Endura APA592

pH / Redox (ORP) transmitter

Rugged design transmitter for industrial applications

Measurement made easy

Introduction

This transmitter is intended for the following uses:

- pH measurement
- ORP or pION measurement
- Ion Concentration measurement

The APA592 transmitter is fully compatible with ABB's full range of glass, antimony and redox (ORP) electrodes. In addition, this transmitter is compatible with many competitor sensor inputs. The APA592 has automatic temperature sensor recognition for both 2 and 3-wire RTD inputs for common inputs such as Pt100, Pt1000 and 3k Balco.

APA592 transmitters are communication-ready field devices with microprocessor-controlled electronics. For bidirectional communication, an FSK signal is superimposed on the 4 to 20 mA output signal via the HART protocol.

The graphical user interface (DTM) can be used to configure, poll and test transmitters on a PC-specific basis. Handheld terminals such as the DHH801 also support communication.

The transmitter is equipped with an LCD display used to show the current process data. The four keys beneath the display enable the transmitter to be configured locally.

For more information

Further publications for the Endura APA592 pH / Redox (ORP) transmitter are available for free download from:

www.abb.com/analytical

See links and reference numbers below or scan this code:

Description	Search for or click on
Data Sheet Endura APA592 pH / RRedox (ORP) transmitter	DS/APA592-EN
Addendum RoHS Directive 2011/65/EU (RoHS II)	ADD/MEASUREMENT/001-EN

Contents

1 Safety

Warning.

- System configuration must be carried out only by users or personnel with approved access rights (user privileges).
- Read all relevant sections of this guide before configuring the system or modifying system parameters.
- Install and use this equipment as detailed in this guide. Install and use associated equipment in accordance with the relevant national and local standards. Installation and repair must only be carried out by the manufacturer, authorized agents or persons conversant with the construction standards for hazardous area certified equipment.

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.

1.1 Technical Limits

The transmitter is designed for use exclusively within the stated values on the name plate and in the technical specifications (see Specifications, page 90). These must be complied with accordingly.

- Do not exceed the maximum / permitted operating temperature.
- Observe the housing protection system.

1.2 Operator Liability

When measuring corrosive and abrasive materials, the operator must examine the resistance of all parts that come into contact with the process being measured. ABB will assist with the selection but cannot, however, accept any liability.

Operators must strictly observe the national regulations applicable in their countries with regards to installation, functional tests, repairs and maintenance of electrical devices.

1.2.1 Operating Safety Information

Before switching on, ensure that the specified environmental conditions in the Specifications section (page 90) are complied with and that the power supply voltage corresponds with the voltage of the transmitter.

When there is a chance that safe operation is no longer possible, put the transmitter out of operation and secure against unintended operation.

1.2.2 Special Conditions of Use (FM Approval)

The APA592–pH transmitter is approved for connection to:

- ABB pH / ORP / ISE sensor types:

TB551	TBX557	TBX562	AP10	765
TBX551	TB561	TB564	AP20	766
TB556	TBX561	TBX564	AP30	767
TB557	TB562	TBX567	2867	

- Simple apparatus – passive devices that do not contain energy-storing components and do not generate more than 1.5 V, 100 mA or 25 mW.
- FM-approved I.S. devices with entity parameters. Such devices must be connected in accordance with their manufacturers' instructions.

1.3 Health & Safety

Health and Safety

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

- The relevant sections of these instructions must be read carefully before proceeding.
- Warning labels on containers and packages must be observed.
- Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
- Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and / or temperature.

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

1.4 Electrical Safety – IEC / EN 61010-1

This equipment complies with the requirements of IEC / EN 61010-1 'Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use' and complies with applicable electrical codes NEC and CEC.

If the equipment is used in a manner NOT specified by the Company, the protection provided by the equipment may be impaired.

1.4.1 Electrical Installation Safety Information

Electrical connection may be performed only by authorized personnel according to the electrical codes of the country of destination.

Observe the electrical connection information in this publication. Failure to do so may affect the electrical protection of the transmitter.

The secure isolation of contact-dangerous electrical circuits is guaranteed only when the connected devices fulfil the requirements of the applicable electrical codes, or DIN VDE 0106 T.101 (basic requirements for secure isolation ['VDE' may not be applicable for NAM]).

For secure isolation, route the process supply lines separately from electrical circuits or additionally isolate them.

1.5 Symbols – EN / IEC 61010-1

One or more of the following symbols may appear on the equipment labelling:

	Protective earth (ground) terminal.
	Functional earth (ground) terminal.
	Direct current supply only.
	Alternating current supply only.
	Both direct and alternating current supply.
	The equipment is protected through double insulation.
	This symbol, when noted on a product, indicates a potential hazard which could cause serious personal injury and / or death. The user should reference this instruction manual for operation and / or safety information.
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and / or electrocution exists and indicates that only individuals qualified to work with hazardous voltages should open the enclosure or remove the barrier.
	This symbol indicates that the marked item can be hot and should not be touched without care.
	This symbol indicates the presence of devices sensitive to electrostatic discharge and indicates that care must be taken to prevent damage to them.
	This symbol identifies a risk of chemical harm and indicates that only individuals qualified and trained to work with chemicals should handle chemicals or perform maintenance on chemical delivery systems associated with the equipment.
	This symbol indicates the need for protective eye wear.

	This symbol indicates the need for protective hand wear.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems. In conformity with European local and national regulations, European electrical equipment users must now return old or end-of-life equipment directly to a specialized recycling facility.
	Products marked with this symbol indicates that the product contains toxic or hazardous substances or elements. The number inside the symbol indicates the environmental protection use period in years.

1.6 Product Recycling Information

	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 13 August 2012. In conformity with European local and national regulations (EU Directive 2012/19/EU), European electrical equipment users must now return old or end-of-life equipment directly to a specialized recycling facility.

Note. If it is not possible to dispose of old equipment properly, please contact the equipment manufacturer or supplier for instructions on how to return end-of-life equipment for proper disposal.

1.7 Product Disposal

ABB, Inc. actively promotes environmental consciousness and has an operational management system in accordance with DIN EN ISO 9001, EN ISO 14001 and OHSAS 18001. Our products and solutions should have minimum impact on the environment and persons during manufacture, storage, transport, use and disposal. This includes the environmentally friendly use of natural resources. Through its publications ABB conducts an open dialog with the public.

The APA592-pH transmitter is manufactured from materials that can be reused by specialized recycling companies.

Note. The following applies only to European customers.

ABB is committed to ensuring that the risk of any environmental damage or pollution caused by any of its products is minimized as far as possible. The European Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU) that came into force on 13 August 2012 aims to reduce the waste arising from electrical and electronic equipment; and improve the environmental performance of all those involved in the life cycle of electrical and electronic equipment.

In conformity with European local and national regulations (EU Directive 2012/19/EU stated above), electrical equipment marked with the above symbol may not be disposed of in European public disposal systems after 13 August 2012.

1.7.1 Information on WEEE Directive (Waste Electrical and Electronic Equipment)

This product is subjected to the WEEE directive and relevant national laws (for example, ElektroG in Germany).

Dispose of the APA592-pH transmitter directly in a specialized recycling facility. **Do not** use municipal garbage. Only privately used products may be disposed of in municipal garbage according to the WEEE directive. Proper disposal prevents negative effects on people and the environment, and supports the reuse of valuable raw materials.

If it is not possible to dispose of old equipment properly, please contact the equipment manufacturer or supplier for instructions on how to return end-of-life equipment for proper disposal.

1.8 Returning Transmitters

Use the original packaging or suitably secure packaging for returning the transmitter for repair or recalibration. Contact the local ABB office or sales representative for return authorization number and address.

All transmitters returned for service or repair to ABB must be free from any hazardous materials (acids, alkali, solvents, etc.).

1.8.1 Transport Safety Information

Observe the following information:

- Do not expose the transmitter to moisture during transport. Pack the transmitter accordingly.
- Pack the transmitter so that it is protected from vibration during transport, e.g. through air-cushioned packaging.

Check the transmitter for possible damage that may have occurred from improper transport. Damages in transit must be recorded on the transport documents. All claims for damages must be claimed against the shipper and before the installation.

1.9 Restriction of Hazardous Substances (RoHS)

RoHS	The European Union RoHS Directive and subsequent regulations introduced in member states and other countries limits the use of hazardous substances used in the manufacturing of electrical and electronic equipment. ABB has made the decision to adopt the recommendations in the Directive as the target for all product design and component purchasing.

1.10 Safety Precautions

Please read the entire manual before unpacking, setting up, or operating this instrument.

Pay particular attention to all warning and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

1.11 Safety Conventions

Warning. Indicates a condition which, if not met, could cause serious personal injury and / or death. Do not move beyond a warning until all conditions have been met.

If a warning sign appears on the instrument itself, refer to Precautionary Labels – product certification and Electrical Safety – EN / IEC 61010-1 for an explanation.

Caution. Indicates a condition which, if not met, could cause minor or moderate personal injury and / or damage to the equipment. Do not move beyond a caution until all conditions have been met.

Note. Indicates important information or instructions that should be considered before operating the equipment.

1.12 Safety Recommendations

For safe operation, it is imperative that these service instructions be read before use and that the safety recommendations mentioned herein be scrupulously respected. If danger warnings are not heeded to, serious material or bodily injury could occur.

1.13 Service and Repairs

Other than the serviceable items listed in Section 11, page 95, none of the transmitter's components can be serviced by the user. Only personnel from ABB or its approved representative(s) is (are) authorized to attempt repairs to the system and only components formally approved by the manufacturer should be used. Any attempt at repairing the instrument in contravention of these principles could cause damage to the instrument and corporal injury to the person carrying out the repair. It renders the warranty null and void and could compromise the correct working of the instrument and the electrical integrity or the CE compliance of the instrument.

If you have any problems with installation, starting, or using the instrument please contact the company that sold it to you. If this is not possible, or if the results of this approach are not satisfactory, please contact the manufacturer's Customer Service.

Note. The transmitter uses a capacitive touch display. Ensure the glass cover is kept in a clean condition to avoid contact problems caused by a dirty screen.

1.14 Potential Safety Hazards

The following potential safety hazards are associated with operating the system:

- Electrical (line voltage)
- Use in hazardous areas

2 Use in Areas Requiring Ignition Protection

Special regulations must be observed in hazardous areas for the auxiliary power connection, signal inputs / outputs and ground connection.

Caution.

- All parts must be installed in accordance with manufacturer information and relevant standards and regulations.
- Startup and operation must be performed in accordance with ATEX User Directive 99/92/EC or BetrSichV (EN60079-14).

2.1 Approvals

2.1.1 CE Mark

The APA592–PH including type B LCD display / configuration software meets all requirements for the CE mark in accordance with applicable EU Directives 2014/30/EU (EMC), 2014/35/EU (LVD) and 2014/34/EU (ATEX).

2.1.2 Ignition Protection

This transmitter is FM, CSA and ATEX/IEC approved – see Section 2.5, page 12 for hazardous area relevant information.

2.2 Ground

If for functional reasons, the intrinsically safe circuit must be grounded by connecting it to an equipotential bonding system, it must be grounded at a single location only.

2.3 Interconnection

If APA592-pH transmitters are operated in an intrinsically safe circuit, proof of interconnection may be required during the installation. In general, intrinsically safe circuits require proof of interconnection.

2.4 Configuration

APA592-pH transmitters can be installed in hazardous areas in compliance with proof-of-interconnection and directly in a hazardous area using approved handheld HART terminals (proof of interconnection may be required during the installation) as well as by coupling an ignition-proof modem to the circuit outside the hazardous area.

2.5 Hazardous Area Relevant Information

Note. The explosion-proof or ignition-proof designation is displayed on the agency certification label.

2.5.1 APA592-pH.A1… (Intrinsic Safety)

ATEX/IECEx approved for use in zone 0/20.

Ex ia (Zone 0):

LCIE 11 ATEX 3058 X

IECEx LCI 11.0050X

Designation

Device design: II 1 G Ex ia IIC T4

Housing design: II 1 D Ex iaD A20 IP66 T135 ºC, –20 ºC ≤ T_{amb} ≤ 60 ºC

Safety-relevant data

Input Parameters	
Maximum voltage	U_i = 30 V
Maximum input current	I_i = 160 mA
Maximum power	P_i = 0,8 W
Internal inductance	L_i = 0,5 mH
Internal capacitance	C_i = 5 nF

Table 2.1 Intrinsic Safety Input Parameters

Output Parameters	
Open-circuit voltage (maximum)	U_o = 11.8 V
Short-circuit current (maximum)	I_o = 5 mA
Maximum output power	P_o = 15 mW
Allowed inductance (total)	L_a = 1 H
Allowed capacitance (total)	C_a = 1.45 µF

Table 2.2 Intrinsic Safety Output Parameters

Notes.

- Parameters apply to entire system inclusive of cables.
- Each specified electrical parameter must be applied individually and in combination. Do not exceed the maximum values when applying the electrical parameters individually or in combination.
- Both Intrinsic safety and dust ratings are combined when APA592-pH.A1… is ordered.

2.5.2 APA592-pH.A2… (Flameproof Protection)

ATEX approved for use in Zone 1/21.

Ex d (Zone 1):

LCIE 11 ATEX 3057 X

IECEx LCI 11.0049X

Designation

Device design: II 2 G Ex d IIC T4

Housing design: II 2 D Ex tD A21 IP66 T135 ºC, – 20 ºC ≤ T_{amb} ≤ 60 ºC

Note. Both flameproof and dust ratings are combined when APA592-pH.A2… is ordered.

2.5.3 APA592-pH.A3… (Type n Non-sparking)

ATEX/IECEx approved for use in zone 2/22.

Ex nA (Zone 2):

LCIE 11 ATEX 1005 X

IECEx LCI 11.0048X

Designation

Device design: II 3 G Ex nA IIC T4

Housing design: II 3 D Ex tD A22 IP66 T135 ºC, –20 ºC ≤ T_{amb} ≤ 60ºC

Note. Both type n and dust ratings are combined when APA592-pH.A3… is ordered.

ABB statement of conformity in accordance with ATEX directive.

2.5.4 APA592-pH.F1 or .C1 (Intrinsic Safety)

Note. See installation drawings P0908 – FM (page 100), or P0910 – CSA (page 102) for allowable sensors.

Agency	Area Classification
FM	Class I, Div. 1, Groups A, B, C, D Class II/III, Div. 1, Group E, F, G; T4 Ta = 60 ºC
CSA	Class I, Div. 1, Groups A, B, C, D Class II, Div. 1, Groups E, F, G Class III; Div. 1: T4

Table 2.3 Intrinsically Safe

Input Parameters	
Maximum voltage	U_i = 30 V
Maximum input current	Ii = 160 mA
Maximum power	P_i = 0,8 W
Internal inductance	L_i = 0,5 mH
Internal capacitance	C_i = 5 nF

Table 2.4 Intrinsic Safety Input Parameters

Output Parameters	
Open-circuit voltage (maximum)	U_o = 11.8 V
Short-circuit current (maximum)	I_o = 5 mA
Maximum output power	P_o = 15 mW
Allowed inductance (total)	L_a = 1 H
Allowed capacitance (total)	C_a = 1.45 µF

Table 2.5 Intrinsic Safety Output Parameters

Notes.

- Parameters apply to entire system inclusive of cables.
- Each specified electrical parameter must be applied individually and in combination. Do not exceed the maximum values when applying the electrical parameters individually or in combination.

2.5.5 APA592-pH.F2 or .C2 (Explosion-proof)

Agency	Area Classification
FM	XP, Class I, Div. 1, Groups A, B, C, D Class II/III, Div. 1, Group F, G; T4 Ta = 60 ºC
CSA	Class I, Div. 1, Groups A, B, C, D Class II, Div. 1; Groups E, F, G Class III; Div. 1; T4

Table 2.6 Explosion-proof

2.5.6 APA592-pH.F3 or .C3 (Non-incendive)

Note. See installation drawings P0909 – FM (page 101), or P0911 – CSA (page 103) for allowable sensors.

Agency	Approvals
FM	Class I, Div. 2, Groups A, B, C, D Class II/III, Div. 2, Group F, G; T4 Ta = 60 ºC
CSA	Class I, Div. 2, Groups A, B, C, D Class II, Div. 2, Groups F, G Class III; Div 2; T4

Table 2.7 Non-incendive

Input Parameters	
Maximum voltage	U_i = 30 V
Maximum input current	current controlled by transmitter
Internal inductance	L_i = 0,5 mH
Internal capacitance	C_i = 5 nF

Table 2.8 Non-incendive Field Wiring – FM and CSA: Input Parameters

Note. For installation not using Associated Equipment, maximum voltage is 42 V DC and input wiring must be installed per Div. 2 wiring methods in accordance with the applicable Electrical Code of the country in use.

Output Parameters	
Open-circuit voltage (maximum)	U_o = 11.8 V
Short-circuit current (maximum)	I_o = 5 mA
Maximum output power	P_o = 15 mW
Allowed inductance (total)	L_a = 1 H
Allowed capacitance (total)	C_a = 1.45 µF

Table 2.9 Non-incendive Field Wiring – FM and CSA: Output Parameters

Notes.

- Parameters apply to entire system inclusive of cables.
- Each specified electrical parameter must be applied individually and in combination. Do not exceed the maximum values when applying the electrical parameters individually or in combination.

3 Mechanical Installation

3.1 Hazardous Area Installation

For hazardous area designation, the Ex installation is described on a separate 'HazLoc' label mounted on the transmitter body – see Section 3.4.5, page 23.

For protection in Ex d / explosion-proof installations, turn the 2 security screws (located beneath the covers on front and rear of the housing body) until they prevent both covers from being rotated (unscrewed) therefore preventing removal of the covers.

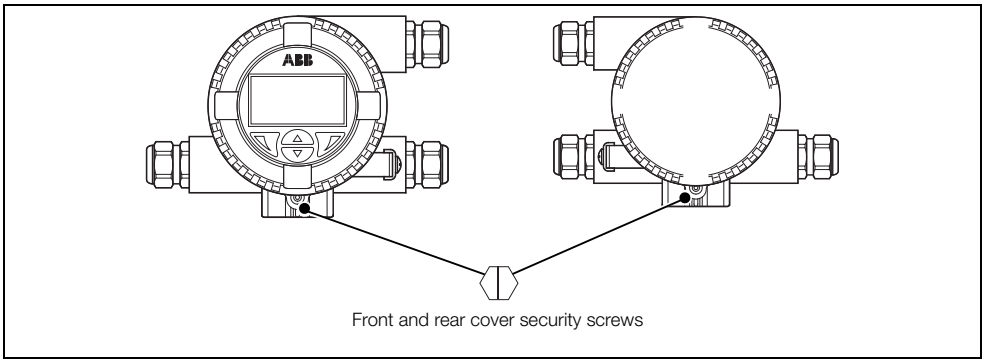


Fig. 3.1 Transmitter Cover Security Screws

3.2 Non-hazardous Area installation

Fig. 3.2 shows a general purpose non-hazardous installation and is for reference only.

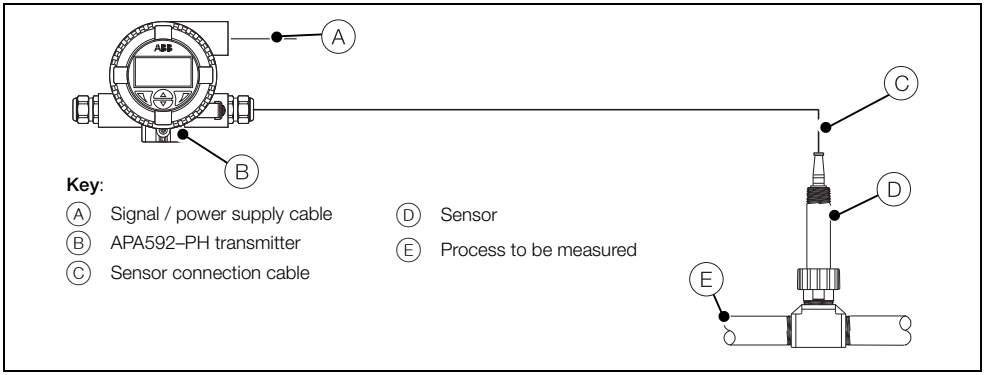


Fig. 3.2 Installation in Non-Hazardous Area

3.3 Installation Conditions

Ensure the following installation conditions are met:

1. Install the transmitter with consideration to ambient conditions.
2. Locate the transmitter in a position where the temperature and humidity specifications are not exceeded and ensure the transmitter is protected from direct sunlight, rain, snow and hail.
3. Ensure the transmitter operating temperature is within the range –20 to 60 °C (–4 to 140 °F).
4. Select a location away from strong electrical and magnetic fields.

3.4 Dimensions

3.4.1 Transmitter-only Dimensions (Excluding Mounting Bracket)

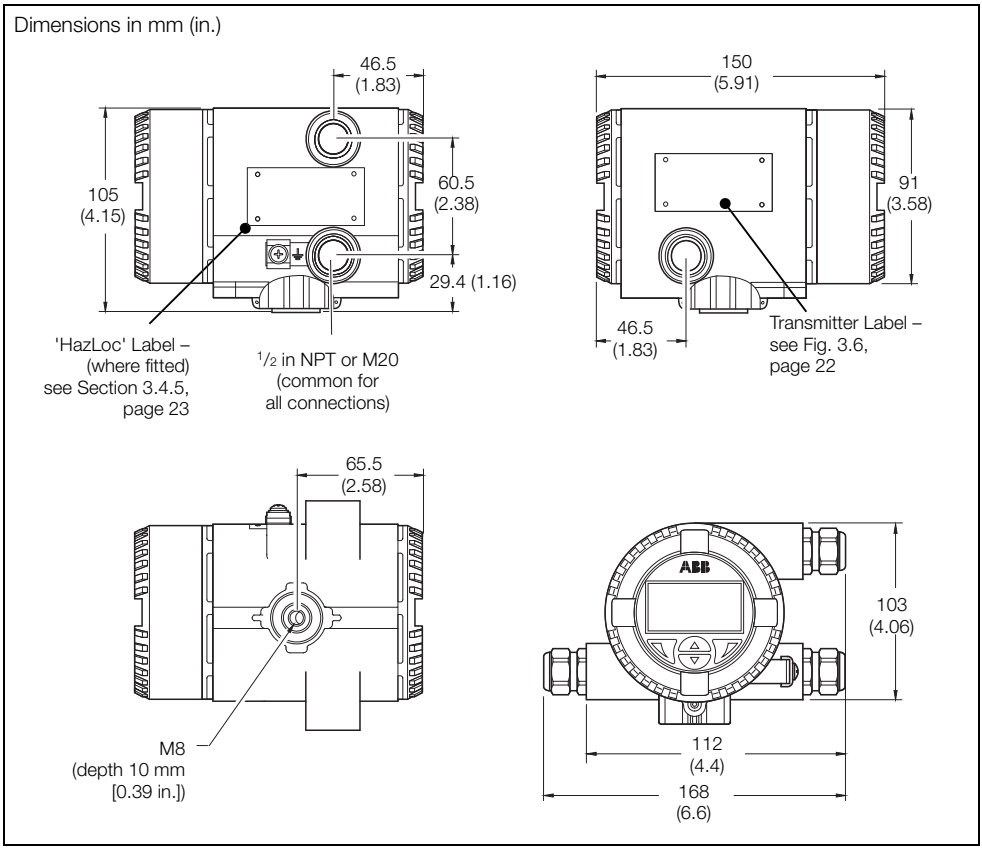


Fig. 3.3 Transmitter-only Dimensions

3.4.2 Wall-mount Transmitter Dimensions

Warning. Install the wall-mounting bracket on a sufficiently stable wall.

