impac®
A LUMASENSE TECHNOLOGIES Company

zertifiziert ISO 9001:2008 IMPAC Infrared

IN 5 · IN 5/5

***INFRATHERM*-Pyrometer**

Betriebsanleitung · User Manual

IMPAC - Spezialist für berührungslose Temperaturmessung
IMPAC - Specialist in non-contact thermometry

Contents

1 General

1.1 Information about the user manual

Congratulations on choosing this high quality and highly efficient IMPAC pyrometer.

Please read this manual carefully and step for step including all notes to security, operation and maintenance before installing the pyrometer. For installation and operation of the instrument this manual is an important source of information and work of reference. To avoid handling errors keep this manual in a location where you always have access to. When operating the instrument it is necessary to follow the generally safety instructions (see **4**, **Safety**).
Additionally to this manual the manuals of the components used are valid. All notes – especially safety notes – are to be considered.

Should you require further assistance, please call our customer service hotline in Frankfurt, Germany, +49 (0)69 9 73 73-0.

1.2 Limit of liability and warranty

All general information and notes for handling, maintenance and cleaning of this instrument are offered according to the best of our knowledge and experience.

IMPAC Infrared GmbH is not liable for any damages that arise from the use of any examples or processes mentioned in this manual or in case the content of this document should be incomplete or incorrect. IMPAC reserves the right to revise this document and to make changes from time to time in the content hereof without obligation to notify any person or persons of such revisions or changes.

All series 5 Instruments from IMPAC Infrared GmbH have a warranty of two years from the invoice date. This warranty covers manufacturing defects and faults which arise during operation only if they are the result of defects caused by IMPAC Infrared GmbH.
This warranty is void if the instrument is disassembled, tampered with, altered or otherwise damaged, without prior written consent from IMPAC.

1.3 Legend

	**Note:** The note symbol indicates tips and useful information in this manual. All notes should be read with regard to an effective operation of the instrument.
MB	Shortcut for temperature range (in German: **M**ess**b**ereich)

1.4 Terminology

The used terminology corresponds to the VDI- / VDE-directives 3511, page 4.

1.5 Copyright

1.6 Disposal / decommissioning

Inoperable IMPAC pyrometers have to be disposed corresponding to the local regulations of electro or electronic material.

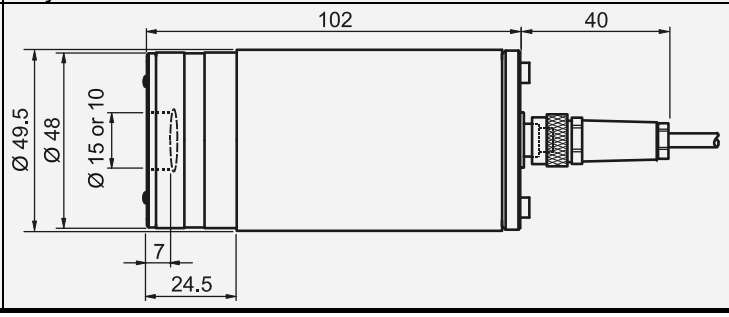
2 Technical data

Temperature ranges:	**IN 5:** 0 ... 100°C, 0 ... 200°C, 0 ... 300°C, 0 ... 400°C, 0 ... 500°C, 0 ... 900°C, -32 ... 50°C, -32 ... 900°C **IN 5/5:** 100 ... 600°C, 200 ... 800°C, 100 ... 1300°C, 400 ... 2500°C (other ranges for both instruments on request)
Data handling:	Digital
Spectral range:	**IN 5:** 8...14 µm **IN 5/5:** 5.14 µm
Lens:	**IN 5:** Germanium (Ge) **IN 5/5:** Zinc Sulfide (ZnS)
IR-Detektor:	Thermopile

Power supply:	24 V DC (10... 30 V) nominal, ripple must be less than 0.5 V
Analog output:	4 ... 20 mA direct current, linear resolution: 2880 steps
Load:	max. 700 Ω at 24 V (max. 100 Ω at 12 V)

