AST

CE

Accurate **S**ensing **T**echnologies

We measure accurate temperature in extreme conditions

AST 450 G-2
Non-contact Infrared Pyrometers

USER MANUAL

Index

Chapter-1
General Information

We are pleased that you have chosen this high quality and highly efficient AST 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. All general information regarding handling, cleaning, and maintenance of pyrometer are offered according to best of our knowledge & experience.

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

AST 450 G-2 instruments have a warranty of two years from the invoice date. AST 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.

AST 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

AST 450 G-2 are specially designed highly accurate digital pyrometers to provide high performance and low maintenance of non contact temperature measurement in the glass industry. Sub-range or response time can be preset ex-works or adjusted through software. This enables the instruments to be adapted to various measuring tasks. The pyrometers have solid body in aluminum housing which provide high operation safety even in rough industrial environment.

2.1 Special features of AST 450 G-2

- Two wire technique

- Highly accurate 0.3% of measured value

- Wide temperature range 600.....1800°C

- Analog output (4-20 mA)

- Fast response time: 250 msec Adjustable upto10sec.

- Adjustable emissivity from 0.05 to 1.00.

- Test current 12mA USB interface for parameter setting.

2.2 Application, Range and Working Principle

AST 450 G-2 is digital pyrometer based on two wire technique provides digital signal processing with simple connections. Temperature measurement 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). This signal is digitally linear zed and converted into standard analog output signal.

The applications in which AST 450G-2 pyrometers can be used:

- Liquid glass

- Furnace Crown

- Furnace sidewall

- Fore hearth

- Feeder

Additional applications are the measurement of brick works in regenerators and tank. Use of robust fiber optic cable with instrument makes it suitable for application in an ambient temperature up to 250°C without cooling.
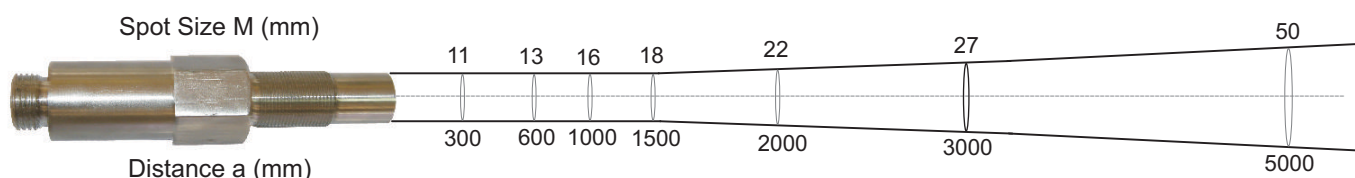
2.3 Technical Specifications

Model	AST 450 G-2
Measured Temperature Range	600° - 1800°C
Emissivity Range	0.05........1 adjustable via Rotary Switch
Spectral Range	1µm
Photodetector Type	Silicon
Response Time	250 msec. Adjustable up to 10sec
Accuracy	± 0.3 % of the measured value or 3°C whichever is greater
Test Current	12mA
Analog Output	4-20mA, Linear, max Load
Digital Output	USB 2.0
Power	24V DC
Spot size	100 : 1; Min. spot 11 mm
Operating temperature	Max. 250°C (Optical Head & Fiber Optic)
	0°C +70°C (Electronics)
Fiber Optic	5 mtr long multi fiber in SS flexible conduit
Operating humidity	Unlimited
Dimensions/Weight	115 mm x 65 mm x 55 mm (L x W x H) / Weight = 0.5 Kg
Adjustable Parameters via Keypad/software	Response time, temperature sub range
Readable parameters via software	Measured temperature, temperature graph, response time, temperature sub-range

Standard Item supplied with AST 450 G-2:-

☑ Signal Processor Box
☑ Optical Head G-2
☑ Multi Fiber FOC (length - 5 m)
☑ Power supply cable (length - 1.5 m)
☑ Manual
☑ Certificate of calibration
☑ Software CD
☑ USB cable

2.4 Optics

The heat radiation from target object is received by the pyrometer via the lens and is then converted to an electrical signal. The measured object may be at any distance from the pyrometer. However, the farther the measured object is from the pyrometer, the larger the area that will be measured by the pyrometer.

Spot Size M (mm)

| | 11 | 13 | 16 | 18 | 22 | 27 | 50 |

Distance a (mm)

| 300 | 600 | 1000 | 1500 | 2000 | 3000 | 5000 |

The following drawing shows the optical head spot sizes and the focus distances in relation to distance from the optical head.

2.5 Fiber optic

The infrared radiation is transmitted from the optics to the signal processor by a fiber optics cable. Fiber & optical head can withstand ambient temperatures up to 250°C .The optical head carry only the objective lens, the signal processor has radiation detector and signal processing circuit.

The transmission of signal is totally loss free because a reflecting coating is provided at the inner surface of the optic cable. Standard length of FOC with pyrometer is 5mtr.

L (MTR.)

