LUMASENSE® TECHNOLOGIES

MANUAL

IMPAC Pyrometer

IN 5/9 plus

Contents

2 Introduction

2.1 Appropriate use

The IN 5/9 plus is a digital, highly accurate pyrometer for non-contact temperature measurement of Sapphire and Sapphire Wafers between 0 °C and 1500 °C.

2.2 Scope of delivery

Instrument with selected optics, works certificate, PC measurement and evaluation software InfraWin

Note: A connection cable is not included with the instrument and has to be ordered separately (see Chapter **10, Reference numbers**).

2.3 Technical data

Temperature Range:	0 … 1500 °C		
Temperature Subrange:	Any range adjustable within the temperature range, minimum span 51 °C		
Spectral Range:	8 … 9.7 µm		
Optics:	Zinc-Sulfide (ZnS)		
Resolution:	Interface: 0.1 °C Analog output:< 0.1 % of the adjusted temperature range		
Meas. Uncertainty*: (ε = 1, t_{90} = 1 s, $T_{amb.}$ = const.)	0.6% of reading in °C or 3 °C (T_{amb} = 15...30 °C) 1 % of reading in °C or 5 °C (T_{amb} = 0…15 or 30…63 °C) Whichever value is greater. The instrument must be at a constant ambient temperature for a minimum of 60 minutes and must be connected to the power supply.		
Repeatability: (ε = 1, t_{90} = 1 s, $T_{amb.}$ = const.)	0.3% of reading in °C or 0.6 °C The instrument must be at a constant ambient temperature for a minimum of 30 minutes.		
Noise Equivalent Temperature Difference (NETD):(at σ=1, ε=1, $T_{amb.}$ = 23 °C)	Temperature	NETD at t_{90} = 180 ms / °C	NETD at t_{90} = 1 s / °C
	350 °C	0.5	0.2
	950 °C	0.4	0.1
Emissivity ε:	0.2 ... 1.2 switchable in the instrument (offline mode: adjustable from 0.2 ... 1.0) or with the software InfraWin (online mode) in steps of 0.01		
Exposure Time t_{90}:	0.18 s; adjustable in the pyrometer: 0.5 s; 1 s; 2 s; 5 s, adjustable via interface: 0.5 s; 1 s; 2 s; 5 s; 10 s; 30 s		
Sighting:	Laser targeting light 650 nm Laser power level < 1 mW Laser class 2 per IEC60825-1-3-4 		
Maximum Value Storage:	Built-in single and double store. Clearing with clear time t_{CL} (0.1 s; 0.25 s; 0.5 s; 1 s; 5 s; 25 s), external contact or via interface or also automatically with each new item to be measured		

Analog Output:	Adjustable 0 ... 20 mA or 4 ... 20 mA (linear)
Load:	Max. 500 Ohm at 24 V (max. 200 Ohm at 18 V)
Digital Interface:	RS232 (RS485 on request)
Parameters:	Adjustable on the pyrometer (in offline mode): Emissivity, exposure time, 0/4 ... 20 mA analog output range, online- / offline switch Readable and adjustable via interface / PC (in online mode): Emissivity, exposure time, 0/4... 20 mA analog output range, sub temperature range, automatic clearing of the max./min value storage, external clearing of the max./min value storage, clear times of the max/min value storage, address, baud rate, internal temperature °C / °F, max. / min. selection, activation of ambient temperature correction

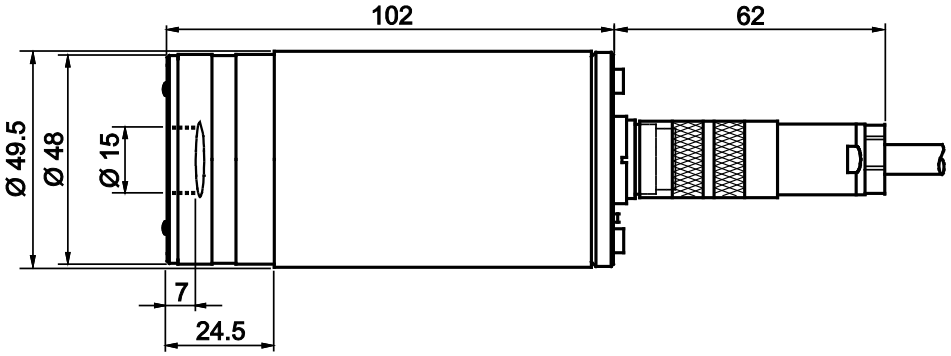
Power Supply:	24 V DC (18 ... 30V DC) nominal, ripple must be less than 0.5 V
Power Consumption:	Max. 70 mA
Isolation:	Power supply, analog outputs and digital interfaces are electrically isolated from each other

Ambient Temperature:	0 ... 63 °C
Storage Temp.:	-20 ... 70 °C
Rel. Humidity:	Non-condensing conditions
Protection Class:	IP65 (DIN 40050)
Operating Position:	Any
Housing:	Stainless steel
Weight:	410 g
Connection:	12 pin connector
CE-Label:	According to EU directives about electromagnetic immunity

Note: The calibration / adjustment of the instruments was carried out in accordance with VDI/VDE directive “Temperature measurement in industry, Radiation thermometry, Calibration of radiation thermometers”, VDI/VDE 3511, Part 4.4.