Emissivity:	0.2 ... 1 switchable in the instrument in steps of 0.01
Exposure time t_{90}:	0.08 s; adjustable to 0.5 s; 1 s; 2 s; 5 s

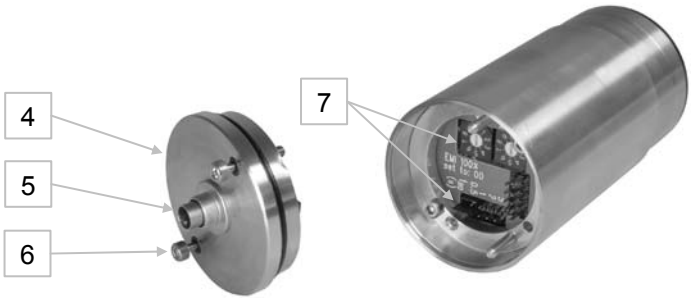
Measurement uncertainty: dependent on object temperature T and ambient temperature T_{amb} (ε = 1, t_{90} = 1 sec):	**IN 5:** T= -32...0°C: 1.5°C (T_{amb} = 15...30°C); 2°C (T_{amb} = 0…15 or 30…63°C) T=0...300°C: 0.6% of reading in °C or 1°C (T_{amb} = 15...30°C) [1)] 1% of reading in °C or 1.5°C (T_{amb} = 0...15 or 30...63°C) [1)] T=300...900°C: 1% of reading in °C (T_{amb} = 15...30°C) 1.3 % of reading in °C (T_{amb} = 0...15 or 30…63°C) **IN 5/5:** T < 1300°C: 0.6% of reading in °C or 2°C (T_{amb}=15...30°C) [1)] 1% of reading in °C or 1,5°C (T_{amb}=0...15 or 30...63°C) [1)] T=1300...1800°C: 0.8% of reading in °C (T_{amb}=15...30°C) 1.2% of reading in °C (T_{amb}=0...15 or 30...63°C) T=1800...2500°C: 1% of reading in °C (T_{amb}=15...30°C) 1.4 % of reading in °C (T_{amb}=0...15 or 30...63°C)
Repeatability (ε = 1, t_{90} = 1 s):	0.3 % of measured value in °C or 0.6 °C [1)]
Noise Equivalent Temperature Difference (NETD): (ε = 1, T_{amb} = 23°C)	**IN 5:** at t_{90} = 80 ms: 0.2°C (at 23°C measuring temperature) at t_{90} = 1 s: 0.05°C (at 23°C measuring temperature) **IN 5/5:** at t_{90} = 80 ms: 0.7°C (at 110°C measuring temperature) at t_{90} = 1 s: 0.4°C (at 110°C measuring temperature)

Ambient temperature:	0 ... 70°C 0 ... 63°C for IN 5/5, MB 25
Storage temperature:	-20 ... 70°C
Relative humidity	Non condensing conditions
Protection class:	IP65 (DIN 40050)
Weight:	410 g
Housing:	Stainless steel
Operating position:	Any
Dimensions:	

CE-label:	according to EU directives about electromagnetic immunity

[1)] Whichever value is greater. The instrument must be at a constant ambient temperature for a minimum of 15 minutes

3 Overview



1 Stainless steel housing
2 Optics
3 Type label

4 Rear panel
5 Electrical connection
6 Fixing screws for rear panel
7 Settings at the pyrometer

3.1 Appropriate use

IN 5: The IN 5 is a stationary infrared thermometer for non-contact temperature measurement of non-metallic surfaces or painted, coated or anodized metals with temperature ranges between -32 and 900°C.

IN 5/5: The IN 5/5 is a stationary pyrometer especially for non-contact temperature measurement of glass surfaces and quartz surfaces with temperature ranges between 100 and 2500°C.

For optimal match of the instrument to the application the pyrometers are equipped ex works with the desired optics (for every instrument 3 different optics are available).

3.2 Scope of delivery

Instrument with selectable optics, allen key 2.5 mm, works certificate, user manual.

Note: A connection cable is not included with the instrument and has to be ordered separately (see section **13**, **Reference numbers**).

