Thermophil® INFRAsmart
R300/R301/R302

Thermophil® INFRAht
R310/R311/R312/R320

Operating Instructions

BA 040120

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1 System description

1.1 Properties and fields of use

Properties

INFRA radiation sensors from the R 3XX series are robust, stationary measuring sensors that are used in connection with indicating devices, controllers or recording instruments for contact-free temperature measurement and temperature monitoring, control or registration.

They enable you to record surface temperatures quickly and reliably even in situations where traditional contact-based measurement is very difficult, is only possible to a limited extent or is not actually possible at all. For instance, they can be used on moving objects, materials with a poor thermal conductivity, plastic materials and aggressive substances, small components with a low thermal capacity, current-carrying elements and rails.

The radiation sensor collects the thermal radiation emitted from the measurement object and uses a lens to concentrate it on the internal infrared sensor. An optical filter restricts the sensor's spectral region.

The IR sensor transforms the collected heat energy into an electric signal, which is then processed in a microprocessor and converted into a linear current output of 4...20 mA. The influence of the ambient temperature on the measuring cell and electronics is compensated.

Sensors from the R3XX series are designed using the two-wire technique. They therefore allow measured values to be transmitted so as to be immune to interference – even over long distances – and make wiring particularly simple. Interfering measured value peaks that occur in quick succession can be suppressed by a variable attenuator.

The size of the measuring field recorded depends on the optics of the sensor concerned and on the distance between the sensor and the measurement object (see measuring field diagrams). It is possible to set the emission factor (which is important for the radiation measurement), the transmission factor and other parameters.

An interface with a HART® protocol is used to transmit the measured values from the sensor and to transmit program information to the sensor.

Fields of use

Thanks to the features mentioned, measurement sensors from the R3XX series can also be used in places where other measuring systems fail due to unfavourable ambient conditions. Examples include:
Thermoforming machines for plastics
Extruders for plastics
Calendering lines for plastic films
Coating machines
Glassworking
Metalworking
Monitoring of goods in transit on conveyor belts
Monitoring of plant overheating

1.2 Sensor versions

The radiation sensors are delivered both in a compact form, with a built-in measuring amplifier (Thermophil® INFRAsmart), and in a two-part form, with a small radiation sensor and a separate measuring amplifier (Thermophil® INFRAht). In this case, the radiation sensors and measuring amplifiers are connected using a heat-resistant cable. The measuring amplifiers available are types TR 40-10 (in a die-cast aluminium housing) and TR 41-10 (in a plastic housing, with a display and keypad).

In order to protect the sensor against dust, vapours and other environmental influences, its measurement opening is sealed with a solid disc or lens. It can be cleaned without difficulty if it is steamed up or damaged. In the case of a highly polluted atmosphere it is a good idea to use an air nozzle (see accessories), which will largely keep the measurement opening clear by continuously cleaning the air. For the event that the sensor is used at fairly high ambient temperatures, special cooling jackets with a cooling water connection are available.

Thermophil® INFRAsmart

Type R300 Sensor with cone 1.7:1, fitted measuring amplifier in IP 65 stainless steel housing

Type R301 Sensor with lens 20:1, fitted measuring amplifier in IP 65 stainless steel housing

Type R302 Sensor with lens 33:1, fitted measuring amplifier in IP 65 stainless steel housing

Thermophil® INFRAht

Type R310 Sensor with cone 1.7:1, separate measuring amplifier (TR 41-10 or TR 40-10)

Type R311 Sensor with lens 20:1, separate measuring amplifier (TR 41-10 or TR 40-10)

Type R312 Sensor with lens 33:1, separate measuring amplifier (TR 41-10 or TR 40-10)

Type R320 Sensor with cone 1.7:1, separate measuring amplifier (TR 41-10 or TR 40-10)
(Same as R 310, but has the design of the old Type R22)

1.3 Scope of delivery

- Sensor, type as ordered, including measuring amplifier
- One Operating Instructions manual
- Work inspection specification
- Accessories as ordered

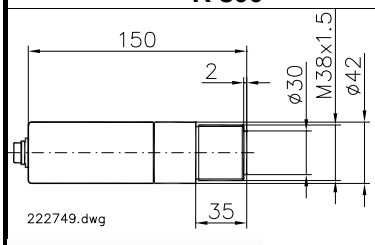
1.4 Technical data

1.4.1 Thermophil® INFRAsmart

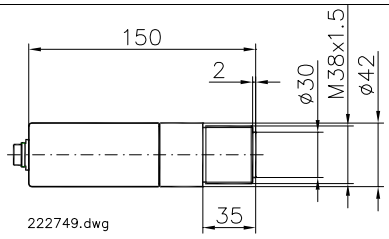
Measuring range				
Overall	max. 0...+ 400 °C with R 300			
	max. 0...+ 2000 °C with R 301/R 302			
Spectral response	8 ...14 µm; 2 ... 2,7µm; 4,9 ... 5,5µm; 7,9µm (R300 only)			
Emission factor	0.1 to 1, settable externally via the HART® interface			
Measuring field	Depending on distance (see “Distance ratio“)			
Interface	HART® protocol (FSK BELL 202, 1,2 kb/s)			
Functions configurable via HART®-Interface see page 1-6 (Transmitter)				
Output (current interface)				
Output signal	4...20 mA, linear			
Permissible load	≤ 500 Ω for standard version/UH = 24 V			
	Intrinsically safe circuit Ex ib IIC			
	max. input voltage U_i = 28 V max. input current I_i = 105 mA max. power input P_i = 1,0 W max. internal capacity C_i = 12 nF max. internal inductance L_i = 0,2 mH			
Accuracy				
Measuring accuracy	≤ 1 % of measuring range (at 23 °C and for emission factor = 1)			
Temperature sensitivity	≤ 0.03 %/C°			
Response time	t 0.9 = 0.2 s			
Ambient conditions				
Ex	Type	Ambient Temperature	Temperature Class	Max. Surface Temperature
	R30x	-20°C … +60°C	T6	T_{100} 105°C
Permissible operating temperature	0...+70 °C			
Permissible storage temperature	-10...+70 °C			
Climatic class	KSF according to DIN 40040			
Power supply				
U_H = DC 12...30 V , max. 25 mA, max. residual ripple ≤ 150 mV rms				
Connection				
4-pole plug connector, degree of protection IP 64				
Mechanical data				
Type	**R 300**	**R 301**	**R 302**	
Housing material	Stainless steel (material no. 1.4301)			
Degree of protection	IP 65			
Weight	1100 g	1100 g	1460 g	

Dimensions

R 300



R 301



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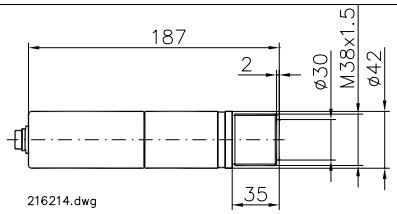
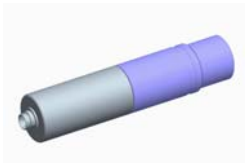
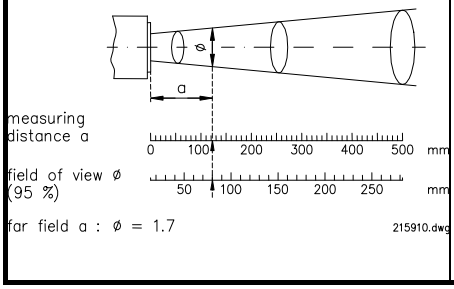




Distance ratio

R 300



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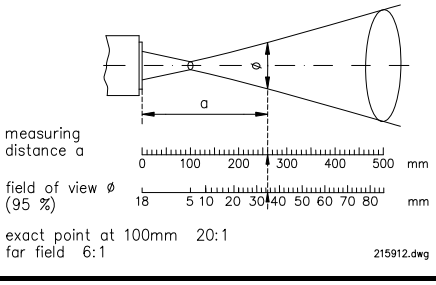

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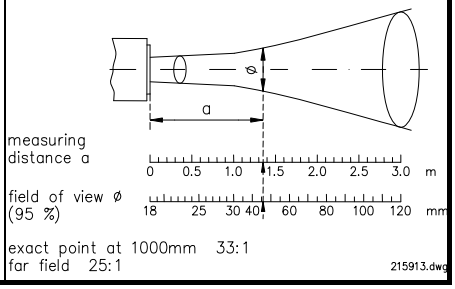
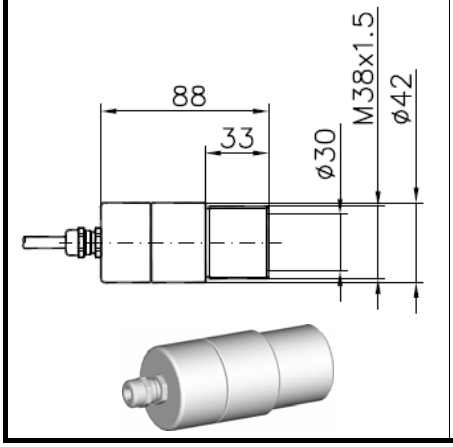
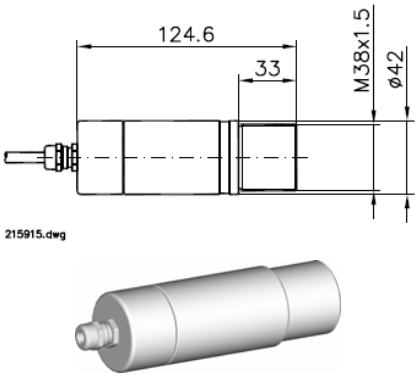
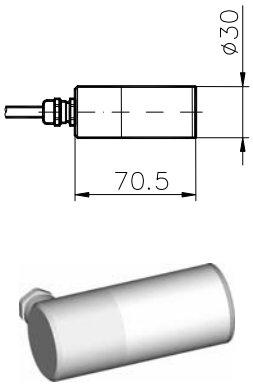


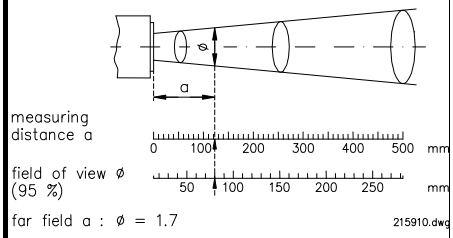
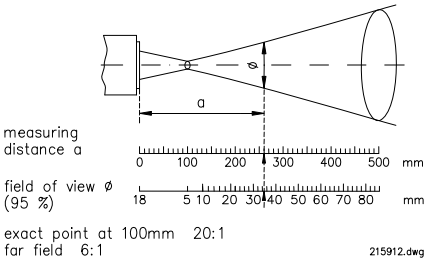
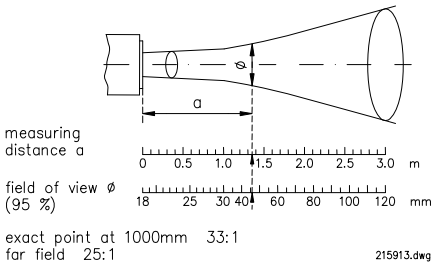
1.4.2 Thermophil® INFRAht

Sensors				
Measuring range				
Overall	max. 0...+400 °C with R 310/R 320			
	max. 0...+2000 °C with R 311/R 312			
Spectral response	8 to 14 µm; 2 ... 2.7 µm; 4.9 ... 5.5 µm; 7.9 µm (R 310/R 320 only)			
Measuring field	Depending on distance (see "Distance ratio")			
Ambient conditions				
Ex	Type	Ambient Temperature	Temperature Class	Max. Surface Temperature
	R31x, R320	-20° C…+70°C	T5	T_{100} 105°C
		-20° C…+125°C	T4	T_{100} 160°C
Permissible operating temperature	0…+ 125 °C			
Permissible storage temperature	-10…+ 125 °C			
Climatic class	KKF according to DIN 40040			
Mechanical data				
Type	**R 310**	**R 311**	**R 312**	**R 320**
Housing material	Stainless steel (material no. 1.4301)			
Degree of protection	IP 64			
Weight	925 g	925 g	980 g	520 g

Dimensions

R 310 / R311	R 312	R 320
		

Distance ratio

R 310 / R320	R 311	R 312
		

Transmitters	
Input	For R 310, R 311, R 312, R 320
	PT100 for ambient temperature (TR 41-10)
Interface	HART® protocol (FSK BELL 202, 1,2 kb/s)
Functions (configurable via HART® interface, with TR 41-10 also via keyboard)	
Unit of measurement	°C or °F
Lower/upper range limits	0…2000 °C (32…3632 °F)
Emission factor	0.1…1
Transmission factor	0.1…1
Ambient temperature alarm	20...70 or 125 °C (68...158 or 257 °F), sensor-dependent
Damping	0...999.9 s
Maximum mode	0...999.9 s
Minimum mode	0...999.9 s
Fault current	3.9...21.5 mA
Fieldbus address	0...15 (0 = point to point, 1…15 = multidrop)
HART® address	0...15 (0 = point to point, 1…15 multidrop)
Display	LC-Display (TR 41-10)
Analogue output	
Output signal	4...20 mA, linear
Permissible load	≤ 500 Ω for standard version/U_H = 24 V
Accuracy	
Measuring accuracy	≤ 1 % of measuring range (at 23 °C and for ε = 1) R 312: ≤ 1% above 50 °C object temperature, less than 50 °C ≤ 3%
Temperature sensitivity	≤ 0.03 %/C°

Response time	t 0.9 = 0.2 s (without damping)

Power supply

U_H = DC 12...30 V, max. 25 mA, residual ripple ≤ 150 mV eff.

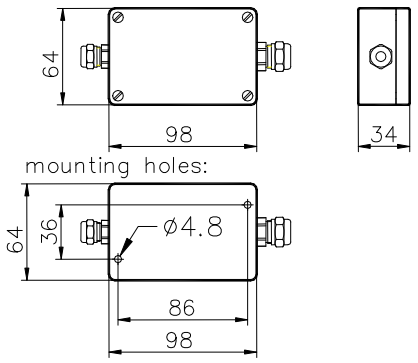
Sensor connection

Pin	*Signal*	*Colour*	*Description*
1	–	–	
2	–	–	
3	R+	rt	Thermistor
4	R–	or	Thermistor
5	U–	sw	Thermopile –
6	U+	bn	Thermopile +

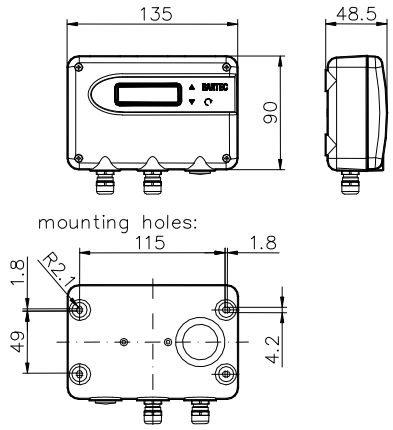
Ambient conditions		
Permissible operating temperature	0...+ 60 °C	
Permissible storage temperature	-10...+ 70 °C	
Climatic class	KSF according to DIN 40040	
Mechanical data		
Type	**TR 40-10**	**TR 41-10**
Housing material	Die-cast aluminium	Plastic
Weight	480 g	520 g
Degree of protection	IP 65	

Dimensions

TR 40-10



TR 41-10



2 Safety precautions

The equipment is produced in line with the regulations currently in force and only leaves the factory following thorough safety tests to ensure that it is in perfect condition. Please follow the instructions provided with regard to installing and operating the equipment.

2.1 General information

- Please read the operating instructions prior to installing and starting up the equipment. Should you have any questions or difficulties, please contact our service staff.
- Provide your operating and maintenance staff with detailed instructions and provide them with all the information they need.
- The equipment's internal self-monitoring systems and fault reports do not replace the safety facilities in the overall system into which the unit is integrated.
- Make sure that all regulations relating to the operation of your system are observed.
- The equipment must be installed and maintained by qualified technical personnel.
- Make sure that the data and operating conditions specified by BARTEC are observed.
- For the utilisation of the IR protection window ZnSe, please observe the safety instructions under chapter 3.3.2.

2.2 Installation location

- When installing the equipment, make sure that you observe the permissible climatic and temperature conditions in line with the technical data.
- If exceptional conditions exist at the installation location, suitable measures must be taken to protect the equipment (cover, cooling, heating). Please also look at the accessories we offer with respect to this.
- Install the equipment in a location that is not subject to vibrations.
- Do not choose a location near any equipment that generates electromagnetic fields (transformers, motors, power lines, magnets, semiconductor actuators, high-frequency generators and the like).
- The sensors should be installed in a separate location to protective circuits wherever possible.
- If, due to the local circumstances, inductive consumers such as contactors or solenoid valves are installed nearby, interference in the contactor coil should be suppressed using an RC circuit. Usually, the manufacturers of this equipment offer appropriate suppressor accessories.