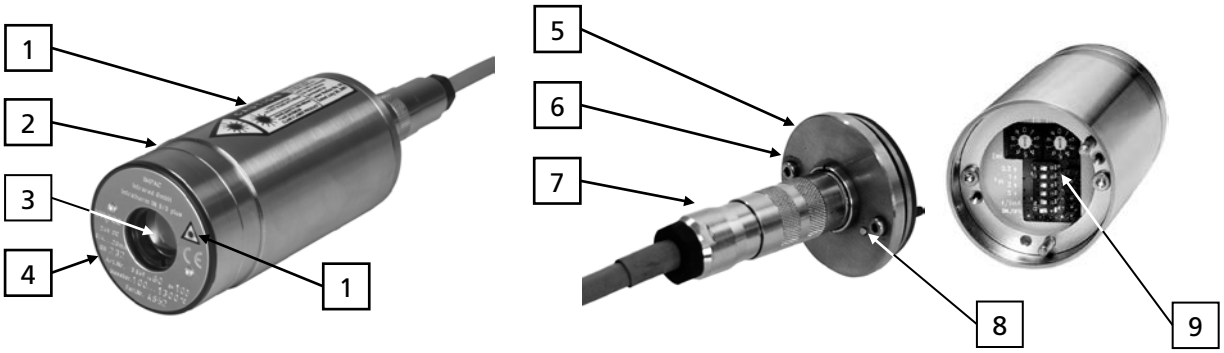
For additional details on this directive, see http://info.lumasenseinc.com/calibration or order the directive from “Beuth Verlag GmbH” in D-10772 Berlin, Germany.

2.4 Dimensions



All dimensions in mm

2.5 Physical user interface



1 Laser warning label
2 Stainless steel housing
3 Optics
4 Type label
5 Housing rear panel
6 Fixing screws for rear panel
7 Electrical connector
8 Laser targeting light button
9 Setting keys at the pyrometer

2.6 Accessories (Optional)

Numerous accessories guarantee easy installation of the pyrometers. The following overview shows a selection of suitable accessories. You can find the entire accessory list with all reference numbers in **Section 10.2 Reference numbers accessories**).

2.6.1 Mounting

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

Mounting angle

2.6.2 Water Cooling Jacket

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

2.6.3 Miscellaneous

The *air purge* protects the lens from contamination with dust and moisture. It must be supplied with dry and oil-free pressurized air and generates an air stream shaped like a cone.

Air purge units

Vacuum support

The pyrometer can be easily mounted on a vacuum chamber with the KF 16 vacuum support with sighting window.

2.6.4 Display

In addition to the built-in temperature indicator of the pyrometer, LumaSense offers several digital displays which can also be used for remote parametrizing of the pyrometer.

Digital display DA 6000

3 Controls and Installation

3.1 Electrical Installation

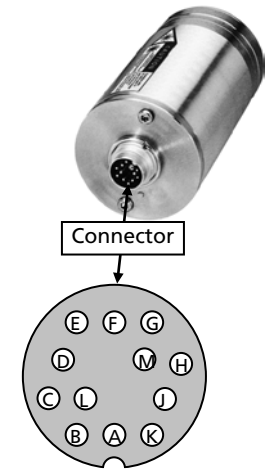
The IN 5/9 plus pyrometer is powered by a voltage of 24 V DC (possible range 18 ... 30 V). Once connected to power, the instrument operates immediately and needs no warm-up time. To switch off the instrument, unplug the connector.

To meet the electromagnetic requirements, a shielded connecting cable must be used. The shield of the connecting cable must be connected only on the pyrometer side to avoid ground loops.

LumaSense offers connecting cables, but they are not part of standard scope of delivery. The main connecting cable has wires for power supply, interface, analog output, external laser switch and external clear of maximum value storage via contact and 12 pin angle connector (see **Chapter 10**, **Reference numbers**). The cable includes a short RS232 adapter cable with a 9 pin SUB-D connector for direct PC communication. This adapter is not used in combination with RS485 interface.

3.1.1 Pin assignment for the connector on the back of the pyrometer

Pin	Color	Indication
K	white	+ 24 V power supply (or 24 V AC)
A	brown	0 V power supply
L	green	+ $I_{outp.}$ analog output
B	yellow	– $I_{outp.}$ analog output
H	gray	external switch for targeting light (bridge to K)
J	pink	external clearing of maximum value storage (bridge to K) *)
G	red	DGND (Ground for interface)
F	black	RxD (RS232) or B1 (RS485)
C	violet	TxD (RS232) or A1 (RS485)
D	gray/pink	B2 (RS485) (bridge to F)
E	red/blue	A2 (RS485) (bridge to C)
M	orange	Screen only for cable extension, don't connect at the switchboard



Pin assignment
(side of male inserts)

*) For setting of clear time to "extern" (see 5.2.1 Maximum / minimum value storage)

3.1.2 Connecting the pyrometer to a PC

The pyrometers are equipped with a serial interface RS232. Only one pyrometer can be connected on the standard PC RS232 interface. Only short distances can be transmitted with RS232 and electromagnetic interferences can affect the transmission.

The pyrometer can also be equipped with an RS485 serial interface (on request). With the RS485, long transmission distances can be realized, and the transmission is, to a large extent, free of problems. The RS485 also allows several pyrometers to be connected in a bus system.

If an RS485 connection is not available at the PC, it can be accomplished using an RS485 or RS232 to USB connector. When using a RS485 to USB adapter, make sure that the adapter is fast enough to receive the pyrometer's answer to an instruction of the master. Most of the

commonly used adapters are too slow for fast measuring equipment, so it is recommended to use the RS485 ⇔ USB adapter cable (ref. no. 3 826 750).

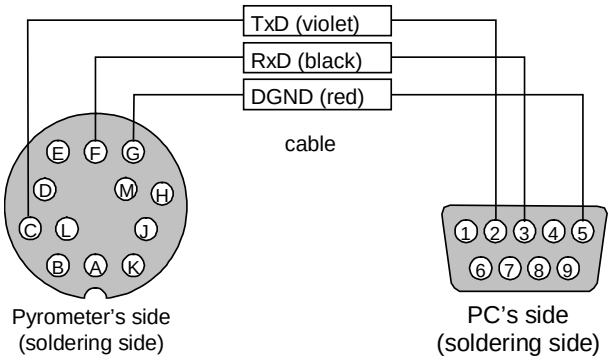
With a slow RS485 connection it is also possible to set a wait time at the pyrometer, which delays the response of a command to the pyrometer (see **5.2.6 Wait time t_w**).

