LUMASENSE® TECHNOLOGIES

MANUAL

IMPAC Pyrometers
IGAR 6 Advanced

Contents

2 Introduction

2.1 Appropriate use

The IMPAC IGAR 6 pyrometer is a stationary, digital ratio pyrometer with possible combination of 1-color and 2-color measurement for non-contact temperature measurements in ranges between 100 and 2000 °C.

Depending on the individual requirements the pyrometer can be operated in different modes. Besides the 1-color mode (100 ... 2000 °C) a 2-color mode (250 ... 2000 °C) or a special Smart mode can be selected. In Smart mode, the measurements in the range between 100 ... 250 °C will be taken in 1-color mode whereas in the range between 280 ... 2000 °C the measurements will be based on the 2-color method (ratio method). In the range from 250 to 280 °C a continuous transition from 1-color to 2-color measurement automatically takes place.

In addition, the pyrometer can also be operated in a special metal mode.

In 2-color mode (ratio method) two adjacent wavelengths are used for the temperature determination.This technique offers the following advantages compared to standard 1-color pyrometers:

- The temperature measurement is independent of the emissivity of the object in wide ranges.
- The measuring object can be smaller than the spot size.
- Measurements are unaffected by dust and other "grey" contaminants in the field of view or by dirty viewing windows.

2.2 Scope of delivery

Pyrometer with PC software *InfraWin* for adjustment/evaluation, works certificate, and manual.

Note: A connection cable is not included with the instrument and has to be ordered separately (see Chapter 8, **Reference Numbers**).

2.3 Technical Data

Measurement

Temperature Ranges:	1-color and Smart mode: 100 to 2000 °C 2-color (ratio) and Metal mode: 250 to 2000 °C
Sub Range:	Any range adjustable within the temperature range, minimum span 50 °C
Spectral Ranges:	Channel 1: 1.5 ... 1.6 µm Channel 2: 2.0 ... 2.5 µm
Resolution:	0.1 °C or 0.2°F at interface; < 0.0015% of selected sub range at analog output, min. 0.1°C, 16 bit; 1°C or 1°F on display
Emissivity ε:	0.050 to 1.000 in steps of 1/1000 (1-color mode)
Transmittance τ:	0.050 to 1.000 in steps of 1/1000 (1-color mode)
Emissivity Slope K:	0.800 to 1.200 in steps of 1/1000 (2-color mode)
Measurement Uncertainty: (K = 1, t_{90} = 1 s, $T_{amb.}$ = 25°C)	< 1500 °C: 0.4% of reading in °C + 2 °C > 1500 °C: 0.8% of reading in °C
Repeatability: (K = 1, t_{90} = 1 s, $T_{amb.}$ = 25°C)	0.2% of reading in °C + 1 °C

Optics

Sighting:	Built-in laser aiming light (max. power level < 1 mW, λ = 630-680 nm, CDRH class II) or through-lens sighting 
Optics:	Manually focusable from rear cover with measuring distance a = 210 to 5000 mm
Distance ratio:	approximately 100 : 1

Environment

Protection Class:	IP 65 IEC 60529 (value in mated condition)
Operating Position:	Any
Ambient Temperature:	0 to 65°C at housing
Storage Temperature:	-20 to 80 °C
Relative Humidity:	Non condensing conditions
Weight:	0.6 kg
Housing:	Stainless steel
CE-label:	According to EU directives about electromagnetic immunity

Interface

Connection:	12-pin connector
Display (in rear cover):	LED, 4 digit matrix, 5 mm high for 2-color or 1-color temperature signal or measuring distance
Parameters:	Adjustable via interface: 2-color / 1-color temperature signal, Smart mode, metal mode, accordingly emissivity slope or emissivity, temperature sub range, settings for maximum value storage, address, baud rate, switch off limit, warning level lens contamination monitoring system, transmittance, response time t_{90}, 0 to 20 mA or 4 or 20 mA analog output range, °C/°F. Readable via interface: measured value, internal temperature of the unit, measuring distance.

Communication

Analog Output:	Adjustable 0 to 20 mA; or 4 to 20 mA, linear (via digital interface)
Digital Interface:	RS485 addressable (half-duplex) Baud rate: 1200 to 115.2 kBd (on request RS232, not addressable)
Switch Off Limit:	2% to 50% (adjustable via interface)
"Dirty Window" Warning:	Relay contact, max. continuous current 0.4 A, setting of the warning level: 0 (off) to 99%
Exposure Time t_{90}:	2 ms (with dynamical adaption at low signal levels); adjustable to min; 0.01 s; 0.05 s; 0.25 s; 1 s; 3 s; 10 s
Maximum Value Storage:	Built-in single or double storage. Clearing with adjusted time t_{clear} (off; 0.01 s; 0.05 s; 0.25 s; 1 s; 5 s; 25 s), via interface, automatically with the next measuring object, external contact, hold-function

Electrical

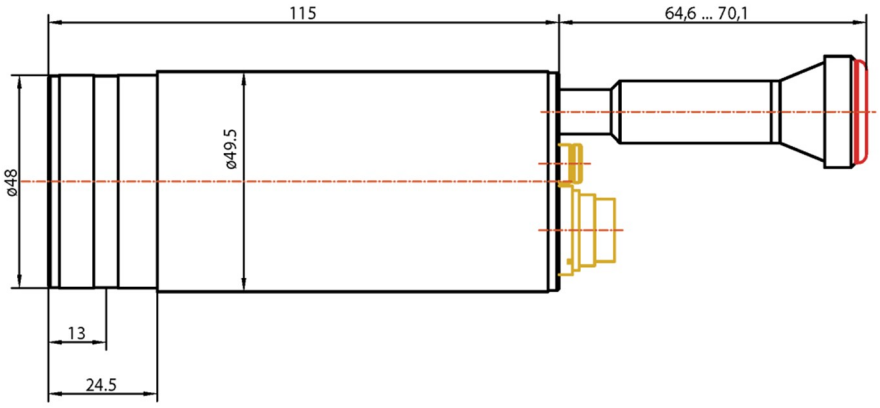
Power Supply:	24 V DC ± 25%, ripple must be less than 50mV
Power Consumption:	Max. 3 W (incl. laser)
Load (analog output):	0 to 500 Ω
Isolation:	Power supply, analog output and digital interface are electrically isolated from each other

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.

