Operating instructions

Series 662

Field transmitter HART®

BA01328O/09/EN/01.14
71258153

Device version
01.03

pyromation inc.

Brief overview

Using the following short form instructions you can commission your system easily and swiftly:

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Quick Setup - fast entry into the unit configuration for standard measurements	

Safety message

Instructions and procedures in the operating instructions may require special precautions to ensure the safety of the personnel performing the operations. Information that potentially raises safety issues is indicated by safety pictograms and symbols. Please refer to the safety messages before performing an operation preceded by pictograms and symbols, → 🗎 5.
Though the information provided herein is believed to be accurate, be advised that the information contained herein is NOT a guarantee of satisfactory results. Specifically, this information is neither a warranty nor guarantee, expressed or implied, regarding performance; merchantability, fitness or other matter with respect to the products; and recommendation for the use of the product / process information in conflict with any patent. Please note that the manufacturer reserves the right to change and / or improve the product design and specifications without notice.

⚠ WARNING

Failure to follow these installation guidelines could result in death or serious injury
- ▶ Make sure only qualified personnel perform the installation.

Explosions could result in death or serious injury
- ▶ Do not remove the housing cover in explosive atmospheres when the circuit is live.
- ▶ Before connecting a Model 375/475 HART® Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with instrinsically safe or non-incendive field wiring practices.
- ▶ Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- ▶ All housing covers must be fully engaged to meet explosion-proof requirements.

Process leaks could result in death or serious injury
- ▶ Do not remove the thermowell while in operation.
- ▶ Install and tighten thermowells and sensors before applying pressure.

Electrical shock could cause death or serious injury
- ▶ Use extreme caution when making contact with the leads and terminals.

Table of contents

1 Safety notes

Safe and secure operation of the field transmitter can only be guaranteed if the operating instructions and all safety notes are read, understood and followed.

1.1 Designated use

- The unit is a universal, presettable temperature field transmitter for resistance temperature detectors (RTD), thermocouple (TC) as well as resistance and voltage sensors. The unit is constructed for mounting in field applications.
- The manufacturer cannot be held responsible for damage caused by misuse of the unit.
- Separate Ex documentation is part of this operating manual, for measurement systems in hazardous areas. The installation conditions and connection values indicated in these instructions must be followed!

1.2 Installation, commissioning and operation

The unit is constructed using the most up-to-date production equipment and complies with the safety requirements of the local guidelines. The temperature transmitter is fully factory tested according to the specifications indicated on the order. However, if it is installed incorrectly or is misused, certain application dangers can occur. Installation, wiring and maintenance of the unit must only be done by trained, skilled personnel who are authorized to do so by the plant operator. This skilled staff must have read and understood these instructions and must follow them to the letter. The plant operator must make sure that the measurement system has been correctly wired to the connection schematics.

Electrical temperature sensors such as RTD's and thermocouples produce low-level signals proportional to their sensed temperature. The temperature transmitter converts the low-level sensor signal to a standard 4 to 20 mA DC signal that is relatively insensitive to lead length and electrical noise. This current signal is then transmitted to the control room via two wires.

The transmitter can be commissioned before or after installation. It may be useful to commission it on the bench, before installation, to ensure proper operation and to become familiar with its functionality. Make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices before connecting a HART® communicator in an explosive atmosphere.

The transmitter electronics module is permanently sealed within the housing, resisting moisture and corrosive damage. Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.

⚠ **WARNING**

Electrical shock

► Electrical shock could cause death or serious injury. If the sensor is installed in a high voltage environment and a fault or installation error occurs, high voltage may be present on the transmitter leads and terminals.

Temperature Effects

The transmitter will operate within specifications for ambient temperatures between –40 and +185 °F (–40 and +85 °C) without display. Heat from the process is transferred from the thermowell to the transmitter housing. If the expected process temperature is near or beyond specification limits, consider the use of additional thermowell lagging, and extension nipple, or a remote mounting configuration to isolate the transmitter from the process.

1.3 Operational safety

The measurement system fulfils the safety requirements according to EN 61010 and the EMC requirements according to EN 61326 as well as NAMUR NE 21, NE 43 and NE 89 recommendations.

NOTICE

Power supply

► The device must be powered by a 11 to 40 V DC power supply with a limited power according to NEC Class 02 (low voltage, low current) limited to 8 A and 150 VA in case of a short circuit.

Hazardous areas

When installing the unit in a hazardous area, the national safety requirements must be met. Make sure that all personnel are trained in these areas. Strict compliance with installation instructions and ratings as stated in this documentation is mandatory.

1.4 Returns

The device should be well packed, preferably in the original packaging when storing for further use or returning it for repair. Repairs must only be done by the service organization of your supplier or by trained skilled personnel.
When returning the device for repair, please add a description of both the fault and the application.

1.5 Notes on safety conventions and icons

Always refer to the safety instructions in these Operating Instructions labeled with the following 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.
	ESD - Electrostatic discharge Protect the terminals against electrostatic discharge. Failure to comply with this instruction can result in the destruction of parts or malfunction of the electronics.
A0011193	Indicates additional information, Tip

2 Identification

2.1 Unit identification

2.1.1 Nameplate

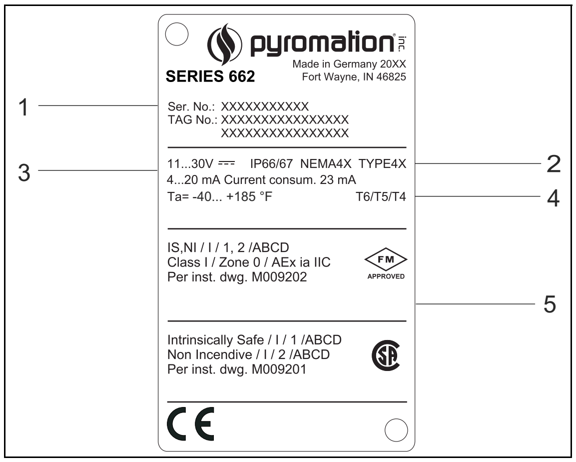


Fig. 1: Example: Field transmitter name plate

1 Product name and serial number
2 Protection class
3 Power supply and output signal
4 Ambient temperature; for hazardous area, see hazardous area certification
5 Hazardous area approvals with symbols

2.2 Delivery contents

The scope of delivery of the field transmitter is as follows:

- Temperature field transmitter
- Entry blank
- Operating instructions
- Additional documentation for devices that are suitable for use in hazardous areas ( ), such as Safety Instructions.

2.3 Certificates and approvals

CE Mark, declaration of conformity
The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which they are safe to operate. The device complies with the applicable standards and regulations in accordance with IEC 61010 "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures" and with the EMC requirements of IEC 61326. The measuring system described in these Operating Instructions complies with the statutory requirements of the EC Directives. The manufacturer confirms successful testing of the device by affixing the CE mark.

CSA GP approved

2.4 Registered trademarks

- HART®
  Registered trademarks of HART® Communication Foundation, Austin, TX, USA
- Microsoft® Windows NT®, Windows® 2000 and Windows® XP
  Registered trademarks of Microsoft Corporation, Redmond, USA

3 Installation

3.1 Quick installation guide

If the sensor is fixed then the unit can be fitted directly to the sensor. For remote mounting to a wall or stand pipe, two mounting kits are available (→ 4). The illuminated display can be mounted in four different positions (→ 2):

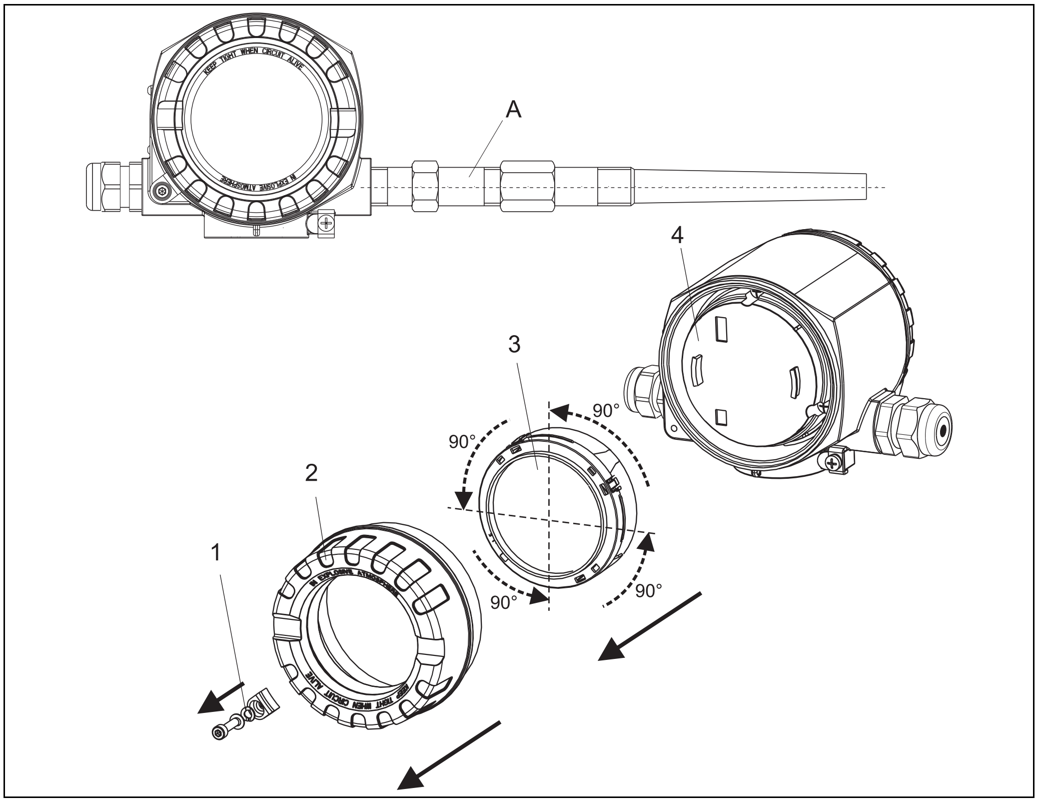


Fig. 2: Temperature field transmitter with sensor, 4 display positions, can be plugged-in in 90° steps

