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User s Guide

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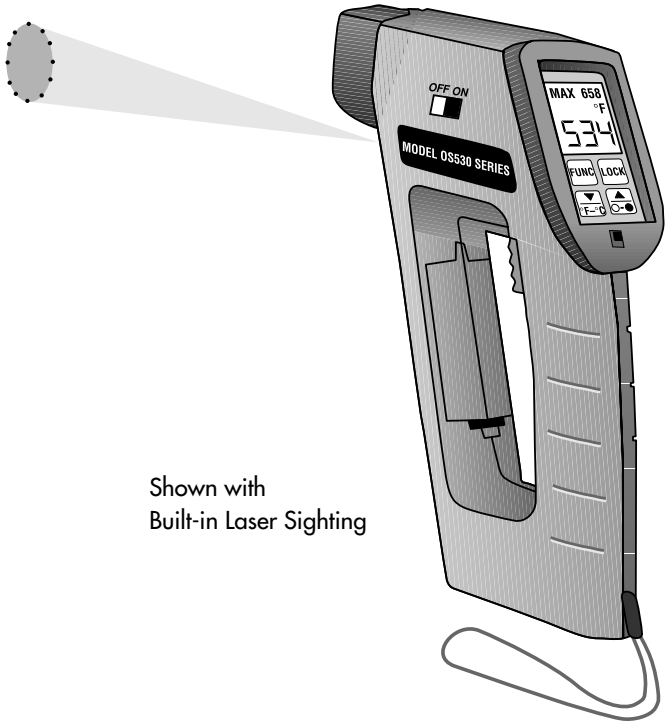

Shown with
Built-in Laser Sighting

OS531, OS532, OS533, OS534
OMEGASCOPE¤
Handheld Infrared Thermometer

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Servicing North America:

USA: One Omega Drive, Box 4047
ISO 9001 Certified Stamford, CT 06907-0047
Tel: (203) 359-1660 FAX: (203) 359-7700
e-mail: info@omega.com

Canada: 976 Bergar
Laval (Quebec) H7L 5A1
Tel: (514) 856-6928 FAX: (514) 856-6886
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Tel: 420 (69) 6311899 Toll-Free: 0800-1-66342
FAX: 420 (69) 6311114 e-mail: czech@omega.com

France: 9, rue Denis Papin, 78190 Trappes
Tel: (33) 130-621-400 FAX: (33) 130-699-120
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e-mail: france@omega.com

Germany/Austria: Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
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FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

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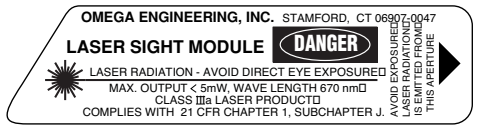

Label Location - refer to Section 3.2

Warnings and Cautions - refer to Section 3.1

Notes

Remove the Packing List and verify that you have received all equipment, including the following (quantities in parentheses):

OS530 Series Handheld Infrared Thermometer (1)
AA Size Lithium Batteries (4)
Soft Cover Carrying Case (1)
Analog Cable (1)
RS232 Cable (only for OS533, OS534)
3.5" Floppy Disk (only for OS533, OS534)
Quick Start Manual (1)
User's Guide (1)
The following table lists the entire family of the 0S530 Series infrared thermometers

Model	Description
OS531	Range: 0 to 750¡F with built-in Laser Circle
OS532	Range: 0 to 1000¡F with built-in Laser Circle & TC Input
OS531LD	OS531 with built-in Laser Dot
OS532LD	OS532 with built-in Laser Dot
OS533	Range: 0 to 1000¡F with Built-in Laser Circle & TC input
OS534	Range: 0 to 1600¡F with Built-in Laser Circle & TC input

Optional Accessaries
ac Adapter
Part Numbers: OS520-ADAPTER-110V for 110 Vac adapter
OS520-ADAPTER-220V for 220 Vac adapter
Surface Probe
Part Number: 88013-K
Hard Carrying Case
Part Number: OS520-RCC

If you have any questions about the shipment, please call the Customer Service Department. When you receive the shipment, inspect the container and equipment for signs of damage. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor damage claims unless all shipping material is saved for inspection. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

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1.1 Introduction

The OS530 series Handheld Infrared (IR) Thermometers provide non-contact temperature measurements up to 1600°F. They offer effective solutions for many non-contact temperature applications, including the following:

- **Predictive Maintenance:** Tracking temperature shifts which indicate pending failure in solenoid valves.
- **Energy Auditing:** Locating wall insulation voids to reduce building heating costs.
- **Food Processing:** Taking accurate temperature readings without direct contact with the food or packaging material.

