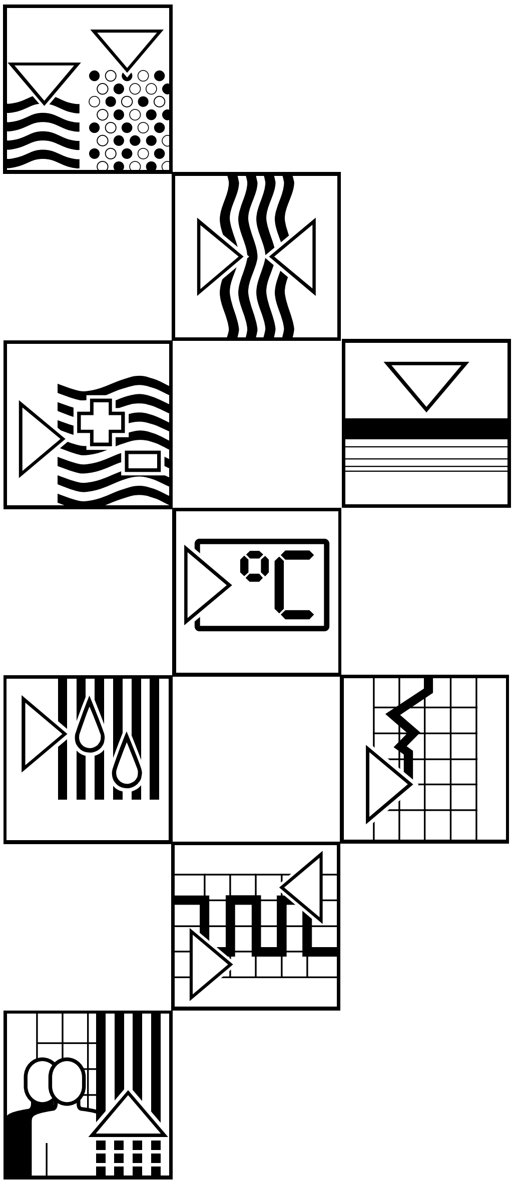
BA 006/05/e/02/98
CV 5.0
Valid for software version 2.0
and below

t-mass S AT70
Thermal Mass Flow Measuring System

Installation and operating manual



Endress+Hauser
Nothing beats know-how

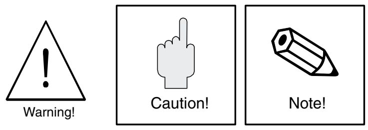
Safety Instructions

The following safety instructions must be carefully observed

Correct Usage

- The t-mass S AT70 flowmeter may only be used to measure the flow of gases.
- The t-mass S AT70 flowmeter is designed and checked according to the regulations in force (DIN 57411 Part 1 / VDE 0411 Part 1 “Protection Measures for Electronic Measuring Equipment”). The flowmeter may be dangerous if it is not used for the purpose it was designed for or is used incorrectly.

  Please carefully note the information provided in this Operating Manual indicated by the pictograms:



- The manufacturer assumes no liability for damage caused by incorrect use of the instrument. Modifications and changes to the instrument may not be carried out.
- For use where contact with special fluids is a possibility, including those used for cleaning, Endress+Hauser will be pleased to advise you on the chemical resistance of wetted parts.

Personnel for Installation, Start-up and Operation

- Mounting, electrical installation, start-up and maintenance of the instrument may only be carried out by trained personnel authorized by the operator of the facility. Personnel must read and understand this operating manual before carrying out its instructions.
- The instrument may only be operated by personnel who are authorised and trained by the operator of the facility. All instructions in this manual are to be observed.

Repairs, Dangerous Chemicals

The following procedures must be carried out before a t-mass S AT70 flowmeter is sent to Endress+Hauser for repair:
- A note must always be enclosed with the instrument, containing a description of the fault, the application, and the chemical and physical properties of any chemical agent that the sensor may have been exposed to.
- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.
- No instrument should be returned to us without all dangerous material being removed first (e.g. in scratches or diffused through plastic).

Incomplete cleaning of the instrument may result in waste disposal or cause harm to personnel (burns, etc.). Any costs arising from this will be charged to the owner of the instrument.

Technical Improvements
The manufacturer reserves the right to modify technical data without prior notice. Your local E+H Sales Office will supply you with all current information and any updates to this Operating Manual.

Contents

1. Introduction

The AT70 series of thermal gas mass flow sensors are relatively simple flow meters to install and commission. The installation requirements are defined in chapter 3. *However, it is very important that they are followed precisely if the maximum measuring performance of the flowmeter is to be obtained.*

Commissioning is then a sequence of simply checking and/or programming a minimal number of meter operating functions to set the meter up to your own requirements.

A typical installation and commissioning sequence can be split into the following sections:

- Installation mechanical

- Installation - electrical

- Checking of installation before the power supply is switched on
  - Clear lengths of upstream pipework
  - Clear lengths of downstream pipework
  - Correct pipe internal diameter and surface finish/quality
  - Correct alignment of pipe/gasket/flowmeter body
  - Gas conditions (e.g. purity, dryness, cleanliness)
  - Correct power supply polarity
  - Correct signal wiring
  - Correct flowmeter switch settings (pulse/current output, active/passive current output)

- After power supply connection and switch on - setup of flowmeter functions to suit the application
  - System units
  - Flow value at 20 mA (current output configuration)
  - Pulse value and pulse width (pulse output configuration only)
  - Low Flow Cutoff value
  - Zero setting (Sensor software version 2 and higher only)

1.1 How to use this manual

The manual is split up into chapters or sections that cover the above mentioned topics.

It is very important that all involved parties read and understand the contents of this manual before attempting to install or commission the AT70 flowmeter

Programming examples have been included to allow the operator to apply the programming instructions and check that the results are correct.

Failure to follow the guidelines expressed in this manual and the associated TI013 Technical Information sheet may result in a reduction of measuring performance of the sensor and in extreme cases severe damage.

2. Description of the System

2.1 Applications

The t-mass thermal flowmeter measures the mass flowrate of a wide range of gas types.

Applications include:
- Natural gas flow to boilers and dryers
- Biogas from waste water plant digesters
- Landfill gas monitoring
- Carbon dioxide metering in the brewing and soft drinks industry
- Instrument air in process plants
- HVAC ducts
- Nitrogen, oxygen and argon flows in the steel industry
- Gas production (e.g. Ar, N2, CO2)
- Hydrogen flow in the chemical industry
- Leak detection

2.2 Measuring Principle

Thermal metering is now a well established method of mass flow measurement. It operates by monitoring the cooling effect of a gas stream as it passes over a heated transducer. Gas flowing through the sensing section passes over two PT100 RTD transducers. One PT100 is used conventionally as a temperature sensing device, whilst the other is used as a heater. The temperature transducer monitors the actual gas process temperature, whilst the heater transducer is maintained at a constant differential temperature by varying the current through it. The greater the mass flow passing over the heated transducer, the greater the cooling effect, and therefore the greater the current required to keep a constant differential temperature. The measured heater current is therefore a measure of the gas mass flowrate.

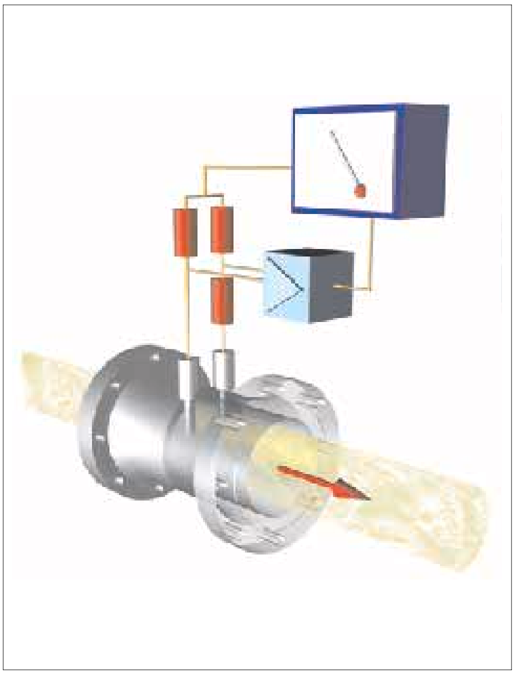


*Fig. 1:
Thermal measuring principle*

The measuring sensor
Each AT70 flow sensor has a four core connection. Two wires carry the power supply and two wires transmit the galvanically isolated measured flow signal back to the control room either as a 4-20 mA current output or as an open collector transistor pulse output.
In addition, the current output connection supports the HART™ communication facility allowing remote interrogation of the flow, totalised flow and process gas temperature values as well as configuration parameters of the sensor.

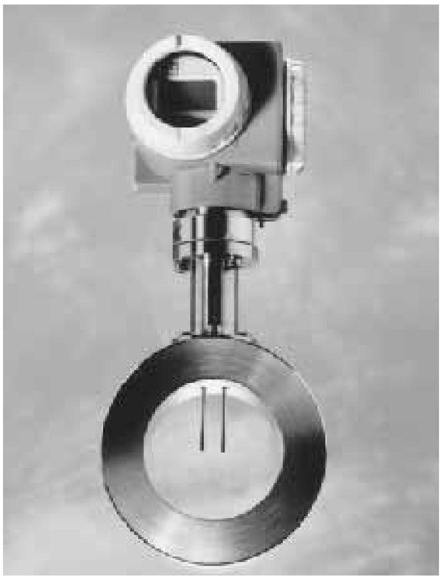


*Fig. 2:
View through the sensor pipe - t-mass AT 70W*

Calibration
Each sensor is subjected to thorough calibration and test procedures and is supplied with an individual calibration certificate traceable to National Standards.

2.3 t-mass Measuring System

A typical measuring system consists of:

- A t-mass S flow sensor
- A 20…30 V DC power supply rated at 150 mA
- A current or pulse output signal for connection to an external indicator or measuring system (e.g. PLC or SCADA)

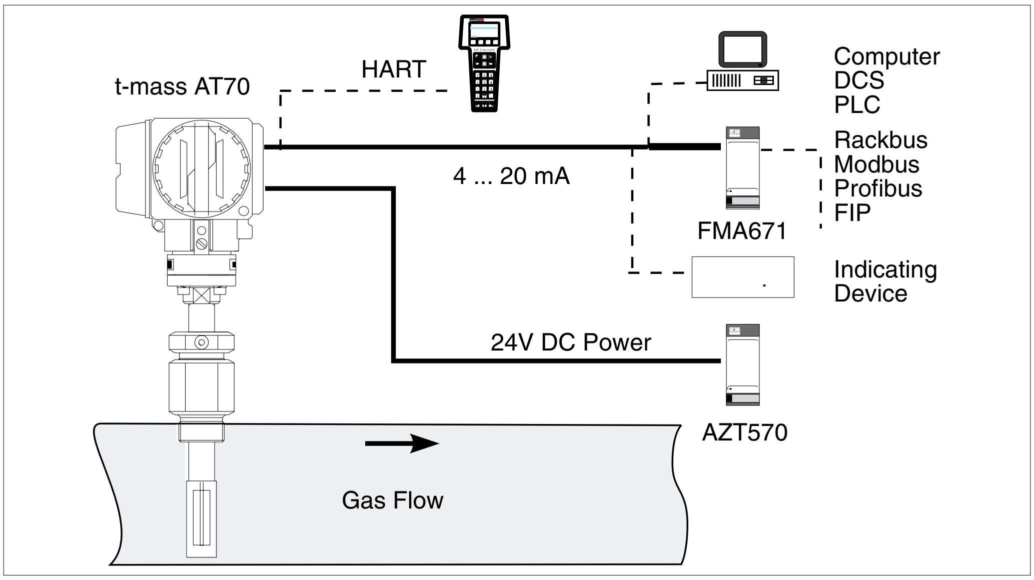


Fig. 3:
t-mass AT70 sensor used as an individual measuring point

The t-mass family of sensors is available in a wide range of mechanical and housing formats

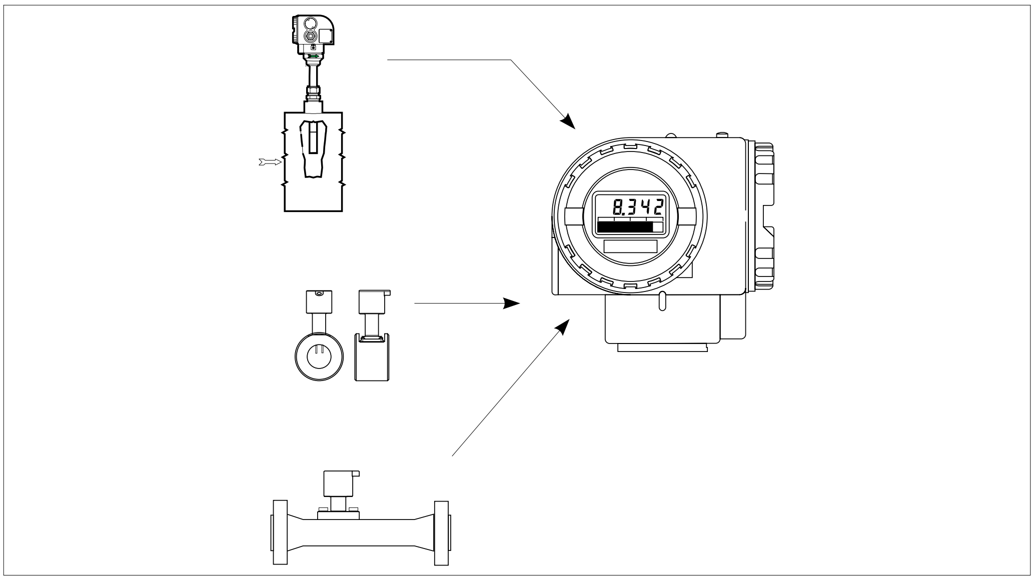


Fig. 4:
Measuring system t-mass

AT70 F (Flanged flowcell, DN 15...150, 1/2"…6")

- integral straight pipework minimises installation requirements and maximises measuring performance
- Welded flange design, with a wide range of optional fittings,
- Optional degreasing for oxygen duty

AT70 W (Wafer, DN 25...100, 1”…4”)
- This space-saving version fits between two flanges with all nominal diameters having the same 65 mm (2.5”) width.
- A mounting set assures fast and accurate centering in the pipeline (see page 14).
- Optional degreasing for oxygen duty

AT70 (Insertion, D80...1000, 3”…39”)
- Installed directly onto the pipework via a variety of mounting stub styles, e.g. flanged, screwed thread

All versions
- Optional 3.1B material traceability certificate.
- Optional dye-penetrant tested

Housing formats - all sensor versions
- Compact style with the electronic, display and keyboard attached to the main sensor body
- Remote version with the electronics, display and keyboard housed separately up to 100 m (325 ft) away from the measuring sensor.

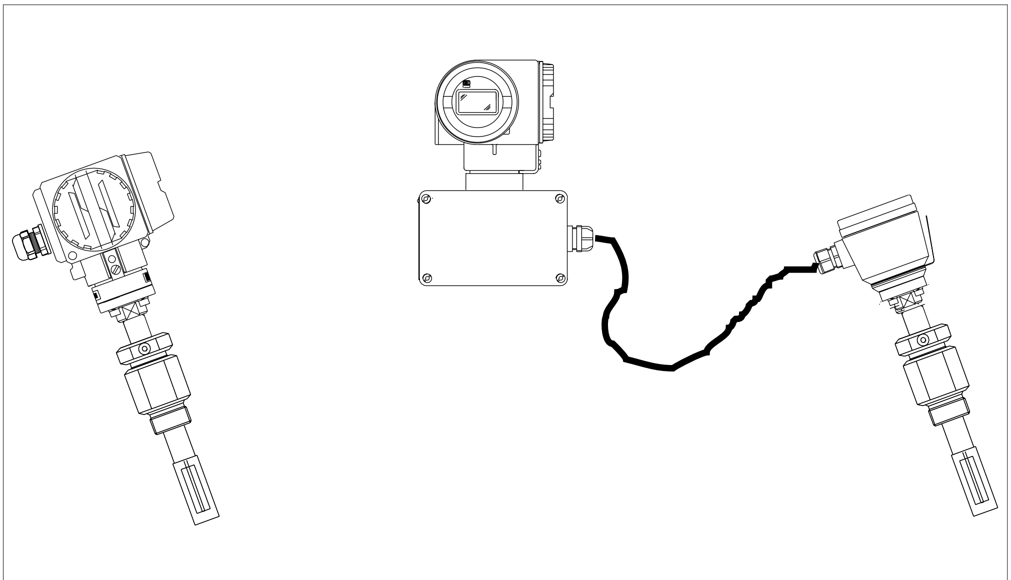
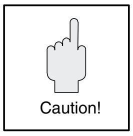


Fig. 5:
Choice of remote and compact housing formats

This page has been deliberately left blank

3. Mounting and Installation



Caution!
All instructions given in this section are to be observed at all times in order to ensure safe and reliable operation of the measuring system.

3.1 General Information - all sensor types

3.1.1 Protection IP 65 (DIN 40050)/NEMA4X

The instruments fulfill all the requirements for IP 65/NEMA4X. After successful installation in the field or after servicing, the following points must always be observed in order to ensure protection to IP 65:

- Pipework gaskets must be clean and undamaged when inserted in the gasket groove. The gaskets may need to be dried, cleaned or replaced.
- All housing screws and the housing cover must be firmly tightened.
- The cables used for connecting must have the correct outer diameter.
- The cable gland must be firmly tightened.
- The cable must loop down before entering the cable gland to ensure that no moisture can enter it (see Fig. 6).
- Any cable glands not used are to be replaced with a plug.
- The protective bushing should not be removed from the cable gland.

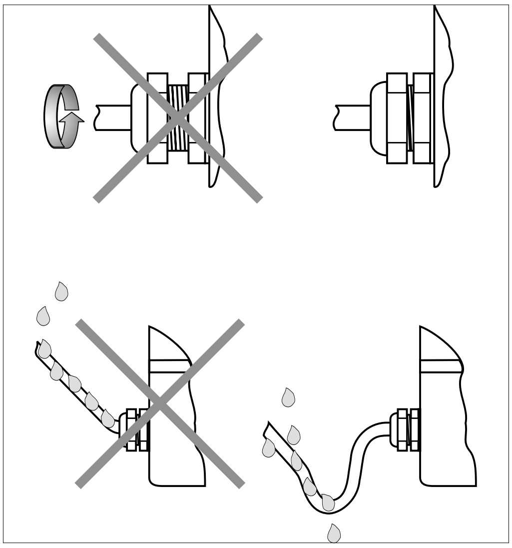


Fig. 6:
IP 65 Protection

3.1.2 Temperature Ranges

- It must be remembered that the sensor operating principle is based on a heat loss mechanism therefore the sensor performs best when the ambient and/or gas temperatures are relatively stable. It is recommended to install the sensor out of any direct sunlight or away from any extremes of temperature.
- The maximum approved ambient and process temperatures must be observed.
- Observe also the instructions on piping insulation and mounting position (see next page).

3.1.3 Clean in place

The sensor is capable of withstanding clean in place processes using heated liquids or steam however the sensor measurement will be adversely affected during the cleaning cycle and a settling down period will be required after the cycle to allow the process and sensor temperatures to stabilise.

3.1.4 Pressure Pulses/Measuring Accuracy

Reciprocating pumps and some compressor systems can create strong changes in process pressure in the piping that can induce spurious internal flow patterns and thus cause additional measuring errors. These pressure pulses must be reduced by the appropriate measures.
E.g.
- using expansion tanks
- with inlet expanders
- with a more suitable mounting location.

3.1.5 Vibration

Free-standing pipes subject to strong vibration should be firmly attached or supported upstream and downstream of the meter.

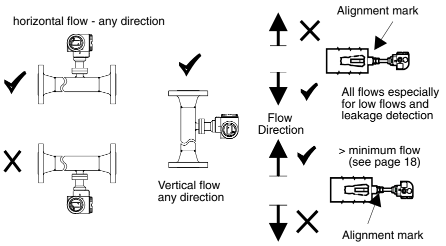


Fig. 7:
Sensor orientation

3.1.6 Orientation

It is recommended to mount the sensor in an horizontal orientation to match its calibration orientation, however for medium to high flows then the sensor can be mounted in any orientation. Special care should be taken when mounting the sensor in vertical pipes when the gas is wet (see below).

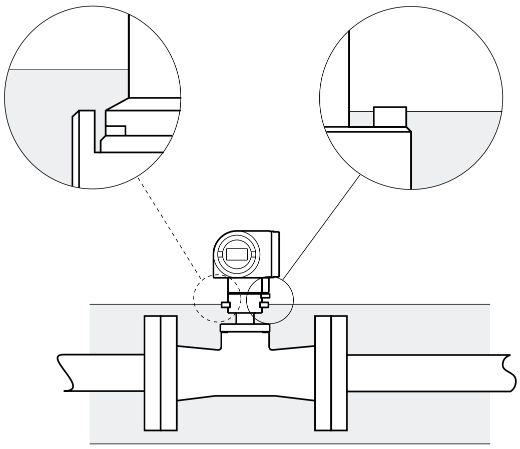


Fig. 8:
Insulation of flowcell/pipework

3.1.7 Pipe insulation

When the gas is very humid or saturated with water (e.g. Bio-gas) the pipeline and flowmeter body should be insulated to prevent water droplets condensing on the pipe wall and/or transducer.
In extreme cases of moisture and/or temperature variation, it may be advisable to provide trace heating of the pipework and/or flowcell body, the latter being preferably installed horizontally with the housing on the top of the pipework to prevent water condensing on the pipewalls and collecting around the transducers.

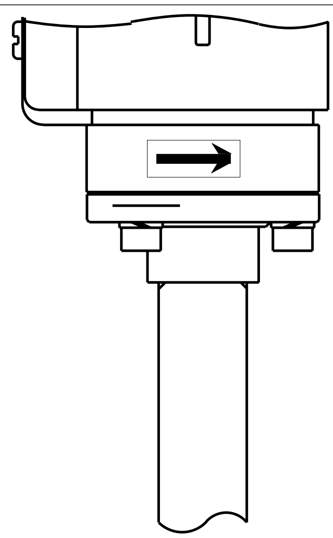


Fig. 9:
Flowdirection alignment

3.1.8 Flow direction

It is very important that the sensor body is always positioned such that the arrow on the lower side of the sensor body is pointing in the same direction as the process flow.

Note!

Note.
The sensor will respond to flow in either direction but cannot deduce the actual flow direction, therefore flow in either direction will produce a positive reading.

3.1.9 Local Display - Viewing Angle

The viewing angle of the liquid crystal display can be changed by loosening the restraining screw at the base of the housing and rotating the housing by up to 340°, the restraining screw should be tightened again when the housing is in the required position.
Also within the housing, the display can be rotated in 90° steps (refer to page18 regarding removal and replacement of the display)

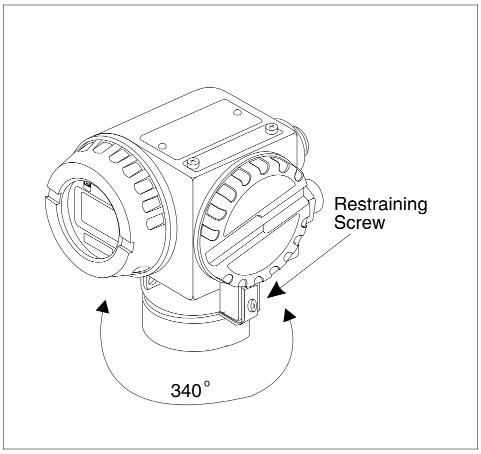


Fig. 10:
Rotation of sensor housing
Adjustable viewing angle

3.2 Pipework Installation

The following installation recommendations should be observed as the minimum requirements when installing t-mass in the pipeline.

Clear upstream and downstream sections
The high sensitivity of the thermal dispersion principle to low flow rates means the flowmeter can also be sensitive to internal disturbances in the flowing gas stream (e.g. swirl) especially in the smaller pipe diameters (=<DN150, 6"). The installed thermal flow sensor should therefore be installed as far as possible upstream of *any* flow disturbances. The recommended clear upstream and downstream lengths are illustrated on page 13 and should be strictly followed to for maximum measuring performance. Disturbance sources can be split into two broad categories:

3.2.1 Construction and/or Assembly Quality

Good construction practice should be followed at all times. For example:
- Cleaned pipe and flange welded joints
- Correctly sized gaskets
- Correctly aligned flanges and gaskets
- The use of seamless pipe immediately upstream of the flowmeter
- The use of pipework with a matching internal diameter to that of the flowmeter to ensure that no step disturbance greater than 1 mm (0.05") can occur at the meter inlet or outlet. (3 mm [0.125"] for diameters > DN200 [8"])
- As a general comment anything that disturbs the smoothness of the internal pipe wall within the dimensions stated on page 13 should be eliminated - the goal should be a smooth uninterrupted internal surface.

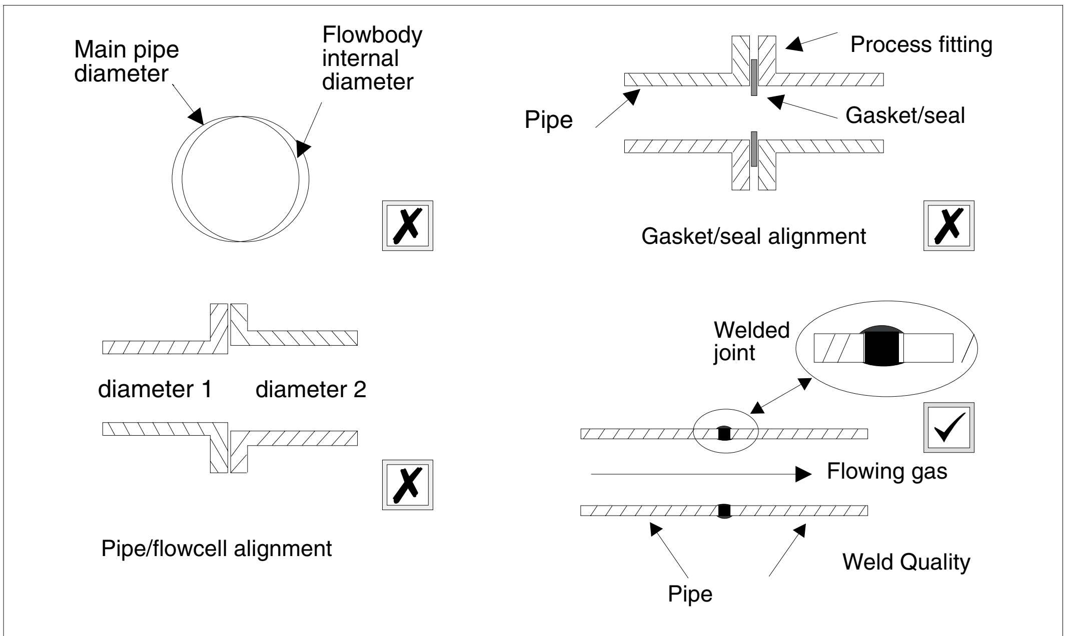


Fig. 11:
Pipework construction and
assembly considerations

3.2.2 Process Components or Pipework Configuration

When disturbances (e.g. pipe elbows, reducers, valves, T-pieces etc.) are located upstream of the thermal meter, precautions must be taken to minimise any effects on the measuring performance.

The figures on page 13 illustrate the *minimum* recommended upstream clear pipe lengths expressed in multiples of the pipe diameter (x DN), *longer lengths should always be used if they are available in the metering run.*

Regardless of any other consideration the minimum recommendations for clear pipework on either side of the sensor are:

- Inlet sections:
  minimum 15 x DN for the flanged flowcell (AT 70F) version.
  minimum 20 x DN for the insertion (AT 70) or wafer flowcell (AT 70W) version.

- Outlet sections:
  minimum 2 x DN for the flanged flowcell (AT 70F) version.
  minimum 5 x DN for the insertion (AT 70) or wafer flowcell (AT 70W) version.

Notes:

Note!

Where two or more disturbances are located upstream of the meter, the longest recommended upstream pipe section is to be observed *as an absolute* minimum.

- It is *always* recommended to install control valves downstream of the flowmeter.
- When an upstream disturbance is present whose disturbing effect cannot be readily evaluated (e.g. a dryer, other measuring device such as an orifice plate, turbine meter, vortex meter), it is recommended to consider the disturbance in the same way as a valve (see page 13).
- For very light gases such as helium and hydrogen *all recommended upstream straight section values should be multiplied by two.*
- Free-standing pipes subject to strong vibration should be firmly attached or supported upstream and downstream of the meter.

3.2.3 Flow Conditioner

With limited space and large pipes, it is not always possible to have the inlet sections given above. The specially developed AZT532 and AZT534 perforated plate flow conditioners in all but the most severe cases of pipeline disturbances allows the sensor to be installed in the pipework with reduced upstream clear distances. Refer to page 16 for further guidelines.

Planning and Installation

All versions

Upstream and Downstream pipe requirements

Note!

Notes

- For very light gases such as helium and hydrogen all upstream distance recommendations should be doubled.
- The DN150 (6") sized flanged AT 70F sensor requires the AZT532 flow conditioner type whereas the DN15 to DN100 (1/2" to 4") sizes require the AZT534 flow conditioner type.
- The Wafer (AT 70W) and Insertion (AT 70) versions require the AZT532 flow conditioner types regardless of line size.
- Flow conditioners are not available for all line sizes - check page and with your E+H sales representative before planning your installation layout.

