as defined by EU directive 94/9/EC (ATEX 100a).

Series Ex n RTD, TC and field housings are devices of group II, category 3 as defined by EU directive 94/9/EC (ATEX 100a.).

### **A.3.2 Groups**

Ex d devices are certified Baseefa 04 ATEX 0033X for use in potentially explosive atmospheres of group II as defined by EN 50014:1997 and EN 50018:1994.

EEx de devices are certified Baseefa 03 ATEX 0124X for use in potentially explosive atmospheres of group II as defined by EN 50014:1997 and EN 50018:1994.

Ex n devices are certified Baseefa 03 ATEX 0126X for use in potentially explosive atmospheres of group II as defined by EN 50021:1999.

### **A.3.3 Temperature Class**

Ex d and Ex n devices are marked with temperature class T6. Higher operating temperatures are possible in case of potentially explosive and atmospheres permissible for temperature class T5 or T4. Operating temperatures are defined in Appendix A.9.

EEx de devices are marked with temperature class T6 and for use in ambient temperatures between -20 and 40 °C (-4 and 104 °F).

TR04, TS02, TR01 And TH02 transmitters are certified for use in temperature classes up to T1 only, where this does not affect the temperature rating of other components.

### **A.3.4 Special Conditions for Safe Use – Ex d Devices**

All connection heads suffixed /G must be provided with an internal earth.

### **A.3.5 Special Conditions for Safe Use – Ex n Devices**

All replacement RTD and TC temperature insets must be fitted with transient voltage suppression devices of the type P6KE-30A or equivalent, with a maximum breakdown voltage of 31.5 V and a peak pulse current rating of 9.0 A minimum at 85 °C (185 °F).

Connection heads types HYP and H9 must be protected from exposure to ultra violet light.

### **A.3.6 Installation**

The general requirements for planning, selection and installation of electrical equipment within potentially explosive atmospheres detailed in EN 60079-14 must be complied with.

## A.4 Assembling RTD and TC with Connection Head

For thermowells or protection and extension tubes to be installed in category 2 or 3 applications:

1. Assemble appropriate Thermowells or protection tubes for the separation of zones.
2. Use seals with appropriate temperature, pressure and corrosion resistance as necessary.
3. Prevent raising of temperature due to heat flow or heat accumulation (for example, by allowing sufficient distance between the RTD/TC and hotter components, by fitting thermal insulation or by enabling heat dissipation by allowing sufficient air circulation).

### A.4.1 Measuring Insets

Use only approved ABB measuring insets with appropriate diameter for the corresponding bore of the connection head.

### A.4.2 Cable Glands

Use only approved cable glands of the correct protection type:

- Observe certification and installation instructions of the cable glands.
- Check threads for damage and apply a suitable threadlocking compound (for example, Loctite 273) before fitting.

**Note.** The use of threadlocking compound is not necessary on NPT threads.

- Ensure cable to be used is suitable (correct type, outside diameter, etc.).
- Tighten cable gland until the cable is secured firmly and sealed by the sealing ring. **Do not overtighten.**
- Use suitable installation measures to protect cable against mechanical loads (tension, torsion, etc.).
- Blank-off all unused cable entry holes with certified plugs.

### A.4.3 Grounding Terminals

Additional grounding connections are not required in the case of a reliable electrical contact to grounded conductive tubing systems or other grounded conductive supporting systems (for example, via a metallic mounting plate).

### A.4.4 Electrical Components

Assemble electrical components with assembling sets (if required).

Connect electrical components according to the relevant operating instructions.

### A.4.5 Cover

Check threads for damage and screw the cover on by hand until the O-ring seal is compressed. Secure the cover with the locking screw.

**Note.** Do not use tools to tighten the cover. Hexagons and recesses are opening aids only.

## A.5 Assembling Field Housings AGLF, AGLFH, AGLFD and TB10

### A.5.1 Installation

Install field housings permanently to fixed walls, supports or pipework.

### A.5.2 Cable Glands

Use only approved cable glands of the proper protection type:

- Observe certification and installation instructions of the cable glands.
- Check threads for damage and apply a suitable threadlocking compound (for example, Loctite 273) before fitting.