The IR thermometer provides information at a glance — the custom backlit dual digital LCD displays both current and minimum, maximum, average or differential temperatures. This versatile instrument provides:

- Measurable target distances from 5 inches to approximately 100 feet
- Emissivity adjustable from 0.1 to 1.00 in 0.01 steps provides ease of use when measuring a variety of surfaces.
- Built-in Laser sighting in Circle & Dot configurations.
- Thermocouple input available.
- An electronic trigger lock feature set via the keypad allows continuous temperature measurement up to 4 times per second.
- Audible and visual alarms. The high and low alarm points are set via the keypad.
- 1 mV per degree (°F or °C) analog output, which allows interfacing with data acquisition equipment (including chart recorders, dataloggers and computers).
- Last temperature recall.
- Backlit display useful in low ambient light conditions.
- Powers from 4 AA size batteries or an ac adapter.
- RS232 serial communication to a PC or printer. This allows downloading data for further analysis.
- Ambient target temperature compensation. This provides more accuracy for measuring low emissivity targets.
- Record up to 100 temperature data points. Review the recorded data on the thermometer LCD, as well as downloading the data to a PC.

The thermometer is easy to use:

- Units have standard “V” groove aiming sights.
- Integral tripod mount permits hands-free operation, if necessary.
- Temperature readings are switchable from °F to °C via the keypad.
- Parameters, such as target material emissivity and alarm setpoints, can be set and remain in memory until reset.

This instrument has a rugged and functional design, including:

- Sealed keypad display.
- Convenient trigger operation.
- Soft carrying case and wrist strap, for safety and ease of carrying.
- Rubber boot around the lens and the display.

Table 1-1. OS530 Series Handheld Infrared Thermometer Features

Features	OS531	OS532	OS533	OS534
Accuracy*	–2% rdg	–1% rdg	–1% rdg	–1% rdg
Range	0 to 750¡F (-18 to 400¡C)	0 to 1000¡F (-18 to 538¡C)	0 to 1000¡F (-18 to 538¡C)	0 to 1600¡F (-18 to 871¡C)
Emissivity	adjustable	adjustable	adjustable	adjustable
Backlit Dual Display	standard	standard	standard	standard
Distance to Spot Size Ratio	10:1	10:1	20:1	30:1
Differential Temperature	standard	standard	standard	standard
Min/Max Temperature	standard	standard	standard	standard
Average Temperature	standard	standard	standard	standard
High Alarm	standard	standard	standard	standard
Thermocouple Input		standard	standard	standard
Audible Alarm & Indicator	standard	standard	standard	standard
Analog Output	1mV/deg	1mV/deg	1mV/deg	1mV/deg
Laser Sighting	built-in circle	built-in circle	built-in circle	built-in circle
Trigger Lock	standard	standard	standard	standard
Last Temperature Recall	standard	standard	standard	standard
Low Alarm			standard	standard
Ambient Target Temperature Compensation			standard	standard
RS232 Interface			standard	standard
Data Storage				standard