3.1.3 Connecting to RS232 interface

The transmission rate (in baud) of the serial interface is dependent on the length of the cable. Values between 1200 and 19200 Bd may be set.

The baud rate must be reduced by 50% when the transmission distance is doubled (see also **5.2.3 kBaud (baud rate)**).

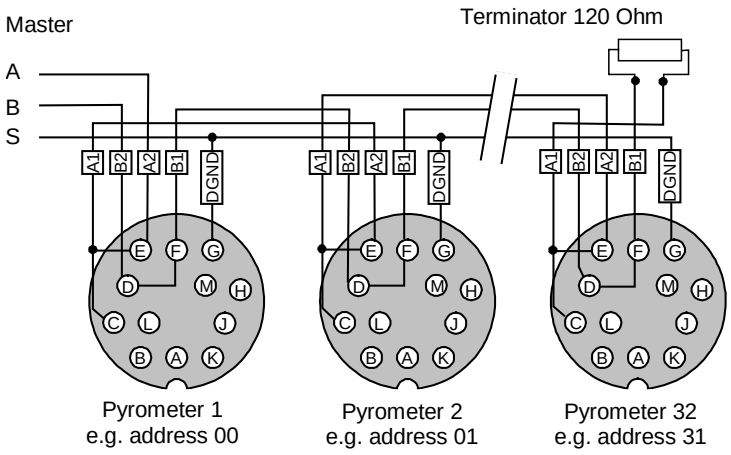
Typical cable length for RS232 at 19200 Bd is 7 m.



3.1.4 Connecting to RS485 interface

Half-duplex mode:

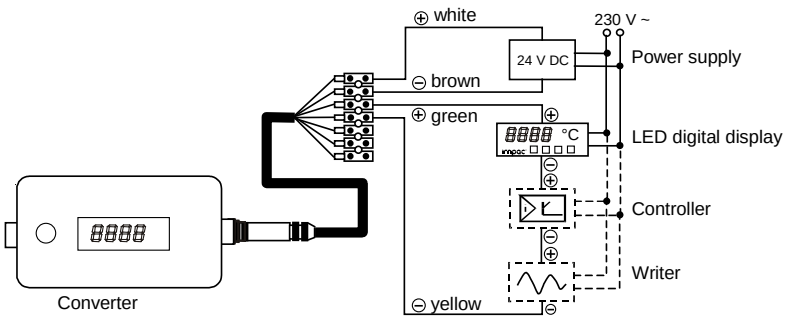
A1 and A2 as well as B1 and B2 are bridged in the 12-pin round connector of the connecting cable, to prevent reflections due to long stubs. It also safeguards against the interruption of the RS485 Bus system should a connecting plug be pulled out. The master labels mark the connections on the RS485 converter. The transmission rate of the serial interface in Baud (Bd) is dependent on the length of the cable. Values between 1200 and 19200 Bd may be set.



The baud rate is reduced by 50% when the transmission distance is doubled (see **5.2.3 Baud Rate (kBaud)**). Typical cable length for 19200 Bd is 2 km.

3.1.5 Connection of additional analyzing devices

Additional analyzing instruments (such as LED digital display instruments) only need to be connected to a power supply and the analog outputs from the pyrometer. Another Instrument, such as a controller or printer, can be connected to the display in series as shown below (total load of resistance max. 500 Ohm).



3.2 Sighting

3.2.1 Laser targeting light

For exact measurement of the object temperature, the pyrometer must be aligned correctly onto the object. For this alignment, the pyrometers are equipped with a laser targeting light. This laser enables the simple and accurate alignment even onto small objects.

The laser marks the center of the measuring spot. The laser targeting light can be used during operation without affecting the measurement.

The laser targeting light can be switched on and off either by pressing the button at the housing or by using an external contact (see **3.1.1 Pin assignment for the connector on the back side of the pyrometer**) or via PC and the software InfraWin. After two minutes, the laser targeting light switches off automatically.

Caution: Do not look directly into the laser beam! Laser class 2 according to IEC 60825-1-3-4

Note: To prevent damage to the laser, the laser targeting light switches off automatically if the internal temperature of the device goes above approx. 50 °C (then it cannot be switched on again until the temperature is lower than 50 °C again)!

Note: The laser warning signs on the pyrometer should be easily viewable at all times, even after it has been installed.

3.2.2 Thermal Alignment

When measuring a hot object in front of a cooler background, it usually suffices to align the pyrometer to achieve the highest temperature reading.

3.3 Optics

The IN 5/9 plus pyrometer is equipped ex works with one of the specified optics shown in the table. Each optic is focussed at a certain distance (main measuring distance). At these distances, each lens achieves its smallest spot size. Normally the spot size will increase at any other distance (shorter or longer).

Select one optics that corresponds to the required measuring distance of the application.

Optics	Measuring Distance *a* [mm]	Spot Size M_{90} [mm]
1	95	1.7
	150	11.3
	250	28.6
2	112	1.9
	200	15
	300	29.9
3	160	2.8
	250	12.7
	350	23.7
4	270	4.5
	500	19.7
	750	36.9
5	400	6.4
	750	25
	1000	38.2
6	620	10
	1000	25.2
	1500	45.2

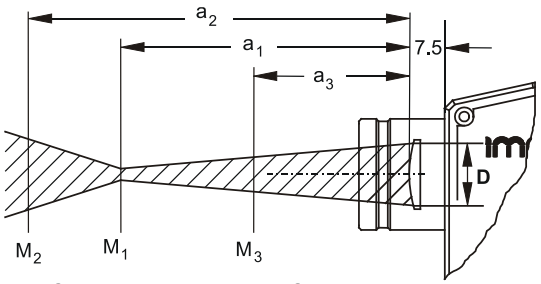
Effective aperture D for all optics is 14.8 mm

For each optic some example values for measuring distance (measured from the front of the lens) and spot size are listed. Keep this in mind when considering the mounting position of the pyrometer as well as the size of the measuring object (the measuring object must be as least as big as the spot size.