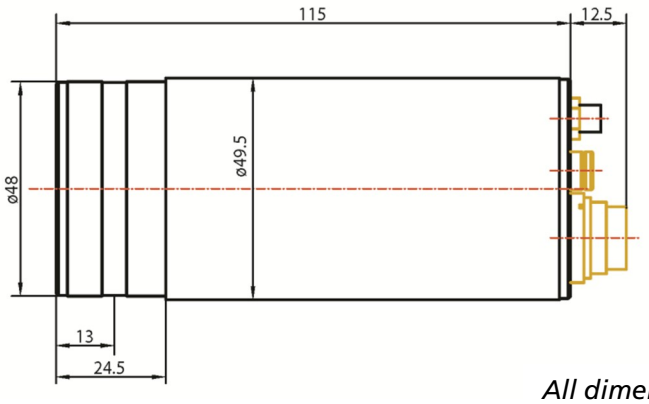
For additional details on this directive, see http://info.lumasenseinc.com/calibration or order the directive from “Beuth Verlag GmbH” in D-10772 Berlin, Germany.

2.4 Dimensions

IGAR 6 Advanced with Through-Lens Sighting



IGAR 6 Advanced with Laser Aiming



All dimensions in mm

2.5 Physical User Interface

IGAR 6 Advanced with Laser Targeting Light

IGAR 6 Advanced with Through Lens Sighting

1 12-Pin Connector
2 Digital Display
3 Sighting Option
4 Focus Adjustment Set Screw
5 LED Distance Indicator Light
6 LED Operating Mode Indicator Light
7 Viewfinder Adjustment Ring

2.6 Accessories (optional)

Numerous accessories guarantee easy installation of the pyrometer. The following overview shows a selection of suitable accessories. You can find the entire accessory program with all reference numbers in Chapter 8.

2.6.1 Mounting

An adjustable mounting angle is available to easily mount the pyrometer and align it to the measured object.

Mounting Angle

2.6.2 Cooling Jacket

The completely covered water cooling jacket is made from stainless steel and serves to protect 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 Air Purge

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

Air Purge

2.6.4 Vacuum support

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

Vacuum Support

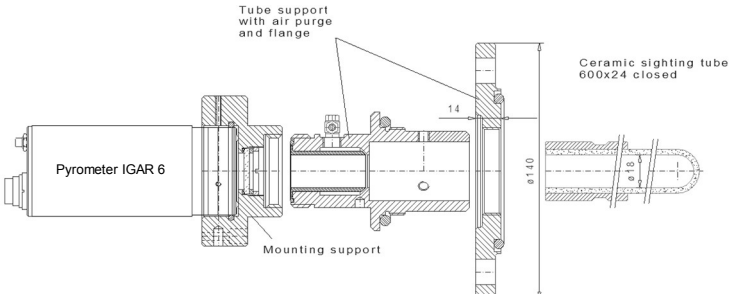
2.6.5 Scanning Mirror

The scanning mirror unit SCA 5 allows the measured object to be scanned over a certain range. The measuring beam of the pyrometer moves straight in one line across the object and collects temperature data of this line. This is useful when used in combination with the maximum value storage (peak picker) to measure objects which move out of the target area. The scanning angle of the mirror is 0 to 12° and the scanning frequency 0 to 5 Hz. Both values are easily adjustable at the scanner.

Scanning Mirror

2.6.6 Flange System

The flange system is a modular mounting system to fix the pyrometer on furnaces, vacuum chambers, etc.



Schematic drawing of the flange system

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. It may consist of an equipment rack, flange, and an open or closed ceramic tube. The equipment rack can be equipped for vacuum applications with a fused silica.

3 Controls and Installation

3.1 Electrical Installation

The pyrometer is powered by 24 V DC ± 25% (very well stabilized, ripple max. 50 mV). It is important to ensure correct polarity when connecting the device to the power supply. The length of the 24 V supply line should not be longer than 30 m. Hence the use of 24 V site internal supply network is also not recommended. This length restriction does not apply for the analog and digital signal lines.

To meet the electromagnetic requirements (EMV), a shielded connecting cable must be used. LumaSense offers connecting cables, which are not part of the standard scope of delivery.

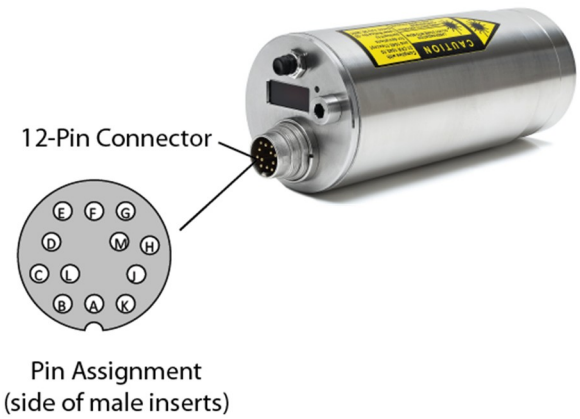
The shield of the connecting cable has to be connected only on the pyrometer's side. If the connecting cable is extended, the shield of the extension also needs to be extended. The shield must be open on the power supply side (switch board), to avoid ground loops.

The connecting cable has wires for the power supply, interface, analog output, external laser switch, and external clear of maximum value storage via contact and 12 pin connector. The cable includes a short adapter cable with a 9-pin D-SUB connector. This connector may be used in combination with the RS485 to USB adapter.

Once the instrument has been connected to the power supply, it is immediately ready for use. Although it does not need to be warmed up, it does need to run for approximately 15 to 30 minutes before achieving full accuracy. The instrument can be switched off by interrupting the power supply or unplugging the electrical connector.

Attention: When connecting the power supply, ensure the polarity is correct.

3.1.1 Pin assignment of the connector



Pin Assignment
(side of male inserts)

Pin	Color	Function
K	white	+24 V DC power supply
A	brown	0 V DC power supply
L	green	+ $I_{out.}$ analog output
B	yellow	– $I_{out.}$ analog output
H	gray	Targeting light activate / deactivate via external switch (bridged with K)
J	pink	External clearing of max. value storage (bridge to K), hold function, or output for "dirty window" monitoring (*see notes below)
G	red	DGND (GND for interface)
F	black	B1 (RS485) or RxD (RS232)
C	violet	A1 (RS485) or TxD (RS232)
D	gray/pink	B2 (RS485) (bridged with F)
E	red/blue	A2 (RS485) (bridged with C)
M	orange	Screen only for cable extension, don't connect to the switchboard

The connector pin J can be used for 3 different functions:

1. **External clearing of the maximum value storage:**

   When the pyrometer is in operating mode, pin J can be used for external clearing of maximum value storage. When external clearing is selected from the t_{clear} dropdown menu, pin J is connected for a short time to pin K (power supply voltage) to clear the stored maximum value.