*or 3¡F whichever is greater

1.2 Parts of the Thermometer

1.2.1 Front of the Thermometer

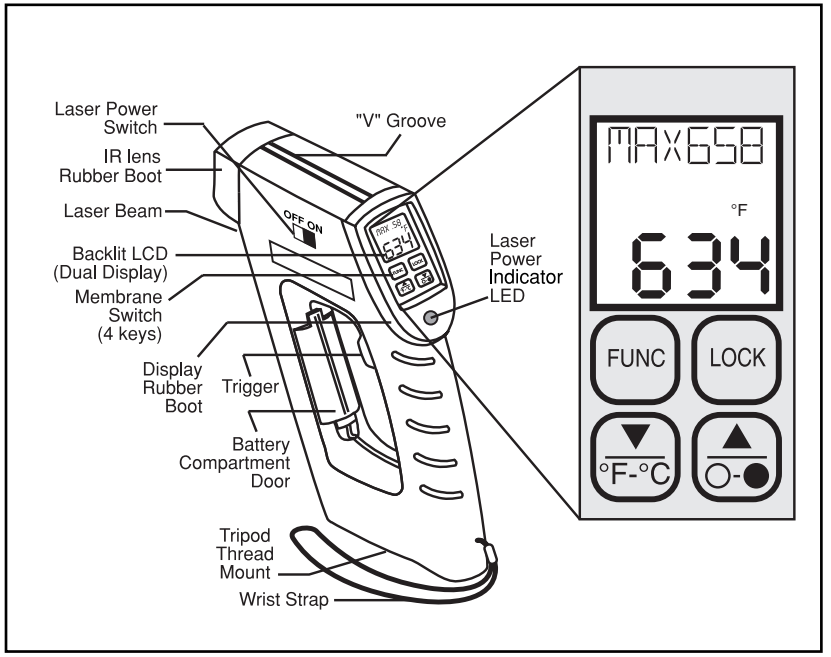


Figure 1-1. OS530 Series Handheld Infrared Thermometer Front View

The display is shown in more detail in Figure 1-2 and described in Table 1-2.
There are no user-serviceable parts in the thermometer.

Refer to Chapter 3 for Laser Sight information.

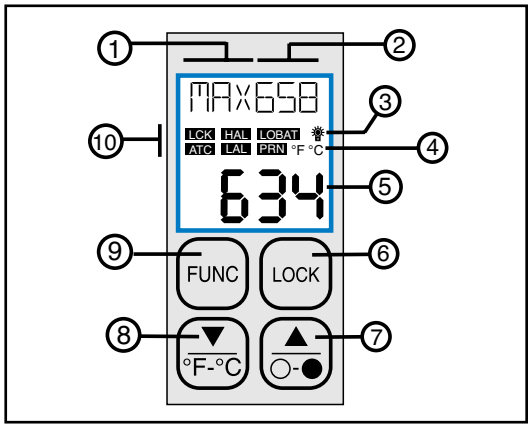


Figure 1-2. Display and Keypad View

Table 1-2. Display Details

Key	Description
①	Display Mode displays one of the following: **E** (Emissivity) **HAL** (High Alarm Setpoint) **MAX** (Maximum Temperature) **LAL** (Low Alarm Setpoint-only on OS533,OS34) **MIN** (Minimum Temperature) **AMB** (Ambient Target Temp-only on OS533, OS534) **dIF** (Differential Temperature) **PRN** (Print Data-only on OS533, OS534) **AVG** (Average Temperature) **MEM** (Store Temperature Data-only on OS534)
②	Data associated with one of the Display Modes
③	Backlighting Icon - allows the display to be viewed under low ambient light
④	Displays the units of measure in either ¡F or ¡C
⑤	Main display - displays the current temperature
⑥	Locks the trigger / Enables or Disables alarms
⑦	▲ for incrementing data; ○•● is for turning on/off the backlighting
⑧	▼ for decrementing data; °F-°C is for changing the units of measure from ¡F to ¡C or vice versa
⑨	Function key for scrolling through the display modes
⑩	Display Icons LCK Trigger Lock LAL Low Alarm ATC Ambient Target LOBAT Low Battery HAL High Alarm PRN Print Data

1.2.2 Rear of the Thermometer

Figure 1-3 shows the various jacks that are used to connect a recorder or the ac adapter to the thermometer. The figure also shows the location of the tripod thread mount used for fixed point monitoring. More details are provided in Section 2.2.1.