2.3 Electrical connection

- Before connecting the equipment, check whether the rated voltage specified on the rating plate corresponds to that available at the installation location.
- The wiring must be carried out by trained specialists.
- Lay sensor and signal lines at a sufficient distance from live lines, in separate cable ducts wherever possible.

2.4 Operating the equipment

- Before switching on the auxiliary power, make sure that the permissible operating voltage for the equipment is not exceeded.
- For the power supply, use only a direct current voltage source with a residual ripple below a maximum of 150 mV rms.
- It is important that the sensing head does not exceed the permissible operating temperature during operation.
- During measurement operation, make sure that the radiation entrance point is kept clear. The solid disc or the lens must not be clouded by splashed water or condensed water and must not have any deposits of dirt.
- In the event of faults, first determine whether you can rectify them yourself. If this is not possible, switch off the equipment and send it to BARTEC for repair, together with a precise specification of the fault.
- If you discover any signs of damage or destruction to any parts of the equipment or if safe operation of the equipment cannot be guaranteed for any other reason, do not start up the equipment or, if already in operation, shut it down immediately. Notify the local service centre.
  Make sure that the equipment cannot be switched on again until the damage has been remedied.
- Contact our service specialists if you discover any faults or defects during operation or if you have cause to doubt whether the equipment is working properly.

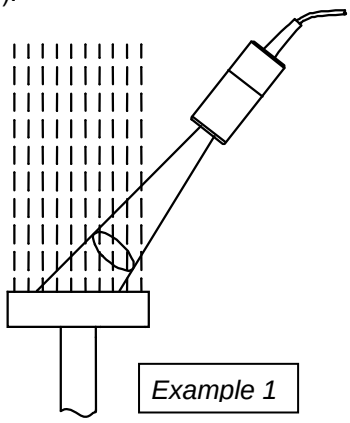
Disclaimer of liability

BARTEC GmbH and its vicarious agents only assume liability in the case of deliberate acts or gross negligence. The extent of liability in such a case is limited to the value of the order placed with BARTEC GmbH.
BARTEC accepts no liability for any damage resulting from non-observance of the safety regulations or from non-compliance with the operating instructions or operating conditions. Secondary damage is excluded from the liability.

3 Installation

3.1 Installation location

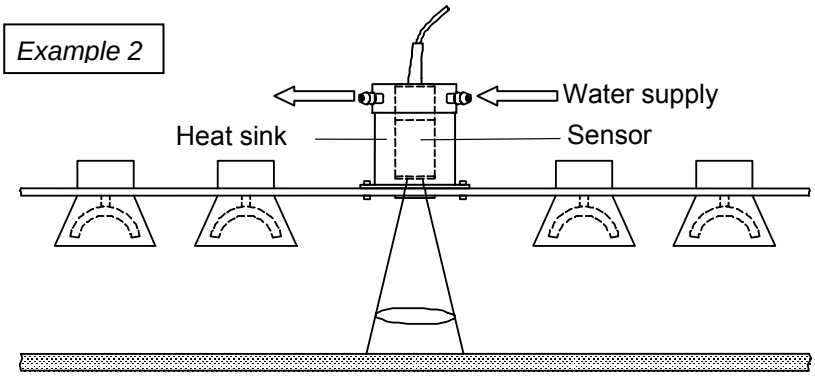
- The ambient conditions at the installation location must be within the permissible temperature and climate ranges. The corresponding data can be found in Section 1.4 Technical data.
- The installation location should be free from vibrations and free of electromagnetic interference fields. Please also refer to the notes in Section 2 with respect to this.
- When choosing an installation location, please make sure that the permissible operating temperature for the particular sensor (Sensor housing temperature) is adhered to (see 1.4).
- In the case of a fairly high ambient temperature, position the sensor in such a way that it is not exposed to heat convection from the measurement object (example 1).



Example 1

- If such an arrangement is not possible, the sensor must be operated with an additional cooling jacket (example 2). The cooling jackets are fitted with a mounting flange (see accessories).

Example 2

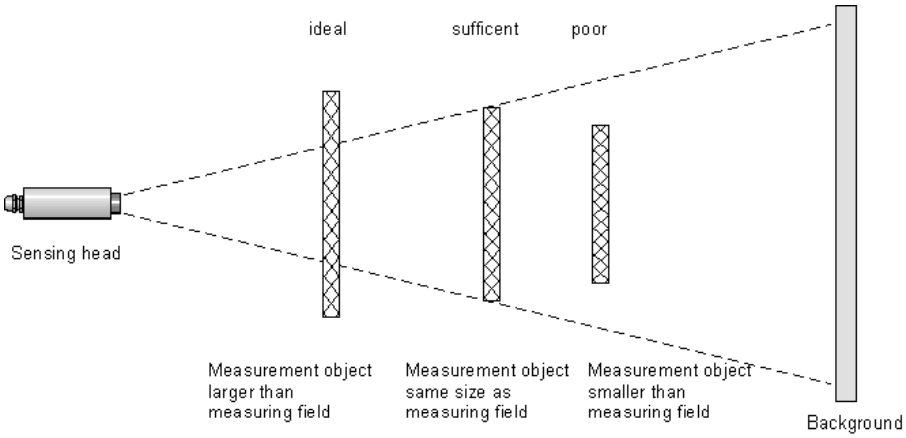


In order to prevent inadmissible heating or damage to the sensor in the event that the supply of cooling water is cut off, it is also necessary to monitor the water circulation. BARTEC offers suitable flow control instruments.

The Thermophil® INFRAht radiation sensors must be positioned in such a way that the cable between the radiation sensor and measuring amplifier is not moved during measurement.

3.2 Measurement distance

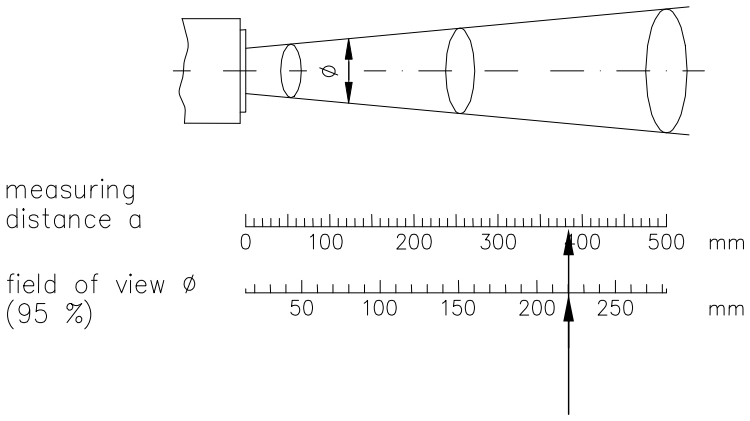
The laws of optics must be taken into account when measuring radiation. Depending on the distance between the radiation sensors and the measurement object there will be certain minimum measuring field diameters – see distance ratio (technical data).
The sensor type that is needed in each case, with the appropriate focal length, must be determined in accordance with the required measuring field size at the measurement object and the possible measurement distance. In order to avoid incorrect measurements, the measurement object must fill the entire field of view of the sensor lens. The lens field of view must therefore be no larger than the measurement object itself.



Example

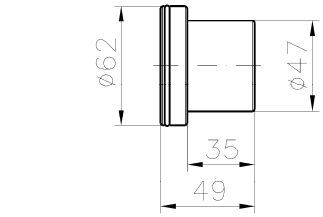
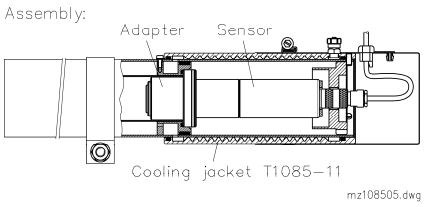
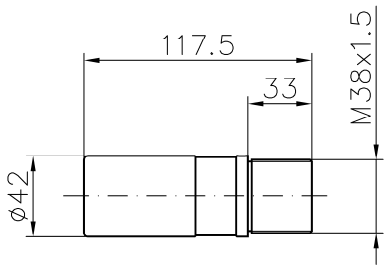
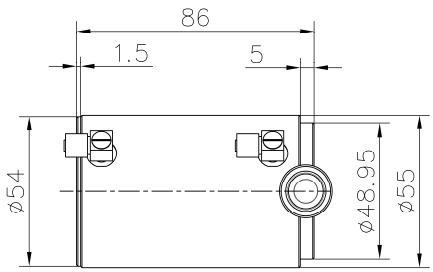
The temperature of a plastic plate with the dimensions 220 x 400 mm is to be measured using a Type R 300 radiation sensor.
At what distance must the sensor be mounted?

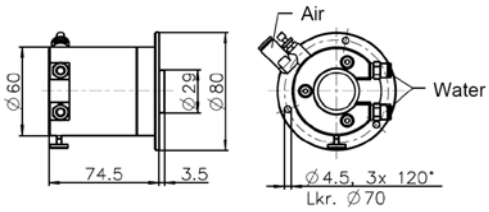
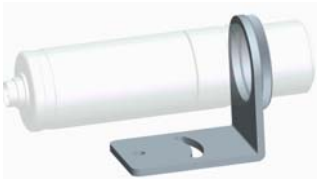
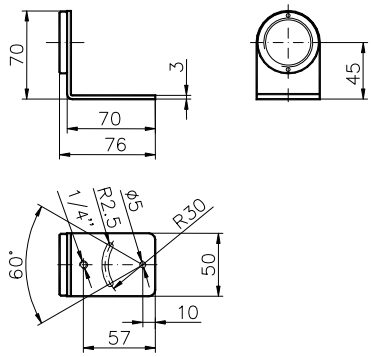
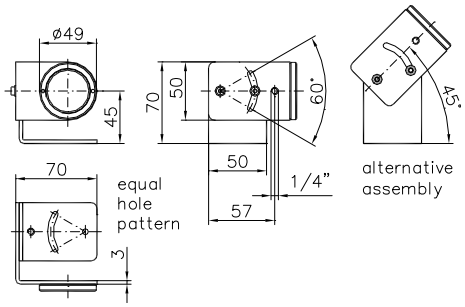
The smallest edge of the plastic plate measures 220 mm in length. For a measuring field diameter of 220 mm, the measuring field diagram for Type R 300 sensors (see also 1.4.1) gives rise to a measurement distance of approximately 380 mm.
Therefore, the distance between the sensor and the measurement object should be no more than 380 mm.

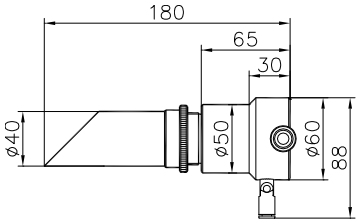
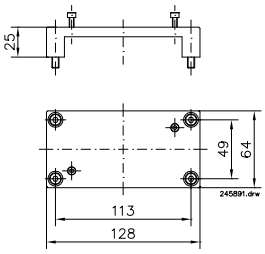
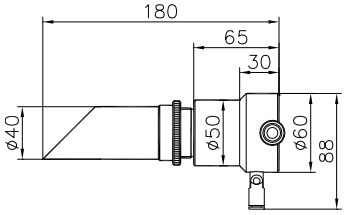
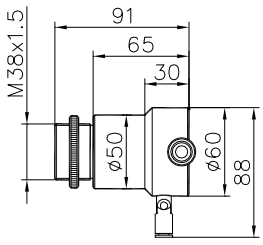
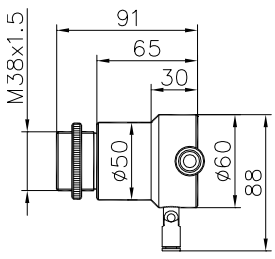


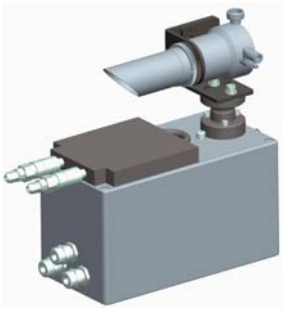
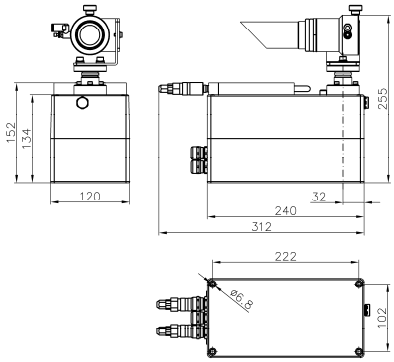
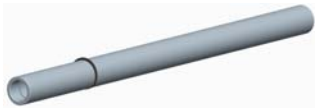
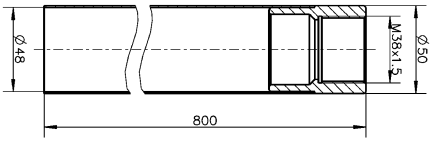
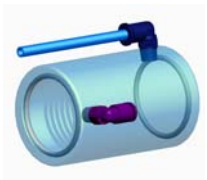
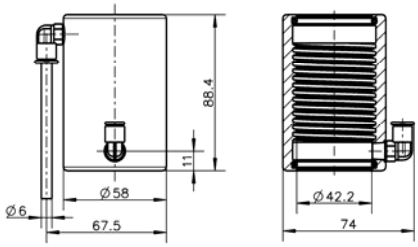
3.3 Aids, accessories

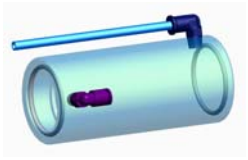
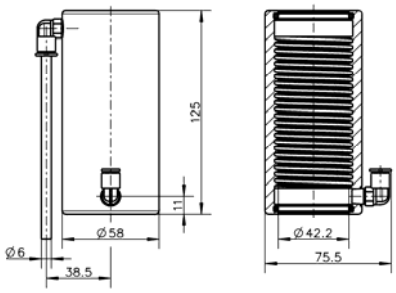
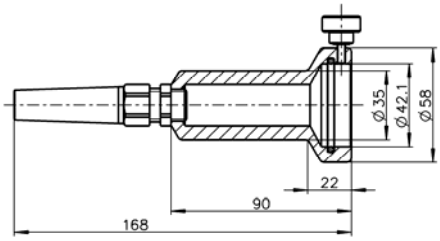
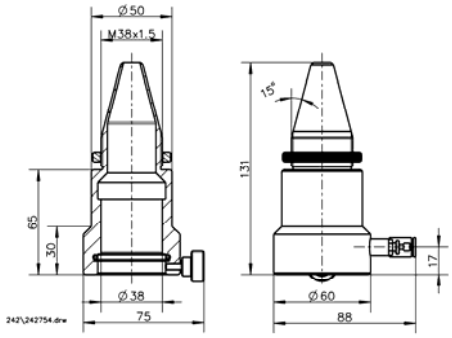
Depending on the installation conditions and the ambient conditions where the sensor is used, various installation aids and accessories can be used. The following overview lists the accessories that can be delivered. Please feel free to request assistance from BARTEC where required.