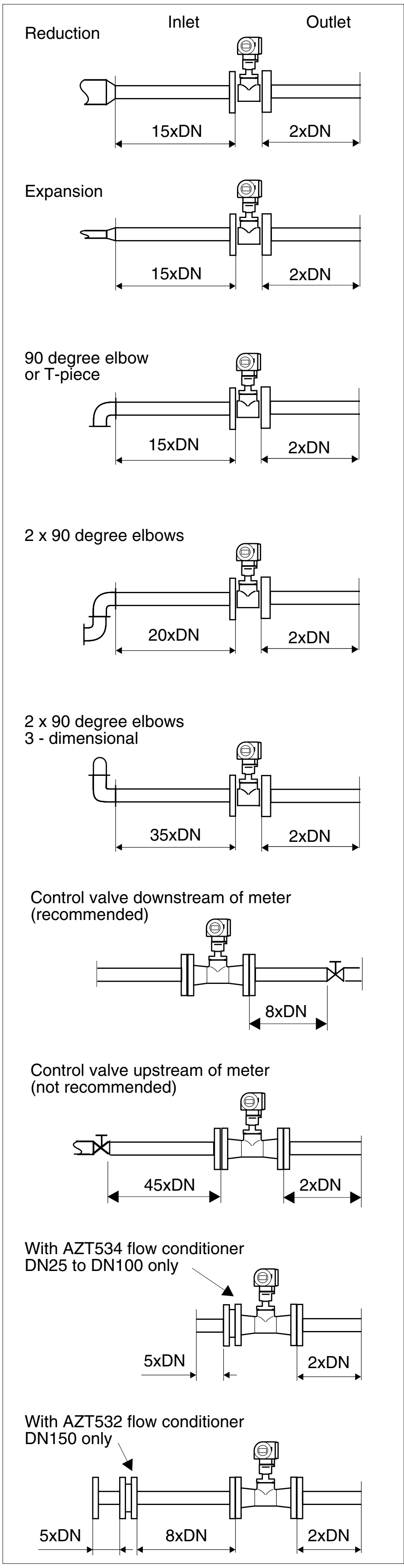


Fig. 12:
Inlet and outlet piping requirements
Flanged flowcell version (AT 70F)

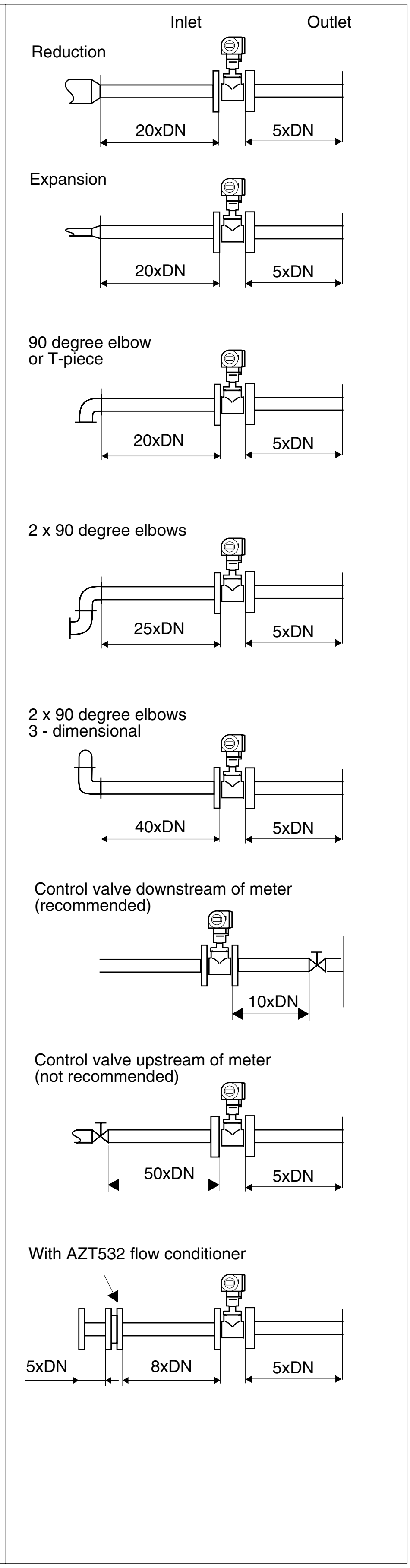


Fig. 13:
Inlet and outlet piping requirements
Insertion (AT 70) and Wafer (AT 70W) versions

3.3 Planning and Installation - AT 70W Wafer version only

Note the following points before mounting the AT 70W sensor:

- The flowcell and wafer style meter bodies are protected against damage during transit by two protective disks. *Remove both protective disks before installing the flowmeter in the pipeline.*
- Take particular care that the internal diameters of any installed gaskets directly upstream and downstream of the meter body are identical or larger than those of the meter body and/or process piping. *Gaskets which protrude into the flow will invariably lead to metering inaccuracies.*

Mounting Set

To ensure the accurate centering of wafer style meters with respect to the flange fitting on any pipework installation, it is essential for maximum performance that the mounting set supplied with the sensor is used.
Each mounting kit comprises
- A set of correctly sized fixing bolts, nuts and washers
- Accurately dimensioned centering rings

Mounting Procedure

- Place one centering ring over each side of the meter body
- Mount two or more bolts as required with washers on both piping flanges
- Adjust the sensor together with the two centering rings between the bolts already mounted and the piping flanges (including gaskets)
- Mount the rest of the bolts
- Screw tight the bolts in a diagonal tightening pattern

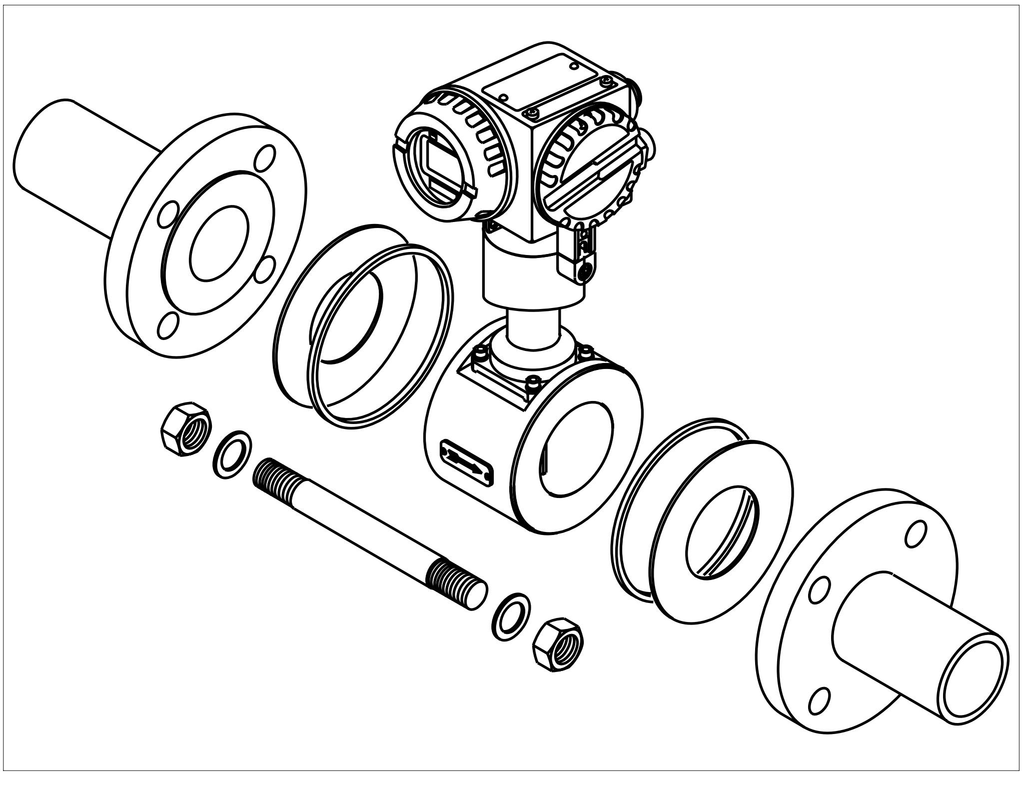


*Fig. 14:
Mounting set for wafer version (AT 70W)*

3.4 Sensor mounting details - AT 70 Adjustable Insertion sensor

Insertion depth

Refer to page for a guideline on specifying the correct sensor length to suit the pipe or duct size, the guidance assumes that a standard AZT70 mounting boss (see page is being used.

Note.

If any other type or size of mounting boss is used (e.g. with an integral ball valve) then the installation must be measured to calculate the correct insertion length which will subsequently allow the correct sensor length to be correctly specified.

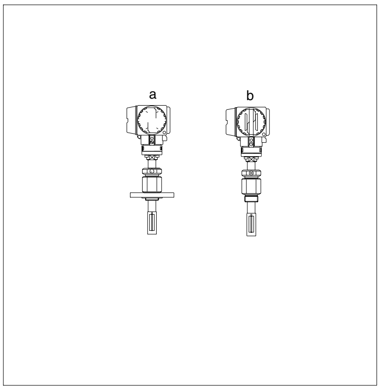


Fig. 15:
Typical mounting arrangements

a - Adjustable process length + flange
b - Adjustable process length + screw fitting

When installing the sensor, the following three dimensions need to be taken into account to allow the correct insertion length to be specified:

- A = Internal diameter of the circular pipe or for a rectangular duct, the duct height if the sensor is to be mounted vertically or duct width if it is to be mounted horizontally
- B = Pipe wall thickness
- C = Depth of the mounting boss on the pipe or duct including the sensor fitting

3.4.1 For Insertion Sensors Fitted With An Adjustable Insertion Probe Depth (i.e. Screwed Process Connection)

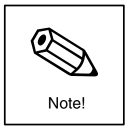
The probe section is supplied with a graduated scale along its length calibrated in millimeters. It is important that the sensor be installed so that the top of the adjustable fitting is aligned with the value on the scale that is equal to the following calculated value: (A, B and C are in millimeters [1" = 25.4 millimeters]).

For pipe diameters DN80 (3") and DN100 (4"):	B + C + 56
For pipe diameters >= DN150 (6"):	[0.15 x A] + B + C + 35

When the probe is at the correct insertion depth the sensor must next be aligned for the correct flow direction detection. (See the next page). After alignment, the probe fitting must be tightened to secure and seal the sensor assembly.

Note

Insertion sensors mounted in DN80 to DN150 (3" to 6") pipes are calibrated in the factory on the actual line size specified and should not be installed on other line sizes without re-calibration. All insertion sensors for pipe sizes >DN150 (6") are calibrated on either a DN150 (6") or DN300 (12") pipe and numerically scaled to suit the process pipe size (this pipe configuration together with the engineering units selection is field programmable via the integral keyboard and display when fitted, thus allowing the user to install these sensors on any line size between DN200 to DN1000 (8" to 29")).



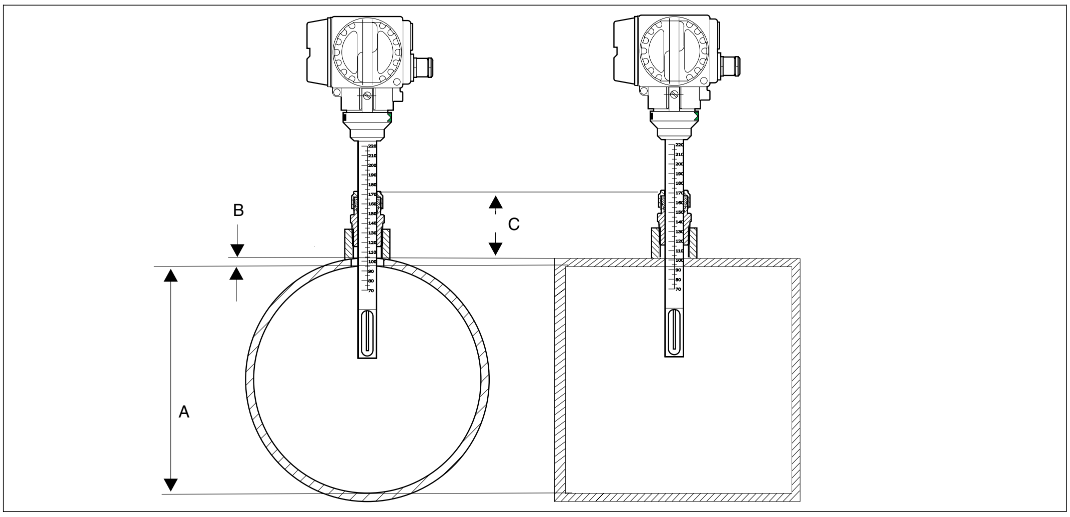


Fig. 16:
Dimensions required to calculate the sensor insertion depth - AT 70

3.4.2 Insertion sensor AT 70 for use with DN80 - DN100 pipe sizes

It is essential that all pipe dimension and mounting details are supplied at the time of order (regardless of the type of process connection) since they require calibration with the identical mechanical setup as the final installation to prevent spurious calibration effects caused by the large blockage factor of the sensor relative to the pipe cross-sectional area.

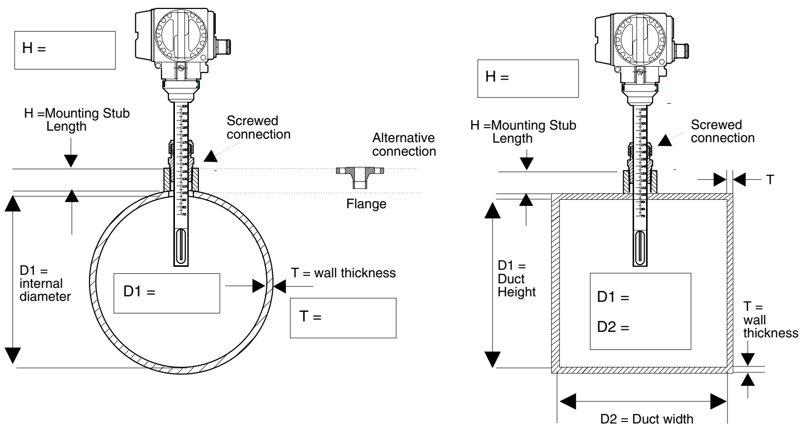


Fig. 17: Installation details to be supplied with order when the mounting stub is supplied by the customer

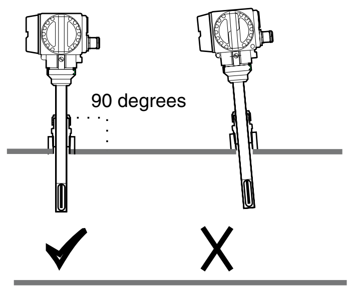


Fig. 18: Vertical alignment

Insertion sensor alignment details

Vertical Alignment
It is important that the sensor mounting boss is welded to the pipe or duct such that the sensor is mounted at 90 degrees to the flow direction. Any deviation from this angle in any plane may cause flow disturbances around the measuring point that could cause errors.

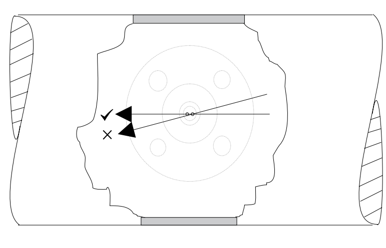


Fig. 19: Flow direction alignment

Flow Direction Alignment
It is very important that the sensor is aligned correctly with the direction of flow. There are two guidelines for correct alignment:

- The arrows on the lower sides of the sensor housing assembly are pointing in the same direction as the flow.
- The graduated scale on the insertion probe section should be aligned directly upstream of the flow direction.
- To ensure optimum exposure of the measuring transducers to the flowing gas stream, the sensor must not be rotated more than 7 degrees from this alignment.

3.5 Flow Conditioning - AZT532 and AZT534 perforated plate flow conditioners

With limited space and large pipes, it is not always possible to have the clear inlet pipe sections specified previously. The perforated plate flow conditioner in all but the most severe cases of flow disturbance allows the sensor to be installed in the pipework with reduced upstream clear distances. There are two versions depending on the sensor version to be used:

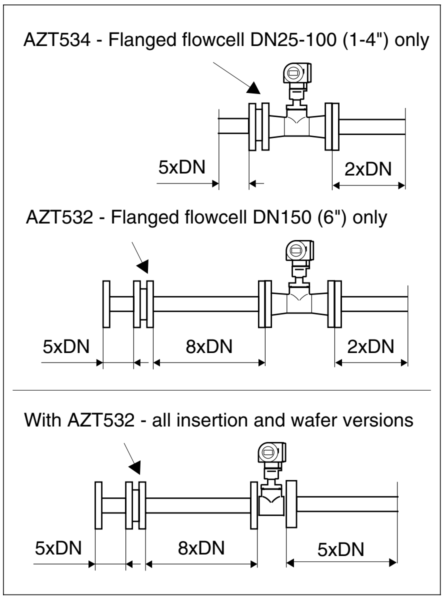


Fig. 20:
Using the flow conditioner

AZT532

For use with the insertion (AT 70), wafer (AT 70W) *and the DN150/6" flowcell (AT 70F) sensors*. This is based on the well known “Mitsubishi” design and for the majority of gas types must be installed 8 diameter lengths upstream of the sensor with a minimum 5 pipe diameter distance required upstream of the actual conditioner itself.

AZT534

This is a special version designed specifically for use with all sizes of the flanged flowcell sensors (AT 70F) *except for the DN150/6" size (see AZT532).* The AZT534 conditioner should be fitted immediately upstream of the sensor flowcell with a minimum 5 pipe diameter distance required upstream of the actual conditioner itself.

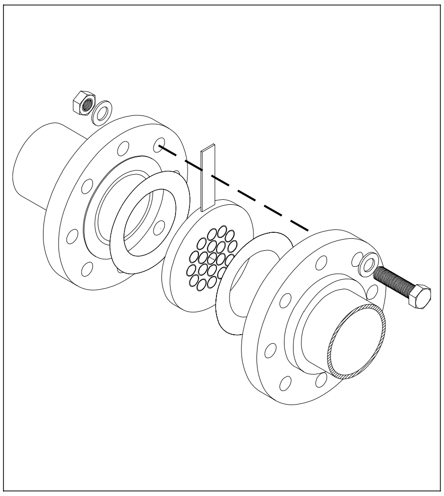


Fig. 21:
AZT532 and AZT534 flow conditioner mounting arrangement

Notes.

- For very light gases such as helium and hydrogen all upstream distance recommendations should be doubled.
- The AZT532/AZT534 conditioners are not available for the DN15 (1/2") and >DN200 (8") pipe diameters.

Note!

Flow Conditioner Pressure Loss Calculation:

Dp [mbar] = A · ρ [kg/m3] · v2 [m/s]   where A=0.005 [AZT532] or 0.0085 [AZT534]

Example for a AZT534 fitted to a DN25/1" sensor with an air flow of 148 kg/hr @ 20°C, 5 bar (v = 12 m/s)

ρ at 5 bar and 20°C = 7.2 kg/m3;
Δp = 0.0085 x 7.2 x 122 = 8.8 mbar

3.6 Local Display (Mounting/Rotating)

If fitted, the display of the t-mass S sensor can be rotated in 90° steps to suit any required viewing angle. To change the rotation angle unscrew the display cover and follow the steps outlined in figure 22.

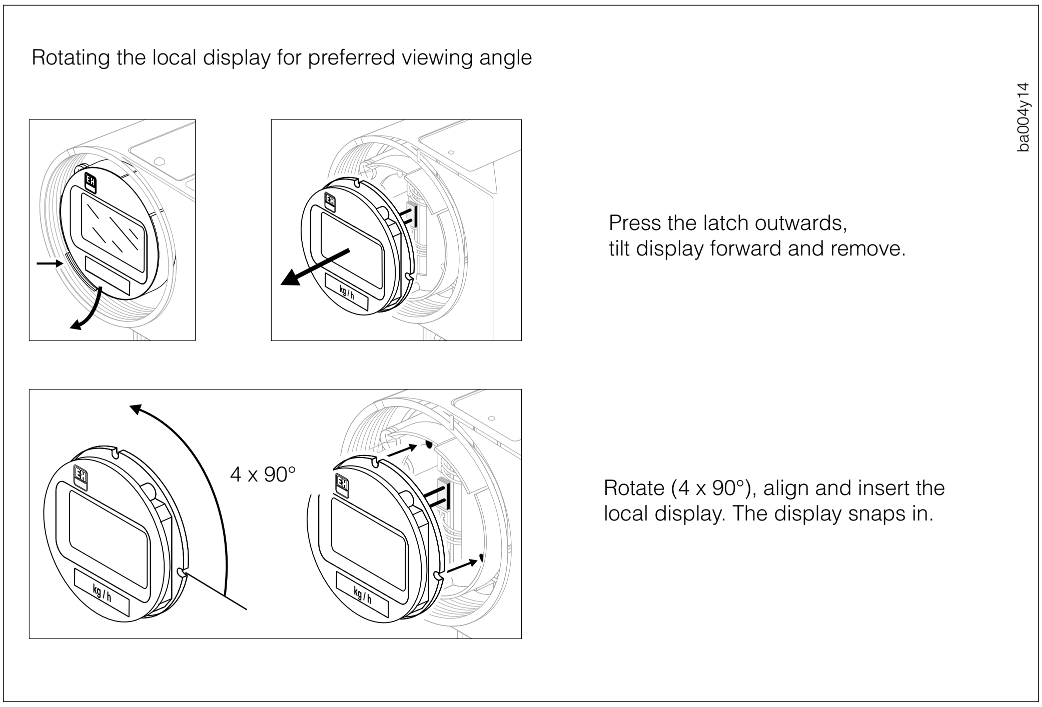


Fig. 22:
Rotating the local display

For blind transmitters (i.e. no display fitted), a display module can easily be fitted in the field. Refer to figure 23 for more details:

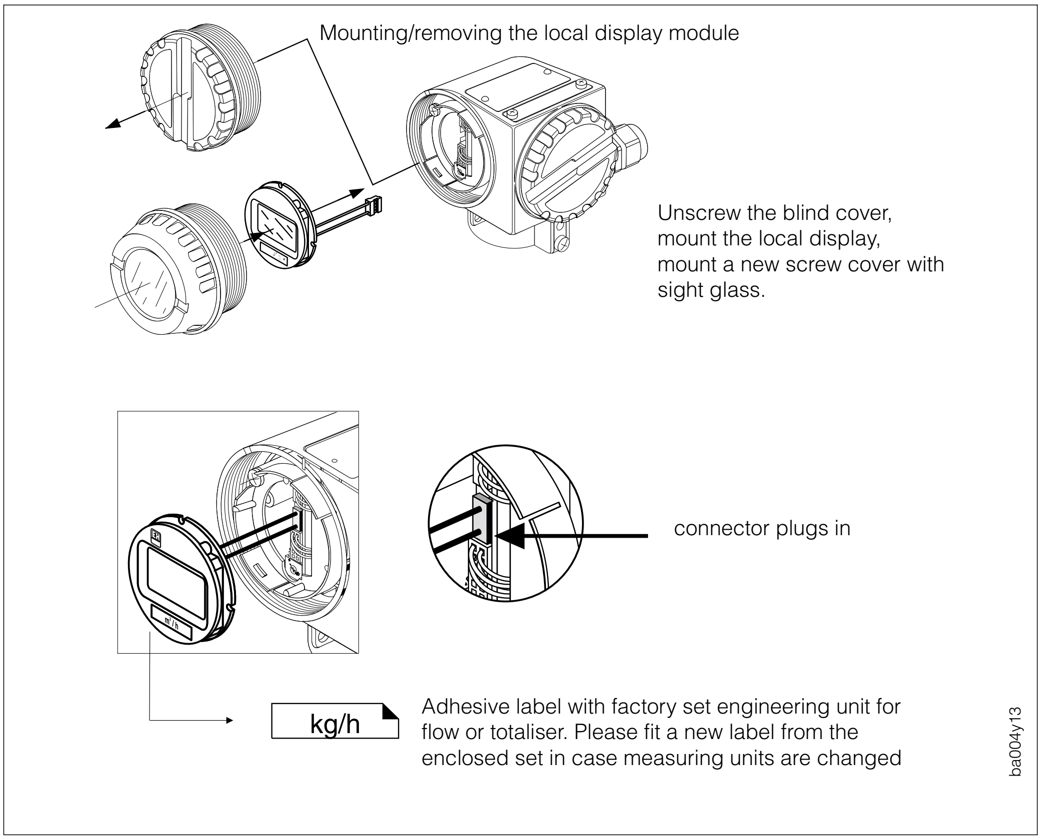


Fig. 23:
Mounting the local display

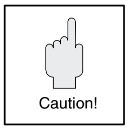
4. Electrical Connection

4.1 General Information

The information in Section 3.1 must be observed in order to maintain the IP 65 protection.

4.2 Connecting the Transmitter

Caution!



- All relevant national electrical regulations must be observed.
- The power supply voltage is a nominal 24 V DC with an absolute maximum value of 30 V DC.
- The DC power supply should be free of any surge and transients for trouble-free operation.

Procedure:

1. Unscrew the wiring compartment cover.
2. Feed the power and signal cables through the cable gland.
3. Wire up according to the wiring diagrams
4. Screw the wiring compartment cover securely back onto the transmitter housing.

4.3 Wiring Diagrams

The galvanically isolated output of the sensor can be configured to have any one of the following formats:

- Open collector pulse output (0-100 pulses/sec)
- Open collector alarm output (not Version 2)
- Passive 4-20 mA current output
- Active 4-20 mA current output (standard)

Current output configuration

The current output configuration (active/passive) is selected via a switch located on the terminal circuit board in the field wiring compartment.

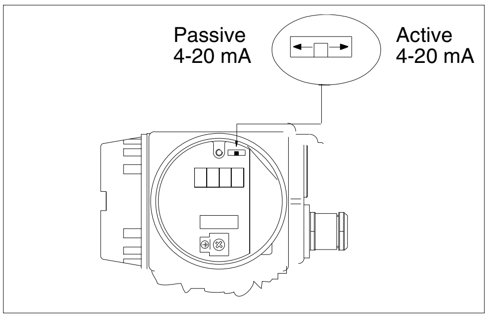


Fig. 24:
Location of the current output passive/active configuration switch on the terminal connection printed circuit board

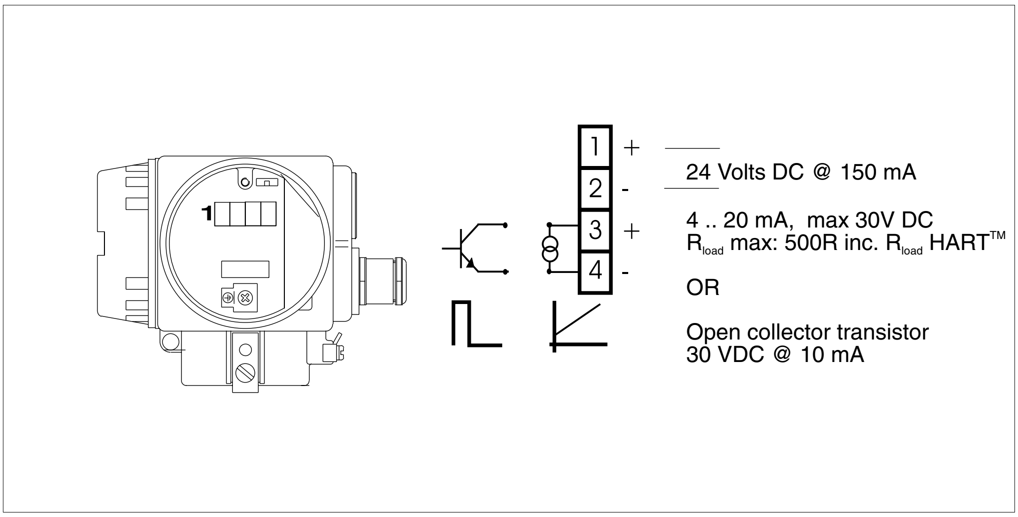
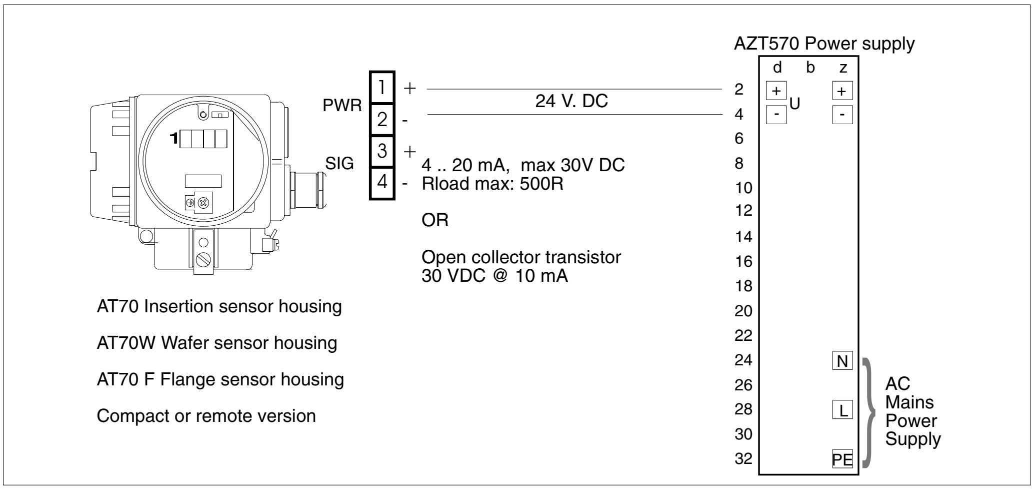


Fig. 25:
t-mass wiring compartment

AZT570 rack mounted sensor field power supply

Fig. 26:
AZT570 rack mounting power supply wiring (rear view of terminal connector block) when used with the AT70 sensor

This is the recommended Endress+Hauser power supply for the t-mass S sensor



Active current output wiring

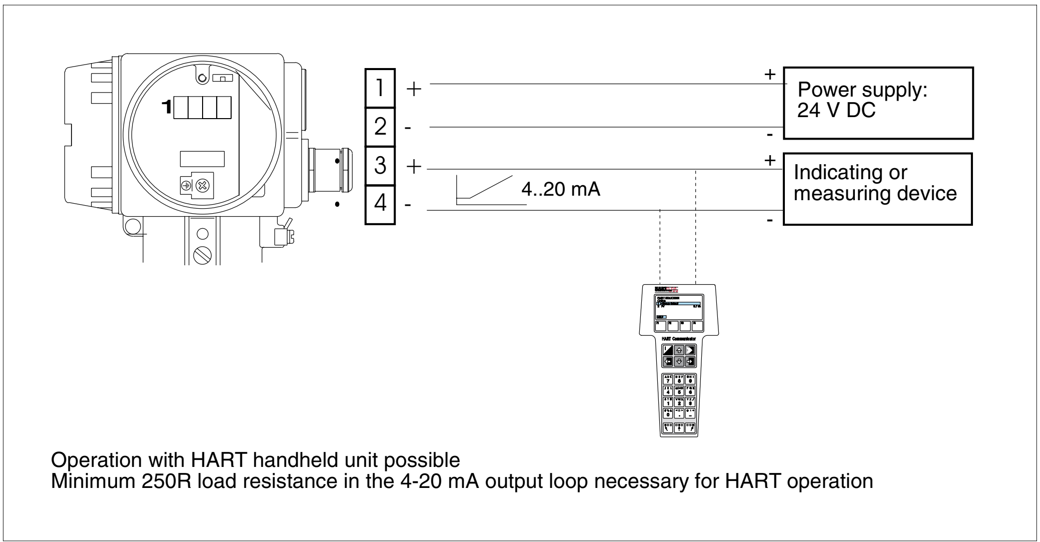
Used where the flow indicator has a passive input (e.g. passive indicator, passive D.C.S (Digital Control System) current input). This is the factory default setting.