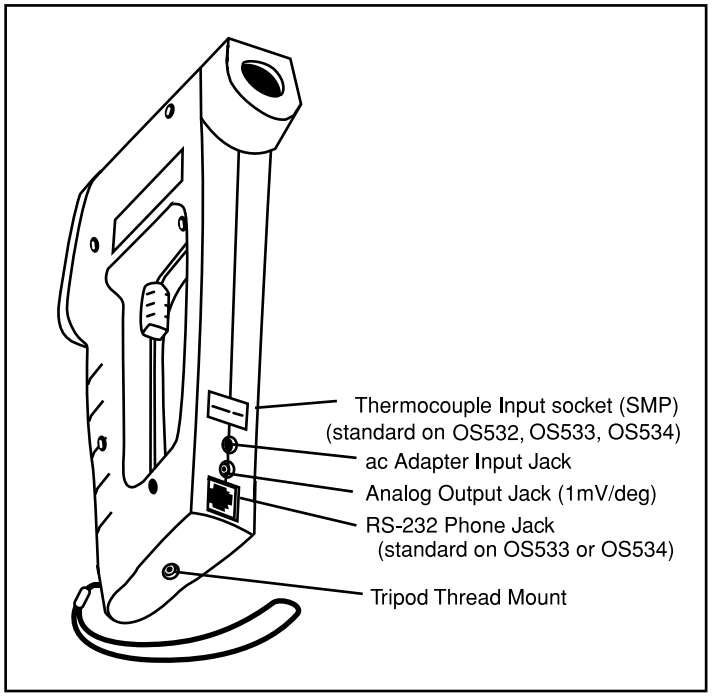


Figure 1-3. OS530 Series Handheld Infrared Thermometer Rear View

Notes

1-6

2.1 How to Power the Thermometer

2.1.1 Battery Operation

Invert the thermometer and install 4 fresh AA size batteries as shown in Figure 2-1. Make sure the batteries' polarities are correct, the batteries are not put in backwards, and are of the same type.

NOTE

If the LOBAT icon flashes, the batteries must be replaced with fresh batteries immediately.

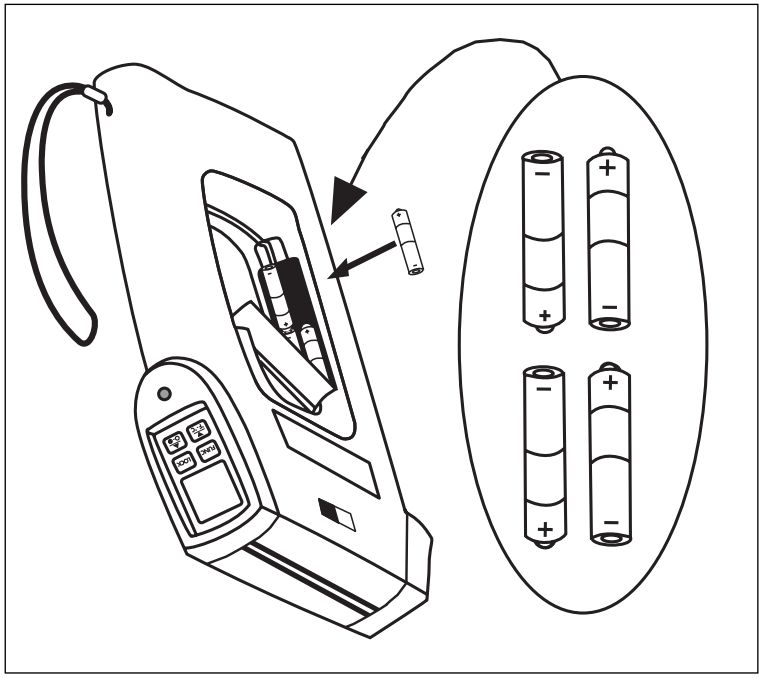


Figure 2-1. Installing the Batteries

2.1.2 ac Power Operation

The thermometer may be operated on ac power using the optional ac adapter. 120Vac/60 Hz and 220Vac/50 Hz adapters are available. When operating on ac power the batteries supply backup power in case of ac power failure. The ac adapter input jack is shown in Figure 1-3.

2.2 Operating the Thermometer

1a. (Without the Laser Sighting) -Aim the thermometer at the target to be measured. Use the V groove (shown in Figure 1-1) on top of the thermometer to align the target to the thermometer s field of view. Look down the V groove with one eye only, in order to guarantee proper sighting. Pull and hold the trigger.

1b. (With the Laser Sighting) - Set the laser power switch to the ON position. Aim at the target and pull the trigger. The laser beam and the red power indicator LED will turn on while the trigger is pulled. Refer to Chapter 3 for more details on the Laser Sighting.

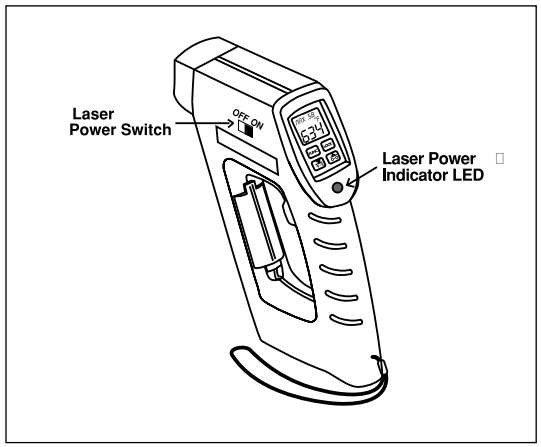


Figure 2-2. OS530 Series with Built-in Laser Sighting

2. The field of view of the thermometer should fall within the area of the target being measured. See Figure 2-3. Figures 2-4 through 2-6 show the field of view vs distance for the various thermometers.