3.3.1 Calculating spot sizes

Spot sizes for other measuring distances can be calculated with the following equations or with the IR calculator of the *InfraWin* software.

Table values: a_1 = measuring distance
M_1 = spot size
D = aperture



$$M_2 = \frac{a_2}{a_1} (M_1 + D) D \qquad M_3 = \frac{a_3}{a_1} (M_1 - D) + D$$

Note: The measuring object must be at least as big as or bigger than the spot size of the pyrometer.

4 Instrument Settings

The pyrometers are equipped with a wide range of setting options for optimal adaption to the required measuring condition and for getting the correct measuring temperature (description of all available parameters see Chapter **5 Parameter description / settings**).

Basic settings can be done at the pyrometer itself and additional settings can be made via serial interface and software *InfraWin*.

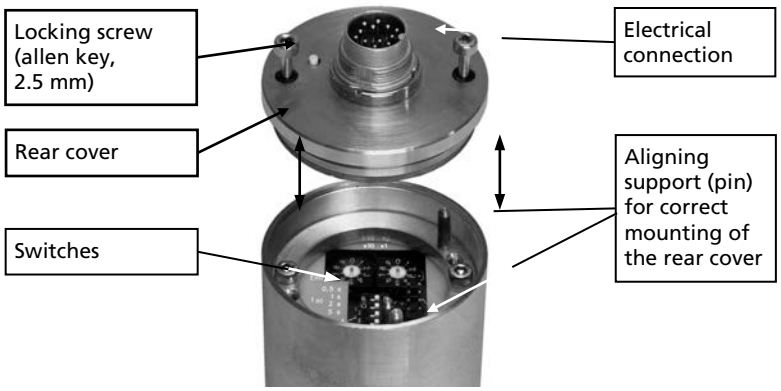
Settings at the instrument: The basic settings are emissivity, exposure time, analog output. These settings can be adjusted at the pyrometer only in offline mode (see **4.2 Online / offline mode (ONL/OFFL)**).

Settings via serial interface: The pyrometer is equipped with the serial interface RS232 (RS485 on request) and can be used for connection to a PC. With the standard software *InfraWin* (or self written communication software), the following settings can be made when the pyrometer is set to online mode (ONL): emissivity, exposure time, analog output, maximum value storage, minimum value storage, reading of the instrument's internal temperature, setting of an address for bus control with RS485 interface, setting of the baud rate, and function for compensating of the off-set of the ambient temperature. Additionally, *InfraWin* allows you to use the temperature display and analysis features.

4.1 Switches at the Instrument

The *controls / switches* are located under the rear cover of the pyrometer and can be accessed by removing the rear cover:

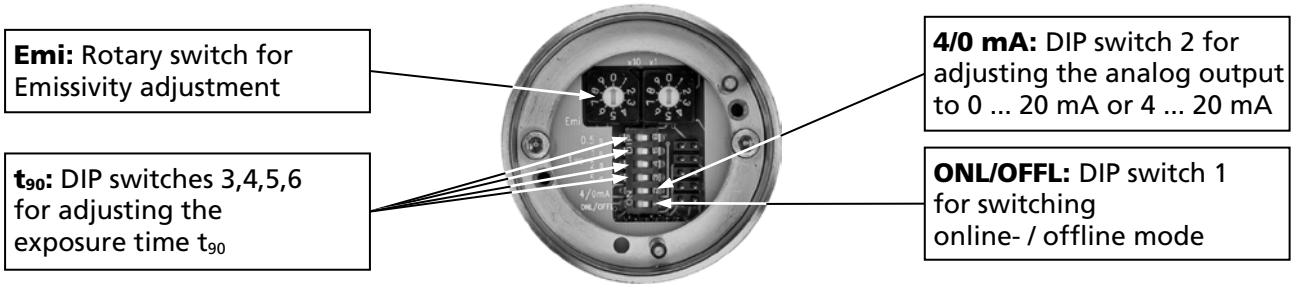
1. Disconnect the electrical connection
2. Unscrew the rear screws with a 2.5 mm allen screw
3. Remove the cover off, making sure it remains straight (without bending or twisting it).



Note: Please make sure that the pyrometer is not contaminated while open. Please reattach cover following adjuments and keep cover closed for permanent use.

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.

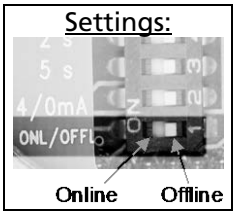
4.1.1 Instrument Switches



See Chapter 5 for the Parameter descriptions / Settings.

4.2 Online/Offline Mode (ONL/OFFL)

4.2.1 Offline (OFFL)



If the settings directly at the pyrometer should be used (emissivity, exposure time and analog output), the pyrometer must be switched to offline mode (OFFL). In the offline mode, these parameters can not be adjusted via digital interface and PC and can only be read. This prevents incorrect set-up or undesired changes via the interface. All additional available parameters (see **5.2 Settings *only* via serial interface**) can be altered via serial interface.

4.2.2 Online (ONL)

When switched to the online mode (ONL), only the serial interface can be used to set the values for the parameters and the instrument's switch settings are ignored. The device is initialized in "online" mode, i.e. it uses the last values set via serial interface!