A: Sensor
1: Cover clamp
2: Housing cover with O-ring
3: Display with retainer and twist protection
4: Electronics compartment

1. Remove the cover clamp (1).
2. Unscrew the housing cover together with the O-ring (2).
3. Remove the display with retainer and twist protection (3) from the electronics compartment (4). Adjust the display with retainer in 90°-stages to the desired position and rearrange it on the particular slot in the electronics compartment.
4. 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 installation to a sensor

If the sensor is fixed to the process installation, the transmitter can be fitted directly to the sensor.

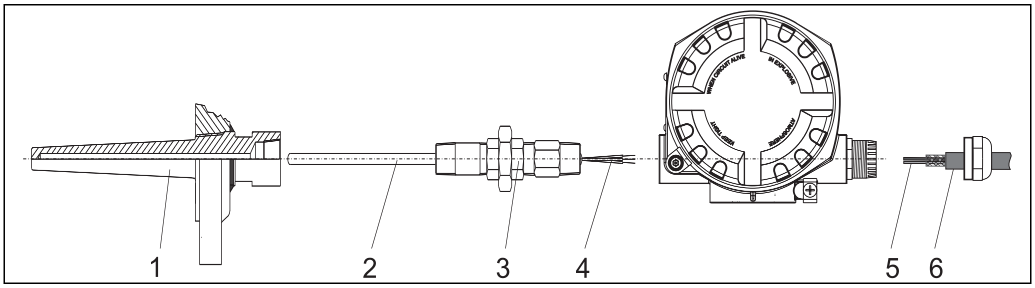


Fig. 3: Installation of the field transmitter directly to a sensor

1 Thermowell
2 Measuring inset
3 Extension nipples and adapters
4 Sensor leads
5 Field wiring leads
6 Field wiring conduit

For installation proceed as follows:

1. Install and tighten thermowell (1). Screw the measuring inset (2) into the thermowell.
2. Attach necessary extension nipples and adapters (3) to the thermowell. Seal the nipple and adapter threads with silicone tape.
3. Pull sensor leads (4) through the extensions and adapters into the terminal side of the transmitter housing.
4. Install field wiring conduit (6) to the remaining transmitter conduit entry.
5. Pull field wiring leads (5) into the terminal side of the transmitter housing.
6. Attach and tighten both transmitter covers. Both transmitter covers must be fully engaged to meet explosion-proof requirements.

3.3.2 Remote installation

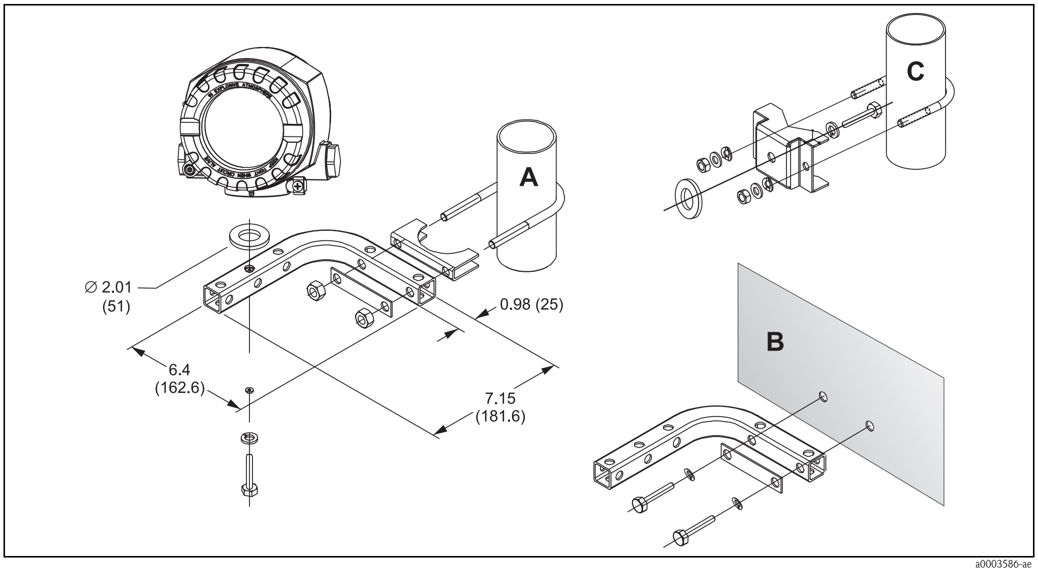


Fig. 4: Installation of the field transmitter using the mounting kit, dimensions in in (mm)

A, B Mounting with combined wall/pipe mounting kit
C Mounting with pipe mounting kit 2"/V4A

3.4 Installation check

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

Device condition and specification	Hint
Is the device visibly undamaged (visual check)?	-
Does the device comply with the measurement point specifications, such as ambient temperature, measurement range, etc.?	→ 🗎 36, section 'Technical data'
Make sure that the transmitter covers are tight. Both transmitter covers must be fully engaged to meet explosion-proof requirements.	-

4 Wiring

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.
- ► 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 these Operating Instructions. The local representative is available for assistance if required.

For wiring the device proceed as follows:

1. Open the conduit entry of the device.
2. Feed the leads through the opening in the cable gland or through the conduit entry.
3. Connect the leads as shown in Fig. 5.
4. Ensure the terminal screws are tight. Re-seal the cable gland or conduit by screwing the cover back on.
5. 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

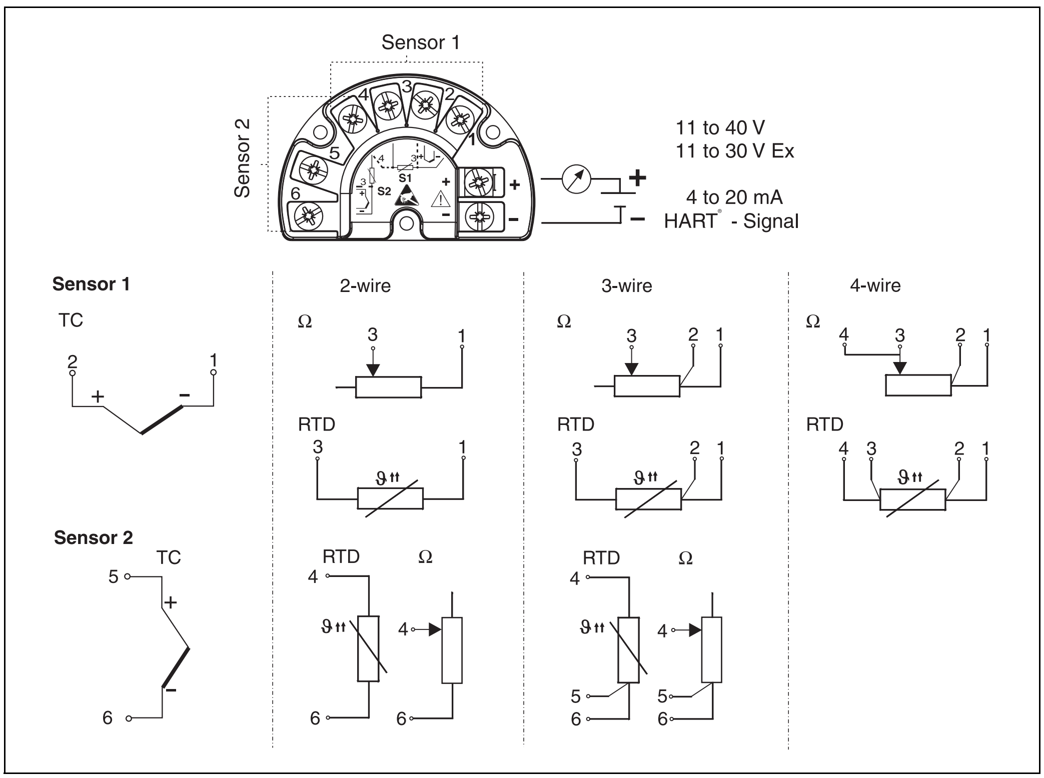


Fig. 5: Wiring the field transmitter

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

When connecting 2 sensors ensure that there is no galvanic connection between the sensors (e.g. grounded duplex thermocouples). The resulting equalizing currents distort the measurements considerably. In this situation, the sensors have to be galvanically isolated from one another by connecting each sensor separately to a field transmitter. The device provides sufficient galvanic isolation (> 2 kV AC) between the input and output.