**Note.** The use of threadlocking compound is not necessary on NPT threads.

- Ensure cable to be used is suitable (correct type, outside diameter, etc.).
- Tighten cable gland until the cable is secured firmly and sealed by the sealing ring. **Do not overtighten.**
- Use suitable installation measures to protect cable against mechanical loads (tension, torsion, etc.).
- Blank-off all unused cable entry holes with certified plugs.

### A.5.3 Grounding Terminals

Additional grounding connections are not required in the case of a reliable electrical contact to grounded conductive tubing systems or other grounded conductive supporting systems (e.g. via a metallic mounting plate).

### A.5.4 Electrical Components

Assemble electrical components with assembling sets (if required)

Connect electrical components according to the relevant operating instructions

### A.5.5 Cover

Check threads for damage and screw the cover on by hand until the O-ring seal is compressed. Secure the cover with the locking screw.

**Note.** Do not use tools to tighten the cover. Hexagons and recesses are opening aids only.

## A.6 Dismantling

Do not open cover when electrical circuits are energized. Allow sufficient time for discharge and cooling before opening cover (this depends on operating conditions, malfunction, etc.).

## A.7 Initial Operation

Before initial operation, ensure that:

- Thermowells and protection tubes are assembled correctly and secure.
- All required components at the connection head or field housing according to all requirements relevant for hazardous area protection (measuring inset, cable gland, cable, cover, etc.) are assembled correctly and secure.
- Grounding terminal is correctly connected (if required).

## A.8 Maintenance And Trouble Shooting

The following measures ensure correct operation of the RTD/TC

- Check enclosures, cables, cable glands, grounding connections, etc. for damage and wear in a regular manner, depending on expected operation stresses.

**Warning.** Disconnect and stop operation immediately if any defect is found that compromises any flameproof relevant feature (for example, enclosure, cable, cable glands, grounding connections, etc.). Do not start operation until safe operating conditions are restored.

- Replace damaged or worn components with approved ABB spare parts only (especially insets, transmitters, displays and seals).
- Do not carry out any unauthorized repair work on any part of the flameproof enclosure.
- Check pressure-loaded components (thermowells, protection tubes, flanges etc.) during routine pressure testing.

## A.9 Specification

### Electrical power limitations

#### Ex d measuring inset with transmitter

Max. supply voltage	29.4 V DC
Max. thermal / electrical power	P <sub>max</sub> determined according to Table A.1, page 15 (overall power consumption of all electrical components)
Max. supply current	$I_{\text{max}} = P_{\text{max}} / V_{\text{max}}$
Fuse rated current	$\leq I_{\text{max}} / 1.7$
Max. number of transmitters per assembly	2

#### EEx de devices

Max. supply voltage	4 V DC
Max. RTD measuring current	<2 mA per sensor element
Max. TC output voltage	<100 mV per sensor element

#### Ex n transmitter with or without indicator

Max. supply voltage	29.4 V DC
Max. thermal / electrical power	P <sub>max</sub> determined according to Table A.1 page 15 (overall power consumption of all electrical components)
Max. supply current	$I_{\text{max}} = P_{\text{max}} / V_{\text{max}}$
Fuse rated current	$\leq I_{\text{max}} / 1.7$
Max. number of transmitters per assembly	4

#### Ex d and Ex n measuring inset without transmitter

Max. supply voltage	10 V DC
Max. RTD measuring current	<2 mA per sensor element
Max. TC output voltage	<100 mV per sensor element
Max. supply current	$I_{\text{max}} = P_{\text{max}} / V_{\text{max}}$
Max. number of transmitters per assembly ( <b>Ex n Only</b> )	4



**Operating temperature range**

**Ex d RTDs and TCs**

Min. operating temperature	-35 °C (-31 °F)
Max. operating temperature (connection heads AGL, AGS, AGLH, AGH, AGLHD, AGFHD, AGSH within Category 2)	See Table A.1
Extension tube within Category 2	See Table A.1