4 Safety

Each person working with the pyrometer must have read and understood the user manual before operation. Also this has to be done if the person already used similar instruments or was already trained by the manufacturer.
The pyrometer has only to be used for the purpose described in the manual. It is recommended to use only accessories offered by the manufacturer.

4.1 Electrical connection

Follow common safety regulations for mains voltage (230 or 115 V AC) connecting additional devices operating with this mains voltage (e.g. transformers). Touching mains voltage can be mortal. A non expert connection and mounting can cause serious health or material damages.
Only qualified specialists are allowed to connect such devices to the mains voltage.

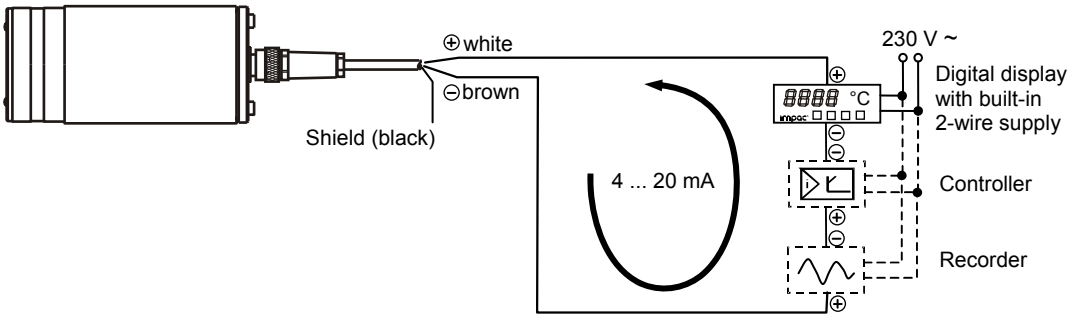
5 Electrical installation

The pyrometers are powered by 24 V DC nominal (possible range: 10 ... 30 V). When connecting the device to the power supply ensure correct polarity. The power consumption (in this case 4 - 20 mA) is also the measuring signal. The instrument don't need any time for starting or preheating and is immediately ready for operation.
To switch off the instrument, interrupt the power supply or unplug the electrical connector.

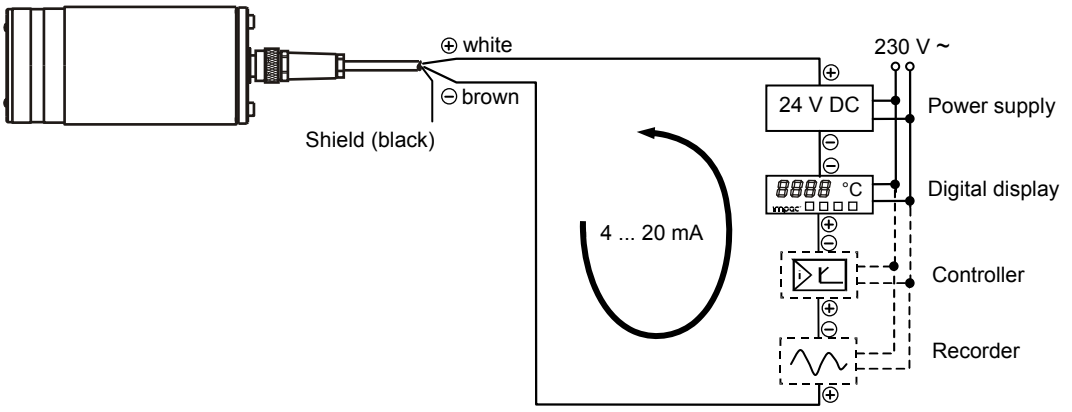
To meet the electromagnetic requirements (EMV), a shielded connecting cable must be used. The shield of the connecting cable has to be connected only on the pyrometer's side. On side of the power supply (switch board) the shield must be open to avoid ground loops.

IMPAC offers connecting cables, they are not part of standard scope of delivery (see section **13**, **Reference numbers**).