For sensor connection terminal layout → 5. On two sensor inputs the following connection combinations are possible:

	Sensor 1: RTD 2-wire	**Sensor 1: RTD 3-wire**	**Sensor 1: RTD 4-wire**	**Sensor 1: TC connection**
Sensor 2: RTD 2-wire	Yes	Yes	No	Yes
Sensor 2: RTD 3-wire	Yes	Yes	No	Yes
Sensor 2: RTD 4-wire	No	No	No	No
Sensor 2: TC connection	Yes	Yes	Yes	Yes

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

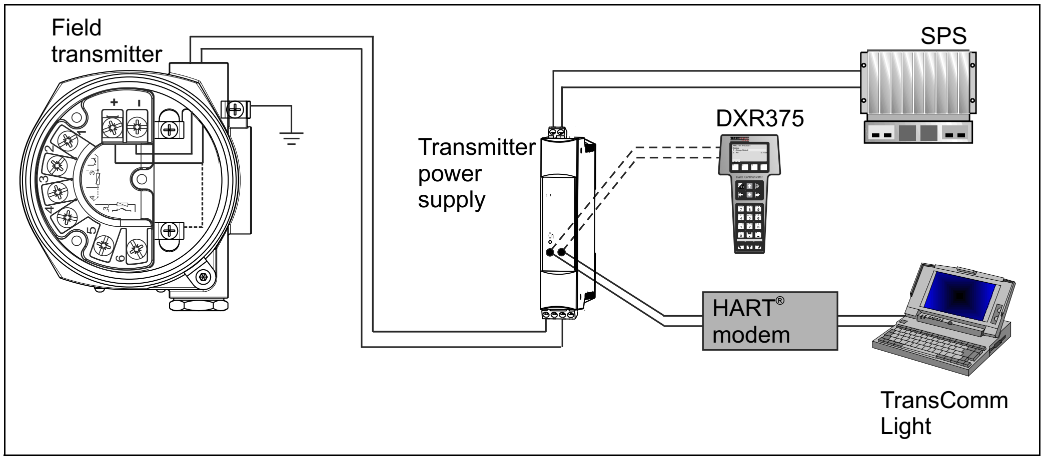


Fig. 6: HART ® connection with a transmitter power supply

Connection using other power supplies

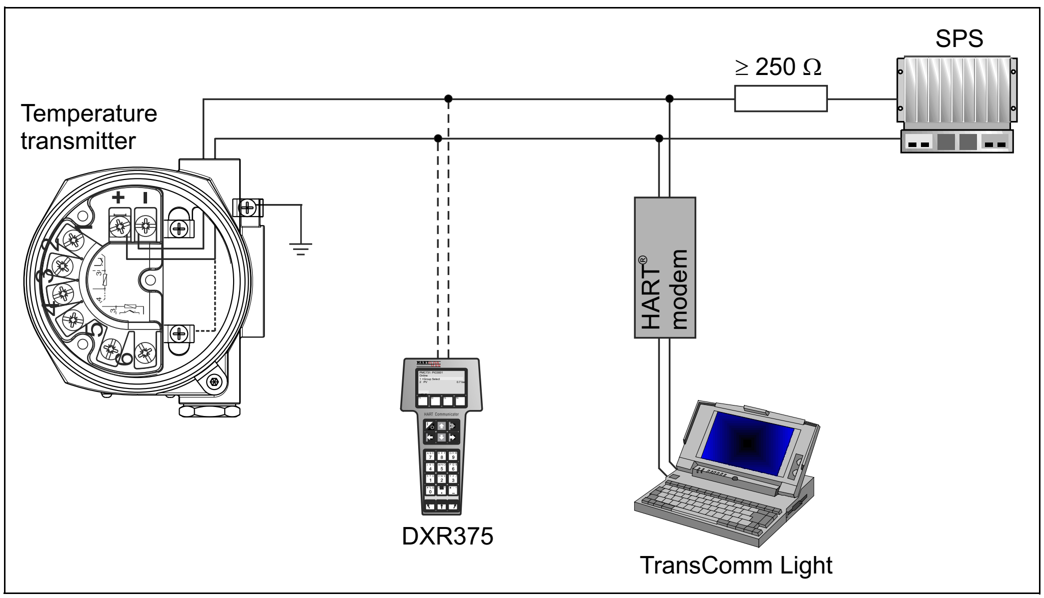


Fig. 7: HART® connection using other power supplies

4.4 Shielding and potential equalization

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

4.5 Degree of protection

The device conforms to the requirements to NEMA 4X (IP 67) ingress protection. In order to fulfil an NEMA 4X (IP 67) degree of protection after installation or service, the following points must be taken into consideration (→ 8):

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

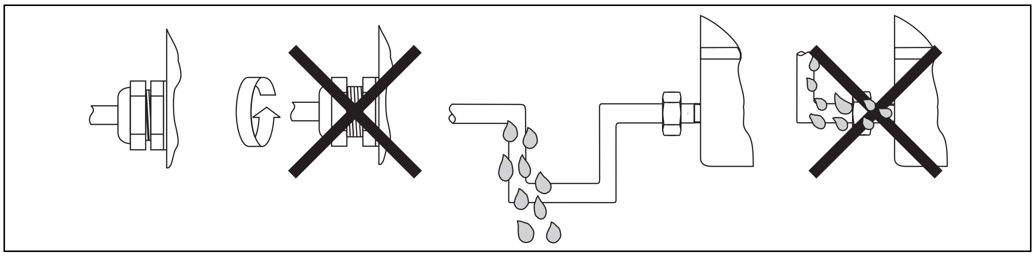


Fig. 8: Connection hints to retain NEMA 4X (IP 67) protection

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 damaged (visual check)?	-
Electrical connection	Hint
Is the cable/conduit 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 → 5.	See connection schematic on the housing
Are all terminal screws tightened? Is the cable or conduit entry sealed? Is the housing cover screwed tight?	Visual check

5 Operation

5.1 Display and operating elements

5.1.1 Display indication

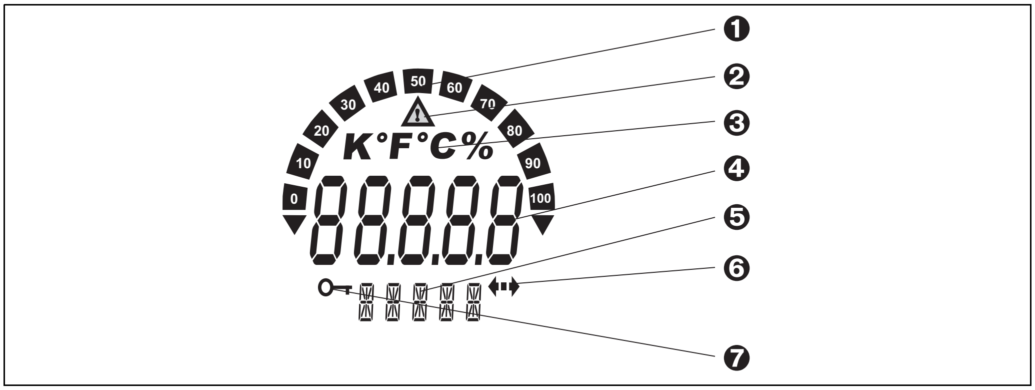


Fig. 9: LC display in the field transmitter (illuminated, can be plugged-in in 90° steps)

5.1.2 Display icons

Pos. no.	Function	Description
1	Bargraph display	In 10% steps with overrange and underrange marks. The bargraph display flashes when an error occurs.
2	Display ’Warning’	This display mode appears when an error occurs or a warning is given
3	Engineering unit display K, °F, °C or %	Engineering unit for the measured value being displayed
4	Measured value display (0.81" / 20.5 mm character size)	Measured value display. If a warning is present this display alternates between the measured value and the warning code. In the event of an error, the error code is dispalyed instead of the measured value.
5	Status and information display	Display of which value is being indicated on the display. On PV a customer specific text can be entered. On warning, the display shows the warning code as well as "WARN". On faults the display shows "ALARM".
6	Display "Communication"	The communication icon appears on read or write access using the HART® protocol
7	Display "Configuration locked"	If the software or hardware setup/configuration is locked, the "Configuration locked" icon appears.

5.2 Local operation

5.2.1 Setup of the hardware

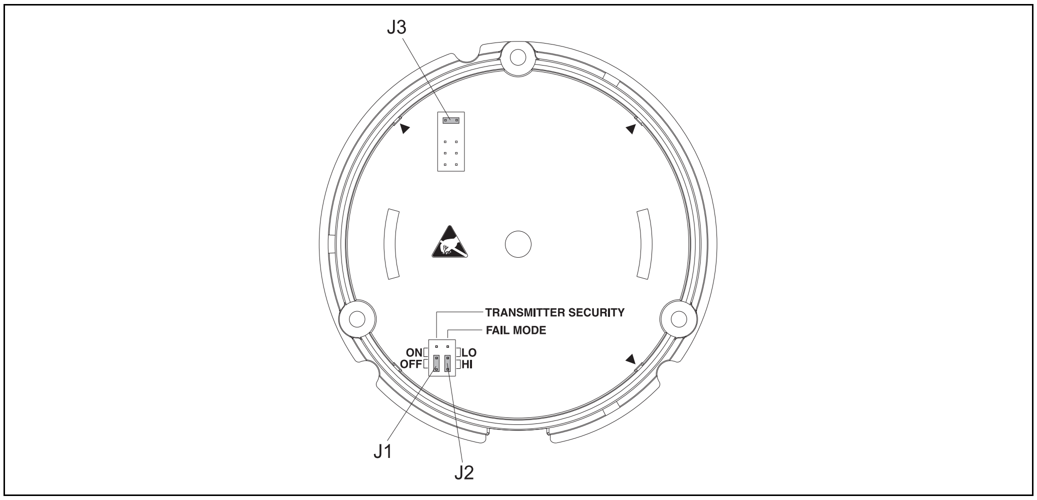


Fig. 10: Hardware setup using jumpers J1, J2 and J3

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 setup can be found in the electronic chamber. In order to set the jumper, open the electronics chamber screwed cover (opposite the connection chamber cover) and if necessary pull off the display.