4.3 Factory settings

Instrument settings:
Emissivity (**Emi**) = 100%
Exposure time (**t_{90}**) = 0.18 s
Analog output (**4/0 mA**) = 0... 20 mA
Online- / offline mode (**ONL/OFFL**) = offline

Interface settings:
Emissivity (**Emi**) = 100%
Exposure time (**t_{90}**) = 0.18 s
Analog output (**4/0 mA**) = 0... 20 mA
Baud rate = 19200 Bd
Address = 00
Max./min. value storage = max.
Clear time of max./min. value storage = OFF
Ambient temperature compensation = auto
Wait time t_w = 02 Bit

5 Parameter Descriptions / Settings

5.1 Settings at the pyrometer or via serial interface

5.1.1 Emissivity (Emi)

Settings:
100%
(in Online Mode, up to 120%)
.
.
.
20%

For a correct measurement, it is necessary to adjust the emissivity. The *emissivity* is the relationship between the emission of a real object and the emission of a blackbody radiation source (this is an object which absorbs all incoming rays and has an emissivity of 100%) at the same temperature.

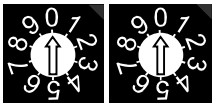
Different materials have different emissivities ranging between 0% and 100% (settings at the pyrometer between 20 and 100%, respectively 120% in Online Mode, the set value is indicated on the display). Additionally, the emissivity is dependent on the surface condition of the material, the spectral range of the pyrometer, and the measuring temperature. The emissivity setting of the pyrometer has to be adjusted accordingly.

For the spectral range of the IN 5/9 plus, the typical emissivity on Sapphire and Sapphire Wafers lies between 98 and 99 %.

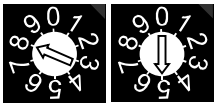
Note: The minimum emissivity setting for the pyrometer is 20%!

Setting examples at the instrument:

Emi = 100%:



Emi = 85%:



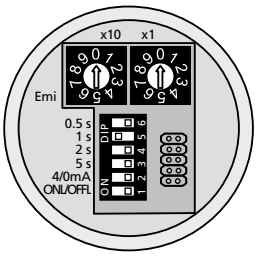
If the settings directly at the pyrometer should be used the pyrometer must be switched into offline mode (OFFL, see **4.2**). To adjust the emissivity via software, see InfraWin description in the program's help menu. Click on the F1 button after loading InfraWin or click on the ? in the menu bar.

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%.

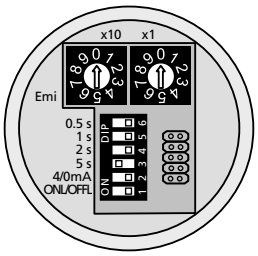
5.1.2 Exposure time (t_{90})

The exposure time is the time interval when the measured temperature has to be present after an abrupt change so that the output value of the pyrometer reaches a given measurement value. The time taken is to reach 90% of the recorded temperature difference. In the "min" position, the device operates using its time constant of < 180 ms. Longer exposure times can be used for the measurement of objects which have rapidly fluctuating temperatures to achieve constant temperature reading.

Setting examples at the instrument:



Example: t_{90} = 1 s



Example: t_{90} = 5 s

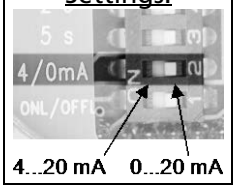
To change the exposure time the corresponding DIP switch for 0.5 s, 1 s, 2 s or 5 s must be set in the ON position. A longer response time of 10 s can be set if the switch for 0.5 s and 5 s is set to the ON position at the same time, a longer response time of 30 s can be set if the switch for 1 s and 5 s is set at to the ON position the same time. In the "OFF" position (Software *InfraWin*: t_{90} = min), the device operates using its time constant (see technical data).

If the settings directly at the pyrometer should be used the pyrometer must be switched into offline mode (OFFL, see **5.2**). To adjust the exposure time via software, see InfraWin description in the program's help menu.

5.1.3 Analog Output 0/4 to 20 mA

When the DIP switch 2 is in the ON position, the analog output will be 4 - 20 mA, in the OFF position, the analog output will be 0 - 20 mA. The analog output has to be selected according to the signal input of the connected instrument (controller, PLC, etc.).

Settings:



If the settings directly at the pyrometer should be used the pyrometer must be switched into offline mode (OFFL, see **5.2**). To adjust the analog output via software, see InfraWin description in the program's help menu.

5.2 Settings *only* via serial interface

5.2.1 Maximum / minimum value storage (t_{Clear})

The integrated maximum value storage is activated when the parameter t_{clear} is set to something other than "OFF". If the maximum value storage is switched on, the highest last temperature value will always be displayed and stored. The minimum value storage saves the lowest measurement taken during a reading (e.g. practical when monitoring cooled goods such as frozen foods). As such, it may be beneficial to periodically clear and reset the stored values to obtain new temperature readings.

Settings:
off
0.1 s
0.25 s
0.5 s
1 s
5 s
25 s
extern
auto

This storage also must be cleared at regular intervals when fluctuating object temperatures cause the display or the analog outputs to change too rapidly or when the pyrometer is not constantly viewing an object to be measured.

The maximum value storage value has two different operating modes:

Single Storage: Single storage mode is used when you want to reset the stored value using an external impulse via one contact closure from an external relay (such as between two measured objects). The relay contact is connected directly to the pyrometer between pins J and K. This mode allows a new value to be established after each impulse from the reset signal.

Double Storage: Double storage mode comes into effect when selecting one of the reset intervals. This mode utilizes two memories. With the first memory, the highest measured value is held and is deleted alternately in the time interval set (clear time). The other memory retains the maximum value throughout the next time interval. The disadvantages of fluctuations in the display with the clock frequency are thereby eliminated.

The following settings are possible:

Off: When set to OFF, the maximum value storage is switched off and all new temperature values are measured but not stored.

0.1...25 s: If any clear time is set, the maximum value is estimated and held in double storage mode. After the entered time the storage will be deleted.

Extern: The external clearing of the storage can be activated and used within an own software (see Chapter **9 Data format UPP** (Universal Pyrometer Protocol)) or via an external contact (for connection see **3.1.1 Pin assignment for the connector on the back of the pyrometer**). In this case, the storage operates only in single storage, because only a single deletion mechanism is used.