Fig. 27:
Active current output wiring

Contact your local E+H representative for details of suitable indicating devices, e.g.. ....
Indicators:
VU2520, VU2550

Computer interfaces:
FXA191, FMA671

Recording indicators:
Chroma-log, Mega-log, Memo-log



Passive current output wiring

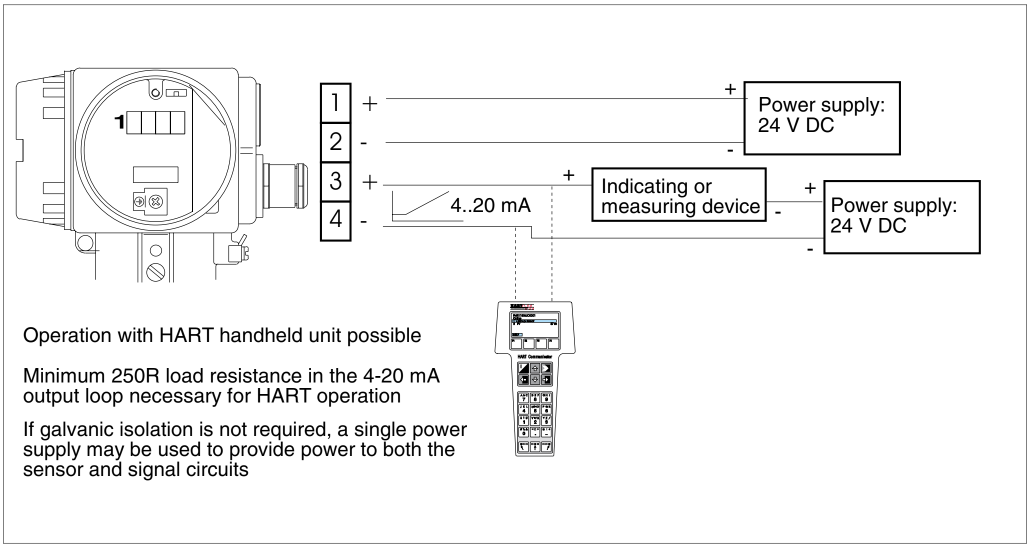
Used where the flow indicator has an active input (e.g. passive indicator with external power supply, active DCS current input).

Fig. 28:
Passive current output wiring

Contact your local E+H representative for details of suitable indicating devices, e.g.. ....
Indicators:
VU2520, VU2550

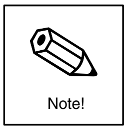
Computer interfaces:
FXA191, FMA671

Recording indicators:
Chroma-log, Mega-log, Memo-log



Open collector transistor pulse output

As an alternative to the current output, the t-mass signal output can be configured as a passive open collector transistor or active voltage pulse output for use with a self or externally powered electronic counter or DCS/PLC pulse input. If specified at the time of order, the output will be configured as requested however the output can be reconfigured in the field by a combination of switch settings and the programming matrix.



Note.
The HART^TM communication feature of t-mass S cannot be used when the open-collector transistor output is selected.

Configuration

The output is configured by two internal switches that can be accessed in the main electronics housing

- Remove the display module by unscrewing the cover with the glass window
- Prise the LCD module carefully from the display bezel with a small screwdriver and unplug the display connector from the main circuit board
- Remove the display bezel by unscrewing the two fixing screws
- Set the two switches on the indicated circuit board (see figure) to the “Pulse” position.
- Re-assemble the display and bezel in the reverse order
- The programming parameter “FS”, “OCFu” and “P.SCA” must be reconfigured before the pulse output will function. This can be done during the commissioning of the system.

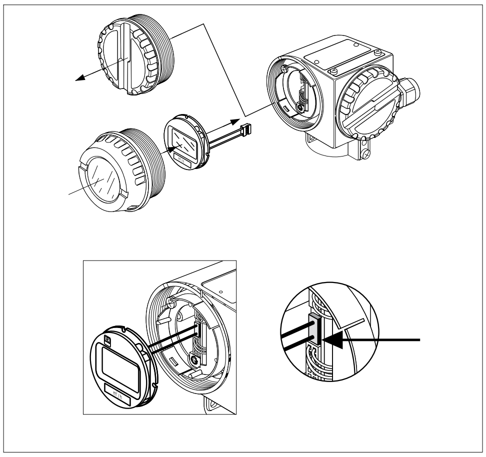


Fig. 29:
Mounting/removing the local display module

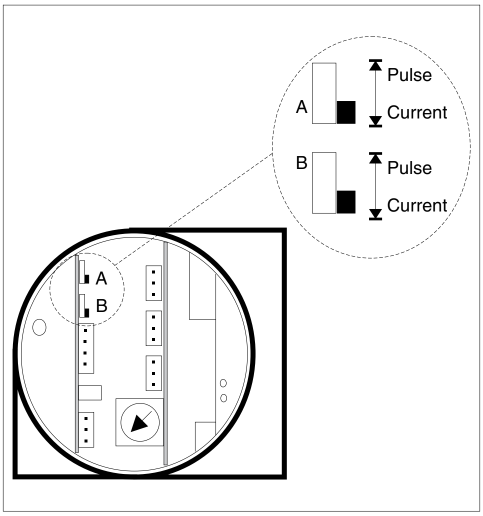


Fig. 30:
Location of the pulse/current selection switches after removing the display and display bezel - compact sensor version only

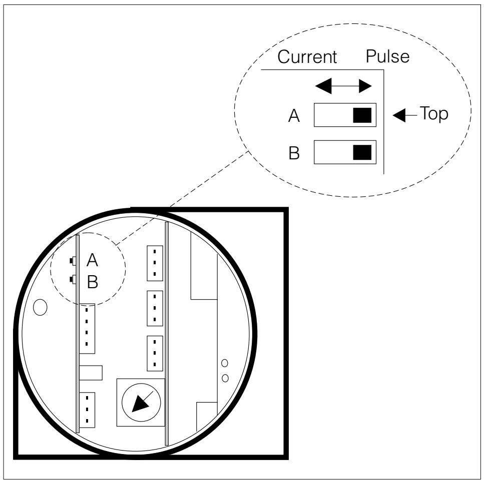


Fig. 31:
Location of the pulse/current selection switches after removing the display and display bezel - remote electronic sensor version only

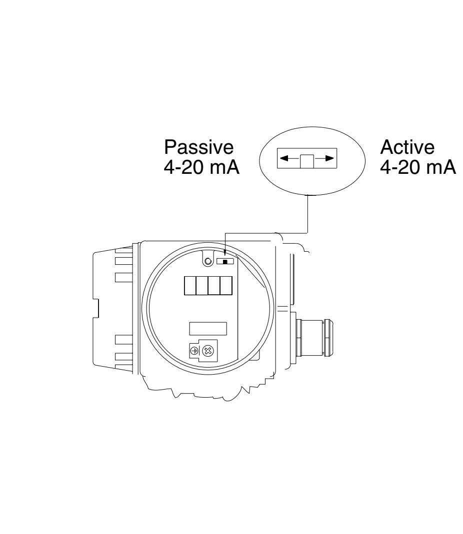


Fig. 32:
Location of passive/active configuration switch on the terminal connection printed circuit board

Pulse Output Type

Once the switches have been set to "Pulse", the active/passive switch on the terminal connector circuit board configures the pulse output as either:

- *Active*: a voltage output from terminal 3 that switches from an open circuit condition when the pulse is "off" and >12V when the pulse is "on" (relative to terminal 4). This is the normal setting for most electronic counters
- *Passive*: an open collector transistor that has an internal current limiting 470R resistor in its collector (see figure below). The transistor functions as a resistive "switch" between terminals 3 and 4.

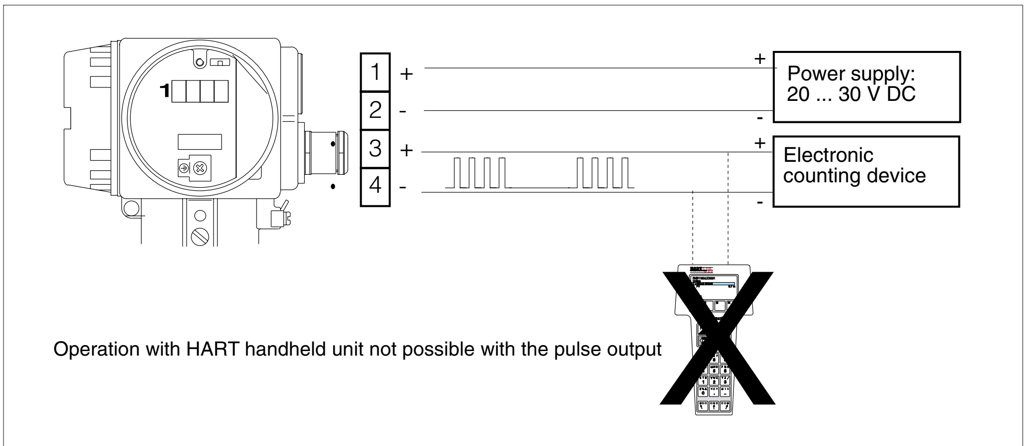


Fig. 33:
Typical wiring configuration for active pulse output operation with a self-powered electronic counter

For some counting devices the active pulse output may not be suitable due to a variety of reasons e.g. incompatible on/off voltage thresholds, very low counter input impedance, high input current demand of the counter.
The "passive" pulse output mode allows the open-collector output to be configured in a variety of different ways to suit the counting device.

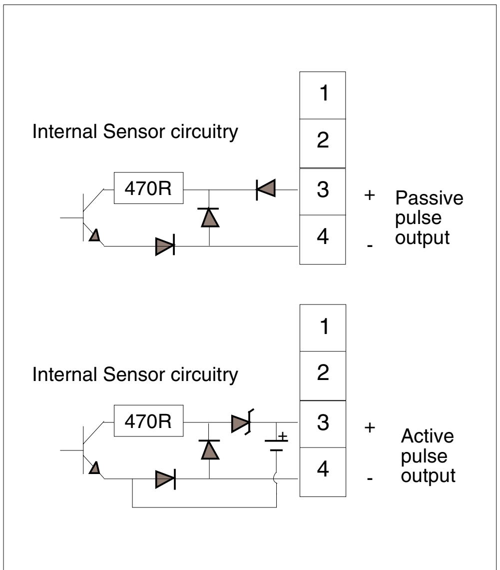


Fig. 34:
The basic AT 70S open-collector output circuit

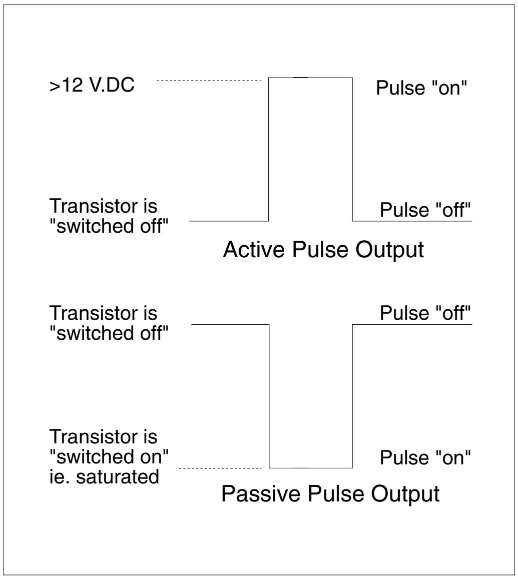


Fig. 35:
Active and passive pulse output waveforms

4.4 EMC/RFI recommendations

In order to conform to statutory EMC/RFI requirements the electrical installation should always accommodate the following points:

- The sensor power supply and signal output should be connected to the measuring / indicating system by either a single 4 core or two twin core screened or shielded cable runs. The screen or shield should be earthed at the sensor end of the cable only. Earth connection points are provided on the outside and inside of the wiring compartment.
- It is always good installation practice not to mix sensor cable runs with other cables carrying high current and/or voltages. This is particularly important if the HART™ communication feature of the sensor is utilised.
- The sensor should always be operated with all of its housing covers fitted.

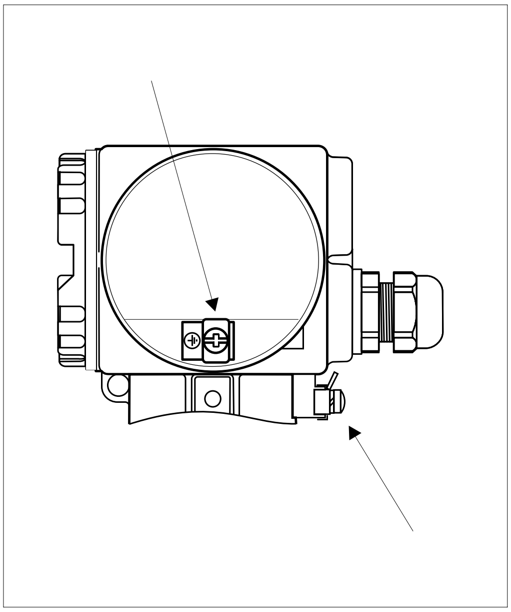
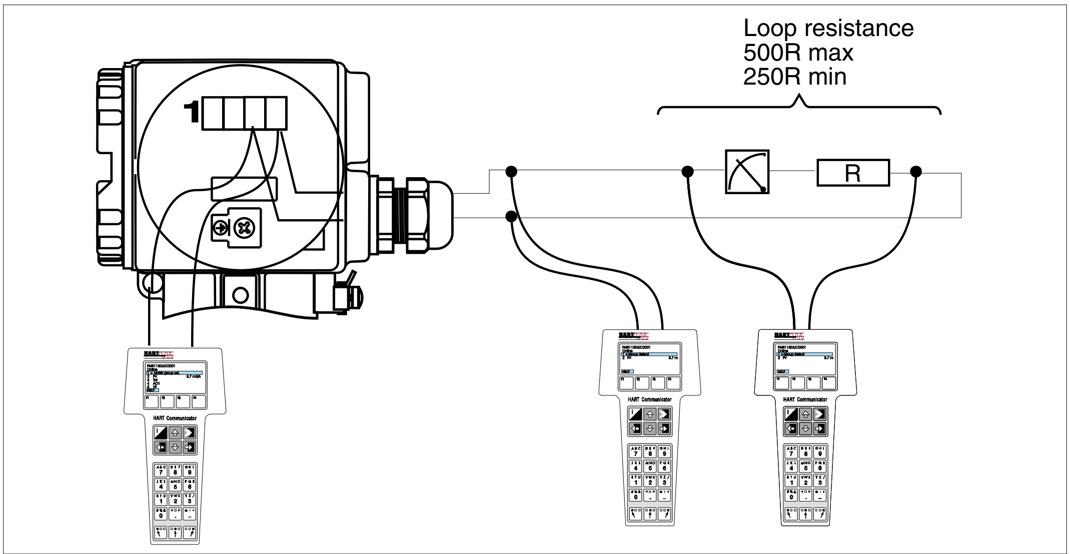


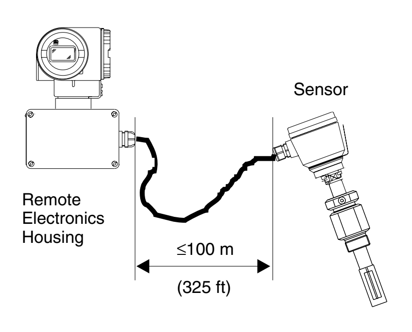
Fig. 36:
Earth connections inside and outside of the housing

4.5 Current output loading - HART



- Where data transfer takes place over the signal cable via HART protocol the minimum current loop load resistance is 250 Ω .

4.6 Remote housing configuration and wiring



The AT70 sensor family can be supplied with the main electronics, display and keyboard contained in a remote housing that can be mounted up to 100m (325 ft) away from the sensor.

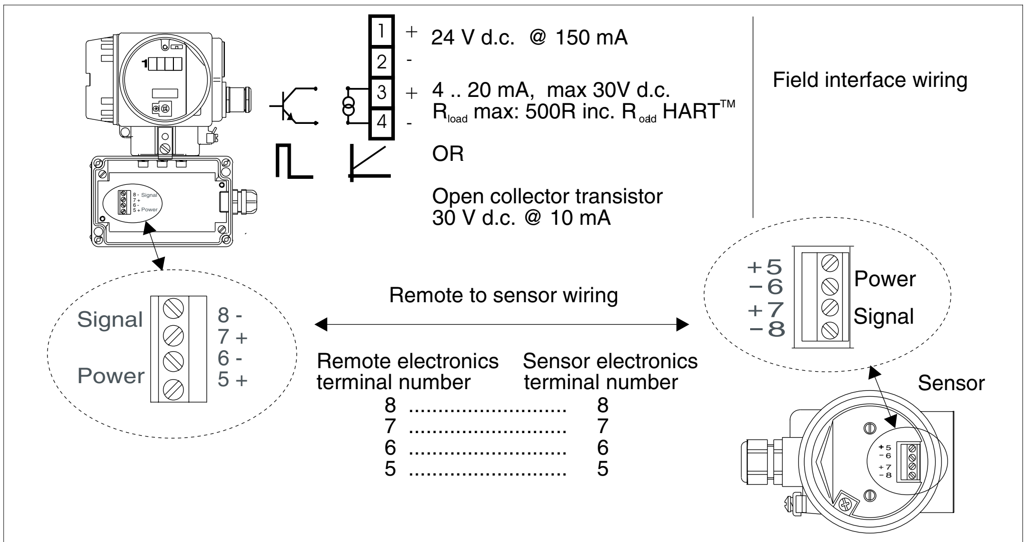


Fig. 37:
General wiring schematic - Separated electronics housing and sensor

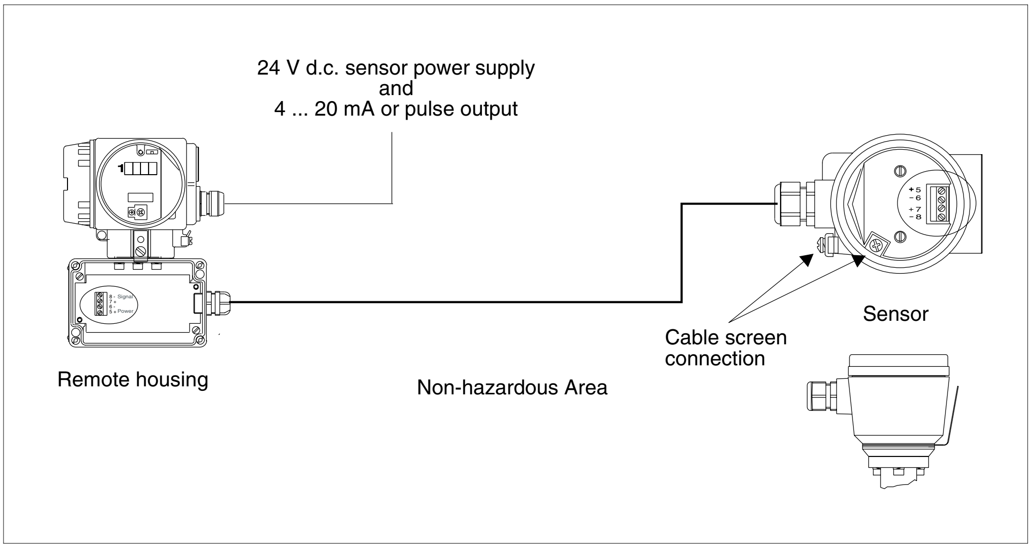


Fig. 38:
Remote housing to sensor wiring - non-hazardous area operation

4.7 Hazardous area operation

In all cases, the meter installation should follow any national codes of practice for hazardous area instrumentation (e.g. BS5345). The following diagrams are for guidance only.
The remote version can be supplied to 4 certification levels depending on the installation requirements and mix of hazardous area classifications:

Remote electronics sensor version

- EEx d [ia] ia IIC T4 Explosion-proof remote housing (field to safe area connection) with an intrinsically safe output connection to the EEx ia IIC T4 sensor allowing both remote electronics and the sensor to be installed in the hazardous area
- [EEx ia] IIC Remote electronics in the safe area with the EEX ia IIC T4 sensor in the hazardous area
- IEC 79-15 Type n for Zone 2 operation

Compact sensor version

The compact sensor can be supplied for hazardous area operation as follows:

- IEC 79-15 (Type n) for Zone 2 operation

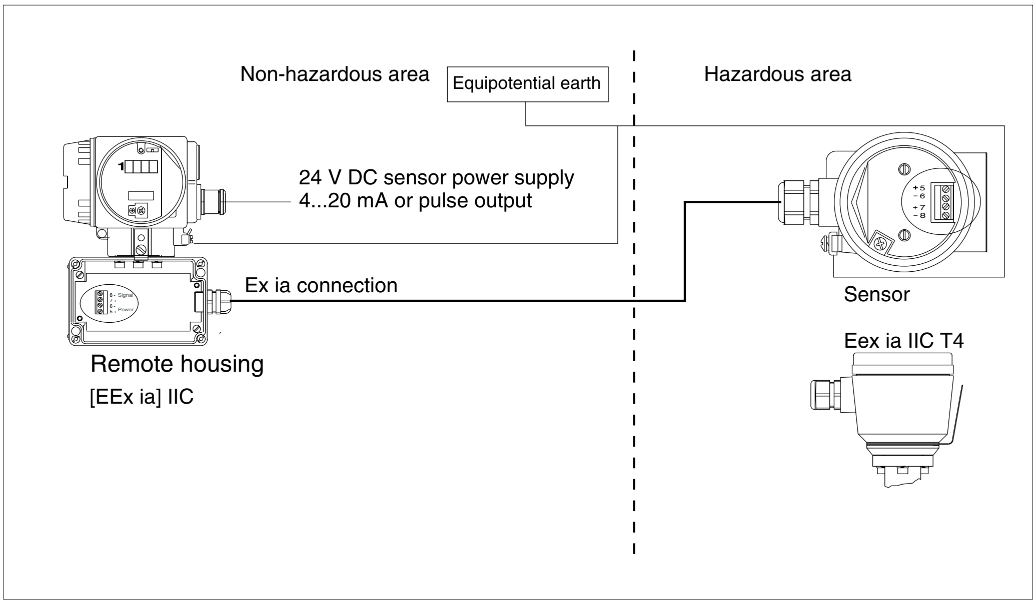


Fig. 39:
Remote housing to sensor wiring - Remote electronics in the non-hazardous area,

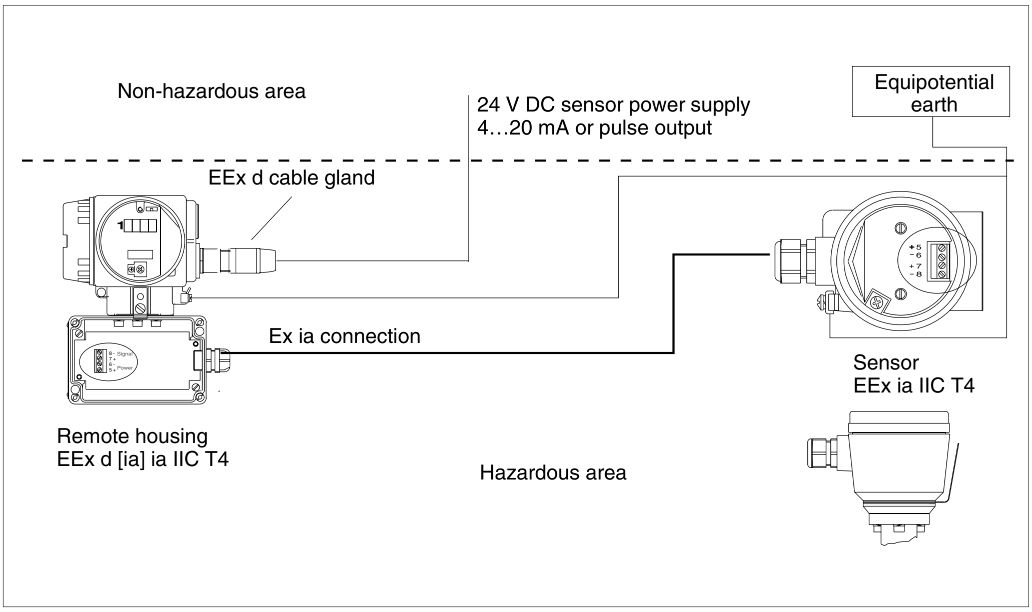


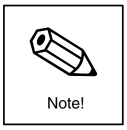
Fig. 40:
Remote housing to sensor wiring - both the remote electronics and the sensor in the

Remote electronics to sensor cable characteristics - EEx

Sensor circuit	Ex gas group	Maximum cable capacitance (nF)	Maximum cable inductance (mH)	Maximum L/R ratio (mH/R)
POWER connections	IIA	3416	4.98	0.576
	IIB	1281	1.87	0.216
	IIC	427	0.622	0.072
SIGNAL connections	IIA	6320	1760	43.2
	IIB	2370	660	16.2
	IIC	790	220	5.4

Cable specification (for the remote housing to sensor wiring only)
Power and Signal circuits

- 4 core, overall screened - 4 x 0.5 mm^2
- Conductor resistance per core - 40R/kilometre
- Capacitance - core/screen <=200 pF/metre



Note
The maximum distance between the sensor and the remote electronics is 100m (325 ft).

5. Operation (local display, pushbuttons)

The t-mass S measuring system has a number of parameters or functions, organised in a list accessable by the user one at a time via the 4 digit liquid crystal display and 4 button integral keyboard. The user can individually set the programmable functions according to the process conditions and field requirements. (These functions can also be accessed and configured by the handheld HART™ terminal)

Note!

• A summary of all factory-set values and selections is given in chapter 6.

Note!

5.1 Display and Operating Elements

The AT70 transmitter is operated by four pushbuttons and using the 4 digit local display. This enables individual functions to be selected and parameters or values to be entered.

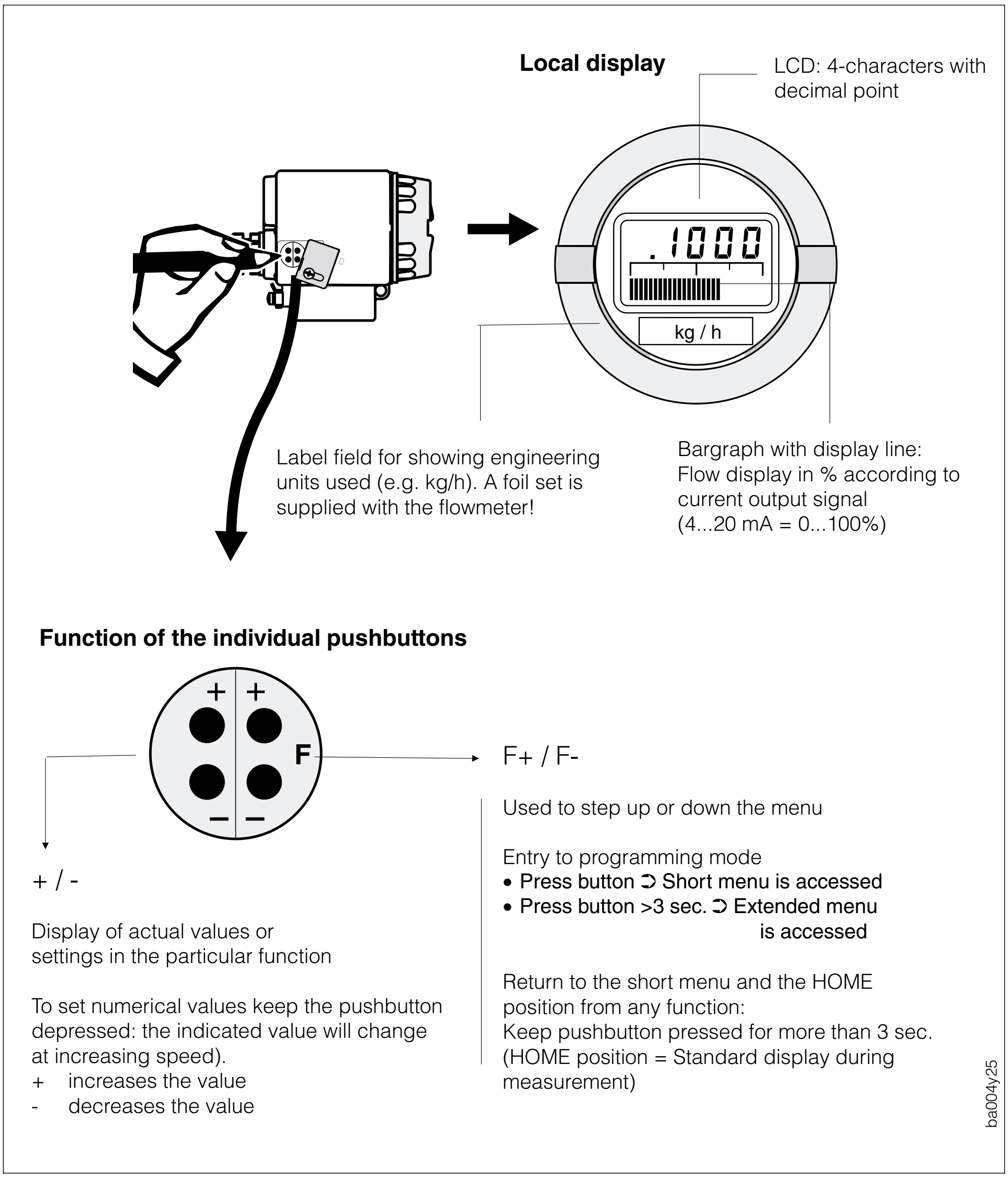


Fig. 41: Display and operating elements

5.2 AT70 Function list

A detailed description of all the functions and their factory-set values and selections is given in chapter 6.