   The function "external clearing" is triggered with the following conditions:

   - The clear time is set to "extern".
   - The "dirty window" warning system is switched off. This can be done through the InfraWin software in the "color-bar" window.
   - The warning level "dirty window" must be set to 0%.

2. **Hold function:**

   When the hold function mode is activated, the current temperature reading is frozen as long as pin J and pin K are connected. (See section 4.7 for clear time for the maximum value storage).

3. **"Dirty Window" Warning system:**

   The pyrometer is equipped with a "dirty window" warning system. The accuracy of the pyrometer will be seriously affected if the lens is not clean and the sight path is obscured by dirt, process material, smoke or steam (this can also happen if the object is smaller than the spot size of the pyrometer).

   To avoid incorrect measurements, a warning signal can be set to detect when the signal level becomes too low or reaches a certain level. When activated, a built in relay (max. continuous current 0.4 A) connects pin J to pin K (power supply voltage).

   The setting of the warning level (0 to 99%) can be done through the "color-bar" window of the InfraWin software. If the warning level "dirty window" is set to 0% (factory setting), the "dirty window" warning system is switched off and pin J can perform one of the functions of "external clearing" or "hold".

   The "dirty window" warning system is triggered with the following conditions:

   - The clear time is not set to "extern" or "hold".
   - The pyrometer is operating in "2-color mode".

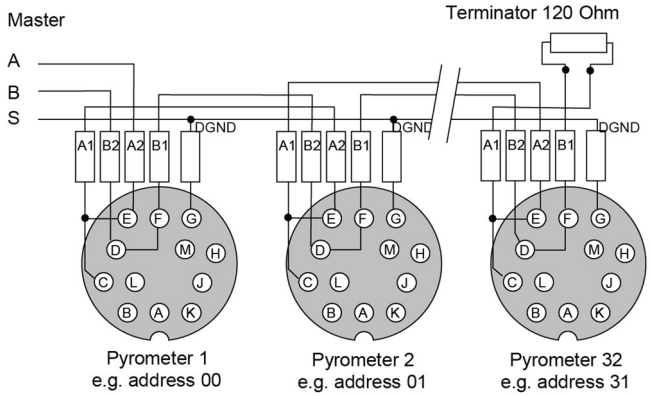
3.1.2 Connecting the pyrometer to a PC

The pyrometer is equipped with an RS485 serial interface. 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 the RS485 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 LumaSense adapter (order no. 3 826 750).

3.1.3 Connection to RS485

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.



RS485 Bus System

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 115200 Bd may be set.

3.1.4 Connection schematic for analyzing devices

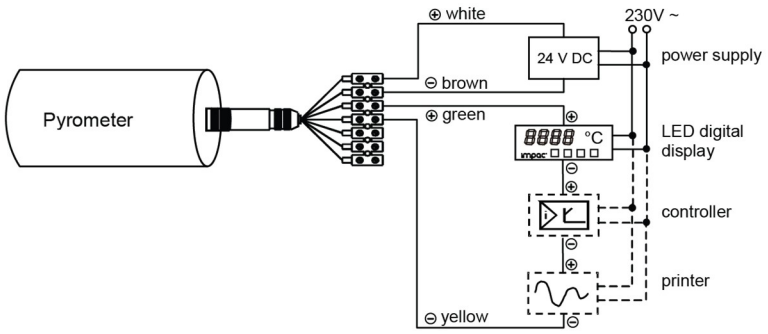
For temperature indication of the pyrometer, LumaSense offers pure indicators (series DA 4000). LumaSense also offers indicators with features to change pyrometer parameters (DA 6000 and DA 6000-N) as well as a fast digital PID controller PI 6000.

Digital Display

Parameterizing Indicator

Digital Controller

Additional analyzing instruments, including LED digital displays only need to be connected to a power supply and the analog outputs of the pyrometer (exception: the digital display DA 6000 can also be connected with its serial interface, whereas the digital display DA 6000-N has to be connected with its serial interface).



Connection Schematic for Analyzing Devices

Instruments like an analog controller or printer can be connected to the display in a series as shown above (total load of resistance max. 500 Ohm).

3.2 Sighting

The IGAR 6 Advanced can be purchased with Through-Lens Sighting or with a Laser targeting light. These sighting options allow you to easily align the pyrometer to the measuring object.

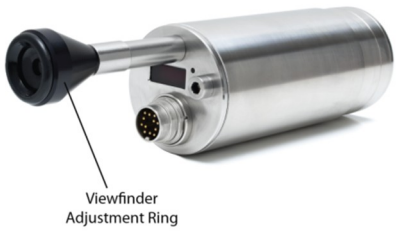
3.2.1 Viewfinder

The IGAR 6 Advanced can be equipped with a viewfinder which offers through-lens sighting. The viewfinder is true-sided and parallax-free. A circle marks the position of the measuring spot, but not the exact spot size.

Warning: To ensure eye protection, make sure you use the shaded filter when viewing objects with temperatures of 1500 °C or higher.

The viewfinder is equipped with an adjustable eye-protection filter, which allows you to view hot objects without exposing your eye to high intensity light. When you are viewing hot objects, turn the adjustment ring on the viewfinder so the filter will let in less light.

When you are viewing low temperature objects, turn the viewfinder adjustment ring so the filter will let in more light.



Note: You can turn the adjustment ring on the viewfinder in both a clockwise and counterclockwise direction to change the filter from light to dark.

3.2.2 Laser Targeting Light

The IGAR 6 Advanced can be equipped with a laser targeting light to assist with aligning the pyrometer to the measuring object. The laser targeting light is a visible red light with a wavelength between 630 and 680 nm and a maximum power of < 1 mW. The laser is classified as product of laser class II.

The laser spot marks the center of the measuring spot on the target. The diameter does not correspond to the spot size. The smallest diameter of the laser spot approximately indicates the measuring distance.

Never look directly into the laser beam. The beam and spot can be watched safely from side. Also make sure that the beam will not be reflected into eyes of people by mirrors or shiny surfaces.

The laser targeting light can be switched on and off by pressing the button of the rear cover of the housing.

The laser targeting light can also be switched on and off by using an external contact (see section 3.1.1 Pin Assignment) or through the InfraWin software. If it is not switched off by one of the above-mentioned methods, it will be switched off automatically after approximately 2 minutes.

