

## Thermal & Cable Solutions

### AL390

Non-contact Infrared Pyrometers

## USER MANUAL



**TEMPSSENS INSTRUMENTS (I) PVT. LTD.**

B-188A, Road No.5, Mewar Industrial Area (M. I. A.),  
Madri, Udaipur-313003 (Rajasthan) INDIA  
Ph.:+91-9116554600, Email: info@tempsens.com

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# Chapter - 1

## General Information

We are pleased that you have chosen this high quality and highly efficient Tempens pyrometer for non-contact temperature measurement.

Please read this manual carefully, step by step before performing any operation with the Pyrometer. It contains all the necessary instructions for set up and operation of the pyrometer. When operating the instrument, it is necessary to follow the general safety instructions.

### 1.1 Safety Measures

This section provides an overview about important safety regulations.

#### 1.1.1 General

Each person working with the pyrometer must have read the user manual before operation. The Pyrometer has only to be used for the purpose described in the manual.

#### 1.1.2 Safety Precaution

The Pyrometer works only with a potential-free low voltage of range 24V DC. This voltage is not harmful for the user.

#### 1.1.3 Maintenance and use of Pyrometer

Pyrometer can be operated by the qualified person who has got instructions from the supervisor. It is strongly prohibited to do technical modifications of the device without permission of the manufacturer.

#### 1.1.4 Environmental Protection

The lens or its coating may contain harmful materials and hence it should not be disposed of with normal waste.

#### 1.1.5 Packaging and storage

Always use a shock-proof package for shipment of the pyrometer. It should be sealed to protect it against humidity. Also protect the lens of the pyrometer with a cover. They should be stored at the temperature ranges from -20° to +70° C.

#### 1.1.6 Warranty

AL390 instruments have a warranty of two years from the invoice date. Tempens will replace defective parts, which arises from design errors or manufacturing faults. In case, if pyrometer is opened, disassembled or modified then the guarantees will loss.

Tempens does not accept liability for any damage or losses which might occur, including consequential damages and financial losses, as a result of use of the equipment.

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# Chapter-2

## Introduction

AL390 model provides the advantage of non - contact temperature measurement of non-metallic surfaces & metal parts in flame heated furnaces i.e. through flames and flue gas. This instrument is designed for easy integration into standard 4 wire system. This format combines the high accuracy of digital signal processing with the simple connection. The AL390 pyrometer is used for target temperature ranging from 300°C to 2500°C. The electronic assembly is protected by IP65 rugged stainless steel housing.

### 2.1 Application, Range and Working Principle

The AL390 pyrometers are especially designed for industrial purposes. They are suitable for high temperature measurement ranging from 300° to 2500° C.

At a wavelength of 3.9  $\mu\text{m}$  hot furnace gases and clean burning gas flames are quite transparent and therefore permit temperatures of substances to be measured as well during the heating up process in industrial furnaces when using AL390. This format combines the high accuracy of digital signal processing with the simple connection. The electronic assembly is protected by IP65 rugged stainless steel housing. These pyrometers have solid body in stainless steel housing which provides high operation safety even in rough industrial environment, and large variety of optics with fixed focus which can be easily used in all industrial areas.

AL390 has a fast response time of 60msec. Pyrometers have USB 2.0, RS232 or RS485 outputs. Response time, emissivity, sub range and peak picker selection can be preset ex works or adjusted through available software.

The pyrometer temperature measurement method utilizes the fact that objects emit thermal radiation in an amount that directly corresponds to their own temperature and surface emissivity.

The pyrometer sensor detects the amount of infrared radiation emitted by the measured object (target). The infrared signal is analyzed and the temperature it represents is analyzed by built-in microprocessor. AL390 work in 4-wire technology.

### Applications

Measurement through flames & combustion without influencing the measurement.

### Standard Item supplied with AL390 :-

1. Tempsens pyrometer
2. Connection cable 12-core (length - 5 m)
3. Digital cable 3-core (length - 1.5 m)
4. USB Cable
5. Tempsens software CD
6. Manual
7. Certificate of calibration

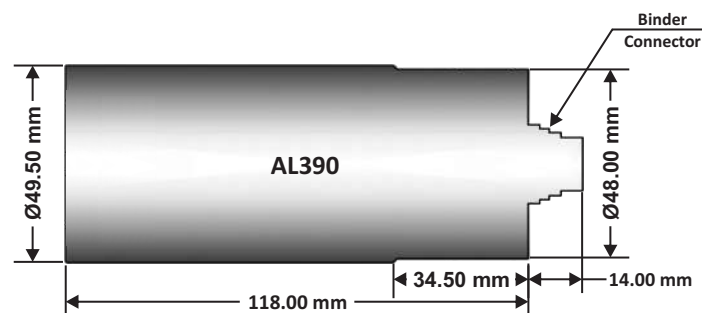
## 2.2 Technical Specifications

Model	AL390
Temperature Range (Analog sub range adjustable)	300°C to 1400°C 400°C to 2500°C
Emissivity Range	0.1 ..... 1.2 adjustable
Spectral Range, $\mu\text{m}$	3.9 $\mu\text{m}$
Photodetector Type	Thermopile
Response Time	60msec
Accuracy	1.5 % of temperature reading <b>(The instrument must be at a constant ambient temperature for a minimum of 25-30min)</b>
Repeatability	0.5% of reading in °C +1°C
Distance to Spot size Ratio	50 : 1
Digital output	USB 2.0, RS-232 / RS-485 (Isolated) User Selectable.
Analog output	4-20 mA or 0-20 mA or 0-10 V User selectable
Power	12V to 28V DC with reverse voltage protection
Sighting	Laser pilot Light
Laser Power	<1m W
Protection class	IP65
Operating temperature range	0°C to 70°C, 0°C to 200°C (with cooling jacket)
Isolation	Power supply and digital output and analog output are galvanically isolated against each other.
Storage temperature	-20°to 70°C
Dimensions/Weight	Dia.= $\varnothing$ 49.5mm; Length= 118mm / Weight= 0.6 kg
Adjustable Parameters via software	Emissivity, Analog output, Address, Response time, Peak picker, Analog Output sub range

**Note:** - After power supply initialization, keep pyrometer under stable temperature condition for 25-30 minutes for to get above stated accuracy.

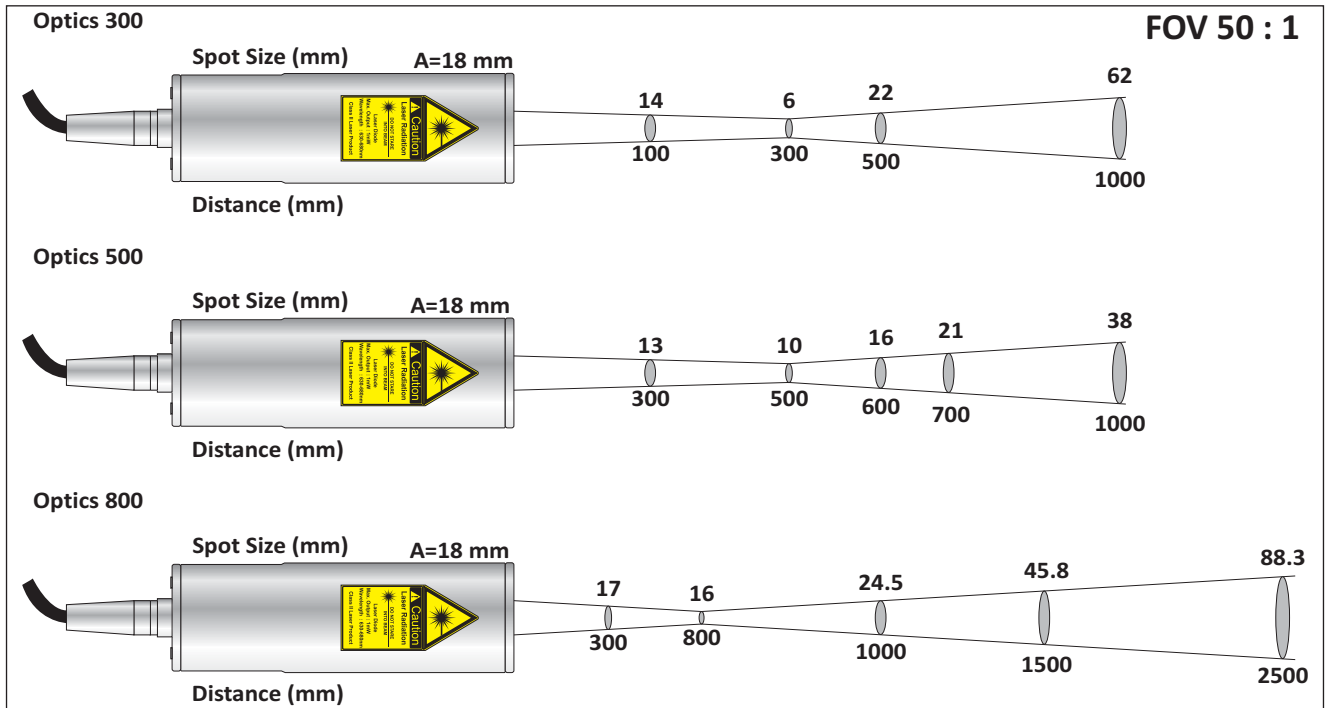
Laser should be used only for targeting purpose. In normal measuring laser should be turned off to get correct measurements.

### Dimensions



## 2.3 Optics

The pyrometer measure temperature by receiving heat radiation from the object whose temperature has to be measured. This heat radiation is passed through the lens, sensor converted to an electrical signal. The farther the measured object is from the pyrometer, the larger the area that will be measured by the pyrometer. Depending on customer need, the pyrometer is designed with fixed optics. Some fixed optics focus is as below:-



\* Manufactured working distance (WD) mentioned on the pyrometer.

If the pyrometer is not installed at manufactured working distance (WD) then spot size at actual installed distance should be calculated. For example, if factory made working distance in 500mm (FOV 50 : 1, Optics 500), then spot size is 10mm (as given in figure). If user installed this pyrometer at 800mm, user have to calculate by the given method below.

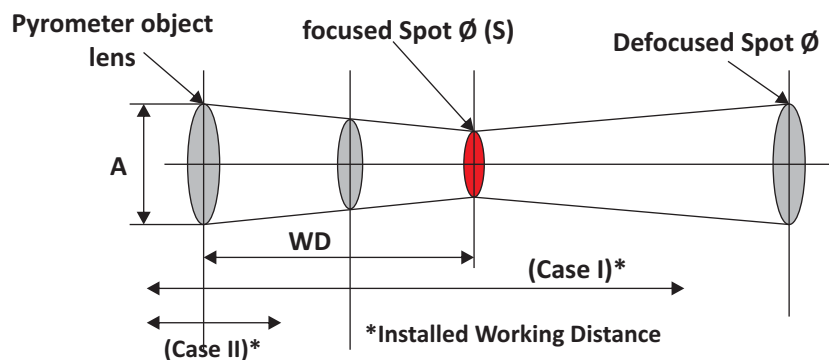


Fig. 2 Spot Size

**Case-I: If installed working distance is greater than manufactured working distance**

$$\text{Installed Spot Size} = \frac{\text{Installed working distance (Case I)}}{\text{WD}} \times (S + A) - A$$

**Case-II: If installed working distance is smaller than manufactured working distance**

$$\text{Installed Spot Size} = \frac{\text{Installed working distance (Case II)}}{\text{WD}} \times (S - A) + A$$

Where : S= manufactured spot size of pyrometer(mm), A = It shows the value of lens opening (aperture in mm)

# Chapter - 3

## Basics & Installation of the Pyrometer

### 3.1 Basics of Infrared temperature measurement of an object

Each and every object emit definite amount of infrared radiation and its intensity varies according to the temperature of object. Wavelength of infrared radiation lies approximately between 0.7 to 1000  $\mu\text{m}$  depending on the material and properties of object. Infrared radiations are sometimes also referred to as “heat radiations” depends mostly on the material. This material dependent constant value is known as “emissivity”, have a look at appendix B for emissivity values.