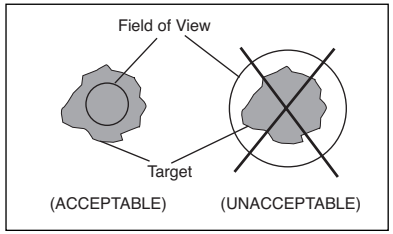


Figure 2-3. Field of View Positions

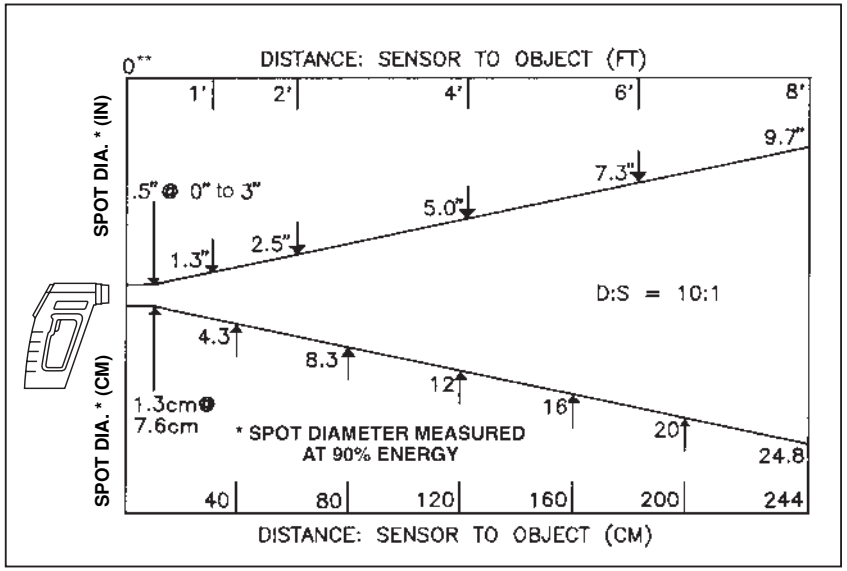


Figure 2-4. Field of View OS531 & OS532

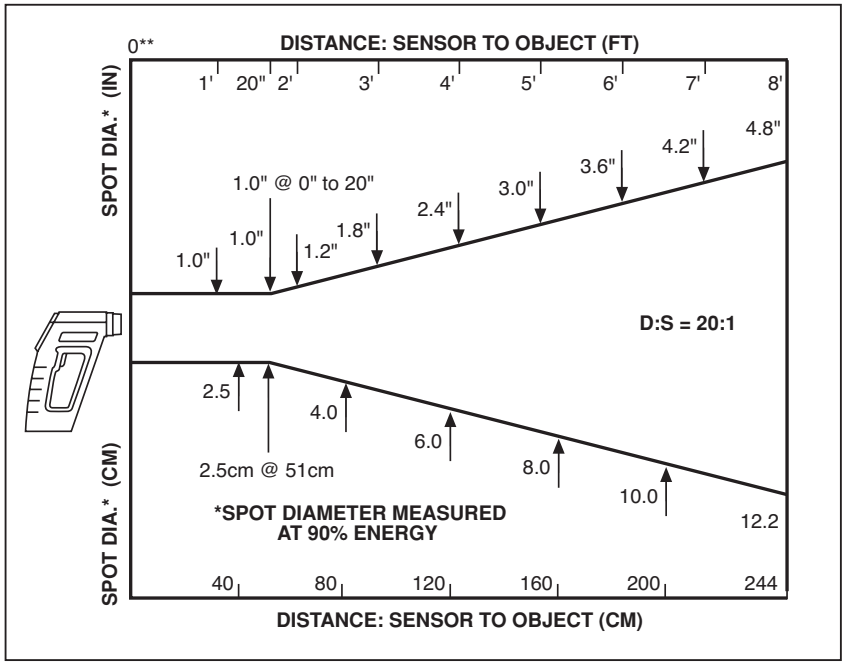


Figure 2-5 Field of View OS533

** **Measurement distance is from the outside surface of the rubber boot.**

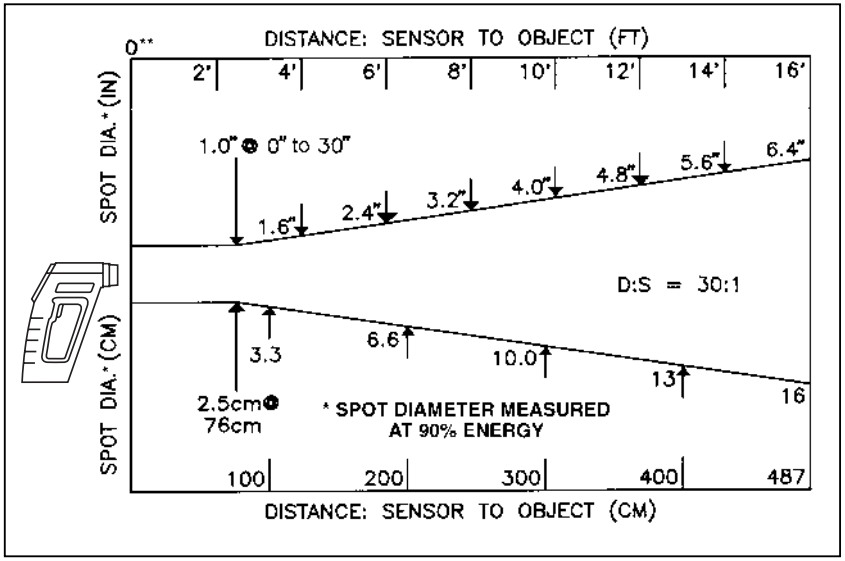


Figure 2-6 Field of View OS534

3. The target temperature and emissivity are displayed on the LCD. Determine the emissivity of the target (refer to Appendix B). Press the ▲ key to increment the target emissivity. Press the ▼ key to decrement the target emissivity.

4. Press the LOCK key to lock the trigger. The LCK icon will appear on the display. This allows the thermometer to operate continuously whether or not the trigger is pulled. To unlock the trigger, press the LOCK key again. The LCK icon is no longer displayed. When the trigger is pulled, the Laser Sighting as well as the display backlight will stay on .

5. After completing a temperature measurement, release the trigger. In order to conserve battery life, the thermometer goes into sleep mode and the Laser Sighting turns off.

2.2.1 Measurement Techniques

You can use the IR Thermometer to collect temperature data in any one of five different ways:

- **Spot Measurement —** Measures the temperature of discrete objects such as motor bearings, engine exhaust manifolds, etc.:
  1. Aim at the desired target and pull the trigger.
  2. If necessary, adjust the emissivity using the ▲ and ▼ keys.
  3. Read the temperature.

- **Differential Measurement —** Measures the temperature differential between two spots (the maximum and minimum temperatures viewed)