To prevent damage to the laser, the targeting light is also switched off automatically if the internal temperature of the pyrometer exceeds 61 °C. It can only be used again once the temperature falls below 61 °C.

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

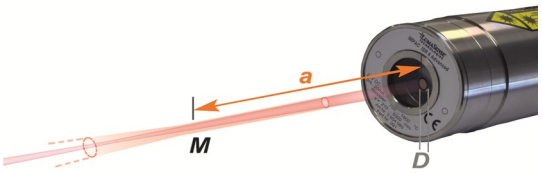
Laser Beam Safety Warning: The instrument is equipped with a class II laser that emits radiation. To reduce the risk of injury to the eyes, do not look directly into the targeting laser and do not point the targeting laser into anyone's eyes.

3.3 Optics

3.3.1 Spot Sizes

The IGAR 6 Advanced has a Vario optics, which can be manually adjusted at all distances between 210 mm and 5000 mm.

The table of spot sizes in relation to measuring distance shows examples of the pyrometer's spot size M [mm] in relation to the measuring distance a [mm] (min. 90% of the radiation intensity). Increasing or decreasing the measuring distance will change the spot size.



Aperture D for all temperature ranges is 13 to 15 mm with the aperture being the effective diameter of the lens. This is dependent on the optical setting. The largest value applies to a very small measuring distance, while the minimum value applies to the largest measuring distance.

Note: In the 1-color (mono) mode, the pyrometer can measure objects at any distance (whether focused or non-focused). However, the object has to be bigger than or at least as big as the spot size of the pyrometer in the measuring distance.

In the 2-color (ratio) mode, the object can be somewhat smaller than the spot diameter.

	Temperature Range
	100 … 2000 °C
Measuring Distance a [mm]	Spot Diameter M [mm]
210	2.1
300	3
500	5
800	8
1300	13
2000	20
5000	50

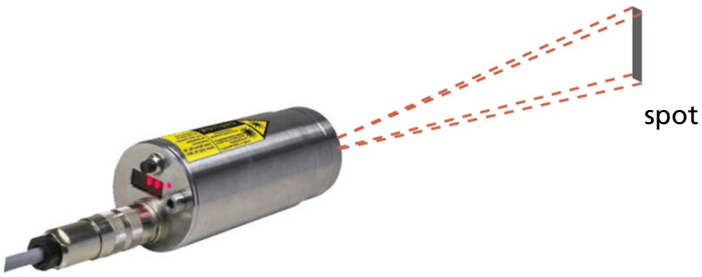
Examples of Spot Sizes in Relation to Measuring Distance

Focused spot sizes between the listed distances can be found by linear interpolation between the listed values. For example, the spot size at 1600 mm distance would be about 16 mm.

Note: Effective aperture D for all temperature ranges is 12 mm (focused to longest distance) to 16 mm (focused to shortest distance).

3.3.2 Line Optics

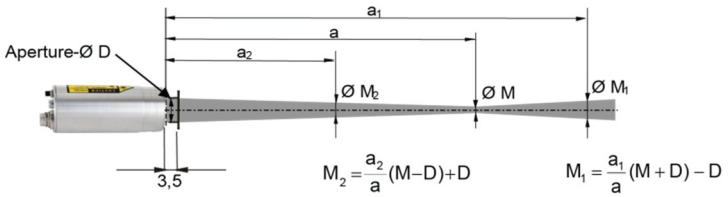
Besides the standard optical heads the IGAR 6 is optionally also available with integrated line optics which features a special spot in shape of a line. It provides additional advantages for some applications such as wire production or pouring stream measurements.



The length of the spot equals 5% of the measuring distance.

3.3.3 Deviation from the focused measuring distance

Spot sizes for non-focused distances (shorter or longer than the focused distance) may be calculated by using the formula below.



Formula for Calculating Spot Sizes

The InfraWin software also includes a Spot Size Calculator that calculates the data for the non-focused regions, if you enter the values of aperture D, focused measurement distance a, and focused measuring field diameter M as found in the above table (see section 3.3.1).

3.3.4 Adjusting the required measuring distance

The measuring distance can be set using the Focus Adjustment Screw on the back of the device. The focused distance value can be adjusted at all distances between 210 mm and 5000 mm. To focus, turn the focus adjustment set screw to make the target image appear sharp and clear.

The LED Distance Indicator Light (labeled mm) will turn red and the approximate focused measuring distance in mm will automatically be shown on the Digital Display for a few seconds after making an adjustment using the Focus Adjustment Set Screw.

Note: The optics are manually focusable with a measuring distance of a = 210 to 5000 mm.

Note: Turning the focus adjustment screw counterclockwise will shorten the measuring distance.

Turning the focus adjustment screw clockwise will lengthen the measuring distance.

4 Settings / Parameters

The pyrometer is equipped with a wide range of settings for optimal adaptation to the required measuring condition and to measure the temperature correctly.

The digital PC interface allows you to exchange data with a PC either by using the supplied InfraWin software or by using the Universal Pyrometer Protocol (UPP) commands with your own communication program (see Chapter 7 for the UPP Data Format commands).

Selecting the pyrometer parameters window shows the current settings of the pyrometer. You can change a value by typing a value in an input box or by selecting a preset value from the list field. The following settings can be made through the RS485 to USB connection.

4.1 Factory Settings

- Temperature display (°C / °F) = °C
- Emissivity (Emi) = 1 (100%)
- Emissivity Slope K = 1
- Transmittance = 100%
- Exposure time (t_{90}) = min
- Clear Peak Memory (t_{clear}) = 0s (off)
- Analog Output (mA) = 0 ... 20 mA
- "Dirty Window" Warning = 0%
- Switch Off Limit = Off% = 10%
- Operating Modes = 2-color mode
- Sub Range = Basic Range
- Device Address (Adr) = 00
- Baud Rate (Baud) = 19200

4.2 Temperature Display

The Digital Display on the back of the pyrometer will show the temperature measurement in either °C or °F. You can select which temperature scale you wish to use through the InfraWin software or by using the UPP Data Format commands.

The Measuring Value can also be viewed at any time through the InfraWin Software or by using the UPP Data Format commands.

4.3 Emissivity ε

Different materials have different emissivities ranging between 0% and 100%. The emissivity is also dependent upon 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.