The function list is organised in to a “short menu” that comprises the functions that are normally accessed on a day to day basis plus the “extended menu” that provides access to extra functions that are normally only required occasionally for commisioning and checking purposes.

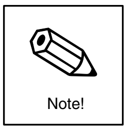
Short Menu

FLo	Flowrate (read only)
L.tot	Lower 4 digits of the integral 7 digit totaliser counter (read only)
H.tot	Upper 3 digits of the integral 7 digit totaliser counter (read only)
tE	Process gas temperature (read only)
P.SCA	Units per pulse (totaliser and pulse output)
L.Cut	Low Flow cutoff
FS	Full Scale output (Current and pulse output)
H.CAL	Maximum sensor calibrated flow (read only)
StAt	Flow meter status register (read only)

Extended Menu (appended to the short Menu when enabled from the keyboard)

r.tot	Totaliser reset and on/off control
Cu.SI	Current output simulation (current output configuration only)
Pu.SI	Pulse output simulation (pulse output configuration only)
t.Con	Time constant (damping)
In.F	Installation Factor
Pro.F	Process Factor
F.SAF	Failsafe mode
U.FLo	Flow units
U.tE	Temperature units
GAS	Calibration gas type (read only)
OCFu	Open collector transistor control
PIPE	Pipework type (Insertion sensor only)
L1	Pipe diameter/Duct height - Insertion sensor only
L2	Duct width (Insertion sensor only)
PUL.t	Pulse width (Pulse out configuration only)
ZEr0	Process zero setting (sensor firmware 2.x and above only)
HI.tE	Hightest process temperature reached (read only)
tP1	Diagnostic flow primary data (read only)
tP2	Diagnostic temperature primary data (read only)
dAC1	Factory setting - D/A convertor 4 mA setting
dAC2	Factory setting - D/A convertor 20 mA setting
CodE	Security access code entry.

Note.



Continual pressing of the F+ function key steps *down* the list, one function at a time. At the end of the list (short or extended depending on which is enabled), the display will step back to the top of the list (ie FLo).
Similarly the F- function key steps *up* the list, on reaching the top of the list, the display will jump to the bottom of the list (ie StAt for short menu, CodE for extended menu)

5.3 Selecting Functions and Changing Parameters

Selecting functions are carried out as follows (see Fig. 42 and Fig. 43):

1) Entering the programming mode
2) Selecting the function
3) Enabling programming (if originally disabled)
4) Changing values/settings
5) Leaving the programming mode; In the Short Menu, programming is automatically disabled if no pushbutton is pressed for 60 seconds.
6) Leaving the programming mode; In the Extended Menu, programming can be disabled by pressing F+ or F- for a minimum period of 3 seconds.

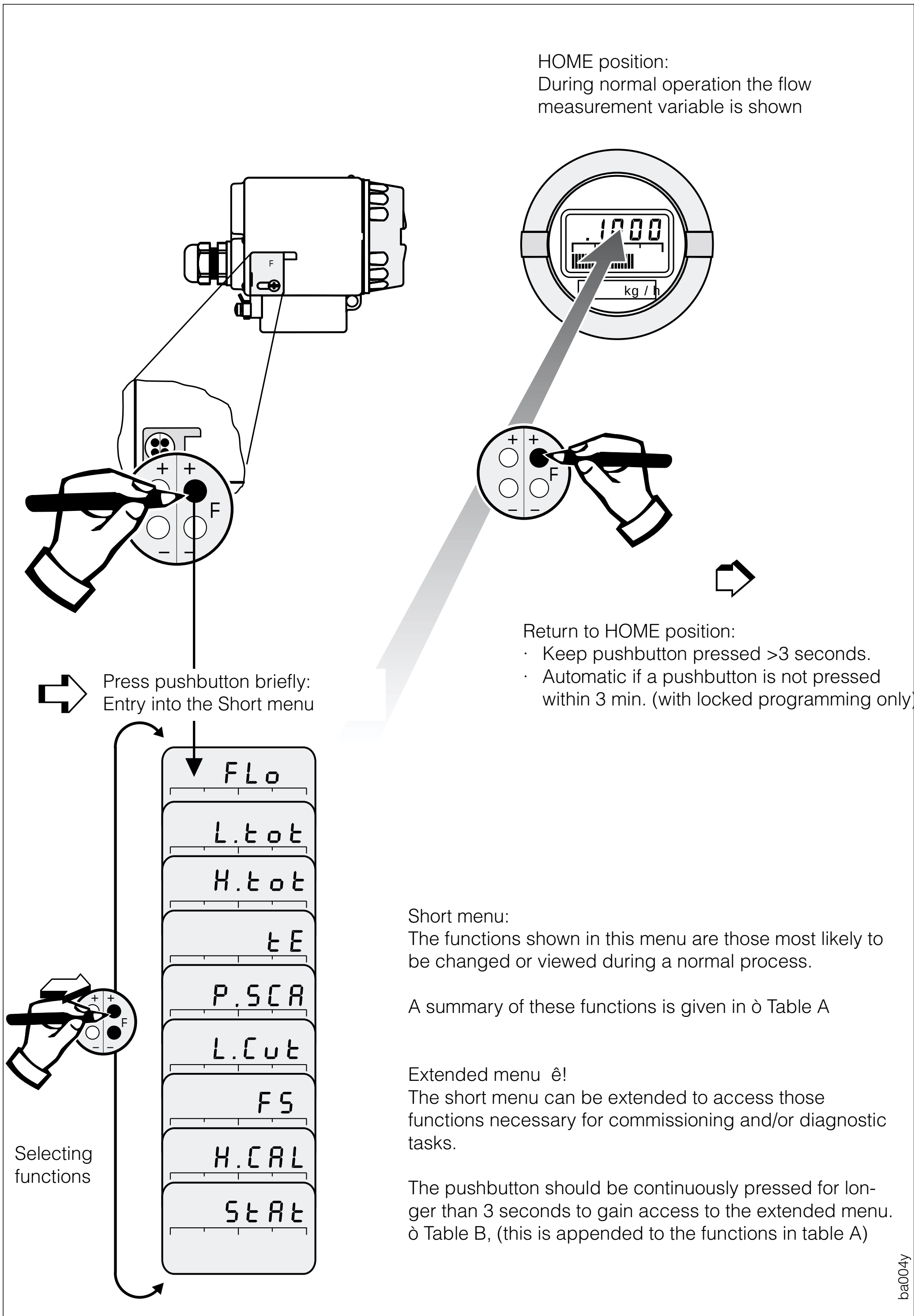
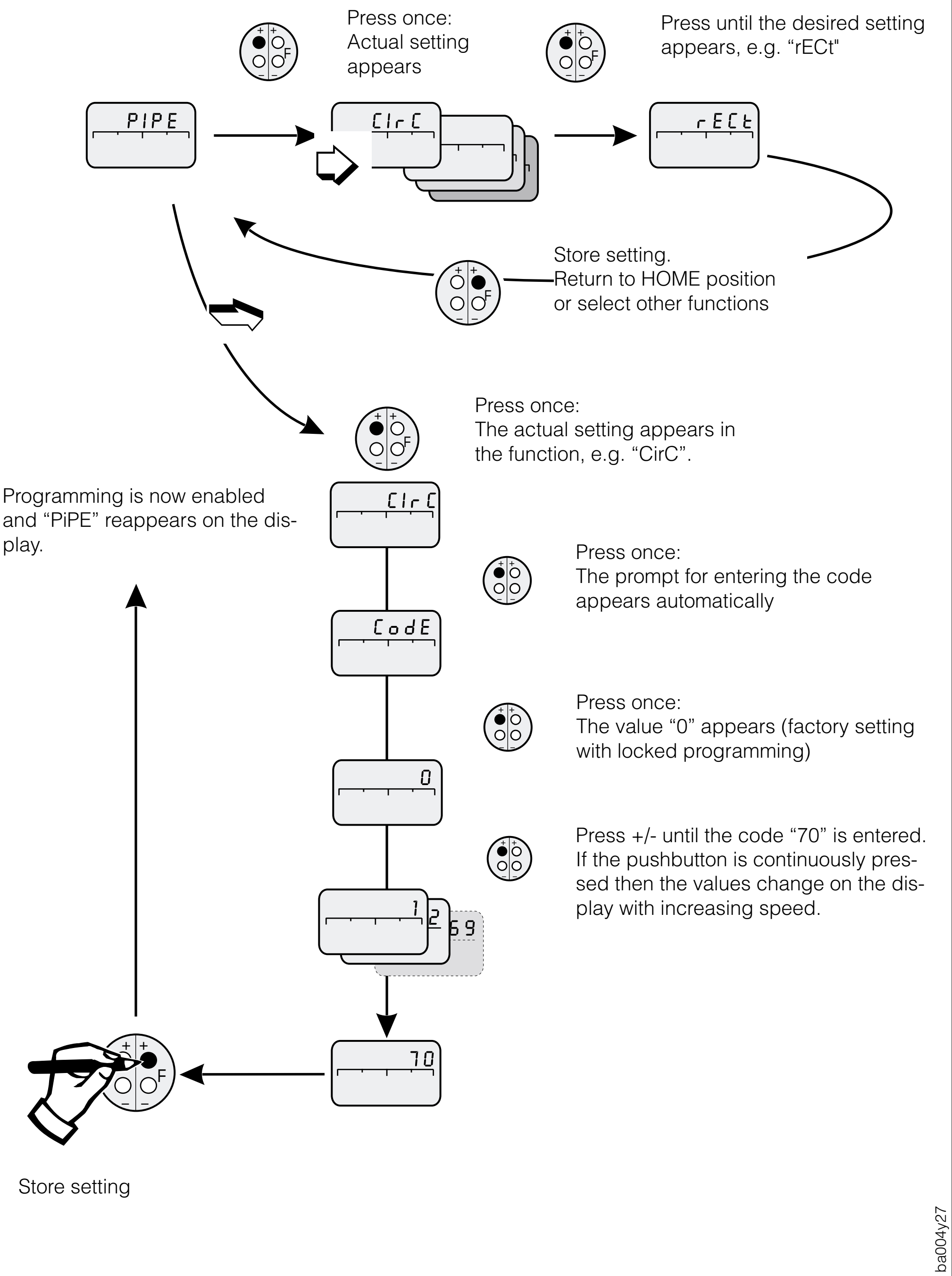


Fig. 42:
Selecting the functions

Enable programming and change functions
(for example Function “PiPE”)



If programming is
not enabled

Enabling programming
- Enter code number (factory setting = 70)

Locking programming
- After returning to the HOME position the programming is again locked if no pushbutton is pressed for 60 seconds.
- Programming can also be locked by entering any other number than 70 in Function “CodE”.

Fig. 43:
Enabling programming, changing functions

6. Functions

This section gives a more detailed description of the individual functions of the AT 70 sensor models.

Start of Short Menu - ACTUAL MEASURED VALUES	
Flowrate FLo	This function displays the actual mass flowrate being measured (mass/time) by the sensor. Note! The engineering units used can be defined or changed in Function U.FLo. Display format: 4-digit number with floating decimal, e.g. 240.5 (kg/h)
Integral totaliser counter	The complete totalised value is a 7 digit number however since the display is limited to 4 digits then the totalised value must be split into two parts: L.tot for the lower 4 digits and H.tot for the upper 3 digits. The complete totaliser value can therefore be calculated from the sum of the value shown in (L.tot) plus the sum of (H.tot x 10,000). E.g. L.tot = 4587 and H.tot = 274, the complete totaliser value = (274 x 10,000) + 4587 = 2,744,587 **Notes.** 1) The totaliser does not retain its contents when the power supply is removed. It will always start at a value of zero when the power is restored. 2) In cases of error the totaliser remains at the value last shown. 3) The totaliser only operates when the function r.tot is set to On 4) The totaliser units are determined by the main flow value units. E.g. flow = kg/hr, totaliser = kg 5) The totaliser can be reset to zero by the function r.tot
L.tot	The lower 4 digits of the integral 7 digit totaliser counter. Note! H.tot is increment by 1 as L.tot overflows from 9999 to 0000 Display format: 4-digit number with floating decimal, e.g. 595 kg)
H.tot	The upper three digits of the integral totaliser counter. Notes! 1) H.tot is incremented by 1 as L.tot overflows from 9999 to 0000 2) A max. of 999 overruns are shown. The display then begins to flash. Display format: 3-digit number, e.g. 645 (overruns)
Process gas temperature tE	This function displays the process gas temperature as measured by the sensor. Note! The engineering units used can be defined or changed in Function "U.tE" Display format: 4-digit number with floating decimal, e.g. 50.3 ('C)

PULSE OUTPUT/LIMIT SWITCH

Units per pulse

P.SCA

Only displayed if OCFu is set to Pout

In this function the flow quantity (E.g. kg or lbs etc.) is determined which each output pulse represents.

Note!

1) This function is only available if the setting "Pout" is selected in Function "OCFU".
2) Ensure that the pulse scaling is chosen so that the pulse frequency for minimum/maximum flow falls within the range of 0.000...100 Hz .

Input format:
4-digit number with floating decimal, e.g. 1.293 (kg/pulse)
This will be pre-programmed at the factory if the required setting is supplied with the order, otherwise the shipped setting will be "0.000"

CURRENT OUTPUT CALIBRATION

Current output low flow cutoff value

L.Cut

The "calibrated" value of 4 mA is always set to zero flow (i.e. 0 kg/h = 4 mA, FS = 20 mA) but there is always a threshold (gas and process conditions dependent) below which the flow sensor will not measure accurately.
It is often desirable therefore, to define a lower limit below which the meter will always indicate zero flow and force the current output to 4 mA.

The Low Flow Cutoff function defines the measured flow at which the indicated flow value and the current output are forced to their respective minimum values (i.e. 0 and 4 mA).

E.g.
L.Cut = 10 kg/h - all measured flows below and equal to 10 kg/hr will force the display to zero and the current output to 4 mA.

Input format:
4-digit number with floating decimal, e.g. 8.500 (kg/h)

Notes!

1) The totaliser will also stop counting during the time that the flow is below the Low Flow Cutoff value.
2) If the pulse output is enabled rather than the current output then the pulse output will be forced to its minimum value when the flow is below the Low Flow Cutoff value.
3) Unless specified with the order, this value will be set to 1% of the FS value or the minimum flow value for the process gas which ever is the greatest value.

Full scale value

FS

Current output configuration:
Is set to the flowrate value equivalent to the 20 mA current value.
Pulse output configuration:
Is set to the flowrate equivalent to the maximum pulse output frequency (as determined by the PuL.t function.

Notes!

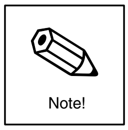
1) The maximum value that FS can be set to is defined by H.CAL (see below).
2) The engineering units for flowrate can be defined or changed in Function U.FLo.
3) Unless specified with the order, this function will be set to the maximum calibrated sensor flow value H.CAL

Input format:
4-digit number with floating decimal, e.g. 325.5 (Nm3/h)

Maximum sensor calibration

H.CAL

This function defines the maximum flow value for the specified process gas that the sensor has been calibrated for. The function F.S can be set to any value below and equal to this value.



Note!
1) The numerical value of H.CAL will be recalculated automatically whenever the U.FLo, In.F or Pro.F functions are changed.
2) This is factory set from the order details and depends on the gas type and pipe line size.

Display format:
4-digit number with floating decimal, e.g. 240.5 (kg/h)

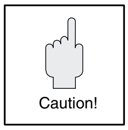
FLOWMETER STATUS

Meter status

StAt

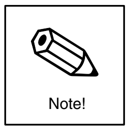
In this function all actual error messages can be called up. Errors which occur during operation are shown by a flashing display. The AT70 measuring system differentiates between two types of error message:

System error message:
An error code flashes on the display (HOME position). These errors directly affect the measurement - Correct the error immediately.



Warning message:
The actual measured value flashes on the display (HOME position). The bargraph also flashes if the measuring range as defined by FS is exceeded.

These errors do not affect the measurement. The measuring system continues to measure but these "non-critical" errors are to be corrected as soon as possible.



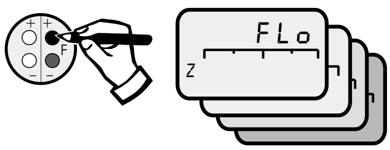
Note!
1) When a number of errors have occurred, the one with the highest priority is shown.
2) No system or warning messages are shown while in the programming mode (except in Functions FLo, L.tot and H.tot). Once the error has been corrected, the normal measured value is again shown on the display and the bargraph stops flashing.

For a full listing and description of these error codes read Chapter 9.

Start of Extended Menu

When a function key is depressed for more than 3 seconds, the short menu is extended to include the following additional menu items.

When the extended menu is open, a "Z" is shown in the display window.



TOTALISER COUNTER CONTROL

Totaliser reset

r.tot

In this function the totaliser (L.tot and H.tot) can be set to 'zero' (reset).

Selection:
ESC = Totaliser will not be changed (i.e. no action)
On = Totaliser enabled
oFF = Totaliser disabled
rSt = Totaliser is reset to zero

SIGNAL OUTPUT SIMULATION AND DAMPING	
Simulation Cu.SI **This is only displayed if OcFu is set to oFF**	With this function, the output current can be simulated to correspond to 4, 12, or 20 mA for checking wiring or connected instruments. Note! 1) The simulation mode affects the current output and totaliser. During simulation the flowmeter FLo function remains operational for measurement 2) The totaliser increment rate is related to the value of the simulated current output value. E.g. if Cu.SI = 20, the totaliser will increment at its maximum setting as determined by P.SCA and FS. 3) During simulation, the bar graph shows the selected output current simulation value and not the actual flowrate in %. Selection: OFF = Current output follows actual measured value) 4 = 4 mA 12 = 12 mA 20 = 20 mA
Simulation Pu.SI **This is only displayed if OcFu is set to Pout**	In this function the pulse output can be simulated to correspond to 0%, 50% or 100% of the programmed measuring range for checking wiring or connected instruments. Note! 1) The simulation mode affects the pulse transistor output and totaliser. During simulation the flowmeter FLo function remains operational for measurement. 2) The totaliser increment rate is related to the value of the simulated current output value. E.g. if Cu.SI = 20, the totaliser will increment at its maximum setting as determined by P.SCA and FS. 3) During simulation, the bar graph shows the selected output current simulation value and not the actual flowrate in %. Selection: OFF = Pulse output follows the actual measured value 0 = 0 Hz 50 = Mid-range 100 = Maximum programmed frequency output (as determined by FS and P.SCA)
Sensor damping (time constant) t.Con	Selecting the time constant determines how quickly the current output signal and the display respond to rapidly fluctuating flowrates (small time constant) or are delayed (large time constant). Input format: 3-digit number with fixed decimal: 0.2...100.0 (seconds) Factory set: “1.0" (seconds) Note! This delay is in addition to the inherent time constant of the physical sensors themselves. This may change with ongoing design improvements but is presently a nominal 1.5 seconds.

INSTALLATION AND PROCESS EFFECTS COMPENSATION	
Installation factor In.F	This is normally a service function and it's main use is to compensate for calibration errors that are caused by external installation or process effects that cannot be corrected for e.g. pipe disturbance, saturated or very wet gas. It is an empirically derived value normally evaluated by comparing the meter reading with a reference meter or knowledge of the process. See section 7.5.10 for more details of this function. The final displayed value in the FLo function is the measured value multiplied by this value, the displayed reading can be scaled upwards or downwards by programming a scale factor into this function. E.g. An installation factor setting of 0.75 will lower the measured flow reading (and current output) by 25%. Input format: 4-digit number with floating decimal: 0.1...999.9 Factory set: "1.0" unless otherwise stated on the Calibration Statement.
Process Factor Pro.F	This is a numerical value that compensates for the fact that the gas temperature and pressure conditions may be operating at a different value to those used to calculate the sensor calibration data. See section 7.5.9 for more details of this function. E.g. The sensor calibration may have been calculated for 20'C and 2 bar abs. whereas the actual operating conditions may be 50'C and 10 bar abs. Input format: 4-digit number with floating decimal: 0.001 ...999.9 Notes: 1) Factory set to "1.0" if the gas process conditions are not specified with the order. 2) This can be changed in the field to suit the actual conditions using a factory supplied value. 3) The value of the Process Factor will also be stated on the Calibration Statement.
FLOWMETER FAILSAFE MODE	
Failsafe mode F.SAF	In cases of sensor fault it is advisable for safety reasons that the current output assumes a previously defined status which can be set in this function. Selection: Lo = minimum current value (the current signal is set to 3.6 mA on error) HI = maximum current value (the current signal is set to 21 mA on error) run = normal measured value given despite error
SYSTEM UNITS	
Flow units U.FLo	In this function the engineering unit can be selected from a variety of pre-programmed mass flow and normalised volumetric flow options. Notes! · Attach the adhesive label showing the engineering units on the field provided on the local display! · The engineering units selected here also define those for: - Full scale value FS - Low Flow cut-off setting L.Cut - Pulse scaling value PSCA For this reason U.FLo should be set before the above. Selection: 0 = kg/h, 1 = kg/m, 2 = kg/s, 3 = NL/h, 4 = NL/min, 5 = NL/s, 6 = Nm3/h, 7 = Nm3/m, 8 = Nm3/s, 9 = lbs/h, 10 = lbs/m, 11 = lbs/s, 12 = Sm3/hr, 13 = Sm3/m, 14 = Sm3/s, 15 = Scf/h, 16 = Scf/m, 17 = Scf/s, 18 = Ton/h, 19 = Ton/m, 20 = Ton/s, 21 = SL/h, 22 = SL/m, 23 = SL/s

Note!

Note!

Temperature units U.tE	With this function the engineering unit can be selected for the temperature display. Selection: 0 = degrees Centigrade 1 = degrees Fahrenheit 2 = degrees Kelvin
Gas type number GAS	This function displays the gas type that the sensor has been calibrated to measure. Display format: 0 = Air 2 = Argon 3 = Carbon dioxide 8 = Nitrogen 9 = Oxygen 11 = Methane 250 = (Mixture) not standard gas Note that this is a factory set read-only value only and cannot be changed in the field.
OPEN COLLECTOR TRANSISTOR	
Open Collector functions OCFU	**Note that changes to internal hardware switches are also required in order to select the signal output to be either open collector or 4-20mA current. Various functions can be assigned to the open collector output. .** Selection: Pout = Pulse output: An output pulse is produced for a defined flow mass (see also Function "PSCA"). OFF = Disabled, output = 4-20mA current
PIPEWORK DIMENSIONS - INSERTION SENSOR ONLY	
Pipe cross section profile PIPE	This function configures the calibration calculation depending on the sensor/pipework type Selection: CELL = Flanged/wafer flowcell version only CIrC = Insertion sensor only - circular pipe. rECt = Insertion sensor only - rectangular duct
Pipe Dimension 1 L1 **Only displayed if PIPE set to CirC or rECt**	If the PIPE function is set to CIrC the L1 must be set to the internal diameter of the pipe. If PIPE is set to rECt then L1 must be set to the height of the duct. Input format: 3-digit number with fixed decimal: 0.1 ... 1000 (millimeters) Factory programmed as per order details. Set to 100 if not specified.
Pipe Dimension 2 L2 **Only displayed if PIPE set to rECt**	Must be set to the width of the duct. Input format: 3-digit number with fixed decimal: 0.1 ... 1000 (millimeters) Factory programmed as per order details. Set to 100 if not specified.

Note!

OPEN COLLECTOR TRANSISTOR	
Open collector transistor pulse width PUL.t **Only displayed if OC.Fu is set to P.out**	This is only displayed if the OC.Fu function is set to P.out (i.e. pulse output enable). This parameter sets the pulse width ON time in milliseconds. Input format: 3-digit integer number 1 ... 255 Factory programmed as per order details. Set to 100 if not specified. Note: 1. The pulse output setting will determine the maximum output pulse rate or frequency of the transistor output. 2. At the maximum pulse output rate the ON/OFF ratio of the output is 1:1. E.g. PuL.t = 100 ms will produce a maximum of 5 pulse per second at the flow rate set by F.S.

PROCESS ZERO SETTING	
Process Zero ZEr0	This functions allow the meter zero point to be adjusted to suit the actual process conditions where these vary from the calibration values. Selection: 0FF = Disabled SET = Fixes the zero point ESC = Removes any setting and returns the meter zero point to that set at factory calibration. Note: This function is not available in sensor firmware versions 0.x and 1.x.

SERVICE	
Maximum temperature re-ached HI.tE	The sensor maintains a read-only record in non-volatile memory of the highest temperature measured. Display format: 4-digit number with floating decimal, e.g. 90.0
Testpoint 1 tP1	A Service data function. In the event of the need to contact your E+H service center for technical support, the value of this function may be useful. Display format: 4-digit number with floating decimal, e.g. 1070
Testpoint 2 tP2	
D/A setting 1 dAC1	Factory setting to set the digital to analogue convertor to 4 mA.
D/A setting 2 dAC2	Factory setting to set the digital to analogue convertor to 20 mA
Access code CodE	All data of the AT70 measuring system is password protected against unauthorised changes. Only by first entering the code number "70" in this function is programming unlocked to allow the instrument settings to be altered. If, when programming is locked and the display is indicating any programmable function, the pushbuttons + / – are pressed, then the measuring system automatically displays the Code prompt to allow the operator to unlock the programming by entering the code number. Note! · Locking programming: After jumping to the HOME position, programming is again locked after 60 seconds if a pushbutton is not pressed during this time. Programming can also be locked by entering any other number (not the code number) in this function. Input: 4-digit number: 0...9999 Factory set: to 70

This page has been deliberately left blank

7. AT70 Sensor Commissioning Guidelines

The commissioning of the AT70 should follow the following basic procedure:
- Check the physical installation.
- Check the electrical wiring before switching the power supply on.
- Check the basic functions of the sensor are programmed correctly (e.g system units, current output or pulse output ranges, gas type ... ...)
- Check and set the process dependent settings of the meter (e.g. zero, Installation factor, process factor ... ...)

7.1 Installation checks

The sensitivity of the thermal dispersion principle to very low flowrates makes the sensor potentially vulnerable to externally created flow disturbances (E.g. swirl, externally induced flow profile disturbances etc.). It is very important that the sensor is installed in accordance with the documented guidelines, in particular the following points should be checked
- Newly installed piping should always be thoroughly rinsed through before mounting the meter, to prevent mechanical damage.

Note
Any residue left in the pipe (e.g. metal or solid particles etc.) presents an extremely high risk of destroying the sensing elements under flowing conditions.

Warning!

- Clear lengths of upstream pipework dependent on the pipework layout. This is especially important for high flows and/or large pipe diameters.
- Clear lengths of downstream pipework
- Ensure that the directional arrow on the meter body agrees with the actual flow direction.
- Gas conditions (e.g. purity, dryness, cleanliness)

.

Specific Insertion sensor (AT70) checks
- The insertion depth is correct.
- The graduation scale on the insertion rod is facing the flow direction.
- The sensor is aligned perpendicular to the pipework.
- The function PiPE is set to CirC or DuCt depending on the pipework type.
- The functions L1 and L2 (for ducts) are configured correctly for the pipework dimensions.

Specific Flanged/Wafer(AT70F/AT70W) flowcell checks
- Correct alignment or pipe/gasket/flowmeter body.
- Correct pipe internal diameter to pipework match.
- Ensure that the sensor body and/or gaskets are correctly aligned with the pipework and do not protrude into the gas stream.
- The PIPE function is set to CELL

Note.
Severe metering errors are likely to occur if any misalignment or obstruction is present.

Warning!

7.2 Electrical connection checks ... .

- Correct power supply polarity
- Ensure that the power supply voltage is not greater than 30 V DC or less than 20 V DC.
- Correct flowmeter switch settings (pulse/current output, active/passive current output)
- Correct signal wiring.
- If the output signal is not being used, it is recommended to configure the meter for active current output and short circuit the current output loop
- If HART™ communication feature is to be used, the current loop resistance must be 250R minimum.

7.3 Function configuration checks ... ...

All types
- Low Flow Cutoff function (L.Cut).
- System units (U.FLo and UtE) set to required units selection.

Signal output = 4-20 mA
- Internal switches (2 off) on the preamplifier circuit board are set for current output.
- Terminal compartment switch set for active or passive output.
- Open Collector function (OC.Fu) set to oFF.
- Flow value at 20 mA (FS) set to required value.