Setup or configuration hardware lock using jumper J1

TRANSMITTER SECURITY	
ON	Setup/configuration locked
OFF	Setup/configuration unlocked

The hardware setup/configuration lock has priority over the software setup.

Setup hardware fault conditioning using jumper J2

FAILURE MODE	
LO	≤ 3.6 mA
HI	≥ 21.0 mA

The failure mode conditioning setup using the jumper is only active when the microcontroller fails.

Please check that the hardware and software failure mode conditioning correspond with each other.

Hardware setup using jumper J3 (only for units without display)

Using jumper 3 the minimum operating voltage can be reduced from 11 V to 8 V.

5.3 Communication using the HART® protocol

The setup 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® (→ 5 and → 6). There are a number of possible setup methods available to the user:

- Operation using the universal handheld module "HART® Communicator FC375, FC475".
- 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" following using the menu "START" ➠ "SETTINGS" ➠ "SYSTEM CONTROL" ➠ "CONNECTIONS". Using the menu string "SETTINGS" ➠ "EXPANDED" switch the command "FIFO active" off. Now restart the PC.
2. For Windows® 2000 and Windows® XP (classic category view):
   Select "Expanded settings for COM1" using the menu "START" ➠ "SETTINGS" ➠ "SYSTEM CONTROL" ➠ "SYSTEM" ➠ "HARDWARE" ➠ "UNIT MANAGER" ➠ "CONNECTIONS" (COM and LPT)' ➠ "COMMUNICATION CONNECTION(COM1)" ➠ "CONNECTION SETTINGS" ➠ "EXPANDED". Deactivate the "Use FIFO buffer". Now restart the PC.

5.3.1 HART® communicator FC375, FC475

With the HART® communicator, all device functions are selected by means of various menu levels with the aid of the function matrix (→ 12). 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 FC375, FC475" handheld module.
   – Measuring device is already connected. The 1st menu level of the device function matrix appears directly (see Fig. 11). All the functions accessible under HART® are systematically arranged in this matrix.
2. Select the function group (e.g. Sensor 1) and then the desired function, e.g. "Sensor type 1".
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.

- With the HART® handheld module, all parameters can be read and programming is disabled. However, you can enable the HART® function matrix by entering 266 in the SECURITY LOCKING function. The enable status is retained even after a power failure. Delete the release (or unlock) code 266 to lock the HART® function matrix again.
- Detailed information can be found in the HART® instruction manual in the handheld module transport pouch.

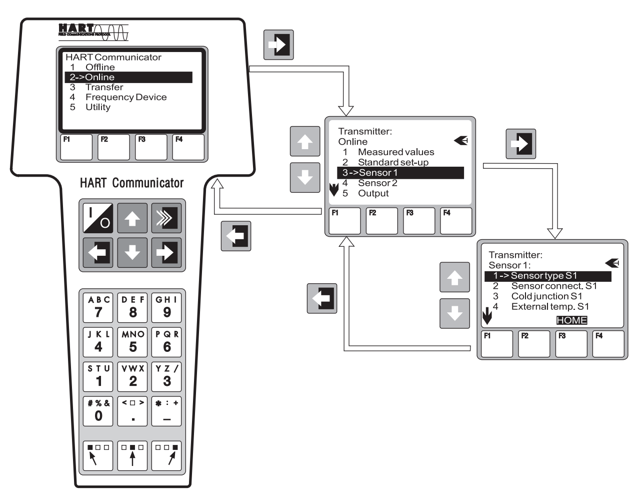


Fig. 11: Configuration at the handheld module, using 'Sensor input' as an example

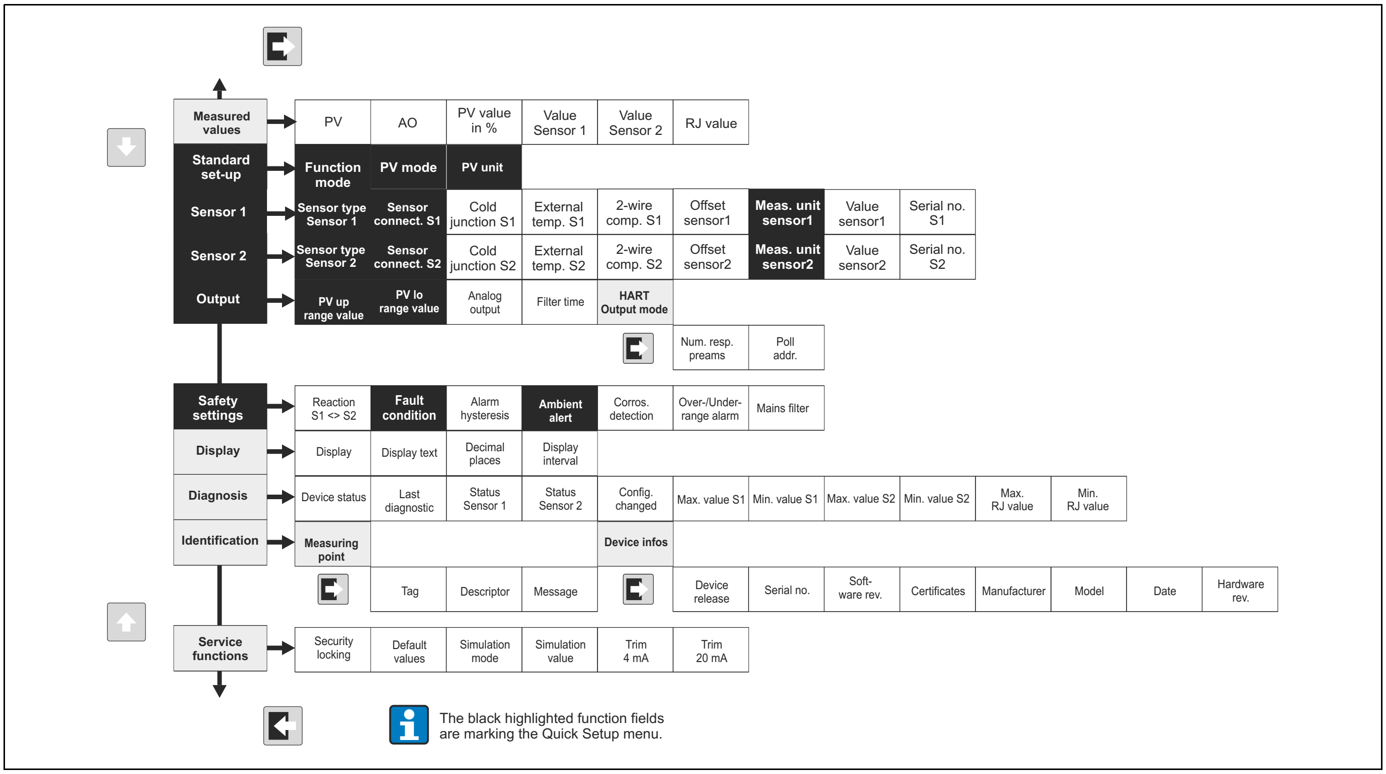


Fig. 12: HART® function matrix

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:

- Setup device functions
- Measured value visualization
- 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 on 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 programs 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 functionality:
  – Recognizing HART® devices
  – Readout 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® standardized. Such commands access, among 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”
- "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 setup		
Available in TransComm Light and HART® communicator FC375, FC475 (Symbol)	TransComm Light	
Function mode	+	+
PV mode	+	+
PV unit	+	+
Sensor 1		
Sensor type	+	+
Sensor connection	+	+
Measuring unit	+	+
Sensor 2		
Sensor type	+	+
Sensor connection	+	+
Measuring unit	+	+
Output		
PV lower range value	+	+
PV upper range value	+	+
Safety settings		
Fault condition	+	+
Ambient alert	+	+

6.4 Device configuration

6.4.1 Description of device functions

All parameters that can be read out and setup for the configuration of the temperature transmitter are listed and described in the following tables. The menu structures in the PC configuration software TransComm Light and in the HART® communicator FC375, FC475 are shown in the following tables.

Factory default setup is shown in bold text.