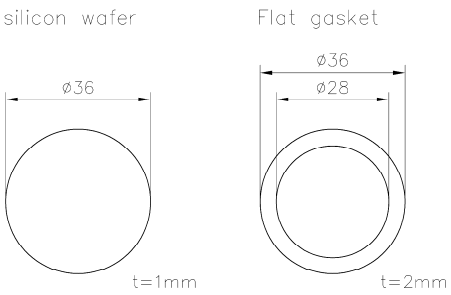
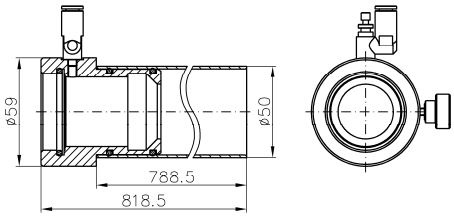
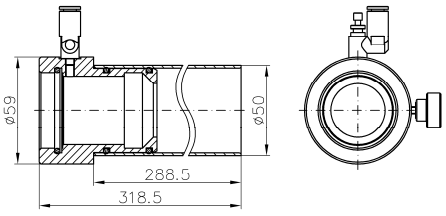
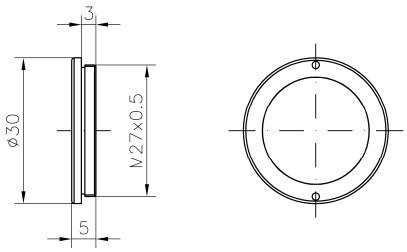
Designation	Type	Dimensions	For sensor R300	R301	R302	R310	R311	R312	R320	Order No.
Adapter replacing R20 with R302 	R 300-100	 			✓					216298
Laser pointer 	R 300-101		✓	✓	✓	✓	✓	✓		216299
Cooling jacket for pyrometer 	R 300-102		✓	✓	✓	✓	✓	✓		216711

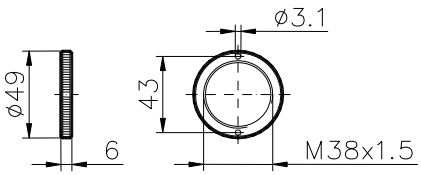
Designation	Type	Dimensions	For sensor R300	R301	R302	R310	R311	R312	R320	Order No.
Cooling jacket/air nozzle Combined, series B 	WN 268								✓	U03012268
Fixed bracket 	R 300-105		✓	✓	✓	✓	✓	✓		216975
Adjustable bracket 	R 300-106		✓	✓	✓	✓	✓	✓		216976
RS 232/HART®modem incl. software	R 300-107		✓	✓	✓	✓	✓	✓	✓	220930

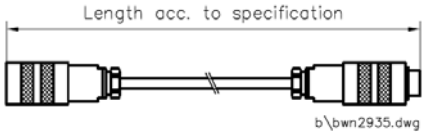
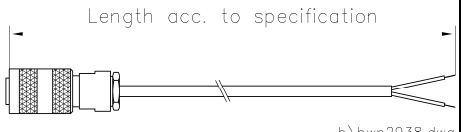
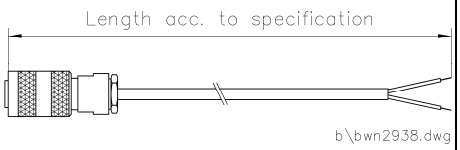
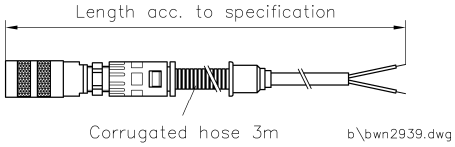
Designation	Type	Dimensions	For sensor R300	R301	R302	R310	R311	R312	R320	Order No.
Test set for testing pyrometers R30x	R300-110		✓	✓	✓					241933
Sensor bracket with air flush 	R 300-111			✓	✓		✓	✓		242754
Mounting plate for TR40-10 	R300-112					✓	✓	✓	✓	245891
Sensor bracket with air flush (plastics) 	R300-113			✓	✓		✓	✓		246173
Sensor bracket with air flush (without cable protection) 	R300-114		✓	✓	✓	✓	✓	✓		247210
Sensor bracket with air flush plastics (without cable protection) 	R300-115		✓	✓	✓	✓	✓	✓		247802

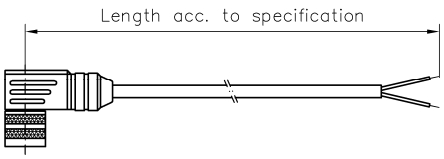
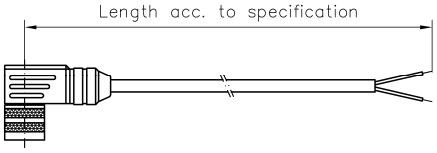
Designation	Type	Dimensions	For Sensor							Order No.
			R300	R301	R302	R310	R311	R312	R320	
Pyrometer slewing device 	R300-116				✓			✓		277319
Connecting kit for pyrometer slewing device	R300-117		R300-116							277409
Cooling water connecting kit for pyrometer	R300-132		R300-116							286185
Pyrometer protection tube (stainless steel) 	R300-118				✓			✓		277420
Cooling jacket for pyrometer 	R300-120			✓						279028

Designation	Type	Dimensions	For Sensor R300	R301	R302	R310	R311	R312	R320	Order No.
Cooling jacket for pyrometer 	R300-121				✓					279027
Protective cap for pyrometer 	R300-122		✓	✓	✓	✓	✓	✓		279030
Sensor bracket with air nozzle (aluminium) 	R300-123			✓			✓			279031
USB/HART-modem incl. software	R300-125		✓	✓	✓	✓	✓	✓	✓	281175
USB/profibus-modem incl. software	R300-126		✓	✓	✓	✓	✓	✓	✓	281176

Designation	Type	Dimensions	For Sensor R300	R301	R302	R310	R311	R312	R320	Order No.
Cleaning kit for pyrometer	R300-128		✓	✓	✓	✓	✓	✓	✓	282302
IR silicon slice with seal e.g. together with R 300-111, R 300-113	R300-129			✓	✓		✓	✓		285141
Pyrometer protection tube D = 50 mm L = 800 mm 	R300-130				✓			✓		285875
Pyrometer protection tube D = 50 mm L = 300 mm 	R300-131				✓			✓		285876
IR safety glass Zn-Se 	R300-136			✓	✓		✓	✓		301954

Designation	Type	Dimensions	For Sensor R300	R301	R302	R310	R311	R312	R320	Order No.
Mounting nut 	R 300-00-024		✓	✓	✓	✓	✓	✓		216989
Connection coupling 4-pole, (axial)			✓	✓	✓					U233085
Connection coupling 4-pole, (90°)			✓	✓	✓					U266182
Power supply unit 230 V, output 24 V DC in rail-mounting housing	5906-3		✓	✓	✓	✓	✓	✓	✓	U8901159063
Power supply unit 230 V, output 24 V DC in surface housing	5906-4		✓	✓	✓	✓	✓	✓	✓	U8901159064

Designation	Type	Dimensions	For Sensor R300	R301	R302	R310	R311	R312	R320	Order No.
Extension cable, 4 pole connector and 4 pole clip	WN 293-5		✓	✓	✓					5 m = 314166 8 m = U01110822935
Connection cable, open ends	WN 293-6		✓	✓	✓					3 m = U01110322936 6 m = U01110622936 10 m = U01191022936 15 m = 246691 20 m = 290525 30 m = 246596 40 m = 246597 50 m = 246598 60 m = 246600 70 m = 246601
Connection cable Ex, open ends	WN 293-8		✓	✓	✓					3 m = 245550 6 m = 245551 10 m = 245552 15 m = 245546 20 m = 280130 30 m = 288916 60 m = 288933 100 m = 286613
Connection cable R3x, flexible hose 3 m, open ends	WN 293-9		✓	✓	✓					6 m = 286186 10 m = 286188 15 m = 286189 30 m = 286190 40 m = 286191 50 m = 286192 60 m = 286193 70 m = 286194

Designation	Type	Dimensions	For Sensor R300	R301	R302	R310	R311	R312	R320	Order No.
Connection cable Connection coupling 90°	WN 293-10		✓	✓	✓					35 m = 294041
Connection cable Ex Connection coupling 90°	WN 293-11		✓	✓	✓					10 m = 302906 60 m = 290261

3.3.1 Safety instructions for the operation of Laserpointer type R300-101

To operate the Laserpointer type R300-101, please keep in mind the following instructions:

The beam emitted by this LASER is strongly bundled.

CAUTION! Do not look into the laser beam or at direct reflexes of reflecting or polished surfaces - not even by means of optical instruments.

The working area has to be protected by suitable protective shields which prevent the laser beam from leaving the protected area in an uncontrolled way.

After the laser beam has crossed the setting range, it has to be blocked and absorbed by means of a suitable shield.
Do NOT lead the laser beam at eye level.

Attach LASER warning signs at clearly visible locations next to all accesses to the laser working area.

CAUTION! Use of laser protective goggles is mandatory if you work with an open laser beam.

The device should only be operated by persons who know these safety instructions and are familiar with complying to them.

3.3.2 Safety instructions for the utilisation of the IR protection window Zn-Se type R300-136 (order no. 301954)

For the utilisation of the IR protection window ZnSe, observe the following basic instructions:

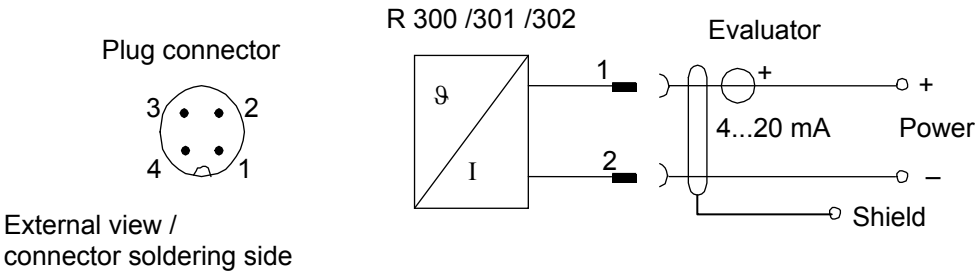
- The IR protection window contains zinc selenide (ZnSe).
- Avoid any damage to the protection window.
- Damaged filters can cause dust formation. Inhaling or swallowing dust or splints can cause intoxication. Call a doctor in case of emergency.
- For removing broken protection windows, wear gloves and in urgent cases a respiratory protection mask and protection goggles.
- Wear gloves to clean the window.
- The protection window should only be replaced by persons familiar with the safety instructions and observing them.

3.4 Connection

3.4.1 R 300, R 301, R 302

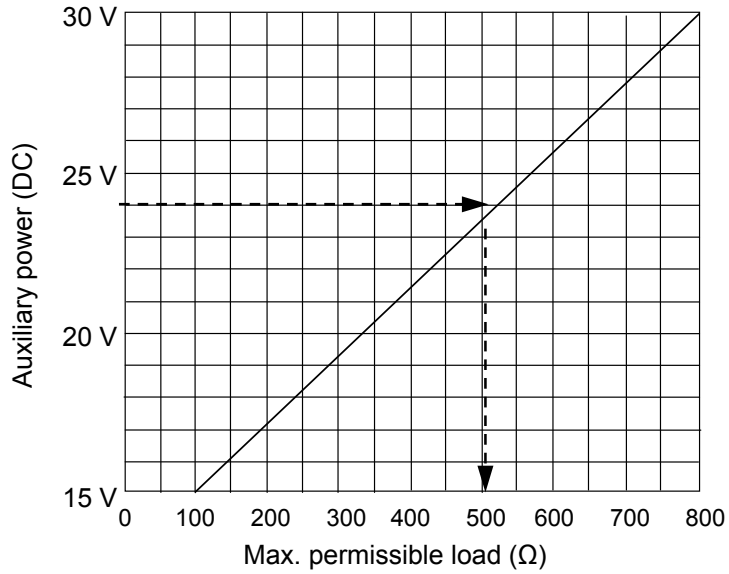
The sensors can be connected either using a 4-pole plug or using a connected cable with free ends.

3.4.1.1 Connection via plug



When connecting the sensors, make sure that the maximal permissible load at the sensor output is not exceeded.
The combined resistance of the connected units and cables must not exceed the maximum value shown in the diagram. This value depends on the auxiliary power used.

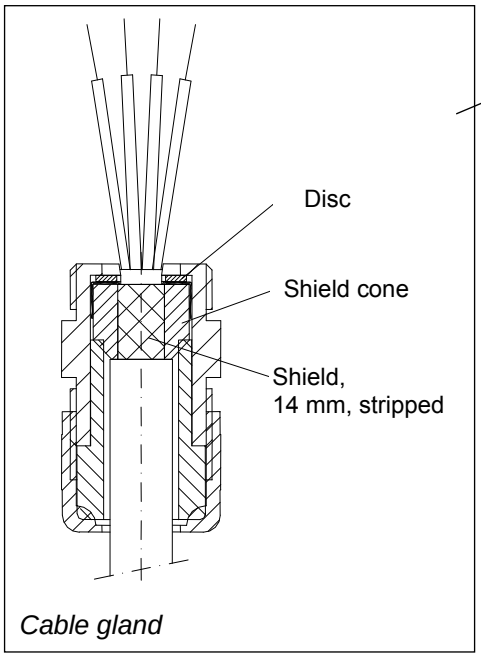
Example *At a supply voltage of 24 V d.c., the maximum permissible load is 500 Ω.*

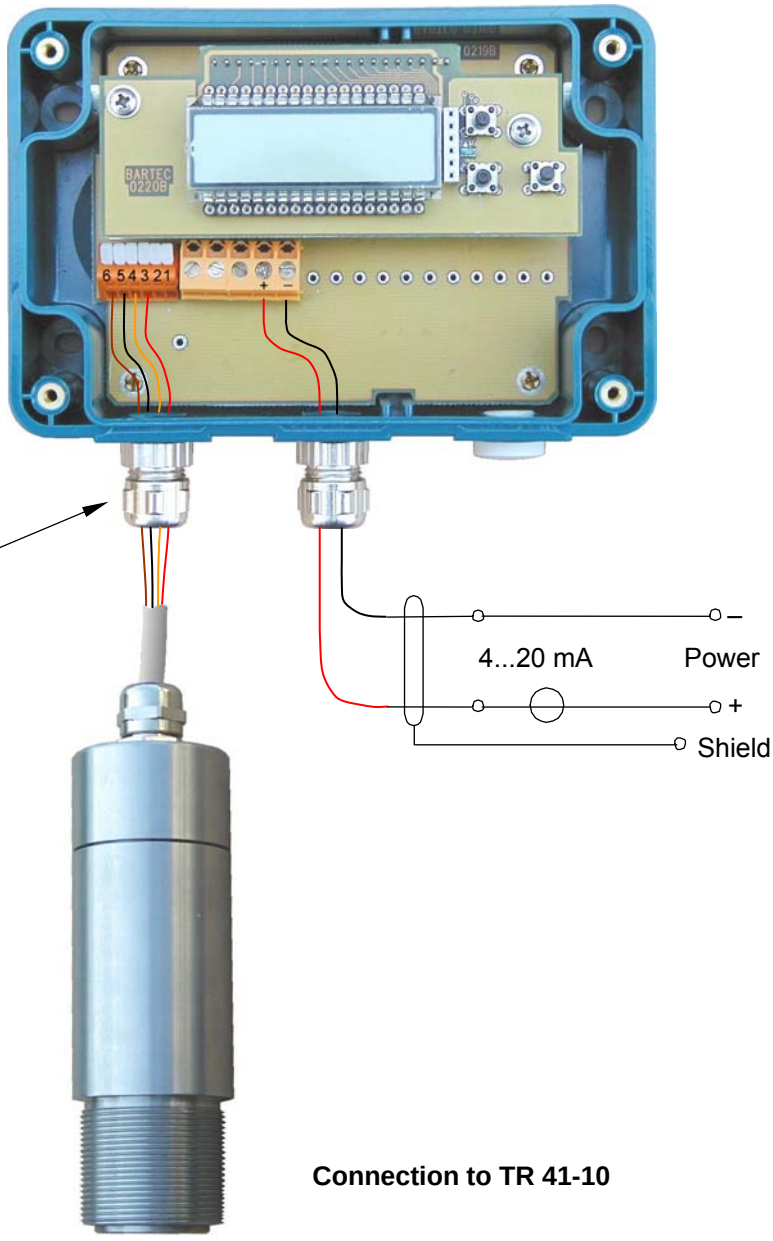


3.4.2 R 310, R311, R312, R320

The sensors are connected to the terminals of the measuring amplifier, Type TR 40-10 or TR 41-10.

