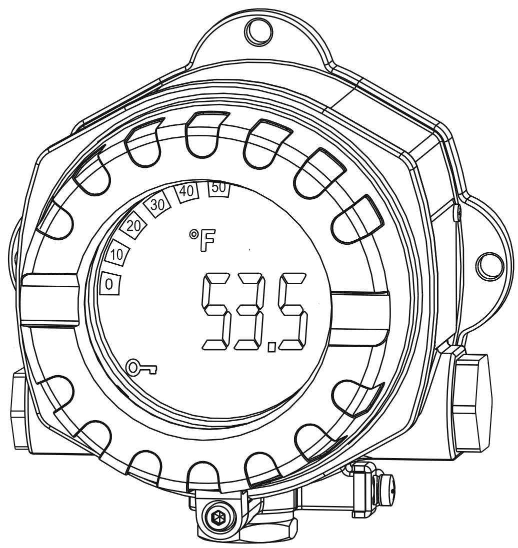
Operating Instructions

Series 642

Field Transmitter HART®



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Device software
01.03

Brief overview

For rapid and easy commissioning:

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Quick SET UP – quick access to device configuration for standard operation	

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1 Safety instructions

1.1 Designated use

- The device is a universal and configurable temperature field transmitter for resistance thermometers (RTD), thermocouples (TC) and resistance and voltage transmitters. The device is designed for installation in the field.
- The manufacturer does not accept liability for damage caused by improper or non-designated use.

1.2 Installation, commissioning, operation

Please note the following:

- Mounting, electrical installation, commissioning and maintenance of the device must only be carried out by trained technical personnel authorised to perform such work by the owner-operator. They must have read and understood these Operating Instructions and must follow the instructions they contain.
- The device may only be operated by staff authorised and instructed by the owner-operator. Strict adherence to the instructions in these Operating Instructions is mandatory.
- The installer must ensure that the measuring system is correctly connected in accordance with the electrical wiring diagrams.
- Observe local regulations governing the opening and repair of electrical devices.

1.3 Operational safety

The measuring device meets the general safety requirements of EN 61010 and the EMC requirements of EN 61326 as well as NAMUR recommendations NE 21, NE 43 and NE 89.

NOTICE

Power supply

► Power must be fed to the device from an 11 to 40 VDC power supply in accordance with NEC Class 02 (low voltage/current) with short-circuit power limit to 8 A/150 VA.

Hazardous area

Separate Ex documentation is provided for measuring systems used in hazardous areas. This documentation is an integral part of these Operating Instructions. The installation instructions and connection data it contains must be observed!

1.4 Return

To reuse later or in case of repair, the device must be packed in protective packaging, preferably the original packaging. Repairs must only be carried out by your supplier's service organisation or specially trained personnel.
Enclose a note describing the fault and the application when sending the unit in for repair.

1.5 Notes on safety conventions and icons

The safety instructions in these Operating Instructions are labelled with the following safety icons and symbols:

Symbol	Meaning
WARNING A0011190-EN	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
CAUTION A0011191-EN	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE A0011192-EN	NOTICE! This symbol contains information on procedures and other facts which do not result in personal injury.
A0011193	Indicates additional information, Tip

2 Identification

2.1 Device designation

2.1.1 Nameplate

Compare the nameplate on the device with the following diagram:

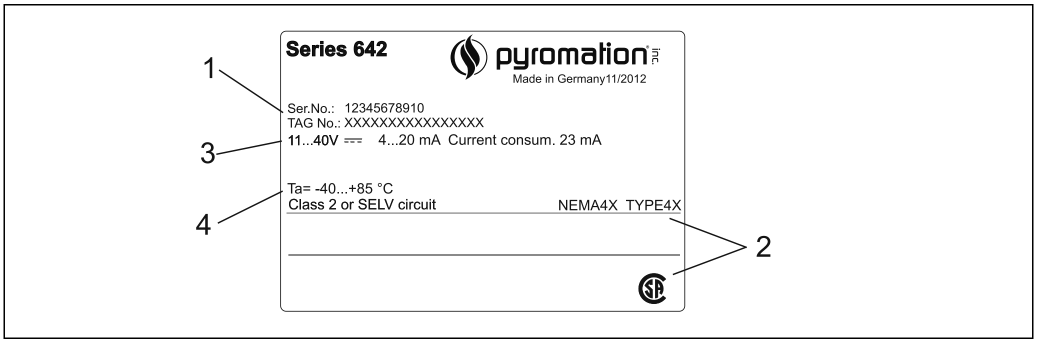


Fig. 1: Nameplate of the field transmitter (example)

1 Order code and serial number of the device
2 Degree of protection and approvals
3 Power supply and output signal
4 Ambient temperature

2.2 Scope of delivery

The scope of delivery of the field transmitter comprises:

- Temperature field transmitter
- Dummy plug
- Mounting bracket
- Operating Instructions

2.3 Certificates and approvals

CE mark, declaration of conformity

The temperature field transmitter is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device meets the relevant standards and directives as per IEC 61 010 "Safety requirements for electrical equipment for measurement, control and laboratory use".
The device described in these Operating Instructions thus meets the legal requirements of the EU directives. The manufacturer confirms that the device has been tested successfully by affixing the CE mark.

CSA GP approved

3 Installation

3.1 Quick installation guide

If the sensor is fixed then the unit can be fitted directly to the sensor.
If the sensor is to be mounted at a right angle to the cable gland, swap the dummy plug and cable gland.
The device can be mounted directly on the wall. A mounting bracket is available for pipe mounting (see Fig. 4). The illuminated display can be mounted in four different positions (→ 2):

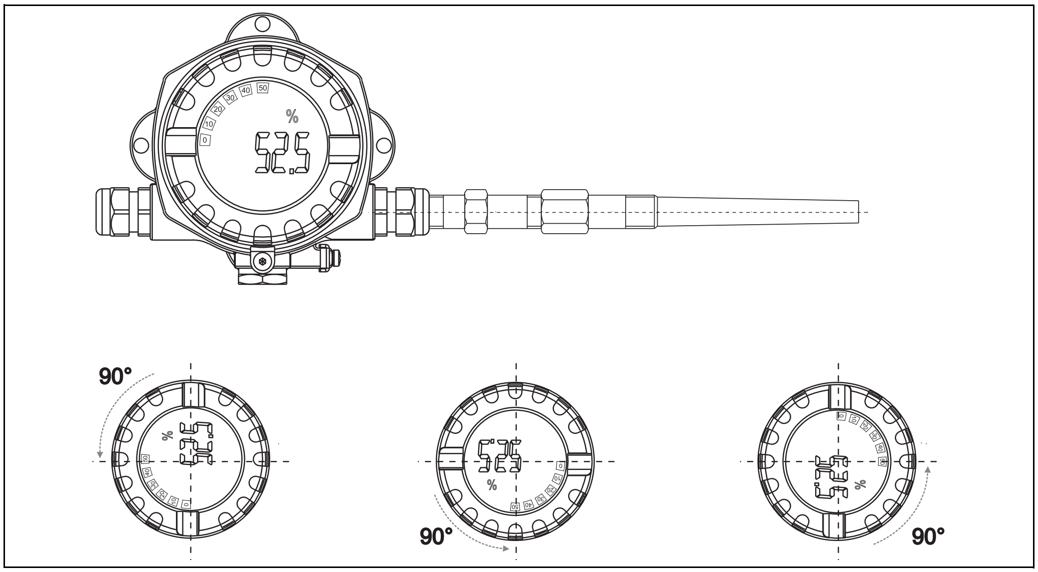


Fig. 2: Temperature field transmitter with sensor, 4 display positions, can be plugged-in in 90° steps

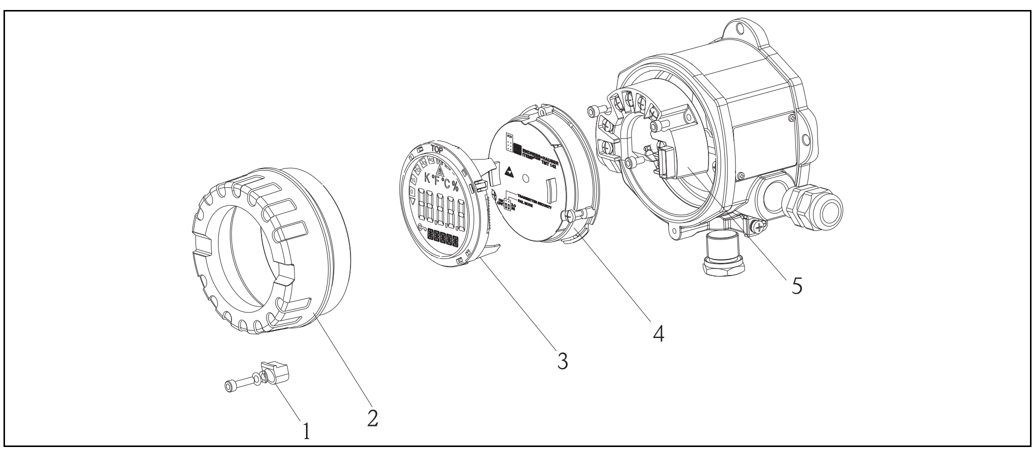


Fig. 3: Turning the display

1. Remove the cover clamp (Pos. 1).
2. Unscrew the housing cover together with the O-ring (Pos. 2).
3. Remove the display with retainer (Pos. 3) from the electronics module (Pos. 4). Adjust the display with retainer in 90°stages to your desired position and rearrange it on the particular slot in the electronics module.
4. Then screw on the housing cover together with the O-ring. Mount the cover clamp.

3.2 Installation conditions

3.2.1 Dimensions

The dimensions of the device can be found in chapter 10 "Technical data".

3.2.2 Installation point

Information on installation conditions, such as ambient temperature, protection classification, climatic class etc., can be found in chapter 10 "Technical data".

3.3 Installation

3.3.1 Direct wall mounting

Proceed as follows to mount the device directly on wall:
- Drill 2 holes
- Attach the device to the wall with 2 screws (M6).

3.3.2 Pipe installation

The mounting bracket is suited for pipes with a diameter between 1.5" - 3.3".
Proceed as follows to mount the device on a pipe:
- Attach the mounting bracket to the pipe
- The additional mounting plate must be used for pipes with a diameter of 1.5" to 2.2".
- Fix the device to the mounting bracket with the two screws supplied. The mounting plate is not needed for pipes with a diameter of 2.2" - 3.3".