Example for wiring using a digital display with integrated power supply:



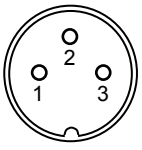
Example for wiring using an external power supply:



Note: Additional analyzing instruments, e.g. controllers, recorders, etc can be connected in series as shown in drawing above.

5.1 Pin assignment at the pyrometer

Pin	Cable color	Connection
Pin 1	(white)	+24 V DC (10 ... 30 V)
Pin 2	(brown)	0 V
Pin 3	(black)	Shield



Instrument's plug:
3 pin flange connector.

6 Mechanical installation

6.1 Accessories (option)

Numerous accessories guarantee easy installation of the pyrometers. The following overview shows a selection of suitable accessories. You can find the entire accessory program with all reference numbers on section **13.2 Reference numbers**.

Mounting:
For easy mounting and aligning the pyrometer to the measured object an adjustable *mounting angle* is available.

Mounting angle

Cooling:
The completely covered water cooling jacket made from stainless steel protects the pyrometer if exposed to a hot environment. It is designed for ambient temperatures up to 180°C.

Water cooling jacket with integrated air purge

Miscellaneous:
The *air purge* protects the lens from contamination with dust and moisture. It has to be supplied with dry and oil-free pressurized air and generates an air stream shaped like a cone.
The pyrometer can be easily fixed on a vacuum chamber with the KF 16 vacuum support with sighting window.

Air purge

Vacuum support

Displays:
For temperature indication of the pyrometer IMPAC offers several digital displays.

Digital display DA 6000

LED large display

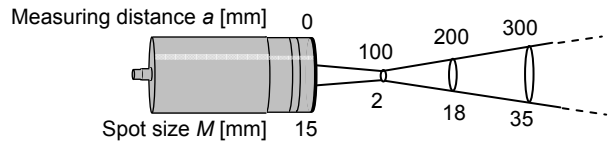
7 Optics

The pyrometers are equipped ex works with one of the following optics. These lenses are focusing to certain distances. In these distances each lens achieves its smallest spot size. The spot size will enlarge in any other distance (shorter or longer). Please notice that the measuring object must be as least as big as the spot size.
The name of the optics (e.g. optics 300) shows the measuring distance in mm (e.g. 300 mm, measured from the front of the lens) in which it has the smallest spot size (e.g. 6 mm).

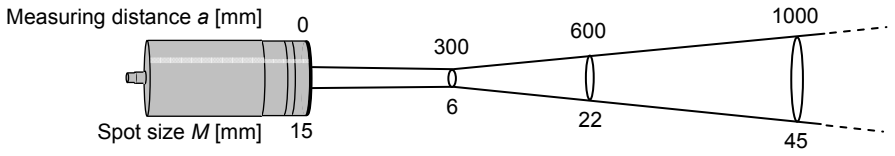
The following drawings show the size of the spots in mm in dependence of the measuring distance. Values between the mentioned data can be calculated by interpolation. The spot size for measuring distance 0 is the aperture diameter *D* of the optics.

IN 5:

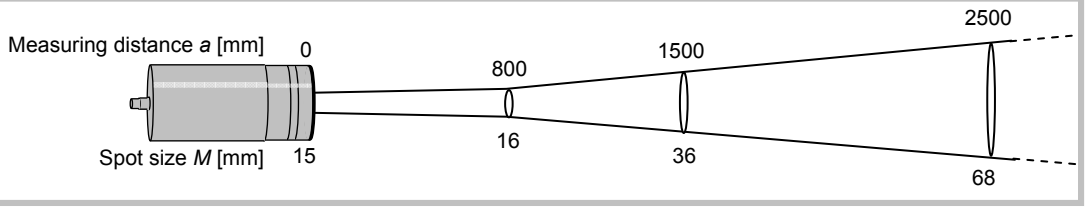
Optics 100



Optics 300

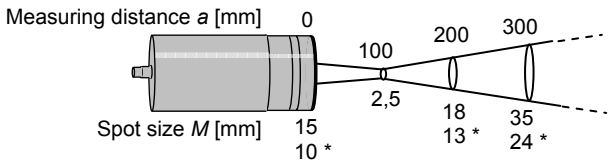


Optics 800

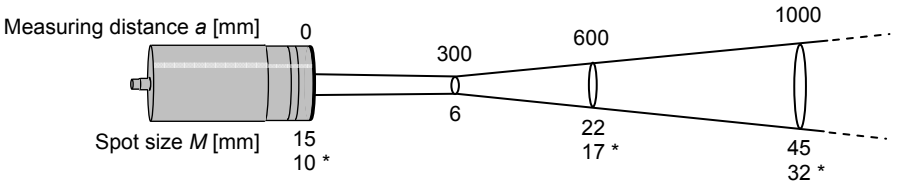


IN 5/5:

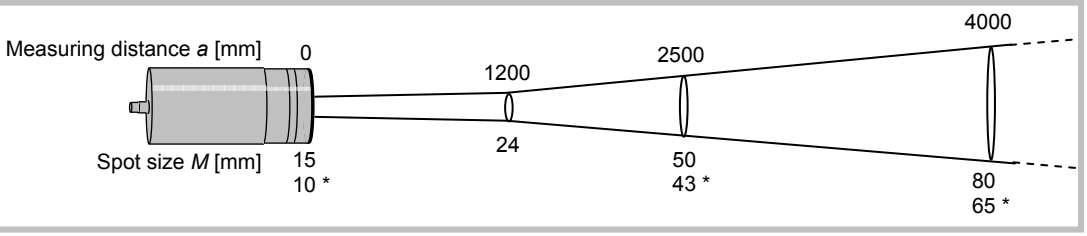
Optics 100



Optics 300



Optics 1200



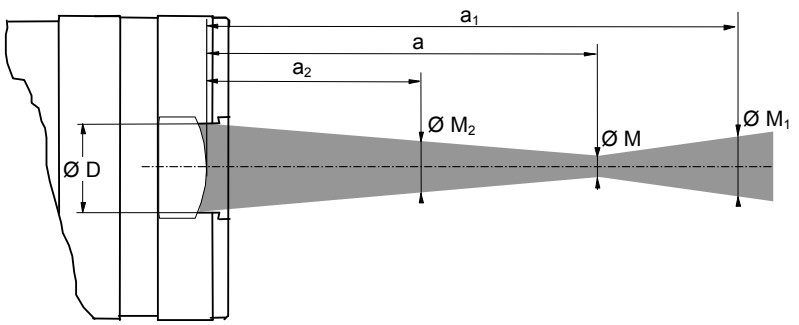
* IN 5/5 (MB 25)

Note: Please note that the optical profiles show nominal dimensions. The spot size diameter or the focal distance may be slightly different due to lens tolerances.

Spot sizes for intermediate distances, that are not shown on the optical profiles, may be calculated using the following formula:

$$M_2 = \frac{a_2}{a}(M - D) + D$$

$$M_1 = \frac{a_1}{a}(M + D) - D$$



8 Alignment of the instrument

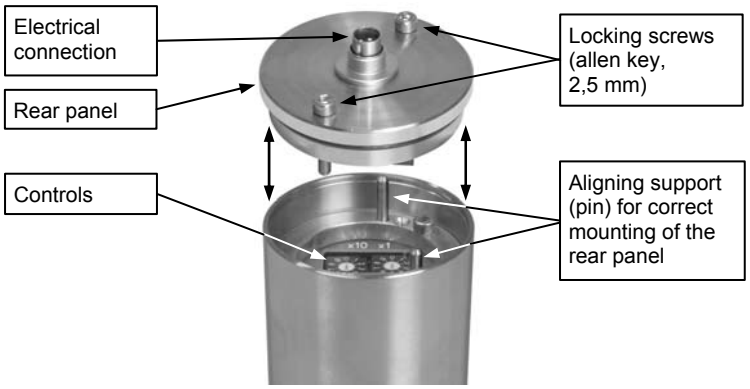
For exact measurement of the object temperature the pyrometer must be aligned correctly onto the object. The instruments are not equipped with a sighting so that the aligning must be done thermally. When measuring a hot object in front of a cooler background, it usually suffices to align the pyrometer to achieve the highest temperature reading.