Signal output = pulse
- Internal switches (2 off) on the pre-amplifier circuit board are set for open collector output.
- Terminal compartment switch set to “active” or “passive”.
- Open Collector function (OC.Fu) set to P.out
- Flow value at 100 Hz (FS) set to required value.
- Pulse width (PUL.t) function
- Units per pulse (P.SCA) function set to required value.

Process dependent functions
- Check that the sensor has been set up for the correct gas type (check label on exterior of instrument housing and the GAS function in the extended menu)
- Has the meter zero point (ZERO) been set to compensate for offset effects caused by high static line pressures? - see page 47
- Installation factor (In.F) - Normally set to 1.000 unless otherwise stated on the Calibration Statement that accompanies the sensor. This may be set to another value later if there are installation effects that need compensating for - see page 49.
- Process Factor (Pro.F) set to the correct value for the gas process conditions. The process conditions that the sensor has been set up for will be indicated on a label attached to the sensor and also on the Calibration Statement that accompanies the sensor. If the site process conditions are different from this value the Process Factor *must* be re-set for accurate performance - see page 48.

7.4 Some additional specific application based checks

Bio-gas or very wet gas
The biggest potential problem is water collecting around the sensor elements or water running down a vertical pipewall onto the sensor elements. To minimise the chance of this happening the following recommendations should be considered:
- Installation *after* any water separating or filtering device
- Horizontal piping runs with the sensor head on top of the pipe
- The use of the AZT532 or AZT534 flow conditioners are not recommended for this type of application
- Install the sensor away from exposure to cold winds or draughts which might encourage condensation of moisture onto the pipe walls.
- Consider the use of pipe lagging and/or trace heating

Gas Mixtures
The biggest threats to meter performance are normally based on incorrect knowledge and/or assumptions of the gas mixtures resulting in incorrect calibration of the meter.
- The gas mixture components and the proportion of each.
- The stability of the mixture.
- The range of process conditions under which the meter should function.
- The cleanliness of the gas.
- The dryness of the gas.

These must be known at the time of ordering, or an insitu calibration or adjustment procedure should be carried out.

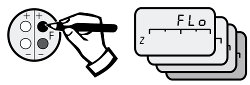
7.5 How to ... ...

The following pages describe in more detail how to configure or check specific functions of the AT70 sensor ... ...

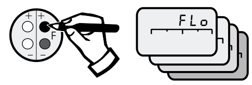
7.5.1 Menu Control

The list of functions are organised into a short list of the most commonly used functions known as the short menu. The list can be extended to include other functions that are used less frequently. The short menu is accessed from power-on.

... ... Access the extended menu
By pressing the F+ or F- keys for greater than 3 seconds the extended menu is enabled. A “z” is displayed in the bottom left hand corner of the display to indicate that the extended menu is enabled.



... ... Close the extended menu
When the extended menu is enabled, pressing the F+ or F- keys for greater than 3 seconds will disable the extended menu and the display will jump to the home position (i.e. FLo).

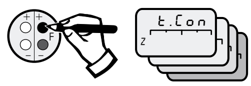


7.5.2 Security code access

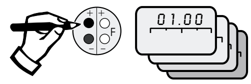
If configuration of functions is disabled (i.e. the sensor security is active) then the settings of the meter cannot be changed.

... ... De-activate the sensor security to permit function configuration

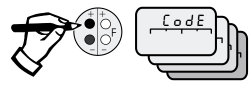
- Select the function to be edited by the F+ or F- keys



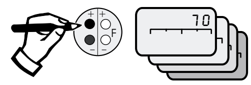
- Press the +/- keys to display the functions value



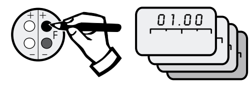
- If the security is active then the display will automatically switch to the CodE function.



- Use the +/- keys to set the CodE display to 70, this can be accomplished by either repeatedly pressing the +/- key for individual increments/decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



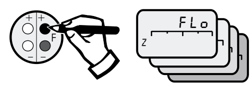
- Press any Function key to load the password into the AT70 memory
.
- If the correct value was entered the sensor security will be de-activated and the display will return to the function to be edited.



- Any further function(s) can now be accessed and edited until the sensor security is re-activated. (if the power supply is switched off, the security will be automatically re-activated when the power is restored).

... ... Re-activate the security password to disable function configuration

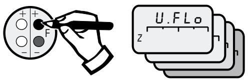
- Pressing the F+ or F- keys for greater than 3 seconds will re-activate the sensor security and the display will jump to the home position (i.e. FLo)



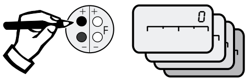
7.5.3 Configure the sensor units

The extended menu must be enabled and the sensor security must first be de-activated as described above.

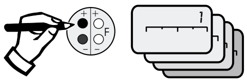
... ... Set the flow units - U.FLo



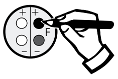
• Select the U.FLo function with the F+ or F- keys.



• Press the +/- keys to display the currently programmed value



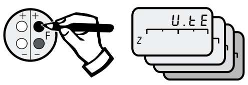
• Press the +/- keys to select the required units ... ...
0 = kg/h, 1 = kg/m, 2 = kg/s, 3 = NL/h, 4 = NL/min, 5 = NL/s, 6 = Nm3/h, 7 = Nm3/m, 8 = Nm3/s, 9 = lbs/h, 10 = lbs/m, 11 = lbs/s, 12 = Sm3/hr, 13 = Sm3/m, 14 = Sm3/s, 15 = Scf/h, 16 = Scf/m, 17 = Scf/s, 18 = Ton/h, 19 = Ton/m, 20 = Ton/s, 21 = SL/h, 22 = SL/m, 23 = SL/s



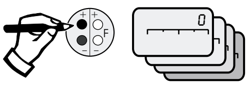
• Press the F+ or F- key to load the new units value into memory

Very Important Note
For high flowrates, the resolution of the 4 digit display may mean that some flow units cannot be selected.

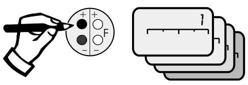
Set the temperature units - U.tE



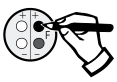
• Select the U.tE function with the F+ or F- keys.



• Press the +/- keys to display the currently programmed value



• Press the +/- keys to select the required units ... ...
0 = degrees Centigrade, 1 = degrees Fahrenheit

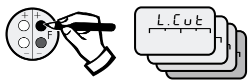


• Press the F+ or F- key to load the new units value into memory

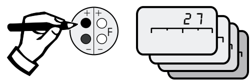
7.5.4 Configure the current output value

… … Hardware setup
Ensure that the internal switches on the pre-amplifier circuit board and the active/passive switch on the terminal circuit board are set correctly (see Chapter 4

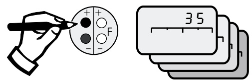
… … Set the 4 and 20 mA values - L.Cut. FS
The sensor security must first be de-activated as previously described.



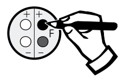
• Select the low flow cut off function L.Cut function with the F+ or F- keys (See chapter 6 for a full description of the low flow cutoff function)



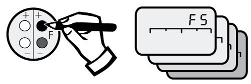
• Press the +/- keys to display the current setting of L.Cut



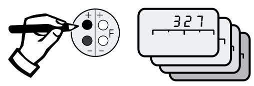
• Use the +/- keys to set L.Cut to the desired flow value. This can be accomplished by either repeatedly pressing the +/- key for individual increments/decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



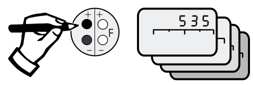
• Press any Function key to load the new value into the AT70 memory.



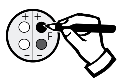
• Select the (full scale output) FS function with the F+ or F- keys



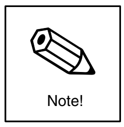
• Press the +/- keys to display the current setting of FS = the flow value when the current output is at 20 mA



• Use the +/- keys to set FS to the desired value. FS can be set to any value between the value of the function HCAL (maximum sensor calibration) and L.Cut. This can be accomplished by either repeatedly pressing the +/- key for individual increments / decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



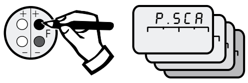
• Press any Function key to load the new value into the AT70 memory.



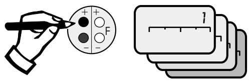
Note
The units for L.Cut and FS **are set by** U.FLo

7.5.5 Configure the integral totaliser counter

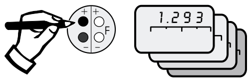
... ... Flow per pulse and minimum flow value - P.SCA. L.Cut. FS
The sensor security must first be de-activated as previously described.



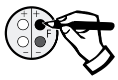
• Select the P.SCA function with the F+ or F- keys



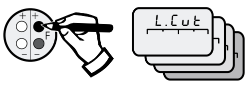
• Press the +/- keys to display the current setting of P.SCA. Note that the units of P.SCA are derived from the U.FLo setting. E.g. U.FLo = kg/h, P.SCA = kg; U.FLo = NM3/hr, P.SCA = NM3; U.FLo = scfm, P.SCA = scf



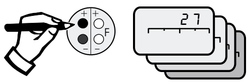
• Use the +/- keys to set PSCA to the desired value. This can be accomplished by either repeatedly pressing the +/- key for individual increments/decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



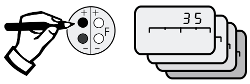
• Press any Function key to load the new value into the AT70 memory.



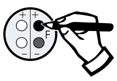
• Select the L.Cut function with the F+ or F- keys



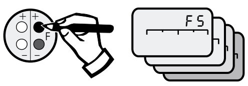
• Press the +/- keys to display the current setting of L.Cut



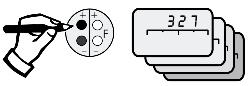
• Use the +/- keys to set L.Cut to the desired value. This can be accomplished by either repeatedly pressing the +/- key for individual increments/decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



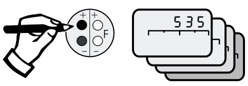
• Press any Function key to load the new value into the AT70 memory.



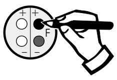
• Select the (full scale) FS function with the F+ or F- keys



• Press the +/- keys to display the current setting of FS (the flow value when the pulse output is at it's maximum pulse rate)



• Use the +/- keys to set FS to the desired value. FS can be set to any value between the value of the function HCAL (the maximum sensor calibration) and L.Cut. This can be accomplished by either repeatedly pressing the +/- key for individual increments/decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



• Press any Function key to load the new value into the AT70 memory.

Warning!

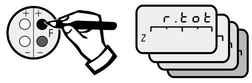
Warning.
The contents of the integral totaliser are NOT retained when the sensor power supply is removed. The totaliser will always start from a zero value when the power is re-applied

7.5.6 Reset, enable or disable the integral totaliser counter

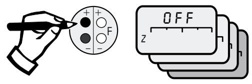
... ... Totaliser reset, on/off control - r.tot

The extended menu must be enabled and the sensor security must first be de-activated as previously described.

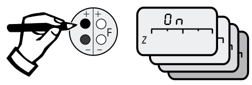
- Select the r.tot function with the F+ or F- keys



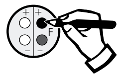
- Press the +/- keys to display the current setting of r.tot



- Use the +/- keys to set r.tot to the desired setting depending on the totaliser action required:
  ESC - No action
  On - Enable totaliser (i.e. Totaliser will count pulses)
  OFF - Disable (i.e. Totaliser will stop counting)
  rST - Totaliser is reset to zero and will stop counting



- Press any Function key to load the new setting into the AT70 memory.

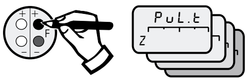


7.5.7 Configure the open collector transistor pulse output

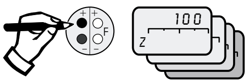
… … Hardware Setup
Ensure that the internal switches on the pre-amplifier circuit board and the active/passive switch on the terminal circuit board are set correctly (see Chapter 4

… … Flow per pulse and minimum flow value - P.SCA. L.Cut. FS.
The pulse output and the integral totaliser counter share the same settings such that every time there is a pulse output, the totaliser counter increments one.

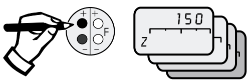
… … Pulse width in milliseconds - PuL.t
The extended menu must be enabled and the sensor security must first be de-activated as previously described.



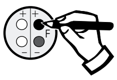
• Select the PuL.t function with the F+ or F- keys



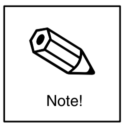
• Press the +/- keys to display the current setting of PuL.t. in milliseconds.



• Use the +/- keys to set PuL.t to the desired value. This can be accomplished by either repeatedly pressing the +/- key for individual increments/decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



• Press any Function key to load the new value into the AT70 memory.



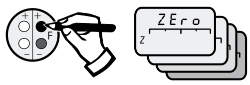
Note
The units for L.Cut and FS are set by U.FLo

7.5.8 Set the meter process zero point

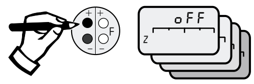
... ... process zero point - ZEro
At zero flow conditions, the output of most thermal mass flow sensors has a strong dependency on the process pressure.
The effect on the true zero point of the meter by the static line pressure is dependent on the gas type and application demands, in many cases the use of the low flow cut off function (L.Cut) is adequate to provide the meter zero point but with some gases and/or a combination of high static line pressures, the zero point may need to be reset under process conditions to restore the very low flow measurement capability of the meter.

The extended menu must be enabled and the sensor security must first be de-activated as previously described. This operation MUST be performed at the operating process conditions with zero flow in the pipe.

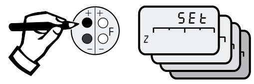
- Select the ZEro function with the F+ or F- keys.



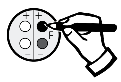
- Press the +/- keys to display the current setting of ZEro.



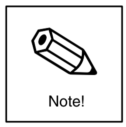
- Use the +/- keys to set ZEro to the desired setting depending on the totaliser action required:
  OFF - Disable - use factory setting for zero point (default setting).
  SET - Reads the meter output and accepts this as being the true zero point.
  ESC - Removes any previously loaded setting and resets the zero back to the factory setting.



- Press any Function key to load the new setting into the AT70 memory.



Note.
If this operation is performed when real flow conditions exist or when the process conditions are not as per operating conditions then severe measurement errors may result.



7.5.9 Configure the meter for real process conditions

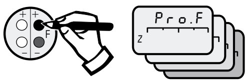
... ... Process factor - Pro.F

The normal calibration procedure for the AT70 is to calibrate the meter using air on the factory flowrig and then, using a numerical algorithm, configure the calibration data for use on the actual process gas at the process temperature and pressure specified with the original order.
It follows therefore, that if the full gas and process conditions were not known or were incorrectly specified at the time of ordering then the basic sensor calibration may need adjusting.
This can be done without returning the meter to the factory - All meters are shipped with a label attached to the sensor head that lists the configuration of the meter including the process conditions and gas type that it has been set up to measure. If the real process conditions (temperature and pressure) are not as specified on the label than it may be necessary to set the process factor to compensate for this difference.
The new value for the process factor must first be derived. It is recommended you contact your Endress+Hauser representative who will have software to compute the required value. You will need to have the following information: gas type (or mixture composition), actual process temperature and pressure conditions and the HCAL value of the sensor - he will provide a new process factor value for you.

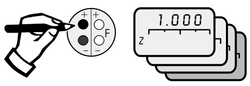
To configure the meter with this new value ... ...

The extended menu must be enabled and the sensor security must first be de-activated as previously described.

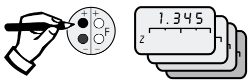
- Select the Pro.F function with the F+ or F- keys.



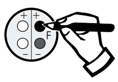
- Press the +/- keys to display the current setting of Pro.F. Make a record of this initial value in case the original setting is needed later.



- Use the +/- keys to set Pro.F to the new value. This can be accomplished by either repeatedly pressing the +/- key for individual increments/decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



- Press any Function key to load the new value into the AT70 memory.




Warning!

Warning
- If the process conditions should change, then metering errors may be introduced depending on the gas type and/or degree of change of the process conditions.
- A field adjustment of the process factor performed in this way is an approximate procedure only and further empirical adjustments to the process factor may be necessary. The recommended way is to provide the correct data with the original order, alternatively an E+H technical support person can perform the correct compensation using the E+H software “WINSOFT”.

7.5.10 Compensation for installation induced metering errors

The sensitivity of the thermal dispersion principle to very low flowrates makes the sensor potentially vulnerable to externally created flow disturbances (E.g. swirl, externally induced flow profile disturbances etc.). It is very important that the sensor is installed in accordance with the documented guidelines in chapters 3 and 4. In many cases it is not practical to meet these requirements due to practical restraints in the field or severe unpredictable installation disturbances resulting in unavoidable metering errors.
Under these conditions there are three actions that can be taken:

1) Correct the installation conditions that are causing the errors.
2) Provide an insitu calibration of the meter including the disturbance using a known and reliable reference meter.
3) Derive a single average correction factor to compensate for the error and program the meter Installation factor to incorporate a correction.

Warning
If insitu calibration or the installation factor is used to correct for installation induced errors, then any change in those disturbances after the correction has been incorporated may result in metering errors.

... ... Insitu calibration
Contact your E+H representative for specific advice

... ... Installation Factor - In.F
Before the meter function is changed, it is necessary to determine the average value of the metering error introduced by the installation disturbance. This should be done by either:

- Reset the integral totaliser counter to zero and compare its reading [Ftmass] after a period of time (minimum 5 minutes), with a similar totaliser counter [Fref] driven by a reliable reverence meter see notes This is the preferred method

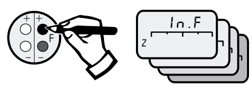
OR

- When the flow is constant - comparing the average of several FLo readings of the AT70 [Ftmass] with the average of simultaneous readings taken from a reliable reference meter see notes [Fref] over a period of time (minimum 30 seconds).

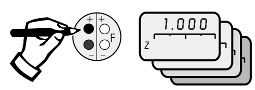
The installation factor required to correct for this can be calculated as:

In.F = Fref ÷ Ftmass

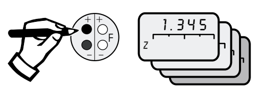
The extended menu must be enabled and the sensor security must first be de-activated as previously described.



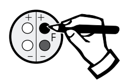
- Select the In.F function with the F+ or F- keys.



- Press the +/- keys to display the current setting of In.F. Make a record of this initial value in case the original setting is needed later.



- Use the +/- keys to set In.F to the new value. This can be accomplished by either repeatedly pressing the +/- key for individual increments/decrements of the value or by holding a key down and allowing the display to auto-repeat the increment or decrement respectively.



Press any Function key to load the new value into the AT70 memory.

Note!

Notes
- The choice of reference meter is critical to the success of this procedure. The tmass sensor responds to mass flow rate changes therefore if the choice of reference meter is one based on volumetric output (e.g. vortex, differential pressure, turbine ... ...) it is absolutely essential that the reference flow value used for comparison is converted to a mass flow rate using measured values of process flow and pressure.
- It is not acceptable just to use “assumed” values of temperature and pressure since even a slight deviations of either measurement can cause errors.
- The process temperature and pressure must be measured at the point of reference flow measurement and not some distance away.
- If this mass flow computation is not adequately applied then severe errors may be introduced undermining the integrity of the procedure.
- Any reference meter should be installed downstream of the AT70 sensor.
- It is very difficult to compare instantaneous readings from the t-mass meter and the reference meter therefore it is strongly recommended to use some kind of recording device to compare readings over a period of time and integrate the results.

8. Routine inspection, cleaning procedures

Although designed for clean dry gases, t-mass S can be used successfully on a wide range of gases that carry moisture, solids and traces of hydrocarbons (e.g. exhaust gases, Bio-gas and fermentation gases). These will have a detrimental effect on the metering accuracy but their effects may be minimised by utilising the Installation Factor (In.F) function in the programming menu.
For gases that do carry impurities it is recommended that the sensor is inspected and cleaned regularly to minimise any possible metering errors that may be introduced by any potential contamination of the sensing transducers. The frequency of this cleaning cycle will depend entirely on the process conditions and metering performance requirements of the application.

8.1 Cleaning procedure

The following is a simple procedure outlining the basic steps in checking and cleaning the flowmeter assembly. In addition to the steps mentioned any local and/or national regulations and codes of practice must also be adhered to.

- Isolate the gas flow and de-pressurise the pipeline.
- Isolate the power connection to the sensor.
- Remove the flowmeter from the pipeline.
- Check the pipeline for evidence of solids or debris build up and remove/clean if necessary.
- If a flow conditioner is in use, remove and check/clean any debris buildup.
- *Insertion sensor only* - If the sensor is fitted with a screw process fitting, check the threads for signs of damage - replace if necessary
- *Wafer/flanged flowcell only* - Remove the flowmeter measuring head retaining screws from the flowcell and carefully withdraw the head from the flowcell taking care not to create any strain on the measuring transducers. (See fig. 44)
- Examine any seals and/or gasket materials for any signs of damage and replace if necessary.
- Examine the measuring transducers for signs of damage e.g. bending, misalignment. if damage is found then the measuring head may need repair or re-calibration - check with your local E+H representative if in doubt.
- Wipe the measuring transducers with a non-abrasive clean cloth (if necessary a suitable solvent or cleaning fluid may also be used). Take extreme care to ensure that excessive force is not applied to the measuring transducers.
- Carefully refit the measuring head and tighten the securing screws.
- The complete assembly should be pressure tested to ensure that there are no leaks present. [note 1]
- Replace the flowmeter in the pipeline using new gaskets when necessary.
- Re-pressurise the pipeline ensuring that there are no leaks at the process connections.

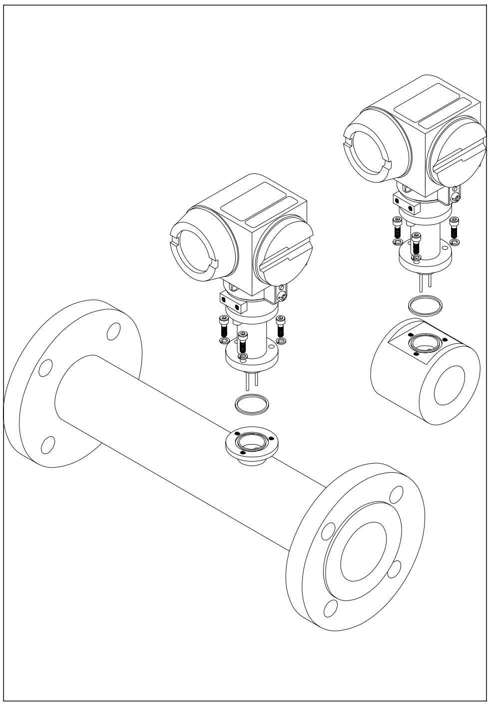
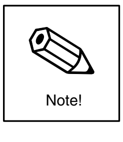


Fig. 44:
Diagrammatic view of the flowcell/measuring head assembly

Note 1:
This may not be necessary if the flowmeter can be pressure tested in situ.



This page has been deliberately left blank

9. Troubleshooting and Diagnostics

The most common problem solving techniques fall into two categories:

1). Reported calibration error when compared with a reference meter and/or knowledge of the process.
2). Sensor failure or malfunction.

Regardless of the reported error, a systematic approach to faultfinding should always be taken.

9.1 AT70 Error Codes

Displayed error code	Error description	Suggested action
E100	Power up reset flag - Indicates an incorrect power up start up sequence	• Remove and re-apply the sensor power • If fault persists, check out the power supply voltage, it's condition and the wiring • If wiring and power supply OK, Check out all connections to the internal sensor circuit boards.
E101	EEROM checksum error - Internal memory error - Pre-amplifier circuit board	• Contact E+H
E102	EEP communications error accessing the calibration data	• Check out all connections to the internal sensor circuit boards. • Remote sensor only - check conenctions between the sensor and the remote electronics
E103	PIC communication error - pulse output controller - Pre-amplifier circuit board	• Check out all connections to the internal sensor circuit boards.
E210	ADC out of range - all the input measurements are out of range	
E211	TP1 over-range - indicates that the flow signal is too high to be measured	
E212	TP1 under-range - indicates that the flow signal is too low to be measured	
E213	Temperature signal is out of its normal range	• If the problem persists, contact E+H
E216	Invalid gas transfer	• Reload the gas transfer calibration data (via the HART™ handheld or via WINSOFT)

E214	The measured flow is greater than the sensor maximum (HCAL) setting	• Check all calibration related functions - PIPE, L1, L2, Pro.F, In.F
		• Check installation for errors caused by external flow disturbances
		• Sensor calibration not high enough for the application
E204	The pulse rate is exceeding its maximum limit	• Check all pulse function settings - PSCA, PUL.t, FS
E203	The current output is exceeding its maximum limit	• Check FS current output function settings
		• Check the factor set functions DAC1, DAC2

9.2 Basic sensor checks

- Wiring
  - Power supply voltage and polarity *at the actual sensor*
  - Current or pulse output polarity and connection
- Hardware configuration
  - Current output switch settings (Active or Passive)
  - Pre-amplifier pulse output switch settings
- Configuration
  - Sensor units (U.FLo, U.tE)
  - Current output minimum and maximum configuration (FS, L.Cut)
  - Pulse output configuration (FS, L.Cut, PSCA., PuL.t, r.tot, OCFu)
  - Process Factor setting (Pro.F) and Installation factor setting (In.F)
  - Gas type sensor calibrated for (GAS)
  - Pipe dimension settings - Insertion sensor only. (PIPE., L1, L2)
  - Error status register (StAt)
- Calibration - The Calibration Certificate and Statement are correct for the application requirements and the serial number of the sensor and certificates are the same.
- The sensor installation should always be checked to ensure that it is installed in accordance with the requirements of chapter 3

9.3 Sensor troubleshooting guidelines

Symptom	Possible causes	Suggested actions
Blank Liquid Crystal Display	• No power to the sensor	• Check Sensor wiring
	• Sensor power < 20 V DC	
	• Sensor power supply is wrong polarity	
	• No power supply to passive 4-20 mA current loop	• Check that an external 18-32V DC power supply is present in the current loop
	• Display module connector not made	• Check that the display connector is fully plugged into the microprocessor circuit board
	• Damaged wires or loose connectors between circuit boards	• Remove the display and display holder and check that all the circuit board connectors are secure.
	• Current output loop broken	• Some earlier designs require the current loop to be made at all times. If the sensor is being used without an indicating device, then short circuit the sensor current output terminals (3 & 4)
	• Faulty display module	• Replace the display module

Display is flashing or blinking	• Actual flow is higher than the sensor maximum flow (HCAL) setting	• If Insertion sensor, check that PIPE. L1 and L2 are set correctly
		• Check that the meter is calibrated for the correct range
Display is flashing or blinking	• Actual flow is lower than the flow meter zero setting	• Reset the ZERO function at the true flow zero (ensure that there are no leaks before setting the ZERO.
		• Check the L.Cut setting
	• Meter fault	Perform the basic checks listed previously , note the following values and contact E+H: P1 P2 AC1 AC2 S A
Meter reading with no actual flow present	• Low flow cutoff value is programmed too low	• Increase the value of L.Cut
	• Leak in the pipeline downstream of the sensor	• Correct the leak
	• Sensor is set in the simulation mode	• Set PUSI or CuSI to OFF
	• High static line pressure	• Raise the value of L.Cut and/or reset the ZERO function.
	• Existence of pressure pulsation in the pipeline	• Reduce or eliminate the pressure pulsation
		• Re-site the meter
	• Damaged transducers	• Remove sensor from process and check for visual damage (e.g. bending)
Unstable reading	• Flow instability induced by process or flow disturbance	• Increase value of t.Con
		• Consider the use of a AZT532 or AZT534 flow conditioner
		• Resite the meter to a point where the flow is more stable
Internal totaliser (L.tot and H.tot) not counting correctly		
Totaliser not counting	• Counter not enabled	• Check that r.tot is set to on
		• Check that PSCA is > 0
	• Low flow cutoff too high	• Reduce the L.Cut setting
Totaliser reading incorrect although the instantaneous flow reading (FL) is OK	• Low flow cutoff too high	• Reduce the L.Cut setting
Both the totaliser and instantaneous flow (FL) reading are incorrect	• Incorrect flow units	• Check U.FLo
	• Installation effects	• See section 9.4 “Errors due to installation or process effects”
	• Calibration error	• Check the sensor documentation to ensure that the sensor is calibrated correctly for the application

Pulse output/external totaliser not counting correctly

Pulse output not present	• Pulse output not enabled	• Internal switches on the pre-amplifier circuit board not set to PULSE
		• Check ACTIVE / PASSIVE switch setting of sensor
		• OCFU not set to Pout
		• Check that PSCA is > 0
	• Low flow cut off is too high	• Reduce the L.Cut setting
External counter reading incorrectly although the instantaneous flow reading (FLo) is OK	• Pulse width not set correctly	• Set PuL.t to correct value
	• Flow value per pulse output not correct	• Set PSCA to correct value
	• Maximum flow setting too low	• Increase the full scale flow setting (FS) up to the limit of HCAL
	• Faulty external counter	• Check/replace counter
	• Incompatible pulse input of counter	• Check ACTIVE / PASSIVE switch setting of sensor
	• Incorrect counter wiring	• Check sensor to counter wiring
Both the external counter and the instantaneous flow (FLO) reading are incorrect	• Incorrect flow units	• Check U.FLo
	• Incorrect settings for the Process factor and the Installation Factor	• Check the settings for Pro.F and In.F
	• Installation effects	• See section 9.4 “Errors due to installation or process effects”
	• Calibration error	• Check the sensor documentation to ensure that the sensor is calibrated correctly for the application
Faultfinding tip for troubleshooting the external counter:		
	• Use the sensor in the simulation mode (PU.SI) to diagnose faults in the interface from the sensor to the external counter.	