Auto: The **auto** mode is used for discontinuous measuring tasks. For example, objects are transported on a conveyer belt and pass the measuring beam of the pyrometer only for a few seconds. Here the maximum value for each object must be indicated. In this mode the maximum value is stored until a new hot (or cold) object appears in the measuring beam. The temperature which must be recognized as **hot** is defined by the low limit of the adjusted sub range. The stored maximum value will be deleted when the temperature of the new hot object exceeds the low limit **from** of the sub range by 1% or at least 2 °C. If a lower limit is not entered, the maximum value storage will be deleted whenever the lower level of the full measuring range has been exceeded. The *minimum value function* operates in the opposite manner. The minimum value stored will be deleted when the upper limit of the set range is below it by 1% (at least 2 °C). If an upper limit is not entered, the minimum value stored will be deleted whenever it drops below the upper level of the full measuring range.

Note: In the command structure, the maximum storage comes after the exposure time. This results in:

- clear time ≤ the adjusted response time is useless
- clear times must be at least 3 times longer than the response time
- only maxima with full maximum value can be recorded, which appear at least 3 times longer than the response time.

5.2.2 Subrange

You can choose a sub range (minimum 51 °C) within the basic measuring range of the pyrometer. This sub range corresponds to the analog output. The lower value (0 or 4 mA) describes the beginning of this measuring range, the upper value (20 mA) the end of the range. With a sub range, it is possible to fulfill the requirements of the "auto" clear mode of the maximum value storage (see above).

5.2.3 Baud rate (kBaud)

The transmission rate of the serial interface in Baud (Bd) is dependent on the length of the cable. A standard cable length with RS232 for 19200 Bd is 7 m, with RS485 2 km. The baud rate is reduced by 50% if the transmission distance is doubled.

Settings via interface:
1.2 kBd
⋮
19.2 kBd

5.2.4 Address

When connecting several pyrometers to one serial interface with RS485, it is necessary for each instrument to have its own device address for communication purposes. First, it is necessary to connect each instrument separately to give it an address. After that, all instruments can be connected and addressed individually.

Settings via interface:
00
⋮
97

Note: Only via own communication program with interface command (not possible with InfraWin, because InfraWin automatically detects a connected pyrometer): If parameters should be changed simultaneously on all pyrometers, the global **Address 98** can be used. This allows you to program all pyrometers at the same time, regardless of the addresses that have already been assigned. If the address of a pyrometer is unknown, it is possible to communicate with it using the global **Address 99** (connect only one pyrometer).

5.2.5 Ambient temperature compensation

Each object has an emissivity ε (maximum 100%). If the measured object is not transparent and has an emissivity of less than 1 (as in most cases), a portion of the resulting radiation will be reflected.

For bright, smooth surfaces, such as mirrors, the reflected radiation is more focused; on rough, harsh surfaces it is diffuse. The rate of diffuse reflection is, in this case (1 - ε).

If the measured object's temperature is the same as the ambient temperature (this is most often the case), you only need to set the emissivity on the pyrometer (when using the *InfraWin* program, the off-set compensation for the ambient temperature must be in "auto").

If the object to be measured is in an oven, where the temperature is higher than the ambient temperature, a portion of the radiation, corresponding to the rate of diffuse reflection, will be "reflected" by the measured object to the pyrometer, resulting in an inaccurate reading (the reading will be too high due to the oven temperature). In this case, it makes sense to activate the off-set compensation for the ambient temperature (in the parameter window of the *InfraWin* program: Compensating for the off-set of the ambient temperature switched to "man." (= manual)) and then enter the ambient temperature value (in this case, the oven temperature) in the corresponding field. The program also makes a compensation calculation to display the correct temperature.

Be aware that the accuracy of such a correction is highly dependent on accuracy of the emissivity value that was set. The off-set compensation for the ambient temperature uses the rate of diffuse reflection when performing its calculation. If you alter the emissivity (ε), you are also altering the rate of diffuse reflection (1 – ε) and in turn, the displayed temperature. The following observation shows how a faulty emissivity reading in conjunction with the compensation for the ambient temperature affects results:

Entry of ε = 91% instead of 92% indicates:
A relative change in emissivity of 1.1%.
Likewise, the assumed rate of reflection changes from 8% to 9%.
This results in a relative increase in reflection of 12.5%.

This change also impacts the displayed result, thereby causing an inaccurate compensation calculation. For hot environments, this calculation will probably serve as a much more accurate assessment than the standard calculation, which assumes that the ambient temperature is the same as that of the object measured.

5.2.6 Wait time (t_w)

Using a pyrometer with RS485 it is possible that the connection is not fast enough to receive the pyrometer's answer to an instruction of the master. In this case, a wait time can be set to slow down the data transfer (e.g.: t_w = 02 at a baud rate 9600 means a wait time of $^2/_{9600}$ sec).

Settings:
00 Bit
⋮
99 Bit

Note: Only available via interface commands, see Chapter **9, Data format UPP**.

5.2.7 Internal temperature

The internal temperature of the pyrometer can be read via interface. It is a few degrees above the ambient temperature due to the warming generated by the pyrometer electronics.

5.3 Avoiding Reading Errors

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 Chapter **3, 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, you can compensate for additional radiation by adjusting the emissivity setting.
3. Please take into account that radiation from other hot materials around the measured object can be reflected and influence the result. Temperatures measured for objects with low emissivities will actually be from the reflected object and not from the intended measured object. Use a mounting tube to prevent ambient radiation from reaching the area. Place the mounting tube as near as possible to the measured object so that the tube's shadow blocks out all of the ambient radiation from the side. Consider whether **5.2.5 Ambient temperature** compensating applies to the measurement application.