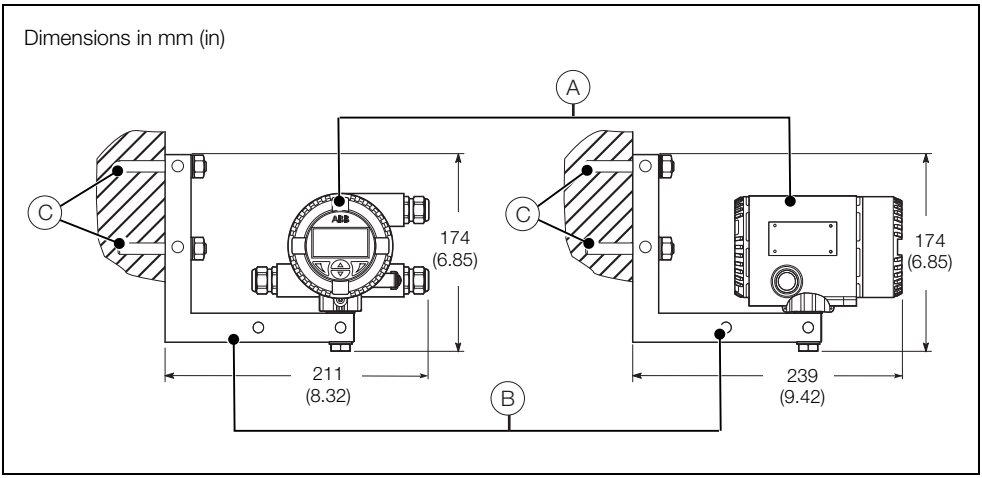


Fig. 3.4 Wall Installation

Wall-mounting an APA592–PH transmitter

Referring to Fig. 3.4:

1. Select a location as close as possible to the sensor.
2. Bolt the transmitter (A) to the wall-mounting bracket (B) securely in the required position.

   Note. The wall-mounting bracket (B) supports variable installation positions. 2 examples of the different options are shown in Fig. 3.4. The mounting bolt enables adjustable positioning (0° to 360°) of the transmitter housing.

3. Attach the wall-mounting bracket (B) to the wall securely using 2 x 10 mm bolts (C).

3.4.3 Pipe-mount Transmitter Dimensions

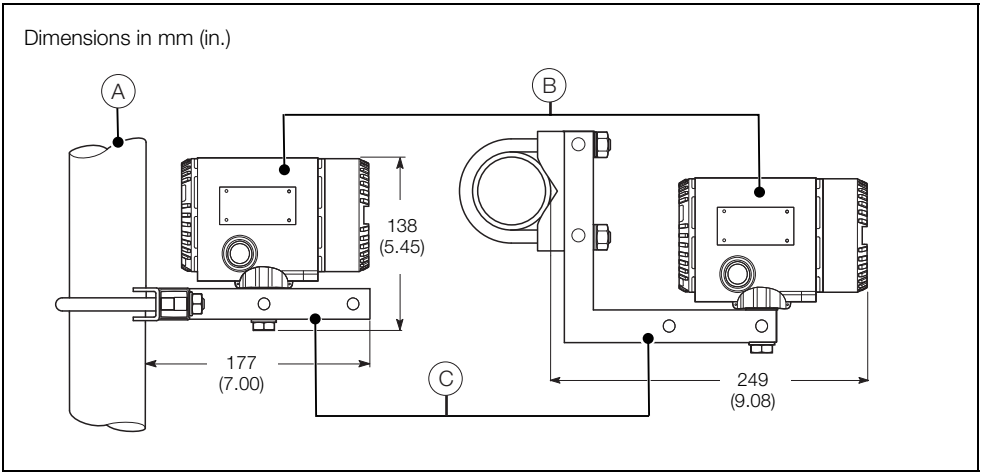


Fig. 3.5 Pipe Installation

Pipe-mounting an APA592–PH transmitter

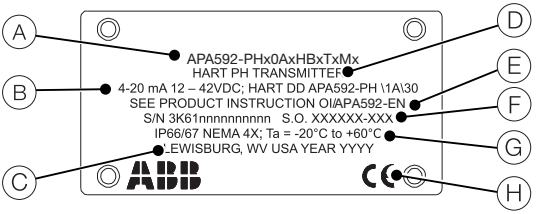
Referring to Fig. 3.5:

1. Select a suitable pipe (A) (maximum 50 mm [2 in.]) as close as possible to the sensor.
2. Bolt the transmitter (B) to the pipe-mounting bracket (C) securely in the required position.

   Note. The pipe-mounting bracket (C) supports variable installation positions. Two examples of the different options are shown in Fig. 3.5. The transmitter mounting bolt enables adjustable positioning (0° to 360°) of the transmitter housing.

3. Attach the pipe-mounting bracket (C) to the pipe securely using the U-bolt, nuts and washers (included).

3.4.4 Transmitter Label



Key:

- (A) Model number
- (B) Permissible power supply
- (C) Manufacturing location
- (D) Transmitter communication type
- (E) Product documentation (manual)
- (F) Product serial number
- (G) Permissible ambient temperature operating range
- (H) CE Mark (EC conformity)

Fig. 3.6 Example of Transmitter Label (APA592-PH Version Shown)

Note. The temperature (G) refers to the permissible ambient temperature range for the transmitter **only** and not to the measuring element used.

3.4.5 'HazLoc' Labels

ATEX (Zone 0, Zone 1, Zone 2) Label

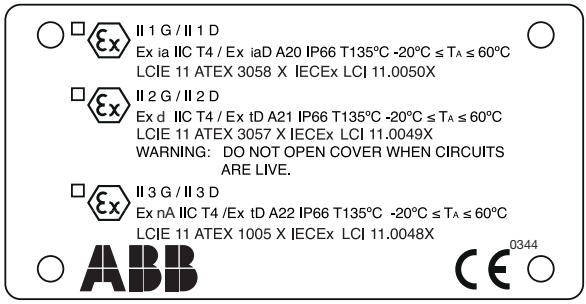


Fig. 3.7 Example of ATEX (Zone 0, Zone 1, Zone 2) 'HazLoc' Label

CSA / FM (Classes I, II, III; Div. 1 Intrinsic Safety and Div. 2 Non-incendive) Label

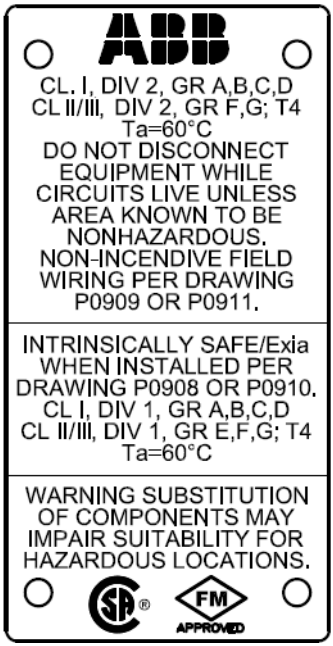


Fig. 3.8 Example of CSA / FM (Classes I, II, III; Div. 1 Intrinsic Safety and Div. 2 Nonincendive) 'HazLoc' Label

CSA / FM (Classes I, II and III; Div. 1 explosion- and ignition-proof) Label

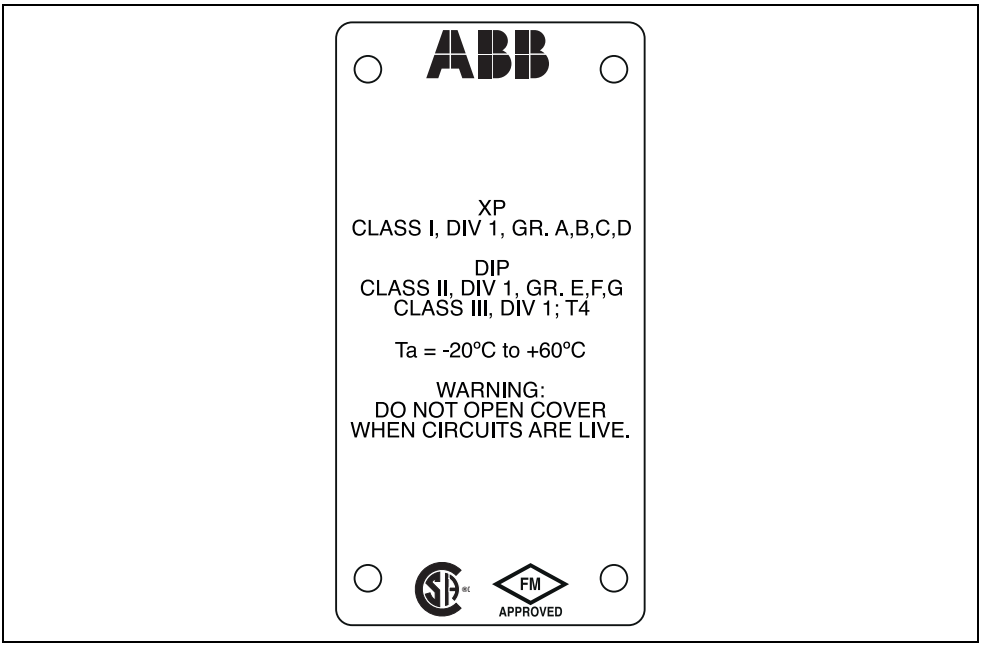


Fig. 3.9 Example of CSA / FM (Classes I, II and III; Div. 1 explosion- and ignition-proof) 'HazLoc' Label

3.4.6 Aligning the Cartridge LCD Display

Warning. Isolate the transmitter from power supplies before aligning the cartridge LCD display.

Because the transmitter's mounting bracket enables the transmitter housing to be positioned in 90 ° steps only between 0 and 360 °, it may be necessary to re-position the cartridge to ensure the cartridge LCD display is readable when mounted.

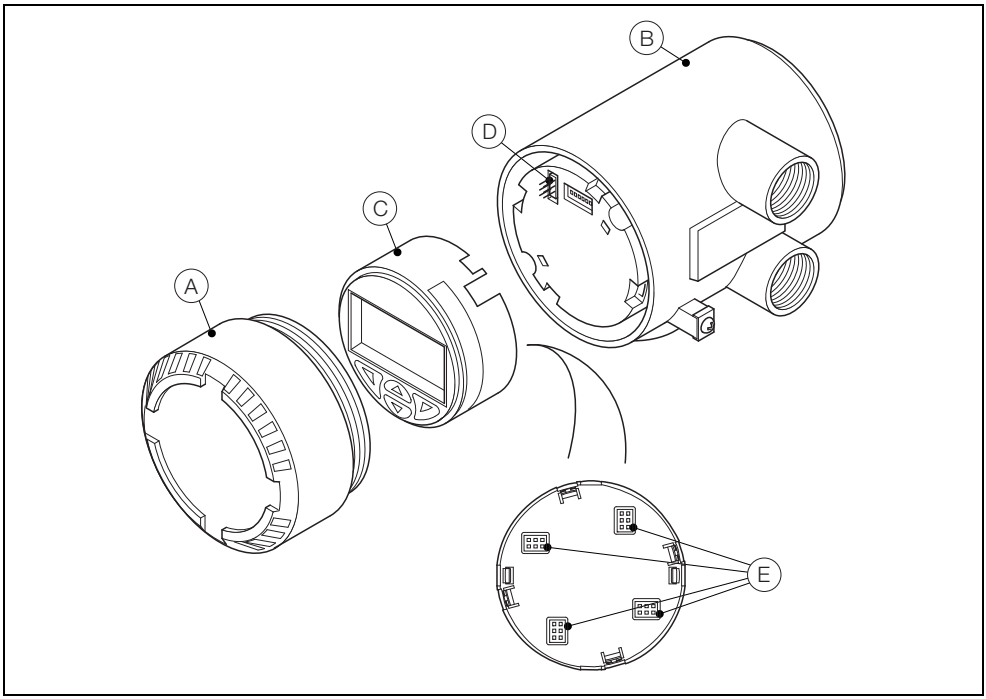


Fig. 3.10 LCD Display Alignment

To align the display:

1. Unscrew the cartridge cover (A) and remove it from the transmitter (B).
2. Depress the 4 locking lugs on the side of the cartridge (C) one at a time.
3. Pull the cartridge (C) carefully but firmly out of the transmitter (B) keeping it straight to avoid bending the 6-pin connector (D).
4. Align one of the 4 plug positions (E) on the rear of the cartridge (C) with the 6-pin connector (D) to ensure the cartridge LCD display is readable when mounted.
5. Refit the cartridge (C) in the new position by pushing it carefully but firmly into the transmitter. Keep the cartridge (C) straight to avoid bending the 6-pin connector (D).
6. Refit the cartridge cover (A) by screwing it until the O-ring is slightly compressed onto the transmitter (B).

4 Electrical Installation

Warning.

- Observe all local instructions and regulations governing electrical installation. Ensure the power supply and / or bus connections are switched off before making connections.
- Use a maximum of 12 SWG (10 AWG) wire for connection of this transmitter.
- Ensure connection to protective earth.
- Do not apply power until fully installed.
- The transmitter is not fitted with a switch and does not have an overvoltage protection device, lightning protection or voltage separation capacity therefore these must be provided on the plant side.
- Power supplies and signals are routed in the same line and must be implemented as SELV or PELV circuits according to requirements (standard version). In the ignition-proof version, the guidelines regarding the ignition-proof requirements must be adhered to.
- Ensure the existing power supply corresponds with the specifications on the name plate and the technical specifications – see Section 10, page 90.
- Use only signal cable wires with tinned or wire end sleeves.

4.1 Cable Glands and Plugs

4.1.1 APA592–PH for Intrinsically Safe, Type n and Non-incendive Installations

Non-Ex d transmitters are supplied with a nylon conduit plug and cable gland. The cable gland is sized to provide a tight seal around the sensor cable.

If a customer-supplied cable gland and plug is used, the cable diameter for the cable gland used must comply with the requirements for IP/NEMA 4X protection. This must be checked during installation.

4.1.2 APA592–PH Ex d / Explosion-proof Models without Cable Gland

APA592–PH Ex d / explosion-proof rated transmitters are supplied with a standard 316 stainless steel rated plug.

Hazardous area 316 stainless steel $^1/_2$ in. NPT or M20 cable glands must be ordered as an accessory based on the hazardous area installation requirements.

Note. For ATEX installations, an approved ATEX Ex d cable gland must be used according to IEC/EN 60079-1. For FM and CSA installations, an approved Ex d cable gland must be used.

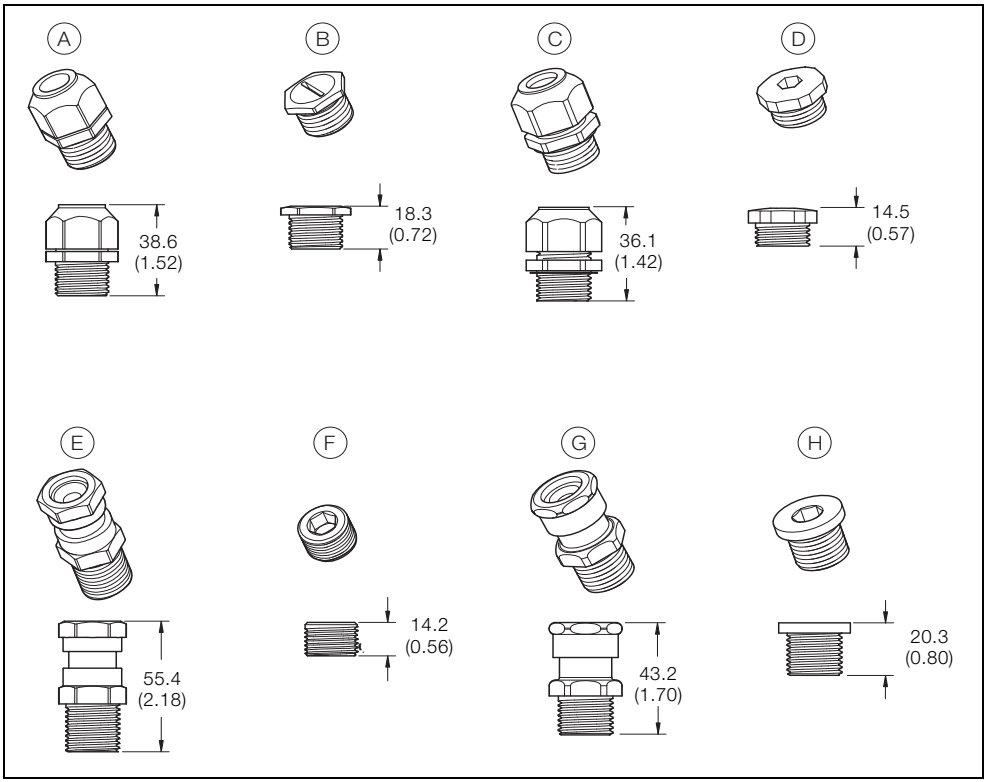


Fig. 4.1 Cable Glands and Plugs

Item	Description
(A)	1/2 in. NPT nylon cable gland
(B)	1/2 in. NPT nylon conduit plug
(C)	M20 nylon cable gland
(D)	M20 nylon conduit plug
(E)	1/2 in. NPT 316 stainless steel Ex d (explosion-proof) cable gland
(F)	1/2 in. NPT 316 stainless steel Ex d (explosion-proof) conduit plug
(G)	M20 316 stainless steel Ex d (explosion-proof) cable gland
(H)	M20 316 stainless steel Ex d (explosion-proof) conduit plug

Table 4.1 Cable Glands and Plugs – Descriptions

4.2 DC Power Supply Connections

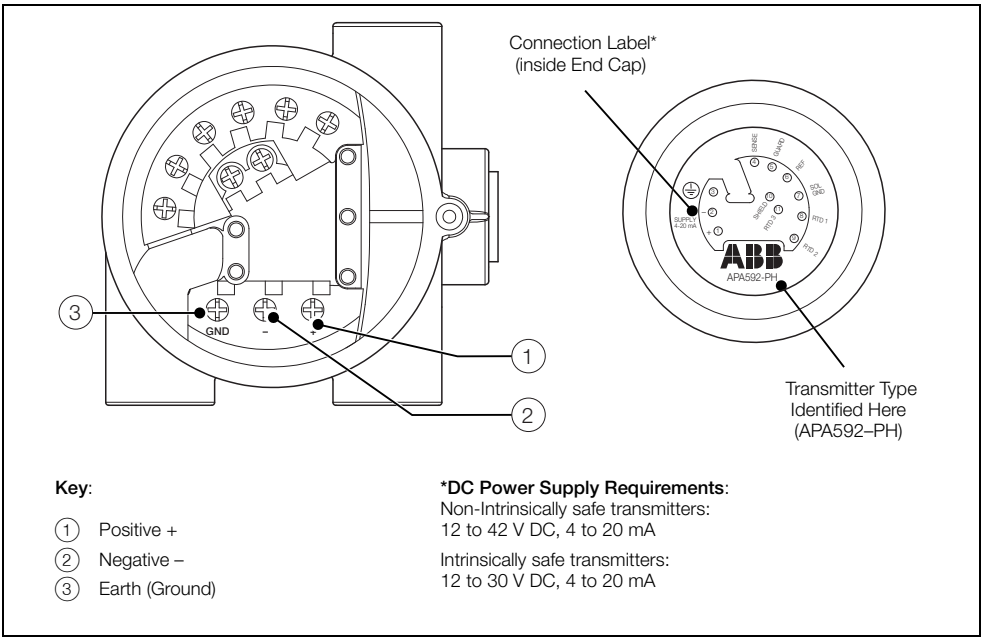


Fig. 4.2 Power Supply Connections at Transmitter Terminals

Note. HART Communication

Communication with the transmitter is supported by the HART protocol. The communication signal is modulated on both wires for the power supply line and decoded. The electrical connection is provided at the (+) and (–) terminals of the transmitter or by the power supply cable installed on-site.

To connect the HART power supply:

1. Route the power supply wiring through one of the three threaded connections in the transmitter housing.
2. Strip the wires and tin or attach wire end sleeves.
3. Loosen the power supply terminal captive screws (①, ② and ③) using a flat-bladed screwdriver (3.5 / 4 mm or Size-1).
4. Connect the (+) wire to the (+) terminal ①.
5. Connect the (–) wire to the (–) terminal ②.
6. Connect the cable shield or earth (ground) wire to the earth (ground) terminal ③ (if required).

4.3 Sensor Connections

To connect the sensor:

1. Refer to Tables 4.2 and 4.3 on pages 30 and 31 to identify the correct cable wires / colors for the APA592–PH transmitter.
2. Route the sensor wiring through one of the three threaded connections and use an appropriate gland in the transmitter housing (refer to Fig. 4.1, page 27 for gland options). Note, a cable gland is required.
3. Loosen the sensor connection terminal captive screws using a flat-bladed screwdriver (3.5 / 4 mm or Size-1).
4. Insert each sensor cable wire under the open terminals and secure by tightening the terminal captive screws.

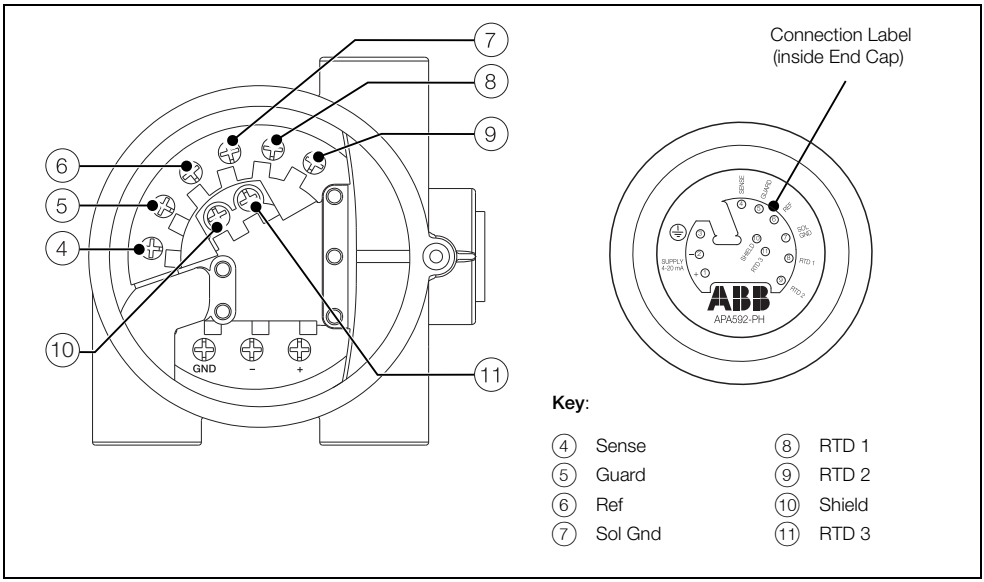


Fig. 4.3 APA592–PH Sensor Connections at Transmitter Terminals

Caution.