  1. Aim the thermometer at the first spot and pull the trigger. Press the LOCK key to lock the trigger.
  2. If necessary, adjust the emissivity.
  3. Aim at the second spot.
  4. Adjust the emissivity of the second spot if required.
  5. To display the differential temperature, press the FUNC key until dIF appears on the display.
  6. Read the differential temperature from the upper display.
  7. Press the LOCK key to unlock the trigger.

- **Static Surface Scan** – Measures the temperature across a static surface:
  1. Aim the thermometer at a starting point and pull the trigger. Press the LOCK key to lock the trigger.
  2. If necessary, adjust the emissivity.
  3. Slowly move the thermometer so that the line of sight sweeps across the surface. The thermometer measures the temperature at each point on the surface.
  4. To record the temperature profile across the surface, connect the IR thermometer to a strip chart recorder. Refer to Figure 2-7 for details. The IR thermometer provides an analog output of 1mV/degree.

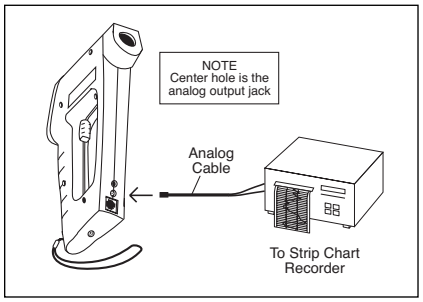


Figure 2-7 Recorder Hookup

5. After all the data has been taken, press the LOCK key to unlock the trigger.

- **Moving Surface Scan** - Measures the Temperature of Points on a Moving Surface:
  1. Mount the thermometer on a camera tripod and aim at a fixed point on the moving surface.
  2. Pull the trigger and press the LOCK key to lock the trigger.
  3. If necessary, adjust the emissivity. The thermometer is now set up for measuring the temperature of a moving surface.
  4. To record the temperature profile of the moving surface, connect the IR thermometer to a strip chart recorder. Refer to Figure 2-7 for details.
  5. After all data is taken, press the LOCK key to unlock the trigger.