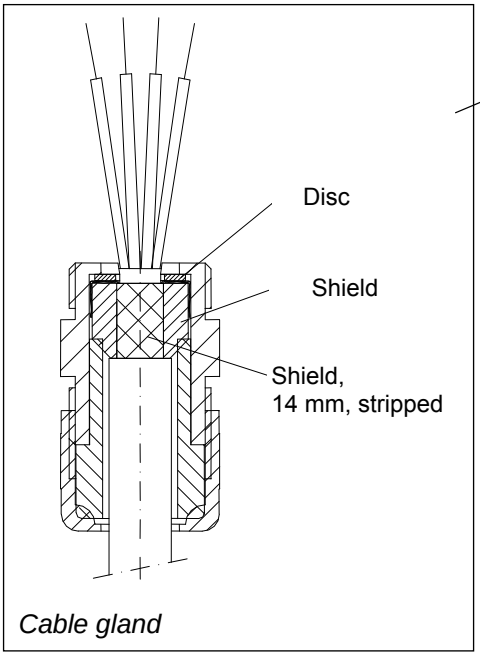
Sensor connection		
Pin	Signal	Colour
1	-	-
2	-	-
3	R+	red
4	R-	orange
5	U-	black
6	U+	brown



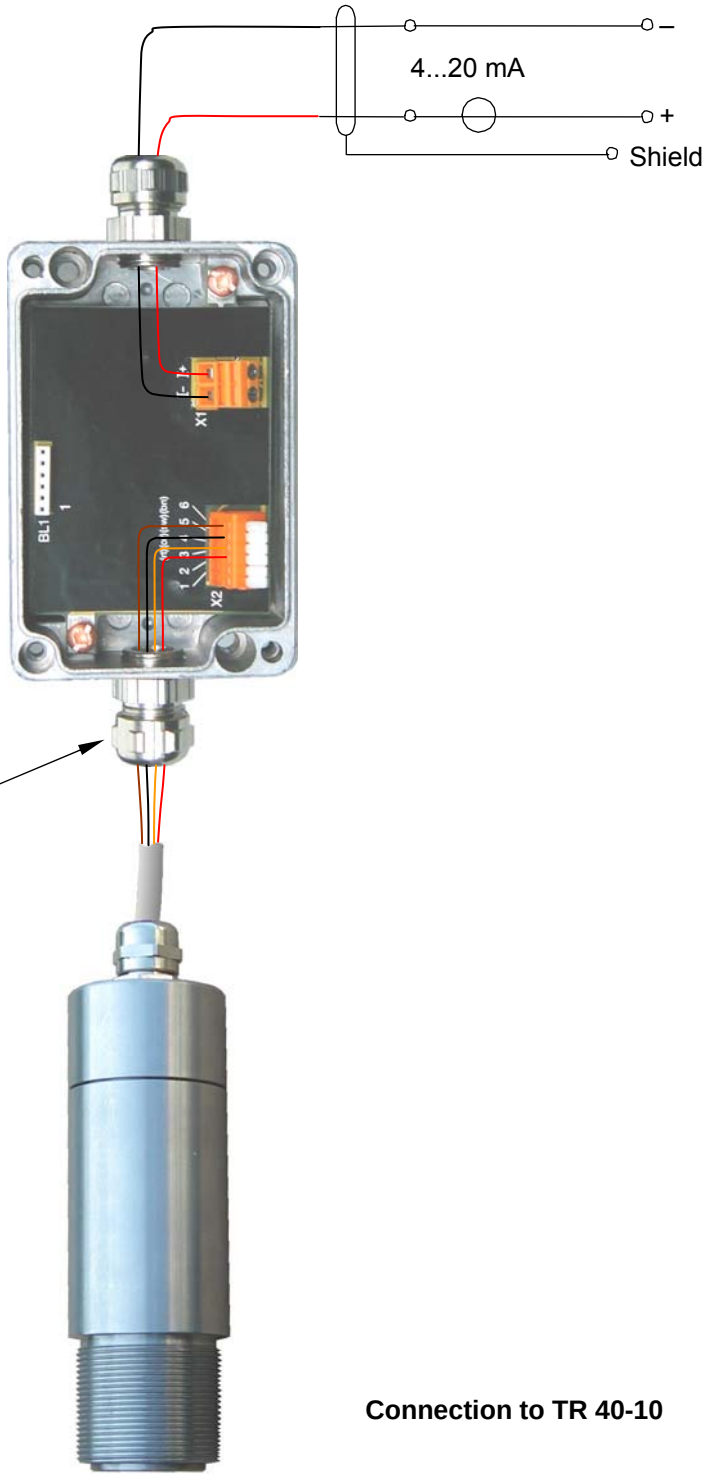


Connection to TR 41-10

Sensor connection		
Pin	Signal	Colour
1	-	-
2	-	-
3	R+	red
4	R-	orange
5	U-	black
6	U+	brown



Cable gland



Connection to TR 40-10

4 Operation

4.1 Measurement operation

Once the auxiliary power has been switched on, measurement operation can be commenced.
Further operation depends on what the sensors are being used for. Please consult the operating instructions for the connected equipment (e.g. display, recording instruments, controllers).

Please heed the following during measurement operation:

- The sensor's measurement opening must be clean. Dust deposits or moisture may falsify the measured values and must therefore be removed.
- Precision specifications are only valid for the measurement range specified on the sensor.
- The radiation sensors must not be subjected to any radiation that is far above the largest measurement range value for the series in question (approximately 30 %). It is important that the radiation sensor does not exceed the permissible operating temperature.
- Please also heed the safety precautions in Section 2.

Error messages

The following error messages can be displayed:

Above upper measurement range limit ("Messbereichsüberschreitung")

This message is displayed if the value exceeds the preset measurement range by more than 1 %.
(measurement range = upper range limit – lower range limit)

Below lower measurement range limit ("Messbereichsunterschreitung")

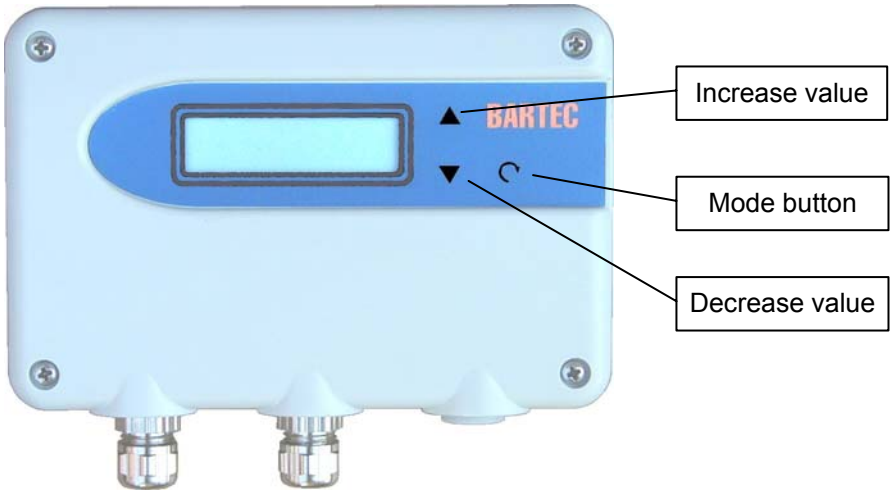
This message is displayed if the value falls short of the preset measurement range by more than 1 %.
(measurement range = upper range limit – lower range limit)

4.2 Configuration

Under various operating conditions it is necessary to select or change certain settings. Configuration is carried out using an interface with a HART® protocol.
A HART® programming device or a suitable PC software solution needs to be used in order to change parameters. The HART® commands are described in Section 7.
Sensors R 310, R 311, R 312 and R 320 can also be configured using measured value transmitter TR 41-10.

4.2.1 Configuration with transmitter TR 41-10

Sensors R 310, R 311, R 312 and R 320 can be configured using a connected transmitter, Type TR 41-10.



4.2.1.1 Configuration process

Starting configuration mode

In order to start configuration, press the mode button ↻.

Selecting parameters

Each time you press the mode button ↻, you branch to the next parameter.

Changing parameters

You can use the ▲ and ▼ buttons to increase or decrease the entered values one value at a time. You can also hold down the respective button, with the result that the value will change slowly to begin with and then speed up. The value will be saved when you proceed to the next parameter using the mode button ↻.

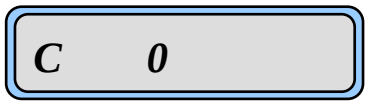
Quitting configuration mode

You quit configuration mode when you press the mode button ↻ for the final parameter. Measurement operation will be continued with the changed parameters.
If no button is pressed for around 20s during configuration mode, the system will automatically return to measurement operation. All changes made to parameters up to then will also be adopted.

4.2.1.2 Parameters

The following overview lists the configurable parameters in the order in which they appear on the display when you press the mode button ↻.

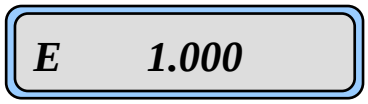
Password prompt



Before you can make any changes to the following parameters, you must enter the valid password here. The password is changed with the last parameter in configuration mode.

Display	C
Minimum value	0
Maximum value	1999
Increment	1
Default value	0

Emission factor

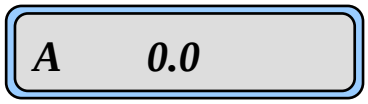


The emission factor is a measure of the ability of materials to absorb or emit infrared radiation.
The value can be between 0.1 and 1.0. A “full radiator”, for instance, has an emission factor of 1.0, whereas a mirror has an emission factor of 0.1.

An emission factor that is set too high will cause the temperature display to be too low.

Display	E
Minimum value	0.100
Maximum value	1.000
Increment	0.001
Default value	0.950

Damping



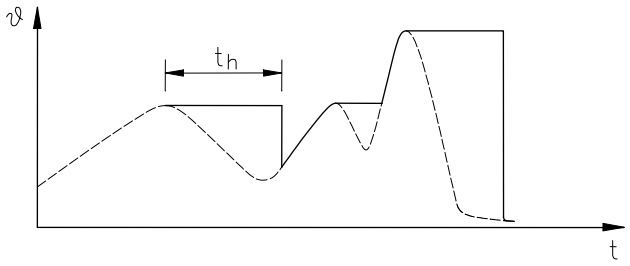
(Calculating the average)
A time over which an average is to be calculated is set here. Each temperature value that is measured is stored in the memory. Once the fixed time has passed, the system calculates the average over all values located in the memory. This damps the temperature display.
The time is set in **seconds**.

Display	A
Minimum value	0.0
Maximum value	999.9
Increment	0.1
Default value	0.3

Maximum mode

A “hold time” for maximum values is set here. The maximum value that has occurred in each case is held for the set time and output. If a new maximum value occurs during the hold time, the hold time will begin all over again.
The time is set in **seconds**.

Example



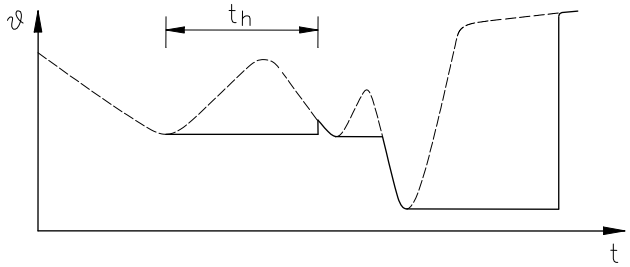
——

Display	P
Minimum value	0.0
Maximum value	999.9
Increment	0.1
Default value	0.0

Minimum mode

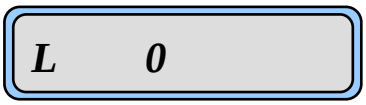
A “hold time” for minimum values is set here. The minimum value that has occurred in each case is held for the set time and output. If a new minimum value occurs during the hold time, the hold time will begin all over again.
The time is set in **seconds**.

Example



t_h Hold time
-------- Actual temperature pattern
—— Temperature pattern that is output

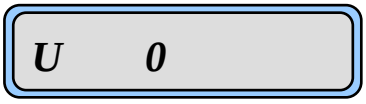
Display	M
Minimum value	0.0
Maximum value	999.9
Increment	0.1
Default value	0.0



Lower measurement range limit

This is where you set the value for the lower measurement range limit. The value defined corresponds to an output signal of 4 mA.

Display	L
Minimum value	0 (corresponds to 32 °F)
Maximum value	1250 (corresponds to 2282 °F)
Increment	1 °C (1 °F)
Default value	Corresponds to the sensor measurement range

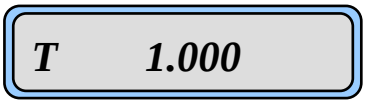


Upper measurement range limit

This is where you set the value for the upper measurement range limit. The value defined corresponds to an output signal of 20 mA.

Display	U
Minimum value	0 (corresponds to 32 °F)
Maximum value	1250 (corresponds to 2282 °F)
Increment	1 °C (1 °F)
Default value	Corresponds to the sensor measurement range

If you define the lower measurement range limit as being a temperature higher than that for the upper measurement range limit, an inverse characteristic curve will be generated for the analogue output.



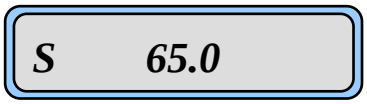
Transmission factor

The transmission factor specifies the percentage of radiation that passes an additional protective window.

Examples 1.000 = 100% transmission (no protective window)
0.800 = 80% transmission

Display	T
Minimum value	0.000
Maximum value	1.000
Increment	0.001
Default value	1.000

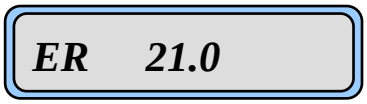
To obtain the transmission factor, please refer to the documentation for the protective window (see also page A-2).



Ambient temperature alarm

As soon as the inside temperature of the radiation sensor exceeds the defined value, the temperature display will start flashing and the analogue output will switch to the programmed state (see fault current).

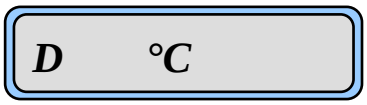
Display	S
Minimum value	20.0 (corresponds to 68 °F)
Maximum value	70.0 or 125.0 (corresponds to 158.0 or 257.0°F)
Increment	0.1 °C (0.1 °F)
Default value	Sensor-related: 65.0 or 125.0 °C (corresponds to 149.0 or 257.0 °F)



Fault current

This is where you define what current is to be output via the analogue output in the event of a fault.
The current is set in **mA**.

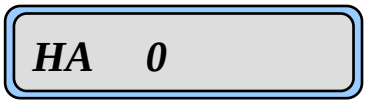
Display	ER
Minimum value	3.9
Maximum value	21.5
Increment	0.1
Default value	21.0



Unit of measurement

You can choose °C or °F as the unit of measurement for the temperature display.

Display	D
Minimum value	°C
Maximum value	°F
Default value	°C

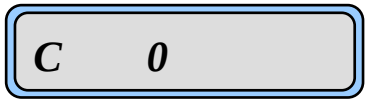


HART® address

You can operate up to 15 transmitters in parallel (multidrop mode). Each sensor (transmitter) then requires an individual address between 1 and 15.
The address must be set to 0 if you want to operate the transmitter in standalone operation (point-to-point operation).

Display	HA
Minimum value	0
Maximum value	15
Increment	1
Default value	0

Changing the password



Once you have started configuration mode and entered the valid password, this menu for changing the password will appear.

Display	C
Minimum value	0
Maximum value	1999
Increment	1
Default value	Current password

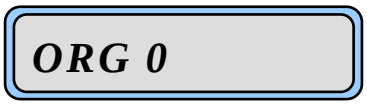
4.2.1.3 Default values

You can reset the equipment to the factory settings and delete the password.

Starting default value mode

Keep the ▲ button pressed down and additionally press the ↻ button for at least 2 seconds. Then let go of the two buttons. The display should then appear as in the screenshot on the left.

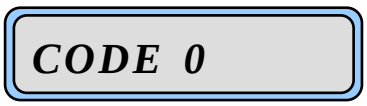
Setting default values



After starting default value mode, press the ↻ button. The display will then appear as in the screenshot on the left.
You can use the ▲ and ▼ buttons to increase or decrease the value displayed.
Set one of the following values:
32 → The factory settings will be used until the equipment is switched off.
34 → The factory settings will be used permanently.

Display	ORG
Minimum value	0
Maximum value	99
Increment	1
Default value	0

Deleting the password



After starting default value mode, press the ↻ button twice. The display will then appear as in the screenshot on the left.
You can use the ▲ and ▼ buttons to increase or decrease the value displayed.
Set the following value:
32 → The user password (code) will be set to 0.

Display	CODE
Minimum value	0
Maximum value	99
Increment	1
Default value	0

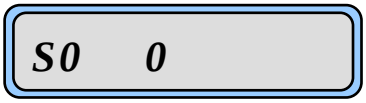
4.2.1.4 Configuration of the sensor data (not implemented)

After you have exchanged a sensor you need to enter the associated configuration data. You can find the data in the relevant sensor documentation.
Before you can enter values you must first enter the valid password (see Section 4.2.1.2, Password prompt).

Starting sensor configuration

Keep the ▲ and ▼ buttons pressed down and additionally press the ↻ button for at least 2 seconds. Then let go of the ↻ first. The display should then appear as in the screenshot on the left.

Selecting a service register



Each time you press the mode button ↻, you branch to the next service register. The service register in question will appear on the display (S0…S9).

Changing parameters

You can use the ▲ and ▼ buttons to increase or decrease the entered values one value at a time. You can also hold down the respective button, with the result that the value will change slowly to begin with and then speed up. The value will be saved when you proceed to the next register using the mode button ↻.

Quitting sensor configuration

You quit sensor configuration when you press the mode button ↻ for the final service register – assuming that no error message is displayed (see page 4-10).
If no button is pressed for around 20s during sensor configuration, the system will automatically end configuration and return to measurement operation.

Meaning of the service registers

Service register 0

Display	S0
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Configuration word

Service register 1

Display	S1
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Thermistor offset

Service register 2

Display	S2
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Thermistor gradient

Service register 3

Display	S3
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Used

Service register 4

Display	S4
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Cell gradient (part 1)

Service register 5

Display	S5
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Cell gradient (part 2)

Service register 6

Display	S6
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Used

Service register 7

Display	S7
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Used

Service register 8

Display	S8
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Reserve

Service register 9

Display	S9
Minimum value	0
Maximum value	65535
Increment	1
Default value	0
Meaning	Checksum

Error messages

If any errors have occurred, they will be displayed once you have left the last service register (S9). Pressing the mode button ↻ takes you back to the beginning of the menu (S0). If a checksum error has occurred, you can make any necessary corrections in the service registers.
If an error is reported, you can only quit the sensor configuration by not pressing any button for around 20 seconds or by switching off the unit.
The following messages may be output:

Incorrect checksum — Check the settings in the service registers and change them as appropriate.

EEPROM access incorrect — Please contact your service centre.