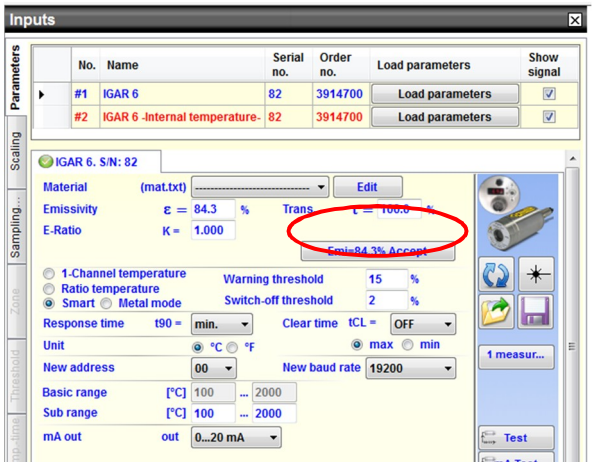
Emissivity settings between 5% and 100% can be established through the InfraWin software or by using the UPP Data Format commands.

Note: Emissivity ε Settings: 5% to 100% in steps of 1/1000 (1-color mode).

The correct setting of the emissivity is a requirement for a precise measurement in 1-color mode as well as for the correct transition from 1-color to 2-color measurement in Smart mode.

When the instrument is operated in 2-color or Smart mode, InfraWin provides the option to automatically determine the emissivity. By pushing the button "Emi=xxx% Accept", this emissivity is set and used for all measurements in 1-color mode or in Smart mode below 280 °C.

However, the emissivity can only be reasonably determined if the Emissivity Slope for the 2-color measurement has been set approximately correct.



4.4 Emissivity Slope K

In 2-color (ratio) mode, the pyrometer is measuring simultaneously with 2 sensors in adjacent wavelengths. It calculates the temperature by ratioing the radiation intensities of the two wavelengths. This ratio technique eliminates a number of factors that degrade the accuracy of conventional 1-color instruments. For example, with ratio pyrometers, measurement is independent of emissivity in wide areas. They are also unaffected by dust in the field of view and unaffected by dirty viewing windows or lenses, etc. as long as these disturbances are “grey” (not colored).

In some cases the emissivities of the two wavelengths can differ so that it is necessary to correct the ratio of the two emissivities (K = ε1 / ε2) to get a correct temperature reading. This correction can be done by adjusting the emissivity slope setting K using the InfraWin software or the UPP data format commands.

The K-factors of metals are normally slightly higher than 1. For a correct measuring result, it is recommended that you make a comparison test. This comparison test may be performed by using a thermocouple probe or by knowing one process temperature point precisely from other sources. The K-factor can then be adjusted until the pyrometer shows the same temperature value.

The IGAR 6 is factory calibrated for graybody targets that exhibit equal changes in emissivity within its two spectral bands.

Note: Emissivity Slope K Settings: 0.800 to 1.200 in steps of 1/1000 (2-color mode).

4.4.1 Slope Adjustment

In some cases the emissivities of the two wavelengths can differ so that it is necessary to correct the ratio of the two emissivities (K = ε1 / ε2) to get a correct temperature reading. This correction can be done by adjusting the emissivity slope setting K using the InfraWin software or the UPP data format commands.

The K-factors of metals are normally slightly higher than 1. For a correct measuring result, it is recommended that you make a comparison test. This comparison test may be performed by using a thermocouple probe or by knowing one process temperature point precisely from other sources. The K-factor can then be adjusted until the pyrometer shows the same temperature value.

The IGAR 6 Advanced is factory calibrated for graybody targets that exhibit equal changes in emissivity within its two spectral bands.

4.4.2 Temperature Errors Cause by Non-Graybodies

A graybody target has emissivity that is the same at each of the two wavelengths used for measurements and is constant throughout the temperature range. The ratio of the emissivities, $\varepsilon 1 / \varepsilon 2 = 1$ and stays constant regardless of the target temperature. When a target deviates from this, that is when $\varepsilon 1 / \varepsilon 2$ does not equal 1.0 and a slope adjustment is required. For many materials, this is a one-time adjustment. The following table illustrates the IGAR 6 reading errors that can occur when the slope setting differs from the actual material emissivity ratio.

TABLE OF EXPECTED ERROR WHEN EMISSIVITY OF ONE WAVELENGTH IS 1% DIFFERENT FROM THE SECOND WAVELENGTH			
TEMPERATURE		ERROR DEG.	
°F	°C	°F	°C
572	300	33.8	1
752	400	34.7	1.5
932	500	35.6	2
1112	600	37.4	3
1292	700	38.3	3.5
1472	800	39.2	4
1652	900	41	5
1832	1000	42.8	6
2012	1100	44.6	7
2192	1200	46.4	8
2372	1300	48.2	9
2552	1400	50	10
2912	1600	55.4	13
3272	1800	60.8	16
3632	2000	68	20
3992	2200	75.2	24
4352	2400	82.4	28
4712	2600	93.2	34
5072	2800	104	40

The table shows typical errors that can result when the emissivity of one wavelength differs from the other wavelength by only 1%. The errors can get quite large as temperatures increase. This error can be much larger than a 1-color IR pyrometer would produce for 1% emissivity change. Therefore, it is important to select the proper mode (2-color vs. 1-color) on the IGAR 6 to measure a specific material.

Another source of error is dust or smoke in the optical path which alters the transmission in one wavelength more than the other. If the "dust" transmits 1% less energy at wavelength 1 than at wavelength 2, the error table above also applies. Since not all smoke, dust, or dense steam transmits equally at each wavelength, errors may become larger than expected for a 2-color instrument. Usually the smoke and dust are the result of the material being processed and can be cleared from the sight path by a fan or air purge tube.

In some materials, the emissivity may change at different rates with material temperature. Some materials exhibit great changes in emissivity with temperature or time as oxidation modifies the surface finish of the material. With such materials, significant measuring errors may occur when measured with 2-color instruments. When problems are compounded with spectrally absorbing dust or smoke (described above), obtaining reliable temperature readings with any 2-color instrument may be impossible. In cases like this, a single color instrument using the shortest wavelength possible would be the better choice. If this problem is encountered, switch the IGAR 6 to 1-color mode. In some situations, the single color mode will outperform the ratio mode.

4.5 Transmittance τ

Transmittance is a parameter that can compensate for signal loss due to external windows etc. For example, if the emissivity of the material is 0.6 and the transmittance of an additional window is 0.9, then the product would be 0.54 which is well inside the allowed range.

The product of transmittance and emissivity (τ x ε) must not be less than 20%.