- **Fixed Point Monitoring Over Time** - Monitors the temperature at a fixed point over time:

  NOTE: It is recommended that you use the ac adapter for long term measurement of temperature.

  1. Mount the thermometer on a camera tripod and aim at the target.
  2. Connect the analog output of the thermometer to a strip chart recorder as shown in Figure 2-7.
  3. Pull the trigger and press the LOCK key to lock the trigger.
  4. If necessary, adjust the emissivity.
  5. The thermometer is now set up for unattended monitoring of temperature over time. You can also download the temperature to a Serial Printer or a PC for further analysis (Models OS533, OS534).
  6. After all data is taken, press the LOCK key to unlock the trigger.

2.3 Real Time Mode (Active Operation)

Definition: Real Time Mode is the active operational mode of the thermometer. In this mode, the thermometer constantly measures and displays temperature.

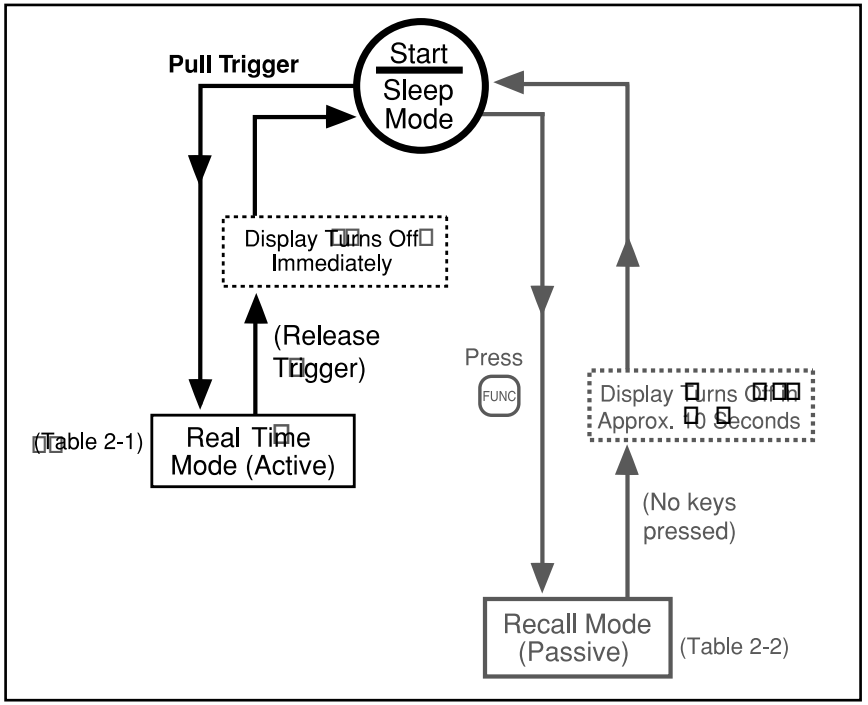


Figure 2-8. General Operational Block Diagram

NOTE

If the trigger is pulled two times in rapid sequence, it may reset the emissivity, high alarm, low alarm and target ambient temperature to the default values.

Table 2-1. Functional Flow Chart when the Trigger is Pulled (Real Time Mode)

Real Time Mode					
Display Mode:	**Display shows:**	**Press FUNC to...**	**Press LOCK to...**	**Press ▼ °F-°C or ▲ ○·● to...**	
E	Current temperature Emissivity	Go to MAX	LOCK or UNLOCK trigger LCK	Set emissivity	
MAX	Current temperature Maximum temperature	Go to MIN		Press ▼ °F-°C to change between °F/°C	
MIN	Current temperature Minimum temperature	Go to dIF		Press ▲ ○·● to turn display backlighting ON or OFF	
dIF	Current temperature Differential temperature	Go to AVG			
AVG	Current temperature Average temperature	Go to TC			
TC	Current temperature Thermocouple temperature	Go to HAL			
HAL	Current temperature High alarm setpoint	Go to LAL or E	ACTIVATE/DEACTIVATE HAL	Set High alarm value	
LAL	Current temperature Low alarm setpoint	Go to AMB	ACTIVATE/DEACTIVATE LAL	Set Low alarm value	
AMB	Current temperature Ambient target temperature	Go to PRN	ACTIVATE/DEACTIVATE ATC	Set target ambient temperature	
PRN	Current temperature Print interval	Go to MEM or E	ACTIVATE/DEACTIVATE PRN	Set printing interval	
MEM	Current temperature Memory location	Go to E	Store temperature data	Set memory location	

OS534
OS533
OS531 & OS532

NOTE: The unit of measure (°F or °C) flashes during the Real Time Mode. The display backlight turns on when the trigger is pulled.