- The connection terminals accept cables up to a maximum peripheral wire cross section of 2.5 mm^2 (12 SWG [10 AWG]).
- If possible use coaxial cable
  (do not use a rigid conductor material as this can result in wire breaks).
- Ensure the connecting cable is flexible.
- To ensure the sensor cable length is sufficient, allow an additional 100 mm (4 in.) of cable to pass through cable glands and into the housing.
- Ensure the correct connections are made to suit the sensor model (see Section 4.4, page 30).

4.4 Sensor Cable Color-Coded Connections

Note. ORP (Redox) and Antimony pH sensors do not have temperature compensation and therefore do not have temperature sensors or related wiring.

4.4.1 Standard Sensors with No Diagnostic Functions

Note. Turn **Off** diagnostics when connecting these sensors

Connection Information		pH Sensor Cable Color				
Transmitter Terminal	**Function**	**2867**	**AP100**	**AP300**	**7650/ 60***	**TB5**
4	Glass / Metal Sensing Electrode	Clear	Clear	Blue	Clear	Blue
5	Guard	–	–	–	–	–
6	Reference	Black	Black	Black	Black	Black
7	Solution Ground	–	–	–	–	–
8	Temperature Compensator (If included with sensor)	–	Red	Red	Red	Red
9	Temperature Compensator (If included with sensor)	–	White	White	White	White
10	Shield /Shield (if fitted)	–	–	–	Yellow	–
11	Temperature Compensator (If included with sensor)	–	Red	Grey	Red	–

*Cut back the 7650 / 60 sensor's redundant green wire.

Table 4.2 Standard Sensors with No Diagnostic Functions

4.4.2 Sensors with Diagnostics Functions

Note. Turn **On** diagnostics when connecting these sensors

Connection Information*		pH Sensor Cable Color		
Transmitter Terminal	**Function**	**AP200**	**TBX5**	**Non ABB**
4	Glass / Metal Sensing Electrode	Clear	Blue	Refer to sensor's manual for wiring colors and their functions
5	Guard	Red	Yellow	
6	Reference	Blue	Black	
7	Solution Ground	Green/ Yellow	Green	
8	Temperature Compensator (If included with sensor)	Green	Red	
9	Temperature Compensator (If included with sensor)	White	White	
10	Shield	–	Dark Green	
11	Temperature Compensator (If included with sensor)	Grey	–	

Table 4.3 Sensors with Diagnostics Functions

4.5 Integral Sensor Cable Connection

For installations where the sensor is close to the transmitter, use an integral sensor cable. This design is preferred for submersible installations as there is no connector that could be affected by moisture.

For ease of sensor replacement, keep the cable length to a minimum.

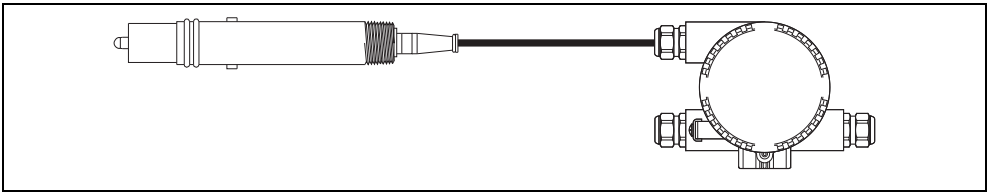


Fig. 4.4 Sensor with Integral Cable

4.6 Junction Box and Extension Cable Connection

Some sensors use a BNC connector. For some applications, an extension cable is available that can be installed permanently between the sensor and the transmitter. The sensor has a junction box mounted either directly on it or in close proximity. The extension cable is connected to the sensor inside the junction box. Maximum distance between the sensor and transmitter is 30 m (100 ft) without preamplifier.

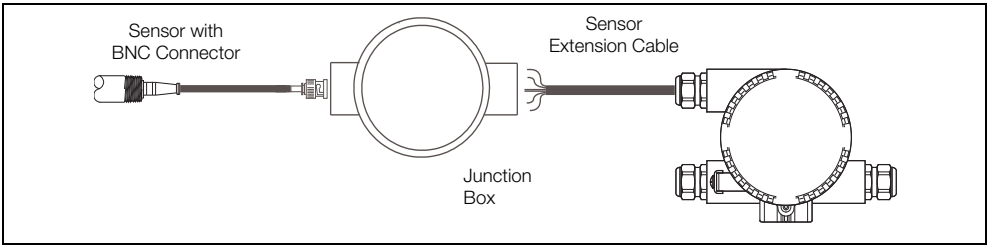


Fig. 4.5 Sensor with Junction Box and Extension Cable

4.7 Quick-disconnect Cable Connection

For sensors that use a quick disconnect-style connector, the extension cable is connected directly to the transmitter. The connection to the sensor is then made in the field at the sensor. The extension cable can be left in place even if the sensor is replaced. Maximum distance between the sensor and transmitter is 30 m (100 ft) without preamplifier.

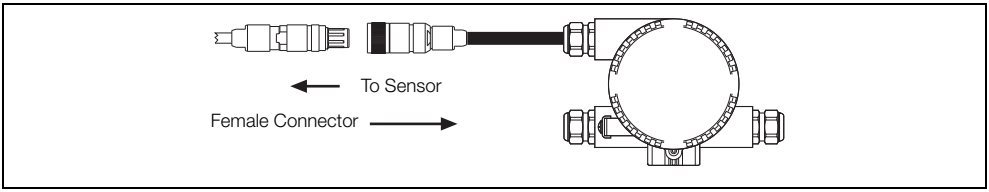


Fig. 4.6 Sensor with Quick-disconnect Style Cable

4.8 Power Supply Requirements

Warning.

- The connection terminals accept cables with a maximum peripheral wire cross-section of 2.5 mm^2 12 SWG (10 AWG).
- Switch off the power supply before connecting the transmitter.

Notes.

- To ensure the sensor cable length is sufficient, allow an additional 100 mm (4 in.) of cable to pass through cable glands and into the housing.
- Use stranded conductor material for the power supply cable.
- Ensure the connecting cable is flexible.
- Do not use a rigid conductor material as this can result in wire breaks. Ensure the connecting cable is flexible.

4.8.1 Standard Application

When connecting APA592–PH transmitters and power supplies in non-hazardous areas, observe the following specification:

$$U_{Smin} > U_{Mmin} + 0.022A \times R_{Ltg}$$

Where:

- U_{Mmin} – Minimum operating voltage of transmitter (refer to technical data for transmitter)
- U_{Smin} – Minimum supply voltage of power supply/SPS input
- R_{Ltg} – Line resistance between transmitter and power supply

For HART functionality, use power supplies or SPS input cards with HART mark. If this is not possible, the interconnection must have a resistance of 250 Ω (< 1100 Ω).

The signal line can be connected with or without an earth (ground) connection. When connecting the earth (ground) (minus side), ensure that only one side of the contact is connected to an equipotential bonding system.

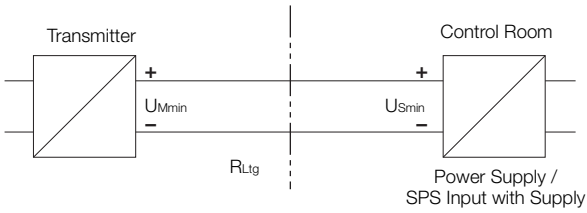


Fig. 4.7 Standard Application

4.8.2 Standard Application with HART Functionality

Adding resistance R_{250} increases the minimum supply voltage:

$$U_{Smin} > U_{Mmin} + 0.02A \times (R_{Ltg} + R_{250})$$

Where:

- U_{Mmin} – Minimum operating voltage of transmitter (refer to technical data for transmitter)
- U_{Smin} – Minimum supply voltage of power supply/SPS input
- R_{Ltg} – Line resistance between transmitter and power supply
- R_{250} – Resistance for HART functionality

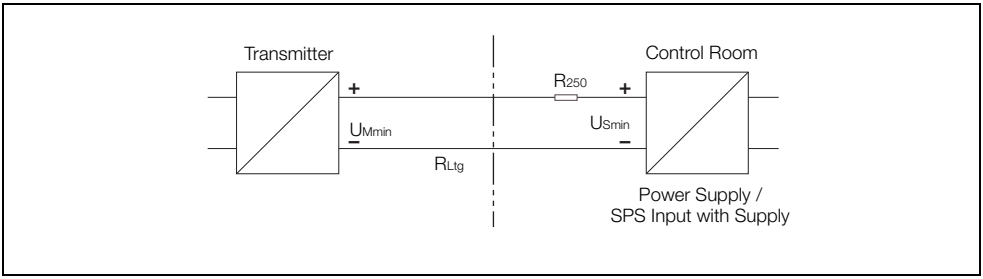


Fig. 4.8 Standard Application with HART Functionality

4.8.3 Electrical Connection in Hazardous Area

Special interconnections are required for use in hazardous areas depending on the safety requirements.

Caution. Refer to Section 2, page 11 and Section 10, page 90 for hazardous area risk requirements.

Intrinsic safety

The power supply SPS inputs must have corresponding input protection circuits available to eliminate spark hazards. An interconnection inspection must be performed. For proof of intrinsic safety, the electrical limit values must be used as the basis for the prototype test certificates of the transmitters, including the capacitance and inductance values of the wires. Proof of intrinsic safety is granted if the conditions in Table 4.4 are fulfilled.

APA592–PH (Intrinsically Safe Transmitter)		Power Supply/SPS Input (Related Apparatus)
U_i	≥	U_o
I_i	≥	I_o
P_i	≥	P_o
$L_i + L_c$ (cable)	≤	L_o
$C_i + C_c$ (cable)	≤	C_o

Table 4.4 Intrinsic Safety Conditions

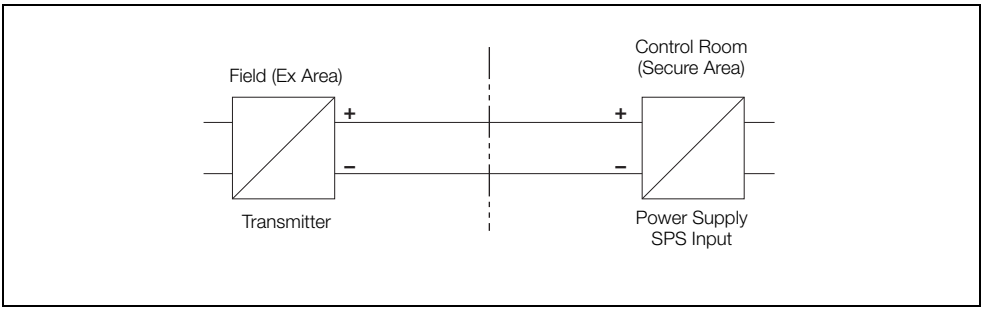


Fig. 4.9 Hazardous Area Risk Application

4.8.4 Installation in Hazardous Areas

APA592–PH transmitters can be installed in a wide variety of industrial sectors. Systems that require ignition protection are divided into zones. As a result, different instruments are also required.

Note. For additional information, refer to Section 2.5, page 12.

Figs 4.10 to 4.16, page 39 provide details of installations in ATEX/IEC Ex areas.

Intrinsic Safety – ATEX / IEC Ex

II 1 G Ex ia IIC T4

II 1 D Ex ia D A20 IP66 T135 ºC, –20 ºC ≤T_{amb} ≤60 ºC

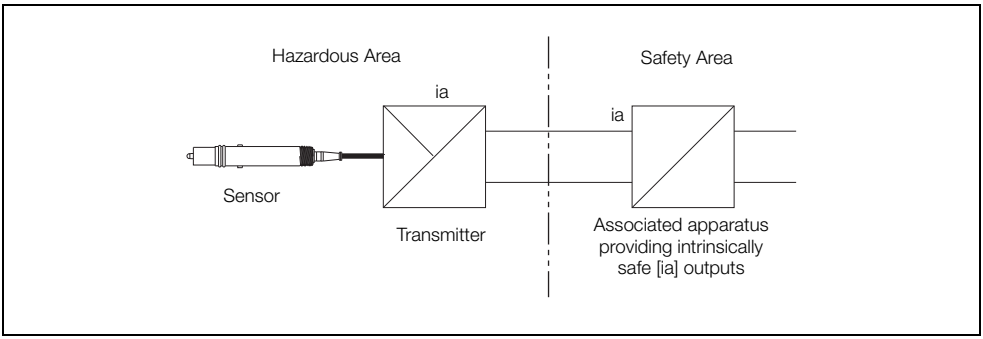


Fig. 4.10 Intrinsic Safety – ATEX/IECEx

Intrinsic Safety – FM and CSA

Entity parameters are specified in Appendix B, installation drawing P0908

FM Class I, Div. 1, Groups A, B, C, D
Class II/III, Div. 1, Group E, F, G; T4
Ta = 60ºC

CSA Class I, Div. 1, Groups A, B, C, D
Class II, Div. 1, Groups E, F, G
Class III; Div. 1; T4

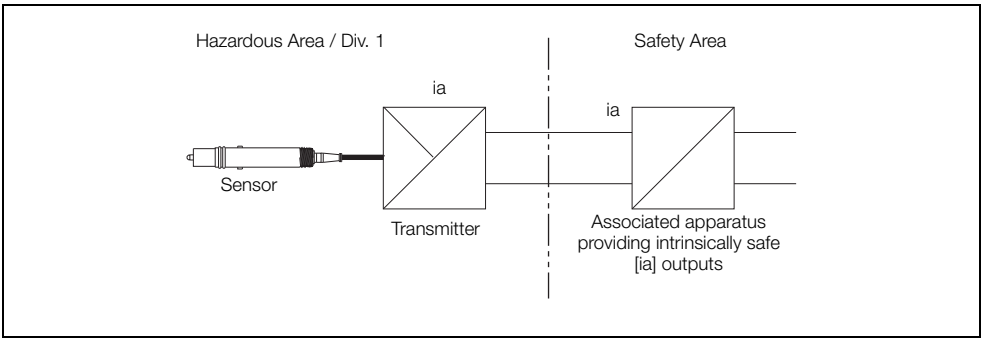


Fig. 4.11 Intrinsic Safety – FM and CSA

Type n (Non-sparking) – ATEX/IEC Ex

II 3 G Ex nA IIC T4

II 3 D Ex tD A22 IP66 T135 ºC, –20 ºC ≤T_{amb} ≤60 ºC

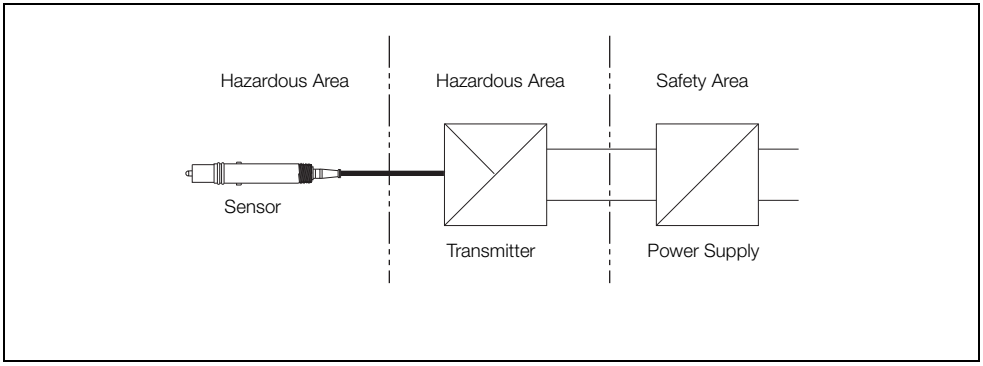


Fig. 4.12 Type n (Non-sparking) – ATEX/IECEx

Non-Incendive (Using Non-incendive Field Wiring) – FM and CSA

Entity parameters are specified in Appendix B, installation drawing P0909

FM Class I, Div. 2, Groups A, B, C, D
Class II/III, Div. 2, Group F, G; T4
Ta = 60ºC

CSA Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III, Div. 2; T4

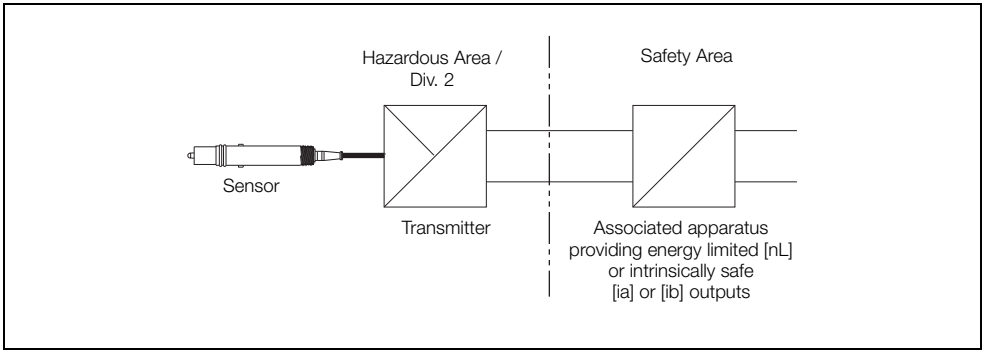


Fig. 4.13 Non-Incendive (using non-incendive field wiring) – FM and CSA

Non-Incendive (using Div. 2 field wiring) – FM and CSA

Note. Local regulations for the power supply must be observed and approved wiring methods for Div. 2 hazardous classified locations must be used.

FM	Class I, Div. 2, Groups A, B, C, D Class II/III, Div. 2, Group F, G; T4 Ta = 60 ºC	CSA	Class I, Div. 2, Groups A, B, C, D Class II, Div. 2, Groups F, G; Class III, Div. 2; T4

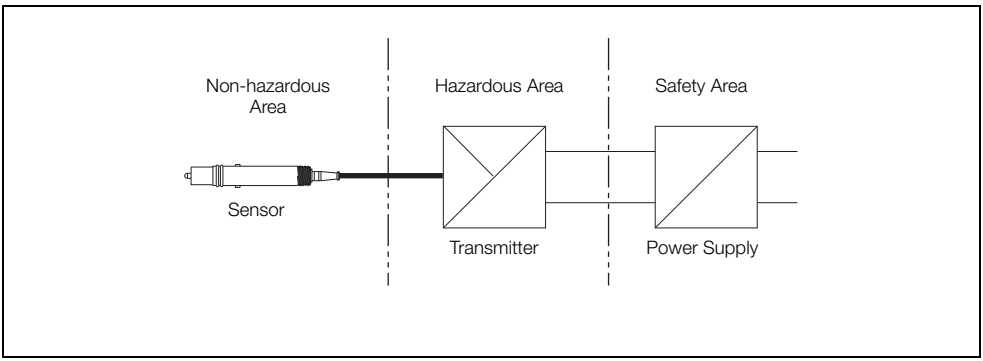


Fig. 4.14 Non-Incendive (using Div. 2 field wiring) – FM and CSA

Flameproof – ATEX

Note. Local regulations governing the installation of the power supply and the sensor must be observed. Do not open the cover when circuits are live.

II 2 G Ex d IIC T4

II 2 D Ex tD A21 IP66 T135 ºC, -20 ºC ≤ T_{amb} ≤ 60 ºC

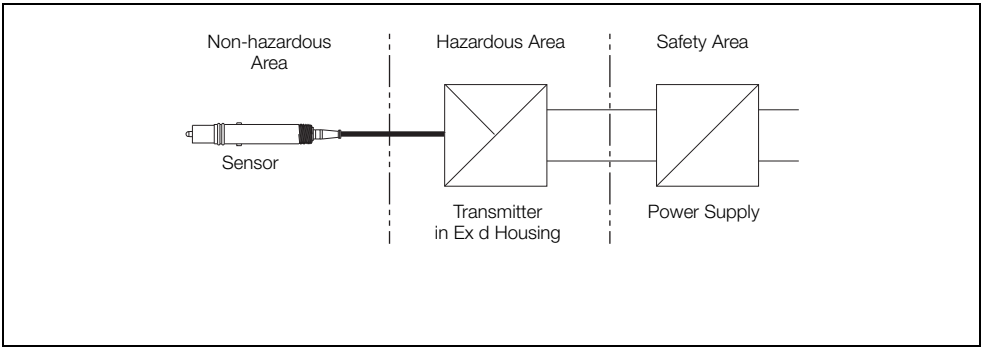


Fig. 4.15 Flameproof – ATEX

Explosion-proof, Dust-Ignition-proof – FM and CSA

Note. Local regulations governing the installation of the power supply and the sensor must be observed. Do not open the cover when circuits are live.

FM	XP, Class I, Div. 1, Groups A, B, C, D DIP, Class II, Div. 1, Groups E, F, G DIP, Class III, Div. 1; T4	CSA	Class I, Div. 1, Groups A, B, C, D Class II, Div. 1, Groups E, F, G Class III, Div. 1; T4

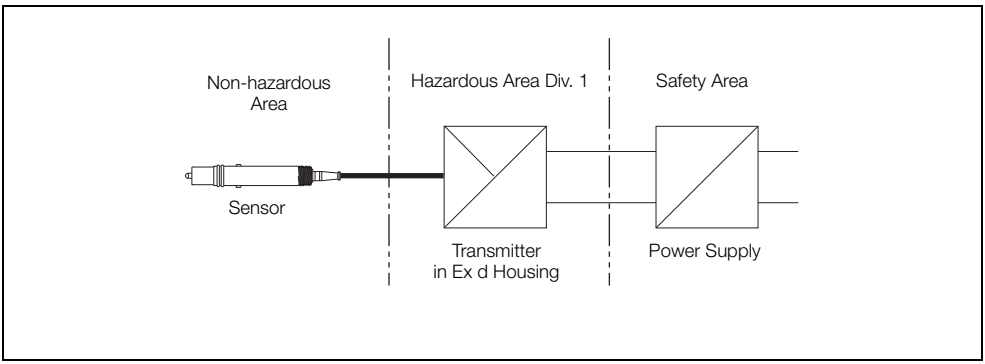


Fig. 4.16 Explosion-proof, Dust-ignition-proof – FM and CSA

5 Start-up and Operation

5.1 Navigating Menus and Parameters

The four keys below the display are used to navigate menus and to execute all system commands and selections.