9 Instrument settings

The emissivity of the measuring object and the and instrument's exposure time can be set via controls in the pyrometer housing.

The controls can be accessed by removing the rear panel in the following way:

1. Disconnect the electrical connection
2. Unscrew the rear screws with a 2.5 mm allen screw
3. Take the cover off, making sure it remains straight (without bending or twisting it).



Assembling:
When reassembling the cover, insert it carefully into the guide pins and then fasten it with the screws. The connector cable can now be plugged in.

9.1.1 Emissivity (EMI)

Settings:
100%
⋮
20%

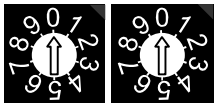
For a correct measurement it is necessary to adjust the emissivity. This emissivity is the relationship between the emission of an real object and the emission of a black body radiation source (this is an object which absorbs all incoming rays and has an emissivity of 100%) at the same temperature. Different materials have different emissivities ranging between 0% and 100% (settings at the pyrometer between 20 and 100%). Additionally the emissivity is depending on the surface condition of the material, the spectral range of the pyrometer and the measuring temperature. The emissivity setting of the pyrometer has to be adjusted accordingly. Typical emissivity values of various common materials for the two spectral ranges of the instruments are listed below. The tolerance of the emissivity values for each material is mainly dependent on the surface conditions. Rough surfaces have higher emissivities.

Note: The minimum emissivity setting for the pyrometer is 20%!

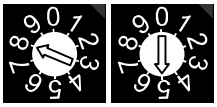
The settings will be done via the rotary switch.

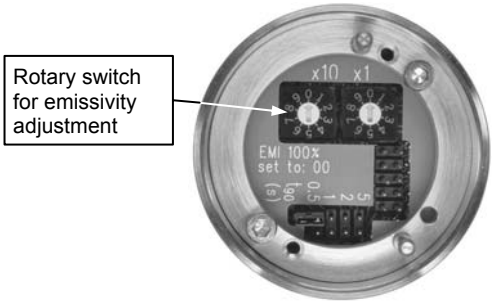
Setting examples:

EMI =100%:



EMI = 85%:





Note: If the emissivity is set to an incorrect value (below 20%) the instrument will automatically utilize an emissivity value of 100%. The setting 00 is interpreted as EMI = 100%.

Measuring object	EMI (at 8 ... 14 µm)
"Black body furnace"	100%
Human skin	98%
Black dull varnish	95%
Carbon soot	95%
Wood	80 ... 92%
Paper	92 ... 95%
Asphalt	85%
Glass / quartz glass	72 ... 87%
Textile	75 ... 95%
Graphite	75 ... 92%
Cement	90%
Water	95%

Measuring object	EMI (at 8 ... 14 µm)
Brickwork	85... 95%
Fire clay	
Rubber	
Porcelain	
Ceramics	
Varnish	
Plaster	
Oil paint	
Steel (oxidized)	60 ... 80%
Steel (smooth)	10 ... 30%
Aluminium (smooth)	2 ... 15%
Aluminium (anodized)	90%

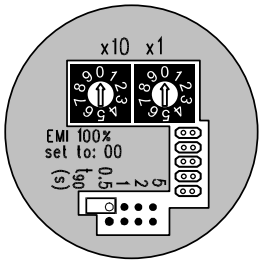
Measuring object	EMI (at 5.14 µm)
Glass / quartz glass	97%

One way to determine an accurate emissivity value for a material is to make a comparison measurement as follows: If possible, coat a portion of the object with dull black paint or carbon soot. Paint and carbon soot have high emissivities (95%) and take on the same temperature as the object. Measure the temperature of the painted area with the emissivity control set to 95%. Then measure the temperature of an adjacent unpainted area of the object and adjust the emissivity until the pyrometer displays the same temperature.