#### 3.1.1 Emissivity ( $\epsilon$ )

Emissivity is the ratio of energy radiated from an object to the exterior and energy radiated from blackbody. The emissivity varies with the surface condition of the object and also with temperature variation and wavelength. If this value is not accurate, then the true temperature cannot be measured. In other words a variation or change in emissivity will cause a change in the measurement.

If the value of emissivity low, your measured results may contain some errors due to interfering infrared radiations from objects which are behind the target object like heating systems, fireclay brick etc. Usually such type of problems occurs while measuring very thin materials like glass, plastic etc or some reflecting surface. This error can be reduced if the sensor is shielded from reflecting radiation sources and also by properly, carefully installing the device.

By the application of Kirchhoff's law of thermal radiation “at thermal equilibrium, the emissivity of the body is equal to its absorptivity ( $\alpha$ )”. So for perfect black body,  $\epsilon$  is 1 while any real object would have  $\epsilon$  less than 1. Also the transmissivity ( $\tau$ ) and reflectivity ( $\rho$ ) is zero. The sum of absorptivity, reflectivity and transmissivity is always 1.

$$\alpha + \rho + \tau = 1$$

By emissivity factor materials can be categorized as

- ✓ Metals
- ✓ Non metals
- ✓ Transparent materials

#### 3.1.2 Calculation of emissivity of target object

There are various methods to do so but one of most prominently used is Calculate the actual temperature of target object using a RTD, Thermocouple etc. Measure the object's temperature; and adjust emissivity settings unless correct temperature value is reached. Hence correct emissivity is measured of the target object.

### 3.2 Installation

#### 3.2.1 Mechanical installation of pyrometer

After all preparations are completed you can install pyrometer. Installation of pyrometer depends on the type of bracket you are using and the type of surface.

### 3.2.2 Distance of pyrometer from object

The desired spot size on the target will determine the maximum measurement distance and the focal length of the optical module. To avoid wrong readings the spot size of target must contain entire field view of the pyrometer. The pyrometer must be mounted so the entire field of view is the same or smaller than the desired target size. This is indicated in the below diagram.

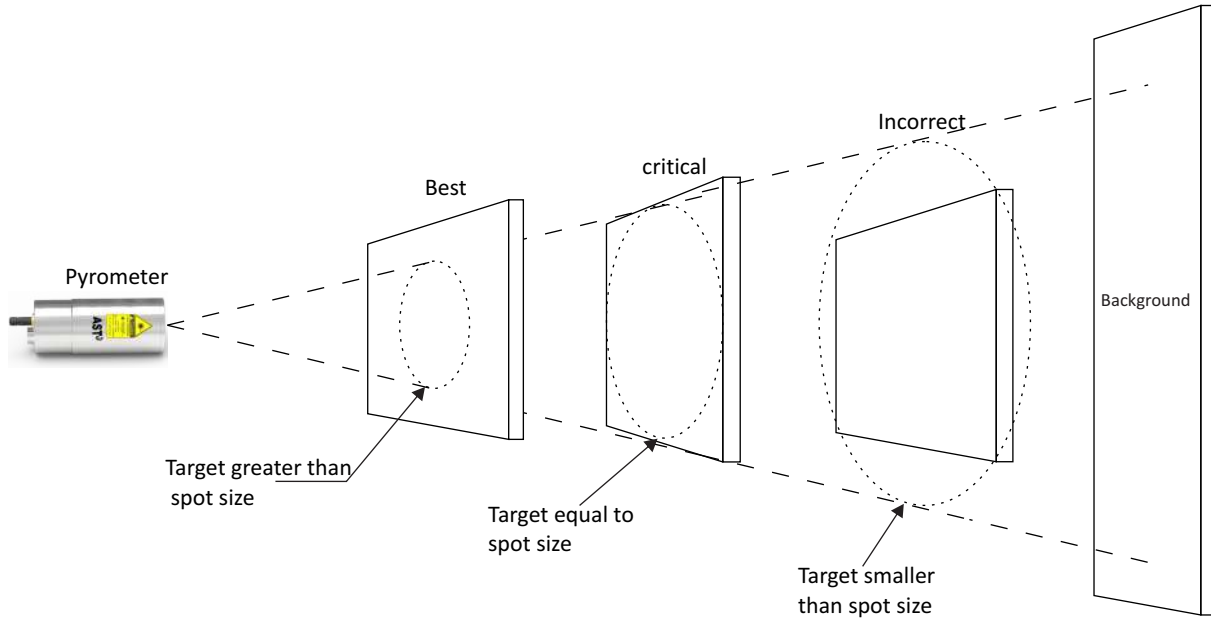


Fig.3 Proper mounting of pyrometer

### 3.2.3 Viewing Angles

The pyrometer can be placed at any angle from the target object up to 30°.indicated in the below diagram.

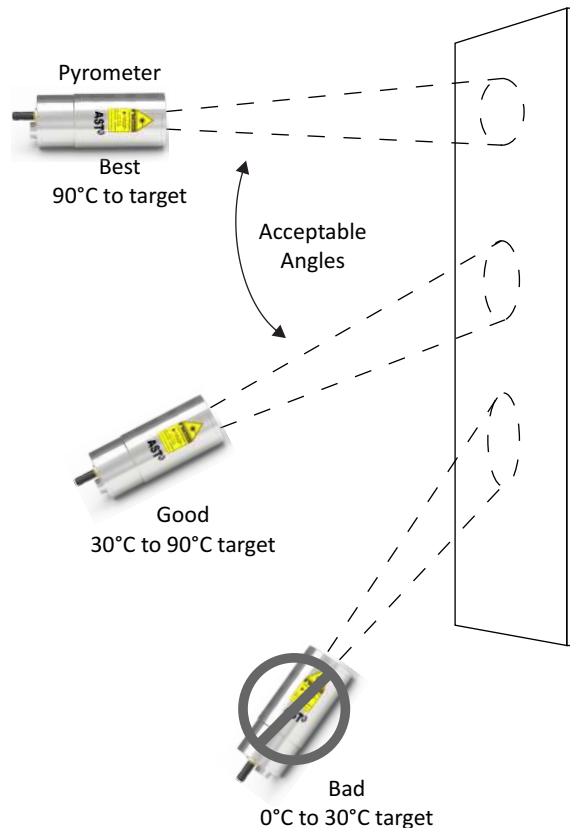


Fig. 4 Pyrometer Acceptable Viewing angles

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### 3.3 Location selection

Qualified operating person should do the installation. Location should be good enough so that pyrometer should get continuous infrared radiation.

Pyrometer distance from object is according to below points:-

1. Pyrometer spot size should be small than object size.(read 3.2.2 & 3.2.3)
2. Know your pyrometer spot size according to point 2.3.
3. Pyrometer ambient temperature should be within 0° to 70°C (read 3.3.3).

#### 3.3.1 Correct Positioning of the pyrometer

*With pilot light (PL)*

A laser targeting light will help to correct the position of the pyrometer. It is recommended that laser should be switched off while measurement. It will increase the life of laser. To avoid measuring errors caused by a too big spot size the pyrometer must be fixed in the correct measuring distance, so that the object under measurement fills the spot size.

*Note: The laser spot (PL) is only for indication of measuring spot, not exactly shows the measuring area.*

#### 3.3.2 Mounting of pyrometer

To install the pyrometer at the place of measurement a mounting support is supplied as an accessory, after losing the clamp screws, it can be fastened correctly.

#### 3.3.3 Ambient temperature

The allowed operation temperature for the pyrometer is 0°C to 70°C. But the temperature at fiber optic & optical head is 250°C max. Therefore if sensor is to be used above 250°C water cooling jacket with built in air purge unit is used otherwise it may damage the pyrometer. The ambient temperature is dependent on the temperature and flow rate of cooling water. Details of water cooling jacket & air purge are given in point 3.4.1.

#### 3.3.4 Atmospheric conditions

The pyrometer cannot receive the full infrared energy for the measurement if atmospheric conditions like smoke, dust or steam are present and hence it result in measuring error. An air purge unit can be helpful to avoid contamination such as dust and humidity on the lens. The air supplied should be at normal temperature with oil & moisture free. The air purge generates an air stream shaped like a cone and blows particles from the lens area.

### 3.4 Mechanical Accessories

#### 3.4.1 Water Cooling Jacket

This accessory is very important in order to use pyrometer at higher temperature. A normal pyrometer can withstand a temperature of 0-70°C. For higher temperature applications the device must be used with water cooling jacket upto 200°C.( for mechanical drawing refer Appendix C.)

- Water pressure : < 10 bar
- Air pressure : < 0.5 bar
- Air consumption : 2...3 m<sup>3</sup>/h
- Ambient temperature : < 200°C
- Metal : Stainless steel
- Weight : 2.75 Kg



**Fig. 5** Water Cooling Jacket (air purge, mounting clamp, water jacket combo)  
(Reference no: 8000-02 (for PL)  
8000-06 (for TL))

#### 3.4.2 Air Purge

This accessory is used to keep dust, moisture, airborne particle and vapours away from the lens head so that correct sighting of target object can be done. ( for mechanical drawing refer Appendix C.)

- Air pressure : < 0.5 bar
- Air consumption : 2...3 m<sup>3</sup>/h
- Metal : Aluminium
- Weight : 0.15 Kg
- Dry, clean air (Oil and dust free)



**Fig. 6** Air Purge Unit  
(Reference no: 8000-04)

#### 3.4.3 Adjustable mounting stand

This adjustable mounting stand will provide appropriate movement to the pyrometer. ( for mechanical drawing refer Appendix C.)

- Metal : Stainless Steel
- Weight : 0.9 Kg



**Fig. 7** Adjustable Mounting Stand  
(Reference no: 8000-07)

#### 3.4.4 Mounting Clamp

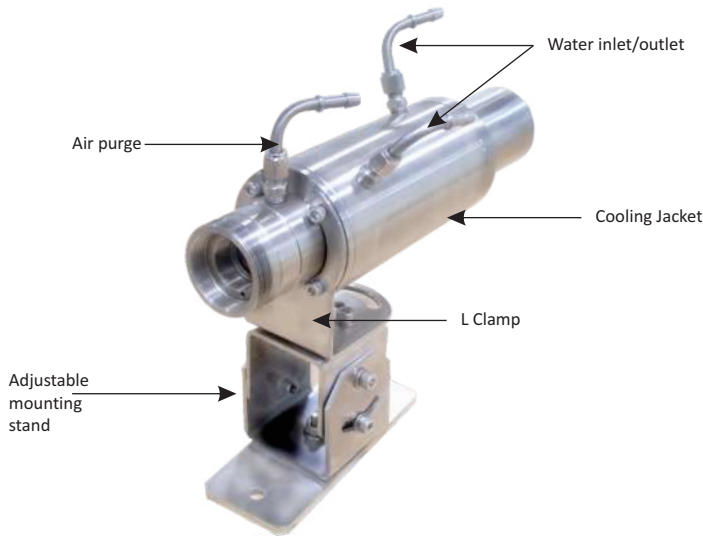
Mounting clamp can be used to hold the pyrometer.(for mechanical drawing refer Appendix C.) Fig. 8.

- Metal : Stainless Steel
- Weight : 0.45 Kg

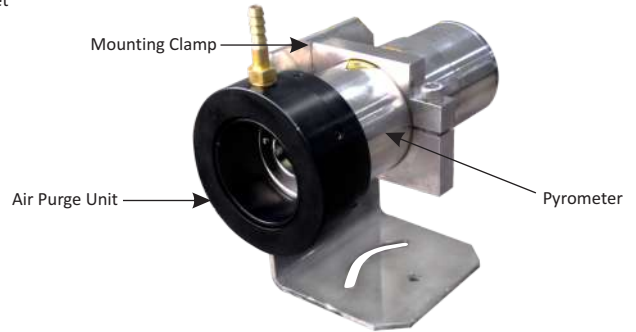


**Fig. 8** Mounting Clamp  
(Reference no: 8000-05)

### 3.4.5 Combination of Accessories



**Fig. 9** Adjustable Mounting Stand + L Clamp + Water cooling jacket with air purge  
(Reference no: 8000-02 or 8000-06 + 8000-07)



**Fig. 10** Air purge unit + Mounting Clamp + Pyrometer  
(Reference no: 8000-04 + 8000-05)

## 3.5 Electrical Installation

### 3.5.1 Power Supply

24V DC (well stabilized ripple max 50mV).The input power supply is 110/230v AC check the polarity before connecting the device.