Ø10
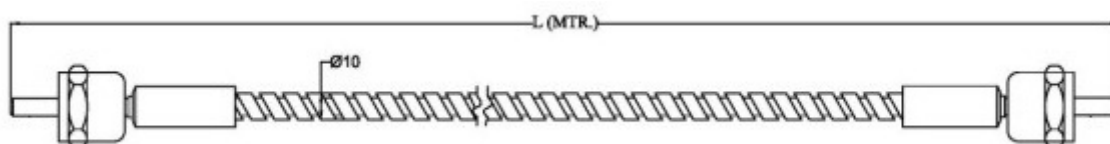
Minimum bending radius:
Momentary, localized (max.250°C) : 30mm
Long term (max.250°C) : 50mm
In coiled condition (max.250°C) : 50mm

Chapter-3
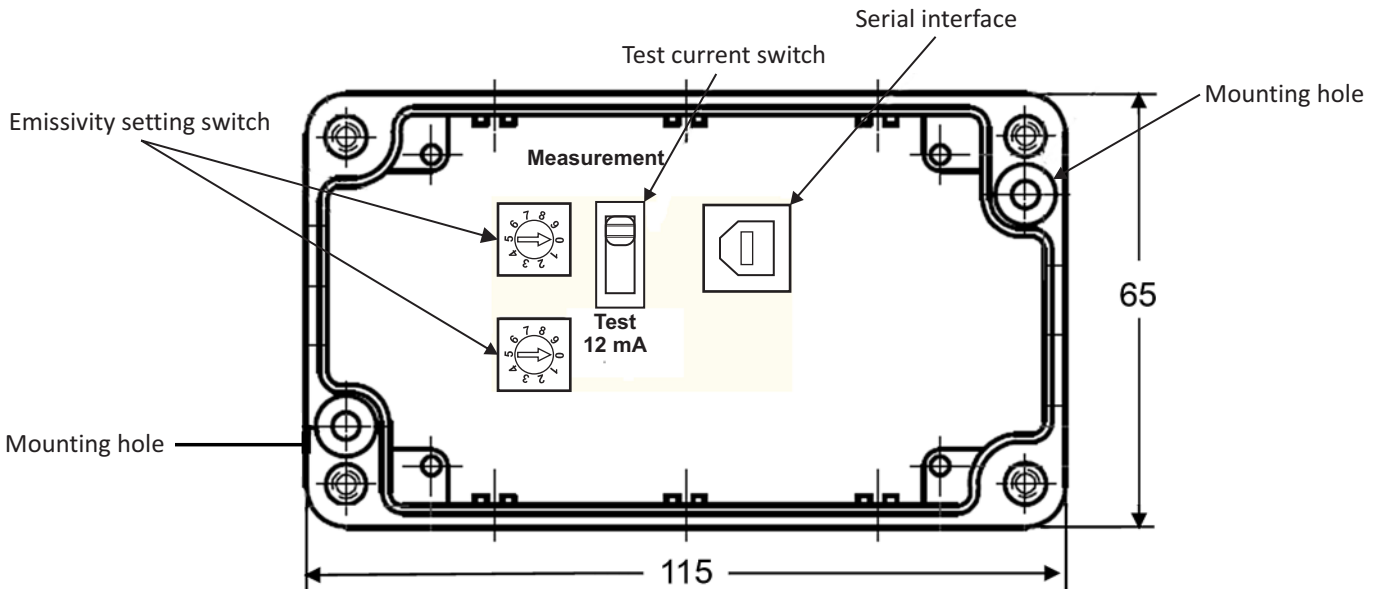## Setting at the instrument

3.1 Control and interface connection

The controls are located under the rear cover, segments are provided to set the parameters. The USB port located near to the rotary set switches is designed for use with an USB cable.

NOTE: The software program serves only as a means of setting the parameters of the signal processor and was not designed as a controlling mechanism for measurement systems! After set-up is complete, disconnect the PC adapter cable and close the converter housing.

ATTENTION :

Prior to connecting: When the PC adapter cable is connected, a direct connection between the PC and the pyrometer is established. However, there is still the possibility that a voltage difference between the PC and the signal processor exists in this connection, which can impact the 4-20 mA current output of the pyrometer. This is especially important if the temperature control of your system (i.e. oven or furnace temperature) is dependent on the output signal from the pyrometer.

3.2 Emissivity
The exact emissivity should be known to measure the accurate temperature of the object. The emissivity is the ratio between the level of radiation from an object and the level of radiation from a black body at the same temperature. Different materials have different emissivity ranging from 0.00 to 1.00 (or 0% to 100%).

Material which reflect more radiation have a lower emissivity & if the material is acting like black body then the value of emissivity will be ε=1.00 means the material absorb all the incoming radiations.

Factory settings:

ε = 1.00 (switch setting: 00)

3.2.1 Example to set emissivity on the signal processor:

Adjust the emissivity ε, by both switches as shown in the example. Emissivity can be adjusted between 0.05 and 1.00 in increments of 0.01.
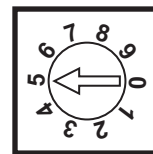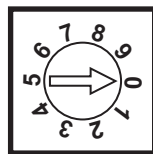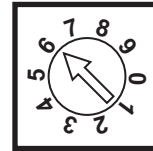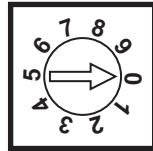
ε=1.00 or 100%   **ε=0.65 or 65%**

NOTE: - If emissivity is set to a value below 5% the pyrometer will automatically set emissivity value of 5%.The setting 00 read as ε=1.00 or 100%

3.2.2 Output test

For test purpose the 4 – 20 mA output can be switched to provide a constant 12 mA signal (corresponding to the middle temperature value of sub measurement range).This provides a known output signal for setting up a controller or display device.

Chapter-4
Installation of the Pyrometer

4.1 Location selection

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

4.2 Ambient temperature

The allowed operation temperature for the pyrometer is 0°C to + 70°C at electronic side and 250°C (max) at fiber and optical head. Therefore ambient temperature must not exceed this temperature range otherwise it may damage the pyrometer / fiber and optical head.

4.3 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 of the lens.

4.4 Correct Positioning of the pyrometer

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.