Function group STANDARD SETTINGS			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Function mode	Selection of device function ■ One sensor input ■ Two sensor inputs Note! Selection only active on two sensor input device.	+	+
PV mode	For selecting the calculation function of the PV (PV = primary value). The PV is shown linear at the analog output. ■ **PV = Sens1** Sensor 1 is the primary value (PV) ■ PV = Sens2 Sensor 2 is the primary value (PV) ■ PV = Sens1-Sens2 Difference ■ PV = (Sens1 + Sens2)/2 Average of sensor 1 and 2 ■ PV = Sens1 (or Sens2) backup Sensor 2 becomes PV if sensor 1 fails. An error signal is not output. If the active backup = switch to redundant sensor, the display shows the "Caution" icon, the corresponding error number (→ 31) and the text 'back'. ■ PV = Sens2 (or Sens1) backup Sensor 1 becomes PV if sensor 2 fails. ■ PV = Sens1 (Sens2, if Sens1 > T) If temperature T is overshot at sensor 1, the measuring temperature of sensor 2 becomes the PV. The system switches back to sensor 1 if the measuring temperature at sensor 1 is at least 3.6 °F (2 °C) below T. S1 or S2 appears on the display to indicate which sensor is currently active. The temperature-dependent switchover means that 2 sensors can be combined, which each have certain advantages in different temperature ranges. Note! Selection only active on "Function - Two sensor inputs".	+ + + +	+ + + +
Temperature T	Switch to sensor 2 Entry only relevant if PV mode is 'PV = Sens1 (Sens2, if Sens1 > T)' Note! Selection only active on "Function - Two sensor inputs".	+	+
PV unit	Input for PV unit Input: **°C**, F, K, R, mV or Ω Note! The setting PV unit has priority, the selection list of the sensor type is shown independently from the PV unit.	+	+

Function group SENSOR 1						
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)					**TransComm Light**	
Sensor type	**Sensor type**	**Lower range value**	**Upper range value**	**min. range**	+	+
IEC 751	**Pt100**	-328°F (-200 °C)	1562 °F (850 °C)	18 °F (10 °C)	+	+
	Pt200	-328°F (-200 °C)	1562 °F (850 °C)	18 °F (10 °C)		
JIS	Pt100	-328°F (-200 °C)	1200 °F (649 °C)	18 °F (10 °C)		
IEC 751	Pt500	-328°F (-200 °C)	482 °F (250 °C)	18 °F (10 °C)		
	Pt1000	-328°F (-200 °C)	482 °F (250 °C)	18 °F (10 °C)		
	Ni100	-76 °F (-60 °C)	482 °F (250 °C)	18 °F (10 °C)		
	Ni1000	-76 °F (-60 °C)	302 °F (150 °C)	18 °F (10 °C)		
Edison Copper Winding No. 15	Cu10	-148 °F (-100 °C)	500 °F (260 °C)	18 °F (10 °C)	+	+
SAMA	Pt100	-148 °F (-100 °C)	1292 °F (700 °C)	18 °F (10 °C)	+	+
Edison Curve No. 7	Ni120	-94 °F (-70 °C)	518 °F (270 °C)	18 °F (10 °C)	+	+
	Pt50	-328°F (-200 °C)	2012 °F (1100 °C)	18 °F (10 °C)	+	+
GOST	Pt100	-328°F (-200 °C)	1562 °F (850 °C)	18 °F (10 °C)		
	Cu50	-328°F (-200 °C)	392 °F (200 °C)	18 °F (10 °C)		
	Cu100	-328°F (-200 °C)	392 °F (200 °C)	18 °F (10 °C)		
	Polynomial RTD	-328°F (-200 °C)	1562 °F (850 °C)	18 °F (10 °C)	+	+
	Callendar - van Dusen (Pt100)	-328°F (-200 °C)	1562 °F (850 °C)	18 °F (10 °C)		
	TC Type B	32 °F (0 °C)	3308 °F (1820 °C)	900 °F (500 °C)		
	TC Type C	32 °F (0 °C)	4208 °F (2320 °C)	900 °F (500 °C)		
	TC Type D	32 °F (0 °C)	4523 °F (2495 °C)	900 °F (500 °C)		
	TC Type E	-454 °F (-270 °C)	1832 °F (1000 °C)	90 °F (50 °C)		
	TC Type J	-346 °F (-210 °C)	2192 °F (1200 °C)	90 °F (50 °C)		
	TC Type K	-454 °F (-270 °C)	2501 °F (1372 °C)	90 °F (50 °C)		
	TC Type L	-328°F (-200 °C)	1652 °F (900 °C)	90 °F (50 °C)		
	TC Type N	-454 °F (-270 °C)	2372 °F (1300 °C)	90 °F (50 °C)		
	TC Type R	-58 °F (-50 °C)	3214 °F (1768 °C)	900 °F (500 °C)		
	TC Type S	-58 °F (-50 °C)	3214 °F (1768 °C)	900 °F (500 °C)		
	TC Type T	-454 °F (-270 °C)	752 °F (400 °C)	90 °F (50 °C)		
	TC Type U	-328°F (-200 °C)	1112 °F (600 °C)	90 °F (50 °C)		
	10 to 400 Ω	10 Ω	400 Ω	10 Ω		
	10 to 2000 Ω	10 Ω	2000 Ω	100 Ω		
	-20 to 100 mV	-20 mV	100 mV	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 linearization of resistance thermometers. A detailed description of the 'Callendar-van-Dusen' method and 'Polynomial RTD' linearization 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 1 has priority, sensor 2 setup is matched to the setup of sensor 1. **Example:** Sensor 1 is set up for a 4-wire connection, sensor 2 is set up for a 3-wire connection; there is an automatic change of sensor 2 to a type K thermocouple.					

Function group SENSOR 1			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
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 thermocouple (TC) in the device function SENSOR TYPE.	+	+
External temperature	Input of the external comparison point measurement value. Input: -40.0 to 185.0 °F / -40.00 to 85.00 °C (°C, F, K) 32 °F **(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.	+	+
Offset	Input of the zero point correction (offset). Input: -18.00 to 18.00 °F (-10.00 to 10.00 °C) 32.0 °F **(0.00 °C)**	+	+
Measurement unit	Display of measurement unit. Sensor 1 unit = PV unit	+	+
Serial no. sensor	Input of the serial number of the sensor connected to this sensor input.	+	+

Function group SENSOR 2 (only on a device with 2 sensor inputs)			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Sensor type	See Function group SENSOR 1 Sensor 1 has priority, sensor 2 setup is matched to the setup of sensor 1. **Example:** Sensor 1 is set up for a 4-wire connection, sensor 2 is set up for a 3-wire connection; there is an automatic change of sensor 2 to a type K thermocouple.	+	+
Sensor connection	See Function group SENSOR 1	+	+
Cold junction	See Function group SENSOR 1	+	+
External temperature	See Function group SENSOR 1	+	+

Function group SENSOR 2 (only on a device with 2 sensor inputs)			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
2-wire compensation	See Function group SENSOR 1	+	+
Offset	See Function group SENSOR 1	+	+
Measurement unit	See Function group SENSOR 1	+	+
Serial no. sensor	See Function group SENSOR 1	+	+

<table>
<tr><th colspan="5">Function group OUTPUT</th></tr>
<tr><td colspan="3">Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)</td><td>TransComm Light</td><td></td></tr>
<tr><td>PV lower range value</td><td colspan="2">Input of 4 mA value.
Input: Limitation values see device function SENSOR TYPE 1/2.
32 °F (0 °C)</td><td>+</td><td>+</td></tr>
<tr><td>PV upper range value</td><td colspan="2">Input of 20 mA value.
Input: Limitation values see device function SENSOR TYPE 1/2.
212 °F (100 °C)</td><td>+</td><td>+</td></tr>
<tr><td>Analog output</td><td colspan="2">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</td><td>+</td><td>+</td></tr>
<tr><td>Filter</td><td colspan="2">Selection of the digital filter 1. order (filter time constant).
Input: 0 to 60 s</td><td>+</td><td>+</td></tr>
<tr><td rowspan="2">HART Output/ Multidrop</td><td>Preamble</td><td>Input: Number of response preambles: 0 to 15
5</td><td rowspan="2">-</td><td rowspan="2">+</td></tr>
<tr><td>Device address</td><td>Input: HART address of the temperature transmitters:
0 to 15
If addresses > 0, the temperature transmitter
is in Multidrop mode and the analog output is set to 4 mA. Device address is shown on the display in the Multidrop mode</td></tr>
</table>

Function group SAFETY SETTINGS			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Drift alert mode	Definition of the behavior if measured values for sensors 1 and 2 deviate from one another. Input: ■ **off** ■ Warning ■ Alarm Warning: The 'Caution' icon becomes active on the display. A warning is transmitted via the HART® protocol. Alarm: The 'Caution' icon becomes active on the display. The device switches to error signal.	+	+
Drift mode	Drift. No input necessary if the drift alert mode = off. Input: ■ **Larger** Alarm/warning if absolute amount for difference between sensor 1 - sensor 2 overshoots a defined limit value (see drift alert value). ■ Smaller Alarm/warning if absolute amount for difference between sensor 1 - sensor 2 undershoots a defined limit value (see drift alert value).	+	+
Drift alert value	No input necessary if the drift alert mode = off. Input of the limit value for the drift alert or warning. Depending on the 'Drift mode' function, the drift alert or warning is active in the event of overshoot or undershoot. Input: 0 to 999 1830.2 °F **(999 °C)**	+	+
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.	+	+
Ambient alert	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.	+	+