#### Device has following specifications

Power supply I/P : 100 - 240VAC, 0.35A  
50/60 Hz  
Power supply O/P : +24V DC, 0.625A



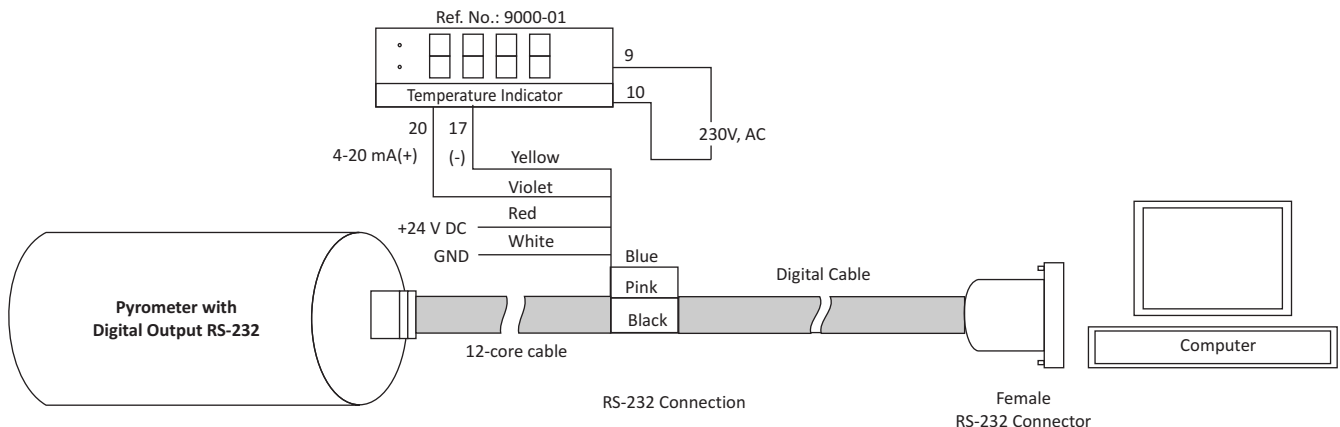
**Fig. 11** 12-Core Cable  
(Reference no: 7002-02)



**Fig. 12** Power Supply Unit  
(Reference no: 9000-02)

### 3.5.2 Connector pin assignment on the back of the pyrometer

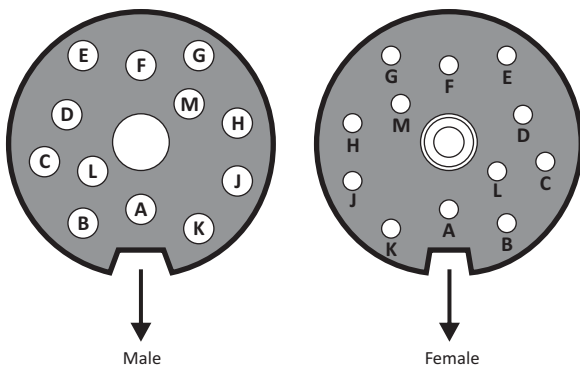
For connecting pyrometer with computer via connector pin (on the back of pyrometer) connection diagram is shown as under .Different colors and their indication is also shown in the table 2. So connections need to be done according to color, indication, used for particular purpose as in the table2.



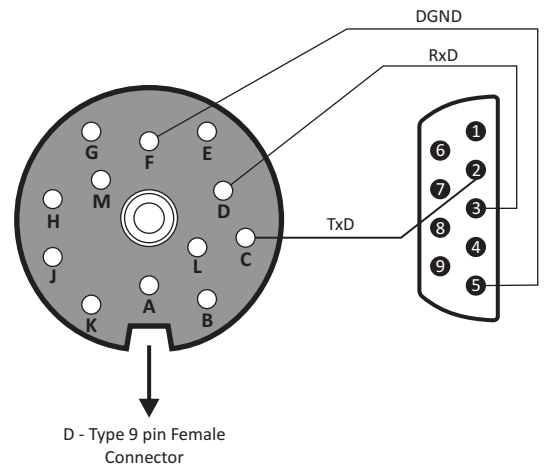
**Fig. 13** Connecting pyrometer (RS-232 Converted) with computer

**Table 2 :** Color code & Pin specification for pyrometer connections

Pin	Colour	Indication	Used for
A	Red	+ 24 V DC In	Power supply
G	White	Ground	
C	Blue	TxD (RS-232) / D- (RS-485)	RS-232/ RS-485 communication
D	Pink	RxD (RS-232) / D+ (RS-485)	
F	Black	RS-232 communication	
H	Yellow	(-) 4-20mA / 0-20mA	Analog current output
M	Violet	(+) 4-20mA / 0-20mA	
J	Brown	Short / Open both wires for laser ON/OFF	Laser ON/OFF
K	Green		
H	Yellow	- (0-10V)	Analog voltage output
B	Grey	+ (0-10V)	
E	Blue-Yellow	N/A	Not used
L	Red-Grey	N/A	



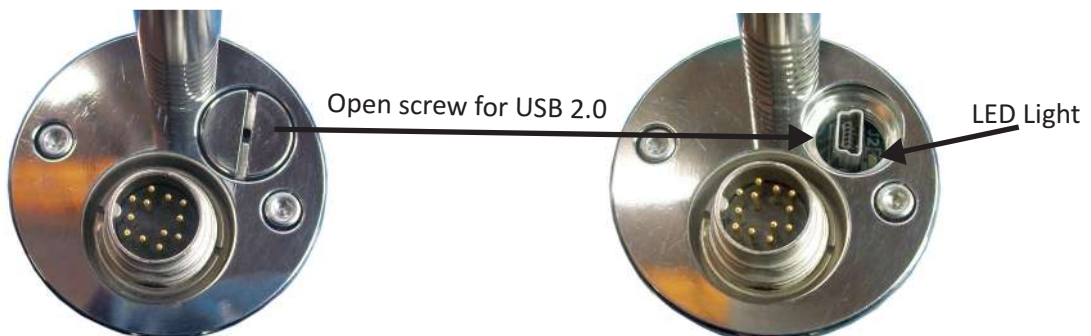
**Fig. 14** 12-pin Binder connector



**Fig. 15** RS-232 communication connection

### 3.5.3 USB 2.0 Connection

USB 2.0 is provided for Parameter Setting and Data Logging. 2Mtr long USB cable is supplied with pyrometer. While USB 2.0 is connected RS-232 / RS-485 communication is not possible. LED light indicates USB 2.0 operation.



**Note :** Power supply +24 V DC required for USB communication.

### 3.5.4 Power ON Pyrometer

1. Connect the 12-core cable (Supplied with pyrometer) with pyrometer 12-pin binder connector given at the back side of pyrometer.
2. Connect the 12-core cable supply wire with +24V DC as given in table above.
3. Connect remaining wires as per your requirement (details given in table above).
4. Provide insulation for not used end points of 12-core cable.
5. Now, the pyrometer can be switch ON.

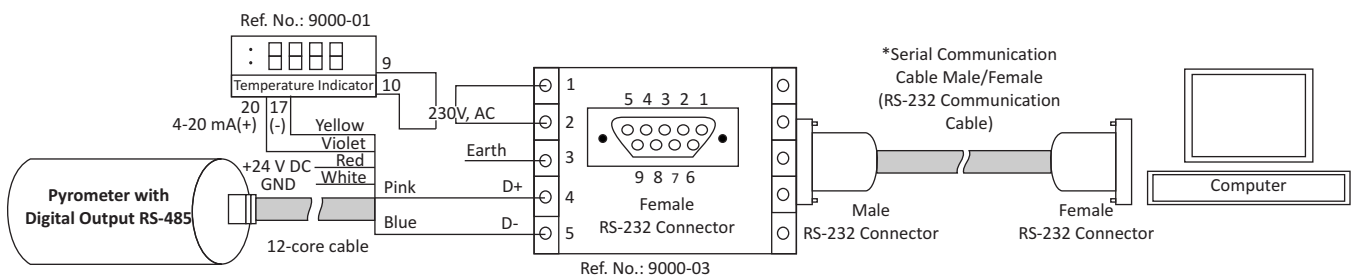
### 3.5.5 Converter RS-232 ↔ RS-485



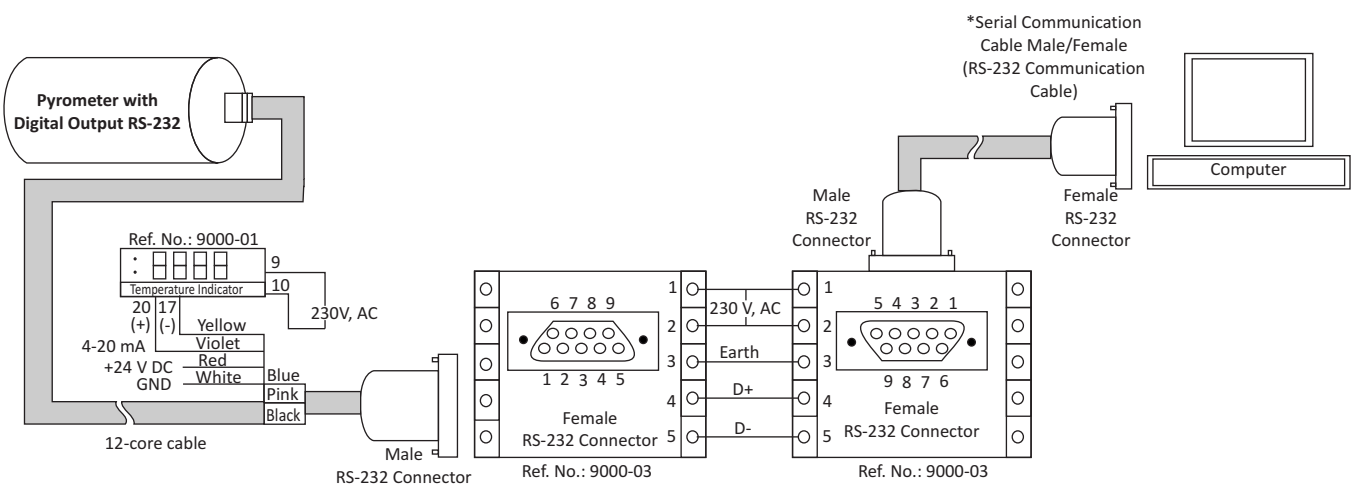
The pyrometer can communicate with PC using RS-232 or RS-485. RS-232 is used only for short distances.

RS-485 is well suited for long distance transmission. Standard on PC is RS-232, so a converter is used which converts RS-485 to RS-232.