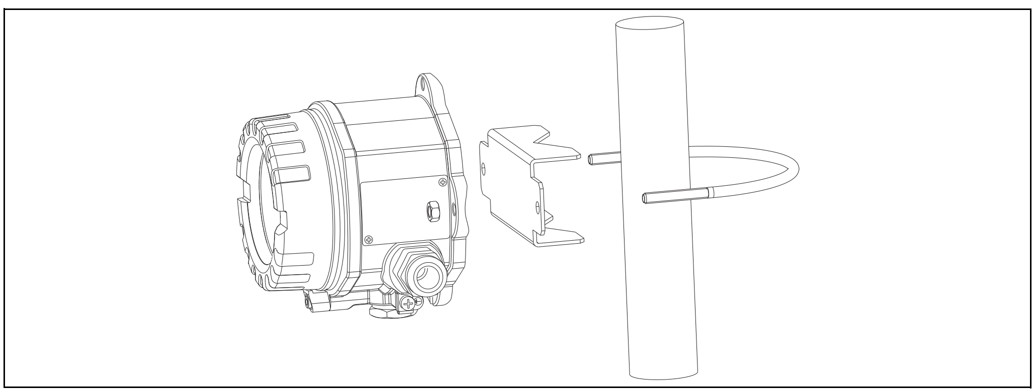


Fig. 4: Mounting the field transmitter with the mounting bracket, see 'Accessories' section

3.4 Installation check

After installing the device, always run the following final checks:

Device condition and specification	Hint
Is the device visibly damaged (visual check)?	-
Does the device comply to the measurement point specifications, such as ambient temperature, measurement range etc.?	See chapter 10 "Technical data"

4 Wiring

NOTICE

Installation in hazardous area

► When installing Ex-approved devices in a hazardous area please take special note of the instructions and connection schematics in the respective Ex documentation added to this operating manual. The local representative is available for assistance if required.

For wiring the device proceed as follows:

1. Remove the cover clamp (→ 3, item 1).
2. Remove the device cover (→ 3, item 2).
3. Remove the display from the electronics module (→ 3, item 3).
4. Open the 2 screws of the electronics unit and remove the electronics unit (→ 3, item 4).
5. Open the cable gland at the device (→ 3, item 5).
6. Feed the cable through the opening in the cable gland.
7. Connect the wires (→ 5).
8. Make sure that the terminal screws are tight. Re-seal the cable gland by screwing the cover back on.
9. In order to avoid connection errors always take note of the hints given in the section connection check!

4.1 Quick wiring guide

Terminal layout

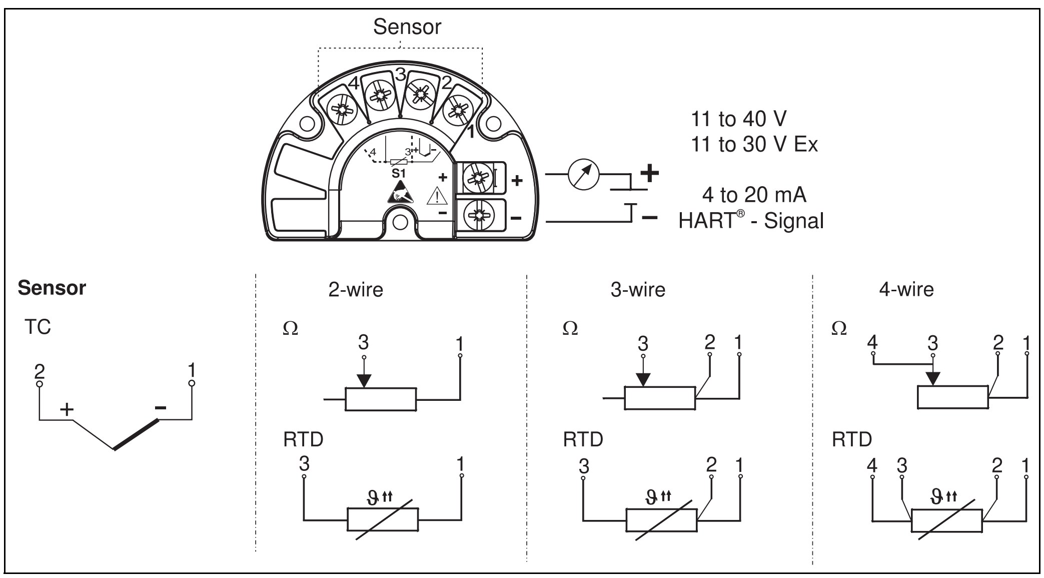


Fig. 5: Wiring the field transmitter

NOTICE

ESD - Electrostatic discharge

► Protect the terminals from electrostatic discharge. Failure to observe this may result in destruction of parts of the electronics.

4.2 Connecting the sensor

Please refer to Section 4.1 "Quick wiring guide" for the terminal assignment of the sensor connections.

4.3 Connecting the measuring unit

NOTICE

Electronic parts may be damaged

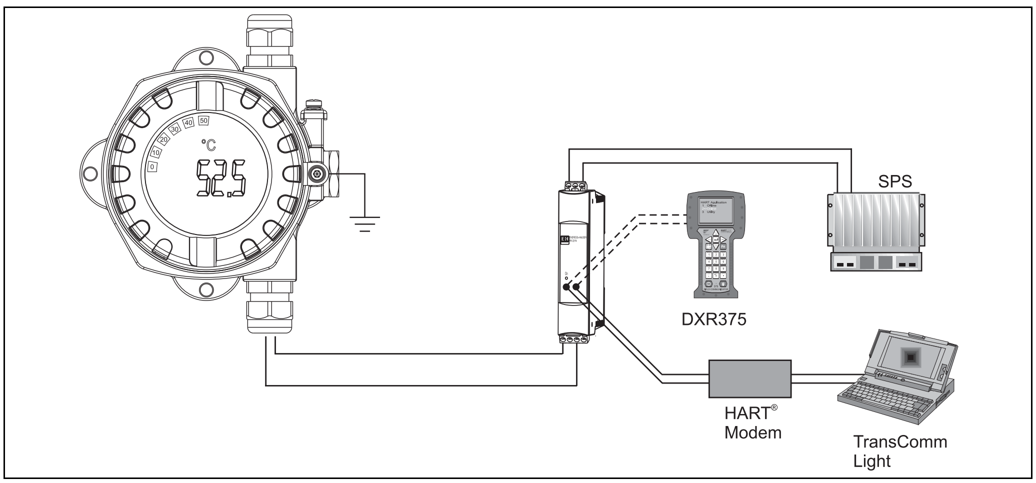
► Switch off power supply before installing or connecting the device. Failure to observe this may result in destruction of parts of the electronics.

► If the device has not been grounded as a result of the housing being installed, grounding it via one of the ground screws is recommended.

4.3.1 HART® connection

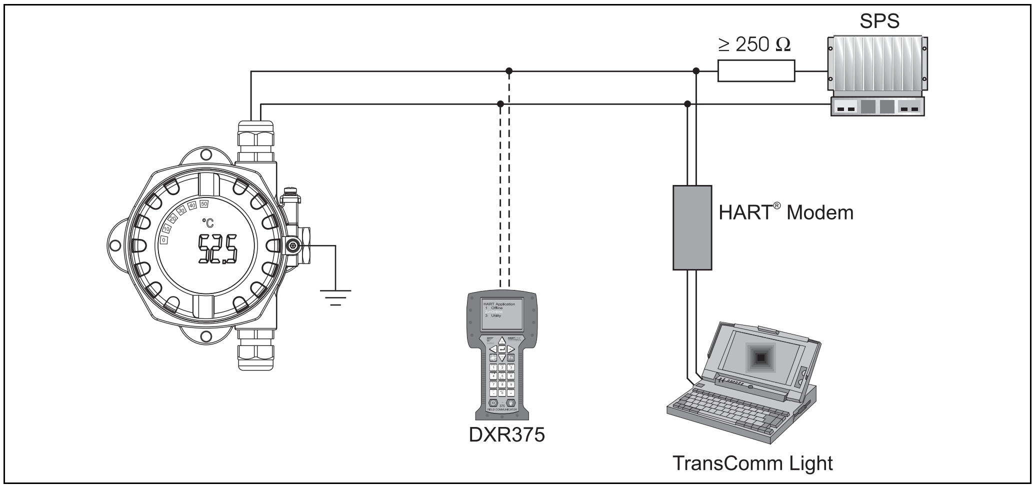
If the HART® communication resistance is not built into the power supply, a 250 Ω communication resistor must be fitted into the 2-wire supply lines.
For connection hints, please take special notice of the documentation supplied by the HART® Communication Foundation, specifically HCF LIT 20: “HART, a technical overview”.

Connection using a transmitter power supply



HART® connection with a transmitter power supply

Connection using other power supplies



HART® connection using other power supplies, e. g. a SPS

4.4 Screening and potential equalization

Please take note when installing the device:
If screened (shielded) cables are used then the screen connected to the output (output signal 4 to 20mA) must be at the same potential as the screen at the sensor connection!
When operating in plants with high electromagnetic fields, it is recommended that all cables be screened using a low ohm ground connection. Due to the possible danger of lightning strikes screening is also recommended for cables that are run outside buildings!

4.5 Degree of protection

The device conforms to the requirements to IP 67 ingress protection. In order to fulfil an IP 67 degree of protection after installation or service, the following points must be taken into consideration:

- The housing seals must be clean and undamaged before they are replaced into the sealing rebate. If they are found to be too dry then they should be cleaned or even replaced.
- All housing screws and covers must be pulled tight.
- The cables used for connection must be of the correct specified outside diameter (e.g. M20 x 1.5, cable diameter from 8 to 12 mm; 0.315 to 0.47 in).
- Tighten cable gland (→ Fig. 6).
- Loop the cable before placing into the cable entry ("Water sack", → Fig. 6). This means that any moisture that may form cannot enter the gland. Install the device so that the cable entries are not facing upwards.
- Cable entries not used are to be blanked off using the blanking plates provided.
- The protective olive must not be removed from the cable gland.