4.2.1.5 Test mode

In test mode, you can test downstream equipment by outputting defined current values.

Starting test mode

Keep the ▼ button pressed down and additionally press the ↻ button for at least 2 seconds. Then let go of the two buttons. The display should then appear as in the screenshot on the left.

Selecting a test

Each time you press the mode button [↻], you branch to the next test. The test in question will appear on the display (T1…T3).

Quitting test mode

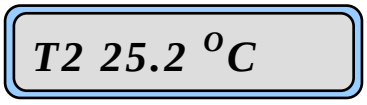
You quit test mode when you press the mode button [↻] for the final test (T3).
If no button is pressed for around 20s during test mode, the system will automatically quit the mode and return to measurement operation.

Outputting current test values

After starting test value mode, press the [↻] button. The display will then appear as in the screenshot on the left.
You can use the ▲ and ▼ buttons to select the current value to be output.
You can set the following values:

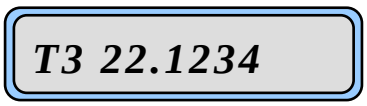
Display	Test value
T 1 I-OUT	Current measured value
T 1 4 MA	4 mA
T 1 5 MA	5 mA
T 1 10 MA	10 mA
T 1 12 MA	12 mA
T 1 16 MA	16 mA
T 1 20 MA	20 mA
T 1 21 MA	21 mA

Displaying the infrared sensor temperature



After starting test value mode, press the [↻] button twice. The display will then appear something like in the screenshot on the left (example).
The last temperature determined will be displayed in °C.

Displaying the infrared sensor voltage



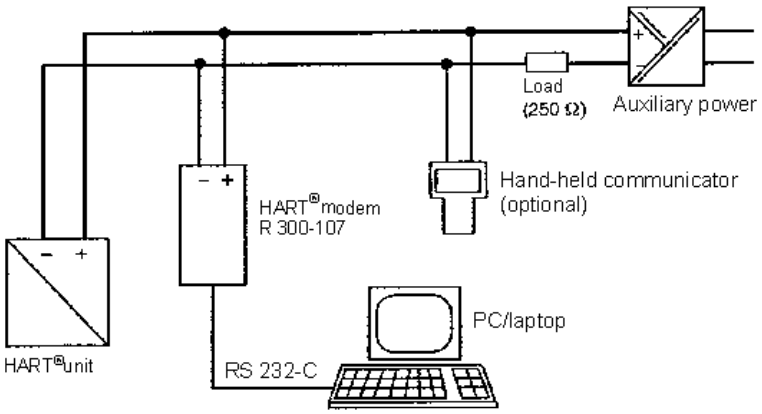
After starting test value mode, press the [↻] button three times. The display will then appear something like in the screenshot on the left (example).
The last voltage determined will be displayed in mV (temperature-compensated value).

4.2.2 Configuration with the HART® modem, Type R 300-107

In the case of radiation sensors not operated with a transmitter that has a display, configuration is carried out using the R 300-107 HART® modem and a PC software solution that is delivered with the modem.

4.2.2.1 Connecting the HART® modem

Connect the modem as described in the documentation provided (see diagram).

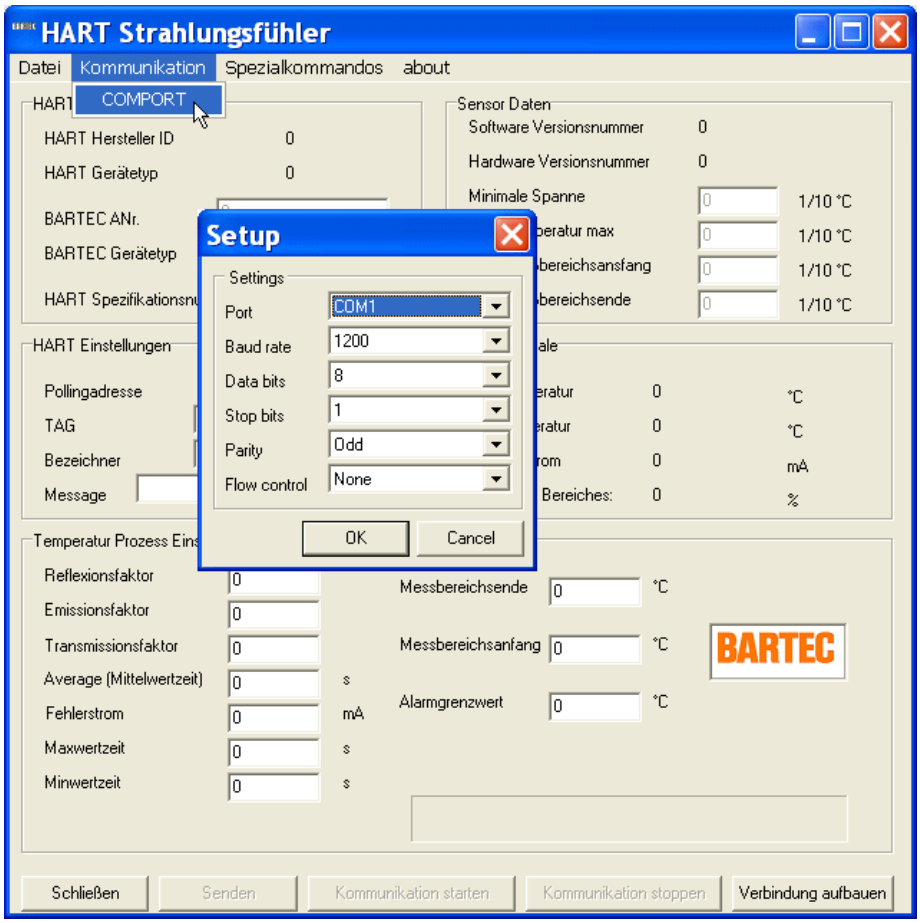


4.2.2.2 Software

- Install the HART infrared configuration software that is delivered together with the HART® modem.

- Start the HART infrared configuration software.

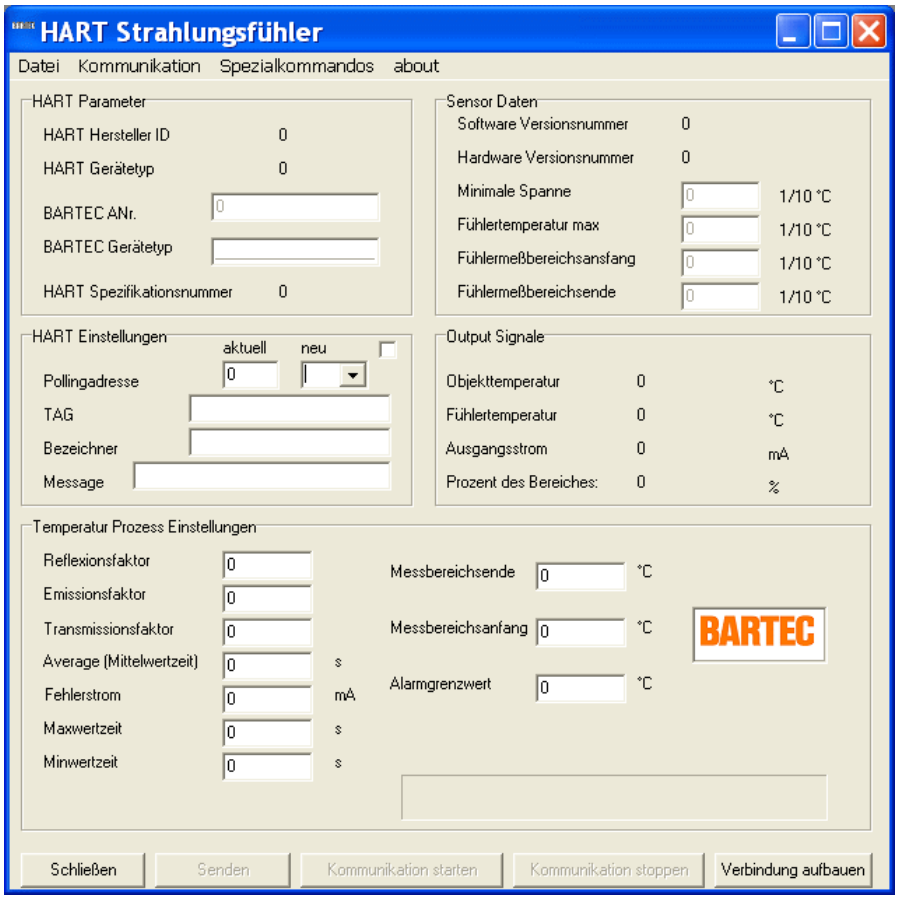
Set the interface parameters as shown in the diagram below, choosing the interface that is connected to the HART® modem.



- Click the [Verbindung_aufbauen] (Set up connection) button.

Changing parameters

Once the connection has been set up, the parameters of the connected HART® unit will be read and displayed.
You can enter the configuration data in the “Temperatur Prozess Einstellungen” (temperature process settings) section (see Section 4.2.1.2).



5 Configuration PACTware

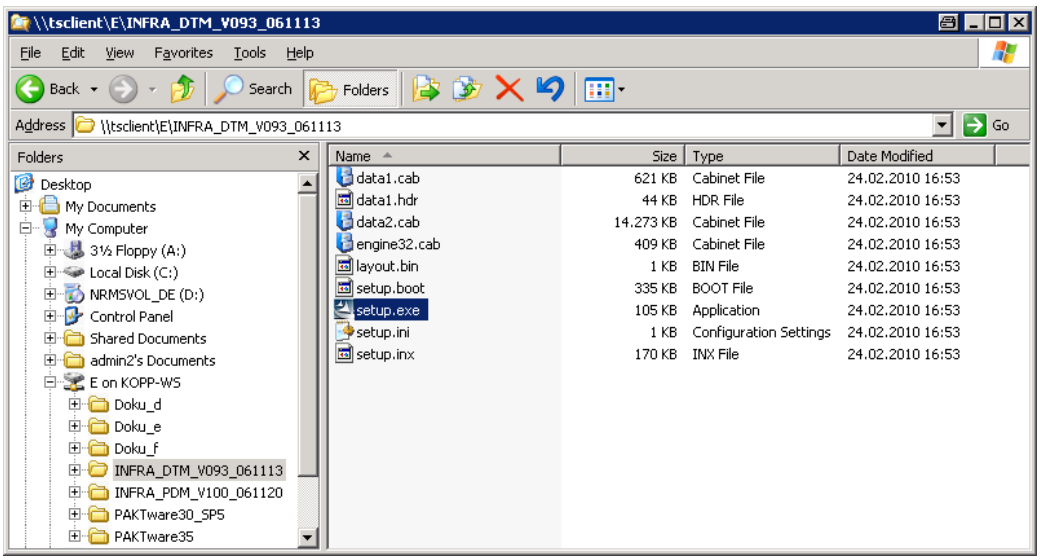
The following installation was carried out on a system running Windows XP Professional Version 2002 SP3.

Installation of the INFRA DTM driver for PACTware

1. Insert the supplied installation CD-ROM for the R 300 software into the CD-ROM drive.

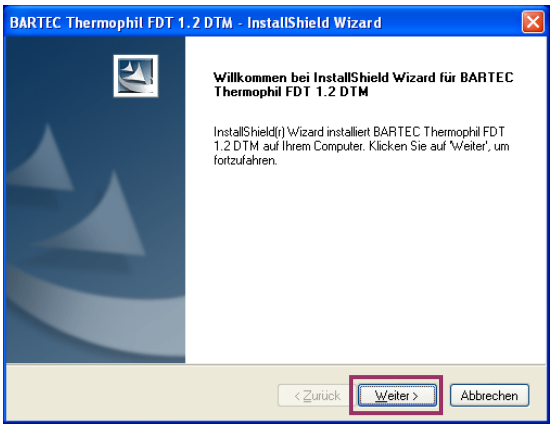
2. Cancel the installation of the HART Infraconfigurator, as it is not needed in conjunction with the DTM driver.

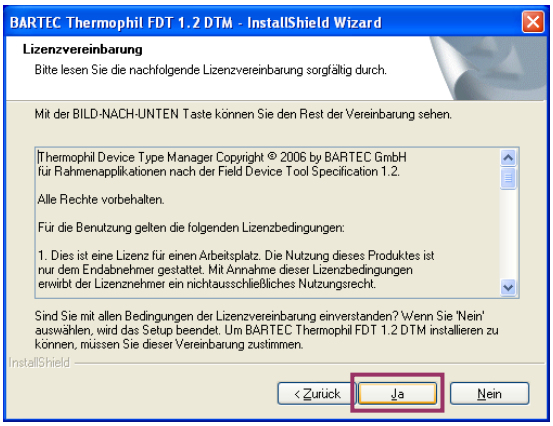
3. Start the setup programme (setup.exe) for INFRA DTM.

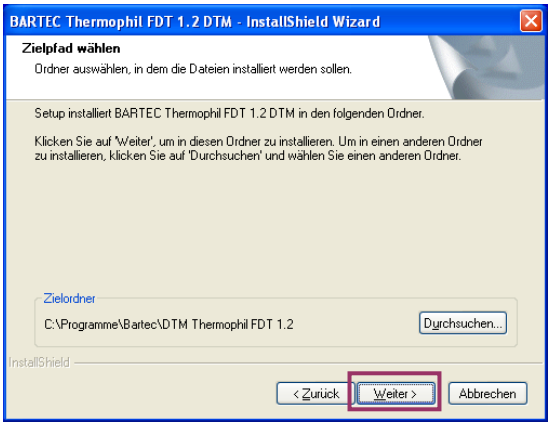


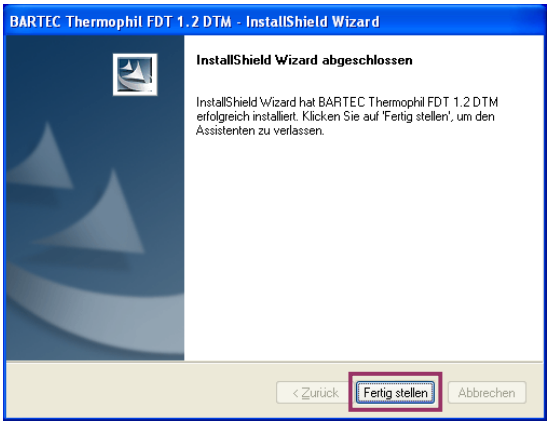
4. The installation commences → follow the on-screen instructions.