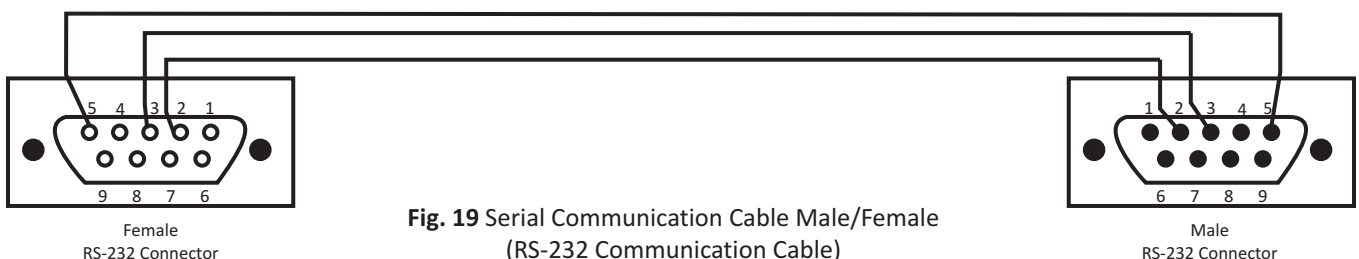
**Fig. 16** Converter RS-232 ↔ RS-485  
(Reference no: 9000-03)



**Fig. 17** RS-485 to RS-232 Connection



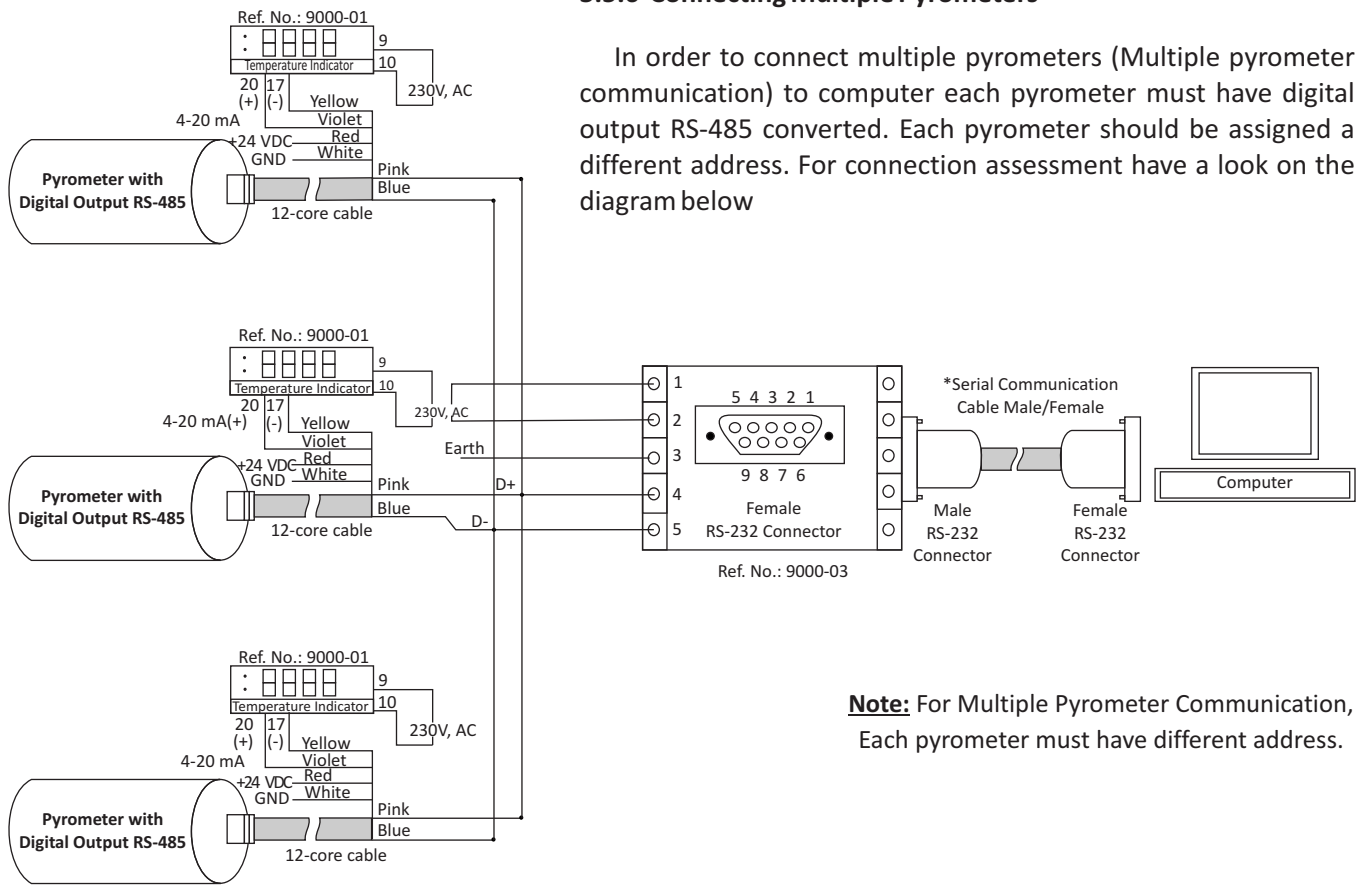
**Fig. 18** RS-232 to RS-485 to RS-232 Connection



**Fig. 19** Serial Communication Cable Male/Female  
(RS-232 Communication Cable)

### 3.5.6 Connecting Multiple Pyrometers

In order to connect multiple pyrometers (Multiple pyrometer communication) to computer each pyrometer must have digital output RS-485 converted. Each pyrometer should be assigned a different address. For connection assessment have a look on the diagram below



**Note:** For Multiple Pyrometer Communication, Each pyrometer must have different address.

Fig. 20 Multi-Pyrometer Connection

### 3.5.7 Display Instrument

To display the measured temperature 7 segment digital indicator is used. Device has following specifications:

Power supply I/P	:	100 to 240 V, AC/DC
Analog I/P	:	4....20 mA
Retransmission	:	4....20 mA
Power supply O/P	:	24V, DC
Display	:	4 Digits
Alarm	:	2

### 3.5.8 Display & Parameterizer

P-120 is a high precision LED indicator for non contact temperature measurement. With indication of measured temperature user can easily parameterize a connected Tempsens digital pyrometer without any PC.

**Device has following specification:**

Power supply	:	100 – 240V, AC or 24V, DC
DC analog O/P	:	0-20 mA or 4-20 mA
Digital interface	:	RS-232 or RS-485
Pilot light	:	Pilot light On/Off with keys



Fig. 21 Temperature Indicator  
(Reference no: 9000-01)



Fig. 22 Display & Parameterizer P-120  
(Reference no: 9001-01)

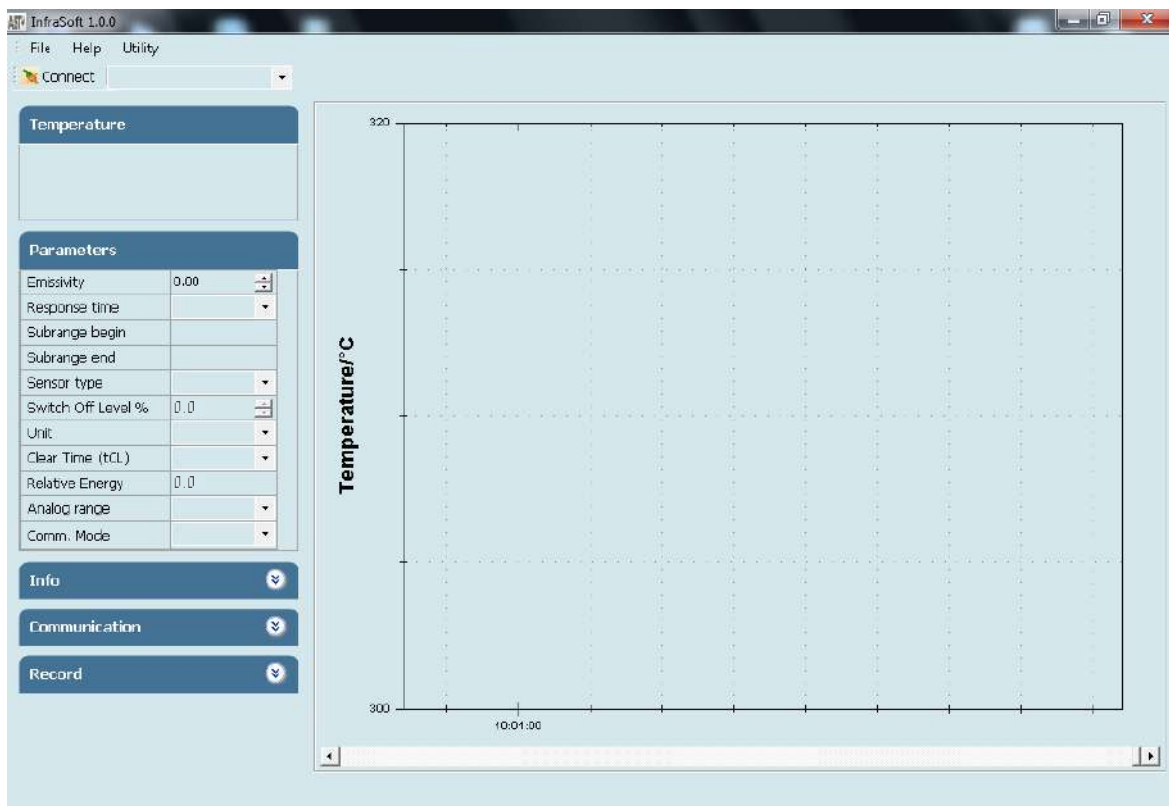
# Chapter - 4

## Software Installation

The provided Tempsens software “InfraSoft” offers digital PC interface RS-232 & RS-485. Using this software we can set all the parameters like response time, analog scale, emissivity, clear time, communication mode. This software provide all necessary information about pyrometer.

### 4.1 Installation

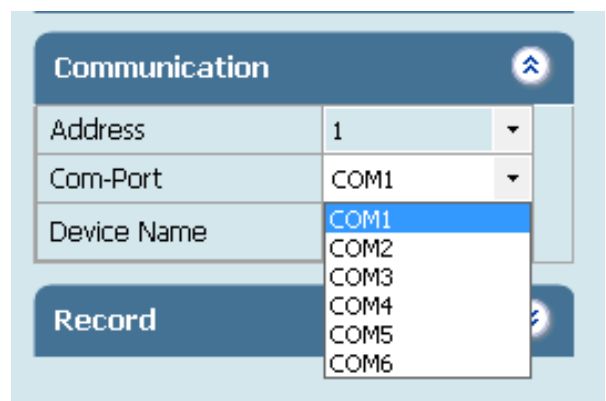
Install the pyrometer software using the installation guide file on CD ROM & restart your PC as per guidelines provided for installation. After installation of the software; Double click the application. It will open the screen of software.



### 4.2 Parameters in main screen

#### 4.2.1 Communication

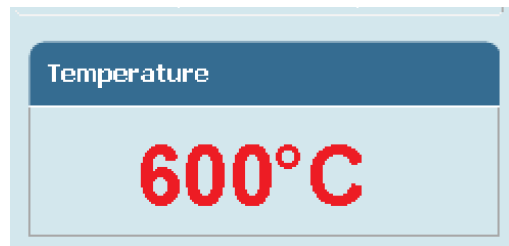
Communication between the Tempsens pyrometer and the software is implemented via a cable connected between the pyrometer and the PC serial port. This enables the acquisition and recording of data, as well as the transfer of commands from the software application to the Tempsens pyrometer. Communication can be done by clicking on “Communication panel” and select correct COM Port address where pyrometer is connected. Also user has to select address of the pyrometer(Example: Default 01/ printed on the pyrometer sticker). Then click on CONNECT Button.



For communication of multiple pyrometers, select different com port and address.