Current output calibration not correct

Current output does not respond to flow	• Current output not enabled	• Internal switches on the pre-amplifier circuit board not set to CURRENT
		• Check ACTIVE / PASSIVE switch setting of sensor
		• OCFU not set to oFF
	• Sensor in simulation mode	• Check that CU.SI is set to oFF
Current output scaling incorrect although the instantaneous flow (FLo) reading is OK	• 4 mA and 20 mA settings of sensor are not correct	• Check and set the low flow cutoff (L.Cut) and the 20 mA setting (FS)
Both the current output and the instantaneous flow (FLO) reading are incorrect	• Incorrect flow units	• Check U.FLo
	• Incorrect settings for the Process factor and the Installation Factor	• Check the settings for Pro.F and In.F
	• Installation effects	• See section 9.4 “Errors due to installation or process effects”
	• Calibration error	• Check the sensor documentation to ensure that the sensor is calibrated correctly for the application
Faultfinding tip for troubleshooting the current output		
	• Use the sensor in the simulation mode (CU.SI) to diagnose faults in the interface from the sensor to the external indicator	

HART™ communication problems		
No HART™ communication	• Incorrect sensor hardware configuration	• Set pre-amplifier switch settings to CURRENT
	• Incorrect sensor software version	• Check sensor is not an INTENSOR version (order code)
	• Incorrect sensor menu configuration	• Check that OCFU is set to OFF
	• Faulty current loop wiring	• Check that the basic current loop operation is OK using the CU.SI simulation mode
		• Check that the current loop has a minimum 250R loop resistance
		• Check that the 250R loop resistance is connected across the HART terminals
Unreliable HART™ communication	• Faulty current loop wiring	• Check that the basic current loop operation is OK using the CU.SI simulation mode
		• Check that the current loop has a minimum 250R loop resistance
	• Noisy cable runs	• Check that screened cable runs are correctly earthed at the sensor
		• Check that cables are not too close to any heavy power cable runs
		• Check for any sources of large electrical noise / interference.
	• Unable to access all of the functions via the handheld terminal	• May be the incorrect DD library being used in the handheld device. Check the software revision of the sensor (display for several seconds after power is applied) and the documentation supplied with the handheld terminal
Tips for ensuring reliable HART™ operation:		
	• If the PASSIVE current loop mode is being used, ensure that the external loop power supply is a nominal 24 V DC	
	• Take care with all signal cable runs avoiding excessively long runs and/or proximity to high levels of external interference	

9.4 Errors due to installation or process effects

There may be several reasons why the meter reading (FLo and pulse or current output) is not in agreement with the expected value, again a systematic approach to diagnosing the reasons is required.

The most likely causes for disagreement with a reference meter are:

1) The reference meter measures volumetric flow (e.g. differential pressure, turbine, variable area, vortex ...) and:
- The incorrect pressure and/or temperature compensation values are being used, the values used should be measured values at the point of the reference measurement and not just assumed from other measurements taken on the plant..
- The incorrect calculation is being used for converting the volumetric measurement to a mass measurement.
- The compressibility factor of the gas is not being taken into account.
- The reference meter is not an accurate one and/or does not have a traceable calibration certificate.

2) The incorrect method is being used to compare the t-mass sensor with the reference meter. See “Comparing the sensor output with a reference meter”
3) The process factor (Pro.F) of the t-mass sensor is not set for the correct process conditions (refer to the Calibration certificate and Calibration statement to check what the t-mass sensor has been configured for.
4) Imperfect installation causing distortions in the flow profile in the pipe or flow disturbance(s) upstream of the t-mass sensor. Common causes include:
- Inadequate upstream clear pipework between the flowmeter and any pipe interruption (e.g. bend, reduction, expansion, valve ...)
- Severe pipe diameter mis-match between the upstream pipework and the flowcell or wafer body.
- Mis-aligned gasket and/or process coupling upstream of the sensor.

5) Gas condition not as expected, e.g. moisture content, cleanliness, gas mixture composition.
6) Unstable process temperature - errors will be present during any transient change in the process gas temperature.

9.5 Comparing the t-mass sensor reading with a reference meter

The most common method of checking the accuracy of the AT70 sensor is by comparing its readings with a reference meter.
The choice and installation of the reference meter is very important ...

9.5.1 Choice of reference meter:

- Another thermal meter should not be used.
- Suitable reference meters are vortex, turbine, differential pressure devices such as orifice or pitot tube. Note that the operating ranges of these meters are considerably less than the thermal meter therefore care should be taken to operate the reference meter only in its calibrated operating band.
- The reference meter should have a valid calibration certificate indicating its calibration conditions and any errors.

9.5.2 Installation considerations

- The reference meter should be installed downstream, and as close as possible to the AT70 sensor.
- The temperature and pressure measurements used to convert the reference meter readings to mass flow values must be taken at the correct point of measurements (i.e. near the reference meter) and not just assumed from readings taken elsewhere on the plant.

- The thermal meter is especially sensitive to very small flows therefore the installation must be checked closely for leaks etc. All valves or take off pipes should be checked carefully.

9.5.3 Reference meter to AT70 comparison procedure

Note!

It is most important to note:
- Unless a computerised data collection system is available, the meter checking procedure is not just a case of comparing the instantaneous readings of the two meters - the very different time responses of the meters plus the need to collect the meter and pressure and temperature readings at the same time will always introduce errors.
- Mass flow readings must be compared - errors will always be present if a volumetric flow is compared directly with the AT70 output without adequate compensation for changes in the process conditions during the comparison (i.e. temperature and pressure)

The preferred approach is by comparison of the totalised mass flow from the reference meter and the totalised flow from the AT70, taking care that:
- The two totalisers are initially reset and have the identical counter/pulse characteristics (i.e. flow value per pulse etc.).
- The time period for flow comparison is identical for both totalisers and the absolute minimum number of totaliser counts is 30 (recommended pulse count is >50)
- The method of comparison can be by either:
  - i) Counting the number of totaliser increments for a pre-determined time period or
  - ii) Counting the time for a pre-determined number of totaliser increments

  Method ii) is recommended.

Note!

Note - In the event of requesting support from your local Endress + Hauser representative, it is always recommended that before requesting help or advice, you should check the above and/or write down the values of the following information to help in any telephone support ...

All sensors
Function values for U.FLo, U.tE, FS, L.Cut, HCAL, OC.Fu, In.F, Pro.F, GAS, r.tot, StAt, TP1, TP2, DAC1, DAC2

Pulse output
Function values for PSCA, PuL.t

Insertion sensor
Function values for PIPE, L1, L2

Application data
Process gas and condition (e.g. dryness, cleanliness), process pressure and/or range, process temperature and/or range, actual pipe dimensions, actual flow ranges, details of any instruments used for checking the AT70.

Very Important Notes

Note!

- If for any reason, a sensor is returned to the factory for repair or diagnosis it must be cleaned thoroughly and accompanied by a statement declaring whether it has been in contact with any hazardous materials. This is a legal requirement.
- The sensor will be stored in quarantine if it is received without such a statement until the declaration is received.
- If no declaration is received within two working weeks of receiving the sensor it will be returned to the sender at their risk and cost.

9.6 Basic Module replacement

The sensor circuit boards cannot be repaired in the field so normal field service activities are limited to module replacement. The following items can be replaced without affecting the sensor calibration (See figure overleaf).

- Microprocessor circuit board
  The user set functions will need to be re-programmed into the sensor after replacement: see note below
- The sensor terminal board
- Liquid crystal display module

Replacement of the pre-amplifier circuit board or the individual flow transducers require recalibration of the sensor, however refer to document SD010 for instructions on how to replace a pre-calibrated sensor module (transducer assembly and pre-amplifier circuit board) in the field.
All reference numbers in brackets refer to figure 45.

9.6.1 Replacement of the liquid crystal display module and/or microprocessor circuit board

- Unscrew the housing cover [4] to gain access to the display and electronics.
- Remove the liquid crystal display module [5] by gently prising it out of the display holder [6] with a small screwdriver or similar tool and disconnecting it from the microprocessor circuit board [7] (Make a note of the correct connector).
- Remove the display holder [6] by removing the two screws.
- Disconnect all the connectors from the pre-amplifier and microprocessor circuit boards taking care to note the correct connector points for re-connection later.
- Gently remove the microprocessor [7] circuit board and with the new one
- Reconnect all the connectors to the circuit boards.
- Replace the display holder [6] with the two fixing screws.
- Re-connect the replacement or existing display module to the microprocessor circuit board and then refit the display module into the display holder with the required orientation (push the display gently into the holder until it locates with a “click”.
- Screw the housing cover [4] back into place.

Note!

Notes

- It is recommended that the complete list of short and extended menu sensor functions as described fully in section 6 are viewed and noted down before removal and replacement of the transducer module. These settings should then be checked against the settings of the repaired sensor prior to use.

Sensor functions to be noted from the original sensor configuration:

P.SCA. L.Cut. FS. HCAL. r.tot. t.Con

In.F. Pro.F. F.SAF. U.FLo. U.tE. GAS.

PIPE. L1. L2. PUL.t. dAC.1. dAC.2

9.6.2 Replacement of the Insertion sensor screwed process fitting [15]

If the screwed process fitting of the insertion sensor is damage then it can be replaced by following the procedure:

- Isolate the gas flow and de-pressurise the pipeline.
- Isolate the sensor power and remove all electrical connection to the sensor.
- Remove the flowmeter from the pipeline, taking care to follow any site or national safety procedures.
- Clean the sensor installation pipework as previously described in section 8, taking care to follow any guidelines and precautions related to exposure to

hazardous materials (e,g COSHH - Control Of Substances Hazardous to Health in the United Kingdom)
- Remove the three screws and washers [14] that retain the housing onto the main measuring assembly.
- Disconnect the electrical connector linking the housing electronics with the transducers [1,12].
- If the housing seal [11] is damaged, replace with a new one.
- Remove the housing collar [16] by unscrewing it from the end of the insertion rod [17] - note that the screw threads of the collar will have been secured to the rod by a locking compound therefore some force will be necessary, care must be taken therefore not to damage the components by any gripping tools (e.g. wrench or vice).
- When the collar is removed, replace the process fitting [15] with a new one including the fitting internal sealing ring.
- Re-assemble in the reverse order using a locking compound to secure the housing collar [16] to the insertion rod [17].

Very Important Notes

Note!

- If for any reason, a sensor is returned to the factory for repair or diagnosis, it must be cleaned thoroughly and accompanied by a statement declaring whether it has been in contact with any hazardous materials. This is a legal requirement.
- The sensor will be stored in quarantine if it is received without such a statement until the declaration is received.
- If no declaration is received within two working weeks of receiving the sensor, it will be returned to the sender at their risk and cost.

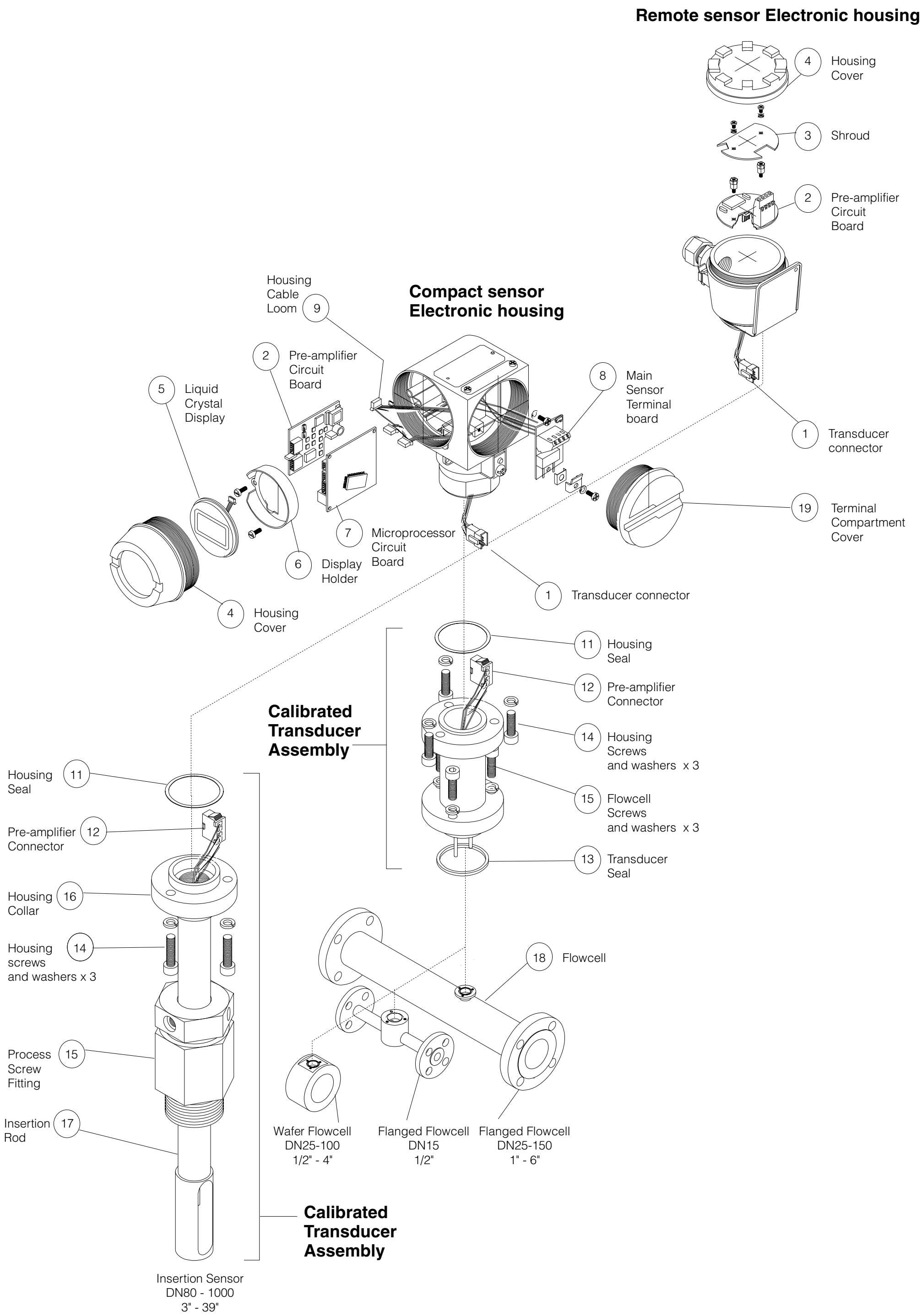


Figure 45
Exploded view of the AT70 family of thermal sensors

10. HART^{TM} digital protocol and functionality

The complete configuration of the t-mass AT70S sensor, including the gas conversion function not normally accessible via the integral keyboard and display, can be carried out by using the 275 HART^{TM} handheld configurator or via any interface device that conforms to the HART^{TM} digital communications protocol as prescribed by the HART User Foundation.
The 275 HART^{TM} handheld configurator or interface device must be pre-programmed with the Device Descriptor module for the AT70 t-mass sensor before access to all the sensor functions is possible. Consult your E+H representative for further advice if your handheld terminal device needs re-programming

Note
It is recommended that the sensor display is set at the HOME position (FLo) when the HART^{TM} communication feature is being used.

Note!

The following descriptions and text apply to the 275 handheld configurator as supplied by E+H.

10.1 Start up display

On first establishing communication, the display as illustrated in figure 45 will be shown. This provides access to all the main functions of the AT70S sensor.

Matrix Group Sel.
Access to all the configuration functions of the sensor.
- see section “10.2 - Configuration of sensor”

Flow
Instantaneous flow - FLO on sensor display.

AO1
Current output value in milliamps

Gas Temp.
Process gas temperature as measured by the sensor - tE on the sensor display

Totaliser
Totalised flow - L.tot and H.tot on the sensor display.

HART Output
Access to the main HART protocol configuration - Not accessible via the sensor keyboard and display

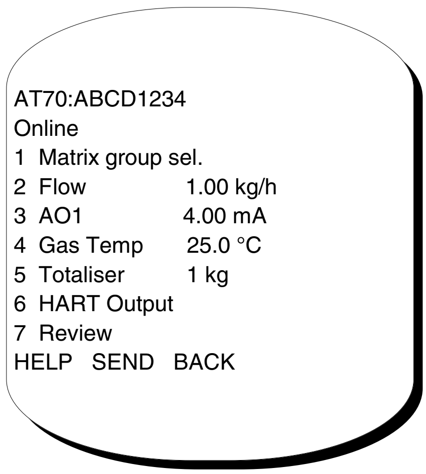


Figure 46
Start up display of handheld configurator

Review
Display in read only mode only a complete list of the sensor function values..

Note
The password must be entered before any sensor function can be modified (see “System Parameters”)

Note!

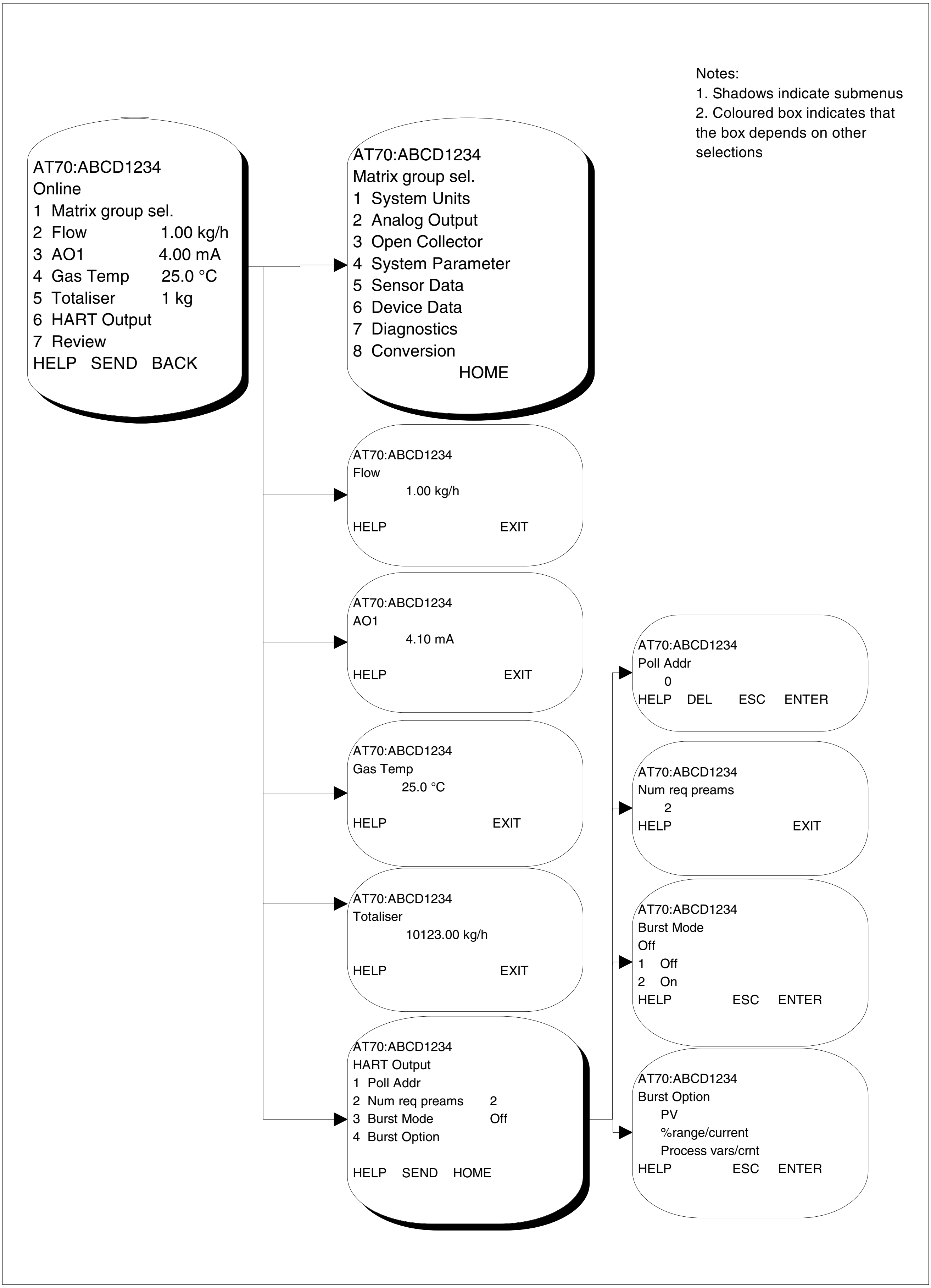


Figure 47
Handheld configurator - top layer displays

10.2 Configuration of sensor

The sensor can be completely configured by selecting the “matrix Group Sel” function (1) from the start up screen.
The following figures demonstrates the access levels to any of the configuration functions. For more information about any individual function see the relevant chapter in the manual.

System Units

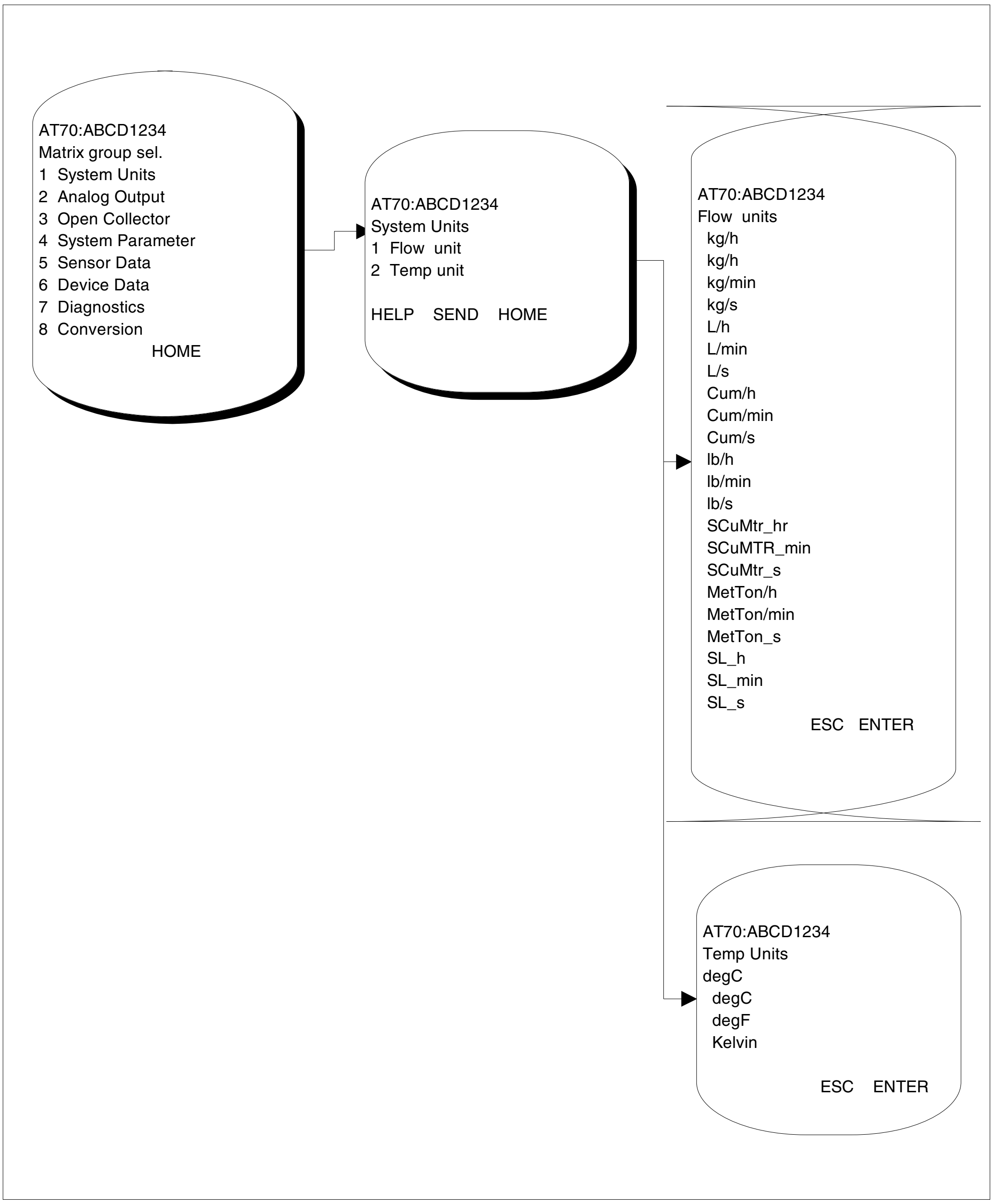


Figure 48
System Units

Note

- The password must be entered before the system units can be modified (see “System Parameters”)
- Functions also accessible via the sensor keyboard and display:
  - U.FLo = Flow units
  - U.TE = Temperature units

Note!

Analogue output

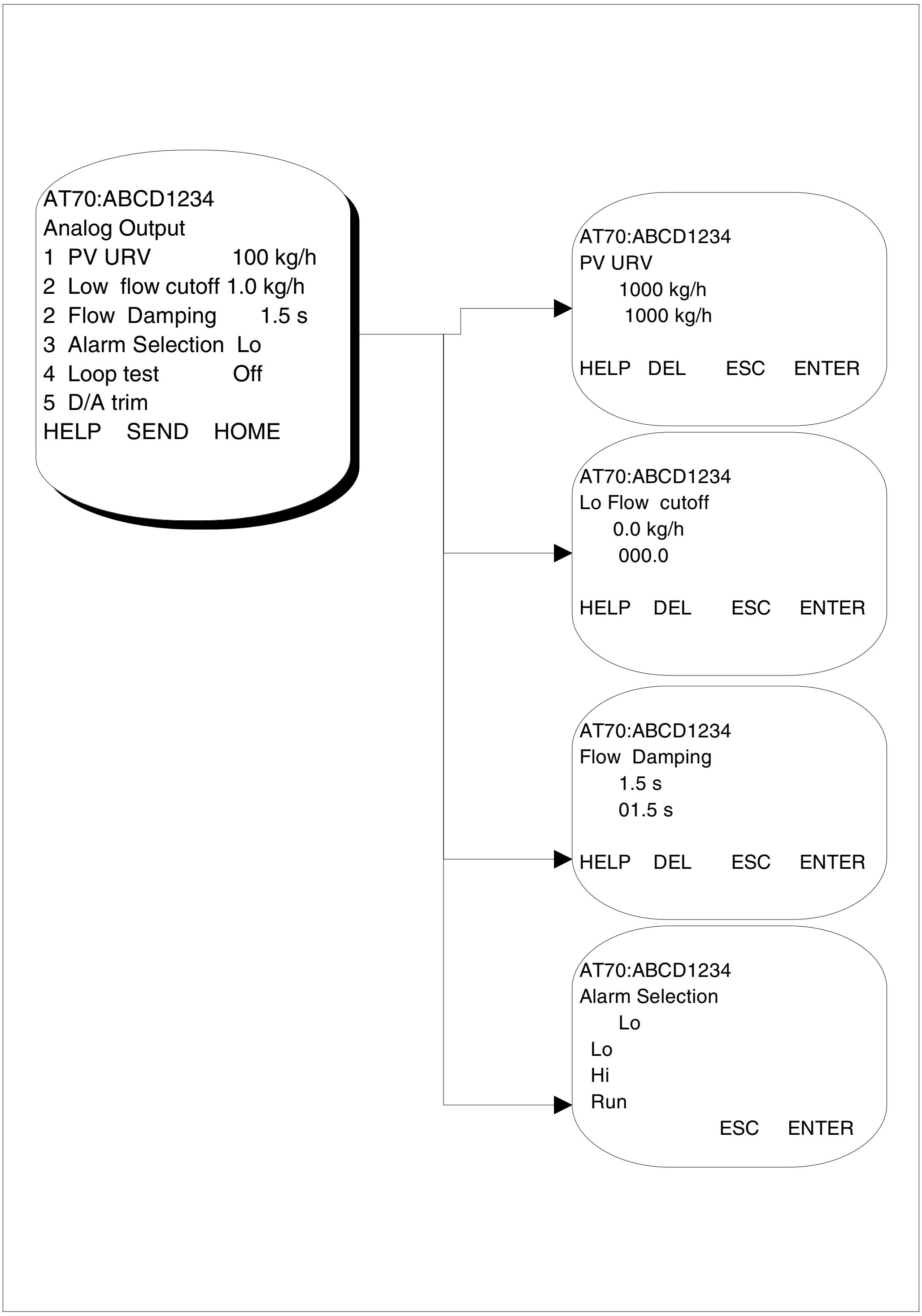


Figure 49
Analogue output configuration

Note!