Function group SAFETY SETTINGS			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Corrosion detection	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. (→ 32). 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** (For North American region 60 Hz is default)	+	+

Function group DISPLAY			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Display	Activating the values to be shown on the device display: ■ Display: PV (1) ■ Display: Sensor 1 value (2) ■ Display: Sensor 2 value (4) ■ Display: RJ value (8) ■ Display Analog output value (16) ■ Display: Status (32) ■ Display: Time **2s** (0) 4s (64) 6s (128) 8s (192) ■ Display: percentage value (on/off) off (0) Primary value (PV) is displayed as a percentage. on (64)	 + + + + + + + +	 + + + + + + + +
	In order to activate the values to be shown in the device display using a HART® communicator FC375, FC475: Add (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			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Diagnostics	Display of information required for device diagnostics. ■ Device status or error code (→ 31) ■ Last error code (status) or previous error code (→ 31) ■ Status sensor 1 (0 = no error; 0 ≠ error) ■ Status sensor 2 (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 1 max. value ■ Sensor 1 min. value ■ Sensor 2 max. value ■ Sensor 2 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 **-10000**. ■ Minimum process value is changed to the actual process value on write access. On reset to factory default value the default value is entered **+10000**.	- + + + + + +	- + + + + + +

Function group IDENTIFICATION			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Measuring point Input and display of the information relating to the measuring point identification			
Measuring point TAG	Input: 8 characters	+	+
Description	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 version	Display of the software version	+	+

Function group IDENTIFICATION			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Hardware version	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 character: Pyromation, Inc.	-	+
Device type	Device type identification: Series 662	-	+
Date	Individual use of this parameter	-	+
Hardware revision	Revisions of the device's electronic components	-	+

Function group SERVICE FUNCTIONS			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
Security locking	Set-up release code. Input: ■ Lock = 0 ■ Release (unlock) = **266**	+	+
Reset to default	Reset to factory default values. Input: 662 **0**	+	+
Output simulation	Activate simulation mode. Input: ■ **OFF** ■ ON	+	+
Simulation value	Input of the simulation value (current). Input: 3.58 to 23 mA as of SW version 01.03.00. To SW version 01.03.00 21.7 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			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
PV	PV value	+	+
AO	PV value in mA	-	+

Function group MEASURED VALUES			
Available in TransComm Light, HART® communicator FC375, FC475 (Symbol)		**TransComm Light**	
PV %	PV value in %	-	+
Sensor 1	Sensor 1 process value	-	+
Sensor 2	Sensor 2 process value	-	+
Internal temperature (RJ value)	Internal temperature of the device (RJ value)	-	+

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

No.	Description	Access
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
0	Overall device status	0 x 01 reserved 0 x 02 reserved 0 x 04 reserved 0 x 08 reserved 0 x 10 reserved 0 x 20 reserved 0 x 40 global bit for a warning 0 x 80 global bit for an error
1		0 x 01 information: device starting 0 x 02 information: device in Multidrop mode 0 x 04 error: supply voltage too low 0 x 08 error: measured value range undershoot 0 x 10 error: measured value range overshoot 0 x 20 warning: sensor drift detected 0 x 40 reserved 0 x 80 reserved
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 error: EEPROM 0 x 02 error: ADC 0 x 04 error: channel 1 0 x 08 error: channel 2 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
4	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
5	Status channel 2	See channel 1
6	Extended device status	0 x 01 maintenance necessary 0 x 02 warnings / error present
7	Device operating mode	Always 0

7 Maintenance

In general, no specific maintenance is required for this device.

8 Trouble-shooting

8.1 Trouble-shooting instructions

If faults occur after commissioning or during measurement always start any fault-finding sequence using the following checklists. The user is guided to the possible fault cause and its removal by question and answer.

8.2 Error messages

Fault code	Cause	Action/Remedy	Mode[1)]
0	No fault, warning	-	-
10	Hardware fault (device defective)	Replace device	F
13	Reference measurement point defective	Replace device	F
15	EEprom defective	Replace device	F
16	A/D convertor defective	Replace device	F
17	Ambient temperature limit exceeded	Electronics possibly damaged due to exceeding the ambient temperature range, return electronics to manufacturer for check	0, F
19	Supply voltage too low	Check supply voltage; check connection wires for corrosion	F
50	Sensor 1 open circuit	Monitor sensor 1	*
51	Sensor 1 short circuit	Monitor sensor 1	*
52	Sensor 1 corrosion	Monitor sensor 1	*
53	Outside sensor range	Incorrect sensor type 1 for application	*
60	Sensor 2 open circuit	Monitor sensor 2	*
61	Sensor 2 short circuit	Monitor sensor 2	*
62	Sensor 2 corrosion	Monitor sensor 2	*
63	Outside sensor range	Incorrect sensor type 2 for application	*
70	Drift alarm	Drift limit exceeded, check sensor	F
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: Up/download active	-	C
107	Warning: Output simulation active	Deactivate output simulation	C
201	Warning: Measured value too small	PV change lower range starting point	M
202	Warning: Measured value too high	PV change upper range end point	M

Fault code	Cause	Action/Remedy	Mode[1)]
203	Warning: Ambient temperature limit exceeded	Electronics possibly damaged due to exceeding the ambient temperature range, return electronics to manufacturer for check	0
204	Drift warning	Drift limit exceeded, check sensor	M
205	Warning: Sensor backup activated	Monitor sensor	M
206	Warning: Sensor 1 corrosion	Monitor sensor 1	M
207	Warning: Sensor 2 corrosion	Monitor sensor 2	M
208	Unit reset to factory default values	-	0
209	Device initialization	-	0
+1000	Other faults active	Remove displayed faults	

1) The modes have the following meaning: F: Fault, C: Device in service mode, M: Maintenance required, S: Out of specification, *: depends on mode (F or M).

If more than one fault is active, then the fault with the highest priority will be displayed. Once this fault has been remedied the next fault is displayed! Multiple fault occurances can be recognized by an "Offset" of 1000.

Unit reaction to sensor faults

	PV = SV1 (2 Sensor inputs)	**PV = SV1 - SV2 (Differential)**	**PV = (SV1+SV2)/2 (Average value)**	**PV = SV1 (or SV2) (Sensor back-up)**
S1 defective	Fault	Fault	Fault	Warning
S2 defective	Warning	Fault	Fault	Warning
S1 and S2 defective	Fault	Fault	Fault	Fault
Drift alarm (IS1-S2I > limit value)	-	Fault	Fault	Fault
Drift warning (IS1-S2I > limit value)	-	Warning	Warning	Warning

The icon "Warning" and error code appear in the display on warnings and errors. On error, the bargraph in the display also flashes – instead of the measured value only the error code is displayed → 14.

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 preventative maintenance/trouble-shooting to be done).

- on (no warning. immediate alarm)

The following table shows the reaction of the device on sensor cable connection resistance change. These also indicate the reaction dependent on the parameter selection on/off.

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

1) Pt100 = 100 Ω at 0 °C (32 °F), Pt1000 = 1000 Ω at 0 °C (32 °F)

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

1) On very high ambient temperatures a 3 x measured value deviation from the specification is possible.

The sensor resistance can influence the resistance shown in the tables. On simultaneous increase of all sensor connection cable resistances the values indicated in the tables can be divided by two. In corrosion detection it has been assumed that this is a slow process with a continuous increase in resistance.

8.2.2 Monitoring the supply voltage

If the required supply voltage is undershot, the analog output value drops ≤ 3.6 mA for approx. 3 s. Error code 19 appears on the display. Afterwards, the device tries 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 continuously outputting an incorrect analog output value.

8.3 Application errors without messages

8.3.1 General application errors

Error	Cause	Action/Remedy
No communication	No power supply on the 2-wire circuit	Connect the cables correctly according to the connection schematic (polarity)
	250 Ω communication resistor is missing	→ 🗎 11
	Power supply too low (<10.5 V or 8 V without display with jumper J3)	Check power supply
	Defective interface cable	Check interface cable
	Defective interface	Check PC interface
	Defective device	Replace device

8.3.2 Application errors for RTD connection

Pt100/Pt500/Pt1000/Ni100

Error	Cause	Action/Remedy
Fault current (≤ 3.6 mA or ≥ 21 mA)	Defective sensor	Check sensor
	Incorrect connection of RTD	Connect cables correctly to terminal schematic
	Incorrect connection of the 2-wire cable	Connect cables correctly to terminal schematic (polarity)
	Faulty setup of the device (number of wire connections)	Change device function SENSOR CONNECTION
	Setup	Incorrect sensor type set up under device function SENSOR TYPE; correct setup to correct type
	Defective device	Replace device

Error	Cause	Action/Remedy
Measured value incorrect/ inaccurate	Faulty sensor installation	Install sensor correctly
	Heat conducted by sensor	Take note of sensor installation point
	Transmitter setup faulty (number of wires)	Change device function SENSOR CONNECTION
	Transmitter setup faulty (scale)	Change scale
	Incorrect RTD set up	Change device function SENSOR TYPE
	Sensor connection (2-wire)	Check sensor connection
	Sensor cable resistance (2-wire) not compensated	Compensate cable resistance
	Offset incorrectly set	Check offset

8.3.3 Application errors for TC connection

Error	Cause	Action/Remedy
Fault current (≤ 3.6 mA or ≥ 21 mA)	Incorrect connection of sensor	Connect cables correctly to terminal schematic (polarity)
	Defective sensor	Check sensor
	Setup	Incorrect sensor type set up under device function SENSOR TYPE; set up correct thermocouple
	Defective device	Replace device

Error	Cause	Action/Remedy
Measured value incorrect/ inaccurate	Faulty sensor installation	Install sensor correctly
	Heat conducted by sensor	Take note of sensor installation point
	Transmitter setup faulty (scale)	Change scale
	Incorrect TC setup	Change device function SENSOR TYPE
	Incorrect cold junction setup	→ 🗎 21, section "Description of device functions"
	Incorrect offset setup	Check offset

8.4 Returns

The unit should be well packed, preferably in the original packaging when storing the unit for further use or returning it for repair. Repairs must only be done by the service organization of your supplier or by trained skilled personnel.
When returning the device for repair, please add a description of both the fault and the application.