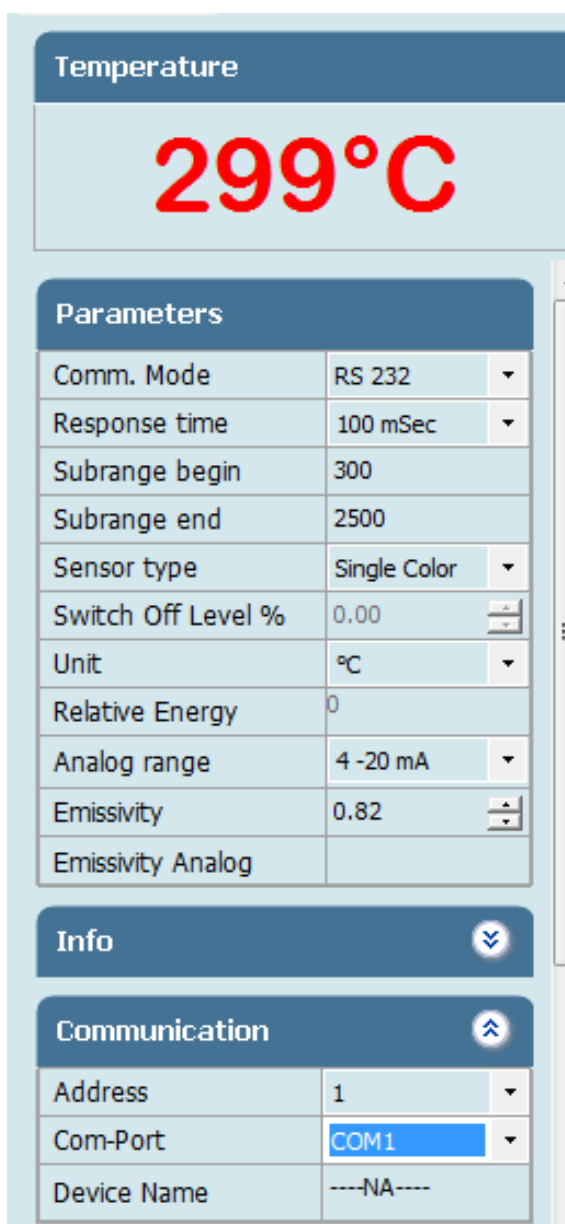
#### 4.2.2 Temperature

It shows the temperature measured by the pyrometer



#### 4.2.3 Parameter Setting

All user selectable device parameters can be set by using the software in the Panel "Parameter"



**(A)Emissivity settings** The emissivity can be set by clicking on "Parameters" and select or type in the desired emissivity directly in the description field. The emissivity value will be transferred to pyrometer by hitting the "TAB" button.

**(B)Response time** The desired response time can be chosen in the panel Parameter by clicking the appropriate list box (as per the values available in the drop box of response time). This parameter is use to set the analog response time of pyrometer.

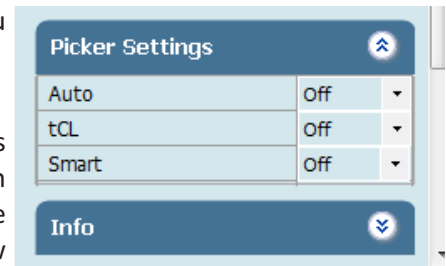
**(C)Sub Range** User can change the sub range of pyrometer in the panel Parameter. Sub range must be within the basic range of pyrometer, the minimum span between higher & lower range is 51. Analog output will be automatically set according to the sub-range by hitting "TAB" button.

**(D)Sensor Type** It shows pyrometer sensor type. User can change sensor type from two color to single color and vice versa (only applicable with two color pyrometer).

**(E)Switch off level% ( for two color pyrometer)** The switch of level is the function that is used to avoid measurement errors caused by signals, which are too low. Although factory default is set to 15 %, the switch off limit can be adjusted between 2 and 50%.

**(F)Unit** User can change the measuring unit of temperature from "Centigrade" to "Fahrenheit" and vice versa.

**(G) Peak Picker Setting** Three Pickers are available in Pickers setting menu (Auto, tCL, Smart) & user can switch on any as per requirement, one at a time.



**(G1) Auto** “Auto” mode is used for discontinuous measuring task, such as object being transported on a conveyer belt in such a case the maximum value for each object has to be indicated. when the object passes the measuring beam of the pyrometer, 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 when the temperature of the new hot object exceeds the low limit “from” of the sub range by at least 1°C. If a lower limit is not entered, the maximum value storage will be deleted whenever the low level of the full measuring has been exceeded.

**(G2) Clear time (tCL)** If the peak picker 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 values in order to obtain new temperature readings.

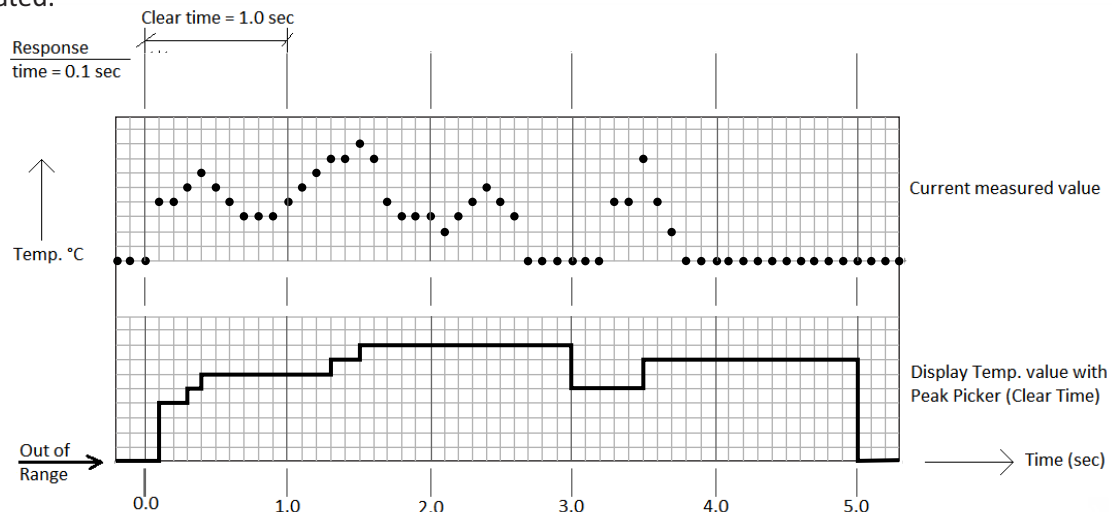
**Example :** If we set the tCL a s “6 sec” the highest last temperature value will be display for 6.0 sec to 12 sec then it capture next pick.

**The following setting are possible :**

**OFF :** At clear time “OFF” the maximum value storage is switched off and only momentary values are measured.

**tCL (10msec...25sec) :** Clear Time tCL can be set between 10msec and 25sec. When set, estimates the maximum values and holds it in two buffer memory. After the entered time, the storage will be deleted.

Clear Time feature is particularly useful when object temperature is not uniform across its dimension or the pyrometer is not constantly viewing an object to be measured. The peak picker works on two buffer memory to find maximum value over a defined interval. 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.



**Note:**

The maximum value storage coincides with adjustments made to response time. Therefore:

- (i) Clear time <= the adjusted response time is useless
- (ii) Clear times must be at least 5 times longer than the response time.
- (iii) Only maxima with full maximum value can be recorded, which appear at least 5 times longer than response time.

**(G3) Smart** If the smart picker is switched on, the highest last temperature value will always be displayed and stored. This feature is particularly useful when object temperature is not uniform across its dimension or the pyrometer is not constantly viewing an object to be measured.

**Smart Picker Functions**

Smart picker can be turn ON & OFF by using the software. When Peak picker is ON, the peak picker menu is enabled for setting of the parameters like decay rate function, reset below temperature and peak picker delay.

**Temperature**

231°C

Sensor type	Single Color
Switch Off Level %	0.00
Unit	°C
Relative Energy	0
Analog range	4 -20 mA
Emissivity	0.13

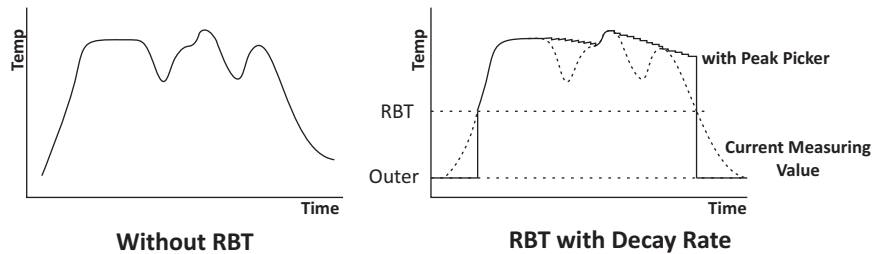
**Picker Settings**

Auto	Off
tCL	Off
Smart	On
Decay Rate (Temp./Sec.)	5
Delay Time (Sec.)	10
Reset Below Temp.	200

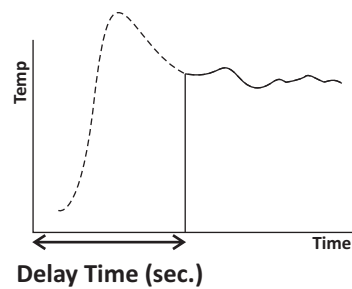
Info
⌵

Communication
⌶

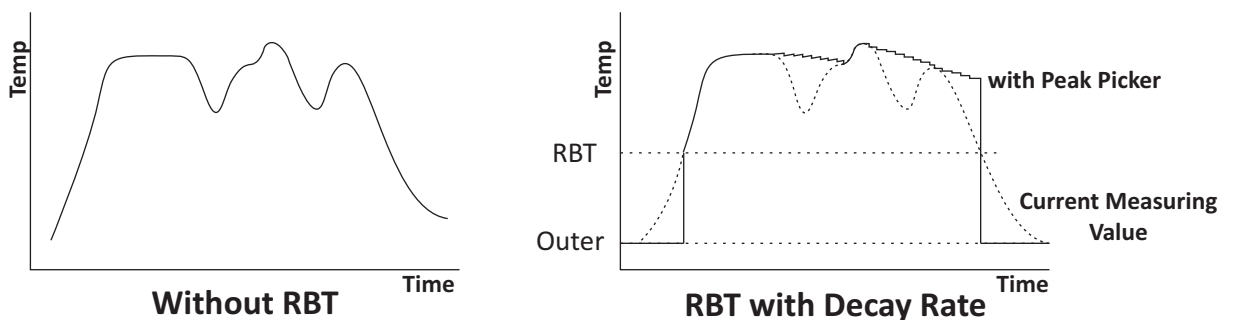
**(I) Decay rate** The Decay rate range is 0.00 to 166.66°C/sec. or 0.00 to 300°F/sec. depending upon °F/°C unit's selection. The slowest Decay rate is 0 degrees per sec. This feature helps to eliminate erratic measurements and allows the peaked value to decay down to lower process temperature values as they occur. Decay rate is set to retain peak measured temperature value and ignore momentary decreases in measured temperature.



**(II) Delay Time** This function set the delay time in sec. before peak picker function starts. The delay time is selectable in the range 0.02 to 10.00 sec. Zero (0) turns delay time OFF. This function is used to delay the start of peaking action for upto 10 sec. following the detection of leading edge of a new target.



**(III) Reset Below Temperature (RBT)** The user can set RBT within the limit of pyrometer sub range. This function sets the temperature above which peak picker action starts. When the target temperature matches or is below the selected value, the sensor indicates temperature without picking action.



**(H)Relative energy(for two color pyrometer)** The relative energy shows a signal weakening which can be caused by contaminations of the optics or a viewing window or by dust in the field of view or a too small measuring object. Relative energy shows the measured intensity compared to the intensity, a black body radiation source would have at a determined ratio temperature of the pyrometer.

**(I)Analog Range** User can select the analog range from the option 4-20mA, 0-20 mA & 0-10V.

**(J)Comm. Mode** User can select the communication mode as per requirement [RS-232 / RS-485].

**Note:** For connection diagram from RS-232 to RS-485 & RS-485 to RS-232 Refer Page No:-9

To view parameters of multiple devices select the pyrometer name from the drop down list that appears at the top of the screen.

#### 4.2.4 Device information

Pyrometer specific information will be displayed in the Info Panel

This screen shows the Model, basic range, serial number, version, Head temperature, internal temperature, working distance, spot size-aperture.

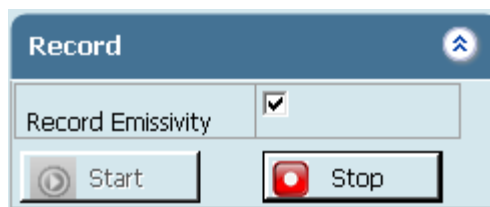
Info	
Model	AST A250 TL
Basic range	300°C...1300°C
Serial number	849
FW Version	11.25
Head Temp.	0°C
Internal temp.	30°C
Working Dist..(mm)	300
Spot Size-Aprt. (mm)	2-5

#### 4.2.5 Record

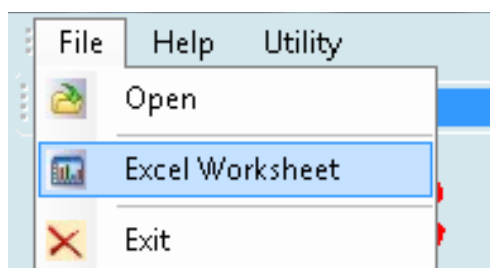
Record is for continuous data logging. It records the measured temperature, emissivity with current date & time. To start data logging click on start button. If user wants to record emissivity, click on record emissivity button. After Clicking Start button window appears where user can specify the file name & location. Record will be saved as **.txt** format and the name of file will be user define.