Notes

- The password must be entered before the analogue output configuration can be modified (see "System Parameters")
- PV URV = "primary variable" = FLO = instantaneous flow value
- Functions also accessible via the sensor keyboard and display:
  L.Cut = Flow flow cutoff
  T.Con = Flow damping
  F.SAF = Alarm selection

Open collector transistor

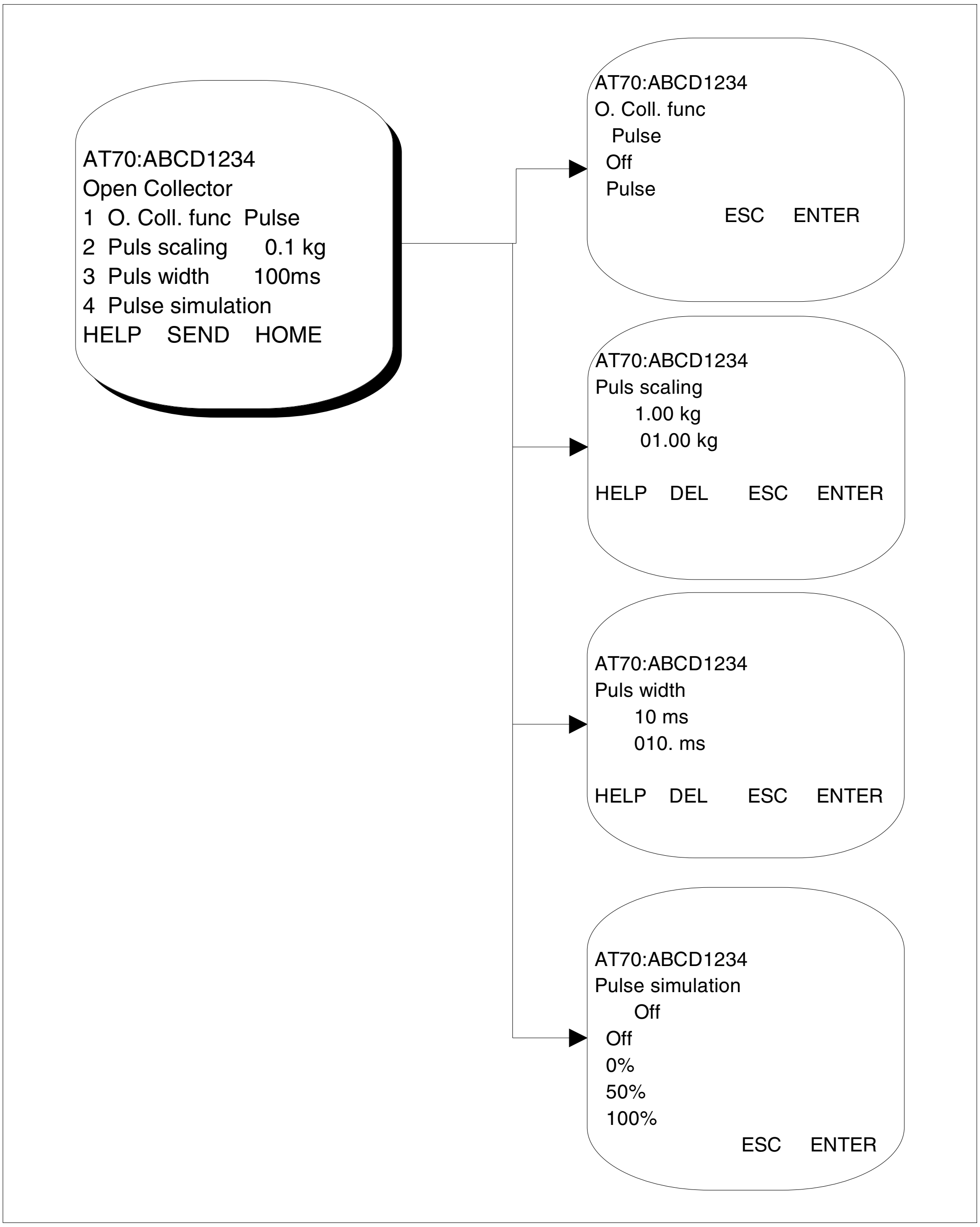


Figure 50
Open collector transistor configuration

Notes

Note!

- The password must be entered before the open-collector transistor configuration can be modified (see “System Parameters”)
- Ensure that the switch settings on the pre-amplifier circuit board are switched to “PULSE” after the pulse output has been enabled.
- The pre-amplifier switch settings must be set to “CURRENT” before the HART™ configurator can be used, i.e. the current output must be enabled with a minimum 250Ω current loop resistance.
- Functions also accessible via the sensor keyboard and display:

OC.Fu	= O.Coll. func.
P.SCA	= Puls scaling
PuL.t	= Puls width
PI.SI	= Pulse simulation

System Parameters

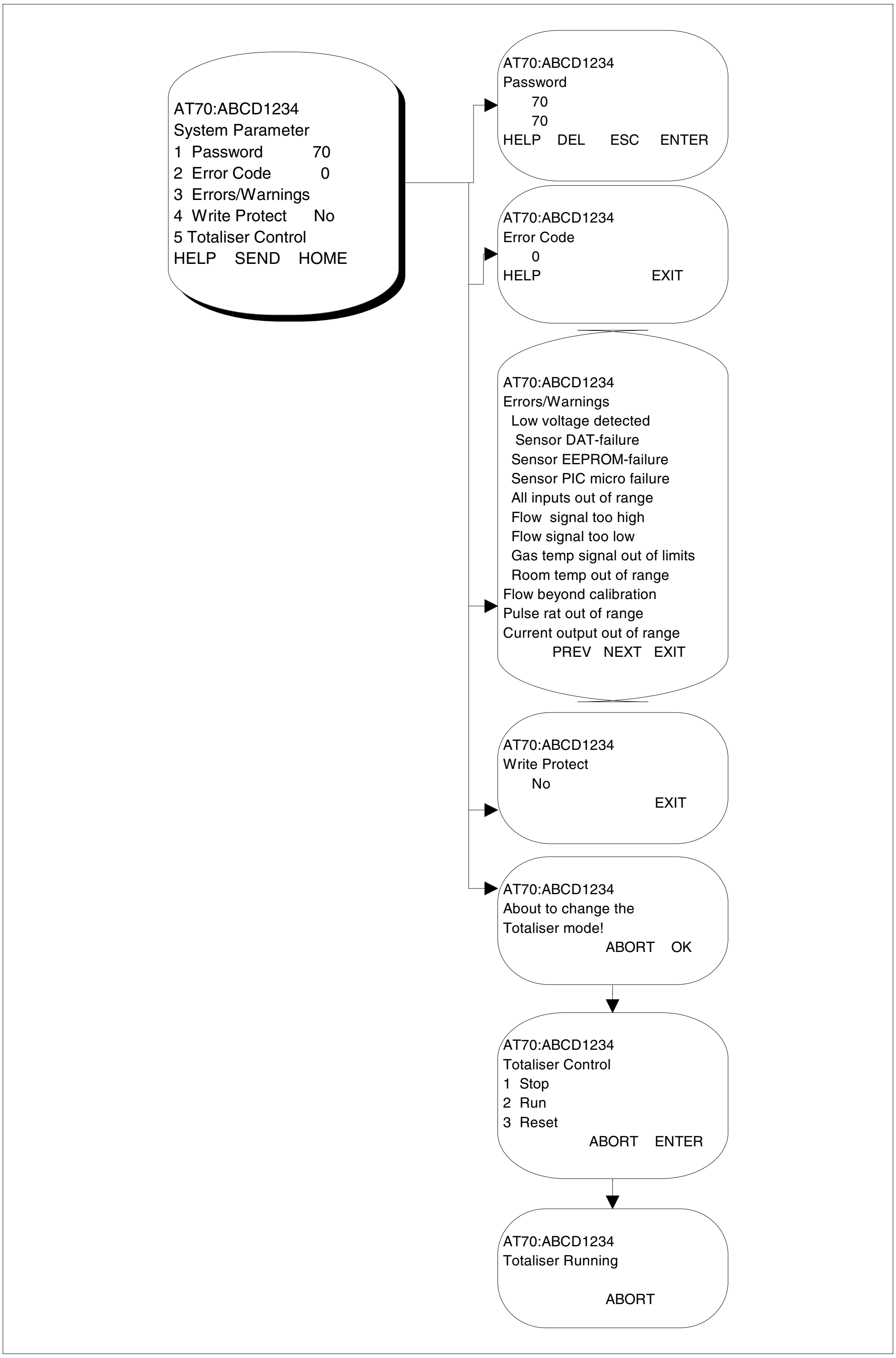


Figure 51
System Parameter configuration

Note!

Note
- The password must be entered at this screen before any function can be modified.
- Functions also accessible via the sensor keyboard and display:
  CodE = Password
  StAt = Errors
  r.tot = Totaliser Control, oFF = Stop, on = Run

Sensor Data

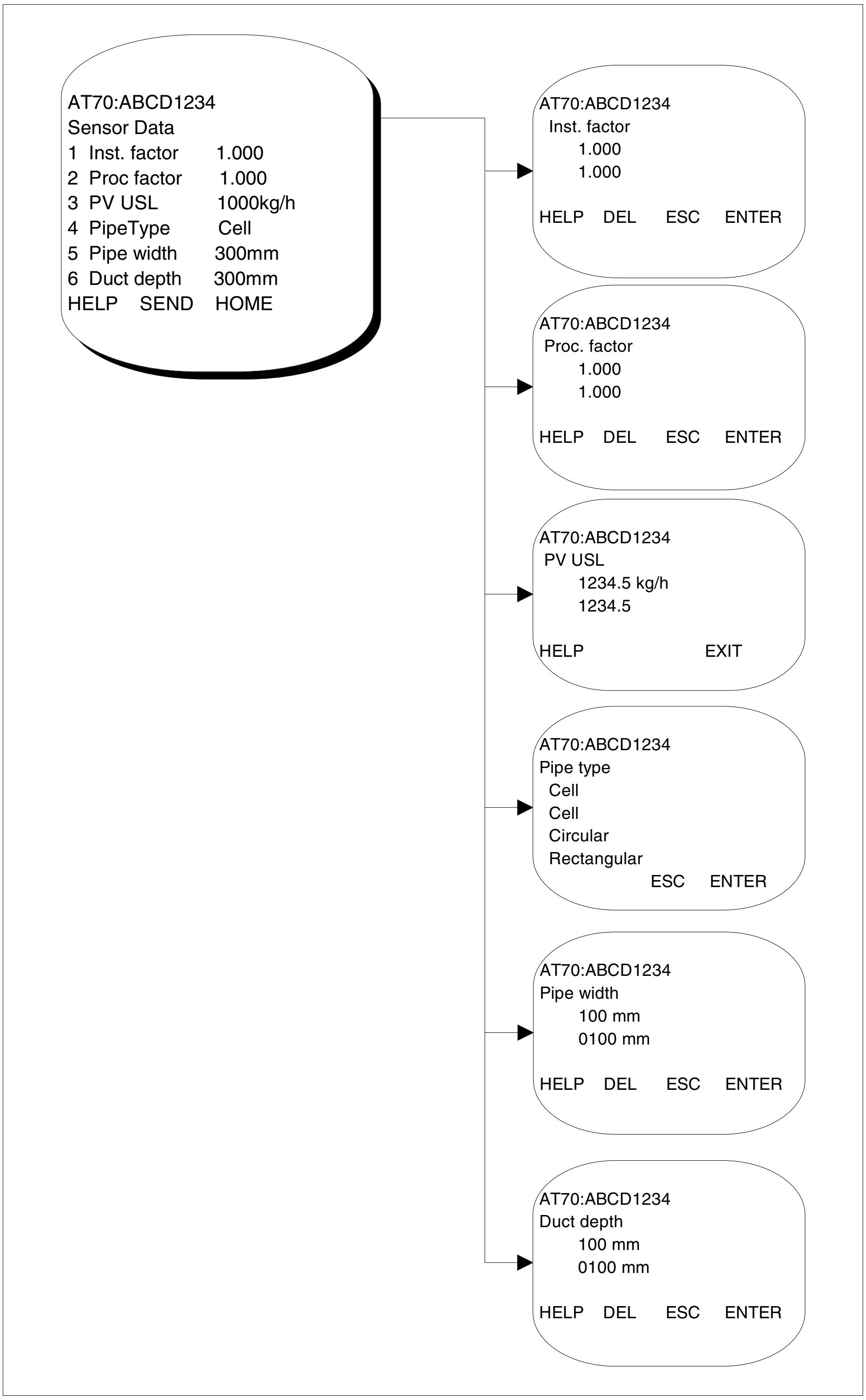


Figure 52
Sensor Data configuration

Note

- The password must be entered before any functions can be modified. (see "System Parameters")
- Functions also accessible via the sensor keyboard and display:

In.F = Inst. factor
Pro.F = Proc factor
PIPE = Pipe Type
L1 = Pipe width
L2 = Duct depth

Device Data

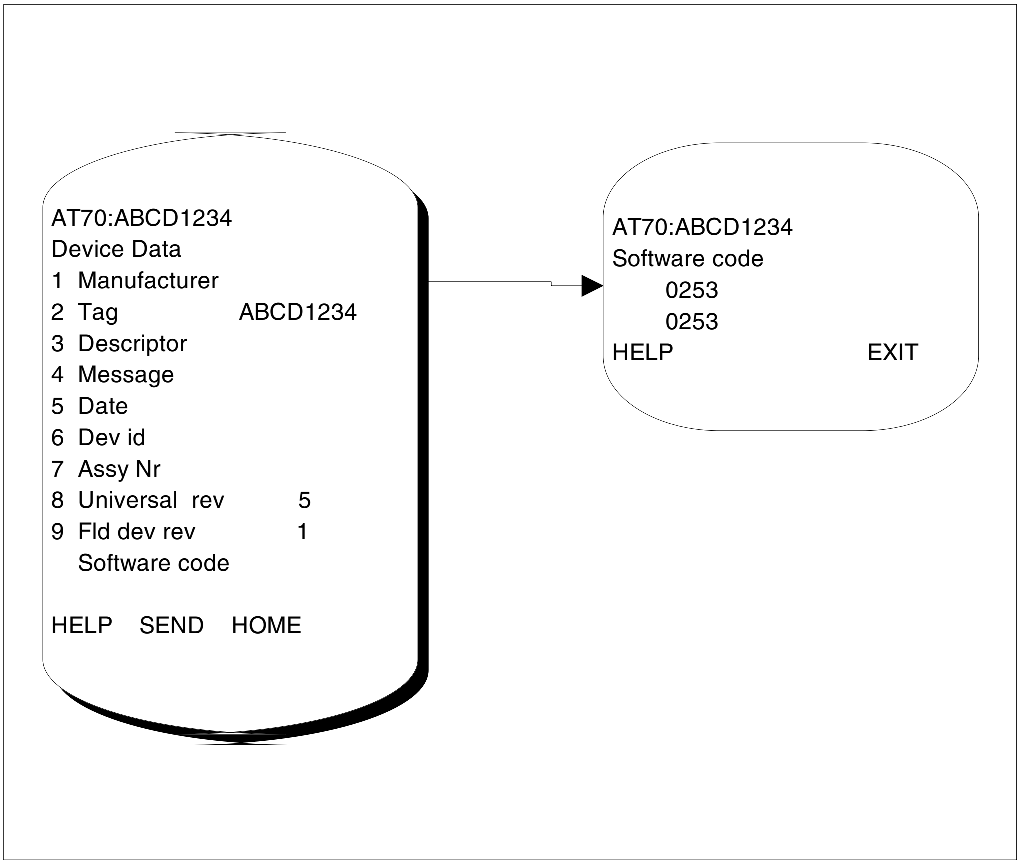
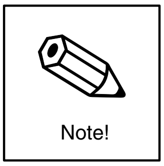


Figure 53
Device Data



Notes

- The above functions are not accessible via the sensor integral keyboard and display.
- The password must be entered before the above functions can be modified. (see "System Parameters")

Diagnostics

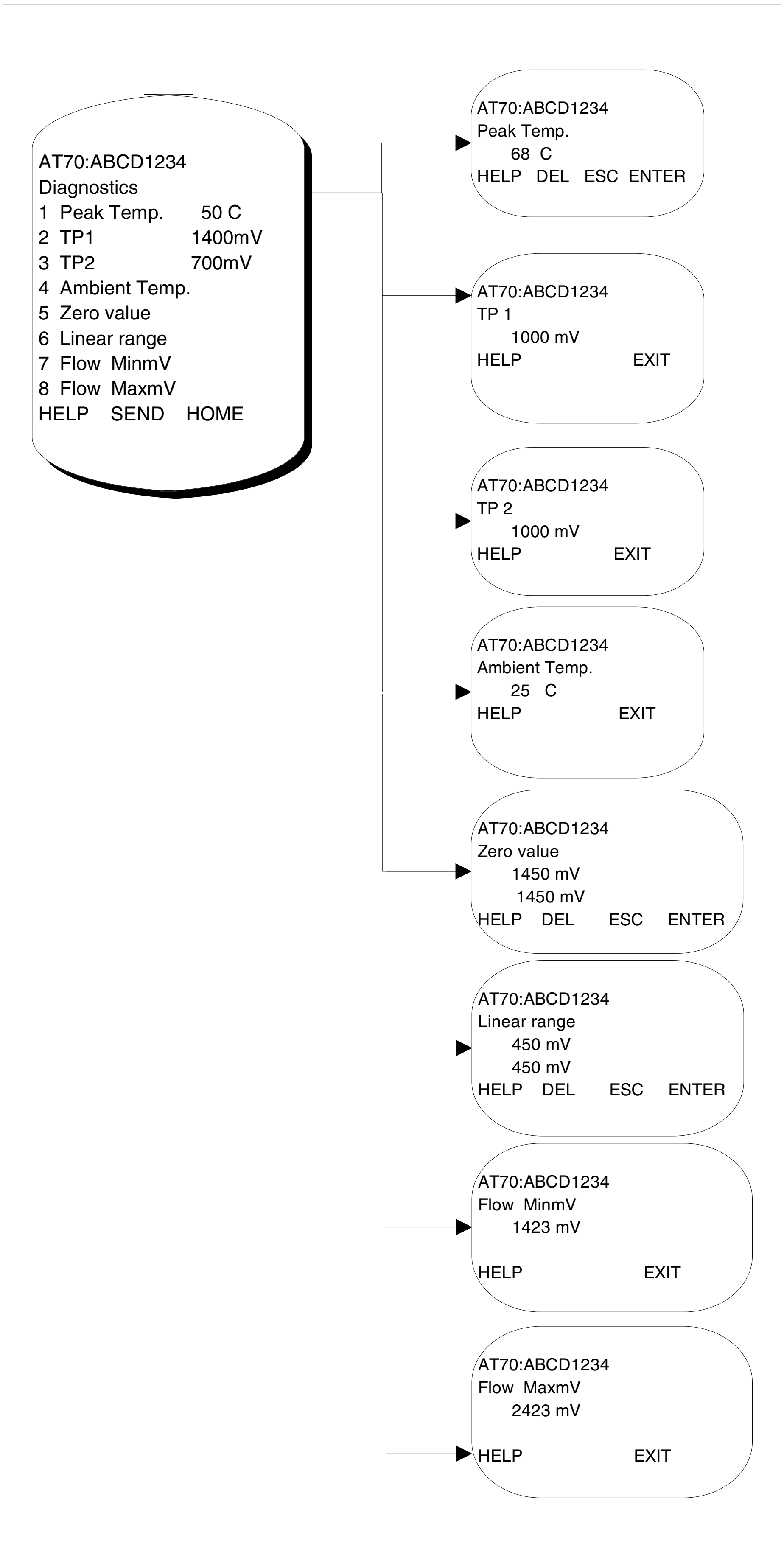


Figure 54
Sensor diagnostics

Gas Conversion (Air to Process gas)

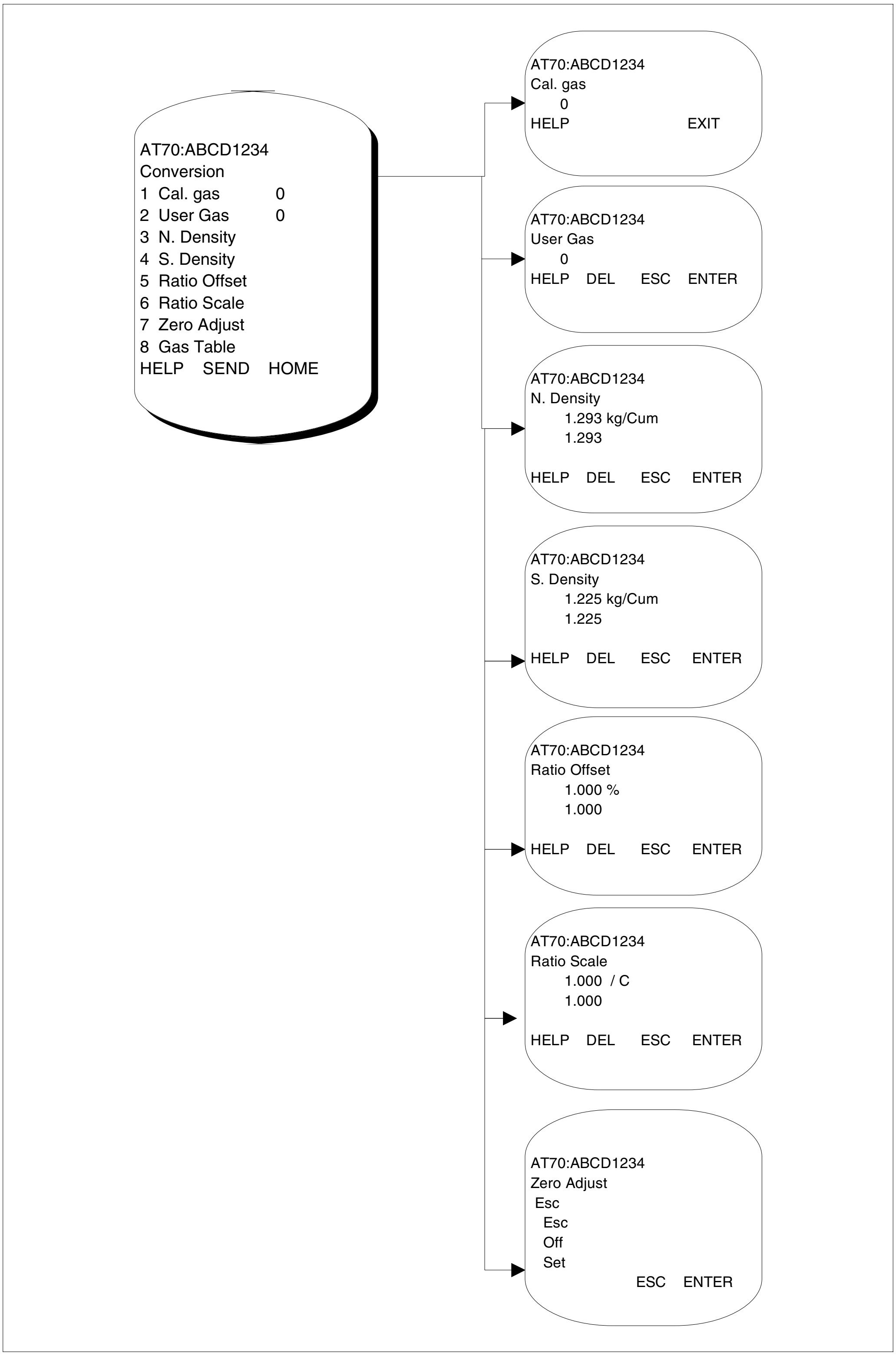


Figure 55
Process gas calibration conversion

Note!

Notes

- The gas conversion functions are not accessible via the sensor integral keyboard and display.
- The password must be entered before the calibration functions can be modified (see "System Parameters").
- If this data is incorrectly modified then the sensor calibration will be violated.

Gas Conversion (Table entry)

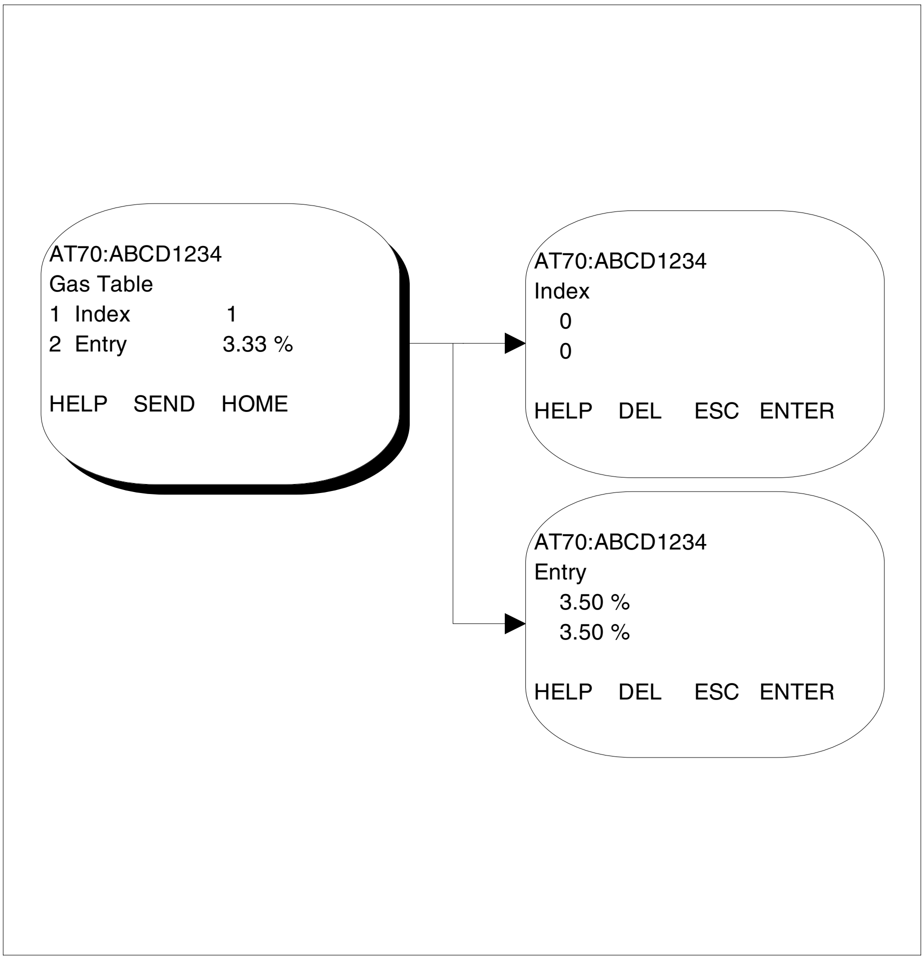
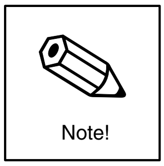


Figure 56
Process gas conversion table entry

Notes!
- The data for the calibration table is supplied on the Calibration Statement documentation that is supplied with the gas calibration certificate.
- This data is unique for any particular sensor and so the Calibration Statement and associated documents should be stored in a secure place.



This page has been deliberately left blank

11. Technical Data

11.1 Dimensions - AT 70F Flanged Flowcell version

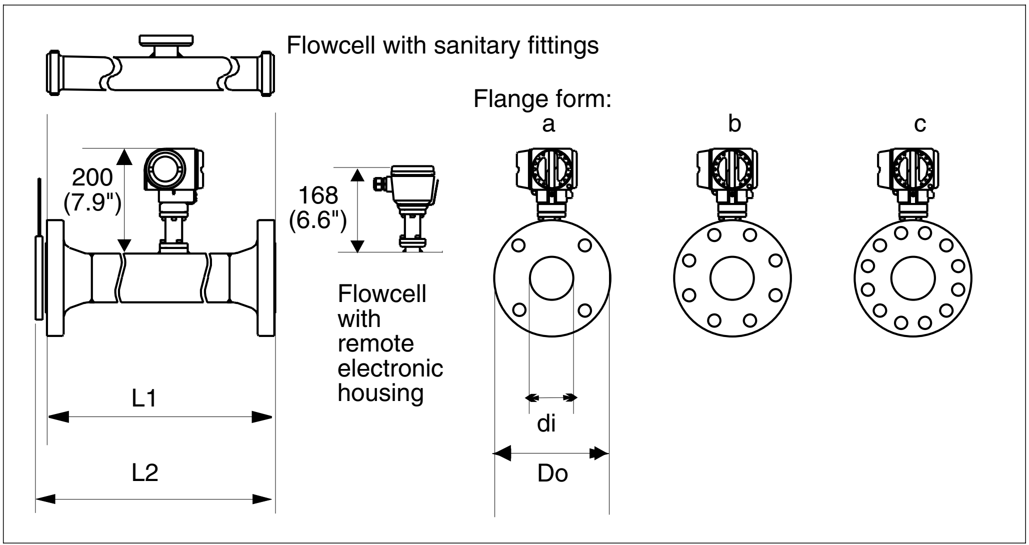


Fig. 57:
Flanged flowcell dimensions

Dimensions
Flanged flowcell version

Pipe size	Pressure rating (DIN/ANSI	L1 mm (inches)	L2 mm (inches)	di mm (inches)	Do mm (inches)	Flange form	Weight kg (lbs)
15 (1/2")	PN40 Cl 150	220 (8.66)		17.08 (0.672) 15.5 (0.622)	95 88.9	a a	1.73 (3.8)
25 (1")	PN40 Cl 150 Cl 300	245 (9.65)	249.3 (9.81)	28.5 (1.12) 26.64 (1.05) 26.64 (1.05)	115 (4.53) 108 (4.25) 123.8 (4.87)	a a a	2.27 (5)
40 (1.5")	PN40 Cl 150 Cl 300	320 (12.6)	326.5 (12.85)	42.72 (1.68) 40.9 (1.61) 40.9 (1.61)	150 (5.91) 127 (5) 155.6 (6.13)	a a a	3.64 (8) 2.73 (6) 4.09 (9)
50 (2")	PN40 Cl 150 Cl 300	400 (15.75)	408.4 (16.08)	54.79 (2.16) 52.51 (2.07) 52,51 (2.07)	165 ((6.5) 152.4 (6) 165.1 (6.5)	a a b	4.09 (9) 3.64 (8) 3.86 (8.5)
80 (3")	PN40 Cl 150 Cl 300	640 (25.2)	652.4 (25.69)	82.8 (3.26) 77.92 (3.07) 77.92 (3.07)	200 (7.87) 190.5 (7.5) 209.5 (8.25)	b a b	8.55 (18.8) 8.18 (18) 9.55 (21)
100 (4")	PN16 PN40 Cl 150 Cl 300	800 (31.5)	816.4 (32.14)	108.2 (4.26) 108.2 (4.26) 102.26 (4.03) 102.26 (4.03)	220 (8.66) 235 (9.25) 228.6 (9) 254 (10)	b b b b	10.91 (24) 12.27 (27) 11.82 (26) 15.91 (35)
150 (6") (see note 4)	PN16 PN40 Cl 150 Cl 300	360 (14.17)	384.6 (15.1)	159.3 (6.27) 159.3 (6.27) 154.06 (6.07) 154.06 (6.07)	285 (11.22) 300 (11.81) 279.4 (11) 317.5 (12.5)	b b b c	12.27 (27) 15 (33) 12.27 (27) 19.55 (43)

Notes.
1 Flange connection to ANSI B16.5 (RF) or BS4504 Type B (RF).
2 The standard flange style is “slip on”.
3 Other flange types or coupling arrangements can be supplied to order.
4 Requires an additional pipe spool piece between the flowcell and the flow conditioner.