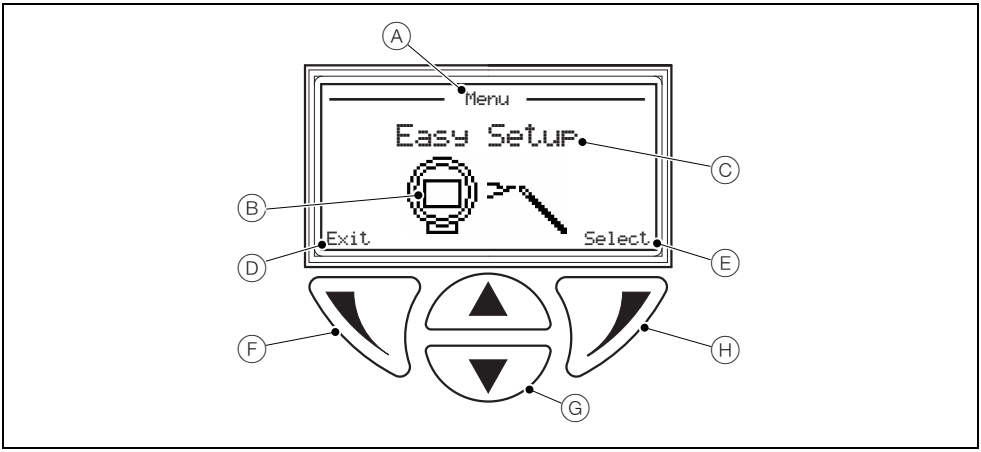


Fig. 5.1 Display and Keys

Item	Description
Ⓐ	Screen title at the current level / parameter
Ⓑ	Main level icon
Ⓒ	Menu level title
Ⓓ	Prompt executed by pressing the key
Ⓔ	Prompt executed by pressing the key
Ⓕ	Left key – used for parameter navigation and to enter editable parameters
Ⓖ	Up / Down keys – used to scroll through menu options and to increase / decrease values in editable parameters
Ⓗ	Right key – used to accept / select parameter values / selections and exit sub-levels

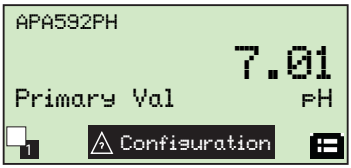
Note. The transmitter uses a capacitive touch display. The capacitive keys are calibrated with the glass cover during initial power up. If problems occur when using the keys, power the transmitter down and power up again to allow the unit to recalibrate the keys with the glass cover.

5.2 Security Levels and Password Access

At power-up, the *Start-up Display* and process display (*Operator Page*) screens are activated in sequence.

Note.

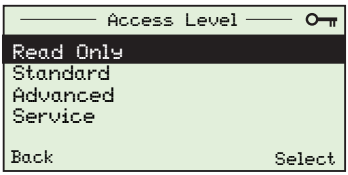
- Passwords at *Standard* / *Advanced* level are disabled by default. They can be enabled and disabled independently by end-users via the *Service* level.
- To navigate from the *Operator Page(s)* directly back to the menus, accept the default access level selection at the *Access Level* screen and press the ◥ key.



Operator Pages (Process Display)

When the start-up routine is completed the process display (*Operator Page*) screen is displayed.

Press the ◥ key to display the *Access Level* screen where the level of user access is selected.



Access Level

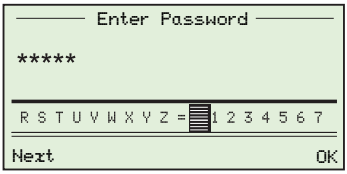
Access to the *Read Only* level does not require a password.

Standard and *Advanced* access levels do not require passwords by default, however, passwords for these levels can be enabled via the *Service* level.

Access to the *Service* level is password-dependent.

The *Enter Password* screen is always displayed for *Service* level access. It is also displayed for *Standard* and *Advanced* level access when the corresponding passwords are enabled.

The *Enter Password* screen is not displayed when accessing *Read Only* level.



Enter Password

To select password characters and enter passwords:

1. Use the ▲ and ▼ keys to scroll to and highlight the first password character to be selected.
2. Press the ◤ key to select the highlighted character (add it to the password set).
3. Use the ▲ and ▼ keys to highlight the next password character to be selected.
4. Repeat steps 2 to 4 until all characters have been added to the password.
5. Press the ◥ key to accept the password and display menus available at the requested access level.

Note. If a time-out occurs (after 5 minutes of no activity), enter the password again to access menus at the same level.

5.2.1 Security Permissions

Table 5.1 (below) provides an overview of the permissions enabled at each access level:

Access Level	Read / Write	Read-only
Read-only	None	All levels and sub-levels
Standard*	■ Calibrate ■ Input / Output ■ Display ■ Diagnostics	■ Easy Setup ■ Device Setup ■ Communication ■ Service
Advanced*	■ Easy Setup ■ Calibrate ■ Device Setup ■ Input / Output ■ Display ■ Diagnostics ■ Communication	■ Service
Service	■ Easy Setup ■ Calibrate ■ Device Setup ■ Input / Output ■ Display ■ Diagnostics ■ Communication ■ Service	–

Table 5.1 Overview of Security Permissions

**Standard* and *Advanced Level* passwords are enabled / disabled via the *Service Level*.

5.2.2 Default Passwords

The transmitter is supplied with factory-set (default) passwords for access to the *Standard, Advanced* and *Service* levels. Passwords cannot be modified.

5.3 Configuration Menus Overview

Note. Parameters displayed are dependent on the option selected at the *Analyzer Type* parameter.

The following measurement-specific parameters are available:

- pH – see Section 7.2.1, page 51
- ORP (or Redox), pION – see Section 7.2.2, page 52
- Ion Concentration: – see Section 7.2.3, page 53

To access menus from an *Operator Page*, press the key (beneath the icon) and select the required level of access (enter a user password if necessary). To scroll between menus, press the and keys.

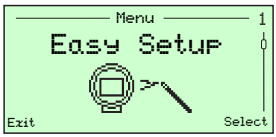
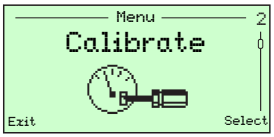
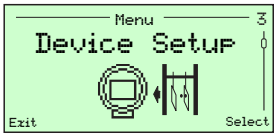
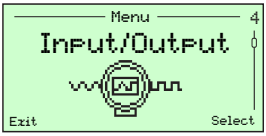
Display Overview	Section and Function
	**Easy Setup** The *Easy Setup* menu is used to set up the system quickly and contains a series of options for users with *Advanced* level access permission. Users with *Read Only* and *Standard* access have read-only permissions and cannot make selections from this menu.
	**Calibrate** Used to calibrate the transmitter.
	**Device Setup** Used to specify temperature sensor and sensor data settings.
	**Input/Output** Used to setup process value high / low ranges, alarm current settings and linearity options.

Table 5.2 Operating Menus Overview

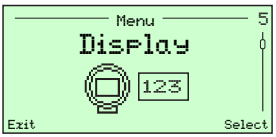
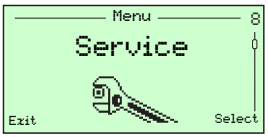
Display Overview	Section and Function
	**Display** Enables screen settings, language selection and the display format to be specified.
	**Diagnostics** Used to set calibration alarm limits, test / fix the output current in loop mode and view the diagnosis simulation status.
	**Communication** Used to configure the transmitter's HART communication support.
	**Service** **Note**. Service level parameters are reserved for ABB factory-trained personnel – contact the Company for support.

Table 5.2 Operating Menus Overview (Continued)

6 Configuration

6.1 Configuration Options

APA592–PH transmitter configuration options comprise:

- Configuration via the transmitter's navigation keys.

  Note.

  - Complete configuration of the transmitter is available through the HMI. However, not all Device DTM functions (for example, such as Diagnosis Masking) are accessible via the transmitter's navigation keys.
  - Communication with the transmitter is supported by the HART protocol – refer to Section 9, page 83 for HART commands.

- Configuration via FDT/DTM technology.

  Configuration can be performed with any FDT network applications that are approved for use with the DTM (for example, ABB AssetVision Basic / Professional). The bus can be connected via FSK modem as well as HART + USB or HART Multiplexer.

- Configuration via EDD technology.

  Configuration can also be performed with EDD master applications such as Siemens Simatic PDM, that is approved for use with EDD.

- Configuration using a handheld terminal.

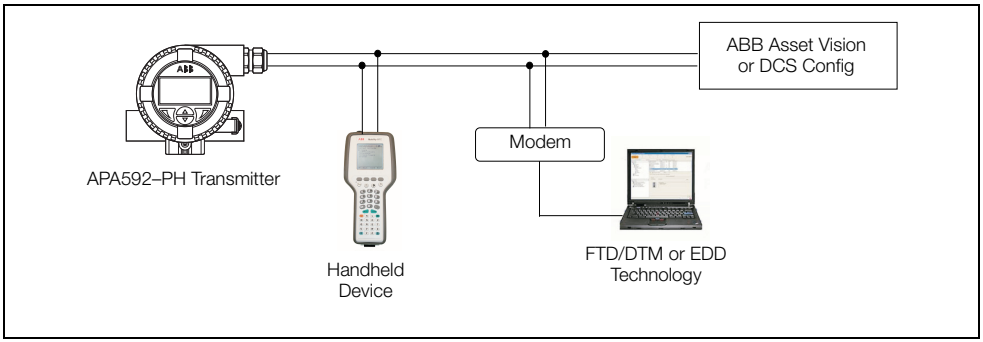


Fig. 6.1 Configuration Options – Schematic

6.2 Configuration DIP Switch

Warning. Isolate the transmitter from power supplies before accessing / setting the DIP switch.

A 6-pin DIP switch located behind the transmitter cartridge is used to enable / protect configuration settings (see Fig. 6.2 below for DIP switch positions). Transmitters are shipped with configuration changes enabled (DIP switch 1 set to the *OFF* position). To protect a configuration, set DIP switch 1 to the *ON* position.

Caution. When setting DIP switch **1**, take care not to move DIP switch **6**.

If DIP switch 6 is in the **ON** position when the transmitter is powered up, the transmitter's configuration is reset to default (factory) settings.

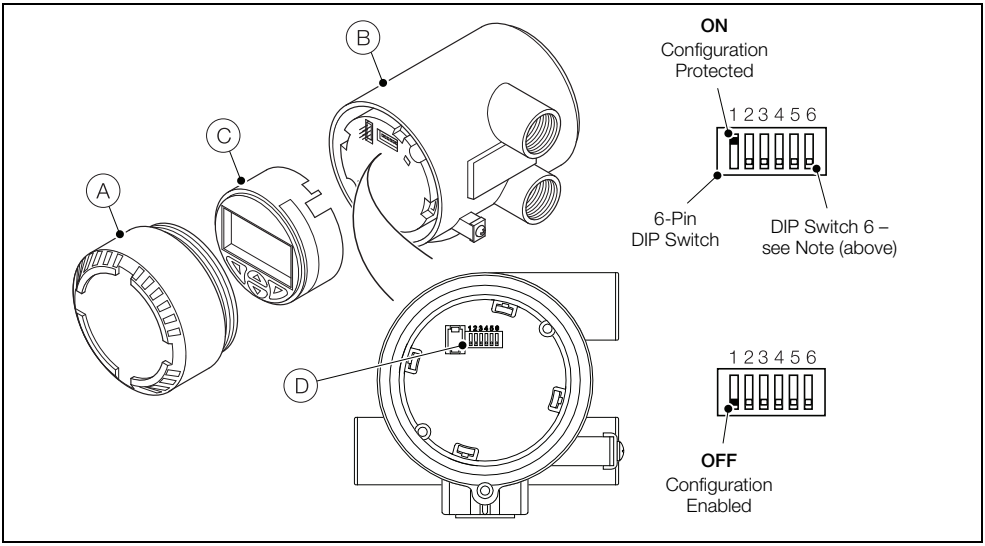


Fig. 6.2 Configuration DIP Switch

To protect a configuration:

1. Unscrew the cartridge cover (A) and remove it from the transmitter (B).
2. Pull the cartridge (C) carefully but firmly out of the transmitter (B) keeping it straight to avoid bending the 6-pin connector (D).
3. At the 6-pin DIP switch (D), set switch 1 to the *ON* position (up).
4. Refit the cartridge (C) by pushing it carefully but firmly into the transmitter. Keep the cartridge (C) straight to avoid bending the 6-pin connector (D).
5. Refit the cartridge cover (A) by screwing it until the O-ring is slightly compressed onto the transmitter (B). For protection in Ex d / explosion-proof installations, turn the 2 security screws (see Fig. 3.1, page 17) until they prevent both covers from being rotated (unscrewed) therefore preventing removal of the covers.

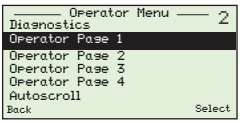
7 Operator Pages and Menus

7.1 Process Display

At power-up (if startup is successful) the startup screen is displayed momentarily after approximately 3 seconds. The display is then blank for the next 6 seconds (while the transmitter performs a self-check). Next the startup screen is displayed again, followed by the *Operator Page*. This is the normal operating state of the transmitter.

Access to the *Operator Menu* and the main menus (used for additional monitoring and configuration) is via an *Operator Page* – see Fig. 7.1. *Operator Page 1* displays information in a single line, *Operator Pages 2* to *4* display information in multi-line formats – see Section 7.1.1, page 48.

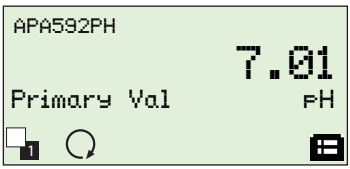
Operator Menu



The *Operator Menu* is used:

- to select a single *Operator Page* (*1, 2, 3* or *4*) as the default display
- to select *Autoscroll* mode (autoscroll each Operator page in sequence every 15 seconds)
- to view current alarms (via the *Diagnostics* menu),

Operator Page



Operator Page Icons

Autoscroll*

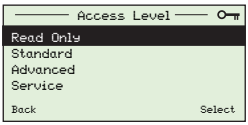
The *Autoscroll* icon is displayed when *Autoscroll* is enabled (selected at the *Operator Menu* – see Section 7.1.1, page 48).

Locked* (Menu Access Denied)

A *Locked* icon is displayed when access to the menus is denied to the current user due to a time-out or attempting to enter an incorrect password.

*If an operational error is displayed, the *Autoscroll* and *Locked* icons are obscured (until the error is cleared).

Access Level

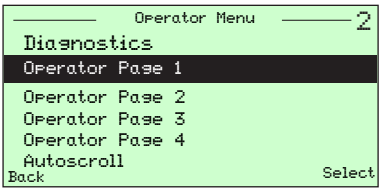


The *Access Level* is used to select access to configuration menus at *Read Only*, *Standard*, *Advanced* and *Service* levels.

To access these menus, scroll to the required level and press . If a password has been enabled the *Enter Password* screen is displayed – see Section 5.2, page 41.

Fig. 7.1 Screen Navigation

7.1.1 Operator Pages



The *Operator Pages* are accessed from the *Operator Menu* by using the ▲ and ▼ to scroll to the required page and pressing the ◢ key.

Four *Operator* pages are available to monitor operation. These can be configured to display live measured input and output values.

An example of an *Operator Page* is shown in Fig. 7.2.

An overview of operator menus (including *Operator Pages*) is shown in Table 7.1, page 49.

Notes.

- It is not possible to configure the system or to modify data within the *Operator Pages*.
- The Operator Page number is displayed on each page.

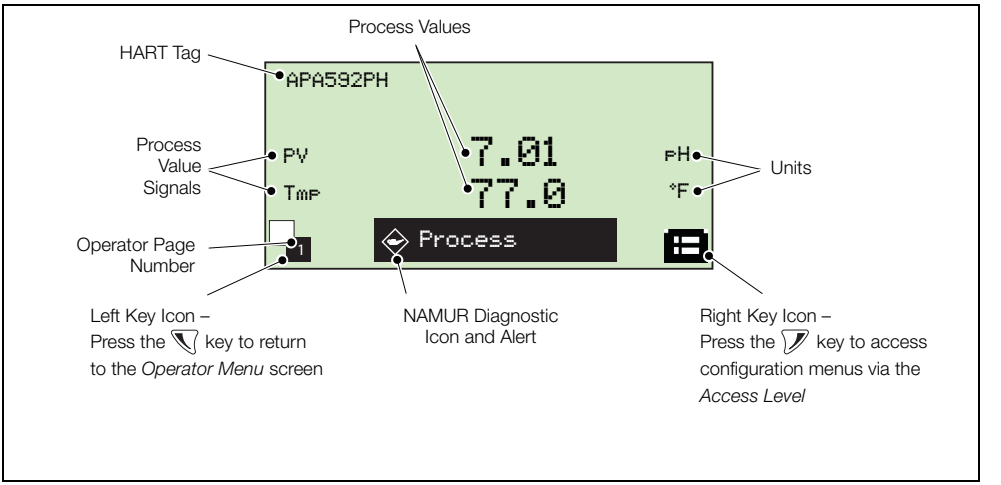


Fig. 7.2 Operator Page Example

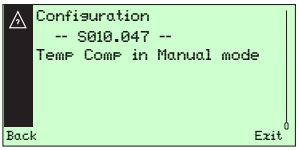
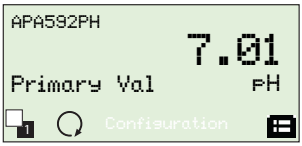
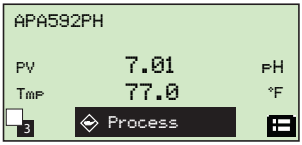
Display Example	Title and Function
	**Diagnostics** *Diagnostic* screen – used to display active diagnostic system data (NAMUR icon, diagnostic code and diagnostic message). Use the ▲ and ▼ keys to scroll through all active diagnostics. Diagnostic messages in this screen do not include historical information that is available from the *Diagnostics* menu – see Section 7.3.6, page 68. Refer to Section 8.1, page 72 for a list of diagnostic messages.
	**Operator Page 1** Large primary value on the first line.
	**Operator Page 2** Large primary value on the first line and a primary value percentage range bar graph.
	**Operator Page 3** Primary value (plus associated unit) on the first line and a temperature value (and associated unit) on the second line. Data displayed on the second line is set via the *Display* menu – see Section 7.3.5, page 67.

Table 7.1 Overview of Operator Menus

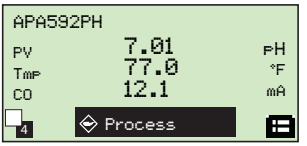
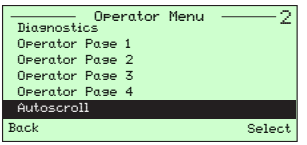
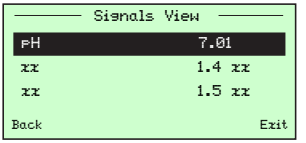
Display Example	Title and Function
	**Operator Page 4** Primary value (plus associated unit) on the first line, a temperature value (plus associated unit) on the second line and the calculated current output value (and associated unit) on the third line. Data displayed on the second and third lines is set via the *Display* menu – see Section 7.3.5, page 67.
	**Autoscroll** By selecting *Autoscroll*, each *Operator Page* is displayed in sequence for 15 seconds. Auto scrolling can be stopped by selecting one of the *Operator Pages* from the *Operator Menu*.
	**Signals View** Displays a list of active signals. Use the ▲ and ▼ keys to scroll through active signals.

Table 7.1 Overview of Operator Menus (Continued)