5. Installation steps:









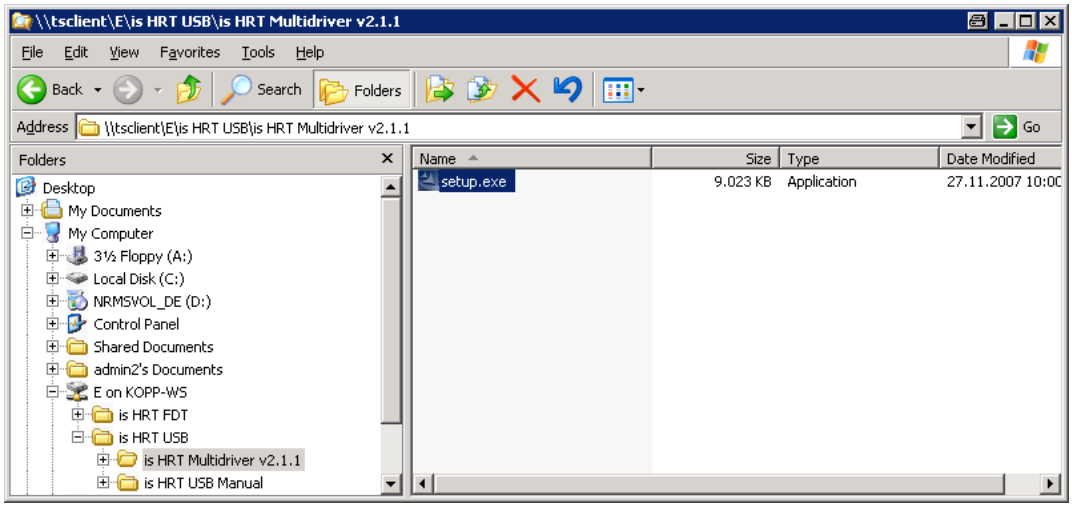
Installing the isHRT USB interface driver

1. Please refer to the isHRT USB user manual.

2. The driver software must be installed before connecting the device!

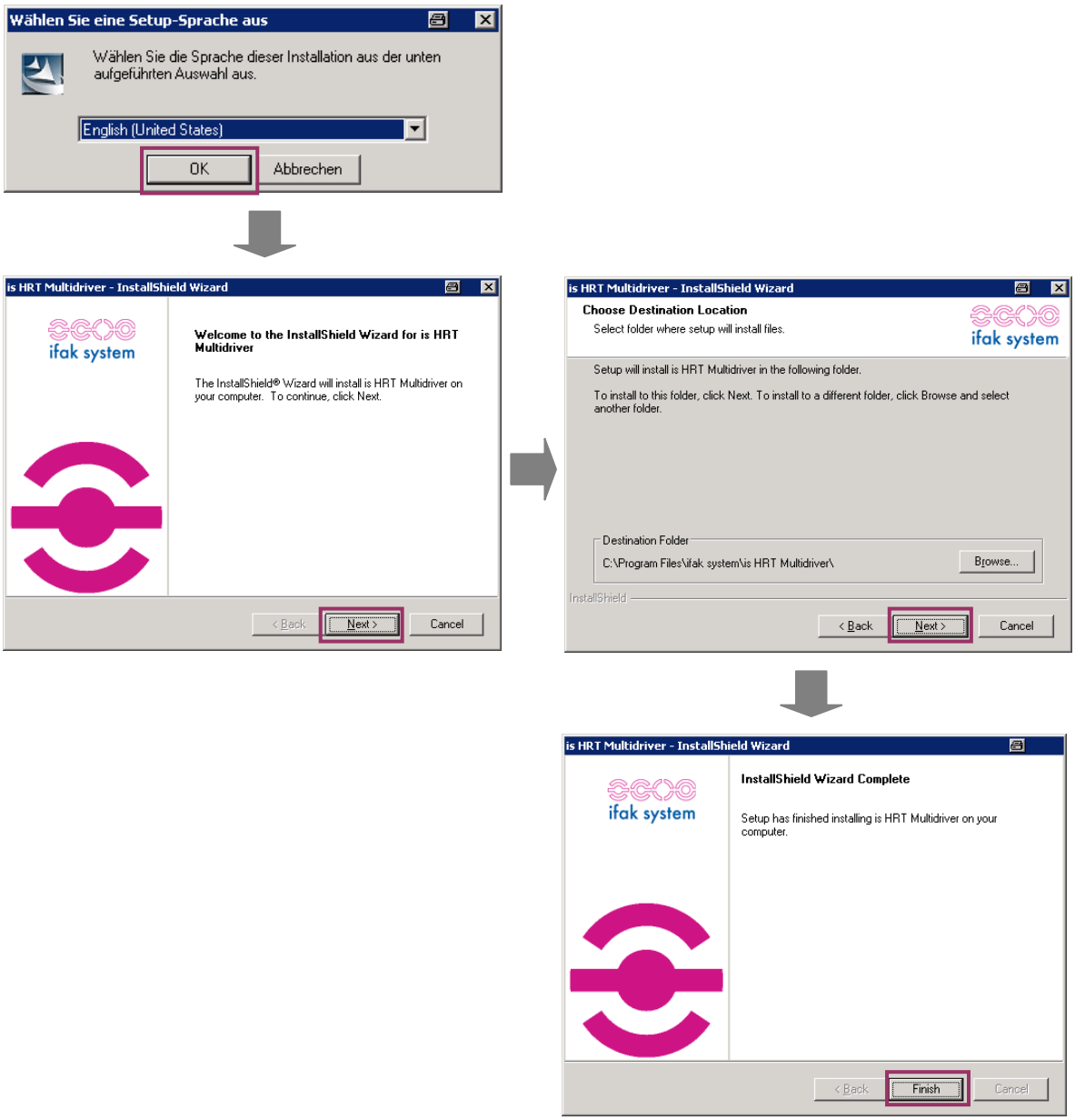
3. Insert the supplied installation CD-ROM for the isHRT driver software into the CD-ROM drive.

4. If the installation does not start automatically, call up the setup programme for isHRT Multidriver.



5. The installation commences → follow the on-screen instructions:

6. Installation steps:

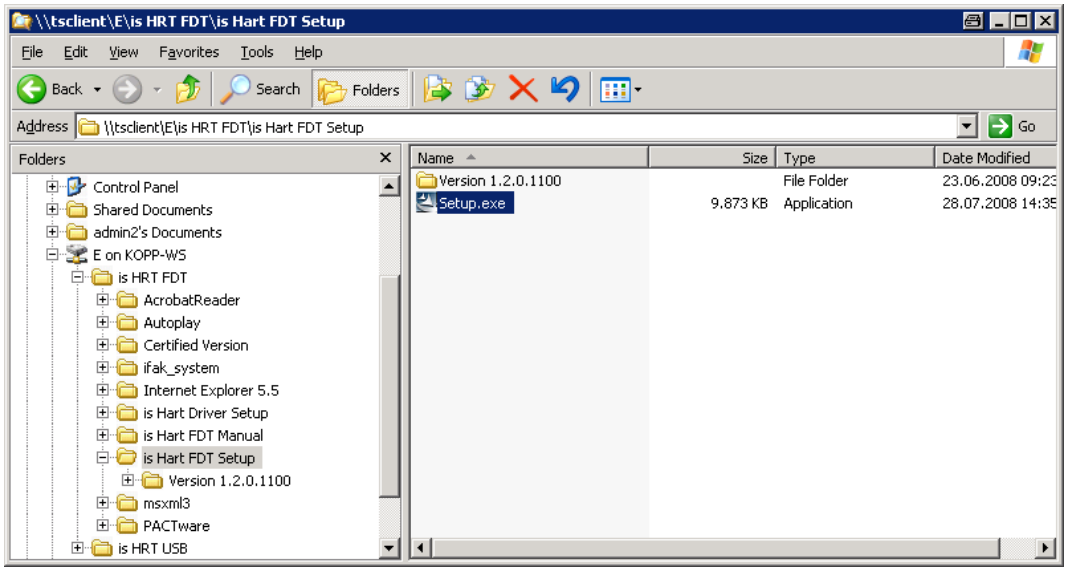


Installing the isHRT FDT driver for PACTware

1. Please refer to the isHRT FDT user manual.

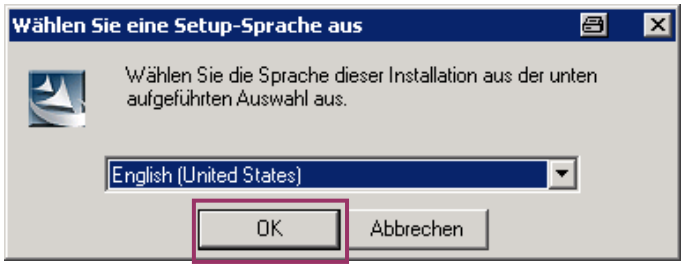
2. Insert the supplied installation CD-ROM for the isHRT driver software into the CD-ROM drive.

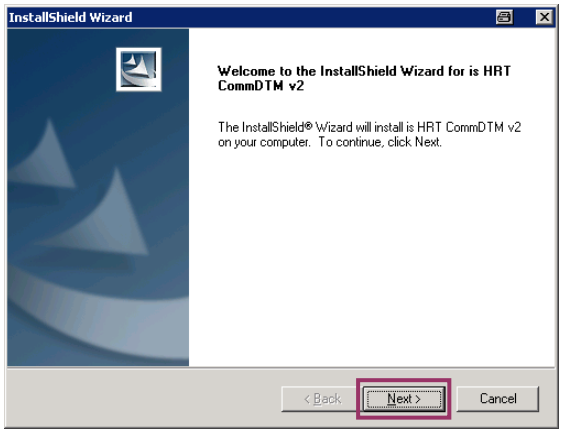
3. Start the setup programme for isHRT FDT Setup.

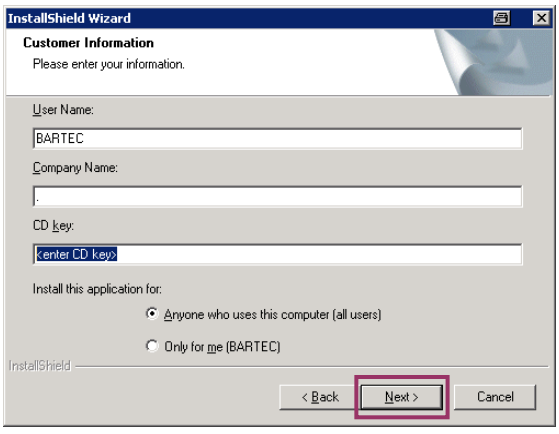


4. The installation commences → follow the on-screen instructions.

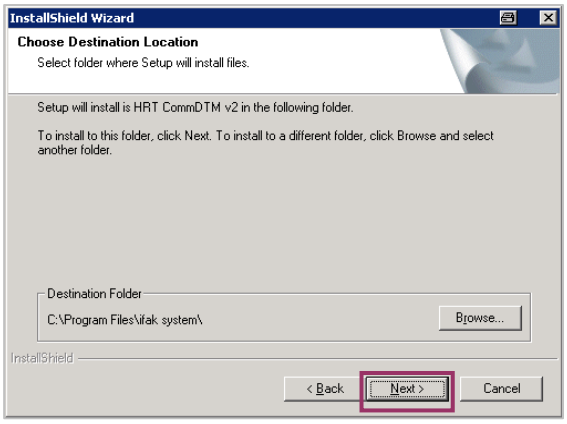
5. Installation steps:

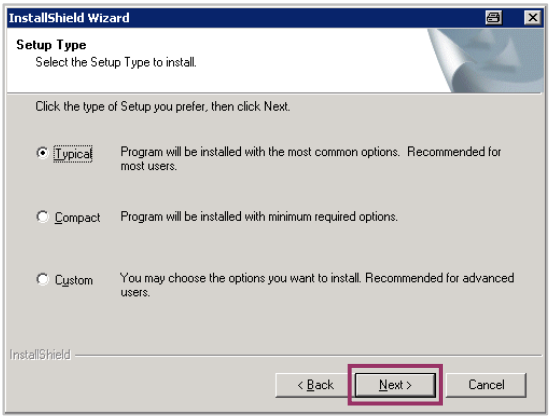


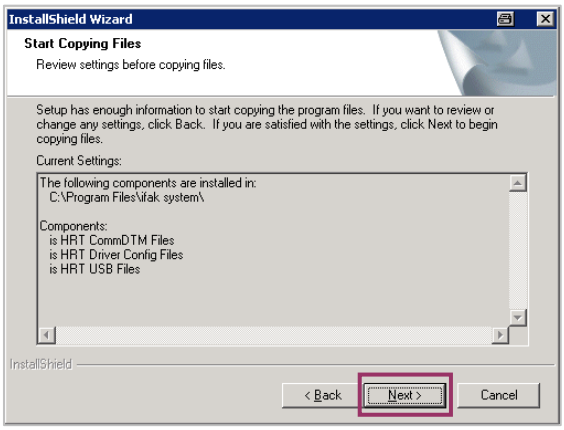


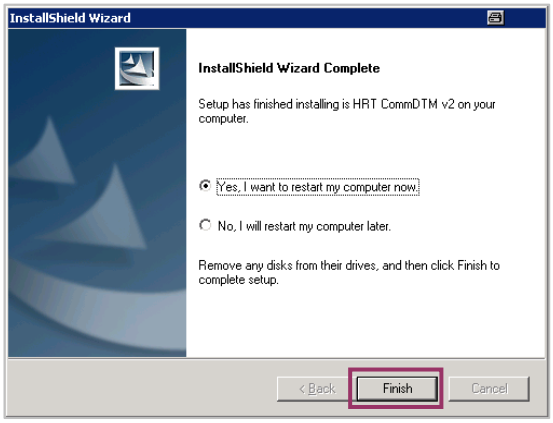


Enter the CD code supplied:
→ Supply your company information
(e.g. company, city)
→ CD code as supplied
(e.g. 1111-2222-AAAA-3333-BB44)