8.5 Disposal

The device contains electronic components and when being disposed of should be placed in the electronic waste. Please take note of any local waste disposal legislation when disposing of the device.

8.6 Software-/firmware history

Release software (SW)-/firmware (FW) version
The SW-/FW version 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-/FW-version, date	Operation, documentation	Modifications
01.03.ZZ, 06/2014	Compatible with: ■ HART Communicator FC375, FC475 ■ TransComm light (as of version 1.27.10.0) ■ AMS (as of version 5.0) ■ PDM (as of version 5.1)	Original firmware

9 Technical data

9.0.1 Input

Measured variable

Temperature (temperature linear transmission behavior), resistance and voltage

Measuring range

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

Type of input

Input	Designation	Measuring range limits	Min. span
Resistance thermometer (RTD) to IEC 60751 (α = 0.00385)	Pt100 Pt200 Pt500 Pt1000	-328 to 1562 °F (-200 to 850 °C) -328 to 1562 °F (-200 to 850 °C) -328 to 482 °F (-200 to 250 °C) -328 to 482 °F (-200 to 250 °C)	18 °F (10 °C) 18 °F (10 °C) 18 °F (10 °C) 18 °F (10 °C)
to JIS C1604-81 (α = 0.003916)	Pt100	-328 to 1200 °F (-200 to 649 °C)	18 °F (10 °C)
to DIN 43760 (α = 0.006180)	Ni100 Ni1000	-76 to 482 °F (-60 to 250 °C) -76 to 302 °F (-60 to 150 °C)	18 °F (10 °C) 18 °F (10 °C)
to Edison Copper Winding No. 15 (α = 0.004274)	Cu10	-148 to 500 °F (-100 to 260 °C)	18 °F (10 °C)
to Edison Curve (α = 0.006720)	Ni120	-94 to 518 °F (-70 to 270 °C)	18 °F (10 °C)
to GOST (α = 0.003911)	Pt50 Pt100	-328 to 2012 °F (-200 to 1100 °C) -328 to 1562 °F (-200 to 850 °C)	18 °F (10 °C) 18 °F (10 °C)
to GOST (α = 0.004278)	Cu50, Cu100	-328 to 392 °F (-200 to 200 °C)	18 °F (10 °C)
	Pt100 (Callendar/van Dusen)	10 bis 400 Ω 10 bis 2000 Ω	10 Ω 100 Ω
	■ Type of connection: 2-wire, 3-wire or 4-wire connection, sensor current: ≤ 0.3 mA ■ 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		
Resistance transmitter	Resistance Ω	10 to 400 Ω 10 to 2000 Ω	10 Ω 100 Ω
Thermocouples (TC) to IEC 60584 part 1	Type B (PtRh30-PtRh6)[1) 2)] 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)	32 to 3308 °F (0 to +1820 °C) -454 to 1832 °F (-270 to +1000 °C) -346 to 2192 °F (-210 to +1200 °C) -454 to 2501 °F (-270 to +1372 °C) -454 to 2372 °F (-270 to +1300 °C) -58 to 3214 °F (-50 to +1768 °C) -58 to 3214 °F (-50 to +1768 °C) -454 to 752 °F (-270 to +400 °C)	900 °F (500 °C) 90 °F (50 °C) 90 °F (50 °C) 90 °F (50 °C) 90 °F (50 °C) 900 °F (500 °C) 900 °F (500 °C) 90 °F (50 °C)
to ASTM E988	Type C (W5Re-W26Re) Type D (W3Re-W25Re)	32 to 4199 °F (0 to +2315 °C) 32 to 4199 °F (0 to +2315 °C)	900 °F (500 °C) 900 °F (500 °C)
to DIN 43710	Type L (Fe-CuNi) Type U (Cu-CuNi)	-328 to 1652 °F (-200 to +900 °C) -328 to 1112 °F (-200 to +600 °C)	90 °F (50 °C) 90 °F (50 °C)
	■ Internal cold junction (Pt100) ■ External cold junction: configurable value -40 to +85 °C (-40 to +185 °F) ■ Max. sensor resistance 10 kΩ (if sensor resistance is greater than 10 kΩ, error message as per NAMUR NE 89)[3)]		
Voltage transmitter (mV)	Millivolt transmitter (mV)	-20 to 100 mV	5 mV

1) High measuring error increase for temperature lower than 572 °F (300 °C).

2) When operating conditions are based over a large temperature range, the device offers you the ability to do a split range. For example a Type S or R thermocouple can be used for the low range and a Type B can be used for the upper range. The device is then programmed by the end user to switch at a predetermined temperature. This allows for utilization of the best performance from each individual thermocouple and provides 1 output that represents the process temperature. Note the dual sensor option must be requested when placing an order.

3) Basic requirements NE 89:
Detection of increased wire resistance (e.g. corrosion of contacts or wires) of TC or RTD/4-wire. Warning - exceeding ambient temperature.

9.0.2 Output

Output signal

Analog output	4 to 20 mA, 20 to 4 mA
Signal encoding	FSK ± 0.5 mA via current signal
Data transmission rate	1200 baud
Galvanic isolation	U = 2 kV AC (input/output)

Signal on alarm

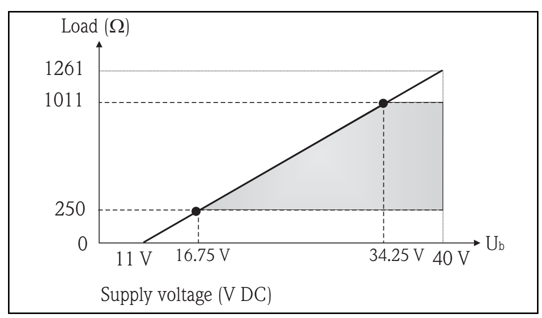
Breakdown information to NAMUR NE 43
Breakdown information is created when the measuring information is invalid or not present anymore and gives a complete listing of all errors occuring in the measuring system.

Under ranging	linear drop from 4.0 to 3.8 mA
Over ranging	linear rise from 20.0 to 20.5 mA
Failure, e. g. sensor break; sensor short circuit	≤ 3.6 mA ("low") or ≥ 21 mA ("high") can be selected[1]

1) The high alarm is adjustable between 21.6 mA and 23 mA allowing for flexibility when working with the requirements of most control systems.

Load

$R_{b\ max.} = (U_{b\ max.} - 11\ V) / 0.023\ A$ (current output)



Linearization/ transmission behavior

Temperature linear, resistance linear, voltage linear

Filter

1st order digital filter: 0 to 60 s

Current consumption

- 3.6 mA to 23 mA
- Min. current consumption ≤ 3.5 mA
- Current limit ≤ 23 mA

Protocol-specific data

Version	5
Device address in multi-drop mode	Software setting
Write lock	Write lock activated by hardware or software setting
Device description files (DD)	Information and files available free of charge online at: www.hartcom.org
Load (communication resistance)	Min. 250 Ω

Switch-on delay

4 s, during switch-on operation $I_a \leq 4.0$ 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

► The device must be powered by a 11 to 40 V DC power supply with a limited power according to NEC Class 02 (low voltage, low current) limited to 8 A and 150 VA in case of a short circuit (according to IEC 61010-1 (EN 61010-1, CSA 1010.1-92).

Residual ripple

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

9.0.4 Performance characteristics

Response time

Measured value update < 1 s per channel, depending on the type of sensor and connection method

Reference operating conditions

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

Maximum measured error

The accuracy data are typical values and correspond to a standard deviation of ± 3σ (normal distribution), i.e. 99.8% of all the measured values achieve the given values or better values.