7.2 Parameter Maps

7.2.1 pH Parameters

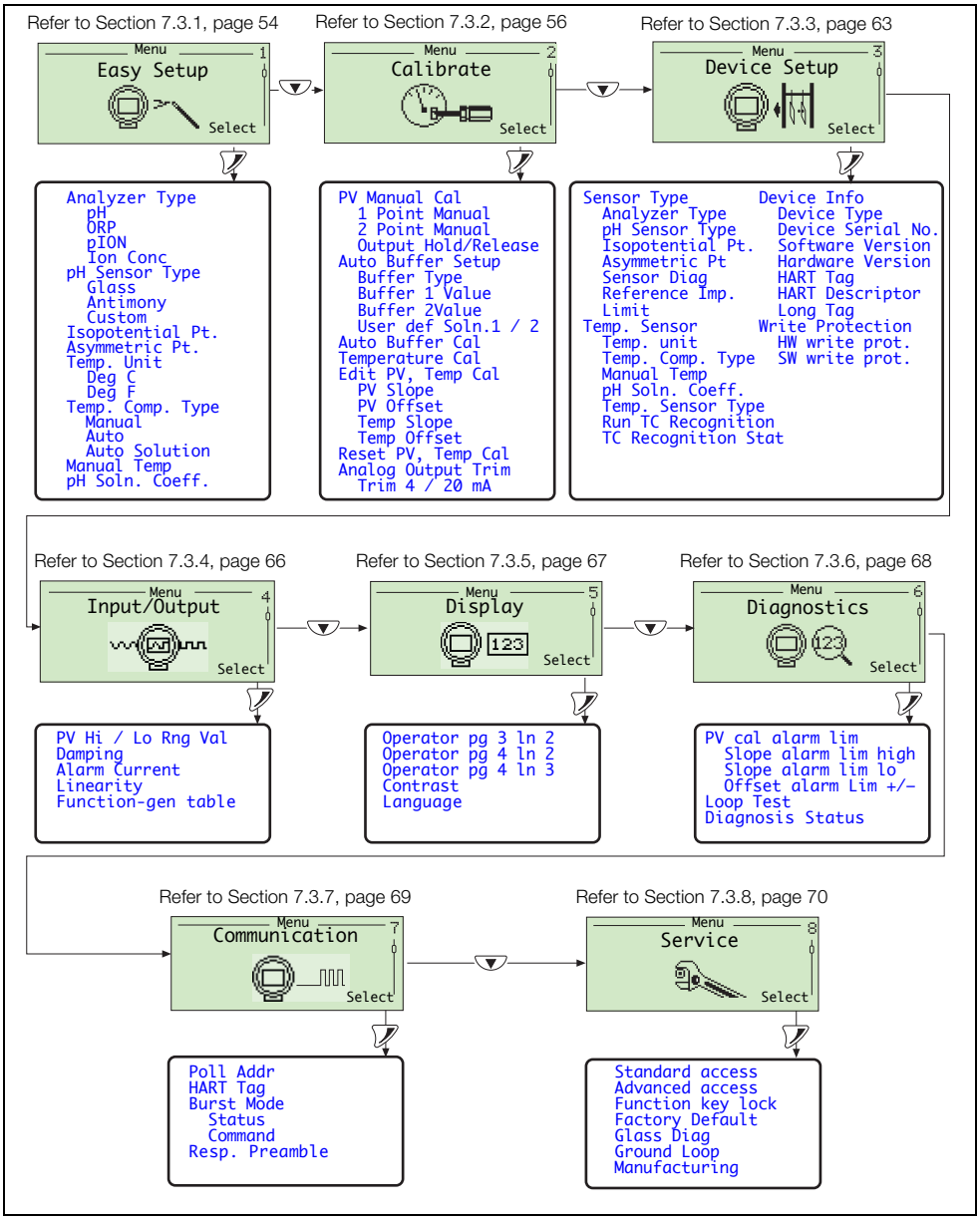


Fig. 7.3 pH Parameters

7.2.2 ORP or pION Parameters

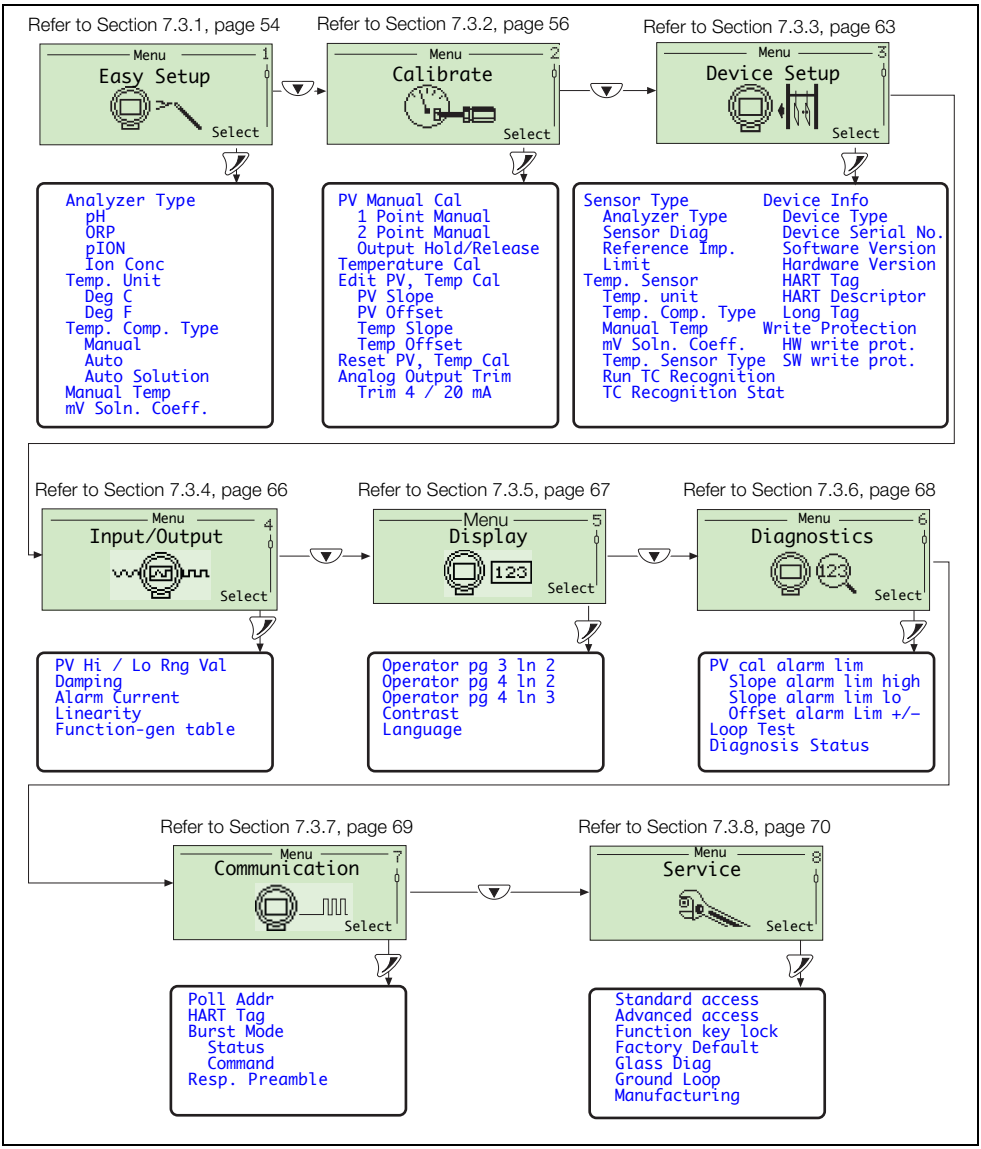


Fig. 7.4 ORP or pION Parameters

7.2.3 Ion Concentration Parameters

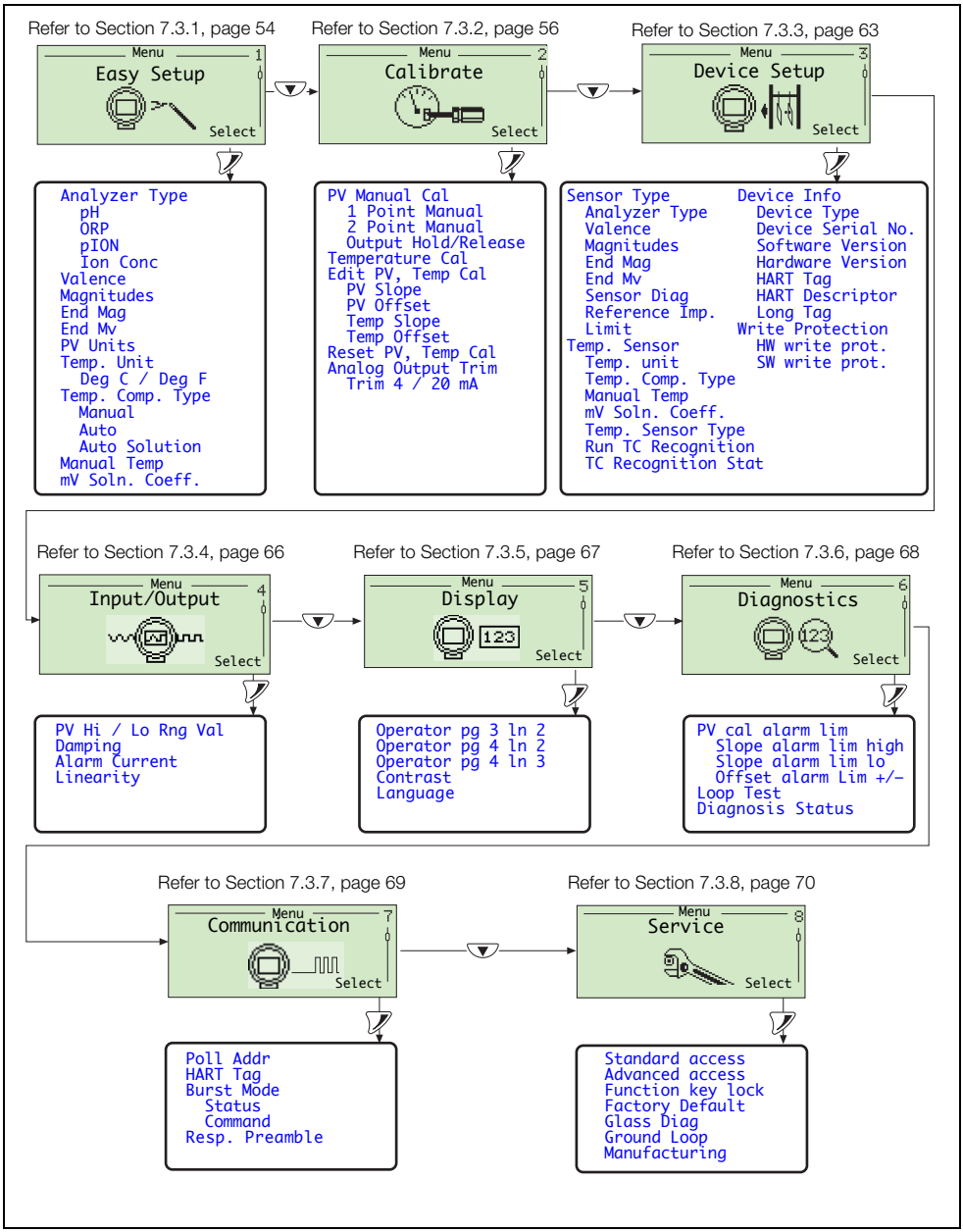
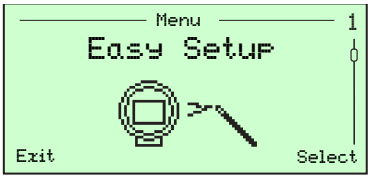


Fig. 7.5 Ion Concentration Parameters

7.3 Parameters

7.3.1 Easy Setup



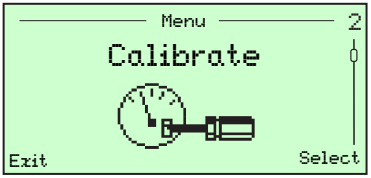
Users with *Advanced* level access have read / write privileges to the parameters listed.

Users with *Standard* and *Read Only* access have read-only privileges to parameters at *Easy Setup* level.

Easy Setup Parameters Parameter	Description	Tx Type
Analyzer Type	Selects the measurement type: ■ pH ■ ORP ■ pION ■ Ion Conc	All
pH Sensor Type	Selects the sensor type used for measurement: ■ Glass ■ Antimony ■ Custom	pH
Isopotential Pt.	(Isopotential Point) Adjustable range –20 to 20 pH. Default = 7 pH. Enabled when *pH Sensor Type* = *Custom*.	pH
Asymmetric Pt.	(Asymmetric Potential) Adjustable range –2000 to 2000 mV. Default = 0 mV Enabled when *pH Sensor Type* = *Custom*.	PH
Valence	Ion valence selection: -3, -2, -1, 1, 2, or 3. The valence determines the millivolt change per decade of concentration.	Ion Conc
Magnitudes	The number of magnitudes ranging from 1 to 3 that defines the ion concentration output.	Ion Conc
End Mag	The ion concentration state functions by associating an end millivolt value to an end magnitude value. The end magnitude value can be set to 10, 100 or 1000.	Ion Conc
End mV	The end millivolt value associated with the end magnitude value.	Ion Conc
PV Units	Sets the process value units (%, ppm, µg/l, ppb, mg/l).	Ion Conc
Temp. unit	(Temperature Units) Sets the temperature unit (°C or °F) applied to all transmitter temperature parameters and values.	All

Easy Setup Parameters		
Parameter	**Description**	**Tx Type**
Temp. Comp. Type	(Temperature Compensation Type)	All
Manual	*Manual* temperature compensation is enabled when the device does not detect any temperature sensor connection either at power-up or upon execution of *Run TC Recognition*. When *Temp Comp Type* is *Manual*, the user configurable *Manual Temp* value is used for temperature compensation.	
Auto	Enabled when a temperature sensor is provided with the probe (the calculation is based on the Nernst equation – see Appendix A.3, page 98). Enabled when a temperature sensor is detected by the device either at power-up or when executing the *Run TC Recognition* routine is run (see page 64).	
Auto Solution	*Auto Solution* temperature compensation can be selected when a temperature sensor is connected and is recognized by the device. This selection provides the ability to include a solution coefficient in the Nernst equation – see Appendix A.3, page 98.	
Manual Temp.	The value in this parameter is used for temperature compensation during *Manual* temperature compensation mode. Adjustable range –20 to 150 °C (–4 to 302 °F). Default = 25 °C (77 °F). Enabled when *Temp. Comp. Type* = *Manual.*	All
pH Soln. Coeff.	Adjustable range –10 to 10. Default = 0 pH / 10 °C (50 °F). Enabled when *Temp. Comp. Type* = *Auto.*	pH
mV Soln. Coeff.	Adjustable range –20 to 20. Default = 0 mV / 10 °C (50 °F). Enabled when *Temp. Comp. Type* = *Auto.*	ORP / pION, Ion Conc

7.3.2 Calibrate



Used to calibrate the transmitter.

Calibrate Parameters Parameter	Description	Tx Type
PV Manual Cal	Reference procedure for calibration of the pH process value. Options comprise: ■ 1 Point Manual – see Table 7.2, page 58 ■ 2 Point Manual – see Table 7.3, page 59 ■ Output Hold/Release – a quick access menu to hold or release the current output	All
Auto Buffer Setup		pH
Buffer Type	Selects the type of buffer used: ■ User-defined ■ ABB ■ NIST ■ DIN 19266 ■ Merck ■ US Tech	
Buffer 1 Value	Enables selection of the *Buffer 1* value based on *Buffer Type*. Enabled when *Buffer Type* is not *User Def*.	
Buffer 2 Value	Enables selection of the *Buffer 2* value based on *Buffer Type*. Enabled when *Buffer Type* is not *User Def*.	
User def Soln.1	Enables entry of a user-defined Buffer Table 1 with up to 5 temperature and pH values. Enabled when *Buffer Type = User Def*.	
User def Soln.2	Enables entry of a user-defined Buffer Table 2 with up to 5 temperature and pH values. Enabled when *Buffer Type = User Def*.	
Auto Buffer Cal	Performs a two-point calibration based on *Auto Buffer Setup* and with automatic sample stability checking – see Table 7.4, page 61. If the sensor is removed from a hot or cold process allow it to normalize to ambient temperature prior to calibration. If the sensor cannot stabilize using automatic buffer calibration, perform a manual calibration.	pH

Calibrate Parameters		
Parameter	**Description**	**Tx Type**
Temperature Cal	The temperature calibration is used to calibrate the temperature input from the sensor against a standard known reading – see Table 7.5, page 62. A two-point temperature calibration is performed using this routine by calibrating, in succession, at a low temperature value and a high temperature value (the two values separated by at least 20 °C [68 °F]). This results in both temperature slope and offset computation. **Note** – **ORP**. The temperature effect on ORP sensors is negligible. The effect of temperature on pION sensors is difficult to characterize, except for specific applications. Therefore, only the solution coefficient option can be used to compensate for electrode and process changes with temperature.	All
Edit PV, Temp Cal	Enables manual adjustment of the sensor PV slope and offset and sensor temperature slope and offset. **Note**. This function may not be suitable for many applications, but it provides quick, easy access to these calibration values for troubleshooting.	
PV Slope	Edits the *PV Slope* value as a percentage.	All
PV Offset	Edits the *PV Offset* value.	
Temp Slope	Edits the *Temp Slope* value as a percentage.	
Temp Offset	Edits the *Temp Slope* value.	
Reset PV, Temp Cal	Resets all process sensor and temperature sensor calibration data to default factory settings.	All
Analog Output Trim	Adjusts the maximum / minimum output signals (4 to 20 mA, ±0.5 mA) to maintain precise transmission of the process variable to the final monitoring system. The transmitter's output current is factory calibrated, however, the output can be trimmed if required. **Note**. Enabled when *HART Poll Addr = 0* – see page *69*. Not applicable to HART multidrop mode where current output is not used.	All

1-Point Manual Calibration

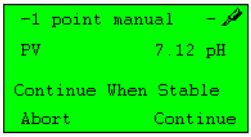
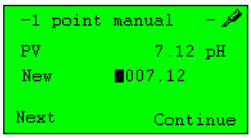
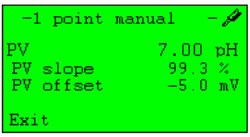
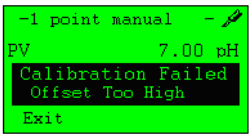
Step	Procedure	Screen
①	At the *PV Manual Cal* parameter select the *1 Point Manual* calibration option and apply an input. Wait for the message '*Continue When Stable*' to be displayed then press the ◢ key to continue.	
②	Enter the new PV value using the ▲ and ▼ keys then press the ◢ key to continue.	
③	At the calibration results screen(s) check the new values. *Press the ◥ key to exit the screen:* or if a calibration failure message is displayed, reset the PV value (see steps 1 and 2).	 

Table 7.2 1-Point Manual Calibration

2-Point Manual Calibration

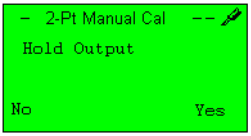
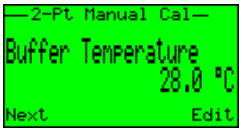
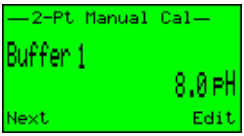
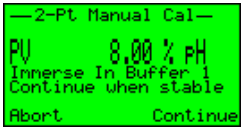
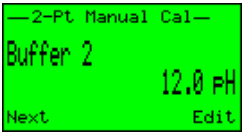
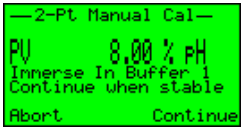
Step	Procedure	Screen
①	At the *PV Manual Cal* parameter select the *2-Point Manual* calibration option – this screen provides an option to hold the output. *Press the* ◥ *key to cancel hold or* the ◢ key to hold the output.	
②	Edit the buffer temperature by pressing the ◢ key and use the ▲ and ▼ keys to select the required temperature. *Press the* ◥ *key to proceed*.	
③	Edit the 1st buffer value by pressing the ◢ key and use the ▲ and ▼ keys to select the required value. *Press the* ◥ *key to proceed*.	
④	Apply Buffer 1 input, watch for PV stability (wait for the message '*Continue When Stable*' to be displayed) then press the ◢ key to continue.	
⑤	Edit the 2nd buffer value by pressing the ◢ key and use the ▲ and ▼ keys to select the required value. *Press the* ◥ *key to proceed*.	
⑥	Apply Buffer 2 input, watch for PV stability (wait for the message '*Continue When Stable*' to be displayed) then press the ◢ key to continue.	

Table 7.3 2-Point Manual Calibration

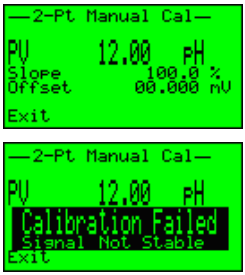
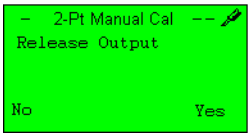
Step	Procedure	Screen
⑦	At the calibration results screen(s) check the new values. *Press the ▽ key to exit the screen:* or if a calibration failure message is displayed, reset the buffer values (see steps 2 to 6).	
⑧	If the *Hold Output* screen was selected at step 1, an option to release the output is provided at the *Release Output* screen. *Press the ▽* key to retain the *Hold Output* state or the *▷ key* release the *Hold Output* state.	

Table 7.3 2-Point Manual Calibration (Continued)

Auto Buffer Calibration

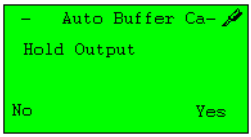
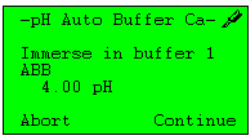
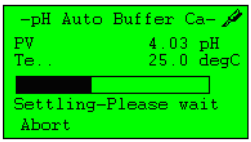
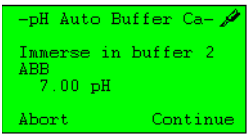
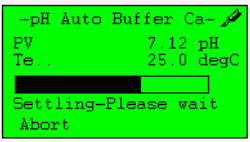
Step	Procedure	Screen
①	At the *Auto Buffer Calibration* parameter press the ▽ key to display the *Hold Output* screen – this screen provides an option to hold the output. *Press the ◁ key to cancel hold or* the ▽ key to hold the output.	
②	The next screen displays a prompt to immerse the sensor in buffer1 and shows the type of buffer and buffer 1 value. Press the ▽ key to proceed.	
③	The next screen shows live PV and temperature values. The progress bar indicates sampling and stability checking for PV and Temperature.	
④	The next screen displays a prompt to immerse the sensor in buffer 2 and shows the type of buffer and buffer 2 value. Press the ▽ key to proceed.	
⑤	The next screen shows live PV and temperature values. The progress bar indicates sampling and stability checking for PV and Temperature.	

Table 7.4 Auto Buffer Calibration

Step	Procedure	Screen
⑥	At the calibration results screen(s) check the new values. *Press the ▽ key to exit the screen:* or if a calibration failure message is displayed, reset the buffer values (see steps 2 to 5).	-pH Auto Buffer Ca- PV 7.00 pH PV slope 99.3 % PV offset -5.0 mV Exit -pH Auto Buffer Ca- PV 7.00 pH Calibration Failed Offset Too High Exit
⑦	If the *Hold Output* screen was selected at step 1, an option to release the output is provided at the *Release Output* screen. *Press the* ▽ key to retain the *Hold Output* state or the ▷ *key* release the *Hold Output* state.	- Auto Buffer Ca- Release Output No Yes

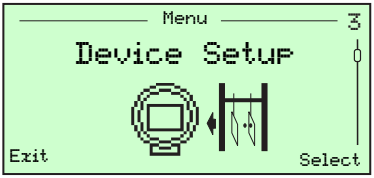
Table 7.4 Auto Buffer Calibration (Continued)

Temperature Calibration

Step	Procedure	Screen
①	At the *Temperature Cal* parameter, wait for the message '*Continue When Stable*' to be displayed then press the ▷ key to continue.	-Temperature cal - Temp. 50.0 °C Continue When Stable Abort Continue
②	Enter the new temperature using the △ and ▽ keys to select the new value then press the ▷ key to continue display the result screen.	-Temperature cal - Temp. 50.0 °C New 025.0 Next Continue

Table 7.5 Temperature Calibration

7.3.3 Device Setup



Used to set the sensor / sensor input, run temperature sensor recognition and obtain transmitter information.

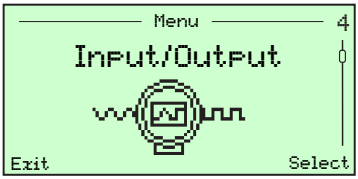
Note. Required access level = *Advanced*.

Device Setup Parameters		
Parameter	**Description**	**Tx Type**
Sensor Type		
Analyzer Type	Sets the analyzer type: ■ pH ■ ORP ■ pION ■ Ion Conc	All
pH Sensor Type	Selects the type of sensor used for measurement: ■ Glass ■ Antimony ■ Custom	pH
Isopotential Pt.	(Isopotential Point) Enabled when *pH Sensor Type* = *Custom*. Adjustable range –20 to 20 pH. Default = 7 pH. Enabled when *pH Sensor Type* = *Custom*.	
Asymmetric Pt	(Asymmetric Potential) Adjustable range –2000 to 2000 mV. Default = 0 mV Enabled when *pH Sensor Type* = *Custom*.	
Valence	Ion valence selection of either –3, –2, –1, 1, 2, or 3. The valence determines the millivolt change per decade of concentration.	Ion Conc
Magnitudes	The number of magnitudes ranging from 1 to 3 that defines the ion concentration output.	
End Mag	The ion concentration state functions by associating an end millivolt value to an end magnitude value. The end magnitude value can be set to 10, 100 or 1000.	
End mV	The end millivolt value associated with the end magnitude value.	
Sensor Diag	Turns sensor diagnostics on (*Yes*) or off (*No*).	All
Reference Imp. Limit	A reference impedance value above this limit triggers a diagnostic error for high-reference impedance. Adjustable range 1 to 1000 KΩ. Default = 50 KΩ. Limit enabled when *Sensor Diag* = *Yes*.	

Device Setup Parameters Parameter	Description	Tx Type
Temp. Sensor	Temperature sensor parameters.	
Temp. unit	Sets the temperature unit (°C or °F) applied to all transmitter temperature parameters and values.	All
Temp. Comp. Type	(Temperature Compensation Type) ■ *Manual* The value in this parameter is used for the referenced temperature compensation during manual temperature compensation mode (default value 25 °C (77 °F). Manual is the default parameter if a valid temperature sensor is not recognized at power-up or when a *Run TC Recognition* routine is run (see below). ■ *Auto* Enabled when a temperature sensor is provided with the probe (the calculation is based on the Nernst equation – see Appendix A.3, page 98). *Auto* is the default parameter if a valid temperature sensor is recognized at power-up or when a *Run TC Recognition* routine is run. ■ *Auto Solution* *Auto Solution* temperature compensation can be selected when a temperature sensor is connected and is recognized by the device. This selection provides the ability to include a solution coefficient in the Nernst equation – see Appendix A.3, page 98.	
Manual Temp	The value in this parameter is used for temperature compensation during *Manual* temperature compensation mode. Adjustable range –20 to 150 °C (–4 to 302 °F). Default = 25 °C (77 °F). Enabled when *Temp Comp Type = Manual.*	
pH Soln. Coeff.	Adjustable range –10 to 10. Default = 0 pH / 10 °C (50 °F). Enabled when *Temp. Comp Type = Auto Solution*.	pH
mV Soln. Coeff.	Adjustable range –20 to 20. Default = 0 mV / 10 °C (50 °F). Enabled when *Temp. Comp Type = Auto Solution*.	ORP / pION, Ion Conc
Temp. Sensor Type	Indicates the type of integral temperature sensor detected: ■ Pt100 ■ Pt1000 ■ Balco 3k	All
Run TC Recognition	Starts the auto-recognition process for the sensor. Acceptable types for this process are: Pt100 2-wire, Pt100 3-wire, Pt1000 2-wire, Pt1000 3-wire, Balco 2-wire, Balco 3-wire.	
TC Recognition Stat	Indicates if the temperature sensor was recognized / not recognized, either during startup or after execution of the *Run TC Recognition* function, above.	