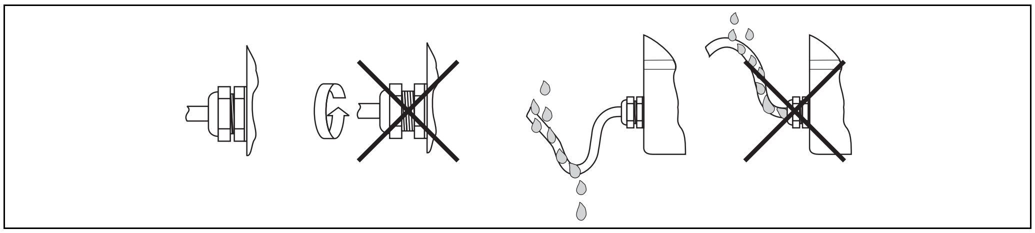


Fig. 6: Connection hints to retain IP 67 protection

4.6 Connection check

After the electrical installation of the device, always perform the following final checks:

Device condition and specification	Hint
Are the device or the cables undamaged (visual check)?	-
Electrical connection	Hint
Is the cable installation correctly separated, with no loops or crossovers?	-
Are the cables load relieved?	-
Have the cables been correctly connected? Compare with the connection schematic on the terminals or → Fig. 5.	See connection schematic on the housing
Are all terminal screws tightened? Is the cable entry sealed? Is the housing cover screwed tight?	Visual check

5 Operation

5.1 Display and operating elements

5.1.1 Display

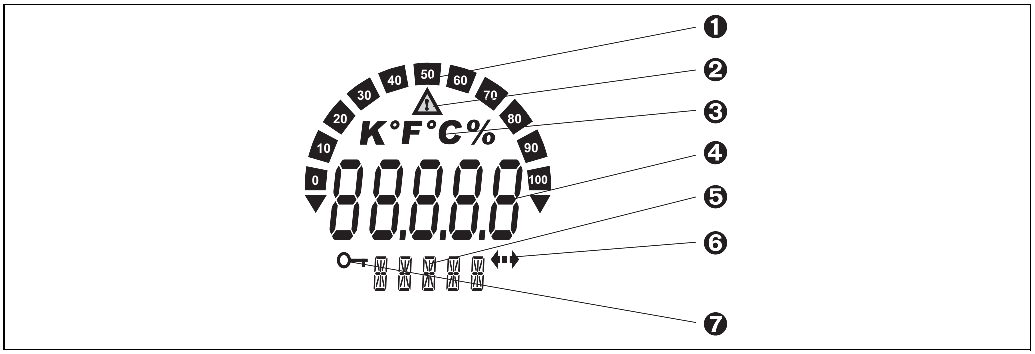


Fig. 7: LC display of the field transmitter (illuminated, can be plugged in 90° stages)

5.1.2 Display symbols

Item No.	Function	Description
1	Bargraph display	In 10 % stages with indicators for overranging/ underranging. The bargraph display flashes when an error occurs.
2	'Caution' indicator	This appears in the event of an error or warning
3	Unit display K, °F, °C or %	Unit display for the measured value displayed
4	Measured value display (digit height 20.5 mm)	The measured value is displayed. In the event of a warning, the display switches between the measured value and the code of the warning. In the event of an error, the error code is displayed instead of the measured value.
5	Status and information display	Indicates which value is currently shown on the display. A customer-specific text can be entered for PV. In the event of a warning, 'WARN' is displayed along with the code for the warning. In the event of an error, 'ALARM' is displayed.
6	'Communication' display	The communication symbol appears for read and write access via the HART® protocol
7	'Configuration blocked' display	The 'configuration blocked' symbol appears if configuration via software or hardware is blocked.

5.2 Local operation

5.2.1 Hardware setting

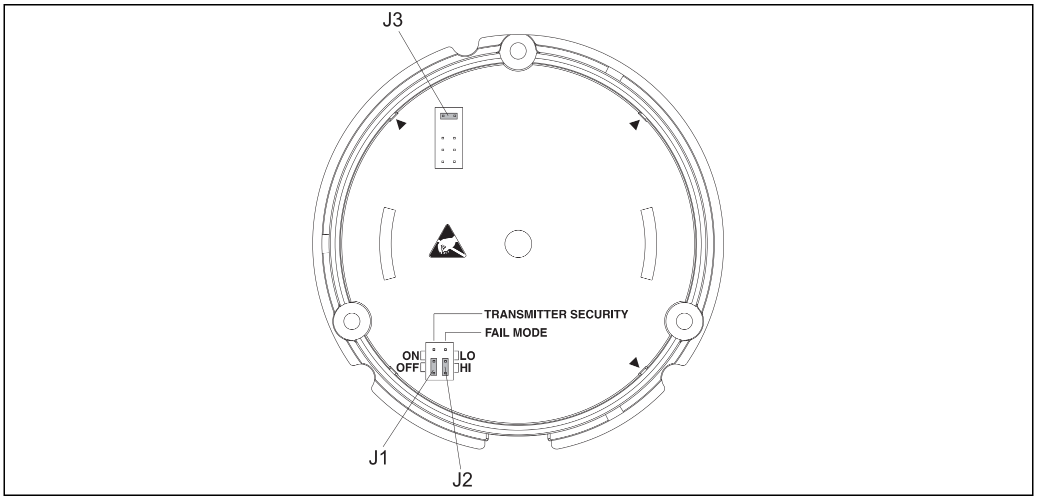


Fig. 8: Hardware settings via jumpers J1, J2 and J3

NOTICE

ESD – Electrostatic discharge

► Protect the terminals from electrostatic discharge. Failure to observe this may result in destruction of parts of the electronics.

Jumpers J1, J2 and J3 for the hardware setting are located at the electronics module. To set the jumper, open the threaded joint of the electronics module (opposite the threaded joint of the connection compartment) and remove the display if necessary.

Hardware locking the configuration with jumper J1

TRANSMITTER SECURITY	
ON	Configuration locked
OFF	Configuration enabled

The hardware setting for configuration locking has priority over the software setting.

Setting the failsafe mode via the hardware with jumper J2

FAILURE MODE	
LO	≤ 3.6 mA
HI	≥ 21.0 mA

The failsafe mode set via the jumpers only takes effect if the microcontroller fails.

Please check that the hardware and software setting for the failsafe mode match.

Hardware setting with jumper J3 (only for devices without a display)

If jumper J3 is set, the minimum operating voltage can be reduced from 11 V to 8 V.

5.3 Communication using the HART® protocol

The set-up and measured value read out of the measuring device is done using the HART® protocol. The digital communication is done using the 4 to 20 mA current output HART® (see Figs. 4 and 5). There are a number of possible set-up methods available to the user:

- Operation using the universal handheld module "HART® Communicator DXR375".
- Operation using a PC combined with an operating software, e.g. 'TransComm Light' as well as a HART® modem.
- Operating programs of other manufacturers ('AMS', Fisher Rosemount; 'SIMATIC PDM', Siemens).

If communication errors occur in the Microsoft® Windows NT ® Version 4.0 and Windows® 2000 operating systems the following measure is to be taken:
Switch off setting "FIFO active".

In order to do this follow these steps.

1. On Windows NT® Version 4.0:
   Select the menu point "COM-Port" using the menu "START" ➠ "SETTINGS" ➠ "CONTROL PANEL" ➠ "PORTS". Using the menu string "SETTINGS" ➠ "ADVANCED" switch the command "FIFO active" off. Now restart the PC.
2. For Windows® 2000 and Windows® XP (classic category view):
   Select "Advanced settings for COM1" using the menu "START" ➠ "SETTINGS" ➠ "CONTROL PANEL" ➠ "SYSTEM" ➠ "HARDWARE" ➠ "DEVICE MANAGER" ➠ "PORTS (COM and LPT)" ➠ "COMMUNICATIONS PORT (COM1)" ➠ "CONNECTION SETTINGS" ➠ "ADVANCED". Deactivate the "Use FIFO buffer". Now restart the PC.

5.3.1 HART® Communicator DXR375

With the HART® handheld module, all device functions are selected by means of various menu levels with the aid of the function matrix (→ 16). All the device functions are explained in chapter 6.4.1 "Description of Device Functions".

Procedure:

1. Switch on the handheld module:
   – Measuring device not yet connected. The HART® main menu appears. This menu level appears for every HART® programming, i.e. irrespective of the measuring device type. Information on off-line configuration can be found in the Operating Instructions of the “Communicator DXR375” handheld module.
   – Measuring device is already connected. The 1st menu level of the device function matrix appears directly (see Fig. 9). All the functions accessible under HART® are systematically arranged in this matrix.
2. Select the function group (e.g. Sensor) and then the desired function, e.g. “Sensor type”.
3. Enter type or change the setting. Then confirm with the function key F4 “Enter”.
4. “SEND” appears via the function key “F2”. Pressing the F2 key transfers all the values entered with the handheld module to the device measuring system.