No. of Device	Date	Time	Temperature	Emissivity
1	15/11/13	9:55:05 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X
1	15/11/13	9:55:06 PM	28°C	X

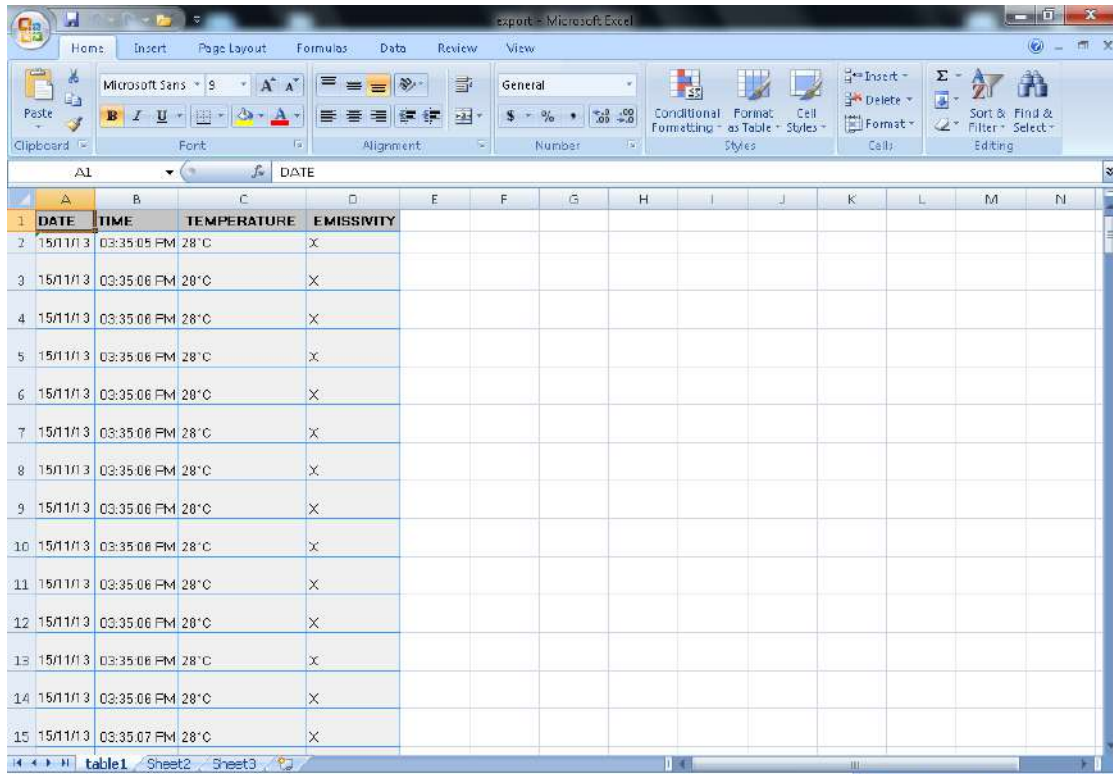
To record emissivity, click on **Record Emissivity** button.



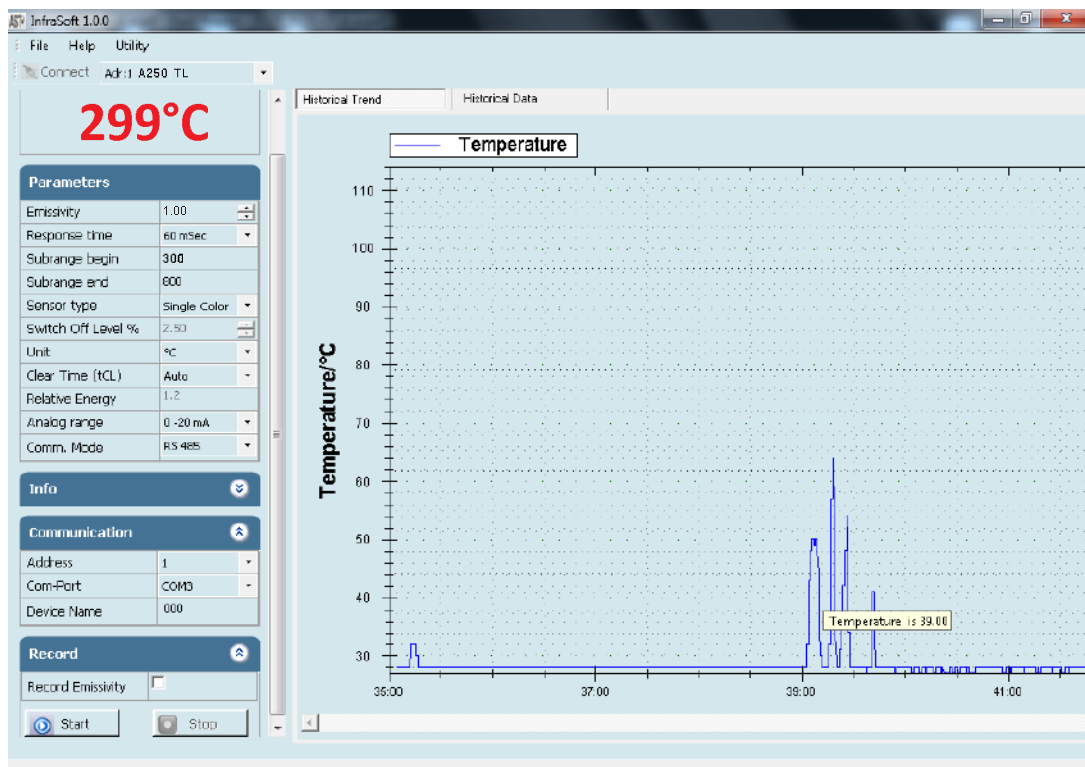
If user wants file in Spreadsheet format, user can export by choosing Excel Spreadsheet in file menu.

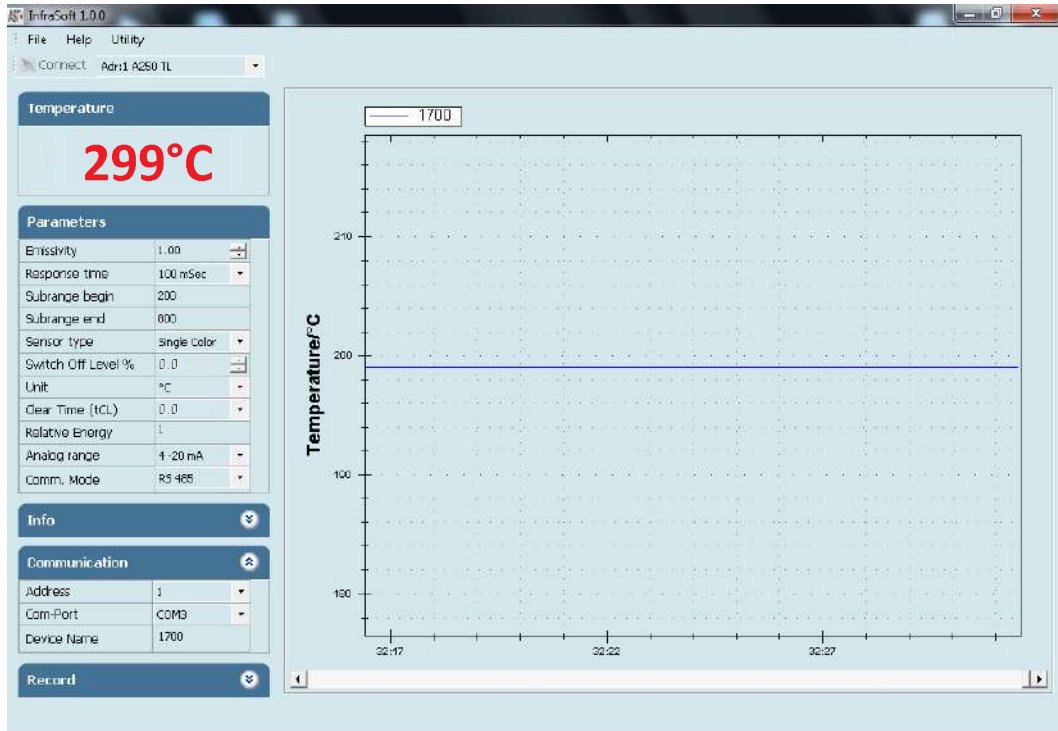


File will be stored in **.xls** format named as “export”. This “export.xls” file will be saved where the software is installed.



To see previous record open the file by clicking on menu **File** → **open**.  
 Screen containing historical trend & historical data will appear.

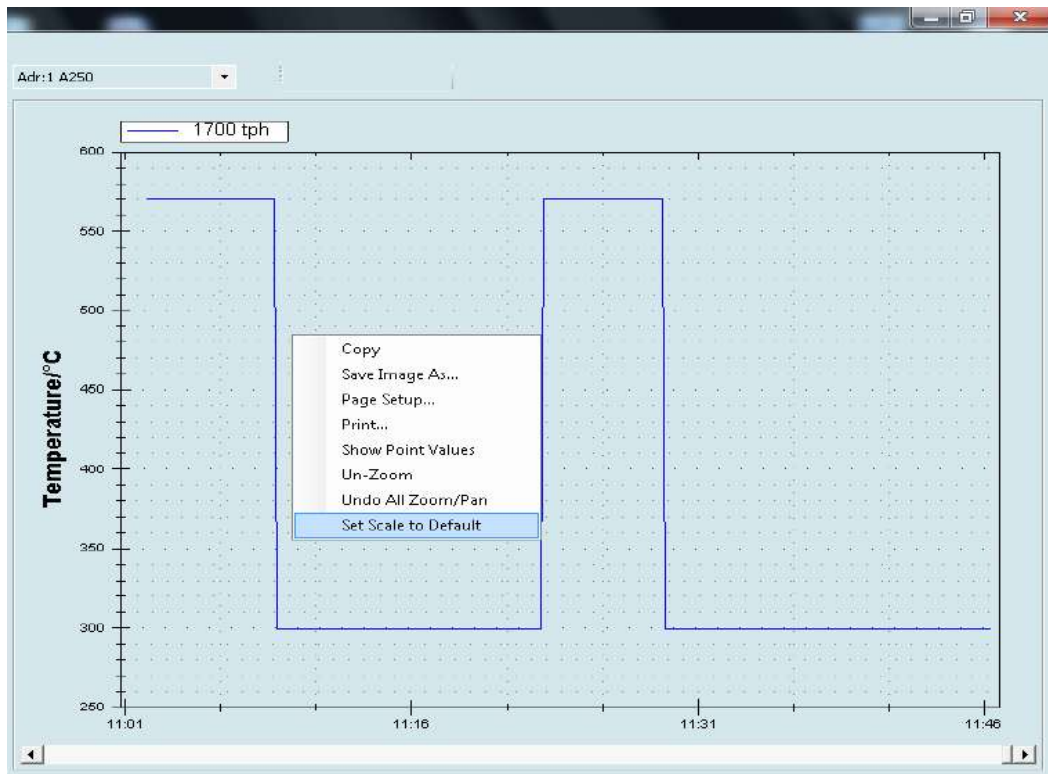




Temperature graph of connected pyrometer is displayed on right side of the screen. This shows the measured temperature corresponding to the time.

**Note:**

After connecting the pyrometer right click on the graph screen and choose "Set to default" option from pop-up menu.