4.5 Mechanical installation and Mechanical accessaries

Signal processor: To fix the signal processor box remove the top cover & mount it with the help of 2 mounting hole
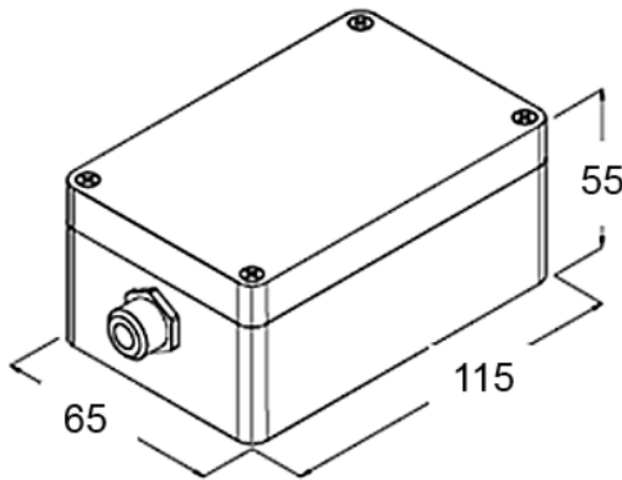
Optical head:

Connection:

- Black fiber mark
- FOC
- Optical head
- Green fiber mark
- Furnace top with clamp
- Signal processor box
- Input power supply +24V
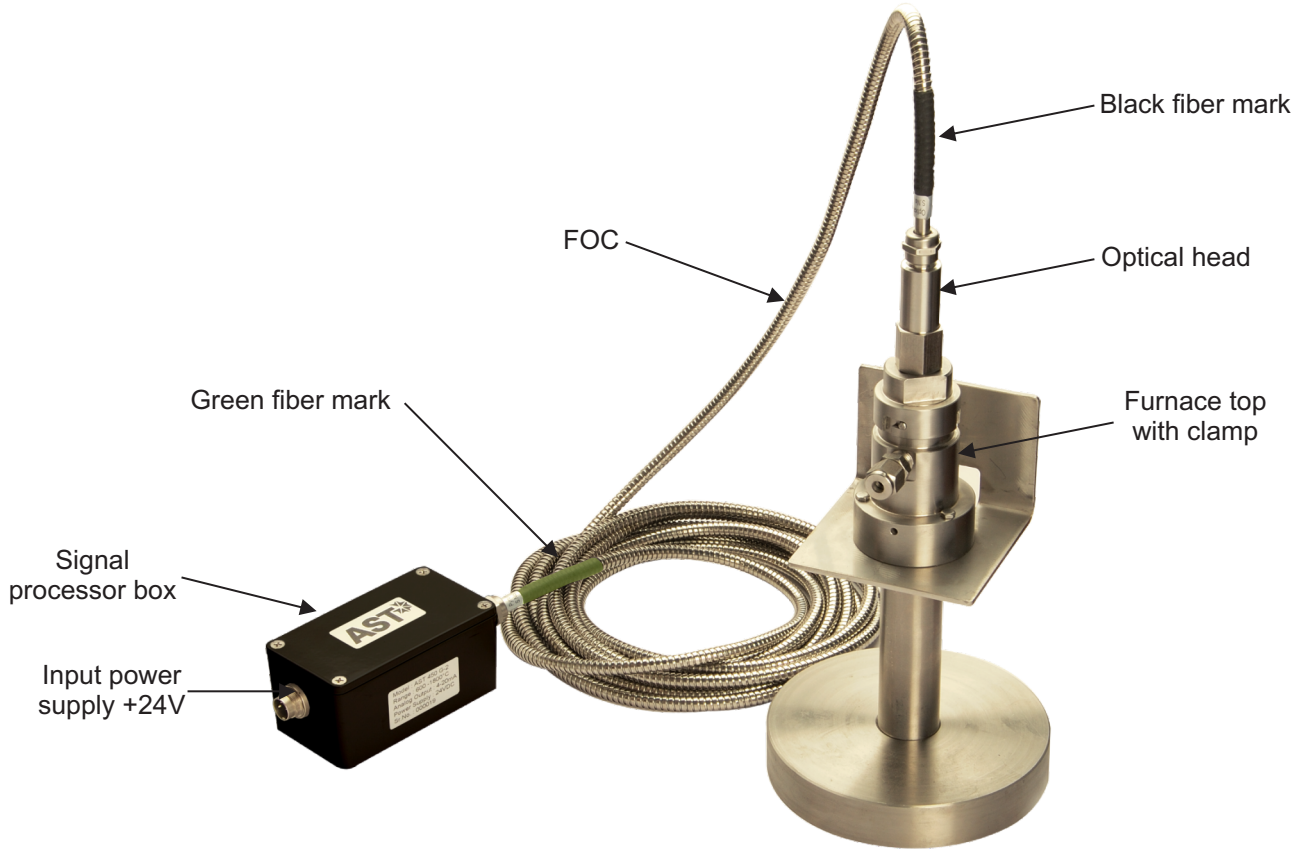
4.5.1 Air purge unit

To protect the lens from contamination of dust, moisture & other suspended particles air purge unit is used. Air purge with mounting support supply dry & oil-free pressurized air which generates an air stream Shaped like a cone.