Device Setup Parameters		
Parameter	**Description**	**Tx Type**
Device Info		
Device Type	The type of device, for example APA592–PH (read-only).	
Device Serial No.	The device-specific serial number (read-only).	
Software Version	The device's software version number (read-only).	
Hardware Version	The device's hardware version number (read-only).	
HART Tag	A configurable HART tag. Default tag is APA592PH.	
HART Descriptor	Use to specify a short HART description for the device (entered from the alphanumeric character set).	
Long Tag	Use to specify a longer HART description for the device (entered from the alphanumeric character set, maximum 32 characters).	
Write Protection	Displays hardware / software write protection status. **Note**. Configurations can be protected by enabling the configuration DIP-switch – see Section 6.2, page 46.	
HW write prot.	Displays the current state of the Hardware Write Protection switch (configuration DIP-switch) – *Off / On*.	
SW write prot.	Turns the software *Write Protection Off / On*. **Note**. Software *Write Protection* cannot be modified when hardware write protection is enabled through the DIP switch – see Section 6.2, page 46.	

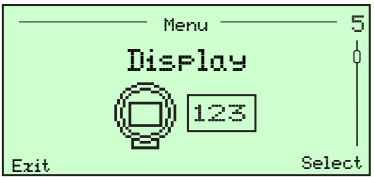
7.3.4 Input/Output



Used to setup process value high / low ranges, damping and alarm current settings.

Input Output Parameters		
Parameter	**Description**	**Tx Type**
PV Hi / Lo Rng Val	–2 to 16 pH (pH transmitter) or –1500 to 1500 mV (ORP / pION, Ion Conc. transmitter)	All
Damping	Minimum value 0.0 s, maximum value 99.9 s.	All
Alarm Current	Level of current loop output under alarm conditions: ■ High (corresponds to alarm current level of 21.5 mA) ■ Low (corresponds to alarm current level of 3.8 mA)	All
Linearity	Options comprise: ■ Function-generator (see below) ■ Linear output	All
Function-gen table	Enabled when *Linearity = Function-generator* Range comprises X1/Y1 to X5/Y5. Example table: X1 = Y1 = 16.70 % X2 = Y2 = 33.30 % X3 = Y3 = 50 % X4 = Y4 = 67.70 % X5 = Y5 = 83.30 %	pH, ORP / pION

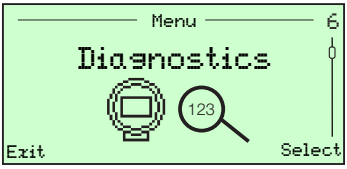
7.3.5 Display



Used to configure and format the information displayed, including: language, data displayed on Operator Pages 3 and 4 and screen contrast.

Display Parameters Parameter	Description	Tx Type
Operator pg 3 ln 2	Selects the type of data displayed on line 2 of *Operator Page 3*: ■ temperature ■ sensor input ■ ref impedance ■ PV% ■ current	All
Operator pg 4 ln 2	Selects the type of data displayed on line 2 of *Operator Page 4*. Options as *Operator pg 3 ln 2* (above).	
Operator pg 4 ln 3	Selects the type of data displayed on line 3 of *Operator Page 4*. Options as *Operator pg 3 ln 2* (above).	
Contrast	Displays the current contrast level (default 50 %) and enables the contrast to be changed using the ▲ and ▼ keys.	
Language	Selects the display language for all parameters: English, Deutsch, Francais, Espanol, Italiano, Portugues	

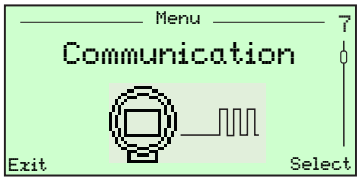
7.3.6 Diagnostics



Used to perform a loop test (output verification) and indicates the diagnostic status (actual / simulated).

Diagnostics Parameters		
Parameter	**Description**	**Tx Type**
PV cal alarm lim		All
Slope alarm lim high	100 % to 150 %. Default = 110 %.	
Slope alarm lim lo	40 % to 100 %. Default = 60 %.	
Offset alarm Lim +/–	0 to ±10000 mV. Default = ±180 mV.	
Loop Test	The current output of the transmitter can be adjusted between 3.8 and 21.5 mA. This feature is useful to verify that the transmitter output matches the current in the control room. Enabled when *HART Poll Addr = 0* – see page 69.	
Diagnosis Status	Used to determine if diagnostics simulation is active. When display reads *Actual*, real-time diagnostics from the transmitter are active.	

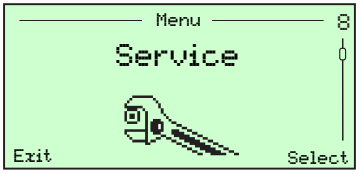
7.3.7 Communication



Used to configure HART communication parameters – see Section 9, page 83.

Communication Parameters		
Parameter	**Description**	**Tx Type**
Poll Addr	The *Poll Addr*. (poll address) is used by a HART communication master to communicate with a HART device. *Poll Addr*. = 0 conforms to HART point-to-point operating mode (4 to 20 mA current output following the Primary Value). *Poll Addr*. = 1 to 15 conforms to HART multidrop operating mode, where more than one HART device can coexist on the same set of communication lines. The current output is fixed at 4.0 mA and does not follow the Primary Value. **Note**. Changing the *Poll Addr.* while the device is communicating with a HART master causes loss of HART communication.	All
HART Tag	A configurable 8-character HART tag used for identification.	
Burst Mode	*Burst Mode* is a HART feature used to continuously transmit one of three Universal HART command response packages on the HART bus, without the need for commands being sent by the Master. This can be used to provide the quickest possible output from the device.	
Status	Enables / Disables Burst Mode (On / Off).	
Command	Selects the HART command for the response package that is transmitted continuously from the device when *Burst Mode* is turned on – refer to Section 9.3, page 86 for details of available commands.	
Resp. Preamble	The *Resp. Preamble* (response preamble) parameter determines the number of communication preamble bytes sent in the response message from the device. The Response preamble can be set for any value from 5 to 20 bytes (default value 5 bytes). **Note**. This value must be synchronized with the control system.	

7.3.8 Service



Service level parameters are reserved for ABB factory-trained personnel.

Service Parameters Parameter	Description	Tx Type
Standard access	Enables / disables password protection to the *Standard Access* level. The factory default is disabled (*Disable password*).	All
Advanced access	Enables / disables password protection to the *Advanced Access* level. The factory default is disabled (*Disable password*)	
Function key lock	Locks *the* ◁, △, ▽, ▷ keys on the keypad. Factory default is unlocked (*No)*. To lock the keypad select *Yes*. To unlock the keypad, first enable the keypad by holding down *the* △ key for 5 seconds, then access the *Function key lock* menu and select *No*.	
Factory Default	Resets all parameters to their factory default settings.	
Glass Diag	An internal value for service use.	
Ground Loop	An internal value for service use.	
Manufacturing	This parameter is reserved for factory access only.	

8 Troubleshooting and Diagnostics

During operation, the APA592–PH transmitter performs continuous diagnostic checks on hardware, software and sensor functions. If a non-conformance condition is detected an alert is displayed in the lower portion of the *Operator* screen. Press the ▽ key to access the *Operator Menu* and select the *Diagnostics* screen to view the messages – see Fig. 8.1 for an example of a message.

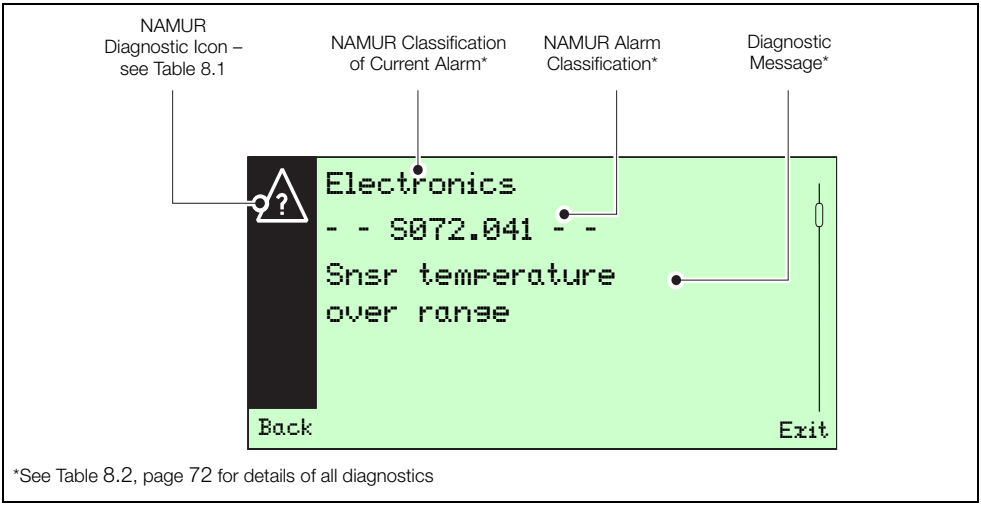


Fig. 8.1 Example of Diagnostic Alert

NAMUR (NE107)-based icons are used to indicate diagnostic conditions. The severity of the condition is related to the icon type displayed with the message – see Table 8.1 (see Section 8.1, page 72 for a list of messages and corrective actions).

Icon and Name	Description
Failure	Transmitter functionality lost due to malfunction in the Instrument itself, its peripherals or due to operating conditions.
Maintenance Required	Transmitter functionality fully available but maintenance required soon to avoid functional restrictions.
Check Function	Transmitter functionality might be temporarily restricted due to on-going work. Example – simulation or a function check.
Out of Specification	Transmitter functionality available but decreased due to operating conditions outside the specified limits or due to internal problems.

Table 8.1 NAMUR Diagnostic Icons

8.1 Diagnostic Messages

Diagnostic messages are related to 5 conditions:

1. Process diagnostics – the process setup or sensor connected to the APA592–PH transmitter.
2. Sensor diagnostics – the sensor, its connections or calibration.
3. Installation diagnostics – HART setup, or, more commonly, during initial installation of the transmitter or a new sensor.
4. Operating conditions diagnostics – the operating condition of the transmitter, such as the DC voltage used to power the transmitter.
5. Electronics diagnostics – the transmitter's internal circuitry or the wiring connected to it.

Note.

- Sub-error messages are displayed on the transmitter's DTM software only.
- Some diagnostic messages can be masked (see Section 8.2.2, page 80). This function is indicated in column 1 of Table 8.2 (below) where available.

Diagnostic Message [Sub-error Message]	Possible Cause(s) [Related Condition]	Corrective Action
Configuration Changed 	The device configuration has been changed by a write or set command or by an operation via device HMI. [INSTALLATION: This condition is not displayed on the HMI. This is just an indication to the HART master. It is visible only on the EDD and DTM]	Ensure that the copy of the device configuration in the DTM is the same as the device, (perform a configuration upload or download as required), then clear the *Configuration Changed* flag from the *Extras / Reset* menu.
C090.030 Output hold is enabled (Loop Test) 	The analog and digital analog outputs for the Primary Variable are held at the requested value. Device is in fixed current (Loop Test) mode. [STATUS]	Use HMI or a HART configurator (DTM / Hand held) to place transmitter back into normal operating mode (Remove from Loop Test – Fixed output mode) if the current operating conditions allow.
F086.000 PV input error 	PV related sensor board electronics malfunction. [ELECTRONICS]	Contact factory.

Table 8.2 Diagnostic Messages

Diagnostic Message [Sub-error Message]	Possible Cause(s) [Related Condition]	Corrective Action
F088.016 Sensor electronics failure or wrong sensor board [Sensor electronics interface error] 	Data exchange with sensor electronics board has failed. [ELECTRONICS]	Power cycle the transmitter and check if the problem is corrected. If the error persists, replace electronics.
F106.032 Unreliable output current 	The D to A converter is not properly Calibrated / Trimmed or output current has reached its hardware limit. [ELECTRONICS]	Perform an Output Trimming. If the error persist, replace the electronics.
F108.035 Output ReadBack failure 	The output circuit could be broken or not correctly calibrated [ELECTRONICS]	Perform an Output Trimming. If the error persists replace electronics.
F116.023 Memory Failure 	Electronic memory corrupted. [ELECTRONICS]	Replace electronics. Contact factory.
M023.036 Sensor electronics voltage warning 	Sensor electronics related malfunction. [ELECTRONICS]	Check sensor wiring. If problem persists, contact factory.
M024.033 Power Supply warning [Power Supply too High] [Power Supply too Low] 	The Device Power Supply is close to the highest / lowest acceptable limit. [CONDITION]	Check the Voltage at the terminal block and if it is not within the valid range check the external power supply.

Table 8.2 Diagnostic Messages (Continued)

Diagnostic Message [Sub-error Message]	Possible Cause(s) [Related Condition]	Corrective Action
M026.024 Non-volatile memory burn error 	Writing to the electronic non-Volatile Memory was not successful. [ELECTRONICS]	Replace the electronics as soon as possible.
M052.037 Sensor diagnostic signal input error [Glass diag signal input error] 	Glass diagnostic signal related sensor board electronics malfunction. [ELECTRONICS]	If the sensor does not support diagnosis, disable the sensor diagnosis feature – see page 63. If the problem persists, contact factory.
M054.012 High reference electr. impd. 	Reference electrode impedance is higher than the user set limit [SENSOR]	Verify sensor wiring. Verify sensor wiring is free of nicks, cuts, breaks and/or open connections. Verify configuration settings are correct. Ensure diagnostics is set to OFF if the sensor does not have a solution ground connection. Verify reference electrode is clean. Remove any foreign material. Verify sensor responds to pH buffers.
M056.002 Ref impedance input error 	Sensor reference diag signal related sensor board electronics malfunction. [ELECTRONICS]	Contact factory.
M058.018 Snsr factory cal data corrupt 	Sensor factory calibration data corrupt or missing. [ELECTRONICS]	Contact factory.

Table 8.2 Diagnostic Messages (Continued)

Diagnostic Message [Sub-error Message]	Possible Cause(s) [Related Condition]	Corrective Action
M060.037 Sensor diagnostic signal input error [Sensor cable diag signal input error] 	Sensor cable diag signal related sensor board electronics malfunction. [ELECTRONICS]	If the sensor does not support diagnosis, disable the sensor diagnosis feature – see page 63. If the problem persists, contact factory.
M080.039 Low pH measuring electrode impedance 	Improper sensor wiring, dirty terminal block, improper configuration or broken or cracked electrode glass. [SENSOR]	Verify sensor wiring. Verify terminal blocks and other connections are free of any liquids, oils, scale or corrosion. Verify configuration settings are correct. Ensure diagnostics is set to OFF if the sensor does not have a solution ground connection. Verify glass electrode is intact. Verify sensor responds to pH buffers.
M082.040 Open snsr cable or snsr out of solution 	Sensor wiring problems, improper configuration of sensor diagnosis option. [PROCESS]	Verify sensor wiring. Verify sensor wiring is free of nicks, cuts, breaks and/or open connections. Verify configuration settings are correct. Ensure diagnostics is set to OFF if the sensor does not have a solution ground connection.
M084.038 Ground loops present or shorted sensor cable 	Sensor wiring problems, improper configuration of sensor diagnosis option. [PROCESS]	Verify sensor wiring. Verify sensor wiring is not shorted to other wiring or metal surfaces. Verify terminal blocks and other connections are free of any liquids, oils, scale or corrosion. If a sensor extension is being used, verify connections are dry and free of corrosion. Verify configuration settings are correct. Ensure diagnostics is set to OFF if the sensor does not have a solution ground connection.
M089.039 Dirty sensor detected 	Sensor is dirty. [SENSOR]	Verify sensor tip is clean. Remove any foreign material. Clean sensor. Verify sensor responds to conductivity standard solutions. If sensor does not respond, electronically test sensor. Verify configuration.

Table 8.2 Diagnostic Messages (Continued)

Diagnostic Message [Sub-error Message]	Possible Cause(s) [Related Condition]	Corrective Action
M098.031 Analog output saturated [Analog output high saturated] [Analog output low saturated] 	The analog output for the Primary Variable is beyond its high scaling limit and no longer represents the true applied process. The Analog Output (4-20 mA) is saturated to the configured Saturation Limit High / Low. [PROCESS]	Adjust the working range if possible.
S010.047 Temp comp in MANUAL mode 	The device is in Manual TC mode and not measuring process temperature. [STATUS]	If a temperature sensor is connected, activate a *Run TC Recognition* routine. If recognition fails, check the temperature sensor wiring. Ignore or mask this warning if Manual TC is required.
S062.046 Large negative sensor offset 	Problem with the sensor, improper calibration, incorrect configuration of user defined positive/negative sensor offset limit. [SENSOR]	Clean sensor and repeat a buffer and / or process calibration. If sensor is functioning properly, order a spare sensor to replace the existing sensor when failure occurs. Replace existing sensor if sensor is not functioning properly. Verify sensor wiring is free of nicks, cuts, breaks, shorts and/or open connections. If wiring is damaged, replace wiring and / or sensor and recalibrate.
S064.045 Large positive sensor offset 	Problem with the sensor, improper calibration, incorrect configuration of user defined positive/negative sensor offset limit. [SENSOR]	Clean sensor and repeat a buffer and/or process calibration. If sensor is functioning properly, order a spare sensor to replace the existing sensor when failure occurs. Replace existing sensor if sensor is not functioning properly. Verify sensor wiring is free of nicks, cuts, breaks, shorts and / or open connections. If wiring is damaged, replace wiring and/or sensor and recalibrate.

Table 8.2 Diagnostic Messages (Continued)

Diagnostic Message [Sub-error Message]	Possible Cause(s) [Related Condition]	Corrective Action
S066.044 Low sensor efficiency (slope) 	Problem with the sensor, improper calibration, incorrect configuration of user defined low sensor efficiency limit. [SENSOR]	Verify the proper buffer values were used for calibration. Repeat calibration with correct buffer values. Clean sensor and repeat a buffer and/or process calibration. If sensor is functioning properly, order a spare sensor to replace the existing sensor when failure occurs. Replace existing sensor if sensor is not functioning properly. Verify terminal blocks and other connections are free of any liquids, oils, scale or corrosion. Verify sensor wiring is free of nicks, cuts, breaks, shorts and / or open connections. If wiring is damaged, replace wiring and / or sensor and recalibrate.
S068.043 High sensor efficiency (slope) 	Problem with the sensor, improper calibration, incorrect configuration of user defined high sensor efficiency limit. [SENSOR]	Verify the proper buffer values were used for calibration. Repeat calibration with correct buffer values. Clean sensor and repeat a buffer and/or process calibration. If sensor is functioning properly, order a spare sensor to replace the existing sensor when failure occurs. Replace existing sensor if sensor is not functioning properly. Verify terminal blocks and other connections are free of any liquids, oils, scale or corrosion. Verify sensor wiring is free of nicks, cuts, breaks, shorts and / or open connections. If wiring is damaged, replace wiring and / or sensor and recalibrate.

Table 8.2 Diagnostic Messages (Continued)

Diagnostic Message [Sub-error Message]	Possible Cause(s) [Related Condition]	Corrective Action
S070.042 Snsr temperature under range 	Sensor temperature is below range. [PROCESS]	Verify sensor wiring. Verify configuration related to temperature sensor and temperature compensation.
S072.041 Snsr temperature over range 	Sensor temperature is above range. [PROCESS]	Verify sensor wiring. Verify configuration related to temperature sensor and temperature compensation.
S074.001 Temperature input error 	Temperature related sensor board electronics error. [ELECTRONICS]	Check temperature sensor connections. If a temperature sensor is not connected, switch temperature compensation to *Manual* mode. If the problem persists, contact factory.
S076.010 PV out of range limits 	The analog output for the Primary Variable is beyond its scaling limit and no longer represents the true applied process. [PROCESS]	Adjust the working range if possible.
S078.004 PV out of physical limit 	The process applied to the sensor for the Primary Variable is beyond the operating limits of the device. [PROCESS]	Verify sensor wiring. Verify configuration setting for the sensor.

Table 8.2 Diagnostic Messages (Continued)

8.2 Diagnosis Screens

Diagnosis screens can be viewed using the DTM or the EDD graphical user interface (they cannot be viewed on the transmitter's display).

8.2.1 Diagnosis Overview Screen

An overview of active / inactive diagnostic conditions can be viewed on the diagnosis *Overview* screen – see Fig. 8.2.

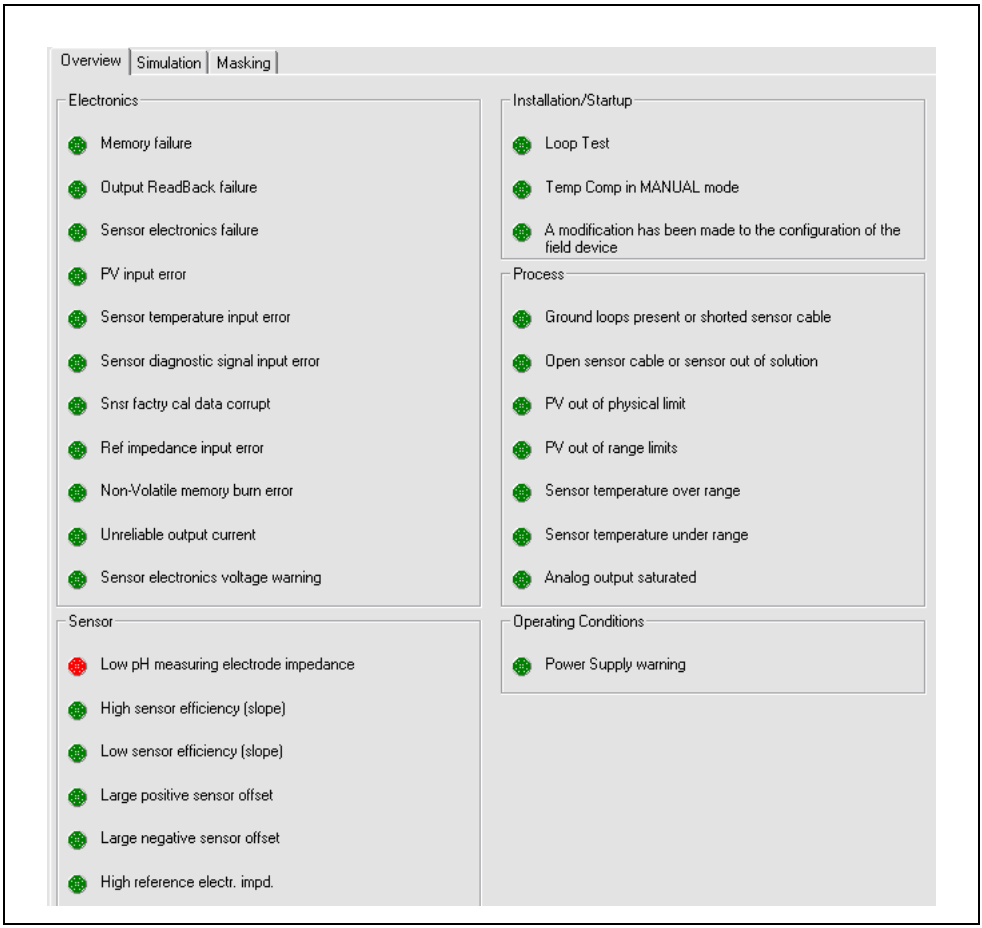


Fig. 8.2 Diagnosis Overview Screen

8.2.2 Diagnosis Masking

Certain non-critical diagnostics can be masked using the DTM or the EDD. This feature is not accessible via the transmitter's display and a masked diagnosis is not reported when it occurs. The list of maskable diagnoses is available on the DTM and EDD graphical user interface only.