5. With the "F3" function key HOME, you return to the 1st menu level.

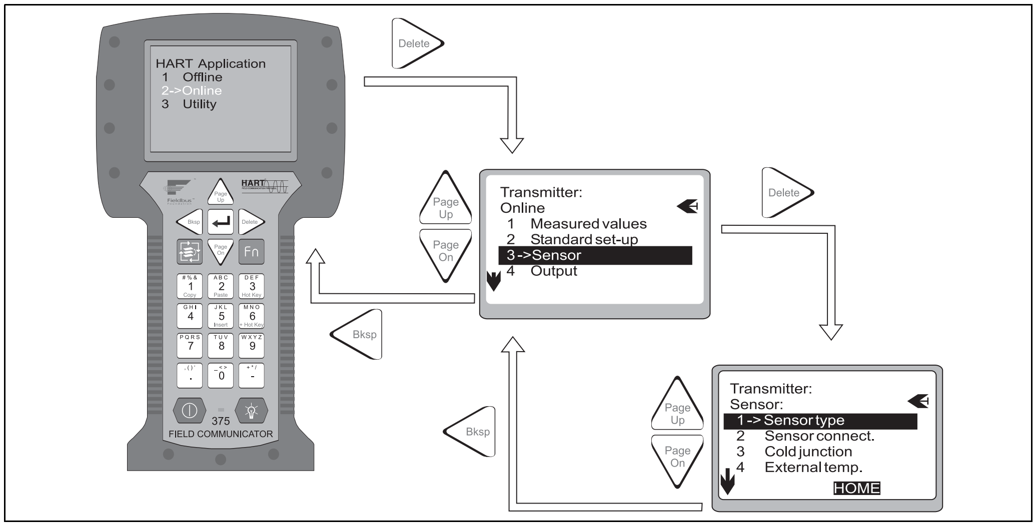
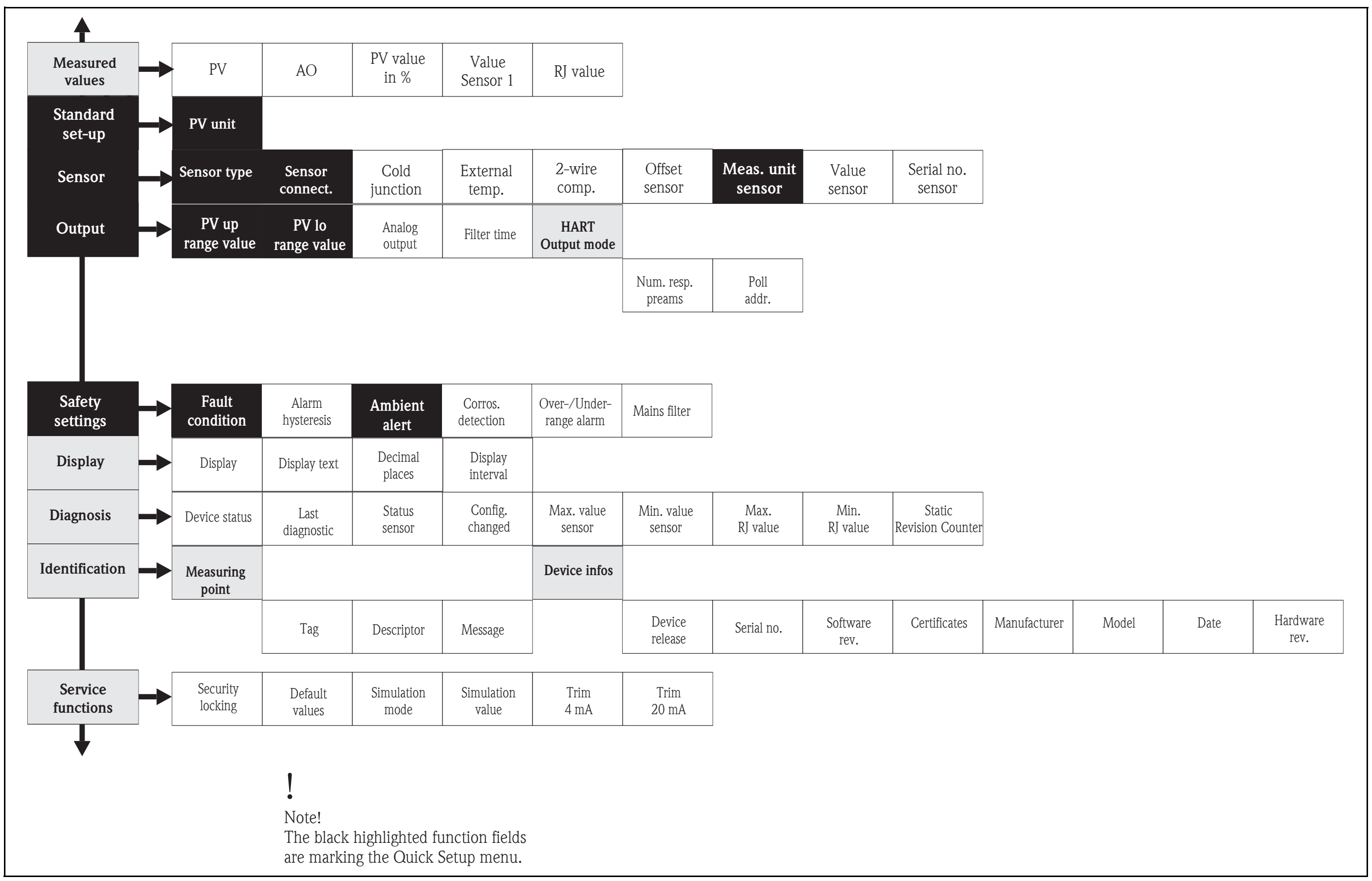


Fig. 9: Configuration at the handheld module, using 'Sensor input' as an example'



HART® function matrix

- With the HART® handheld module, all parameters can be read and programming is disabled. However, you can enable the HART® function matrix by entering 246 in the SECURITY LOCKING function. The enable status is retained even after a power failure. Delete the release code 246 to lock the HART® function matrix again.
- Detailed information can be found in the HART® instruction manual that can be found in the handheld module transport pouch.

5.3.2 TransComm Light

This is a universally applicable service and configuration software. Connection is made using a HART® modem. The operating software offers the user the following possibilities:

- Set-up device functions
- Measured value visualisation
- Device parameter data storage
- Measuring point documentation

NOTICE

Analog output

► The analog output is undefined when downloading the device function parameters from the PC configuration software to the device.

Further in-depth information to operation via TransComm Light can be found in the online documentation of the software. TransComm Light can be downloaded free of charge from the following address:

www.pyromation.com

5.3.3 Command classification in the HART® protocol

The HART® protocol makes it possible for configuration and diagnostic purposes to transmit measured and device data between the HART® master and the respective field device. HART® masters such as the handheld module or PC-based operating programmes require so-called device description files (DD = device descriptions, DTM), these make it possible to access all information in a HART® device. Transmission of such information is done exclusively using "commands".

There are three command classifications:

- Universal commands
  Universal commands are supported and used by all HART® devices. Combined are, for example, the following functionalities:
  - Recognising HART® device
  - Read out of digital measured values
- Common practice commands:
  These general commands offer functions that are supported or used by some but not all field devices.
- Device specific commands
  These commands enable access to device specific functions that are not HART® standardised. Such commands access, amongst other things, individual field device information.

Chapter 6.4.2 contains a list of all HART® commands supported.

6 Commissioning

6.1 Installation check

Before commissioning the measurement point make sure that all final checks have been carried out:

- Checklist "Installation check"
- Checklist "Connection check"

6.2 Switch on the device

Once the power has been connected, the field transmitter is operational.

6.3 Quick Setup

Using the Quick Setup the operator is led through all the most important unit functions, which must be set up for standard measurement operation of the unit.

Standard set-up		
Availability in TransComm Light and HART® communicator DXR375 (symbol)	TransComm Light	
Function	+	+
PV mode	+	+
PV unit	+	+
Sensor		
Sensor type	+	+
Sensor connection	+	+
Unit	+	+
OUTPUT		
PV lower range value	+	+
PV upper range value	+	+
Safety/maintenance functions		
Fault condition	+	+
Alarm ambient temperature	+	+

Further set-up for special measurement applications are possible (see Section 6.4.1).

6.4 Device configuration

6.4.1 Description of device functions

All parameters that can be read out and set-up for the configuration of the temperature transmitter are listed and described in the following tables. The menu structure in the PC configuration software TransComm Light and in the HART® communicator DXR375 are shown in the following tables.

Factory default setup is shown in bold text.

Function group STANDARD SETTINGS			
Availability in TransComm Light, HART® communicator DXR375 (symbol)		TransComm Light	
PV unit	Enter the unit of the PV (= Primary Value) Input: **° C**, °F, K, R, mV or Ω The setting PV unit has priority, the selection list of the sensor type is shown independently from the PV unit.	+	+

Function group SENSOR						
Availability in TransComm Light, HART® communicator DXR375 (symbol)					TransComm Light	
Sensor type	**Sensor type**	**Meas. range start**	**Meas. range full scale value**	**min. range**	+	+
IEC 60751	**Pt100**	-200 °C (-328 °F)	850 °C (1562 °F)	10 K (18 °F)		
	Pt200	-200 °C (-328 °F)	850 °C (1562 °F)	10 K (18 °F)		
JIS	Pt100	-200 °C (-328 °F)	649 °C (1200.2 °F)	10 K (18 °F)		
IEC 60751	Pt500	-200 °C (-328 °F)	250 °C (482 °F)	10 K (18 °F)		
	Pt1000	-200 °C (-328 °F)	250 °C (482 °F)	10 K (18 °F)		
	Ni100	-60 °C (-76 °F)	250 °C (482 °F)	10 K (18 °F)		
	Ni1000	-60 °C (-76 °F)	150 °C (302 °F)	10 K (18 °F)		
Edison Copper Winding No. 15	Cu10	-100 °C (-148 °F)	260 °C (500 °F)	10 K (18 °F)		
SAMA	Pt100	-100 °C (-148 °F)	700 °C (1292 °F)	10 K (18 °F)		
Edison Curve No. 7	Ni120	-70 °C (-94 °F)	270 °C (518 °F)	10 K (18 °F)		
GOST	Pt50	-200 °C (-328 °F)	1100 °C (2012 °F)	10 K (18 °F)		
	Pt100	-200 °C (-328 °F)	850 °C (1562 °F)	10 K (18 °F)		
	Cu50	-200 °C (-328 °F)	200 °C (392 °F)	10 K (18 °F)		
	Cu100	-200 °C (-328 °F)	200 °C (392 °F)	10 K (18 °F)		
	Polynomial RTD	-200 °C (-328 °F)	850 °C (1562 °F)	10 K (18 °F)		
	Callendar - van Dusen (Pt100)	-200 °C (-328 °F)	850 °C (1562 °F)	10 K (18 °F)		