Air purge with stainless steel Inconel tubes:

- Air purge connector
- Mounting bracket
- Thread G 1/8"
- Inconel sighting tube
- Bayonet fixing
- Optical head SW 19, Ø 22
- Ø 54
- Ø 63
- Ø 26.64
- Ø 33.5
- 3 x M4
- 64
- 3
- 82
- 200
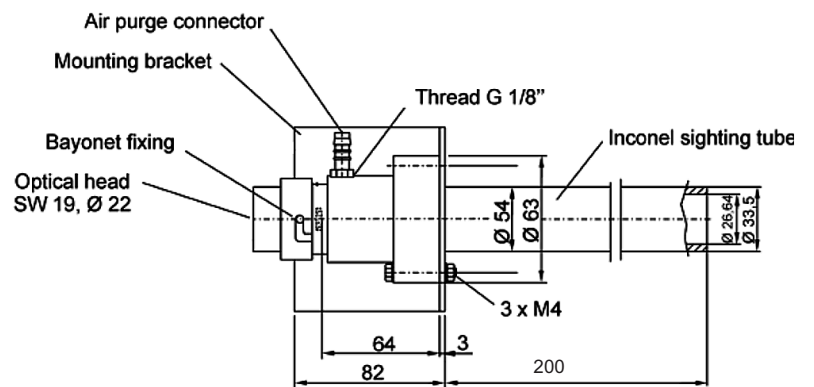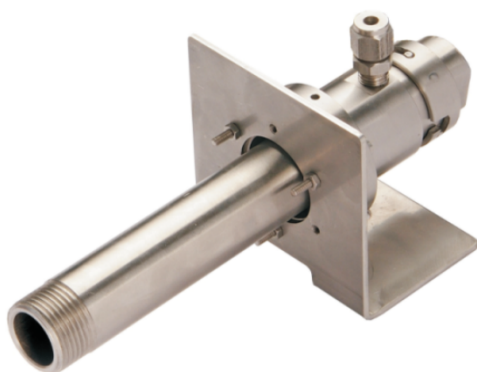
(Reference No. : 8100-01)

Air purge unit with 600 mm ceramic sighting tube:

(Reference No. : 8100-02)

Air purge connector
Mounting bracket
Thread G 1/8"
Ceramic sighting tube
Bayonet fixing
Optical head SW 19, Ø 22

Ø 54
Ø 63
Ø 27
Ø 35

64
3
82
600
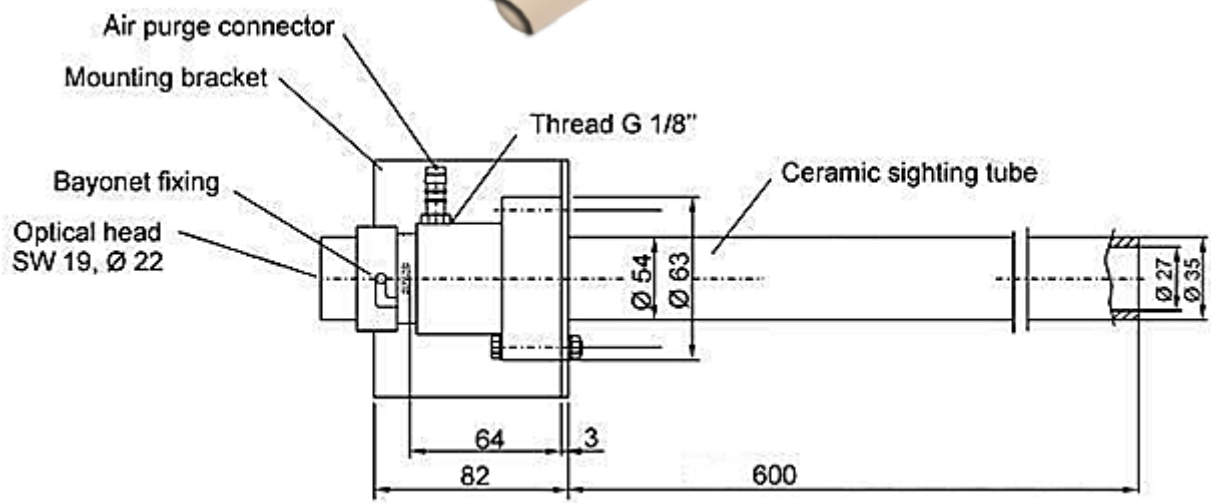
Air purge with mounting flange for furnace top:

SCREW HOLE Ø3.5mm
Ø63mm
FLANGE
HOLDING TUBE :OD X ID: Ø33.5 X Ø27.5mm
Ø12mm, THREAD HOLE
15
Ø27.8 Ø15
Ø33
Ø93
Ø153
THREAD
15
43
60
180
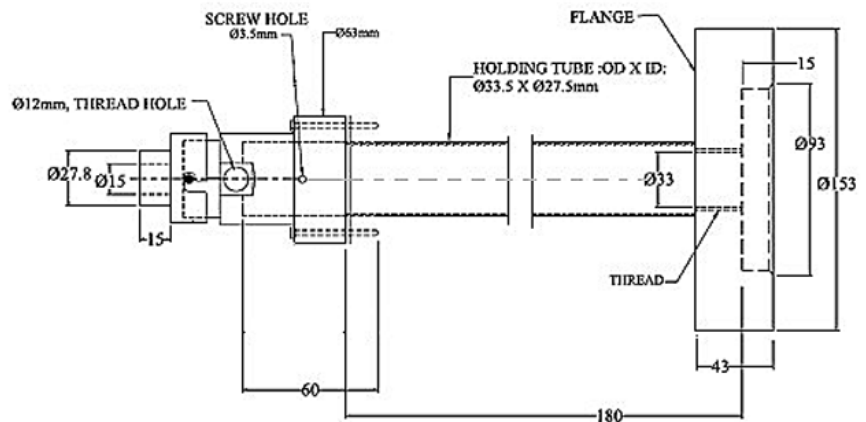
(Reference No. : 8100-03)

4.6 Electrical

AST 450G-2 are powered by 24 V DC (very well stabilized, ripple max. 50 mV). When connecting the device to the power supply ensure correct polarity. The device does not need to be warmed up or run in advance and is immediately ready for use.