The diagnosis *Masking* screen is shown in Fig. 8.3.

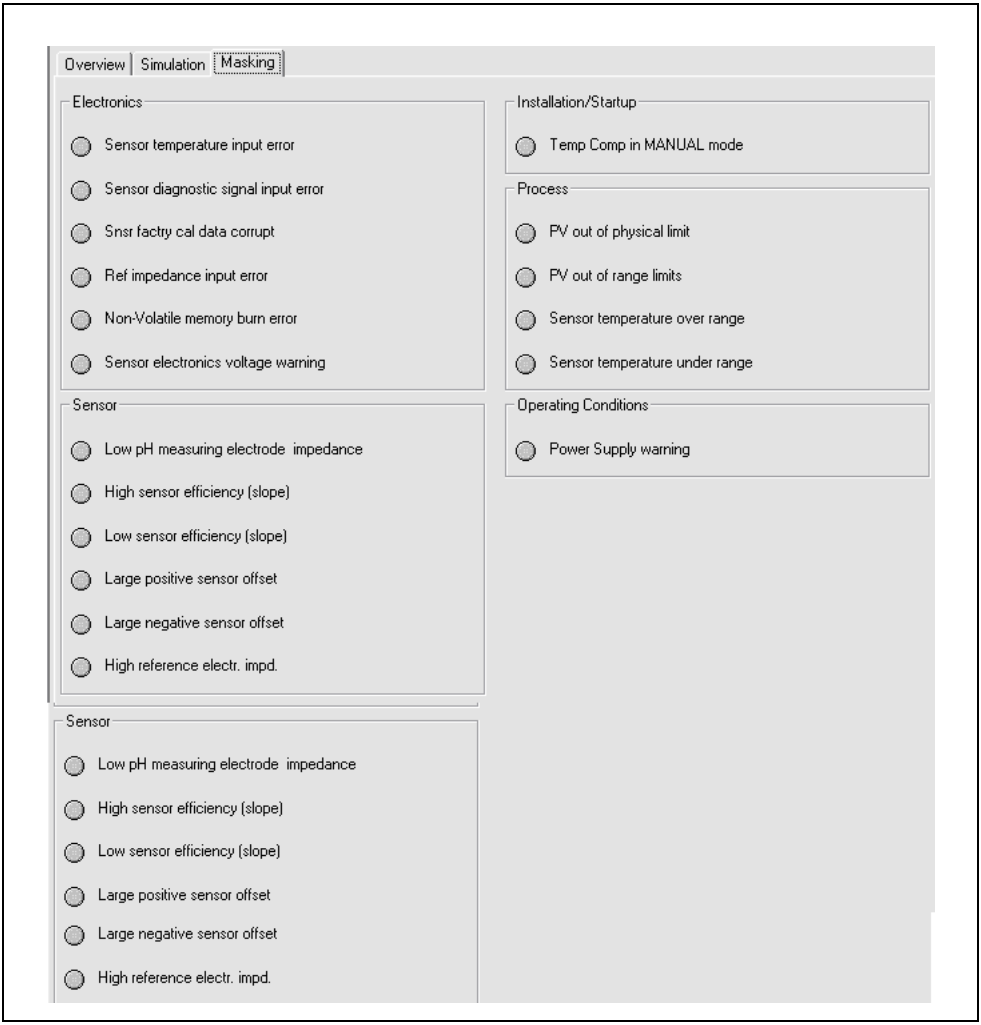


Fig. 8.3 Diagnosis Masking Screen

8.2.3 Diagnosis Simulation

All diagnosis conditions except *Loop test* (see page 72) can be simulated individually using the DTM or EDD.

To simulate a diagnosis, turn diagnosis simulation ON, select a diagnosis and send it to the transmitter. In *Simulated Diagnosis* mode, all active diagnoses are suppressed and only the simulated diagnosis is reported.

Diagnosis simulation status can be viewed on the HMI using *Diagnostics / Diagnosis Status* menu (see Section 7.3.6, page 68). The status is either *Simulated* or *Actual* (diagnosis simulation cannot be set or cleared from the HMI.

Caution.

- Diagnosis simulation cannot be performed via the transmitter's display.
- Diagnosis simulation should be used for advanced test purposes only.
- Diagnosis simulation is volatile – simulation setting is lost after a power-up.

The diagnosis *Simulation* screen is shown in Fig. 8.4.

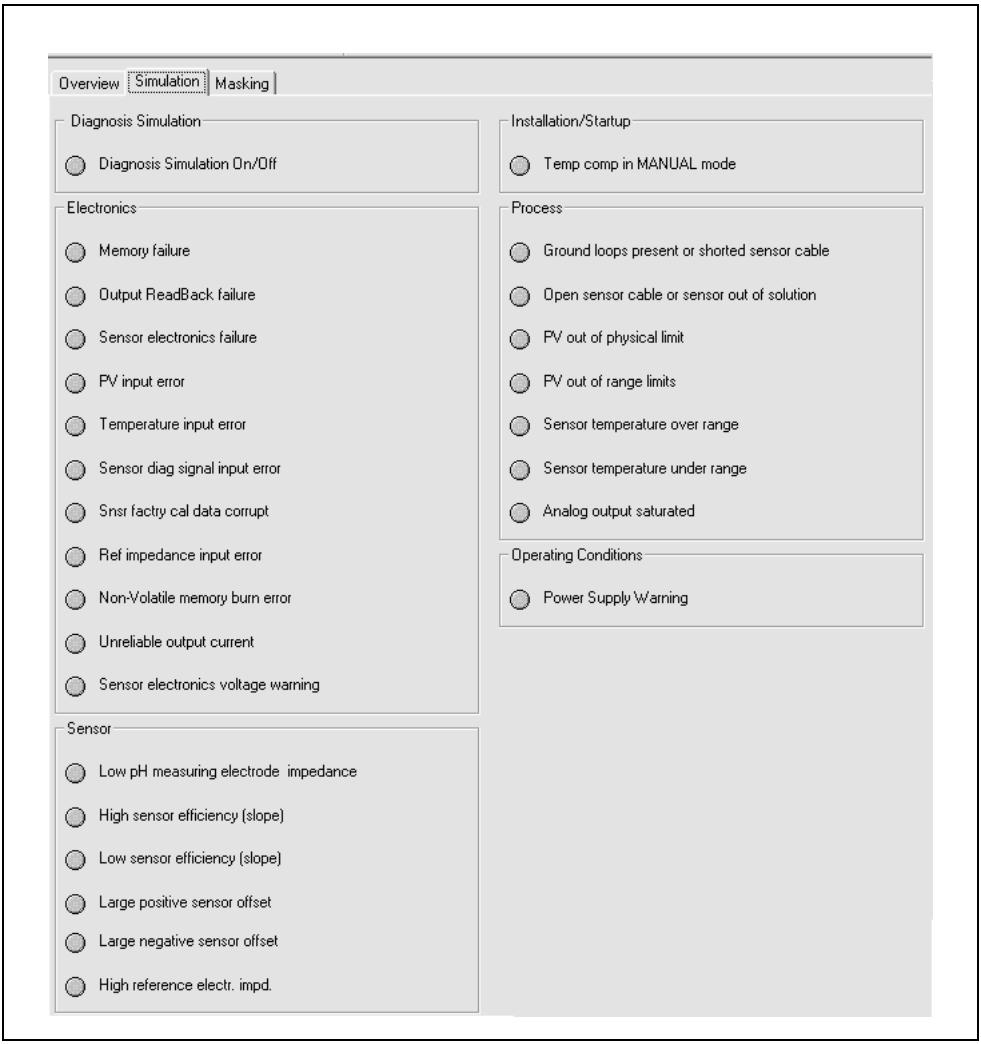


Fig. 8.4 Diagnosis Simulation Screen

9 HART Communication

For ease of identification, each HART device features a configurable 8-character HART tag. In addition to the HART tag, each device has a HART address (set to the default value 0). At this address, the device operates in HART standard communication mode (point-to-point operation).

When an address in the range 1 to 15 is used, the device switches to HART multidrop mode. This operating mode enables users to connect up to 15 devices in parallel to a power supply.

In multidrop mode, an analog output signal that matches the Primary Value is not available. The output signal in multidrop mode is basically a constant 4 mA and is used exclusively for the power supply. In multidrop mode, sensor or process data information is available as a HART signal only.

In addition to point-to-point and multidrop modes, the third type of HART communication is burst mode. When *Burst Mode* is activated, the device transmits a HART telegram continuously, containing process information approximately every 500 ms without prompting by a HART command – refer to page 69 for further details of *Burst Mode*.

9.1 HART Device Type Codes

All HART products contain unique identifiers that specify the device type.

The device type code for APA592-PH is 48 (30 hex) under manufacturer type code 26 (1A hex).

9.2 HART Configuration map

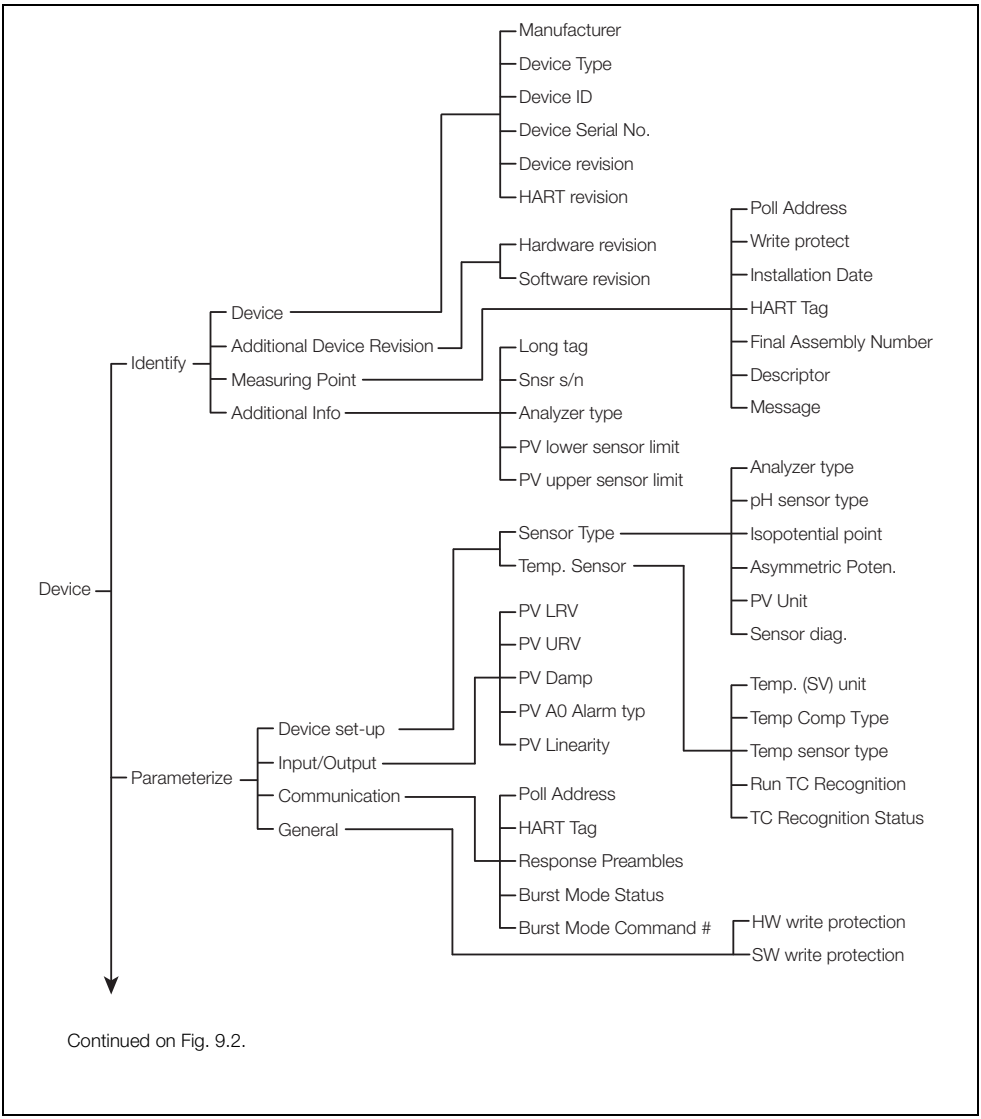


Fig. 9.1 HART Configuration Parameters

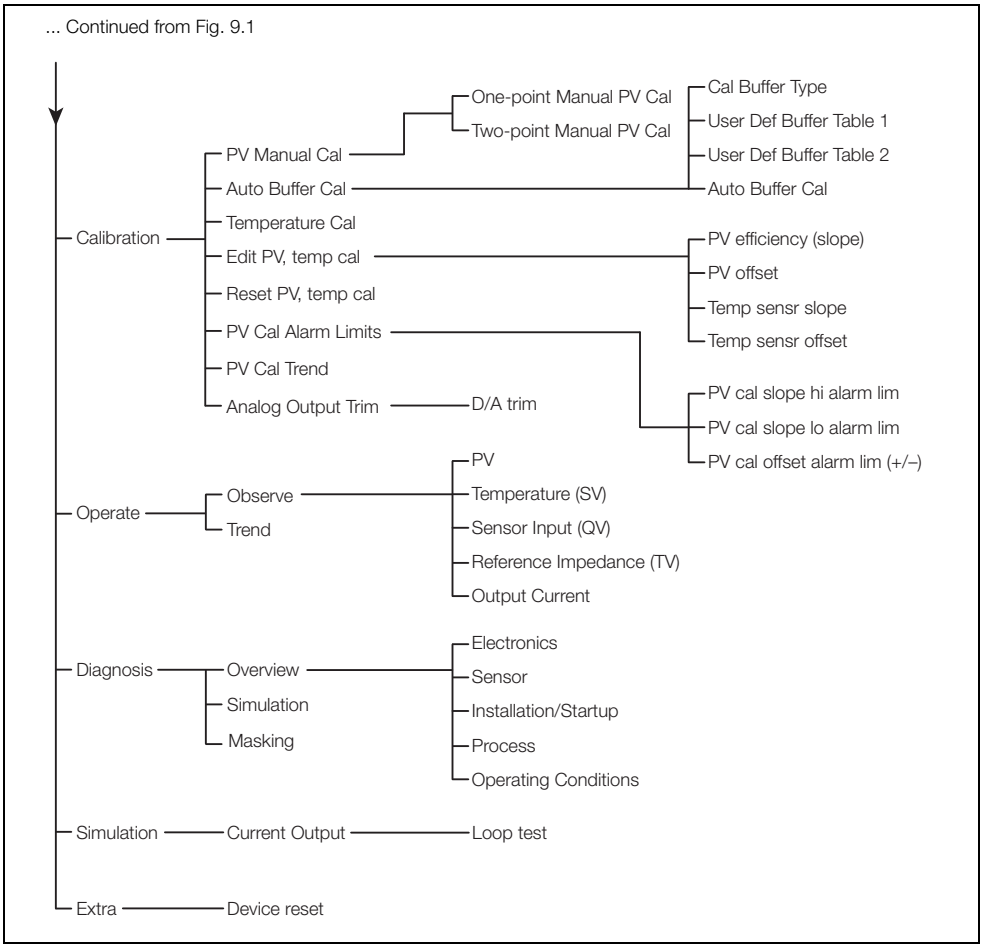


Fig. 9.2 HART Configuration Parameters (continued)

9.3 HART Universal Commands

Command No.	Description	Details
0	Read Transmitter Unique Identifier	Expanded device type code. Manufacturer identification code. Manufacturer device type code. Number of preambles. Revision level of HART Universal Command set implemented. Revision level of device-specific command set implemented. Transmitter software revision level. Transmitter hardware revision level. Device identification number.
1	Read Primary Variable	pH, ORP, pION or Ion Concentration process value with units.
2	Read Current and % of Range	PV (pH, ORP, pION or Ion Conc) and PV percentage of range.
3	Read Dynamic Variables and Current	Current output value (mA). PV value (pH, ORP, pION or Ion Conc) and PV unit (pH, mV, ppb, ppm, %, ug/l, mg/l). Temperature value and unit (°C or °F). Reference Impedance value and unit (Kohm). Sensor input value and unit (mV).
6	Write Polling Address	When set to 0, Current Output is active and provides an analog output proportional to the Primary Value. HART operates in point-to-point mode. When set between 1 to 15, Current Output is fixed at 4 mA and HART operates in multi-drop mode.
11	Read unique Identifier Associated with Tag	Returns the expanded device type code, revision levels and identification number of the device that contains the HART identification tag sent with this command.

Table 9.1 HART Universal Commands

Command No.	Description	Details
12	Read message	Returns the user-defined HART message.
13	Read Tag, Descriptor and Date	Returns the user-defined HART information: HART Tag HART Descriptor Device installation date
14	Read Primary Variable Sensor Information	Returns the sensor limits and minimum permissible span of the sensor.
15	Read Primary Variable Output Information	PV Alarm selection code: 0 = Low, 1 = High, PV upper and lower range values. Damping time. Write protection status. Any private label distributor code associated with the device.
16	Read Final Assembly Number	Returns the user-defined final assembly number.
17	Write Message	Enables a user-defined message of up to 32 characters to be entered.
18	Write Tag, Descriptor and Date	Enables the user to assign a user-defined 8-character tag to the device. Enables a user-defined 16-character descriptor to be entered. Enables an installation date to be entered.
19	Write Final Assembly Number	Enables a user-defined final assembly number to be entered. This can be used for inventory or maintenance purposes.

Table 9.1 HART Universal Commands (Continued)

9.4 HART Common Practice Commands

Command No.	Description	Details
34	Write Damping	Enables the user to alter the PV damping value in seconds
35	Write the PV Range	Enables the PV (pH, ORP, pION or Ion Conc) low and high range values to be set for the range.
38	Write Configuration Reset	Enables the configuration changed flag to be changed.
40	Write Fixed Output Value	A value in the range of 3.8 to 21.5 can be written to fix the output of the device. A value of 0.0 should be written to fixed Output Value to exit the device from fixed output mode.
41	Start Self Test	Performs self-test function on the device.
42	Master Reset	Device can be reset.
44	Write PV Units	PV unit (pH, mV, ppb, ppm, %, ug/l or mg/l) ug/l = micro-grams/liter mg/l = milli-grams/liter
45	Write Trim Loop Current Zero	Enables user to trim the lower endpoint (for example,~4.0mA) of the device's output.
46	Write Trim Loop Current Gain	Enables user to trim the upper endpoint (for example, ~20.0 mA) of the device's output.
47	Write PV Transfer function	User can alter the PV output linearity (used if a function-generator is needed for output adjustment)

Table 9.2 HART Common Practice Commands

Command No.	Description	Details
48	Read Device Status	The status of the device, determined from results of the continuous self-diagnostics, is reported every time communications with the device are established. If the device indicates there is additional status information, it can be obtained via this command.
49	Write Sensor Serial Number	Sensor serial number can be entered.
59	Write Number of Response Preambles	User can access and write the number of Response Preambles
108	Write Burst Mode Command Number	Burst command numbers 1, 2, 3 can be entered.
109	Write Burst Mode Control	User can turn ON/OFF Burst mode with this command.

Table 9.2 HART Common Practice Commands (Continued)

10 Specification

Input

Process Variable

pH	Glass, antimony (Sb)
ORP (Redox)	Platinum (Pt), Gold (Au)
pION	Custom user-programmable

Resistance

Glass	$1x10^{13}\ \Omega$

Range

pH	0 to 14 pH (–2 to 16 pH over range)
ORP	–1500 to +1500 mV

Resolution / Accuracy / Linearity / Stability

pH	+/– 0.01pH
ORP / pION	+/– 1mV

Temperature

Sensor

Auto-recognition	PT100, PT1000, 3 kΩ Balco 2- and 3-wire inputs

Input Range

–20 to 200 °C (–4 to 392 °F)

Accuracy / Stability

+/– 0.1 °C (0.18 °F) after calibration

Compensation Modes

pH	Manual, Automatic Nernstian, Nernstian with solution coefficient
ORP / pION	Manual, solution compensation coefficient

Dynamic Response

<3 Seconds for 90 % step change at 0.00 second dampening

Output

Signal

Configurable	4 to 20 mA (standard with HART)
	User-programmable linear and non-linear across the entire range
Dynamic range	3.9 to 20.75 mA (3.8 mA = low alarm level, 21.5 mA = high alarm level)

Minimum Span
1 pH / 100mV

Maximum Span
14 pH / 3000 mV

Damping
Adjustable 0.0 to 99 seconds

Power Supply (Polarity Safe)

Supply Voltage
U_s = 12 to 42 V DC (Non-intrinsically safe installations)

U_s = 12 to 30 V DC (Intrinsically safe and Ex ia installations)

Maximum Permissible Ripple
Maximum ripple for supply voltage during communication in accordance with HART FSK physical layer specification, version 8.1 (08/1999) section 8.1

Under-voltage Protection
$U_{Terminal\text{-}Mu} < 12$ V results in I_a = 3.8 mA

Maximum Load
Rload = (supply voltage – 12 V) / 22 mA

Max. load Ω depending on supply voltage (V DC)

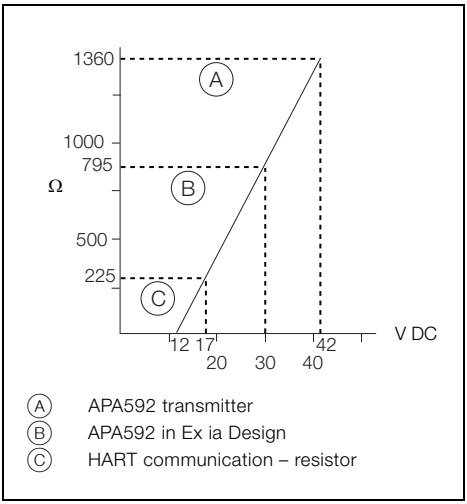


Fig. 10.1 Maximum Load

General Information

Display Update Speed
< 250 milliseconds

Environmental (Temperature)
Operating: –20 to 60 °C (–4 to 140 °F)

Storage: –40 to 80 °C (–40 to 176 °F)

Humidity
< 95 % RH non-condensing

Enclosure Protection
Aluminum, die cast, chromized inside / outside,
70 µm epoxy powdercoat (aluminum,
magnesium content < 6 %, copper-free < 0.5 %)

Weight
1.3 Kg (3 lb.)