Dimensions:
Sanitary version

Pipe size	Pressure rating (DIN/ANSI	L1 [mm] (inches)	di [mm] (inches)	Do [mm] (inches)	Weight [kg] (lbs)
40 (11/2")	IDF DIN11851	320 (12.6)	34.9 (1.37) 38 (1.5))	50.7 (2) 65 (2.56)	1 (2.2) 1.14 (2.5)
50 (2")	IDF DIN11851	400 (15.75)	47.6 (1.87) 50 (1.97)	64.2 (2.53) 65 (2.56)	1.18 (2.6) 1.18 (2.6)
80 (3")	IDF DIN11851	640 (25.19)	73 (2.87) 81 (3.19)	91.2 (3.59) 110 (4.33)	1.73 (3.8) 2.05 (4.5)
100 (4")	IDF DIN11851	800 (31.5)	97.6 (3.84) 100 (3.94)	125.9 (4.96) 130 (5.12)	2.95 (6.5) 2.95 (6.5)

11.2 Dimensions - AT 70W Wafer version

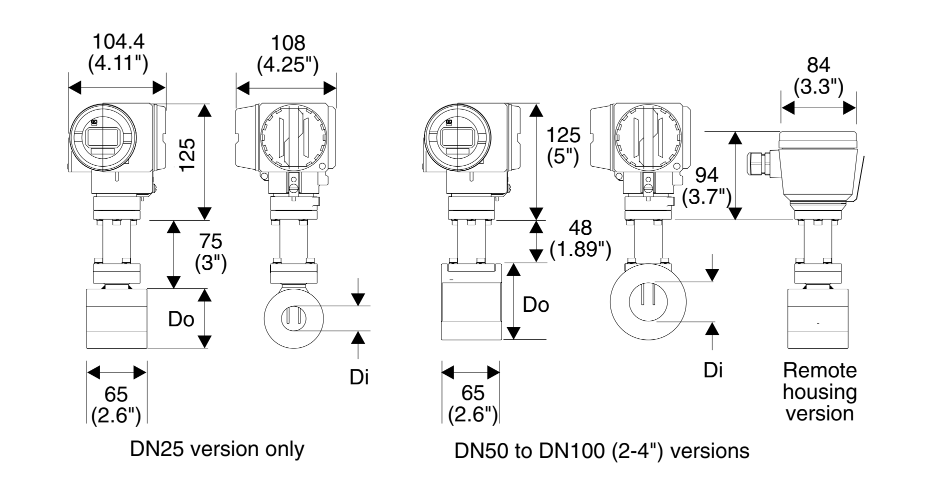


Fig. 58

Pipe size	di mm (inches)	Do mm (inches)	Weight - kg (lbs)
DN25 1"	28.5 (1.12) 26.64 (1.05)	63.5 (2.5) 63.5 (2.5)	1.27 (2.8)
DN40 1 1/2"	43.1 (1.7) 40.9 (1.61)	82 (3.23) 82 (3.23)	1.45 (3.2)
DN50 2"	54.5 (2.15) 52.5 (2.07)	92 (3.62) 92 (3.62)	1.59 (3.5)
DN80 3"	82.5 (3.25) 77.9 (3.07)	127 (5) 127 (5)	2.41 (5.3)
DN100 4"	107.1 (4.22) 102.3 (4.03)	157.2 (6.19) 157.2 (6.19)	3 (6.6)

11.3 Dimensions - AT 70 Insertion version

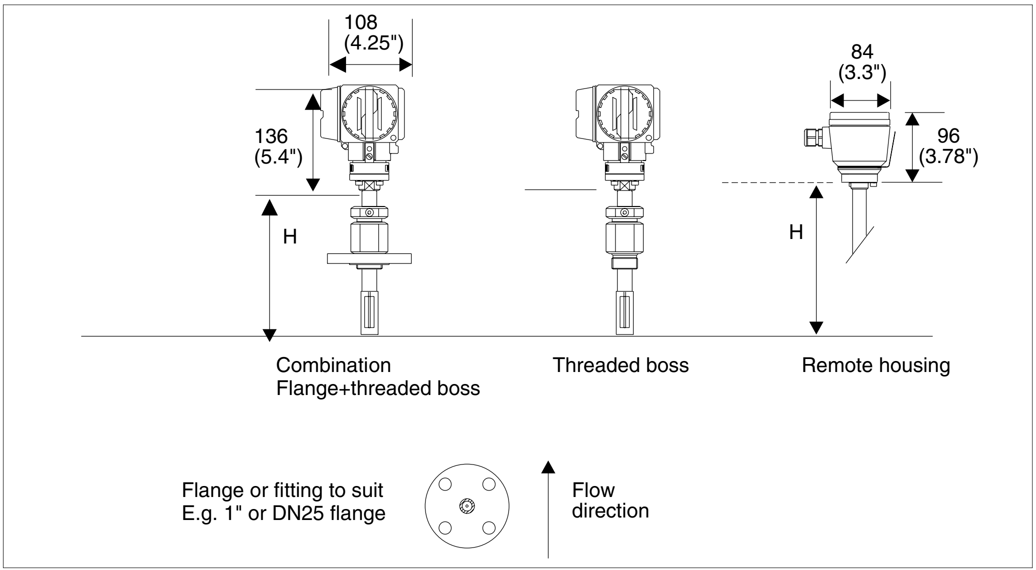


Fig. 59
H = total length of insertion of the sensor

Standard lengths are:

235 mm (9.25")
335 mm (13.2")
435 mm (17.13")

Other lengths can be supplied to order

Dimensions - Insertion version

Process pipe diameter or duct height	See the next page for details of the AZT70 mounting boss		
	Combination (AZT70 = 60 mm [2.36"])	Threaded boss (AZT70 = 40 mm [1.57"])	Threaded boss with integral ball valve (AZT70 =153 mm (6")
3-8"/DN80-DN200	335	235	335
10-16"/DN250-DN400	335	235	435
18-22"/DN450-DN550	335	335	435
24"-28"/DN600-DN700	335	335	435
30"/DN750	435	335	435
32"-36"/DN800-DN900	435	335	435
For pipe or duct sizes not specified select the nearest size above the actual size.			

Table showing the standard insertion length (H) required to suit the pipe size and process connection when mounted with a standard length AZT70 mounting boss (see next page).

Important notes for specifying the insertion lengths.

- Any other mounting arrangement or dimension may require a different sized insertion length - if in doubt contact your E+H sales office for advice.

Note!

11.4 Accessories - AZT 70 Insertion sensor mounting boss

The AT70 insertion sensor can be mounted to the pipe utilising a wide range of mounting arrangements.
The AZT70 mounting boss is designed to allow an installation point to be easily obtained by welding a fixed assembly directly onto the pipework.

The standard part has a fixed length L:
Flanged version L = 60 mm (2.36")
Threaded version L = 40 mm (1.57")

The AZT70 can be supplied with other lengths to order including an integral isolating ball valve. When fitted with such a valve L = 153 mm (6")

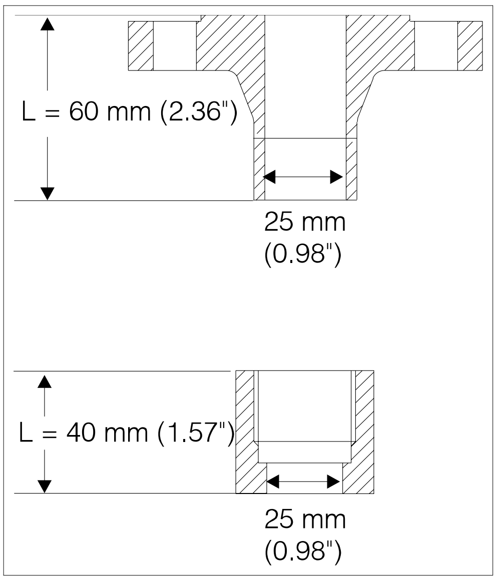


Figure 60

11.5 Flow conditioners

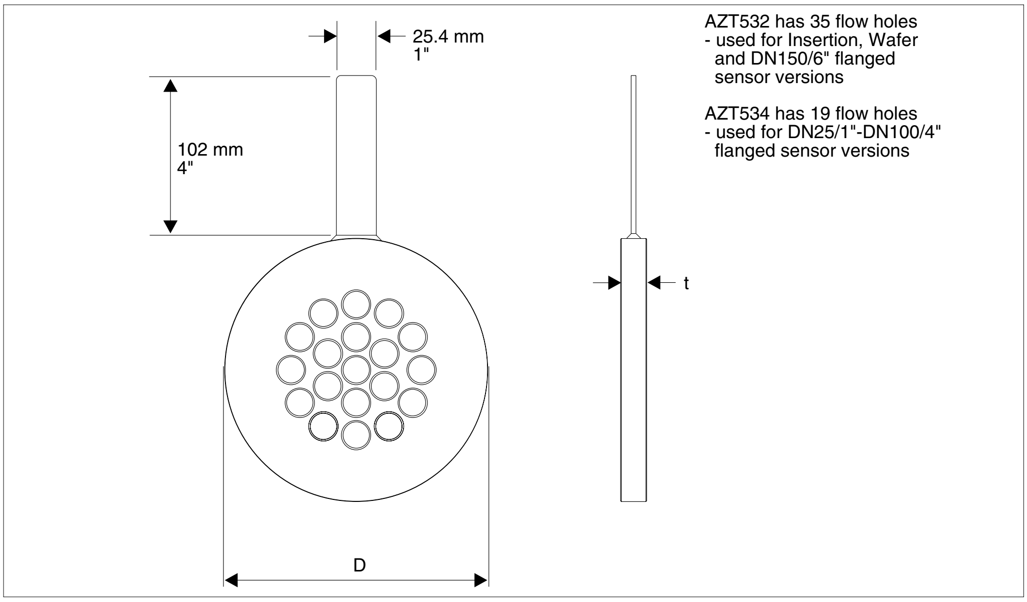


Fig. 61: AZT532/AZT534 perforated plate flow conditioner

Line Size	Process fitting	D mm (inches)	AZT534	AZT532 *
			t mm (inches)	
DN25	PN16/25/40	74 (2.91)	4.6 (0.18)	3.7 (0.15)
1"	Cl 150	68.5 (2.7)	4.3 (0.17)	3.5 (0.14)
	Cl 300	75 (2.95)	4.3 (0.17)	3.5 (0.14)
DN40	PN16/25/40	95 (3.74)	6.8 (0.27)	5.6 (0.22)
1 1/2"	Cl 150	88 (3.46)	6.5 (0.26)	5.3 (0.21)
	Cl 300	97.5 (3.84)	6.5 (0.26)	5.3 (0.21)
DN50	PN16/25/40	110 (4.33)	8.8 (0.35)	7.1 (0.28)
2"	Cl 150	107 (4.21)	8.4 (0.33)	6.8 (0.27)
	Cl 300	113 (4.45)	8.4 (0.33)	6.8 (0.27)
DN80	PN16/25/40	145 (5.71)	13.2 (0.52)	10.8 (0.43)
3"	Cl 150	138.5 (5.45)	12.5 (0.49)	10.1 (0.4)
	Cl 300	151 (5.94)	12.5 (0.49)	10.1 (0.4)
	PN16	165 (6.5)	17.3 (0.68)	14.1 (0.56)
DN100	PN25/40	171 (6.73)	17.3 (0.68)	14.1 (0.56)
4"	Cl 150	176.5 (6.95)	16.4 (0.65)	13.3 (0.52)
	Cl 300	183 (7.2)	16.4 (0.65)	13.3 (0.52)
DN150	PN16	221 (8.7)		20.7 (0.81)
	PN25/40	227 (8.94)		20.7 (0.81)
6"	Cl 150	224.5 (8.84)		20 (0.78)
	Cl 300	253 (9.96)		20 (0.78)
* Other sizes can be supplied to order (upto 350 mm (14"))				

11.6 General Specifications

Process Limits	
Nominal diameters:	70W: DN25 ... 150 DIN) 1" ... 4" ANSI 70F: DN15 ... 150 DIN 1/2" ... 6" ANSI 70: DN80 ... 1000 DIN 3" ... 39" ANSI
Nominal pressure:	70W/F: PN40 (DIN2501) Cl.300 (ANSI B16.5) 70: PN16 (DIN2501) Cl. 150 (ANSI B16.5)
Permissible process temperature:	70/W/F: -10 ... +100 °C 14 ... +212 °F
Materials-wetted parts:	
meter body:	SS316L
transducers:	SS316 optional Hastelloy
transducer seals:	viton, optional kalrez, EPDM
Materials - mounting set:	70W only
centering rings: mounting bolts/hex nuts: washers:	2 pieces, stainless steel 1.4301 1.7258 galvanised galvanised steel
Housing	
Housing material	cast aluminum, painted
Protection type	IP 65 (DN 40050)
Ambient temperature	-20...+80 °C (excluding the liquid crystal display)
Display	Liquid crystal display; 4 numeric character with decimal point plus bargraph in % of current output full scale
Cable glands	PG 13.5 standard, others to order
Electrical	
Electromagnetic compatibility (EMC)	IEC 801 part 3: E = 10 V/m (30 MHz...1GHz)
Power supply	20...30 V DC @ nominal 150 mA
Power consumption	< 3 W
Open collector output	Imax = 10 mA, Umax = 30 V, P = 300 mW Scaleable pulse output up to 100 Pulse/sec.
Current output	4...20 mA analogue current output, Full-scale value and time constant may be set from the keyboard. (minimum T = 1.5 secs @ 63%)
Data storage	Integral non-volatile memory [note 4]
Communication	SMART technology, HART™ protocol via current output

Hazardous area approval	
Remote display/keyboard housing	Cenelec and SEV EEx d [ia] ia IIC T4 Cenelec and SEV [EEX ia] IIC IEC 79-15 (Type n)
Remote sensor	Cenelec and SEV EEx ia IIC T4
Compact sensor version	IEC 79-15 (Type n)
Accuracy Limits	
70F: 70/70W: Expected installed accuracy:	+/- 2% R on calibrated gas [note 1] +/- [0.5% FS + 2% R] on calibrated gas [note 2] R = “of measured value” FS = “of full-scale value”
Repeatability (standard deviation)	70F: +/- 0.25 % 70/70W: +/- 0.25 %
Process Effects	
Temperature coefficient Pipe sizes > DN25 (1") Pipe sizes <= DN25 (1")	0.1%/°C [note 3] 0.1%/°C for flows >5 kg/h 0.5%/°C for flows < 5 kg/h [note 3]
Pressure coefficient	0.2%/bar [note 3]

Note 1 This is normally air at ambient conditions with a fully developed flow profile.

Note 2 Installation dependent.

Note 3 Dependent on gas type

Note 4 The integrated totaliser contents are stored in volatile memory and therefore are not retained when the power is removed

11.7 AZT570 - Sensor field power supply

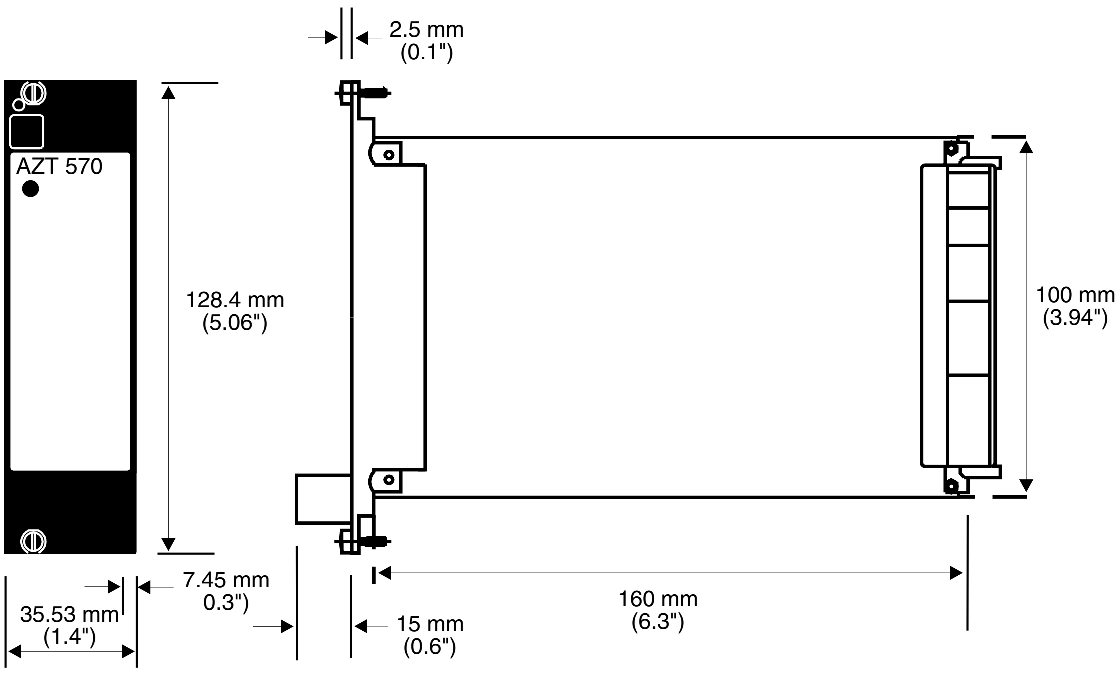


Fig. 62

Power supply
90/110/115/120/220/230/240V AC
±15%, 50/60 Hz
Integrated mains fuse
90/110/115/120V AC - 125 mA slow-blow 220/230/240V AC - 63 mA slow-blow

Power output
24 VDC field power to single AT70 sensor

Permissible ambient temperature
-10°C...+65°C (do not install in direct sunlight)

Storage temperature
-20°C...+85°C

Weight:
Approx. 0.5 kg

Mechanical Design
Racksyst plug-in board in accordance with DIN41494, part 5,
d=160 mm (6.3"),
h=100 mm (4") (Eurocard standard).

Male electrical connector
Multi-pin, compatible in accordance with DIN41612 part 3, type F (32 pin).

Width
7 pitch units (35 mm [1.28"]).

Protection
Front panel to IP20

Conformity
CE mark compliance with electromagnetic compatibility according to EN50081-1:1992 and EN50082-1:1992

Representations in Europe

Austria
■ Endress+Hauser Ges.m.b.H.
Postfach 173,
1235 Wien
Tel. (02 22) 88 056 -0, Fax (02 22) 88 056 -35

Belgium/Luxembourg
■ Endress+Hauser S.A./N.V.
Rue Carli Straat 13, 1140 Bruxelles/Brussel
Tel. (02) 216 73 00, Telex 24564,
Fax (02) 216 54 53

Bulgaria
INTERTECH, Dipl.-Ing Metodi Stamenov
Alexander-Dimitrov-Str. 15, 4000 Pazardjik
Tel. (034) 51074, Fax (034) 24548

Croatia
Endress+Hauser GmbH+Co., c/o Berhe
Fabrkoviceva 7, 41000 Zagreb
Tel. (041) 41 58 12, Fax (041) 44 78 59

Czech Republic
Endress+Hauser GmbH+Co., Pracoviste Ostrava
Varenska 51, 70200 Ostrava 1
Tel. (069) 661 1948, Fax (069) 661 28 69

Denmark
■ Endress+Hauser ApS
Poppelgårdvej 10-12, 2860 Soborg
Tel. (31) 67 31 22, Fax (31) 67 30 45

Eire
FLOMEACO Co. Ltd.
Main Street, Clane, Co. Kildare
Tel. (045) 6 86 15, Fax (045) 6 8182

Finland
■ Endress+Hauser Oy
Mikkellankallio 3, 02770 Espoo 32
Tel. (90) 8 59 61 55, Fax (90) 8 59 60 55

France
■ Endress+Hauser S.A.
3, Rue du Rhin, BP150
68331 Huningue (Cedex)
Tel. (89) 69 67 68, Telex 881511 nivo slo
Fax (89) 69 48 02

Germany
■ Endress+Hauser Meßtechnik GmbH+Co.
P. O. Box 22 22, 79574 Weil am Rhein
Tel. (0 76 21) 975-01, Fax (0 76 21) 975-5 55

International sales:
■ Endress+Hauser GmbH+Co.- Instruments International
P. O. Box 22 22, 79574 Weil am Rhein
Tel. (0 76 21) 975-02, Telex 7 73 926, Fax (0 76 21) 975-3 45

Great Britain
■ Endress+Hauser Ltd.
Floats Road, Manchester M 23-9PH
Tel. (061) 998 0321, Fax (061) 998 18 41

Greece
I & G Building Services Automation S.A.
132 Syngron Avenue, Athens 17672
Tel. (01) 9 24 15 00, Fax (01) 9 22 17 14

Hungary
MILE-KVENTA, Lonyal u. 15, 1121 Budapest,
Tel. (01) 117-0285, Fax (01) 186-6996

Italy
■ Endress+Hauser SpA
Via Grandi 2/a, 20063 Cernusco S.N. (Mi)
Tel. (02) 9 21 06 4 21, Telex 32 21 89 nivo i, Fax (02) 92107153

Netherlands
■ Endress+Hauser B.V., Postbus 5102, 1410 AC Naarden
Tel. (0 21 59) 5 86 11, Fax (0 21 59) 5 88 25

Norway
■ Endress+Hauser A/S
Doeslasletta 4, Postboks 62, 3408 Tranby
Tel. (032) 851085, Telex 19 435, Fax (032) 851112

Poland
DJ+UT Sp. z o.o., Reprezentant firmy Endress+Hauser
ul. Rydygiera 8, 01-793 Warszawa 86
Tel. (02) 6 33 84 80, Telex 815 887, Fax (02) 6 33 84 92

Portugal
Tecnisis
Rua Elisa Sousa Pedroso, 2-1.F, Apartado 512 Carnaxide
2795 Linda a Velha, Tel. (1) 417 26 37, Fax (1) 4 18 52 78

Romania
Ing. Cheorge Cioboata
Str. Cetatuia 10, Bloc. 25/1 77535 Bucuresti
Tel. 16350350, Telex 11958

Slovenia
Endress+Hauser GmbH+Co.
Gerbiceva 101, 61111 Ljubljana
Tel. (061) 26 41 90, Fax (061) 1231180

Spain
■ Endress+Hauser, S.A.
Constitucion, 3, Bloque A., 08960 Sant Just Desvern
Tel. (3) 4 73 46 44, Fax (3) 4 73 38 39

Sweden
■ Endress+Hauser AB
Bergkällavägen 24 A, Box 7006, 19107 Sollentuna
Tel. (08) 6 26 16 00, Telex 116 08, Fax (08) 6 26 94 77

Switzerland
■ Endress+Hauser AG
Sternenhofstr. 21, 4153 Reinach/BL 1
Tel. (061) 715 62 22, Fax (061) 711 16 50

Turkey
INTEK Endüstriyel ölcü ve Kontrol Sistemleri
Vildiz Posta Cad, AS Sitesi, B/1 Gayrettepe, Istanbul 80680
Tel. (1) 275 13 55, Fax (1) 266 27 75

Overseas Representations

Argentina
Servotron S.A.
Av. Belgrano 768, 5 Piso, 1092 Buenos Aires
Tel. (1) 3 310168, Telex 23 378, Fax (1) 334 0104

Australia
GEC
ALSTHOM AUSTRALIA LTD., Industrial Products
25 Princes Road, Regents Park N.S.W. 2143
Tel. (2) 6 45 07 77, Telex 20 729, Fax (2) 7 43 70 35

Brazil
SERVOTEC
Av. Dr. Lino De Moraes Leme, 997/999,
CEP.: 04360 J.D. Aeroporto, Sao Paulo
Tel. (011) 5 363455, Telex 5 7411, Fax (011) 5 363457

Canada
■ Endress+Hauser Ltd.
1440 Grahams Lane, Unit No. 1
Burlington, Ontario L7S 1W3
Tel. (905) 681 92 92, Fax (905) 681 94 44

Endress+Hauser Ltée.
6800 Côte de Lièsse No. 301
Ville St. Laurent, Quebec H4T 2A7
Tel. (514) 7330254, Fax (514) 7332924

Chile
DIN Instrumentos Ltda., Av. Holanda 2023, Santiago
Tel. (2) 274 42 30, Telex 24 08 46, Fax (2) 2 25 8139

China
Beijing E+H Equipment, Technical service station
No. A2 Taiping street, Xuan Wu district
P. O. Box 100 050, Beijing
Tel. (1) 301 4866, Telex. 222233, Fax. (1) 3010347

Hong Kong
Endress+Hauser (H.K.) Ltd.
2302 Malaysia Building, 50 Gloucester Road, Wanchai
Tel. (852) 5 28 3120, Fax (852) 8 65 4171

India
■ Toshniwal Bros. (Bombay) Pvt. Ltd.
46, Shahid Bhagat Singh Road, Khatau Building,
Bombay-400 023
Tel. (22) 286 37 87, Telex 011 83115, Fax (22) 2 04 03 96

Indonesia
PT Grama Bazita, 3rd Floor Multika Building, Suite 301
JL. Mampang Prapatan Raya 71-73, Jakarta 12790
Tel. 62-21-7 97 50 83, Fax 62-21-7 97 50 89

Japan
■ Sakura Endress Co., Ltd.
3-4-22 Naka-Machi, Musashino-Shi, Tokyo 180
Tel. (0422) 54 0611, Telex 028-22 615, Fax (0422) 55 02 75

Korea
■ Han-Il Level Co., Ltd., 255-2, Nai Dong
Bucheon City, Kyung Gi-Do, Seoul
Tel. (032) 672-3131, Telex 27137, Fax (032) 672-00 90/1

Malaysia
■ Endress+Hauser (M) Sdn. Bhd.
No 37, Jalan PJS 11/2, Subang Indah
46000 Petaling Jaya, Selangor Darul Ehsan
Tel. (03) 733 48 48, Fax (03) 733 88 00

Mexico
Maquinaria y Accesorios, S.A. de C.V.
Cincinnati 81, 4-0 Piso, 03720 Mexico, D.F.
Tel. (5) 5 63 8188, Telex 1774217, Fax (5) 6110 0 03

Morocco
TEK Control
17, Ave. des Far, 3me Etage No. 9, B.P. 15893, Casablanca
Tel. 26 27 47, Telex 2 26 62, Fax 26 67 71

New Zealand
Electric Measurement+Control Ltd., 171-175 Target Road
Glenfield, Auckland 9, Tel. (9) 4 44 92 29, Fax (9) 4 4411 45

Pakistan
Abgurt (Pvt.) Ltd.
63, 4th Fl. Luxmi Bldg., M.A. Jinnah Rd, Karachi-400
Tel. (21) 24 36 579, Telex 2 10 68, Fax (21) 241 0513

Philippines
Brenton Industries Inc.
2nd Floor JM Bldg., South Super Highway Cor
Rockefeller St., Makati, Metro Manila
Tel. (2) 88 66 46, Telex 2 24 63, Fax (2) 8 17 57 39

Saudi Arabia
Intrah International Trading House
P.O.Box 326, Damman 31411/K.S.A.
Tel. (3) 8 34 78 79, Fax (3) 8 34 48 32

Singapore
■ Endress+Hauser (S.E.A.) Pte., Ltd.
215 Upper Bukit Timah Road,
3rd Storey, Courtaulds House, Singapore 2158
Tel. (0 65) 4 68 82 22, Telex 36 229, Fax (0 65) 4 66 68 48

South Africa
■ Endress+Hauser Pty. Ltd.
5 Commerce Crescent West, Eastgate Ext. 13,
P.O.Box 783 996, Sandton 2146
Tel. (011) 4441386, Telex 431119 sa, Fax (011) 4441977

Sultanate of Oman
Mustafa & Jawad, Trading Co., LLC., P.O. Box 4918, Ruwi
Tel. 70 99 55, Telex 37 31, Fax 564005

Taiwan
Kingjarl Corporation
9 F-2 No. 307, Tung Hwa N. Road, Taipei R.O.C.
Tel. (2) 712 98 89, Fax (2) 713 41 90

Thailand
Endress+Hauser Ltd,
Wangdek Building 1C/D Floor
19/1-2 Vipavadi-Rangsit Road,
Lardyao, Chatuchak, Bankok 10900
Tel. 66-2-2 72 36 74-5, Fax. 66-2-2 72 36 73

United Arab Emirates
MUSTAFA & JAWAD TRADING CO., P. O. Box 50998
803 Zener Building, Jumbo Roundabout, Dubai
Tel. (4) 52 01 18, Telex 4 7820 mujat, Fax (4) 52 15 09

Uruguay
CEMI Ltda., San Jose 1179, Of. 302, P.O. Box 6330,
Montevideo 11100
Tel. (2) 926754, Fax (2) 926963, Telex 901 pboothuy

USA
■ Endress+Hauser Inc.
2350 Endress Place, P.O.Box 246
Greenwood, Indiana 46 142
Tel. (317) 535-7138
Fax (317) 535-7223

Venezuela
H.Z. Instrumentos, C.A.
Edif la Piramide, Local 20-A
Urb. Prado Humbolt, P.O. Box 61.429, Caracas 1060-A
Tel. (2) 9798813, Telex 28583, Fax (2) 9799608

■ Members of the Endress+Hauser group

Endress+Hauser
Nothing beats know-how

Printed in United Kingdom by Blackburns of Bolton Printers Ltd