4.6.1 Connector pin assignment on the back of connection cable

Binder 3-pin female connector

Pin 1	(White)	+24 V
Pin 2	(Brown)	Ground
Pin 3	(Black)	Shield

4.6.2 Connection of display device

AST offers temperature display device with integrated power supplies for two-wire instruments.

The following model is currently available:

AST 9000- 01: With two limit switches
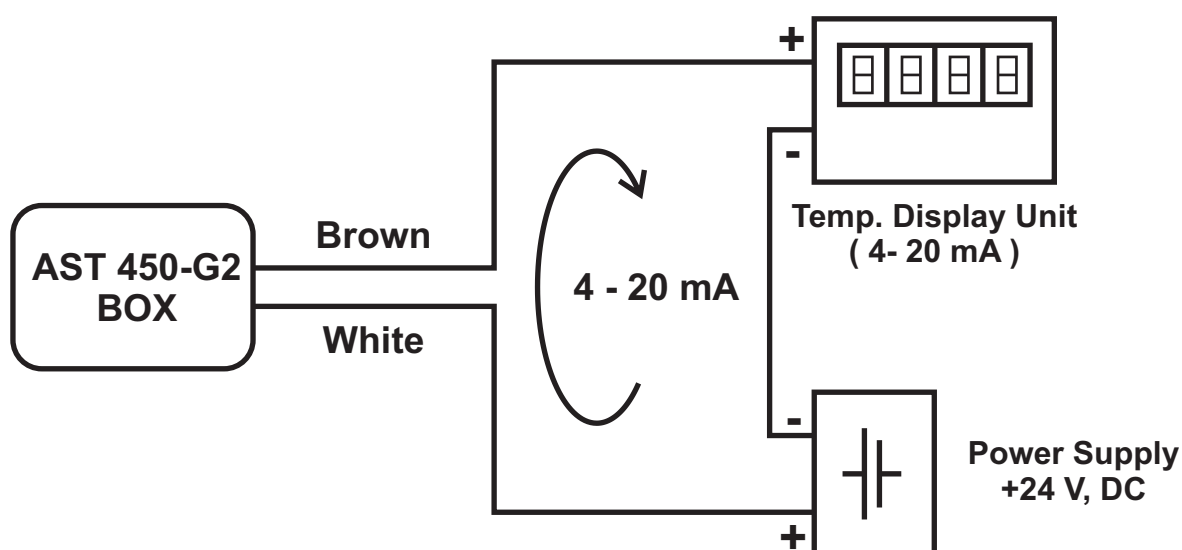
Chapter - 5

Software Installation

The provided AST software offers possibilities to connect three pyrometers simultaneously for parameter setting, view real time graph, offline graph and to evaluate measuring data.

5.1 Installation

Install the pyrometer software using the installation guide file on CD ROM. After installation of the software; Double click the application. It will open the main screen of software.

(Main screen)

5.2 Parameters in main screen

5.2.1 COM Port, Address:
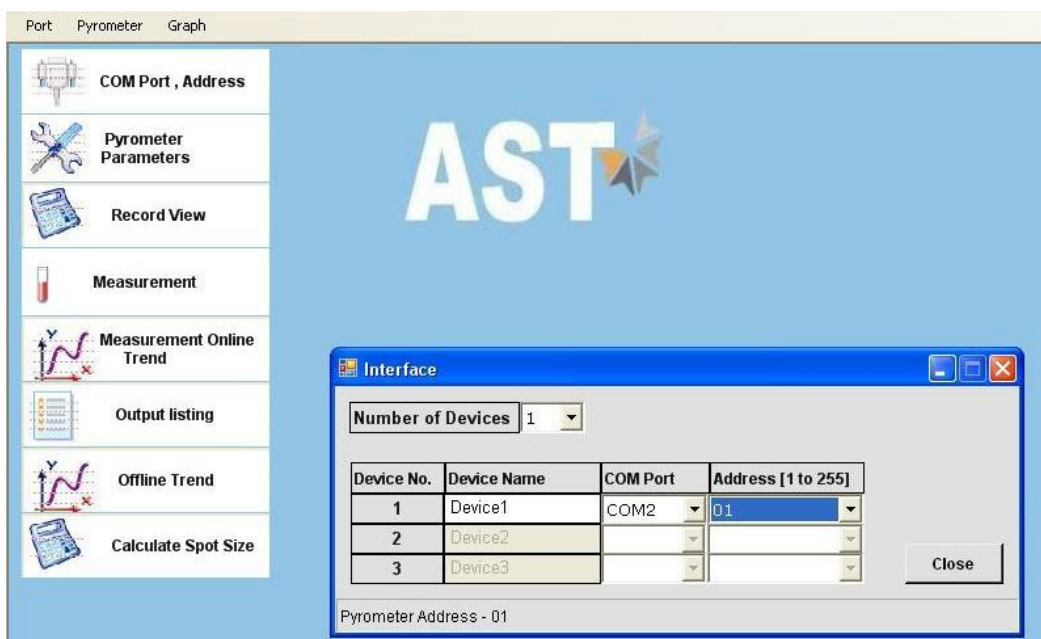
Communication between the AST pyrometer and the software is implemented via a cable connected between the pyrometer and the PC serial port. This enables the acquisition and recording of data, as well as the transfer of commands from the software application to the AST pyrometer.

When user select this option then a new box will open where user has to select correct COM Port address where pyrometer is connected (Example: COM2 in above fig.). Also user has to select address to the pyrometer (Example: Default 01/printed on the pyrometer sticker). Then click on the close button.

For multiple devices connection, first select number of device & then correctly select COM port & address of devices.