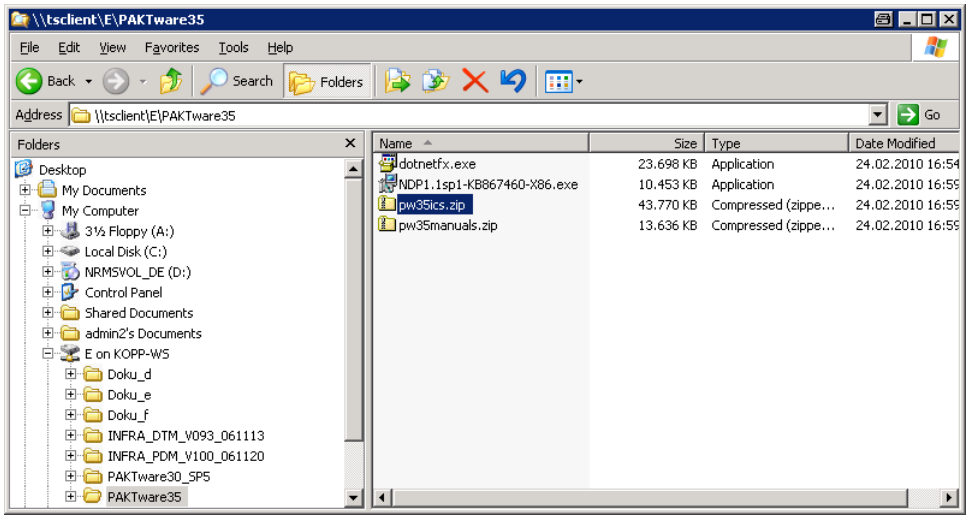


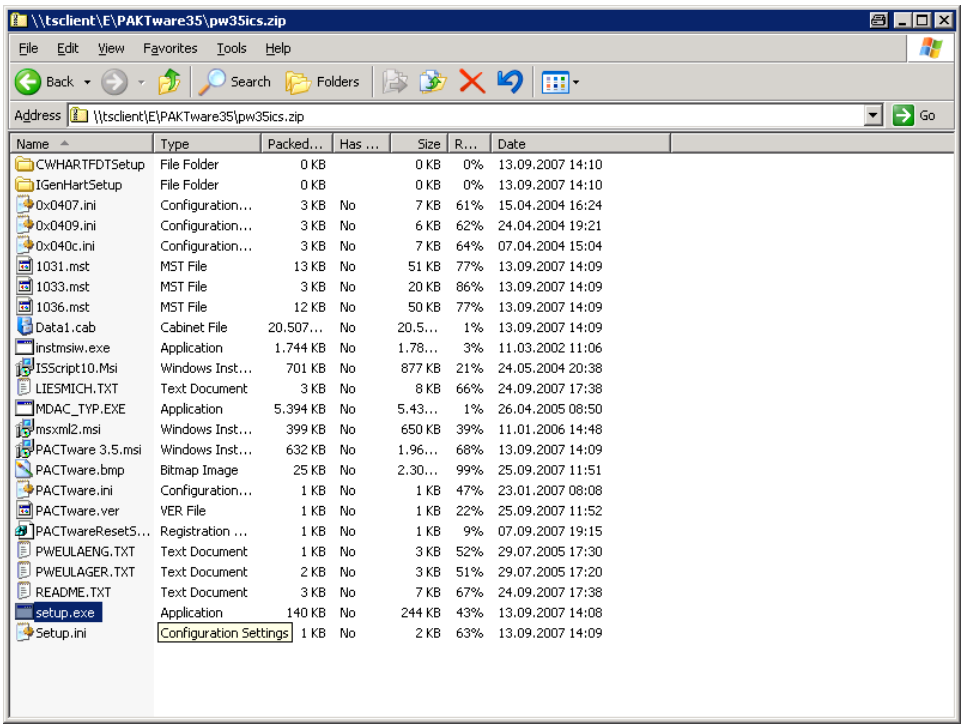
Installing PACTware

1. Insert the supplied installation CD-ROM for the R 300 software into the CD-ROM drive.

2. Cancel the installation of the HART Infraconfigurator, as it is not needed in conjunction with PACTware.

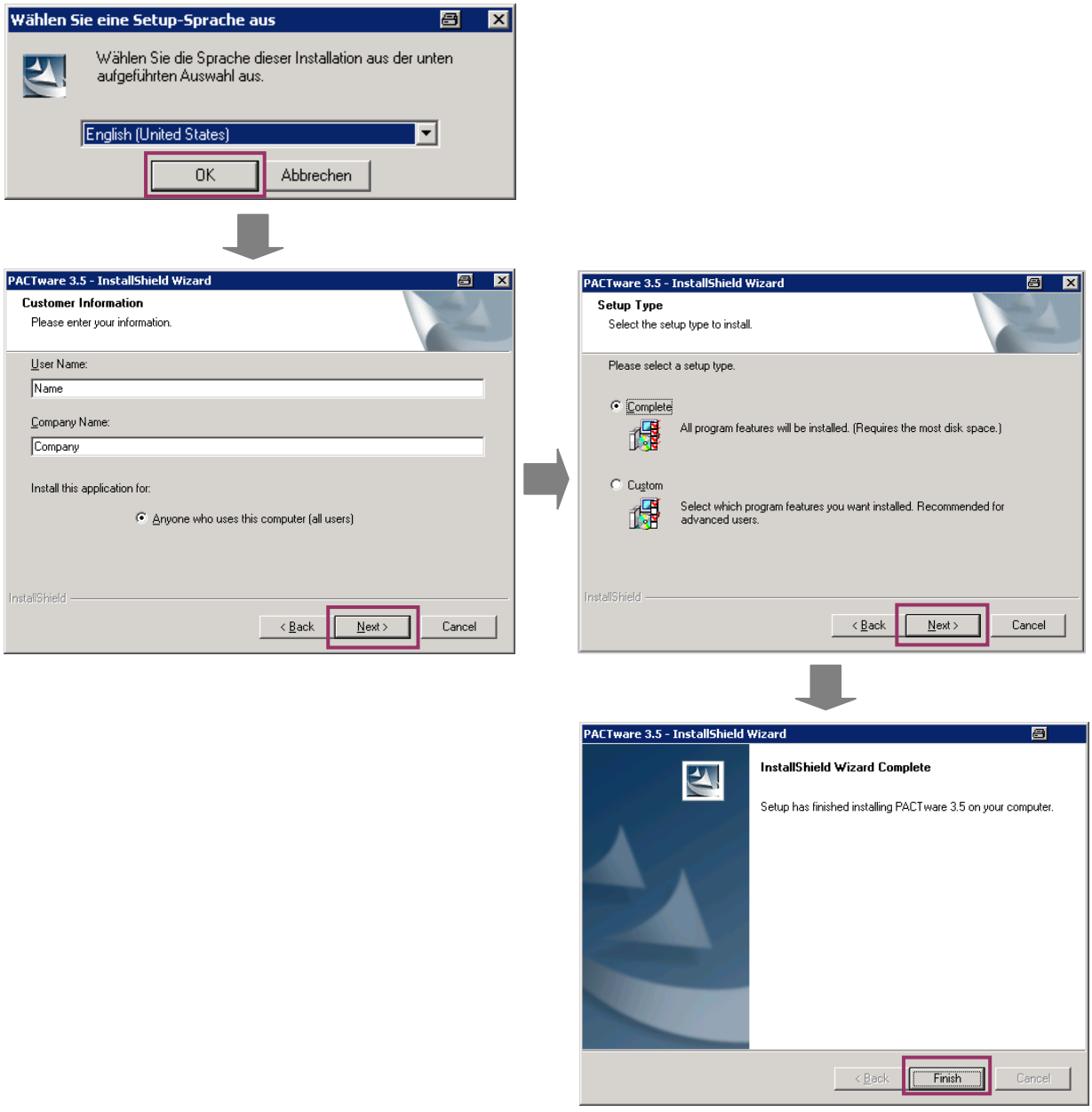
3. Decompress the installation archive pw35ics.zip. Start the setup programme (setup.exe) for PACTware. Where required, download the current PACTware version from www.pactware.com.





4. The installation commences → follow the on-screen instructions. Several programme parts are installed.

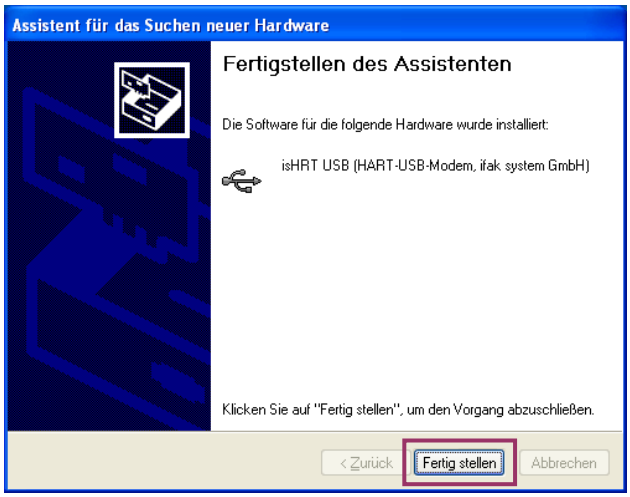
5. Installation steps:



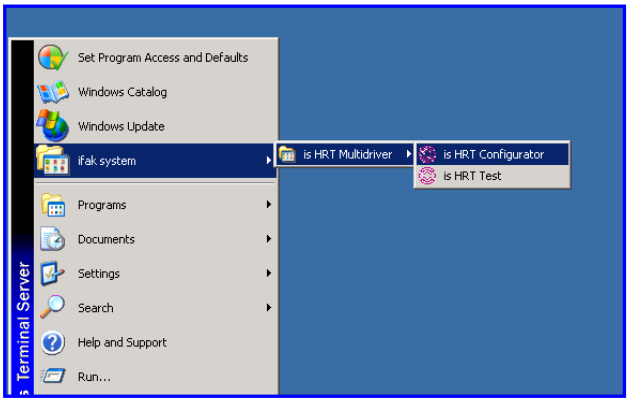
Configuring the isHRT USB modem

1. You can now connect the isHRT USB modem to your PC.

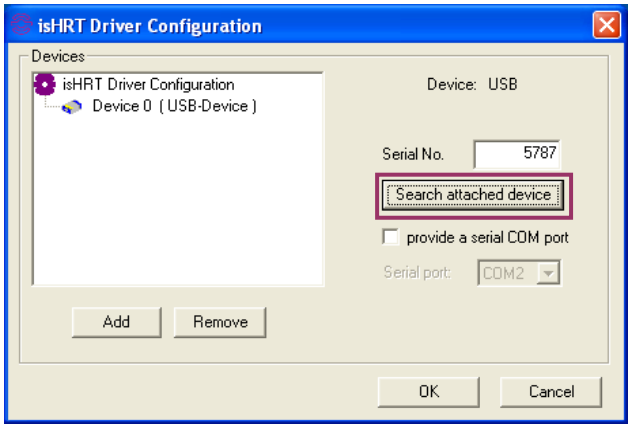
2. Windows will now install the driver modem. Follow the on-screen instructions. The following should be displayed on-screen, once installation has concluded successfully.



3. You now need to configure the modem. Call up the programme isHRT Configurator.

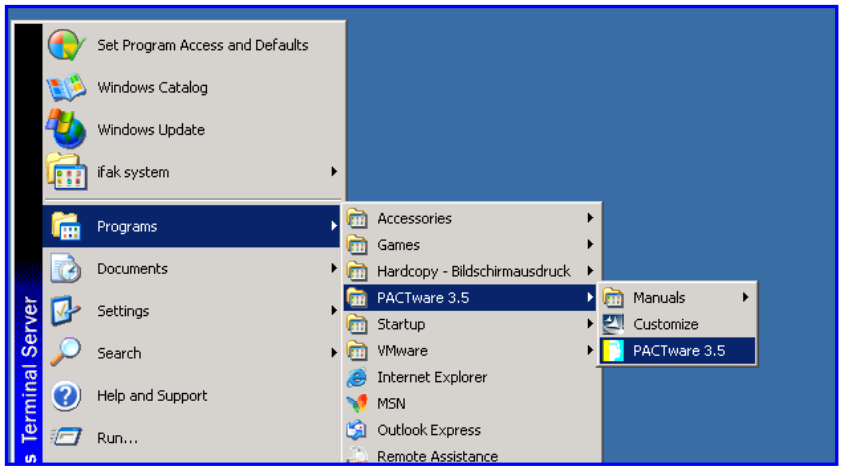


4. Find the modem with the function 'Search attached device'. The modem's serial number will be displayed.

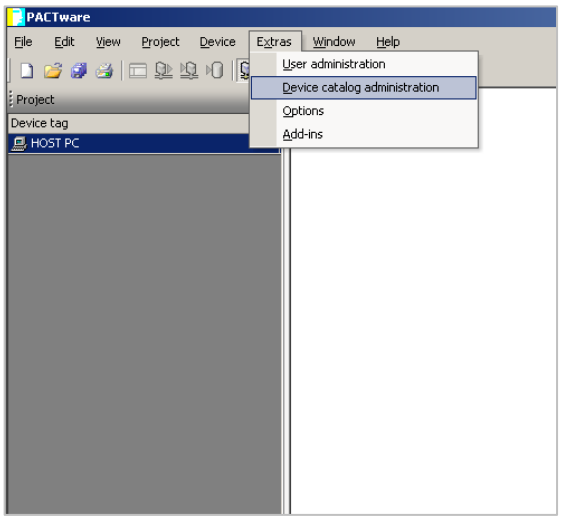


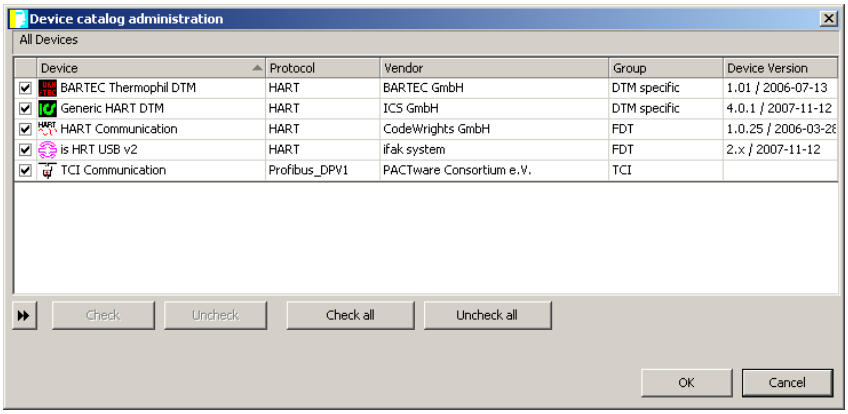
Configuration PACTware

1. Start the PACTware programme.

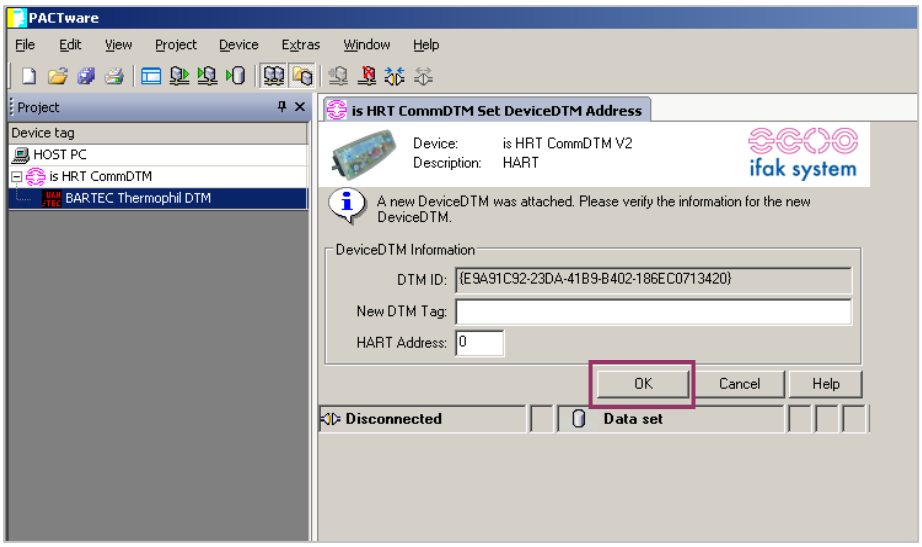


2. Call up the menu point Tools → Manage Device Catalogue. The device entries 'BARTEC Thermophil DTM' and 'isHART USB v2' must be displayed there. Should these entries not be visible, try locating the driver with 'Update Device Catalogue'.

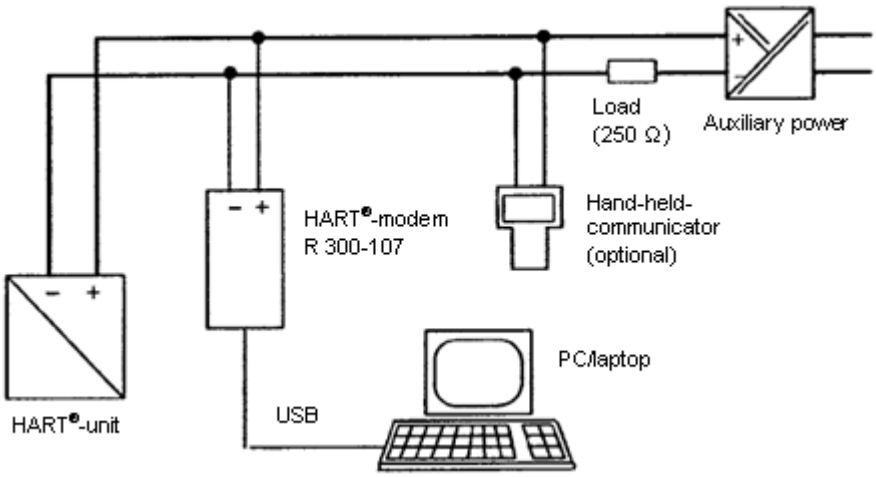




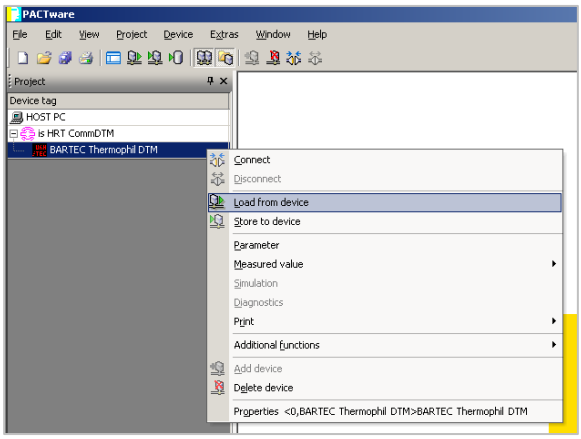
3. Create a new device configuration. Press OK when prompted to add the BARTEC Thermophil DTM driver.

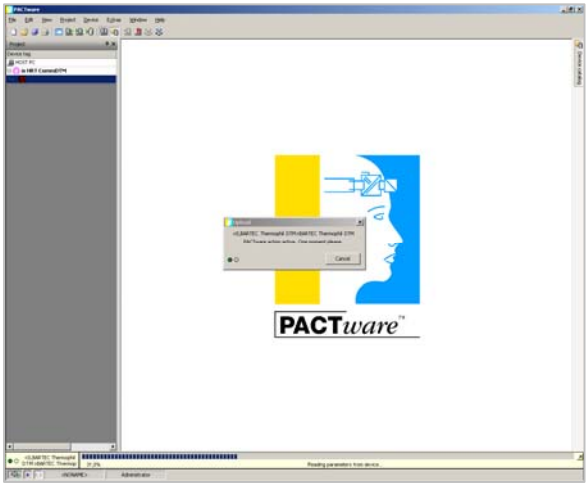


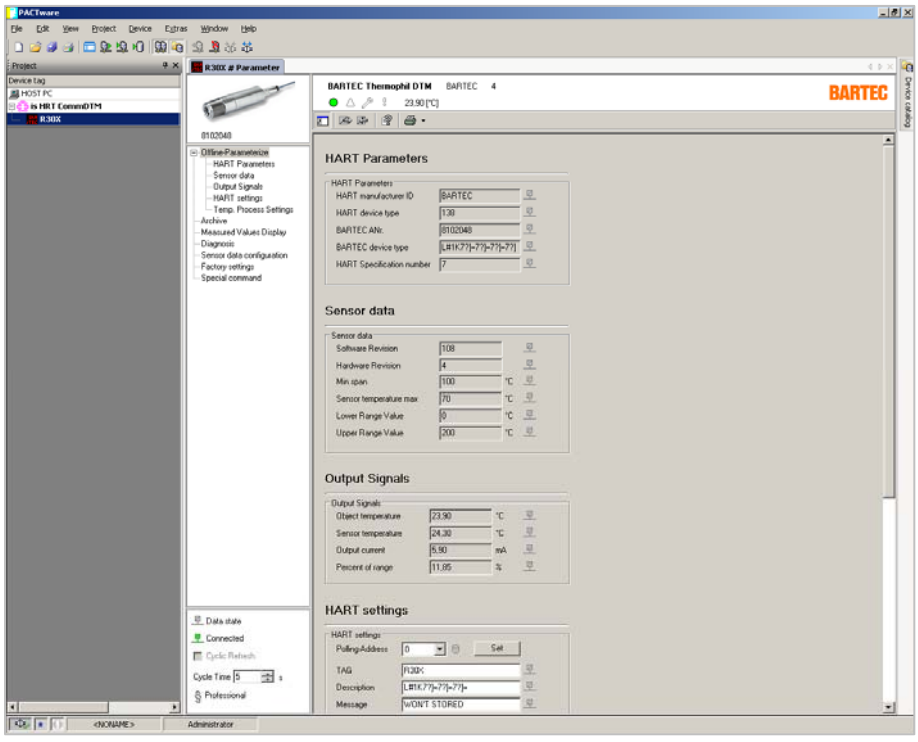
4. Supply the sensor with voltage and connect the HART modem to the sensor.