Cable Gland Protection
IP66 and 67 for plastic glands supplied with general purpose / Intrinsically safe instruments.

IP67 for stainless glands required for explosion-proof instruments.

EMC and RF Interference
Emission and immunity for Class A and B equipment in accordance with EN 61326-1for Class A and Class B equipment

Galvanic Isolation
900 V DC for 1 second
(insulation test voltage)

Equipment markings

Intrinsic Safety – FM and CSA

FM Class I, Div. 1, Groups A, B, C, D
Class II/III, Div. 1, Group E, F, G; T4 Ta = 60ºC

CSA Class I, Div. 1, Groups A, B, C, D
Class II, Div. 1, Groups E, F, G
Class III, Div. 1; T4

Intrinsic Safety – ATEX / IECEx

Approved for:
– II 1G Ex ia IIC T4
– II 1D Ex iaD A20 IP66 T135 °C, –20 °C≤T_{amb}≤60 °C

Intrinsically Safe and Ex ia IIC Hazardous Area

Parameter	Supply circuit
Maximum voltage	U_i = 30 V
Maximum input current	I_i = 160 mA
Maximum power	P_i = 0,8 W
Internal inductance	L_i = 0,5 mH
Internal capacitance	C_i = 5 nF

Type n (Non-sparking) and Dust – ATEX / IECEx

Approved for:

II 3 G Ex nA IIC T4

II 3 D Ex tD A22 IP66 T135 ºC, –20 °C≤T_{amb}≤60 °C

Non-incendive – FM and CSA
(when installed in accordance with the installation drawing P0909 of Appendix B)

FM Class I, Div. 2, Groups A, B, C, D
Class II/III, Div. 2, Group F, G; T4 Ta = 60 ºC

CSA Class I, Div. 2, Groups A,B,C,D
Class II, Div. 2, Groups F, G
Class III, Div. 2; T4

Hazardous Area, Dust-, Ignition-proof – FM and CSA

FM XP, Class I, Div. 1, Groups A,B,C,D
Class II/III, Div. 1, Group E, F, G; T4 Ta = 60 ºC

CSA Class I, Div. 1, Groups A,B,C,D
Class II, Div. 1, Groups E, F, G
Class III, Div. 1; T4

Flameproof and Dust Protection – ATEX / IECEx

Approved for:

II 2 G Ex d IIC T4

II 2 D Ex tD A21 IP66 T135 ºC, –20 °C≤T_{amb}≤60 °C

Agency Enclosure Ratings

IP66 and IP67

NEMA 4X

Approvals

CE Mark

The APA592–PH including type B LCD display / configuration software meets all requirements for the CE mark in accordance with the applicable directives 2014/30/EU (EMC), 2014/35/EU (LVD) and 2014/34/EU (ATEX).

DS/APA592-EN

11 Spares and Accessories

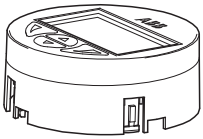
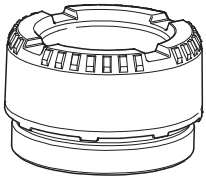
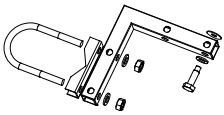
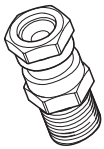
Part Number	Description	Item
4TB9515-0281	LCD Display	
4TB9515-0282	Window cover	
4TB9515-0283	Wall and pipe mounting kit	
4TB9515-0285	1/2 in. NPT nylon cable gland (I.S./Non-Incendive)	
4TB9515-0286	1/2 in. NPT nylon conduit plug (I.S./Non-Incendive)	
4TB9515-0287	M20 nylon cable gland (I.S./Non-Incendive)	
4TB9515-0288	M20 nylon conduit plug (I.S./Non-Incendive)	
4TB9515-0289	1/2 in. NPT 316 stainless steel Ex d (Explosion-proof) cable gland	

Table 11.1 Spares and Accessories

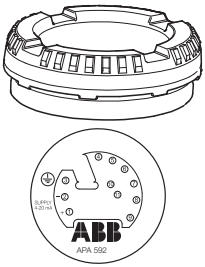
Part Number	Description	Item
4TB9515-0290	1/2 in. NPT 316 stainless steel Ex d (Explosion-proof) conduit plug	
4TB9515-0291	M20 316 stainless steel Ex d (Explosion-proof) cable gland	
4TB9515-0292	M20 316 stainless steel Ex d (Explosion-proof) conduit plug	
4TB9515–0280	Rear blind cover, plus pH terminal block sticker	

Table 11.1 Spares and Accessories (Continued)

Appendix A

A.1 Permits and Certification

Symbol	Description
Explosion-proof approval 	The Ex label indicates a device that complies with the directive 2014/34/EU (ATEX)
CE mark 	The CE mark indicates that the device complies with the following directives and their basic safety requirements: ■ CE mark on the name plate of transmitter – EMC directive 2014/30/EU, Low Voltage directive 2014/35/EU, ATEX directive 2014/34/EU ■ For ignition-protection applications: – Conforms with hazardous area directive 2014/34/EU (ATEX 114) By placing the CE mark on its devices, ABB declares its conformance with these directives.

Table A.1 Permits and Certification

A.2 Temperature Compensation

The Endura APA592 transmitter has three types of temperature compensation options:

- manual Nernstian.
- automatic Nernstian with solution coefficient

The temperature effect on ORP sensors is negligible. The effect of temperature on pION sensors is difficult to characterize, except for specific applications. Therefore, only the solution coefficient option can be used to compensate for electrode and process changes with temperature.

A.3 Nernstian Temperature Compensation

Manual and automatic Nernstian temperature compensation types adjust for the thermodynamic properties of electrochemical half sensors.

The Nernstian effect is characterized by the mathematical equation:

$$E=E_{reference} +(2.3 \times R \times T_K \times LOG[ai] /n \times F)$$

where:

E	Overall sensor output
$E_{reference}$	Reference half sensor output (typically a constant)
R	Constant
TK	Absolute temperature (Kelvin)
n	Ion charge
F	Constant
$[a_i]$	Ion activity

The ion activity is nearly equal to the ion concentration for weak solutions containing that particular ion. The Nernstian equation is used to adjust the output of an electrochemical sensor to a reference temperature that is typically 25 °C (77 °F).

Temperature effects of pH sensors are well behaved and are characterized by the Nernst equation. The APA592–PH transmitter applies Nernstian compensation to all three temperature compensation options when the transmitter is configured as a pH analyzer. If interested in the uncompensated value, set the transmitter to manual temperature compensation and calibrate the temperature to 25 °C (77 °F). This enables monitoring of the uncompensated value.

Automatic Nernstian temperature compensation provides the most useful information and is recommended in most cases. Since ion dissociation is affected by temperature, the pH value can also be affected. If these processes behave in a repeatable manner, the dissociation can be characterized and a solution coefficient can be used to compensate for these effects.

A.3.1 Solution Coefficient

The solution coefficient compensates the Nernstian value for pH measurements, and the raw voltage value for ORP or pION measurements, by a fixed value per each 10 °C (50 °F).

The temperature compensation factor is derived from the following equations:

$pH_{indication} = pH_{Nernstian} \pm COEF \times ((T - 25\ °C)/(10\ °C\ [50\ °F]))$

$mV_{indication} = mV \pm COEF \times ((T - 25\ °C) / (10\ °C\ [50\ °F]))$

where:

COEF	pH or mV change per 10 °C (50 °F).
$pH_{Nernstian}$	Nernstian pH value referenced at 25 °C (77 °F) after applying the factory and process calibration values.
$pH_{indication}$	pH value indicated on the transmitter and proportional to the current output value.
mV	millivolt value of the sensor output after applying the factory and process calibration values.
$mV_{indication}$	mV value indicated on the transmitter and proportional to the current output value.
T	temperature of the solution in °C after applying the factory and process calibration values.

Examples of solution coefficients for pure water applications are:

pure water = +0.18 pH /(10°C [50 °F])

pure water with 1 ppm ammonia = +0.31 pH /(10°C [50 °F])

The solution coefficient for the APA592–PH transmitter either adds or subtracts a configured amount of the process variable per 10 °C (50 °F) to the Nernstian compensated process variable. Thus, an application with a process liquid that decreases in its pH value as the temperature increases uses a positive solution coefficient correction factor. Conversely, an application with a process liquid that increases in its pH value as the temperature increases uses a negative solution coefficient correction factor.

The solution coefficient affects the uncompensated process variable for ORP and pION analyzer types in the same manner as the pH analyzer type.

Appendix B Installation Drawings

B.1 Drawing P0908

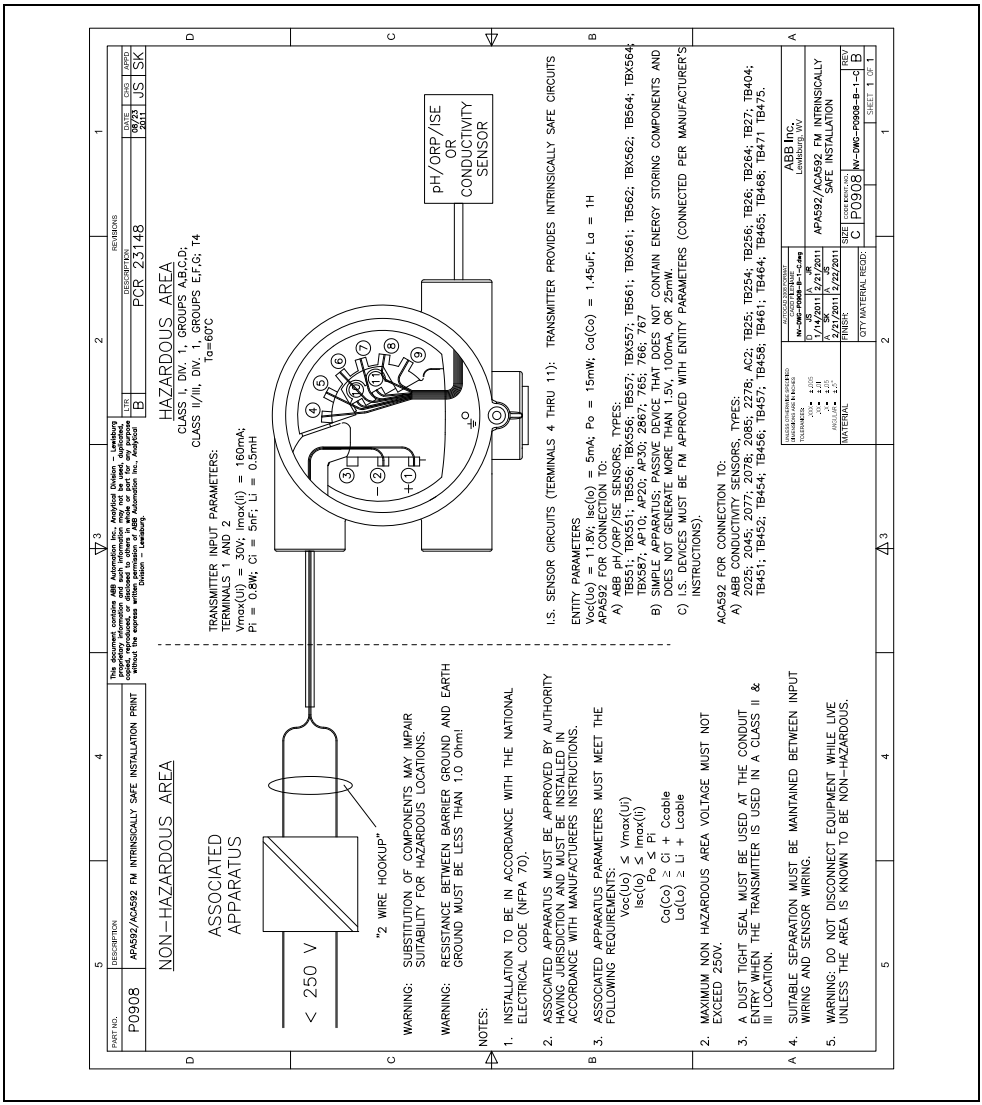


Fig. B.1 Installation Drawing P0908

B.2 Drawing P0909

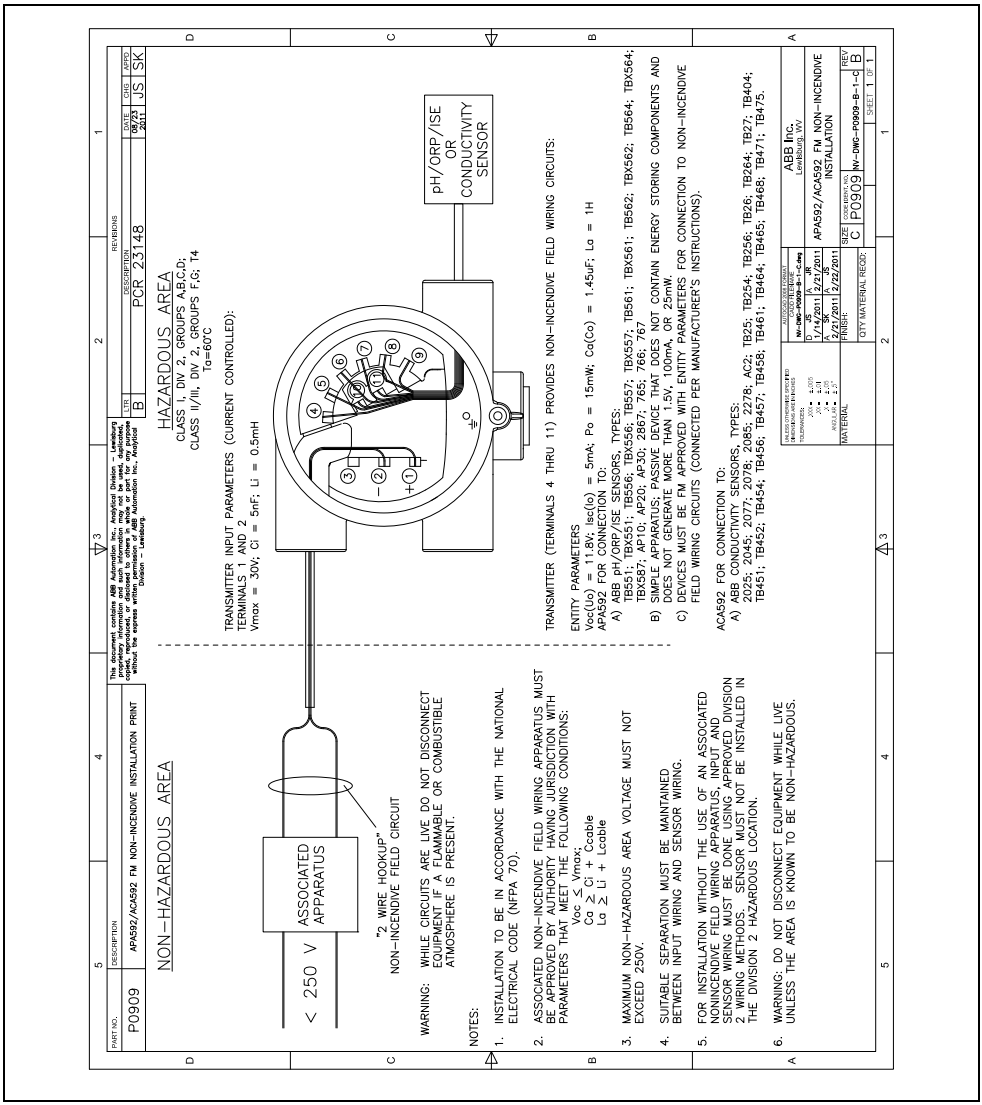


Fig. B.2 Installation Drawing P0909

B.3 Drawing P0910

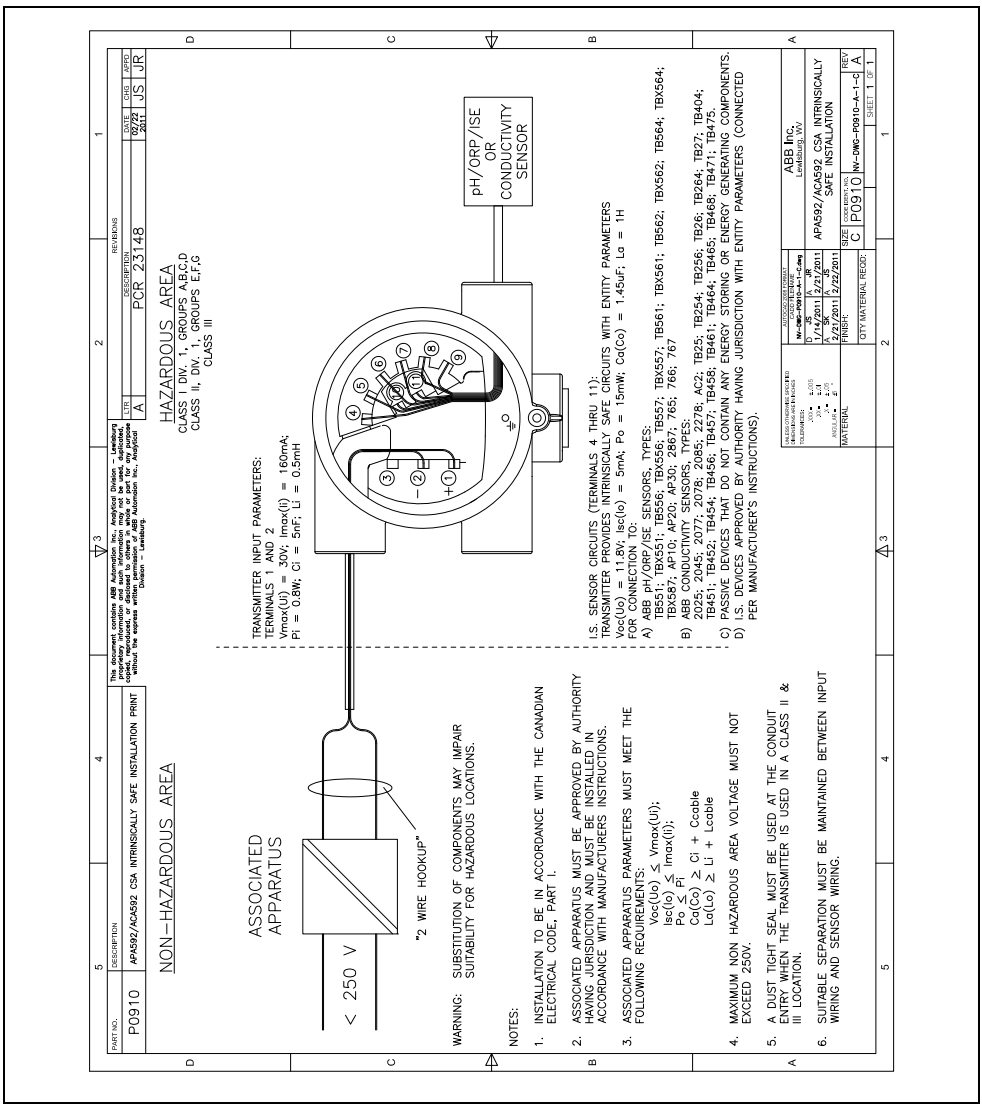


Fig. B.3 Installation Drawing P0910

B.4 Drawing P0911

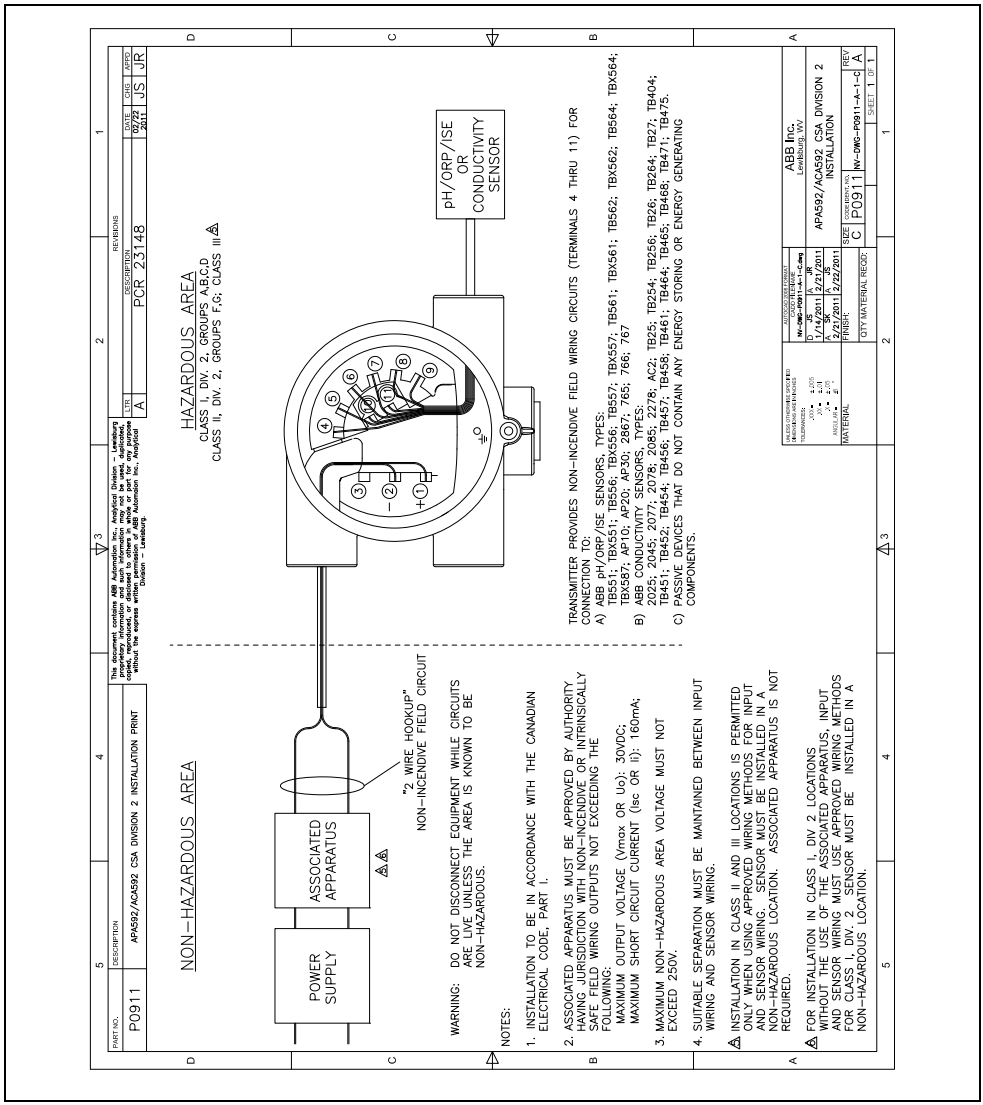


Fig. B.4 Installation Drawing P0911

Notes

Acknowledgements

- HART is a registered trademark of the HART Communication Foundation.
- Siemens is a copyright of Siemens AG.

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