5.2.2   Pyrometer parameters

After selecting the COM port and address, click on the "pyrometer parameter" option, it will display a parameter screen as shown below.
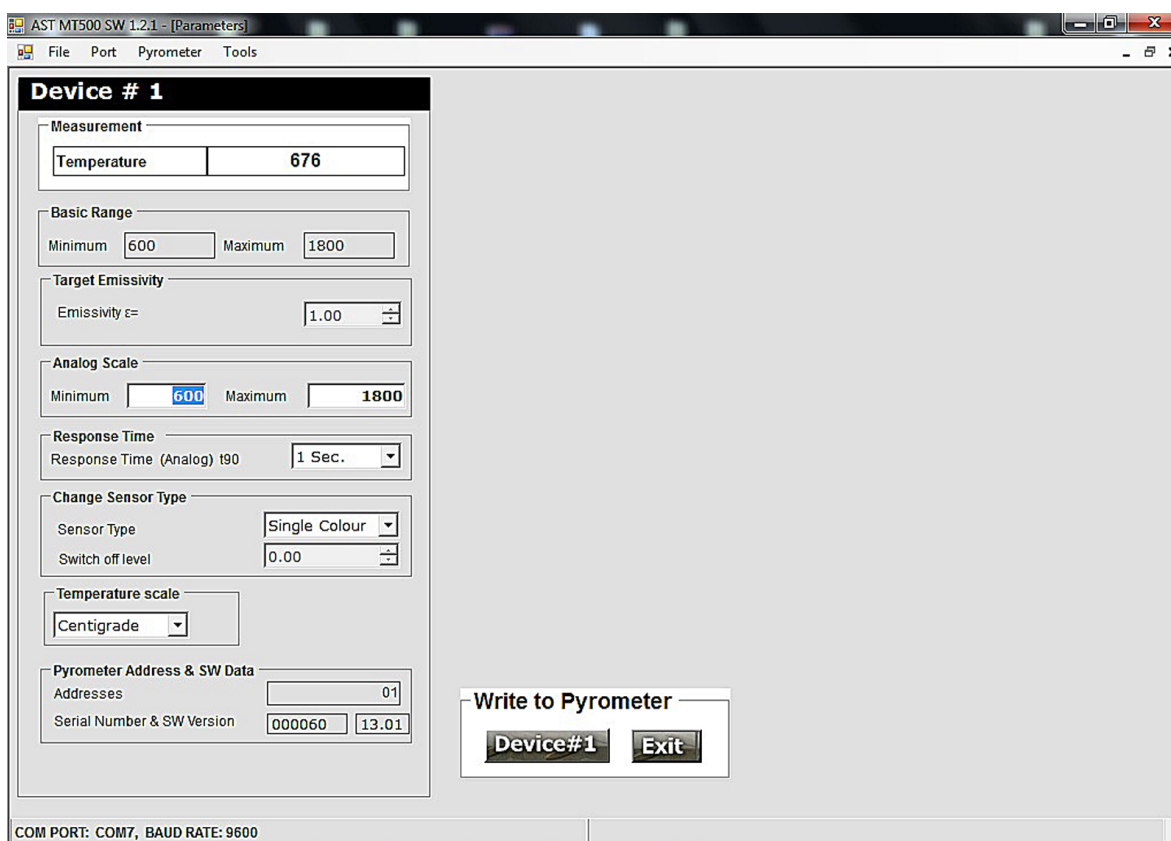
(A) Measurement   -   It shows the temperature measured by the pyrometer.

(B) Basic Range   -   It shows the minimum and maximum range of pyrometer, User cannot change this range.

(C) Emissivity   -   The emissivity factor is important in the calculations that determine temperature. Here, user can't set the emissivity. To set the emissivity see the topic "**3.2 Emissivity" (3.2.1 Example to set emissivity on the signal processor)**. The software will display manually set emissivity by user.

(D) Analog Scale   -   User can change the sub - range of pyrometer. 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.

(E) Response time - This parameter is use to set the analog response time of pyrometer. It is adjustable from 250mS to 10 second.

(F) Change 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).

(G) Temperature scale - User can change the measuring unit of temperature from "Centigrade" to "Fahrenheit" and vice versa.

(H) Pyrometer address - This parameter shows the pyrometer device address, serial number
& SW Data - and software data software version.