5. Read the device data from the sensor.







6 Maintenance

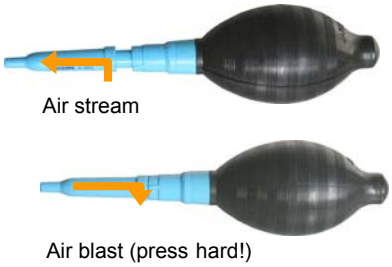
Cleaning kit type R300-128 for pyrometers

BARTEC pyrometers are very durable and almost maintenance-free. Maintenance is restricted to checking and cleaning the optics. If it is cleaned regularly and carefully, the high reliability of the measuring system can be preserved and guaranteed.
Arranged in a stable and convenient carrying case, the cleaning kit contains all facilities to carry out the cleaning quickly and thoroughly and without any risk for the process and the sensor.
If required, the components contained in the kit can be re-ordered individually.

Use the **vacuum brush** to remove loose dirt and dust particles. Dust that is raised can be sucked off by means of the rubber bellows.

Use the **bellows** to remove dirt particles even from areas of the optics that are difficult to access for the brush.
To access deeper areas, you can attach an extension nozzle.

The air stream can be emitted either continuously or as a strong air blast. Change the position of the air outlet nozzle accordingly.



Use the **cleaning spray** if there are deposits or hard-sticking dirt particles.
Let the fluid take effect for a short time.

With a **cleaning tissue** and by applying only little pressure, carefully wipe off the dissolved dirt.

⚠ Never wipe across the lens before solid particles have been removed or dissolved.

⚠ For the utilisation of the IR protection window ZnSe, please observe the safety instructions under chapter 3.3.2.

Ordering details

Designation	Order number
Cleaning kit type R300-128 complete	282302
Cleaning fluid PUROSOL	282366
Cleaning tissues PREMATEX	282367
Vacuum brush	282368
Bellows	282369

7 HART® protocol

The following table contains an overview of the relevant HART® commands in HART® Version 7.

No and function		Data in the instruction	Data in the reply
0	Read unique identifier		
1	Read primary variable		Byte Range unit code Float PV
2	Read current and percent of range		Float Current Float Percent of range
3	Read current and four (predefined) dynamic variables		Float Current (present output current) byte Range unit code float PV (object temperature) byte Range unit code float SV (present housing temperature UT) byte Range unit code float TV (object temperature prior to damping) byte Range unit code float VV (object temperature prior to min/max value)
6	Write polling address	byte HART-address byte Loop Current Mode (not implemented)	byte HART-address Byte Loop Current Mode (not implemented)
8	Read dynamic variable configuration		
11	Read unique ident. Associated with tag		
12	Read message		
13	Read tag, descriptor, date		
14	Read PV sensor information		
15	Read output information		
16	Read final assembly number		
17	Write message *Only stored in RAM!*		
18	Write tag, descriptor, date		
19	Write final assembly number *Only stored in RAM!*		

No and function		Data in the instruction	Data in the reply
34	Write damping value for the PV	float average value 0…999.9 s	float average value 0…999.9 s
35	Write range values for the PV	byte range unit code float upper range value (MBE) float lower range value (MBA)	byte range unit code float upper range value (MBE) float lower range value (MBA)
38	Reset "config changed" flag		
40	Enter/exit fixed current mode loop test (fix the analogue current at specified value	float current (0 = exit fixed current mode)	float current
128	Read emissivity		float Emissivity
129	Write emissivity	float Emissivity 0.100…1.000	float Emissivity
130	Read reflectivity		float Reflectivity
131	Write reflectivity	float Reflectivity 0.100…1.000	float Reflectivity
132	Read transmissivity		float Transmissivity
133	Write transmissivity	float Transmissivity 0.100…1.000	float Transmissivity
134	Read error current		float error current [mA]
135	Write error current	float error current	float error current [mA]
136	Read max/min hold time		float Max hold time [s] float Min hold time [s]
137	Write max/min hold time	float Max hold time 0.0 … 999.9 s float Min hold time 0.0 … 999.9 s	float Max hold time [s] float Min hold time [s]
138	Read alarm values		float Alarm value [°C]
139	Write alarm values	float Alarm value [°C]	float Alarm value [°C]
144	Special command (read only) *see description*	float Value 1 float Value 2	float Value 1 float Value 2
145	Special command s*ee description*	float Value 1 float Value 2	float Value 1 float Value 2
146	Read factory settings and write them to EEPROM	int Password Password [32] >only RAM Password [34] >EEPROM	int Success message (0 = error ; 1 = ok)

No and function	Data in the instruction	Data in the reply
148 Read device data		long ANr char[15] Type int Software version

Description of command 144

Command	Data in the instruction float float	Data in the reply float float
144	0 Unimportant Display service register no. 0	0 Content of service register
144	1 Unimportant Display service register no. 1	1 Content of service register
144	2 Unimportant Display service register no. 2	2 Content of service register
144	3 Unimportant Display service register no. 3	3 Content of service register
144	4 Unimportant Display service register no. 4	4 Content of service register
144	5 Unimportant Display service register no. 5	5 Content of service register
144	6 Unimportant Display service register no. 6	6 Content of service register
144	7 Unimportant Display service register no. 7	7 Content of service register
144	8 Unimportant Display service register no. 8	8 Content of service register
144	9 Unimportant Display service register no. 9	9 Content of service register

Description of command 145

Command	Data in the instruction float float	Data in the reply float float
145	0 Value Describe service register no. 0	0 Content of service register
145	1 Value [0-65536] Describe service register no. 1	1 Content of service register
145	2 Value [0-65536] Describe service register no. 2	2 Content of service register
145	3 Value [0-65536] Describe service register no. 3	3 Content of service register
145	4 Value [0-65536] Describe service register no. 4	4 Content of service register
145	5 Value [0-65536] Describe service register no. 5	5 Content of service register
145	6 Value [0-65536] Describe service register no. 6	6 Content of service register
145	7 Value [0-65536] Describe service register no. 7	7 Content of service register
145	8 Value [0-65536] Describe service register no. 8	8 Content of service register
145	9 Value [0-65536] Describe service register no. 9	9 Content of service register Upon error: 999990 = checksum incorrect
145	10 Value [0-65536] Check sensor data and write to EEPROM Password [34]	10 Content of service register Upon error: 999990 = checksum incorrect 999991 = errors when writing to EEPROM
145	146 Value [0…65536] Read factory settings and write them to EEPROM Password [32] >only RAM Password [34] >EEPROM	146 Return value 0 = error 1 = ok

8 Additional instructions for use in dust-explosive areas

This supplementary chapter provides additional instructions for the safe usage of

- Thermophil® INFRAsmart type R300 / R301 / R302 and
- Thermophil® INFRAht Typ R310 / R311 / R312 / R320 with measuring amplifier TR40-10

in potentially explosive areas.

General information

Installation[2), 3)]

- The following details on the type plate have to meet the requirements of the Ex field of application on site: device group, category, temperature class, maximum surface temperature
  (II 2 G Ex ib IIC T6…T4, II 2 D Ex ib IIC T_{100} 105°C / 160°C)

- Make sure there is no potentially explosive atmosphere during installation.

- Installation and start-up may only be carried out by an appropriately qualified electrician. The electrical connection is carried out via the respective cable or the respective connection assembly. For Thermophil® INFRAsmart with connection via plug, only use the appropriate connectors or connection cables which guarantee a protection type of at least IP 64 (see “accessories”). The connectors have to be mounted correctly.

- The intrinsically safe cables and wires leading to the device and between the measuring head and the measuring amplifier have to be designated as intrinsically safe. This can be done by means of an appropriate label or by a light-blue wrapping.

- Check the compatibility of the housing sealing materials to the mediums existing at the place of application by taking into consideration the ambient temperature (see resistance).

- Do not open the housing with the exception of the measurement amplifier type TR40-10!

- Avoid or, if this is not possible, safely discharge any electrostatic charges. It may be necessary to earth the metallic housing and any parts in the environment. If a purge air facility is used at the optical system, pay attention to the risk of a separation of charges caused by flowing air polluted by dust.

- Caution! Before working with circuits and before opening the connection assembly within a potentially explosive area, switch off the power supply of the circuits. Within a potentially explosive area, only the tools and measurement equipment approved for this purpose may be used.

Maintenance

- Dust deposits should be restricted or completely prevented if possible. In order to prevent any unusual temperature rise at the dust-proof housing caused by excessive dust deposits, clean the housing regularly.

Ambient conditions

The maximum surface temperature or the temperature class depends on

- the type
- the maximum ambient temperature

Type	Ambient temperature	Temperatur e class IIG	Maximum surface temperature II D[1)]
R300, R301, R302, TR40-10	-20°C … +60°C	T6	T_{100} 105°C
	-20°C … +70°C	T5	
R310, R311; R312, R320	-20°C … +60°C	T6	
	-20°C … +70°C	T5	
	-20°C … +125°C	T4	T_{100} 160°C

Safety instructions

- Potentially explosive areas are defined under atmospheric conditions within a temperature range from –20°C to +60°C and a pressure range between 0.8 bar and 1.1 bar. Any operation outside these limits may result in additional restrictions.

- Make sure that any potential dust deposits do not exceed a maximum thickness of 100 mm.

Resistance

The following plastic materials are used as sealing materials for the housing:

- polybutylenterephthalate (PBT)[4)]
- viton (O-rings)

Before the application, the operator has to check the resistance of these plastic materials to the mediums existing at the place of application by also taking into consideration the climatic ambient conditions at the place of application (temperature, humidity..).

Technical data

At the (+) and (-) connections of the auxiliary energy (supply / signal circuit) the device has to be supplied with a certified intrinsically safe Ex ib IIC circuit or with a certified intrinsically safe EEx ia IIC circuit with the following maximum values:

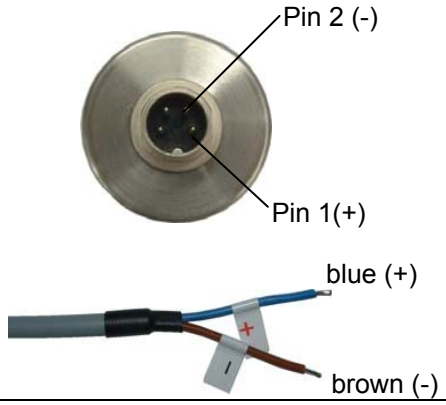
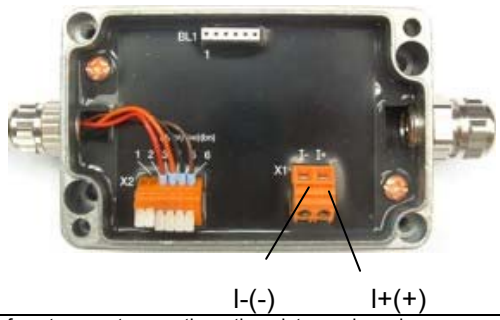
Maximum input voltage	U_i	28 V
Maximum input current	I_i	105 mA
Maximum input power	P_i	1,0W

The maximum internal capacity and inductance including a cable of up to 15 m are as follows:

Maximum internal capacity	C_i	12 nF
Maximum internal inductance	L_i	0,2mH

Note 1: The internal capacity between the intrinsically safe supply /signal circuit and the housing is 12 nF. Any potential differences between the intrinsically safe supply /signal circuit and the housing have to be avoided. If required, the installation location of the device and / or the device as well as the environment of the cable routing have to be integrated in the potential compensation.

Note 2: The mentioned values are safety-related maximum values. The operating values / nominal values for tension are U_H = DC 12 V ... DC 24 V and for maximal current consumption = 25 mA.

Typ	Connections of supply / signal circuit
R300, R301, R302	
TR40-10	

1) The details on the maximum surface temperature on the rating plate are based on measurements under normal ambient and installation conditions. Changes of these conditions (e.g. constricted conditions of installation) may have considerable effects on the temperature.

2) see also EN 50281-1-2

3) see also EN 60079-14

4) male / female connector of the connection assembly (auxiliary energy)

Annex

Emission factor

If you want to measure the temperature of an object without contact, you need to know the emission degree “E” and include it in the measurements. The calibration basis for IR temperature measuring units and control units is the black body with the emission degree E = 1.

Determining the actual E factor

The emission factor depends on the material and the condition of its surface. Theoretical values are specified in the corresponding literature.
Due to the fact that the E factor also depends on the wavelength, the temperature and the direction in which the radiation is emitted, however, the values listed in the table can only be used as rough approximates, for instance for project planning. It can generally be said that raw, matt or oxidized surfaces have a higher E factor than shiny materials.

Table showing the emission factor E at room temperature

Surface	Temperature (°C)	E factor
Asbestos slate	20	0.93
Bakelite varnish	80	0.935
Lead, oxidized	200	0.63
Chrome nickel, oxidized 20 Ni 25 Cr 55 Fe	200	0.90
Chrome nickel, oxidized 20 Ni 25 Cr	500	0.97
Chrome nickel, oxidized 60 Ni 12 Cr 28 Fe	270	0.89
Roofing felt	20	0.93
Ice, smooth, water layer	0	0.966
Ice, rough surface	0	0.985
Enamel, white / porcelain	20	0.9...0.92
Iron, oxidized	100	0.74
Iron, oxidized	500	0.84
Iron, rusty	25	0.85
Iron, rolling skin	20	0.77
Plaster	20	0.85
Glass	20...90	0.94
Graphite	20	0.45
Rubber, soft, grey	25	0.86...0.94
Rubber, hard	25	0.955
Skin, dry	30	0.96
Radiator varnish, oil paint	85	0.925
Wood (beech)	20...70	0.915
Plastics (PVC, PTFE, PE at thicknesses of 0.4 mm or more)	20...150 20...130	0.91 0.77
Copper, oxidized	20...120	0.96
Matt varnish, e.g. 3 M 1020	200...600	0.60
Brass, oxidized	20	0.85
Paper	40...400	0.79...0.94
Steel, raw	70	0.91
Clay, baked	20	0.93
Brick, mortar, plaster		

In practice, it is a good idea to verify the E factor once by taking a comparison measurement. Various measurement procedures may be suitable depending on the circumstances.

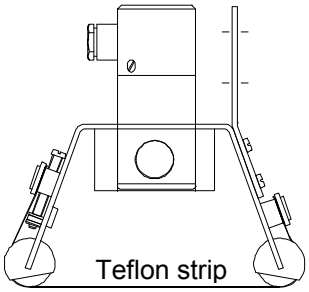
Drill hole method:
A hole with a depth of 2 - 3 mm is drilled into the measurement object and an immersion measurement is taken in the hole using a low-mass sensor (semiconductor or thermal element, ∅ 0.5 mm). Then, the temperature is measured using a radiation sensor and the E factor is adjusted until the “true temperature” determined beforehand is displayed.

Emission conversion:
The surface of the measurement object is covered with a substance for which the E factor is known (e.g. black 3M "Velvet Coating 2010" matt varnish; E 0.93).

You can also apply this method if you want to measure the surface temperature of shiny rollers (E 0.2). Usually, it is possible to apply the adhesive matt varnish at the edge of this isothermally heated calendar.

If this is not possible, or if the temperature distribution across the roller length is irregular, you should use what is called an emission converter, like the one shown in the picture. In the process, a thin black Teflon strip (E 0.95) stretched on a frame makes contact with the roller and is measured using the radiation sensor.

Taking a measurement on a slow-running roller with the aid of the emission converter:



Contact-based measurement:
Measure the surface temperature of the measurement object, for instance using a low-mass thermal spiral or band element. This method cannot be used for substances with a very poor thermal conductivity, though.

Convection measurement:
If it is not possible to take a contact-based measurement because the measurement object is moving extremely quickly (as may be the case for a calendar or roller, for instance), a roller sensor that works based on the convection principle can be used. The large time constant of the sensor must be taken into account but it does not interfere with this one-off measurement.

Test method:
If you blacken part of a material sample (e.g. with Velvet Coating from 3M) and then, for instance, heat it up in a climatic test cabinet, you can take a differential measurement to establish the exact value of the emission factor. In other words, with the E factor set to 1, you take a measurement on the blackened part and then take a measurement on the part that has not been blackened. By changing the E factor, you set the same display as before and can now read the E factor on the E regulator.

Transmission factor

The transmission factor specifies the percentage of radiation that passes an additional protective window.
If you do not have the details of the transmission factor for the protective window used, you can work it out yourself.

Determining the transmission factor

- Measure the temperature of the measurement object with the sensing head, without using the protective window. When you do this, make sure that the correct emission factor is set.
- In the configuration, enter 1.000 as the transmission factor (see page 4-5 Transmission factor).
- Use the protective window.
- Change the transmission factor in the configuration and repeat the measurement. Compare the measured temperature with the temperature that was measured without the protective window.
- Keep repeating this process until the temperature displayed is the same as that for the measurement without the protective window.

***