**Ex n RTDs and TCs**

Min. operating temperature	-20 °C (-4 °F)
Max. operating temperature (connection heads AGL, AGS, AGLH, AGH, AGLHD, AGFHD, AGSH, KNE, HYP, KI, H3, H4, H6 and H9 within Category 3)	See Table A.1
Extension tube within Category 3	See Table A.1

**Ex d Field Housings AGLF, AGLFH, AGLFD, AGSF, AGSFD, AGSFH within Category 2**

Min. operating temperature	-35 °C (-31 °F)
Max. operating temperature	See Table A.2

Max Power (W)	Maximum Ambient Temperature – °C (°F)				
	0 (0 TX)	2 (1 TX)	4 (2 TX)	6 (3 TX)	8 (4 TX)
T4	95 (203)	95 (203)	89 (192)	83 (181)	79 (174)
T5	95 (203)	91 (196)	86 (187)	81 (178)	77 (171)
T6	80 (176)	76 (169)	71 (160)	66 (151)	62 (144)

Table A.1 Maximum Permissible Operating Temperatures of Connection Heads (including extension tubes, thermowells, protection tubes, assembling sets etc. with direct thermal contact).

Max Power (W)	Maximum Ambient Temperature – °C (°F)				
	0 (0 TX)	2 (1 TX)	4 (2 TX)	6 (3 TX)	8 (4 TX)
T4	130 (266)	126 (259)	121 (250)	116 (241)	112 (234)
T5	95 (203)	91 (196)	86 (187)	81 (178)	77 (171)
T6	80 (176)	76 (169)	71 (160)	66 (151)	62 (144)

Table A.2 Maximum Permissible Operating Temperatures of Field Housings (including extension tubes, thermowells, protection tubes, assembling sets etc. with direct thermal contact).

**Ex n Field Housings AGLF, AGLFH, AGLFD, AGSF, AGSFD, AGSFH and TB Series (10–14) within zone 2**

Min. operating temperature	–20 °C (–4 °F)
Max. operating temperature	See Table A.3

Max Power (W)	2 (1 TX)	4 (2 TX)	6 (3 TX)	8 (4 TX)
Resulting temperature rise (°K) (including 5 °K safety margin)	12	19	26	33
Temperature Class T6 limit – °C (°F)	73 (163)	66 (151)	59 (138)	52 (126)

*Table A.3 Maximum Permissible Operating Temperatures of Connection Heads and Field Housings (Including Extension Tubes, Thermowells, Protection Tubes, Assembling Sets etc. With Direct Thermal Contact).*

**Temperature measurement**

Use appropriate thermowells or protection tubes for temperature measuring within category 2 for Ex d devices and within category 3 for Ex n devices.

**Physical Requirements****Minimum bend radius (EEx de devices only)**

6 x stem diameter

**or**

4 x stem diameter provided bending is accomplished over a mandrel in one set without straightening.

**Minimum wall thickness**

- 3 mm in the case of thermowells or protection tubes made of stainless steel (according to DIN 17440) or made of non-corrosive nickel alloys (according to DIN 17742).
- 3 mm in the case of thermowells or protection tubes made of other steels.

**Design**

Specified material and dimensions of thermowells and protection tubes must be sufficient to resist permanently all operating loads with sufficient safety margins (temperature, pressure, flow-induced bending stress and vibration, corrosion etc.).

**Testing**

Thermowells and protection tubes must be pressure tested at 1.5 times the nominal pressure.

# 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 and Strip Chart Recorders
- Paperless Recorders
- Process Indicators

### Flexible Automation

- Industrial Robots and Robot Systems

### Flow Measurement

- Electromagnetic Flowmeters
- Mass Flowmeters
- Turbine Flowmeters
- Wedge Flow Elements

### Marine Systems & Turbochargers

- Electrical Systems
- Marine Equipment
- Offshore Retrofit and Refurbishment

### 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.

### United Kingdom

ABB Limited  
Tel: +44 (0)1946 830 611  
Fax: +44 (0)1946 832 661

### United States of America

ABB Inc.  
Tel: +1 215 674 6000  
Fax: +1 215 674 7183

#### 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 all storage, installation, operating and maintenance records relating to the alleged faulty unit.

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Printed in UK (02.09)

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