Note: Transmittance τ Settings: 5% to 100% in steps of 1/1000 (1-color mode)

4.6 Response Time (t_{90})

The response time t_{90} is the time interval for the analog output of the pyrometer to go from a low temperature value up to 90% of the temperature step to a high value when measuring an abrupt increase from said low to said high temperature.

Independently of this, the pyrometer performs a measurement every millisecond and updates the analog output. Slower response times can be used to achieve a constant temperature reading for measuring objects that have rapidly fluctuating temperatures.

The response time is set using the InfraWin software or by using the UPP Data Format commands. When the setting is set to min., the IGAR 6 Advanced operates using a time constant of <2 ms (with dynamic adaption at low signal levels). The response time can be extended to 0.01 s; 0.05 s; 0.25 s; 1 s; 3 s; 10 s.

Note: Settings for Response Time t_{90} : min, 0.01 s; 0.05 s; 0.25 s; 1 s; 3 s; 10 s

4.7 Clear Peak Memory (t_{CLEAR})

The integrated maximum value storage is activated when the parameter tclear is set to something other than “OFF” or “HOLD”.

If the maximum value storage is switched on, the highest last temperature value will always be displayed and stored. As such, it may be beneficial to periodically clear and reset the stored maximum values in order to obtain new temperature readings.

This storage also has to 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.

Note: Settings for Clear Peak Memory t_{CLEAR} : OFF, 0.01 s, 0.05 s, 0.25 s, 1 s, 5 s, 25 s, EXTERN, AUTO, HOLD

4.7.1 Single and Double Storage Modes

Depending upon the selected settings, the maximum value storage will either work in single storage mode or in double storage mode.

Note: The maximum value storage setting coincides with adjustments made to the response time.

The response time setting (working like a low-pass filter) is applied first. After that, the maximum storage is processed. So when using both, the maximum storage takes the peak of the signal that was previously smoothed by the response time filter.

So when using both, the maximum storage takes the peak of the signal that was previously smoothed by the response time filter.

Single Storage Mode: 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. Single storage mode also comes into effect when the Clear Peak Memory t_{clear} is set to AUTO.

Double Storage Mode: 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.

4.7.2 Clear Time Settings

The following settings are available through the InfraWin software or by using the UPP data format commands.

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

0.01 s...25 s If the clear time is set between **0.01 s and 25 s**, the maximum value is held in double storage mode. After the entered time, the value will be cleared alternately from one of the storages, while the value of the other storage is shown.

EXTERN With the external clearing function, the storage operates in single storage mode. The values are immediately cleared from the storage by contacting the wires connected to pins J and K, if the **EXTERN** mode was selected.

AUTO The **AUTO** mode is used for discontinuous measuring tasks. For example, when objects are being transported on a conveyer belt and pass the measuring beam of the pyrometer only for a few seconds. In this case, the maximum value for each object has to be obtained.

With the **AUTO** mode, the maximum value is stored until a new hot object appears in the measuring beam. The temperature, which has to be recognized as "hot" is defined by the low limit of the adjusted sub range.

The stored maximum value will be deleted once the temperature of the new hot object exceeds the low limit of the sub range by 1% (transition in positive direction) or by at least 2 °C. This is also valid if the sub range equals the basic range.

HOLD The **HOLD** function allows you to freeze the current temperature reading at any moment. This feature is activated using an external switch that has been connected between connector pins J and K.

The temperature reading will remain frozen as long as the contact remains closed.

4.8 Analog Output

The analog output has to be selected according to the signal input of the connected instrument (controller, PLC, etc.). If 4 to 20 mA is set, the analog output gives 3.9 mA for temperatures below lower range limit.

Note: Settings for Analog Output: 0 to 20 mA/21 Low or 4 to 20 mA/21 Low (setting /21 Low = Analog Out shows 21 mA if signal intensity falls below Switch-Off level)

4.9 Relative Signal Strength

Relative signal strength stands for the product of emissivity, surface coverage, and transmission of the material between the object and the pyrometer.

4.10 "Dirty Window" Warning

The IGAR 6 Advanced pyrometers are equipped with a warning level "dirty window" monitoring system. A correct temperature measurement might be impossible if the ratio pyrometer is working at a too low signal level. To avoid these wrong measurements in advance, a warning signal can be set to a certain contamination level. A built-in relay switch can be used to switch to a warning signal when the incoming radiation becomes too low.

The warning level can be set between 0 and 99%. 0% means the "dirty window" warning system is switched off (factory setting) and the relay can perform the function external clearing of maximum value storage, when it is activated (see section 4.6.2 Clear Time Settings).

Note: Settings for "Dirty Window" Warning: 0 (off) to 99%.

4.11 Minimum Intensity Switch-Off Level

The minimum intensity switch-off level is a function that is used to avoid measuring errors caused by signals which are too low. This may e.g. be caused by a dirty viewing window, dust in the field of view, or when the spot is not filled by the measuring object.

Note: Settings for Minimum Intensity Switch-Off Level: 2% to 50%

Ratio pyrometers are able to measure temperatures correctly even with very low signals. If the signal is too low for a correct measurement, the pyrometer interrupts the measurement and displays 1 °C below of beginning of the temperature range. If signal intensity falls below the Switch-Off level, the Analog Output will show 21 mA if one of the settings "…/21 Low" has been selected for the Analog Output.

Although the factory default is set to 10%, switch-off limit can be adjusted between 2 and 50%, depending on the application.

Note: The smaller the value, the higher the chance that daylight or reflections will affect a correct temperature measurement.

4.12 Operating Modes

Ratio (2-color) mode is the factory default operating mode for the IGAR 6 pyrometer. However, the device can be set to mono (1-color), Smart, or metal mode using the InfraWin software or by using the UPP Data Format commands.

4.12.1 2-color mode

In 2-color mode (ratio method) two adjacent wavelengths are used for the temperature determination.This technique offers the following advantages compared to standard 1-color pyrometers:

- The temperature measurement is independent of the emissivity of the object in wide ranges.
- The measuring object can be smaller than the spot size.
- Measurements are unaffected by dust and other "grey" contaminants in the field of view or by dirty viewing windows.