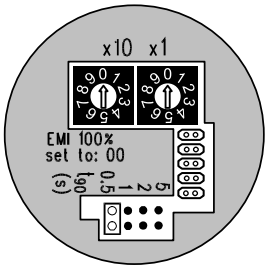
9.1.2 Exposure time t_{90}

The exposure time t_{90} is the time interval from the start of measurement up to the respective change in the output signal (4 ... 20 mA) which is the time taken to reach 90% of the recorded temperature difference.

The exposure time is changed by adjusting the jumper position. In the open position shown in the diagram on the left, the response time is 0.08 s.
For alternative settings (t_{90} = 0.5 s, 1 s, 2 s or 5 s) select the respective jumper position (see diagram on the right).



Example: t_{90} = 0.08 s



Example: t_{90} = 0.5 s

Longer exposure times are useful when measuring objects with fluctuating temperatures.

9.2 Factory settings

Emissivity (**Emi**) = 100%
Exposure time (**t_{90}**) = 0.08 s

9.3 Avoiding reading errors caused by faulty assembly

To avoid reading errors, please note the following points when mounting the pyrometer:

1. The diameter of the measuring object cannot be smaller than the pyrometer's spot size (see section **7**, **Optics**).
2. A source of radiation behind or around the measuring object can influence the result. If the object is transparent or partly transparent another material behind the object could transmit its radiation to the pyrometer as well. In this case the location of the pyrometer should be changed, or, if the background radiation remains constant it can be compensated for by changing the emissivity setting respectively.
3. Please take into account that radiation, from other hot materials around the measured object, can be reflected by these materials and influence the result. If the measured object has a low emissivity, the temperature measured will be mainly that from the reflected object - not from the intended measured object itself. To prevent ambient radiation from reaching the spot area, a mounting tube should be used. The mounting tube should be placed as near as possible to the measured object so that the tube's shadow blocks out all the ambient radiation from the side.

10 Transport, packaging, storage

With faulty shipping the instrument can be damaged or destroyed. To transport or store the instrument, please use the original box or a box padded with sufficient shock-absorbing material. For storage in humid areas or shipment overseas, the device should be placed in welded foil (ideally along with silica gel) to protect it from humidity.

The pyrometer is designed for a storage temperature of -20 … 70°C with non-condensing conditions. A storing out of these conditions can damage or malfunction the pyrometer.

11 Maintenance

11.1 Safety

Attention during pyrometer services:
Should the pyrometer be integrated in a running machine process the machine has to be switched off and secured against restart before servicing the pyrometer.

11.2 Service

The pyrometer does not have any parts which require regular service, only the lens has to be kept clean. The lens can be cleaned with a soft cloth in combination with alcohol (do not use acid solutions or dilution). Also standard cloths for cleaning glasses or photo objectives can be used.
The Germanium lens of the IN 5 has an anti-reflective coating which appears slightly colored. Be extremely careful - this layer can easily be rubbed off - this will greatly affect the measuring results!

12 Trouble shooting

Before sending the pyrometer for repair, try to find the error and to solve the problem with the help of the following list.

Temperature indication too low

- Incorrect alignment of the pyrometer to the object
  ⇒ New correct alignment to achieve the max. temperature signal (see **8**)
- Measuring object smaller than spot size
  ⇒ check measuring distance, smallest spot size is at nominal measuring distance (see **7**)
- Emissivity set too high
  ⇒ Set lower correct emissivity corresponding to the material (see **9.1.1**)
- Lens contaminated
  ⇒ Clean lens carefully (see **11.2**)

Temperature indication too high

- Emissivity set too low
  ⇒ Set lower correct emissivity corresponding to the material (see **9.1.1**)
- The measurement is influenced by reflections of hot machine parts
  ⇒ Use mechanical construction to avoid the influence of the interfering radiation