6 Software InfraWin

The operating and analyzing *InfraWin* software is included with delivery of the pyrometer. In addition to allowing you to make parameter adjustments via PC, the *InfraWin* software also provides temperature indication, data logging, and measurement analysis features.

A software description can be found in the program's help menu. Click on the F1 button after loading InfraWin or click on the ? in the menu bar.

The latest version is available for free as download from the homepage www.lumasenseinc.com.

6.1 Connecting the pyrometer to a PC

The program *InfraWin* can operate up to two devices. Two devices using RS485 may be operated simultaneously by the same interface, if two different addresses have been properly entered (see section **5.2.4 Address** for more information).

6.2 Installation

To install the *InfraWin* software, select setup.exe from the *InfraWin*-CD or from the downloaded and unpacked zip file from the internet and then follow the installation instructions.

6.3 Program start

The first time you load *InfraWin* 5, you will be prompted to select a default language. The *InfraWin* software is available in German, English, Spanish, French, Portuguese, and Chinese. Once installed, click **Language/Languages** if you would like to select another language.

7 Maintenance

7.1 Cleaning the front window

Since the device does not contain parts that require regular maintenance, the only regular maintenance required is periodic inspection of the front window for build-up of foreign particiles. If allowed to build up, the particles can influence the energy received by the instrument.

The window is not water soluable and can be cleaned with standard lens tissue dampened with a commercially available glasses or camera lens cleaning solution. Use a soft blower/brush (available in camera stores) to remove any grit on the window before you rub the lens with lens tissue and solution.

Attention: NEVER CLEAN THE WINDOW WITH A DRY TISSUE OF ANY KIND! The only time dry lens tissue may be used is to dry a window which has already been cleaned with wet lens tissue.

7.2 Safety

Attention: 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.

8 Troubleshooting

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
- Measuring object is smaller than spot size.
  ⇒ Choose correct measuring distance
- Measuring object is not always in the measuring spot of the pyrometer (e.g. swinging wire or pouring stream)
  ⇒ Use max. value storage
- Emissivity set too high
  ⇒ Set lower correct emissivity corresponding to the material
- Lens contaminated
  ⇒ Clean lens carefully

Temperature indication too high

- Emissivity set too low
  ⇒ Set higher correct emissivity corresponding to the material
- The measurement is influenced by reflections of hotter machine parts
  ⇒ Try to avoid the influence of the interfering radiation or change measuring position

Measuring errors

- Indicated temperature is decreasing during the use of the pyrometer, contamination of the lens
  ⇒ Clean lens
- 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
- Strong HF-interferences
  ⇒ Change position of the pyrometer
- Instrument overheated
  ⇒ Use cooling jacket with air or water cooling
- Temperature Indication is fluctuating, probably caused by changing emissivity
  ⇒ Wrong pyrometer type, use of ratio pyrometer recommended

Laser targeting light

- Laser targeting light fails
  ⇒ Instruments max. temperature is exceeded. Use cooling jacket

9 Data Format UPP (Universal Pyrometer Protocols)

Via interface and a suitable communication software or via "Test" function of the *InfraWin* software commands can be exchanged directly with the pyrometer.

Note: The ONL/OFFL switch must be in the ONL position before adjusting the following parameters via the software (see **4.2**).

The data exchange occurs in ASCII format with the following transmission parameters:

The data format is: 8 data bits, 1 stop bit, even parity (8,1,e)

The device responds to the entry of a command with: output (e.g. the measuring value) + CR (Carriage Return, ASCII 13), to pure entry commands with "ok" + CR.

Every command starts with the 2-digit device address AA (e.g. "00"). This is followed by 2 small command letters (e.g. "em" for level of emissivity ε), finished with CR

This is followed, if necessary for that command, by the ASCII parameter "X". If this parameter "X" is omitted, then the device resets with the current parameter.

A „?" after the small command letters answers with the respective settings (only at setting commands, not at enquiry commands).

Example: Entry: "00em"+ <CR>

The emissivity setting (ε) of the device with the address 00 is returned

Answer: "0970"+ <CR> means Emissivity = 0.97 or 97.0%

Description	Command	Parameters
Reading measuring value:	AAms	Output: YYYYY 5-digit decimal, in 1/10°C or. °F 88880 = temp. overflow 02563 = 256.3 °C or °F -0170 = -17.0 °C or °F
Repeatedly reading measuring values:	AAmsXXX	XXX = 000 to 999 XXX = No. of measuring values
Emissivity:	AAemXX AAemXXXX	XX = 20 to 99%, 00 = 120% (decimal) XXXX = 0200 to 1200 in ‰
Exposure time t_{90}:	AAezX	X = 0 ... 6 (decimal) 0 = intrinsic time constant of the device 1 = 0.5 s 3 = 2 s 5 = 10 s 2 = 1 s 4 = 5 s 6 = 30 s
Analog output [1]:	AAasX	X = 0;1 0 = 0 - 20 mA 1 = 4 - 20 mA
Changing °C / °F [1]:	AAfhX	X = 0;1 (decimal) 0 = Output Celsius 1 = Output Fahrenheit
Clear time of maximum / minimum value storage:	AAlzX	X = 0 ... 8 (dec.) 0 = Maximum value storage off 1 = 0.10 s 4 = 1.00 s 7 = externally deleted 2 = 0.25 s 5 = 5.00 s 8 = automatically cleared 3 = 0.55 s 6 = 25.00 s
External clearing:	AAlx	Simulation of an external deletion contact
Reading basic temperature range:	AAmb	Output: YYYYZZZZ (hex 8-digit, °C or °F) YYYY = beginning of temperature range ZZZZ = end of temperature range