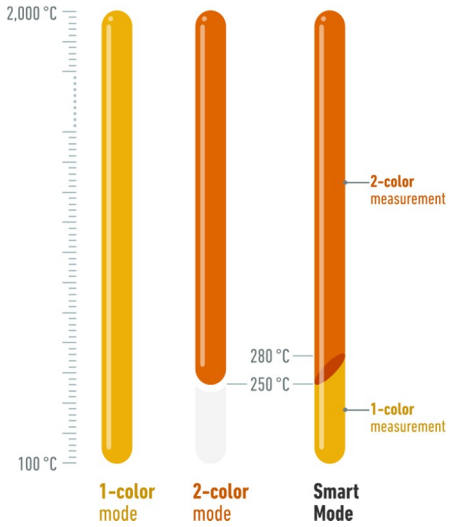
4.12.2 1-color mode

Mode LED indicator

With 1-color mode, the device adjustments are simplified by sending the emissivity corrected one channel temperature to the analog output. This operating mode is indicated by a red LED in the back cover of the instrument.

For a correct measurement in the 1-color mode, it is necessary to adjust the emissivity using the InfraWin software or by using the UPP Data Format commands. This 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.

4.12.3 Smart mode



In Smart mode, the measurements in the range between 100 ... 250 °C will be taken in 1-color mode whereas in the range between 280 ... 2000 °C the measurements will be based on the 2-color method (ratio method). In the range from 250 to 280 °C a continuous transition from 1-color to 2-color measurement does automatically take place. In this operating mode, the red LED on the back cover is blinking (long dark, shortly illuminated).

4.12.4 Metal mode

The metal mode is a special mode which calculates the temperature combining the ratio and the 1-color signal with an algorithm. The metal mode can be used to determine the temperature of metals and alloys with unknown emissivity ratio (K). It should be used only for a short time to achieve a good approximation of the object temperature if the temperature reading in 2-color or 1-color mode seems to be incorrect. After this the pyrometer has to be switched back into 2-color mode and the temperature reading has to be corrected with the adjustment of the emissivity slope K until the instrument shows the temperature determined in the metal mode. A condition for the use of the metal mode are settings of $\varepsilon = 1$ and $K = 1$. In this operating mode, the red LED on the back cover is blinking (shortly dark, long illuminated).

4.13 Sub Range

You have the opportunity to choose a sub range (minimum span 50 °C) within the basic measuring range of the pyrometer. This sub range corresponds to the analog output.

Example: Range 250…2000 °C, Sub Range 925…975 °C.

If a sub range is defined for the single color mode it does automatically also apply to the Smart mode (and vice versa).

If a sub range is defined for the ratio mode it also automatically applies to the metal mode (and vice versa).

The sub range setting also affects the maximum value storage when the Clear Peak Memory t_{clear} is set to AUTO. For more information on the t_{clear} AUTO setting, refer to Section 4.7.

Note: Settings for Sub Range: Any range adjustable within the temperature range with a minimum span of 50 °C.

4.14 Device 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.

Note: Settings for Device Address:
Individual Addresses: 00…97 Global Addresses: 98, 99

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).

4.15 Focused Distance

The focused distance value can be adjusted at all distances between 210 mm and 5000 mm using the Focus Adjustment Screw on the back of the device.

The LED Distance Indicator Light will turn red and the focused measuring distance in mm will automatically be shown on the Digital Display within a few seconds of making an adjustment using the Focus Adjustment Set Screw.

The focused distance can be viewed at any time through the InfraWin software or by using the UPP Data Format commands.

4.16 Baud Rate

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

Note: Settings for Baud Rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200.

4.17 Pyrometer Internal Temperature

The internal temperature of the pyrometer can be read through the PC interface using the InfraWin software or by using the UPP Data format commands. It is a few degrees higher than the ambient temperature due to the heat generated by the electronics.

When using the Laser Targeting Light, the targeting light is switched off automatically if the internal temperature of the pyrometer exceeds 61 °C. This safety feature is used to prevent damage to the laser. It can only be used again once the temperature falls below 61 °C.

5 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 www.lumasenseinc.com.

5.1 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.

5.2 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.

5.3 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.

6 Maintenance

6.1 Cleaning IGAR 6 Window

Because there are no moving parts in the IGAR 6, the only regular maintenance required is a periodic inspection of the front window for build-up of foreign particles which, in time, can influence the energy received by the instrument. The IGAR 6 has a "Dirty Window" warning alarm feature that can measure the current window/optical path transmission and provide a contact closure alert when the window transmission falls below the user set point.

The IGAR 6 window is not water soluble and, therefore, can be cleaned with standard lens tissue dampened with a camera-store lens-cleaning solution. A soft blower/brush (also at camera stores) should be used to remove any grit on the window before you rub the lens with lens tissue and solution.

Attention: NEVER CLEAN THE IGAR 6 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.

6.2 Calibration

LumaSense calibrated your pyrometer at the factory and delivered your instrument with a Works Certificate. Normally we advise against changing the factory set calibration. If you believe that the calibration may have changed, perhaps because your operating environment is severe, an approximate field (on-site) calibration is possible. You have the choice of an on-site calibration or arranging a more precise calibration at the LumaSense factory.

6.2.1 Laboratory Calibration

Contact LumaSense for information about calibration at the LumaSense factory. For most of our customers who do not have large numbers of infrared thermometers in service, we recommend that our laboratory be chosen to do calibration. When you have many infrared thermometers, you may find it most convenient and economical to have your own calibration laboratory. LumaSense has a variety of blackbody calibration sources including very economical ones. Among these you may find the source most suitable for your own laboratory.

6.2.2 On-Site Calibration

Note: The instrument was calibrated at the factory to its original accuracy as stated. Refer to Chapter 9 in this manual before attempting to perform your own calibration.

Nearly all erroneous temperature readings are caused by application problems such as:

- **Emissivity factor:** Carefully read "Emissivity Slope K" found in section 4.4 of this manual for information on this topic. Also use the InfraWin "K: AutoFind" function as described in the InfraWin manual to determine the actual emissivity ratio of the target.
- **Reflections:** Unexpectedly high readings may be caused by the IGAR 6 "seeing" a reflection of another hotter source, especially if the target emissivity is less than 0.8.
- **Spot Sizes:** Ensure the IGAR 6 is using a proper focused distance and takes into account the spot size in relation to measuring distance.

- In the 1-color (mono) mode, the pyrometer can measure objects at any distance. However, the object has to be bigger than or at least as big as the spot size of the pyrometer in the measuring distance.
- In the 2-color (ratio) mode, the object can be somewhat smaller than the spot diameter.

Information on this topic can be found in Section 3.3 and Section 4.15.

- **Obscured window:** Refer to Cleaning IGAR 6 Window, Section 6.1.

7 Data format UPP (Universal Pyrometer Protocol)

Software commands can be exchanged directly with the pyrometer through an interface using suitable communication software or by using the **Test** function located in the **Pyrometer Parameters** window of the InfraWin software package.