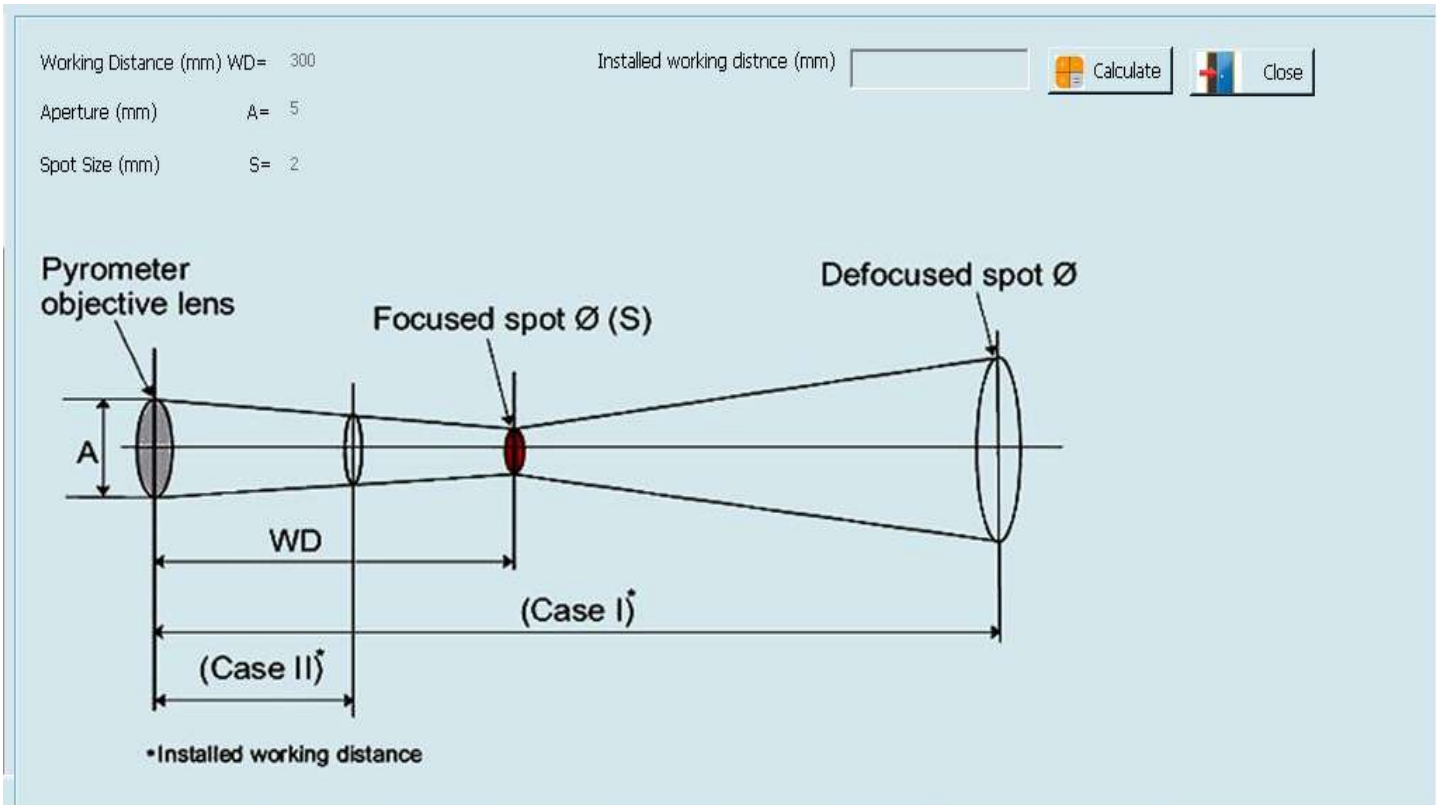


# Chapter - 5

## Calculate Spot Size

To calculate Spot Size click on **Utility** → **Calculate Spot Size**

This option is used to calculate the spot size at installed working distance of the Pyrometer. When you click on calculate spot size the new window will open.



- WD** = Manufactured working distance in (mm).
- A** = It shows the value of lens opening (Aperture in mm)
- S** = Manufactured spot size of the pyrometer (mm)

User has to enter the value of WD, A, S, of the installed pyrometer (These values are given in section – 2.3). Now, putting the value of “Installed working distance” it will show the value of “Installed spot size”.

---

# Chapter - 6

## Maintenance

In case of any queries, questions regarding repair, solutions to problems, calibration and assistance you may contact our sales representatives. Most of problems can be solved telephonically.

### 7.1 Cleaning Lens

The lens should be kept clean all the time as it aims at center of target object. When cleaning lens care should be taken and it can be done as follows :

- Firstly blow off lightly loose particles with “canned air” which is used for cleaning computer equipment or a small bellows squeeze (used for cleaning lenses).
- Now brush out gently remaining particles with a soft hair brush, a soft lens tissue can also be used.
- At last clean remaining particles “dirt” using a cotton or soft lens tissue dampened in distilled water. Do not scratch the surface.

In case of finger prints or any other grease material uses any of the following removing elements:

- Kodak lens cleaner
- Ethanol
- Denatured alcohol

Gently wipe with a soft, clean cloth after application of any of the above elements and wipe until you are able to see colours on the surface, then allow to air dry.

Do not wipe the surface dry, as this may result in scratches on the surface.

**Note:** Do not use any cleaners containing ammonia or simple ammonia to wash or clean the optical lens of pyrometer as this may permanently damage the surface of lens.

# Chapter - 7

## Serial communication protocol-MT500

This protocol is developed to use in the half duplex addressable communication mode. Master device should periodically issue requests to each Slave device. The request contains an address of polling “Slave” device. Slave device reply only on the requests issued by Master. Each Slave has its own address to recognize the issued request. Tempsens sensors always operate as Slave devices. Using RS485 serial communication option allows connecting more than one sensor to Master device. Tempsens sensors always perform delay of 5 ms before sending an answer on Master request to meet RS485 hardware requirement.

MT500\_Tempsens protocol uses only RD (Batch Read) and WD (Batch Write) commands. Sending other MT500 protocol commands causes sensor to consider it as error condition and answer with unknown command reply. Symbols enclosed within apostrophes ('symbol') means ASCII representation of the symbols. String enclosed with quotation mark ("string") means ASCII representation of the string (ended by '\0'). Data format is: 8 data bit, 1 stop bit, No parity, baud-rate 19200.

Description	Address	Items	Parameters
Emissivity	'0400'	'01'	Object emissivity multiplied by 1000. Refer user manual for adjustable range.
Emissivity slope	'0401'	'01'	Emissivity slope parameter multiplied by 1000. Refer user manual for adjustable range.
Response time ( $\tau$ )	'0105'	'01'	Parameter specifies analog and serial output response time. See Table 1.
Upper basic range	'0100'	'01'	Upper measurement range limit in °K (read only)
Lower basic range	'0101'	'01'	Lower measurement range limit in °K (read only)
Analog output type	'0F01'	'01'	'0000': 4 to 20 mA (Default); '0001': 0 to 20 mA, '0002': 0 to 10 Volt; '0003': K type TC; '0004': J type TC
Upper sub range	'0102'	'01'	Upper analog scale value in °K
Lower sub range	'0103'	'01'	Lower analog scale value in °K
Station number	'0200'	'01'	Adjustable between '0001' to '0255'
Temperature unit	'0201'	'01'	Flag is used to instruct PC SW to show temperature '0000': Centigrade (Default); '0001': Fahrenheit
Switch off level	'0107'	'01'	Parameter multiplied by 10. Adjusted between 0 and 100%, Default set to 15%.
Sensor mode	'0204'	'01'	'0000' = Single color; '0001' = Two color This parameter is useless for single color sensors.
Internal temperature	'0006'	'01'	Temperature inside device case in °C (read only)
Head temperature	'0007'	'01'	Temperature inside optical head m°C(only for E –series pyrometers) (read only)
Clear time(tCL)	'0303'	'01'	Adjustable between 0 to 12, Default 0, 0=OFF, 1=Auto. 2-12 = 10msec to 25sec [refer to page-13(clear time)]
Laser control	'0F00'	'01'	'0000': LASER OFF; '0001': LASER ON (Default)
Communication type selection	'0F03'	'01'	'0000':RS-485,, '0001': RS-232 (Default)
Set point	'1700'	'01'	Set point for relay actuation (only for E –series pyrometers)
Hysteresis	'1800'	'01'	Hysteresis value relay actuation
LCD back light control	'1801'	'01'	'0000': BL OFF; '0001': BL ON(Default) (Only for E-series pyrometers)
Device name	'1D00'	'01'	10 Bytes “Hot end ”, if less then 10 bytes pad with space at end.
Working distance (mm)	'1D01'	'01'	10 Bytes “1000 ”, if less then 10 bytes pad with space at end.
Spot size-aperture (mm)	'1D02'	'01'	10 Bytes “1000-6000” if less then 10 bytes pad with space at end. '.' sign between spot size and aperture is compulsory
Relative energy (read only)	'0002'	'01'	Relative energy multiply by 1000 for 2 color pyrometers only

Device model number (read only)	'0E00'	'01'	10 bytes "AST450C ", if less than 10 byte pad with space at end
Firmware version	'1300'	'01'	Firmware version number of device (read only)
Sensor serial number (read only)	'1400'	'01'	6 bytes in hex, if less than 6 bytes pad with '0' at start. Only numbers allowed.
Device type (read only)	'1301'	'01'	'0001': Single color; '0002' : Two color '0003': Thermopile; '0004' : Reserved
Real temperature and status code (read only)	'0000'	'02'	Calculated object temperature in °K and status of sensor (As shown in Appendix A). First process status code then real temperature.

### Batch Read (RD)command

Byte 1	Bytes 2,3	Bytes 4, 5	Bytes 6-9	Bytes 10, 11	Byte 12	Bytes 13, 14
1 Byte	2 Bytes	2 Bytes	4 Bytes	2 Bytes	1 Byte	2 Bytes
STX	Station ID	RD	Address	Items	ETX	Checksum

Byte 1: Always STX (0x02)

Bytes 2, 3: The Station Number of the device to read from (2 Hex digits)

Bytes 4, 5: The command to execute (RD)

Bytes 6-9: This is the starting address to read from. Must be 4 bytes long

Bytes 10, 11: This is the number of addresses to read. Must be 2 bytes long

Byte 12: Always ETX (0x03)

Bytes 13, 14: The checksum is the lowest 8 bits of the sum of bytes 2 through 12

**Example :** Read two parameters starting from address 0000, from the station number 10 (0AH). This will read addresses 0000 and 0001.

Byte 1	Bytes 2, 3	Bytes 4, 5	Bytes 6-9	Bytes 10, 11	Byte 12	Byte 13, 14
STX	0A	RD	0000	02	ETX	2E
0x02	0x30, 0x41	0x52, 0x44	0x30,0x30,0x30,0x30	0x30, 0x32	0x03	0x32, 0x43,

Checksum is calculated as the lowest 8 bits of the sum of the Hex codes for bytes 2 to 12.

### Reply:

The reply length is  $L = (N * 4) + 8$ , Where N = the number of requested Items.

If the command is successful, the reply length will be at least 12 bytes. It consists of the STX, followed by four bytes for each requested item, then the ETX and Checksum.

Byte 1	Bytes 2, 3	Bytes 4, 5	Bytes 6-9	Bytes 10-13	Byte L-2	Byte L-1, L
STX	Station	RD	Data 1	Data N	ETX	Checksum

Reply to above command if address '0000' contains value 1497 and address '0001' contains value 0000.