Measuring errors

- Indicated temperature is decreasing during the use of the pyrometer, contamination of the lens
  ⇒ Clean lens. Recommendation: use of air purge (see **11.2**, **6.1**)
- Indicated temperature is decreasing during the use of the pyrometer, although the air purge unit is used. Probably compressed air is not clean or air failed
  ⇒ Clean the lens and use clean, dry and oil free compressed air
- Air contamination in the sighting path between pyrometer and object
  ⇒ Change position of the pyrometer with a clean sighting path (if necessary use a ratio pyrometer)
- HF-interferences
  ⇒ Correct the connection of the cable shield (see **5**)
- Instrument overheated
  ⇒ Use cooling jacket with air or water cooling (see **6.1**)
- Temperature Indication is fluctuating, probably caused by changing emissivity
  ⇒ Wrong pyrometer type, use of ratio pyrometer recommended

13 Reference numbers

13.1 Reference numbers instruments

Type	Optics	Temperature range	Reference number
IN 5	When ordering please select one optics (optics a = 100, 300 or 800).	0 ... 100°C	3 869 010
		0 ... 200°C	3 869 020
		0 ... 300°C	3 869 030
		0 ... 400°C	3 869 040
		0 ... 500°C	3 869 050
		0 ... 600°C	3 869 090
		-32 ... 50°C	3 869 100
		-32 ... 900°C	3 869 080
IN 5/5	When ordering please select one optics (optics a = 100, 300 or 1200).	100 ... 600°C	3 869 110
		200 ... 800°C	3 869 120
		100 ... 1300°C	3 869 130
		400 ... 2500°C	3 869 140

Note: A connection cable is not included in scope of delivery and has to be ordered separately.

13.2 Reference numbers accessories

	Connection cable:	Length 2 m	Length 5 m	Length 10 m	Length 15 m	Length 30 m
3 820 ...		... 210	... 560	... 570	... 580	... 590

3 852 290 Power supply for DIN rail mounting NG DC (100...240 V AC ⇒ 24 V DC, 1 A)
3 852 550 Power supply NG 2D (85...265 V AC ⇒ 24 V DC, 600 mA, with 2 limit switches)

3 890 640 DA 4000-N: LED digital display with built-in 2-wire supply (for switchboard assembling)
3 890 650 DA 4000: as DA 4000-N, additionally with 2 limit switches
3 890 520 DA 6000: LED digital display with built-in 2-wire supply, digital- and analog input, 2 limit switches, maximum value storage, analog output, RS232
3 890 530 DA 6000 with RS485
3 890 610 Galvanic separator for DIN rail mounting (no extra power supply necessary)
3 863 010 Converter IW 5-C (4 - 20 mA into 0 - 20 mA)
3 843 500 SCA 5, scanning attachment with CaF_2 window; 24 V AC/DC

3 835 290 Air purge unit for scanning attachment SCA 5
3 834 210 Adjustable mounting support
3 835 160 Air purge unit, aluminium
3 835 440 Air purge unit, stainless steel
3 837 230 Water cooling jacket (heavy design) with integrated air purge unit
3 837 350 Water cooling jacket (heavy design) with ZnSe window for IN 5
3 837 340 Water cooling jacket (heavy design) with CaF_2 window for IN 5/5
3 837 370 Water cooling jacket (lightweight design) with integrated air purge unit
3 837 400 Water cooling jacket (lightweight design) with ZnSe window for IN 5
3 837 390 Water cooling jacket (lightweight design) with CaF_2 window for IN 5/5
3 846 100 Mounting tube
3 846 120 Flange tube
3 846 630 Vacuum flange KF16 mit Zinc Selenide window (ZnSe) for IN 5
3 846 620 Vacuum flange KF16 with Calcium Fluoride window (CaF_2) for IN 5/5
3 846 660 Spare window ZnSe, Ø 25 x 3 with Viton-O-ring
3 846 650 Spare window CaF_2, Ø 25 x 3 with Viton-O-ring

Flange system: the flange system is a modular mounting system to fix the pyrometer on furnaces, vacuum chambers, etc. It can consist of e.g. mounting support, tube support with air purge and flange and an open or closed ceramic sighting tube. The mounting support can be equipped with a quartz window for vacuum applications

3 846 260 Instrument's support
3 846 610 Support with ZnSe window (for IN 5)
3 846 600 Support with CaF_2 window (for IN 5/5)
3 846 240 Tube support with air purge nozzle
3 846 750 Window slide, without window