Function group SENSOR						
Availability in TransComm Light, HART® communicator DXR375 (symbol)					TransComm Light	DXR375
Sensor type	**Sensor type** TC Type B TC Type C TC Type D TC Type E TC Type J TC Type K TC Type L TC Type N TC Type R TC Type S TC Type T TC Type U 10 to 400 Ω 10 to 2000 Ω -20 to 100 mV	**Meas. range start** 0 °C (32 °F) 0 °C (32 °F) 0 °C (32 °F) -270 °C (-454 °F) -210 °C (-346 °F) -270 °C (-454 °F) -200 °C (-328 °F) -270 °C (-454 °F) -50 °C (-58 °F) -50 °C (-58 °F) -270 °C (-454 °F) -200 °C (-328 °F) 10 Ω 10 Ω -20 mV	**Meas. range full scale value** 1820 °C (3308 °F) 2320 °C (4208 °F) 2495 °C (4523 °F) 1000 °C (1832 °F) 1200 °C (2192 °F) 1372 °C (2501.6 °F) 900 °C (1652 °F) 1300 °C (2372 °F) 1768 °C (3214.4 °F) 1768 °C (3214.4 °F) 400 °C (752 °F) 600 °C (1112 °F) 400 Ω 2000 Ω 100 mV	**min. range** 500 K (900 °F) 500 K (900 °F) 500 K (900 °F) 50 K (90 °F) 50 K (90 °F) 50 K (90 °F) 50 K (90 °F) 50 K (90 °F) 500 K (900 °F) 500 K (900 °F) 50 K (90 °F) 50 K (90 °F) 10 Ω 100 Ω 5 mV	+	+
Specific linearization and sensor matching Selecting the sensor types 'Callendar-van-Dusen' or 'Polynomial RTD' improves the accuracy of the system or defines user-specific linearisation of resistance thermometers. A detailed description of the 'Callendar-van-Dusen' method and 'Polynomial RTD' linearisation is provided in the Appendix to these Operating Instructions.						
	The selection list of the sensor type is displayed depending on the PV unit. Example: When selecting a resistance thermometer the PV unit must first be set to Ω.					
Sensor connection	Input of RTD connection mode. Input: ■ 2-wire ■ **3-wire** ■ 4-wire Function is only active on selection of a resistance thermometers (RTD) in the device function SENSOR TYPE.				+	+
Cold junction	Selection of the internal (Pt100) or an external comparison measurement point. Input: ■ **internal** ■ external Function is only active on selection of a thermo-couple (TC) in the device function SENSOR TYPE.				+	+
External temperature	Input of the external comparison point measurement value. Input: -40.00 to 85.00 °C (°C, °F, K) **0 °C** Function is only active when "external" has been selected in the device function COLD JUNCTION.				+	+
2-wire compensation	Input of cable resistance compensation on a 2-wire RTD connection. Input: **0.00** to 30.00 Ω Function is only active when a 2-wire connection has been selected in the device function SENSOR CONNECTION.				+	+

Function group SENSOR			
Availability in TransComm Light, HART® communicator DXR375 (symbol)		TransComm Light	
Offset	Input of the zero point correction (offset). Input: -10.00 to 10.00 °C (-18.00 to 18.00 °F) **0.00 °C**	+	+
Unit	Display of measurement unit. Sensor unit = PV unit	+	+
Serial no. sensor	Input of the serial number of the sensor connected to this sensor input.	+	+

Function group OUTPUT				
Availability in TransComm Light, HART® communicator DXR375 (symbol)			TransComm Light	
PV lower range value	Input of 4 mA value. Input: Limitation values see device function SENSOR TYPE. **0 °C**		+	+
PV upper range value	Input of 20 mA value. Input: Limitation values see device function SENSOR TYPE. **100 °C**		+	+
Analog output	Input of the standard (4 to 20 mA) or inverse (20 to 4 mA) current output signal. Input: ■ **4 to 20 mA** ■ 20 to 4 mA		+	+
Filter	Selection of the digital filter 1. order (filter time constant). Input: **0** to 60 s		+	+
HART Output/ Multidrop	Preamble	Input: Number of response preambles: 5 to 20 **5**	-	+
	Device address	Input: HART address of the temperature transmitters: **0** to 15 If addresses > 0, the temperature transmitter is in Multidrop mode and the analogue output is set to 4 mA. Device address is shown on the display in the Multidrop mode		

Function group SAFETY/MAINTENANCE			
Availability in TransComm Light, HART® communicator DXR375 (symbol)		TransComm Light	
Fault condition	Input of the output signal on sensor rupture or short circuit. Input: ■ **max** (≥ 21.0 mA) ■ min (≤ 3.6 mA)	+	+
Error current specification	Input only possible if fault condition = max Input: 21.6 to 23 mA **21.7 mA**	+	+
Alarm hysteresis	Transient alarms are suppressed at the analog output (e.g. caused by electrostatic discharge). Input: ■ **0 s** ■ 2 s ■ 5 s In the time entered, the last measured value before the alarm is output. If the error is still present after this period, an alarm is signalled.	+	+
Alarm ambient temperature	An alarm for overshooting/undershooting of permitted ambient temperature is deactivated here. Input: ■ **on** ■ off If the ambient temperature alarm is deactivated then the unit will not go into alarm but will transmit a warning. Change is the responsibility of the user.	+	+
Corrosion detection	Sensor connection cable corrosion can lead to false measured value readings. Therefore our unit offers the possibility to recognise any corrosion before the measured values are affected. (see chapter 9.2.1). There are 2 different steps selectable dependent on the application requirements: ■ **off** (warning output just before reaching the alarm set point. This allows for preventative maintenance/trouble-shooting to be done.) ■ on (no warning, immediate alarm)	+	+
Alarm for undershooting/ overshooting	Input: ■ **OFF** If the measuring range is undershot or overshot, the output signal is temperature-linear up to 3.8 mA or 20.5 mA and remains at these values (as per NAMUR NE43). ■ ON An error is signalled if the measured temperature corresponds to an output value < 3.8 mA or > 20.5 mA, (see 'Fault condition').	+	+
Mains filter	Selection of mains filter ■ 50 Hz ■ **60 Hz**	+	+

Function group DISPLAY			
Availability in TransComm Light, HART® communicator DXR375 (symbol)		TransComm Light	
DISPLAY	Activating the values to be shown on the device display:		

Function group DISPLAY			
	■ Display: PV (= Primary Value) (DXR=1) ■ Display: sensor value (DXR=2) ■ Display: RJ value (DXR=8) ■ Display Analogue output value (DXR=16) ■ Display: Status (DXR=32) ■ Display: percentage value (on/off) The primary value (PV) is displayed as a percentage. off (DXR=0) on (DXR=64) In order to activate the values to be shown in the device display using HART® handheld module DXR375: Add (DXR=x) of the values to be displayed and enter the sum. ■ Display: time (2s, 4s, 6s, 8s) ■ Display: figures after decimal point (0,1,2) ■ Display PV text (customer specific text, 8 characters)	+ + + + + + + + +	+ + + + + + + + +

Function group DIAGNOSTICS			
Availability in TransComm Light, HART® communicator DXR375 (symbol)		TransComm Light	
Diagnostics	Display of information required for device diagnostics. ■ Device status or error code (See chapter 9.2 "Error messages") ■ Last error code (status) or previous error code (See chapter 9.2 "Error messages") ■ Status sensor (0 = no error; 0 ≠ error) ■ Configuration changed	 + + - +	 + + + +
Diagnostics	■ Static revision The "Static revision" is increased on every parameter change. This is for compliance to 21 CFR Part 11, showing that no further parameter changes have been made. ■ Sensor max. value ■ Sensor min. value ■ RJ max. value ■ RJ min. value Display of the maximum process value. The process value will be accepted after starting the measurement. Display of the minimum process value. The process value will be accepted after starting the measurement. Display of the maximum and minimum measured temperatures of the internal Pt100 DIN B comparison measurement point. ■ Maximum process value is changed to the actual process value on write access. On reset to factory default value the default value is entered **-9999.99**. ■ Minimum process value is changed to the actual process value on write access. On reset to factory default value the default value is entered **+9999.99**.	- + + + +	- + + + +

Function group IDENTIFICATION		
Availability in TransComm Light, HART® communicator DXR375 (symbol)	TransComm Light	
Measuring point Input and display of the information relating to the measuring point identification		

Function group IDENTIFICATION			
TAG	Input: 8 characters	+	+
Descriptor	Input: 16 characters	+	+
Message	Input: 32 characters	-	+
Device information Display of the information relating to the device identification			
Device release	Display of device release	-	+
Serial number	11 digit display of the device serial number (equal to that on the legend plate).	+	+
Software rev.	Display of the software version	+	+
Hardware rev.	Display of the hardware version	+	+
Certificates	Display of device approvals	-	+
Device Display of the information relating to the HART® device identification			
Manufacturer	Manufacturer’s identification: Pyromation Inc.	-	+
Model	Device type identification: Series 642	-	+
Date	Individual use of this parameter	-	+
Hardware Rev.	HART Device Revision	-	+

Function group SERVICE FUNCTIONS			
Availability in TransComm Light, HART® communicator DXR375 (symbol)		TransComm Light	
Security locking	Set-up release code. Input: ■ Lock = 0 ■ Release = **246**	+	+
Reset to default	Reset to factory default values. Input: 642 **0**	+	+
Output simulation	Activate simulation mode. Input: ■ **OFF** ■ ON	+	+
Simulation value	Input of the simulation value (current). Input: 3.58 to 23 mA	+	+
User calibration (trim) analog output	For changing the 4 or 20 mA value by ± 0.150 mA ■ Trimming 4 mA ■ Trimming 20 mA	+	+

Function group MEASURED VALUES			
Availability in TransComm Light, HART® communicator DXR375 (symbol)		TransComm Light	
PV	PV value	+	+
AO	PV value in mA	-	+
PV %	PV value in %	-	+
Sensor	Sensor process value	-	+
Internal temperature	Internal temperature of the device	-	+

6.4.2 Supported HART® commands

r = read access, w = write access

No.	Description	Access
	Universal Commands	
00	Read unique identifier	r
01	Read primary variable	r
02	Read p.v. current and percent of range	r
03	Read dynamic variables and p.v. current	r
06	Write polling address	w
11	Read unique identifier associated with tag	r
12	Read message	r
13	Read tag, descriptor, date	r
14	Read primary variable sensor information	r
15	Read primary variable output information	r
16	Read final assembly number	r
17	Write message	w
18	Write tag, descriptor, date	w
19	Write final assembly number	w
	Common practice	
34	Write primary variable damping value	w
35	Write primary variable range values	w
38	Reset configuration changed flag	w
40	Enter/exit fixed primary variable current mode	w
42	Perform master reset	w
44	Write primary variable units	w
48	Read additional device status	r
59	Write number of response preambles	w
	Device specific	
144	Read matrix parameter	r
145	Write matrix parameter	w
231	Check Device Status	r

- HART® command No. 48 (HART-Cmd #48)
  Apart from the response code and the device status byte, the field transmitter calls up a detailed diagnosis by means of Cmd #48. This diagnosis is 8 bytes long.