Byte 1	Bytes 2, 3	Bytes 4, 5	Bytes 6-9	Bytes 10-13	Byte 14-15
STX	0A	RD	059D	0000	9C
0x02	0x30, 0x41	0x52, 0x44	0x30,0x35,0x39,0x44	0x30, 0x30, 0x30, 0x30	0x39, 0x43

in the event of an error, the reply is

Byte 1	Byte 2, 3	Byte 4, 5	Byte 6
NAK	0A	'R', 'D'	01
0x15	0x30, 0x41	0x52, 0x44	0x30, 0x31

### Batch Write (WD) command

Byte 1	Bytes 2, 3	Bytes 4, 5	Bytes 6-9	Bytes 10, 11	Bytes 12-15	Bytes (L-6) - (L-3)	Byte L-2	Byte L-1, L
STX	Station ID	WD	Address	No. of Items	Data 1	Data N	ETX	Checksum

Byte 1	Bytes 2, 3	Bytes 4, 5	Bytes 6-9	Bytes 10, 11	Bytes 12-15	Byte 16	Byte 17,18
STX	0A	WD	0400	01	03E8	ETX	74
0x02	0x30, 0x41	0x57, 0x44	0x30, 0x34, 0x30, 0x30	0x30, 0x31, 0x30, 0x30	0x30, 0x33, 0x45, 0x38	0x03	0x37, 0x34

### Reply :

If the command is successful, the reply is

Byte 1	Byte 2, 3	Byte 4, 5
ACK	0A	'W', 'D'
0x06	0x30, 0x41	0x57, 0x44

In the event of an error, the reply is

Byte 1	Byte 2, 3	Byte 4, 5	Byte 6
NAK	0A	'W', 'D'	01
0x15	0x30, 0x41	0x57, 0x44	0x30, 0x31

## Error Codes

Error Code	Description	Comments
'1'	Invalid check sum	See how to calculate a check sum
'2'	Unknown command	Protocol uses only RD (Batch Read) and WD (Batch Write) commands
'3'	Data length error	Number of items in WD (Batch Write) command doesn't match number of data bytes
'4'	ETX not found	ETX (0x03) not present in command
'5'	Illegal Address	number of items in a request is set to 0; memory segment number in a request is out of 0-25; Wrong command value, No data at requested address;
'6'	More items requested	More than 99 items were requested in command
'7'	Unsuccessful write	It informs Master that it should repeat WD command

**Table 1**

Tau ( $\tau$ )	Analog Response Time, ms	Serial Response Time, ms
1	2	20
3	6	50
5	10	100
10	20	200
30	60	300
50	100	500
100	200	1000
300	600	2000
500	1000	3000
1000	2000	4000
3000	6000	5000
5000	10000	10000

# Appendix A

DATA	Comments
Status code	'0000' : No error '0001' : Signal is lower than sensor sensitivity '0002' : Out of range due to T brightness minimum '0003' : Too low energy '0004' : Signal is higher than sensor sensitivity '0006' : Sharp brightness jump '0007' : Non stable object measurement '0011' : Internal temperature warning '0013' : Thermopile ambient temperature too low '0014' : Thermopile ambient temperature too high '0015' : Pyrometer in testing mode '0016' : Pilot light ON '0017' : Measurement below lower basic range '0018' : Measurement exceeds upper basic range '0019' : Pyrometer in warm up period

## Broadcast Message:

WD (Batch Write) command with Station ID of 0 is considered as broadcast message. Sensors process this command regardless of their Station Number and do not issue replies.

It is useful when master issues a request to change the same parameters of more than one Slave devices.

For more information write us at, [info@tempsens.com](mailto:info@tempsens.com)

# Appendix B

Typical emissivity values for various materials available:

All the emissivity values shown in the table are only approximate, as it depends various parameters and it may affect the emissivity of a material. These parameters are as under:

1. Temperature
2. Thickness of material
3. Angle of measurement
4. Spectral range of measurement
5. Geometry
6. Surface quality (polished, rough , oxidized, sandblasted)
7. Transmission

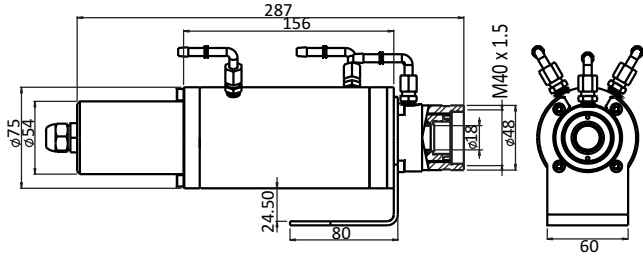
Material	Emissivity
Aluminum, polished	0.05
Aluminum, rough surface	0.07
Aluminum, strongly oxidized	0.25
Asbestos board	0.96
Asbestos fabric	0.78
Asbestos paper	0.94
Asbestos slate	0.96
Brass, dull, tarnished	0.22
Brass, polished	0.03
Brick, common	0.85
Brick, glazed, rough	0.85
Brick, refractory, rough	0.94
Bronze, porous, rough	0.55
Bronze, polished	0.10
Carbon, purified	0.80
Cast iron, rough casting	0.81
Cast iron, polished	0.21
Charcoal, powdered	0.96
Chromium, polished	0.10
Clay, fired	0.91
Concrete	0.54
Copper, polished,	0.01
Copper, commercial burnished	0.07
Copper, oxidized	0.65
Copper, oxidized to black	0.88
Electrical tape, black plastic	0.95
Enamel **	0.90
Formica	0.93
Frozen soil	0.93
Glass	0.92
Glass, frosted	0.96
Gold, polished	0.02
Ice	0.97
Iron, hot rolled	0.77
Iron, oxidized	0.74
Iron, sheet galvanized, burnished	0.23
Iron, sheet, galvanized, oxidized	0.28
Iron, shiny, etched	0.16

Material	Emissivity
Iron, wrought, polished	0.28
Lacquer, Bakelite	0.93
Lacquer, black, dull	0.97
Lacquer, black, shiny	0.87
Lacquer, white	0.87
Lampblack	0.96
Lead, gray	0.28
Lead, oxidized	0.63
Lead, red, powdered	0.93
Lead, shiny	0.08
Mercury, pure	0.10
Nickel, on cast iron	0.05
Nickel, pure polished	0.05
Paint, silver finish**	0.31
Paint, oil, average	0.94
Paper, black, shiny	0.90
Paper, black, dull	0.94
Paper, white	0.90
Platinum, pure, polished	0.08
Porcelain, glazed	0.92
Quartz	0.93
Rubber	0.93
Shellac, black, dull	0.91
Shellac, black, shiny	0.82
Snow	0.80
Steel, galvanized	0.28
Steel, oxidized strongly	0.88
Steel, rolled freshly	0.24
Steel, rough surface	0.96
Steel, rusty red	0.69
Steel, sheet, nickelplated	0.11
Steel, sheet, rolled	0.56
Tar paper	0.92
Tin, burnished	0.05
Tungsten	0.05
Water	0.98
Zinc, sheet	

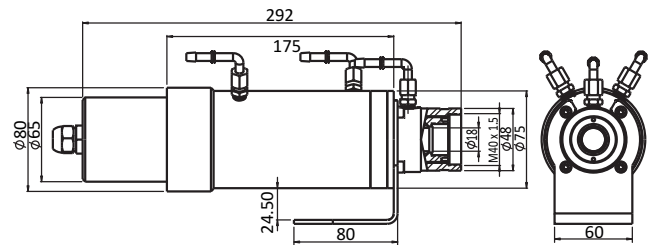
# Appendix C

## Mechanical Drawings

### 1. Water Cooling Jacket



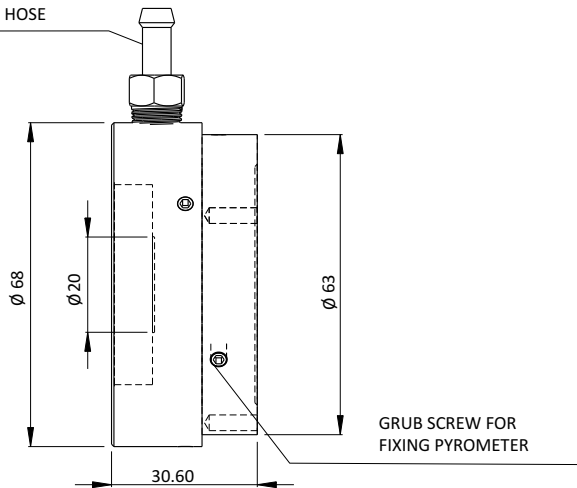
Water Cooling Jacket with Adjustable Flange PL  
(Reference no: 8000-02)



Water Cooling Jacket with Adjustable Flange TL  
(Reference no: 8000-06)

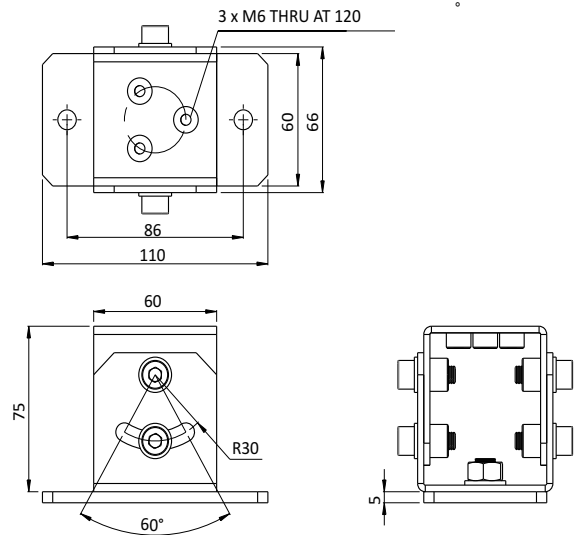
### 2. Air Purge Unit

FOR 6 mm INSIDE  
DIAMETER HOSE



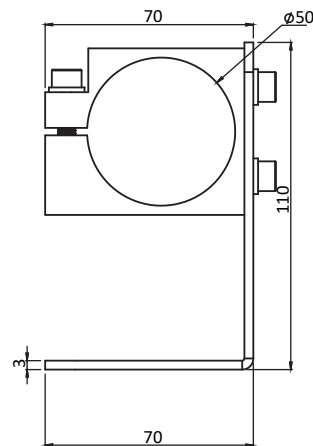
Air Purge Unit  
(Reference no: 8000-04)

### 3. Adjustable Mounting Stand



Adjustable Mounting Stand  
(Reference no: 8000-07)

### 3. Mounting Clamp



Mounting Clamp  
(Reference no: 8000-05)

---

# Information

## Maintenance

The pyrometer has no internal parts, which have to be cleaned. The lens can be cleaned with compressed air, which is dry and free of oil. If the protection glass requires more thorough cleaning, use a soft, dry cloth such as that used to clean camera lenses.

## Packing instructions

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

## Warranty

AL390 instruments have a warranty of two years from the invoice date. This warranty covers manufacturing defects. User-induced faults are not covered under this warranty.

## Software warranty

The windows compatible software was thoroughly tested on a wide range of windows operating systems. Nevertheless, there is always a possibility that windows or PC configuration or some other unforeseen condition exists that would cause the software not to run smoothly. The manufacturer assumes no responsibility or liability and will not guarantee the performance of the software. Liability regarding any direct or indirect damage caused by this software is excluded.

## Limit of liability

Tempens not liable for any damages that arise from the use of any examples or processes mentioned in this manual.

***Specifications are subject to change without notice***

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# ABOUT US

## **Tempsens Instruments (I) Pvt. Ltd.**

Tempsens Instruments (I) Pvt. Ltd. is a part of Pyrotech Group which was established by four technocrats in 1976 at Udaipur, with their first product as Thermocouples and RTDs. Today 'Tempsens' is one of the largest manufacturers of Temperature Sensors in India.

Tempsens Instruments (I) Pvt. Ltd. U #II was started in 2009 to produce cables with high standard of manufacturing process conforming to national & international specifications. We manufacturer wide range of cables for Temperature sensors and Instrumentation in various insulations as PTFE, FEP/PFA, Kapton, Silicon, Fiber Glass, Ceramic Fiber, Refrasil/Nextel, PVC etc. in variety of configurations. These cables are available in temperature range -60°C to 1200°C.

All our products are manufactured under strict ISO-9001 quality management system. We also provide Calibration Certificates with all cables. We stock most types of cables which enable us for fast delivery of goods. Our engineering staff are capable to custom design solutions for all applications for customers.

We are dedicated to provide the highest quality products that meet our customer's specifications for various applications.

We continuously focus on improving our manufacturing processes and competitiveness in the industry



[www.tempsens.com](http://www.tempsens.com)

**TEMPSENS INSTRUMENTS (I) PVT. LTD.**

B-188A, Road No.5, Mewar Industrial Area (M. I. A.),  
Madri, Udaipur-313003 (Rajasthan) INDIA

**Ph.:+91-9116554600, Email: info@tempsens.com**