Description	Command	Parameters
Reading temperature sub range:	AAme	as with mb
Baud rate:	AAbrX	X = 0 to 4 0 = 1200 Baud 2 = 4800 Baud 4 = 19200 Baud 1 = 2400 Baud 3 = 9600 Baud
Reading ambient temperature:	AAut	Output: stored value, 4-digit hex e.g. 0258 corresponds to 600 degrees
Entering ambient temperature:	AAutXXXX	XXXX = value of ambient temperature, 4-digit, hex XXXX e.g. FFEC corresponds to –20 degrees - 99dez = FF9Dhex means: automatic, no manual compensation
Marginal values for ambient temperature:	AAut?	Output: marginal values for the entry, 2 x 4-digit, hex e.g. FF9D0384 corresponds to -99 to 900 degrees
Reading marginal values:	AAmi?	Output: marginal value for entry, always 01
Device address [1]:	AAgaXX	XX: Device address decimal 00 to 31 variable device addresses
Laser targeting light:	AAlaX	X = 0;1 (decimal) 0 = switch off pilot light 1 = switch on pilot light
Internal pyrometer temperature:	AAgt	Output: XX (dec. 00 to 98, in °C)
Max. internal temperature:	AAtm	Output: XX (dec. 00 to 98, in °C)
Reading parameters:	AApa	Output decimal 11-digit: Digit 1 and 2 (20...99 or 00): Emissivity Digit 3 (0 ... 6): Exposure time (t_{90}) Digit 4 (0 ... 8): Clear time max. storage (t_{clear}) Digit 5 (0 ... 1): Analog output Digit 6 and 7: (00 ... 98): Temperature Digit 8 and 9 (00 ... 31): Address Digit 10 (0 ... 4): Baud rate Digit 11: always 0
Error status:	AAfs	Output 1 Byte hex Bit 0 = 1: EEPROM error Bit 1 = 1: Watch dog Reset Bit 2 = 1: Under voltage reset
Reset [1]:	Aare	Reset device
Command delay:	AAtwXX	XX = 00 to 20 relative delay value
Reading maximum/ minimum values:	AAmi	Output: 0 or 1 0 = maximum value, 1 = minimum value
Setting maximum/ minimum values:	AAmiX	X = desired setting 0 = maximum value, 1 = minimum value
Serial number:	AAsn	Output: XXXXX (5-digit decimal)
Device model / software version:	AAve	Output: XXYYZZ (6-digit decimal) XX = 70 (IN 5/9 plus) YY = month of the software version ZZ = year of the software version

Note: The letter "l" means the lower-case letter of "L".

[1] After entering these commands, the device carries out an automatic reset. The device needs approx. 150 ms before it is ready to use and work with the changed settings.

Additional instruction for the RS485 interface:
Requirements to the master system during half-duplex operation:

1. After an inquiry, the bus should be switched into a transmission time of 3 bits (some older interfaces are not fast enough for this).
2. The pyrometer's response will follow 3 ms at latest.
3. If there is no response, there is a parity or syntax error and the inquiry must be repeated.

10 Reference Numbers

10.1 Reference numbers instrument

IN 5/9 plus	Reference Number
Instrument with optics a = 95 mm	3 871 800
Instrument with optics a = 112 mm	3 871 810
Instrument with optics a = 160 mm	3 871 820
Instrument with optics a = 270 mm	3 871 830
Instrument with optics a = 400 mm	3 871 840
Instrument with optics a = 620 mm	3 871 850

Scope of delivery:

Instrument with selected optics, works certificate, PC measurement and evaluation software InfraWin

Ordering notes:
A connection cable is not included with the instrument and has to be ordered separately.

10.2 Reference numbers accessories

3 820 330	Connection cable, 5 m, straight connector
3 820 500	Connection cable, 10 m, straight connector
3 820 510	Connection cable, 15 m, straight connector
3 820 810	Connection cable, 20 m, straight connector
3 820 820	Connection cable, 25 m, straight connector
3 820 520	Connection cable, 30 m, straight connector
3 820 320	Connection cable, 5 m (angled connector, additional laser targeting light push button)
3 820 740	Connection cable, 5 m, (straight connector, temperature resistant up to 200 °C)
3 852 290	Power supply NG DC for DIN rail mounting; 100 to 240 V AC ⇒ 24 V DC, 1 A
3 852 430	Converter I-7520; RS485 ⇔ RS232 (half duplex)
3 852 440	Protocol converter RS485/RS232 (switchable) ⇔ Profibus-DP for 1 instrument
3 852 460	Protocol transducer RS485 <-> Profbus DP for 32 devices
3 852 620	Protocol converter UPP RS485 or RS232 <-> ProfNet, for 1 pyrometer
3 852 630	Protocol converter UPP RS485 <-> ProfNet, for max. 32 pyrometers
3 891 220	DA 4000: LED-display, 2-wire power supply, 2 limit switches (relay contacts), 115 V AC
3 890 650	DA 4000: LED-display, 2-wire power supply, 2 limit switches (relay contacts), 230 V AC
3 890 560	DA 6000-N: LED digital display with digital input RS232 and possibility for pyrometer parameter settings
3 890 520	DA 6000, digital display, digital and analog input, dual limit switch, maximum value storage, analogue output, RS232
3 890 530	DA 6000, digital display, digital and analog input, dual limit switch, maximum value storage, analogue output, RS485
3 826 500	HT 6000: portable battery driven indicator and instrument for pyrometer parameter settings; RS232 and RS485 interface

3 826 510	PI 6000: programmable PID controller
3 834 210	Adjustable mounting support
3 835 160	Air purge unit
3 835 440	Air purge unit, stainless steel
3 837 230	Water cooling jacket (heavy design) with integrated air purge unit
3 837 350	Heavy water cooling jacket with protection window
3 837 370	Water cooling jacket (lightweight design) with integrated air purge unit
3 837 400	Lightweight water cooling jacket with protection window
3 846 100	Mounting tube
3 846 120	Flange tube
3 846 630	Vacuum flange KF16 with protection window
3 846 660	Spare protection window, Ø 25 x 3 with Viton-O-ring

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