Byte	Contents	Meaning
1	Overall device status	0 x 01 error: EEPROM 0 x 02 error: ADC 0 x 04 error: channel 1 0 x 10 error: comparison measurement point 0 x 20 error: HART ASIC 0 x 40 warning: measured value range undershoot 0 x 80 warning: measured value range overshoot
2		0 x 01 warning: backup switched on 0 x 02 information: maintenance necessary 0 x 04 information: drift too small/large 0 x 08 information: corrosion at terminals 0 x 10 information: ambient temperature too high/low 0 x 20 information: output current at fixed value 0 x 40 information: no LCD connected or LCD error 0 x 80 information: upload/download active
3		0 x 01 information: device starting 0 x 02 error: supply voltage too low
4		0 x 40 global bit for a warning 0 x 80 global bit for an error
5	Status channel 1	0 x 01 warning corrosion 0 x 02 corrosion 0 x 04 sensor rupture 0 x 08 sensor short circuit 0 x 10 range undershoot 0 x 20 range overshoot 0 x 40 channel not operational 0 x 80 error A/D conversion
7	Extended device status	0 x 01 maintenance necessary 0 x 02 warnings / error present
8	Device operating mode	Always 0

- HART® command No. 231 (HART-Cmd #231)
  The classified diagnosis of the device can be checked by means of this command. Fault classes according to GMA VDE NAMUR 2650 guidelines:

Byte	Contents	Meaning
1	Information acc. to GMA VDE NAMUR 2650	0x01 -F- Fault 0x02 -C- Device in service mode 0x03 -M- Maintenance required 0x04 -S- Out of specification
2+3	Device error messages, see section 9.2	

Fault classification see Section 9.2 Error messages.

7 Maintenance

No special maintenance work is required on the device.

8 Trouble-shooting

8.1 Trouble-shooting instructions

Always begin trouble-shooting with the following checklists if errors occur after commissioning or during measuring operation. The questions guide you to the cause of the error and the appropriate remedial action.

8.2 Error messages

Fault code	Cause	Action/cure	Mode[1)]
0	No error, warning	-	-
10	Hardware error (device defective)	Replace device	F
13	Reference measuring point defective	Replace device	F
15	EEprom defective	Replace device	F
16	A/D converter defective	Replace device	F
17	Ambient temperature limit overshot	Electronics possibly damaged by overshooting ambient temperature limits, return electronics to manufacturer for checking	0, F
19	Supply voltage too low	Check supply voltage; check connection wires for corrosion	F
50	Sensor cable open circuit	Check sensor	*
51	Sensor short-circuit	Check sensor	*
52	Sensor corrosion	Check sensor	*
53	Outside sensor range	Wrong sensor type for application	*
81	Alarm: measuring range undershoot	Measuring range poss. set too small	F
82	Alarm: measuring range overshoot	Measuring range poss. set too small	F
106	Warning: upload/download active	-	C
107	Warning: Output simulation active	Deactivate output simulation	C
201	Warning: Measured value too low	Change PV lower range value	M
202	Warning: measured value too large	Change PV upper range value	M
203	Warning: Ambient temperature limit overshot	Electronics possibly damaged by overshooting ambient temperature limits, return electronics to manufacturer for checking	0
206	Warning: Sensor corrosion	Check sensor	M
208	Reset device to factory default values	-	0

Fault code	Cause	Action/cure	Mode[1]
209	Device initialization	-	0
+1000	Additional errors active	Eliminate error displayed	

1) The modes have the following meaning: F: Fault, C: Device in service mode, M: Maintenanca required, S: Out of specification, *: depends on mode (F or M). See also section 6.4.2 Supported HART® commands.

If several errors are present, the error with the highest priority is output. Once this error is eliminated, the next error is output! An offset of 1000 indicates that more than one error is present.

Device behavior in event of sensor error

In the event of a warning or error, the "Caution" symbol appears on the display and the error code is shown. If an error occurs, the bargraph also flashes on the display and only the error code is displayed and not the measured value. (See also Section 5.2).

8.2.1 Corrosion detection

Corrosion detection only for RTD 4-wire connection.

Sensor connection cable corrosion can lead to false measured value readings. Therefore our unit offers the possibility to recognize any corrosion before the measured values are affected.

There are 2 different steps selectable dependent on the application requirements:

- off (warning output just before reaching the alarm set point. This allows for preventative maintenance/trouble-shooting to be done.)
- on (no warning, immediate alarm)

The following table describes how the device behaves when the resistance changes in a sensor connection line, depending on whether on or off is selected.

RTD [1]	< ≈ 2 kΩ	2 kΩ ≈ < x< ≈ 3 kΩ	> ≈ 3 kΩ
off	—	WARNING	ALARM
on	—	ALARM	ALARM

1) Pt100 = 100 Ω at 0°C / Pt1000 = 1000 Ω at 0°C

TC	< ≈ 10 kΩ	10 kΩ ≈ < x< ≈ 15 kΩ	> ≈ 15 kΩ
off	—	WARNING [1]	ALARM
on	—	ALARM	ALARM

1) If the ambient temperature is very high, it is possible to have a measured error 3 times that of the specified value.

The sensor resistance can have an effect on the resistance data in the table. If all the sensor connection line resistances are increased simultaneously, the values described in the table are halved. In corrosion detection, it is assumed this is a slow process with a continuous increase in resistance.

8.2.2 Monitoring the supply voltage

If the necessary supply voltage is undershot, the analog output value drops approx. 3 s ≤ 3.6 mA. Error code 19 appears on the display. Then the device attempts to output the normal analog output value again. If the supply voltage remains too low, the analog output value drops again to ≤ 3.6 mA. This prevents the device from constantly outputting an incorrect analog output value.

8.3 Application errors without messages

8.3.1 Application errors in general

Error pattern	Cause	Action/cure
No communication	No power supply via the 2-wire line	Connect connecting cables correctly in accordance with terminal plan (polarity)
	250 Ω communication resistance missing	See Section 4.3.1 "Connecting HART®"
	Supply voltage too low (<11 V or 8 V without display with jumper J3)	Check power supply
	Interface cable defective	Check interface cable
	Interface defective	Check interface of your PC
	Device defective	Replace device

8.3.2 Application errors for RTD connection

Pt100/Pt500/Pt1000/Ni100

Error pattern	Cause	Action/cure
Error current (≤ 3.6 mA or ≥ 21 mA)	Sensor defective	Check sensor
	Incorrect RTD connection	Connect connecting cables correctly (terminal plan)
	Incorrect 2-wire line connection	Connect connecting cables correctly in accordance with terminal plan (polarity)
	Faulty device programming (number of wires)	Change SENSOR CONNECTION device function
	Programming	Incorrect sensor type configured in the SENSOR TYPE device function; change to correct sensor type
	Device defective	Replace device

Error pattern	Cause	Action/cure
Measured value is incorrect/ inaccurate	Orientation of the sensor is incorrect	Install sensor properly
	Heat conducted by sensor	Observe face-to-face length of the sensor
	Faulty device programming (number of wires)	Change SENSOR CONNECTION device function
	Faulty device programming (scaling)	Change scaling
	Incorrect RTD configured	Change SENSOR TYPE device function
	Sensor connection (2-wire)	Check sensor connection
	Line resistance of sensor (2-wire) was not compensated	Compensate line resistance
	Offset incorrectly configured	Check offset

8.3.3 Application errors for TC connection

Error pattern	Cause	Action/cure
Error current ($\leq$ 3.6 mA or $\geq$ 21 mA)	Sensor connected incorrectly	Connect sensor in accordance with terminal plan (polarity)
	Sensor defective	Check sensor
	Programming	Incorrect sensor type configured in the SENSOR TYPE device function; set correct thermocouple
	Device defective	Replace device

Error pattern	Cause	Action/cure
Measured value is incorrect/ inaccurate	Orientation of the sensor is incorrect	Install sensor properly
	Heat conducted by sensor	Observe face-to-face length of the sensor
	Faulty device programming (scaling)	Change scaling
	Wrong thermocouple type (TC) configured	Change SENSOR TYPE device function
	Incorrect comparison measurement point configured	See Section "Description of device functions"
	Offset incorrectly configured	Check offset
	Interference through thermo-wire welded in thermowell (interference voltage coupled in)	Use sensor that does not have a weld-on thermo-wire

8.4 Return

To reuse later or in case of repair, the device must be packed in protective packaging, preferably the original packaging. Repairs must only be carried out by your supplier's service organisation or specially trained personnel.
Enclose a note describing the fault and the application when sending the unit in for repair.

8.5 Disposal

The device contains electronic components and must, therefore, be disposed of as electronic waste in the event of disposal. Please observe in particular the local waste disposal regulations of your country.

8.6 Software history

SW Revision
The software version in the Operating Instructions indicates the device release history: XX.YY.ZZ (example 01.02.01).

XX	Change in the main version. No longer compatible. Changes to device and Operating Instructions.
YY	Change in the functionality and operation. Compatible. Changes to Operating Instructions.
ZZ	Debugging and internal modifications. No changes to Operating Instructions.

SW Revision, date	Operation, documentation	Modifications
01.03.01, 03/2005	Compatible with: ▪ HART Communicator DXR375 (from OS1.6) ▪ (TransComm Light as of version 1.0.15.0) ▪ AMS (as of version 5.0) ▪ PDM (as of version 5.1)	
01.03.03, 12/2006	-	Internal SW modifications.

9 Technical data

9.0.1 Input

Measured variable

Temperature (temperature linear transmission behaviour), resistance and voltage

Measuring range

The transmitter records different measuring ranges depending on the sensor connection and input signals.