	Designation	**Accuracy**	
		Digital	D/A[1)]
Resistance thermometer (RTD)	Cu100, Pt100, Ni100, Ni120 Pt500 Cu50, Pt50, Pt1000, Ni1000 Cu10, Pt200	0.1 °C (0.18 °F) 0.3 °C (0.54 °F) 0.2 °C (0.36 °F) 1 °C (1.8 °F)	0.02% 0.02% 0.02% 0.02%
Thermocouples (TC)	K, J, T, E, L, U N, C, D S, B, R	typ. 0.25 °C (0.45 °F) typ. 0.5 °C (0.9 °F) typ. 1.0 °C (1.8 °F)	0.02% 0.02% 0.02%
	Measuring range	**Accuracy**	
		Digital	D/A[1]
Resistance transmitter (Ω)	10 to 400 Ω 10 to 2000 Ω	± 0.04 Ω ± 0.8 Ω	0.02% 0.02%
Voltage transmitter (mV)	-20 to 100 mV	± 10 µV	0.02%

1) % relates to the set span. Accuracy = digital + D/A accuracy, for 4 to 20 mA output

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, U
-5 to 30 mV	Thermocouple type: B, R, S, T

Sensor transmitter matching

RTD sensors are one of the most linear temperature elements for measurement. However, the output still needs to be linearized. To significantly improve temperature measurement accuracy, the device allows you to utilize two methods to achieve that:

- Customer specific linearization
  Using the TransComm Light software or the HART® communicator the device can be programmed with sensor specific curve data. Once the sensor-specific data has been entered, the device utilizes this to generate a custom curve.
- Callendar - Van Dusen coefficients
  The Callendar - Van Dusen equation is described as:

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

  where A, B and C are constants, commonly referred to as Callendar - Van Dusen coefficients. The precise values of A, B and C are derived from the calibration data for the RTD, and are specific to each RTD sensor.

The process involves programming the device with curve data for a specific RTD, instead of using the standard curve.
Sensor transmitter matching using any of the above methods substantially improves the temperature measurement accuracy of the entire system. This is as a result of the transmitter using the sensor's actual resistance vs. temperature curve data instead of the ideal curve data.

Repeatability

0.0015% of the physical input range (16 Bit)
Resolution A/D conversion: 18 Bit

Influence of the supply voltage

≤ ±0.005%/V deviation from 24 V, related to the full scale value

Long-term stability

≤ 0.18 °F/year (≤ 0.1 °C/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 (see example below)

Effect on the accuracy when ambient temperature changes by 1 K (1.8 °F):	
Input 10 to 400 Ω	typ. 0.001% of measured value, min. 1 mΩ
Input 10 to 2000 Ω	typ. 0.001% of measured value, min. 10 mΩ
Input -20 to 100 mV	typ. 0.001% of measured value, min. 0.2 µV
Input -5 to 30 mV	typ. 0.001% of measured value, min. 0.2 µV
Output 4 to 20 mA	typ. 0.001% of span

Typical sensitivity of resistance thermometers:		
Pt: 0.00385 * $R_{nominal}$/K	Cu: 0.0043 * $R_{nominal}$/K	Ni: 0.00617 * $R_{nominal}$/K

Example Pt100: 0.00385 x 100 Ω/K = 0.385 Ω/K

Typical sensitivity of thermocouples:					
B: 10 µV/K at 1000 °C (1832 °F)	C: 20 µV/K at 1000 °C (1832 °F)	D: 20 µV/K at 1000 °C (1832 °F)	E: 75 µV/K at 500 °C (932 °F)	J: 55 µV/K at 500 °C (932 °F)	K: 40 µV/K at 500 °C (932 °F)
L: 55 µV/K at 500 °C (932 °F)	N: 35 µV/K at 500 °C (932 °F)	R: 12 µV/K at 1000 °C (1832 °F)	S: 12 µV/K at 1000 °C (1832 °F)	T: 50 µV/K at 100 °C (212 °F)	U: 60 µV/K at 500 °C (932 °F)

Example for calculating measured error for ambient temperature drift:

Input temperature drift $\Delta\vartheta$ = 10 K (18 °F), Pt100, measuring range 0 to 100 °C (32 to 212 °F)
Maximum process temperature: 100 °C (212 °F)
Measured resistance value: 138.5 Ω (IEC 60751) at maximum process temperature

Typical temperature drift in Ω: (0.001% of 138.5 Ω) * 10 = 0.01385 Ω
Conversion to Kelvin: 0.01385 Ω / 0.385 Ω/K = 0.04 K (0.054 °F)

Influence of the reference junction (internal cold junction)

Pt100 IEC 60751 Cl. B (internal cold junction for thermocouples TC)

9.0.5 Environment conditions

Ambient temperature limits

- Without display: -40 to +185 °F (-40 to +85 °C)
- With display: -40 to +176 °F (-40 to +80 °C)

For use in hazardous area, see hazardous area certification or control drawing

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 +212 °F (-40 to +100 °C)
- With display: -40 to +176 °F (-40 to +80 °C)

Altitude

Up to 6560 ft (2000 m) above sea level according to IEC 61010-1 (EN 61010-1), CSA 1010.1-92

Climate class

As per IEC 60 654-1, Class C

Degree of protection

Aluminum die-cast housing IP67, NEMA 4X

Shock and vibration resistance

3g / 2 to 150 Hz as per IEC 60 068-2-6

Care should be taken when using L-form brackets since this can cause resonance. Caution: vibrations at the transmitter must not exceed the specified values.

Electromagnetic compatibility (EMC)

CE Electromagnetic Compatibility Compliance
EMC meets all relevant requirements listed under EN 61326 Series and NAMUR NE21. Details as per declaration of conformity.

This recommendation is a uniform and practical way of determining whether the devices used in laboratories and process control are immune to interference with an objective to increase its functional safety.

ESD (Electrostatic discharge)	IEC 61000-4-2	6 kV cont., 8 kV air	
Electromagnetic fields	IEC 61000-4-3	0.08 to 2 GHz 0.08 to 2 GHz 2 to 2.7 GHz	10 V/m 30 V/m 1V/m
Burst (fast transient)	IEC 61000-4-4	2 kV	
Surge	IEC 61000-4-5	0.5 kV sym.	
Conducted RF	IEC 61000-4-6	0.01 to 80 MHz	10 V

Condensation

Permitted

Measuring category

Measuring category II as per IEC 61010-1. The measuring category is provided for measurements at circuits with a direct electrical connection to the low voltage supply.

Pollution degree

Pollution degree 2 as per IEC 61010-1

9.0.6 Mechanical construction

Design, dimensions

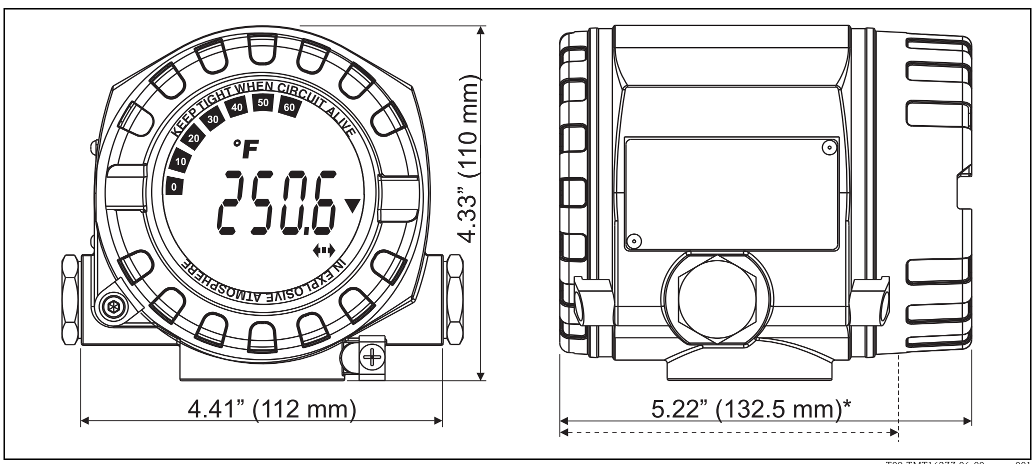


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Fig. 13: Data in inches (mm)

Die-cast aluminum housing for general purpose
**dimensions without display = 112 mm (4.41 in)*

- Separate electronics compartment and connection compartment
- Display rotatable in 90° stages

Weight

Approx. 1.4 kg (3 lbs), with display, aluminum housing

Material

Housing	Nameplate
Die-cast aluminum housing AlSi10Mg/AlSi12 with powder coating on polyester basis	Aluminum AlMgl, anodized in black

Terminals

2.5 mm^2 (12 AWG) plus wire end ferrules

9.0.7 Certificates and approvals

CE mark

The measurement system fulfils the requirements demanded by the EU regulations. The manufacturer acknowledges successful unit testing by adding the CE mark.

MTBF

147 a according to Siemens Standard SN29500

Hazardous area approval

For further details on the available Ex versions (CSA, FM, etc.), please contact your representative office on request. All explosion protection data are given in a separate documentation which is available upon request.

Other standards and guidelines

- IEC 60529:
  Degrees of protection by housing (IP-Code)
- IEC 61010:
  Safety requirements for electrical measurement, control and laboratory instrumentation.
- EN 61326-series:
  Electrical equipment for measurement, control and laboratory use - EMC requirements.
- NAMUR
  Standardization association for measurement and control in chemical and pharmaceutical industries. (www.namur.de)
- NEMA
  Standardization association for the electrical industry.

CSA GP

CSA General Purpose

Functional safety according to IEC 61508/ IEC 61511

FMEDA including SFF determination and PFD_{AVG} calculation according to IEC 61508. See also corresponding Functional Safety manual.

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 iTEMP® 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 iTEMP® 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 TransComm Light) and start to transmit to the device.

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