5.2.3   Record view

Record view is for continuous data logging .It records the measured temperature, emissivity with current date & time.
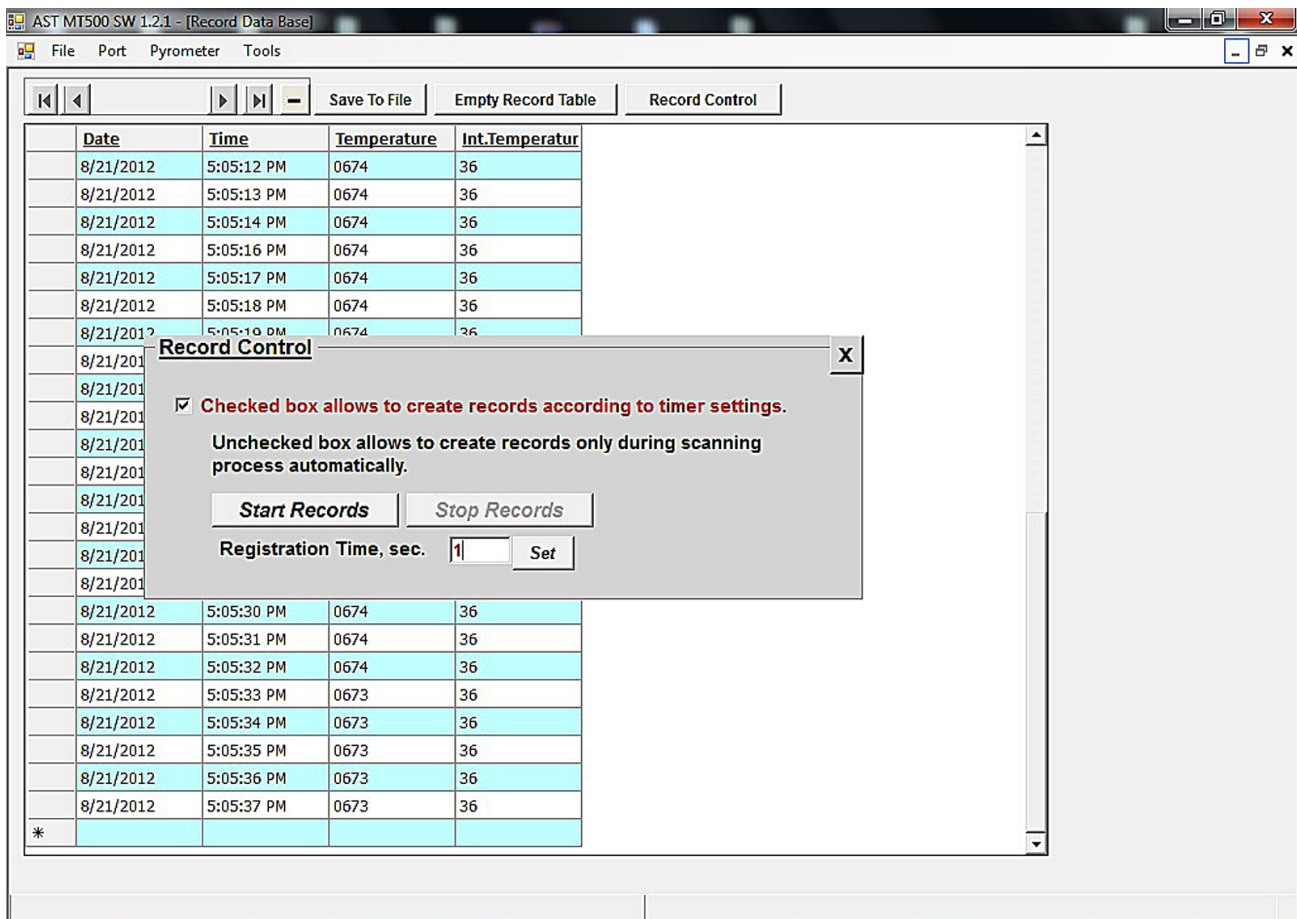
Steps to start data logging:

1. Click on record view option this will open a new dialog box.
2. Click "record control", this will open "record control" box & click "Save to file" this will ask to give a file name & then save the file.
3. Now, press "start record" .This will start data logging. If user want to store sample in a particular time delay then tick on check box & enter time in "Registration time, Sec" then press set. Now the software will take sample in a particular duration.

5.2.4 Measurement
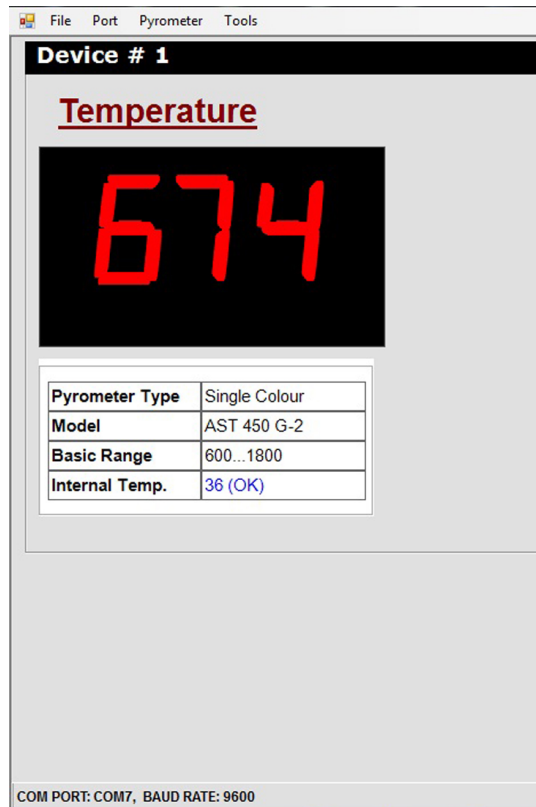
This screen shows the real temperature, sensor type, model, basic range, internal temp.& picker status of pyrometer. Internal temperature of pyrometer will show OK for temperature less than 63°C, if temperature exceeds 63°C, its start blinking in red color.