Input	Designation	Measuring range limits	Min. span
Resistance thermometer (RTD) To IEC 60751 (α = 0.00385)	Pt100 Pt200 Pt500 Pt1000	-200 to 850 °C (-328 to 1562 °F) -200 to 850 °C (-328 to 1562 °F) -200 to 250 °C (-328 to 482 °F) -200 to 250 °C (-238 to 482 °F)	10 K (18 °F) 10 K (18 °F) 10 K (18 °F) 10 K (18 °F)
To JIS C1604-81 (α = 0.003916)	Pt100	-200 to 649 °C (-328 to 1200 °F)	10 K (18 °F)
To DIN 43760 (α = 0.006180)	Ni100 Ni1000	-60 to 250 °C (-76 to 482 °F) -60 to 150 °C (-76 to 302 °F)	10 K (18 °F) 10 K (18 °F)
To Edison Copper Winding No.15 (α = 0.004274)	Cu10	-100 to 260 °C (-148 to 500 °F)	10 K (18 °F)
To SAMA (α = 0.003923)	Pt100	-100 to 700 °C (-148 to 1292 °F)	10 K (18 °F)
To Edison Curve (α = 0.006720)	Ni120	-70 to 270 °C (-94 to 518 °F)	10 K (18 °F)
To GOST (α = 0.003911)	Pt50 Pt100	-200 to 1100 °C (-328 to 2012 °F) -200 to 850 °C (-328 to 1562 °F)	10 K (18 °F) 10 K (18 °F)
To GOST (α = 0.004278)	Cu50, Cu100	-200 to 200 °C (-328 to 392 °F)	10 K (18 °F)
	Polynomial RTD Pt100 (Callendar - van Dusen)	-200 to 850 °C (-328 to 1562 °F) -200 to 850 °C (-328 to 1562 °F)	10 K (18 °F) 10 K (18 °F)
	▪ Type of connection: 2-wire, 3-wire or 4-wire connection ▪ With 2-wire circuit, compensation of wire resistance possible (0 to 30 Ω) ▪ With 3-wire and 4-wire connection, sensor wire resistance to max. 50 Ω per wire ▪ Sensor current: ≤ 0.3 mA		
Resistance transmitter	Resistance Ω	10 to 400 Ω 10 to 2000 Ω	10 Ω 100 Ω
Thermocouples (TC) To NIST monograph 175, IEC 584	Type B (PtRh30-PtRh6)[1)] Type E (NiCr-CuNi) Type J (Fe-CuNi) Type K (NiCr-Ni) Type N (NiCrSi-NiSi) Type R (PtRh13-Pt) Type S (PtRh10-Pt) Type T (Cu-CuNi)	0 to +1820 °C (32 to 3308 °F) -270 to +1000 °C (-454 to 1832 °F) -210 to +1200 °C (-346 to 2192 °F) -270 to +1372 °C (-454 to 2501 °F) -270 to +1300 °C (-454 to 2372 °F) -50 to +1768 °C (-58 to 3214 °F) -50 to +1768 °C (-58 to 3214 °F) -270 to +400 °C (-454 to 752 °F)	500 K (900 °F) 50 K (90 °F) 50 K (90 °F) 50 K (90 °F) 50 K (90 °F) 500 K (900 °F) 500 K (900 °F) 50 K (90 °F)
to ASTM E988	Type C (W5Re-W26Re) Type D (W3Re-W25Re)	0 to +2320 °C (32 to 4208 °F) 0 to +2495 °C (32 to 4523 °F)	500 K (900 °F) 500 K (900 °F)
to DIN 43710	Type L (Fe-CuNi) Type U (Cu-CuNi)	-200 to +900 °C (-328 to 1652 °F) -200 to +600 °C (-328 to 1112 °F)	50 K (90 °F) 50 K (90 °F)
	▪ Internal cold junction (Pt100); accuracy of cold junction: ± 1 K ▪ Max. sensor resistance 10 kΩ (if sensor resistance is greater than 10 kΩ, error message as per NAMUR NE 89)		

Input	Designation	Measuring range limits	Min. span
Voltage transmitter (mV)	Millivolt transmitter (mV)	-20 to 100 mV	5 mV

1) Increasing inaccuracy for temperatures < 300 °C (< 572 °F)

9.0.2 Output

Output signal	Analog 4 to 20 mA, 20 to 4 mA
Signal on alarm	■ Underranging: Linear drop to 3.8 mA ■ Overranging: Linear rise to 20.5 mA ■ Sensor break; sensor short-circuit (not for thermocouples TC): ≤ 3.6 mA or ≥ 21.0 mA (configurable 21.6 mA to 23 mA)
Load	Max. ($V_{power\ supply}$– 11 V) / 0.022 A (current output)
Linearisation/transmission behaviour	Temperature linear, resistance linear, voltage linear
Filter	1st order digital filter: 0 to 60 s
Galvanic isolation	U = 2 kV AC (input/output)
Input current required	≤ 3.5 mA
Current limit	≤ 23 mA
Switch-on delay	4 s (during switch-on operation I_a= 4 mA)

9.0.3 Power supply

Supply voltage

U_b= 11 to 40 V (8 to 40 V without display), reverse polarity protection

NOTICE

Power supply

► Power must be fed to the device from an 11 to 40 VDC power supply in accordance with NEC Class 02 (low voltage/current) with short-circuit power limit to 8 A/150 VA.

Residual ripple

Perm. residual ripple $U_{ss} \leq 3$ V at $U_b \geq 13.5$ V, $f_{max.} = 1$ kHz

9.0.4 Accuracy

Response time

1 s

Reference operating conditions

Calibration temperature: +25 °C, ± 5 K; (+77 °F, ± 9 °F)

Maximum measured error

	Designation	**Accuracy**	
		Digital	D/A[1)]
Resistance thermometer (RTD)	Cu100, Pt100, Ni100, Ni120 Pt500 Cu50, Pt50, Pt1000, Ni1000 Cu10, Pt200	0.2 K (0.36 °F) 0.6 K (1.08 °F) 0.4 K (0.72 °F) 2 K (3.6 °F)	0.02% 0.02% 0.02% 0.02%
Thermocouples (TC)	K, J, T, E, L, U N, C, D S, B, R	typ. 0.5 K (0.9 °F) typ. 1 K (0.18 °F) typ. 2 K (3.6 °F)	0.02% 0.02% 0.02%

1) % relates to the set span. Accuracy = digital + D/A accuracy

	Measuring range	**Accuracy**	
		Digital	D/A[1)]
Resistance transmitter (Ω)	10 to 400 Ω 10 to 2000 Ω	± 0.08 Ω ± 1.6 Ω	0.02% 0.02%
Voltage transmitter (mV)	-20 to 100 mV	± 20 µV	0.02%

1) % relates to the set span. Accuracy = digital + D/A accuracy

Physical input range of the sensors	
10 to 400 Ω	Cu10, Cu50, Cu100, polynomial RTD, Pt50, Pt100, Ni100, Ni120
10 to 2000 Ω	Pt200, Pt500, Pt1000, Ni1000
-20 to 100 mV	Thermocouple type: C, D, E, J, K, L, N
-5 to 30 mV	Thermocouple type: B, R, S, T, U

Repeatability

0.03% of the physical input range (15 Bit)
Resolution A/D conversion: 18 Bit

Influence of supply voltage	≤ ±0.005%/V deviation from 24 V, related to the full scale value
Long-term stability	≤ 0.1 K (0.18 °F)/year or ≤ 0.05%/year Data under reference conditions. % relates to the set span. The larger value applies.

Influence of ambient temperature (temperature drift)

Total temperature drift = input temperature drift + output temperature drift

Effect on the accuracy when ambient temperature changes by 1 K (1.8 °F)	
Input 10 to 400 Ω	0.002% of measured value
Input 10 to 2000 Ω	0.002% of measured value
Input -20 to 100 mV	typ. 0.002% of measured value (maximum value = 1.5 x typ.)
Input -5 to 30 mV	typ. 0.002% of measured value (maximum value = 1.5 x typ.)
Output 4 to 20 mA	typ. 0.002% of measured value (maximum value = 1.5 x typ.)

Typical sensor resistance change when process temperature changes by 1 K (1.8 °F):				
Cu10: 0.04 Ω	Pt200: 0.8 Ω	Ni120: 0.7 Ω	Cu50: 0.2 Ω	Pt50: 0.2 Ω
Cu100, Pt100: 0.4 Ω	Pt500: 2 Ω	Pt1000: 4 Ω	Ni100: 0.6 Ω	Ni1000: 6 Ω

Typical change in thermoelectric voltage when process temperature changes by 1 K (1.8 °F):					
B: 10 µV	C: 20 µV	D: 20 µV	E: 75 µV	J: 55 µV	K: 40 µV
L: 55 µV	N: 35 µV	R: 12 µV	S: 12 µV	T: 50 µV	U: 60 µV

Examples for calculating the accuracy:

- **Example 1**
  Input temperature drift Δϑ = 10 K (18 °F), Pt100, span 0 to 100 °C (32 to 212 °F)
  Maximum process value: 100 °C (212 °F)
  Measured resistance value: 138.5 Ω (see IEC 60751)
  Typ. influence in Ω: (0.002% of 138.5 Ω) * 10 = 0.0277 Ω
  Conversion Ω to °C: 0.0277 Ω / 0.4 Ω/K = 0.07 K (0.013 °F)
- **Example 2**
  Input temperature drift Δϑ = 10 K (18 °F), thermocouple type K with span 0 to 600 °C (32 to 1112 °F)
  Maximum process value: 600 °C (1112 °F)
  Measured thermoelectric voltage: 24905 µV (see IEC584)
  Typ. influence in µV: (0.002% of 24905 µV) * 10 = 5 µV
  Conversion Ω to °C: 5 µV / 40 µV/K = 0.12 K (0.216 °F)
- **Example 3**
  Output temperature drift Δϑ = 10 K (18 °F), measuring range 0 to 100 °C (32 to 212 °F)
  Span: 100 K (180 °F)
  Typical influence: (0.002% of 100 K) * 10 = 0.02 K; (0.002% of 180 °F) * 10 = 0.036 °F

Δϑ = deviation of ambient temperature from the reference operating condition

Total measuring point error = max. possible measured error + temperature sensor error

Influence of cold junction	Pt100 DIN IEC 60751 Cl. B (internal cold junction with thermocouples TC)

9.0.5 Environment

Ambient temperature limits	■ Without display: -40 to +85 °C (-40 °F to +185 °F) ■ With display: -40 to +80 °C (-40 °F to +176 °F) For use in hazardous areas, see Ex certificate At temperatures < -4 °F (-20 °C) the display may react slowly. Readability of the display cannot be guaranteed at temperatures < -30 °C (-22 °F).
Storage temperature	■ Without display: -40 to +100 °C (-40 °F to +212 °F) ■ With display: -40 to +85 °C (-40 °F to +185 °F)
Operating height	Up to 2000 m above MSL
Climate class	As per EN 60 654-1, Class C
Degree of protection	IP 67, NEMA 4x
Shock and vibration resistance	3g / 2 to 150 Hz as per IEC 60 068-2-6
Electromagnetic compatibility (EMC)	Interference immunity and interference emission as per EN 61 326-1 (IEC 1326) and NAMUR NE 21 0.08...2 GHz 10 V/m; 1.4...2 GHz 30 V/m to EN 61000-4-3
Condensation	Permitted
Installation category	I
Pollution degree	2