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) no handshake;
- The device responds to the entry of a command with output (such as the measuring value) + CR (**C**arriage **R**eturn, ASCII 13), to pure entry commands with **ok** + **CR**, or **no** + **CR**.
- Every command starts with the 2-digit device address AA followed by two lower case command letters and finished with CR.

  Example Read Command: 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%
- The ASCII parameter "X" indicates a change to be made in a parameter. When used, the command contains the new value.

  Example Write Command: Entry: "00emXXXX" + CR

  The parameter used for the emissivity setting (ε) with the address 00 is changed.

  Answer: "00em0853" + <CR> changes the Emissivity to 0.853 or 85.3%
- A "?" after the lower case command letters answers with the limits of the respective settings (only at setting commands, not at query commands).

  Example Read Limits Command: Entry: "00em?" + ˜CR!

  Answer: Could be 00501000 + <CR>, which means that E can vary between 0.050 and 1.000 (or 5% and 100%)

Description	**Command**	**Parameters**
Analog output	AAasX	X=0 (0 to 20mA) X=1 (4 to 20mA)
Minimum intensity switch-off level	AAawXX AAaw	XX=02 to 50 (2% to 50%) Answer: DD 2 decimal digit 02 to 50
Reference number	AAbn	Output: XXXXXX (hex 6-digit)
Baud rate (set)	AAbrX	X = 0 to 6 or 8 (dec.) 0 = 1200 Baud 1 = 2400 Baud 2 = 4800 Baud 3 = 9600 Baud 4 = 19200 Baud 5 = 38400 Baud 6 = 57600 Baud 7 = is not allowed 8 = 115200 Baud
"Dirty Window" Warning	AAdwXX	XX = 00 …99% (2 digit, hex.)

Description		Command	Parameters
Measuring value (one-channel and ratio temperature)		AAek	Answer: SSSSSQQQQQ 2x5 decimal digits (in °C or °F, last digit is 1/10 °C or °F), SSSSS = one-channel temperature QQQQQ=ratio temperature
Emissivity ε for one-channel temperature		AAemXXXX AAem	XXXX=0050 to 1000 ε=0.050 to 1.000 Answer: DDDD 4 decimal digits 0050 to 1000
Transmittance τ of window		AAetXXXX AAet	XXXX=0050 to 1000 τ=0.050 to 1.000 Answer: DDDD 4 decimal digits 0050 to 1000
$K = \varepsilon_1 / \varepsilon_2$ Emissivity ratio		AAevXXXX AAev	XXXX=0800 to1200 $\varepsilon_1 / \varepsilon_2$=0.800 to 1.200 Answer: DDDD 4 decimal digits 0800 to 1200
Response time t_{90}		AAezX	X=0 to 6 0=min. 1=0.01 s 2=0.05 s 3=0.25 s 4=1.00 s 5=3.00 s 6=10
Temp. Display °C or °F		AAfhX	Output: X = 0 display in °C X = 1 display in °F
Device Address		AAgaXX	XX = (00 to 97) 00 to 97 = regular device addresses 98 = global address with response 99 = global address without response (settings only)
Internal temperature (read)		AAgt AAtm	Answer: DDD 3 decimal digits (000 to 098 °C or 032 to 210 °F) gt=current temp. tm=maximum temp. (memory)
Operation mode		AAkaX	X = 0 metal mode X = 1 mono mode (1 channel) X = 2 ratio mode (2 channel) X = 3 Smart mode
Laser		AAlaX AAla	X=0 off X=1 on Answer: 1 digit: "0" or "1" 
Software simulation of external clearance		AAlx	Clears maximum storage
Clear peak memory t_{clear}		AAlzX	X=0 to 8 0= OFF 1=0.01s 2=0.05s 3=0.25s 4=1.0s 5=5.0s 6=25.0s 7=EXTERN 8=AUTO 9=HOLD
Basic range (read)		AAmb	Answer: XXXXYYYY 2x4 hex-digit for lower and upper range limit (°C or °F)
Sub range (read)		AAme	Answer: XXXXYYYY 2x4 hex-digit for lower and upper range limit (°C or °F)
Sub range (set)	1.	AAm1XXXXYYYY	XXXXYYYY=2x4 hex-digit for lower and upper sub range limit (°C or °F)
	2.	AAm2	AAm2 confirms the change (auto reset)
Measuring value		AAms	Answer: QQQQQ (88880=Overflow) 5 decimal digit (in °C or °F, last digit is 1/10 °C or °F)
Device type		AAna	Output: "IGAR 6 Advanced " (16 ASCII-characters)

Description	Command	Parameters
Read parameters	AApa	Answer: 15 decimal digits DD . . . . . : Emissivity (see em) . . D . . . . . : Response time (see ez) . . . D . . . . . : Clear peak memory (see lz) . . . . D . . . . . : Analog output (see as) . . . . . DD . . . . . : Internal temperature (see gt) . . . . . DD . . . . . : Device address (see ga) . . . . . 4 . . . . . : Baud rate (see br) . . . . . 0 , , , , : always 0 . . . . . DDDD : Ratio correction (see aw)
Serial number	AAsn	Output: XXXXX (hex 5-digit)
Read signal strength*	AAtr	Answer: DDDD 4 decimal digit 0000 to 1500
Device type/ software version	AAve	Answer: VVMMJJ VV=54 MM=Month JJ=Year of software version
Communication Module/ software version in detail	AAvc	tt.mm.jj XX.YY tt = day; mm = month; yy = year; XX.YY = software version
Software version in detail	AAvs	tt.mm.yy XX.YY tt = day; mm = month; yy = year; XX.YY = software version

*Read Signal Strength stands for product of emissivity, surface coverage and transmission of the measuring distance.

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

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 after 5 ms, at the latest.
3. If there is no response, there is a parity or syntax error and the inquiry has to be repeated.
4. After receiving the response, the master has to wait at least 1.5 ms before a new command can be entered.

上海麦兴仪器设备有限公司
Shanghai MaxSun Industrial Co., Ltd.
地址：上海市浦东新区张杨路188号汤臣中心A座
邮编：200122
电话：(86 21) 5888 6718 / 133 8186 8102
传真：(86 21) 5888 7876
邮箱：mx@imaxsun.com

麦兴（中国）有限公司
MaxSun (China) Limited.
地址：香港湾仔告士打道151号国卫中心11楼
电话：(852) 2836 8361
传真：(852) 3011 5863
邮箱：mx@imaxsun.com