Chapter - 6
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.
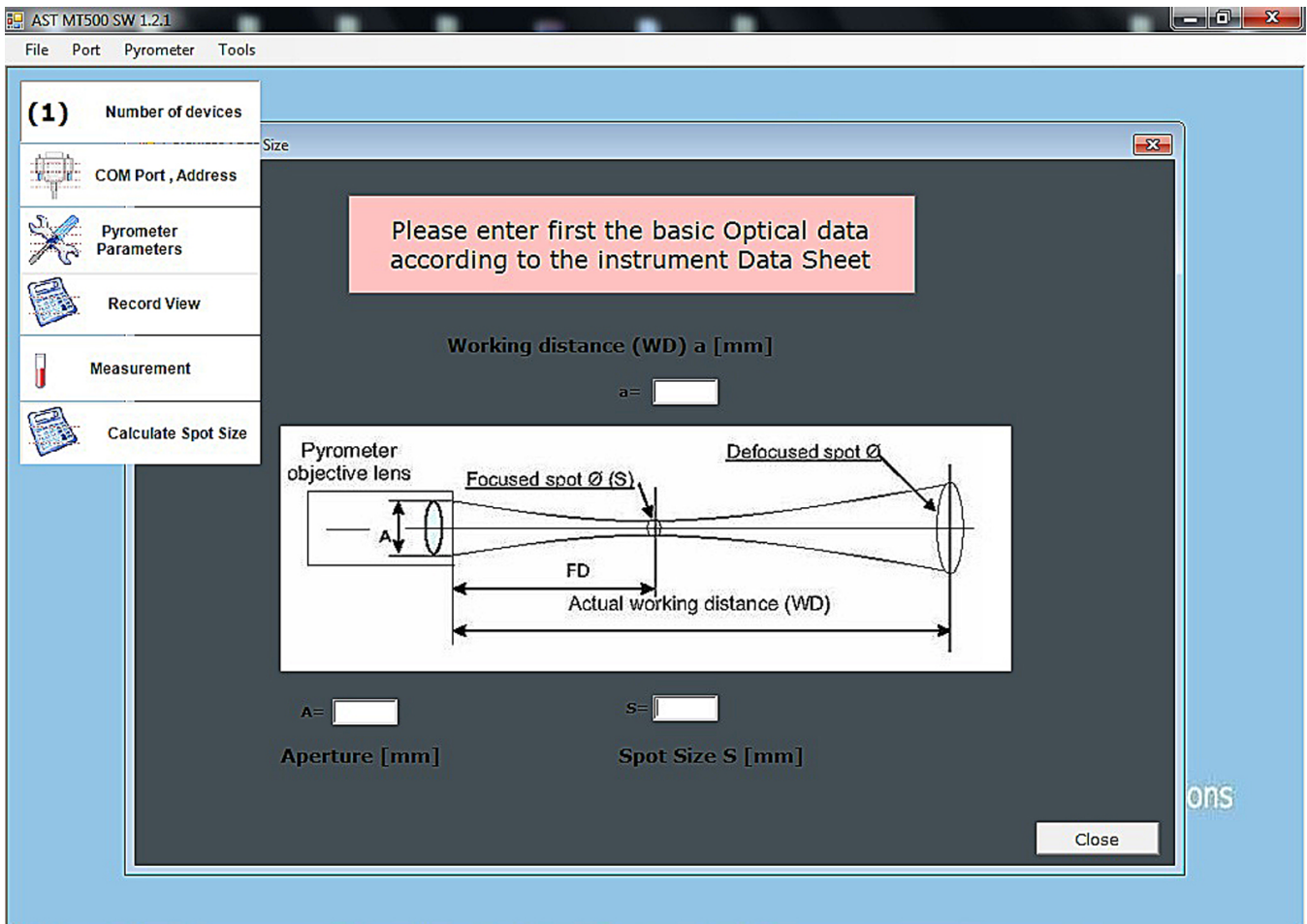
WD	**=**	**Manufactured working distance in (mm).**
A	**=**	**It shows the value of lens opening (Aperture in mm)**
S	**=**	**Manufactured spot size of the pyrometer (mm)**

User has to enter the value of WD, A, S, of the installed pyrometer. Now, putting the value of "Installed working distance" it will show the value of "Installed spot size" and vice versa also. For spot size see section 2.4.

Chapter - 7
Serial communication protocol-MT500

This protocol is developed to use in the <u>half duplex addressable</u> 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. <u>AST sensors always operate as Slave devices.</u> AST sensors always <u>perform delay of 5 ms</u> before sending an answer on Master request. <u>MT500_AST 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</u>. 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').
<u>Data format is: 8 data bit, 1 stop bit, No parity, baud-rate 19200.</u>

Description	Address	Items	Parameters
Emissivity	'0400'	'01'	Calculated object emissivity multiplied by 1000. Adjustable between 0.100 to 1.000
Response time (τ)	'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)
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
Sensor mode	'0204'	'01'	'0000' = Single color; '0001' = Two color This parameter is useless for single color sensors.
Internal temperature	'0006'	'01'	Internal temperature inside device case (read only)
Device model number (read only)	'0E00'	'01'	10 bytes "AST450C ", if less than 10 bytes pad with space at endbetween 0.100 to 1.000
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 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 14, 15
STX	0A	RD	0000	02	ETX	2E
0x02	0x30, 0x41	0x52, 0x44	0x30, 0x35, 0x39, 0x44	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.

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

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 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	Bytes 16	Bytes 17, 18
STX	0A	WD	0400	01	03E8	EXT	74
0x02	0x30, 0x41	0x57, 0x44	0x30, 0x34, 0x30, 0x30	0x30, 0x31	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 than 99 items were requested	More than 99 items were requested in command
'7'	Unsuccessful write	It informs Master that it should repeat WD command

Table 1:

Tau (τ)	Analog Response Time, ms	Serial Response Time, ms
2	250	500
7	500	1000
15	1000	2000
35	2000	5000
90	5000	7000
195	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

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, sales@astinfrared.com

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

AST 450 G-2 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

AST 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

ABOUT US

AST - Accurate Sensing Technologies

Accurate Sensing Technologies established in 1994 focusing on the development and commercialization of non-contact temperature measurement technologies.

Based on these technologies, AST has bought to the market a line of pyrometers for the remote measurement of target temperatures using no physical contact. AST pyrometers use a totally new approach for remote temperature measurement achieving high accuracy.

The following products are available from AST

- ❖ Single color pyrometer
- ❖ Ratio (2 color) pyrometer
- ❖ Fiber optics with single color and two color pyrometer
- ❖ Multi wavelength pyrometer specially for Aluminum & other Non - ferrous application
- ❖ Black Body calibration sources
- ❖ Special system for automatic Isothermal Extrusion (MOMAS)
- ❖ Parameter setting Devices

AST
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www.astinfrared.com