9.0.6 Mechanical construction

Design, dimensions

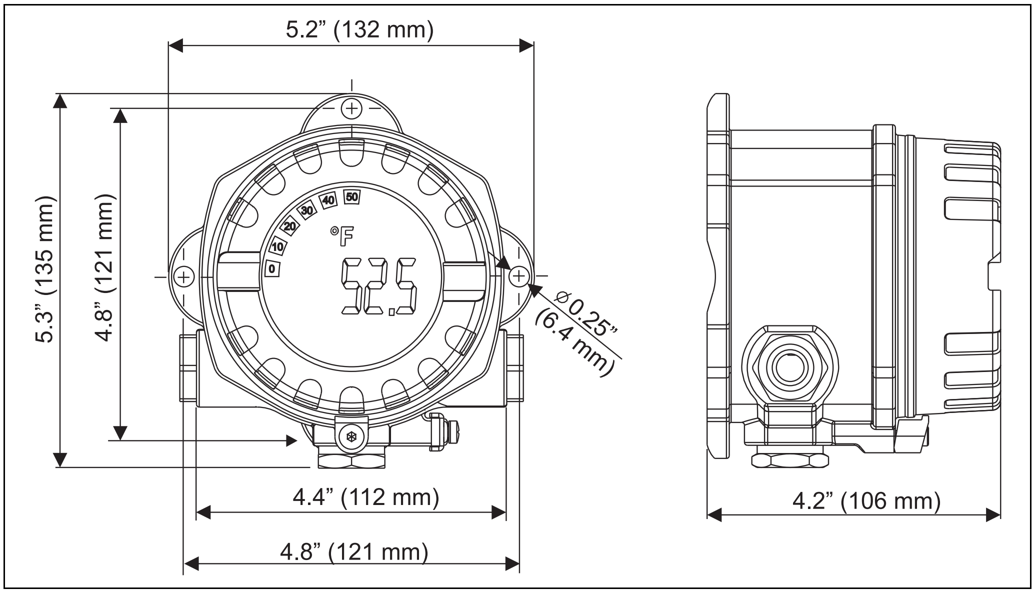


Fig. 10: Dimensions in inches (mm in brackets)

- Display rotatable in 90 stages

Weight	Approx. 1.6 kg (3.53 lb) (aluminum housing)
Material	■ Housing: die–cast aluminum housing AlSi10Mg with powder coating on polyester basis ■ Nameplate: 1.4301 (AISI 304)
Terminals	Cables / wires up to max. 2.5 mm² (AWG 13) plus ferrule

9.0.7 Certificates and approvals

CE mark	The device meets the statutory requirements of the EC directives. The manufacturer confirms successful testing of the device by affixing to it the CE mark.
Hazardous area approval	Information about currently available hazardous area versions (FM, CSA, etc.) can be supplied by your representative office on request. All explosion protection data are given in a separate documentation which is available upon request.
CSA GP	CSA General Purpose
Other standards and guidelines	■ IEC 60529: Degree of protection through housing (IP code) ■ IEC 61010: Protection measures for electrical equipment for measurement, control, regulation and laboratory procedures ■ IEC 1326: Electromagnetic compatibility (EMC requirements) ■ NAMUR: Association for Standards for Control and Regulation in the Chemical Industry

10 Appendix

10.1 The Callendar - van Dusen Method

It is a method to match sensor and transmitter to improve the accuracy of the measurement system. According to IEC 60751, the non-linearity of the platinum thermometer can be expressed as (1):

$$R_T = R_0[1 + AT + BT^2 + C(T - 100)T^3]$$

in which C is only applicable when T < 0 °C.

The coefficients A, B, and C for a standard sensor are stated in IEC 60751. If a standard sensor is not available or if a greater accuracy is required than can be obtained from the coefficients in the standard, the coefficients can be measured individually for each sensor. This can be done e.g. by determining the resistance value at a number of known temperatures and then determining the coefficients A, B, and C by regression analysis.

However, an alternative method for determination of these coefficients exists. This method is based on the measuring of 4 known temperatures:

- Measure R_0 at T_0 = 0 °C (the freezing point of water)
- Measure R_{100} at T_{100} = 100 °C (the boiling point of water)
- Measure R_h at T_h = a high temperature (e.g. the freezing point of zink, 419.53 °C)
- Measure R_l at T_l = a low temperature (e.g. the boiling point of oxygen, -182.96 °C)

Calculation of α
First the linear parameter α is determined as the normalized slope between 0 and 100 °C (2):

$$\alpha = \frac{R_{100} - R_0}{100 \bullet R_0}$$

If this rough approximation is enough, the resistance at other temperatures can be calculated as (3):

$$R_T = R_0 + R_0\alpha \bullet T$$

and the temperature as a function of the resistance value as (4):

$$T = \frac{R_T - R_0}{R_0 \bullet \alpha}$$

Calculation of δ
Callendar has established a better approximation by introducing a term of the second order, δ , into the function. The calculation of δ is based on the disparity between the actual temperature, T_h, and the temperature calculated in (4) (5):

$$\delta = \frac{T_h - \frac{RT_h - R_0}{R_0 \bullet \alpha}}{\left(\frac{T_h}{100} - 1\right)\left(\frac{T_h}{100}\right)}$$

With the introduction of δ into the equation, the resistance value for positive temperatures can be calculated with great accuracy (6):

$$R_T = R_0 + R_0\alpha\left(T + -\delta\left(\frac{T}{100} - 1\right)\left(\frac{T}{100}\right)\right)$$

Calculation of β

At negative temperatures (6) will still give a small deviation. Van Dusen therefore introduced a term of the fourth order, β , which is only applicable for T < 0 °C. The calculation of β is based on the disparity between the actual temperature, t_l, and the temperature that would result from employing only α and δ (7):

$$\beta = \frac{T_l - \left[\frac{RT_l - R_0}{R_0 \bullet \alpha} + \delta\left(\frac{T_l}{100} - 1\right)\left(\frac{T_l}{100}\right)\right]}{\left(\frac{T_l}{100} - 1\right)\left(\frac{T_l}{100}\right)^3}$$

With the introduction of both Callendar's and van Dusen's constant, the resistance value can be calculated correctly for the entire temperature range, as long as one remembers to set $\beta = 0$ for T > 0 °C (8):

$$R_T = R_0 + R_0\alpha\left[T - \delta\left(\frac{T}{100} - 1\right)\left(\frac{T}{100}\right) - \beta\left(\frac{T}{100} - 1\right)\left(\frac{T}{100}\right)^3\right]$$

Conversion to A, B and C

Equation (8) is the necessary tool for accurate temperature determination. However, seeing that the IEC 751 coefficients A, B and C are more widely used, it would be natural to convert to these coefficients.

Equation (1) can be expanded to (9):

$$R_T = R_0(1 + AT + BT^2 - 100CT^3 + CT^4)$$

and by simple coefficient comparison with equation (8) the following can be determined (10):

$$A = \alpha + \left(\frac{\alpha \bullet \delta}{100}\right)$$

(11)

$$B = \frac{\alpha \bullet \delta}{100^2}$$

(12)

$$C = \frac{\alpha \bullet \beta}{100^4}$$

The device accepts the coefficients to be specified as α, β, δ and A, B, C.

Information on the coefficients can be requested from the sensor manufacturers in question.

10.2 Polynomial RTD

With "Polynomial RTD", the sensor is defined by a polynomial ($X4*x^4+X3*x^3+X2*x^2+X1*x^1+X0$) with 5 coefficients. The physical measuring range is 10 to 400 **Ω**.
The 5 coefficients of the polynomial are calculated using the PC configuration software TransComm Light. There are two different ways of determining the polynomial:

- **The sensor-matching-calibration**
  The deviation (compared to standard RTD) of the sensor or at the complete measuring point (transmitter with connected sensor, Measured = ΔT /°C or mA) is measured at different temperatures (sampling points). By using a "weight factor" it is possible to set special focus either on the given points (the deviation on the rest of the curve can be quite high) or on the trend compared to the reference linearization (The sampling points are only reference points of an e.g. aged sensor). These sampling points lead to a new revised linearization, which is transferred to the temperature transmitters.
- **The customer specific linearization**
  The linearization is made by measured resistance or current values over the target temperature range. These sampling points lead also to a new revised linearization, which is transferred to the temperature transmitters.

10.2.1 How to use with the PC configuration software TransComm Light:

1. Select **POLYNOM RTD** in Choice-field "Sensor type".
2. Press button **LINEARIZATION** to open module SMC32.
3. Default setting is Sensor-matching-calibration which can be recognized by "ΔT/°C" in the groupbox "Measured". Alternative choice is "Ohm" or "mA" for customer specific linearization.
4. Default reference RTD linearization is Pt100. Check "Type of Sensor" if another RTD is required. With customer specific linearization it is not possible to select "Type of Sensor".
5. "Weighting" default is 50%. As described above 100% means full focus on the accuracy at the sampling points, 0% uses the sampling points as trend information for the complete curve.
6. The "sampling points" can be edited in the shown table, default points are the min and max temperature of the reference element. These values can be modified to a reduced range.
7. To see the results of the new linearization use menu **Calculate … Calculate Curve** and/or **Calculate … Show Coefficients** (Coefficients are shown in an extra form).
8. The red curve in the graph (scale on right) shows the deviation between calculated and reference curve. This graph easily shows the effect of changing the "weighting".
9. When files exist, data can also be loaded (**Data … Load**). Files made with older versions (SW < 2.0) do only supply sampling points, the extra information ("Measured", "Type of Sensor") has to be edited after loading data.
10. Storing all data in files use **Data … Save** or **Data … Save as...**.
11. For using this functionality in the transmitter please press **OK** (data will be taken over in the PC configuration software TransComm Light) and start to transmit to the device.

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pyromation inc.

Pyromation, Inc.
5211 Industrial Road
Fort Wayne, IN 46825
USA Tel: (260) 484-2580
Fax: (260) 482-6805 or (800) 837-6805

www.pyromation.com

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