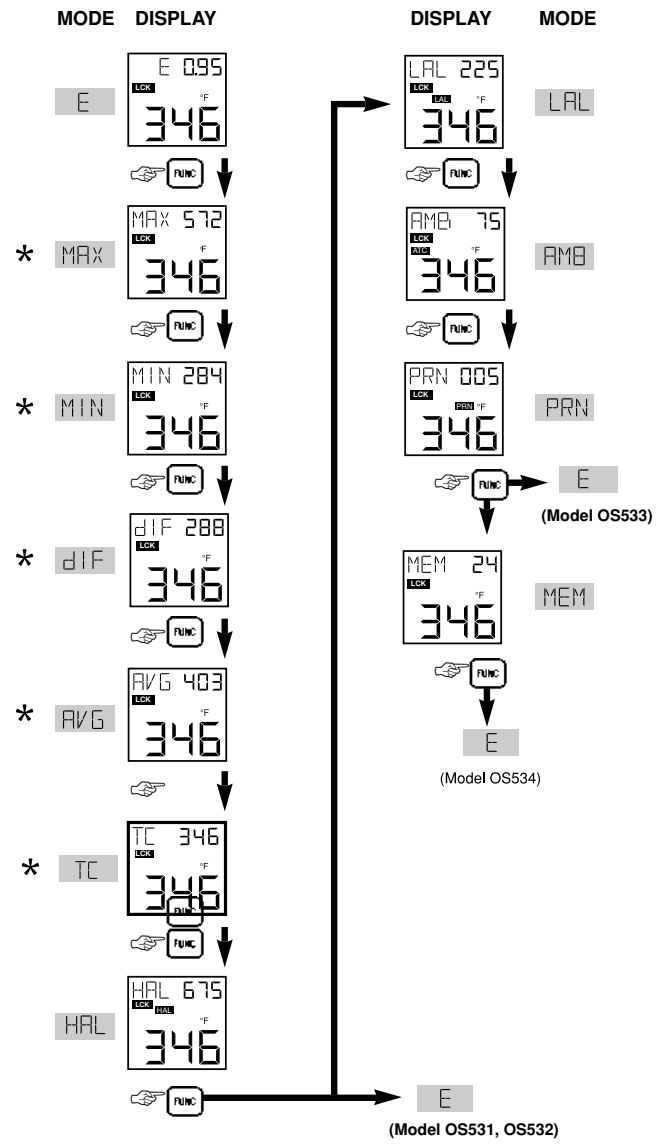


Figure 2-9. Visual Function Flow Chart

* While in these 5 modes:

Use ▼ °F-°C key to change temperature from °F to °C or vice versa.

Use ▲ ○·● key to turn on the display backlighting.

2.3.1 Adjusting Emissivity

Refer to Appendices B and C for information on emissivity.

1. Determine the emissivity of the target.
2. Aim at the target and pull the trigger.
3. If necessary, press the key to increment the target emissivity or press the °F·°C key to decrement the target emissivity.

NOTE

The Emissivity Display Mode (E) appears every time the trigger is pulled regardless of how the Display Mode was previously set.

NOTE

The emissivity setting does not change when the thermometer is turned off. However, when the batteries are replaced, the emissivity is reset to 0.95, the default value.

2.3.2 Using the LOCK Function

This function electronically locks the trigger mechanism:

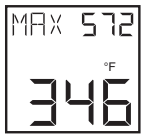
1. Pull the trigger and press the LOCK key to lock the trigger. The LCK icon will appear on the display.
2. Release the trigger. This allows the thermometer to operate continuously whether or not the trigger is pulled.

NOTE

To unlock the trigger function, press the LOCK key again, and the LCK icon is no longer displayed.

2.3.3 Calculating Temperature Values

The thermometer calculates the MAX, MIN, dIF, and AVG temperatures based on the current temperature.



is the maximum temperature since the temperature measurement session starts (pulling the trigger).

is the minimum temperature since the temperature measurement session starts.

is the difference between the MAX and MIN temperatures.

is the true average temperature since the temperature measurement session starts. The average temperature under continuous operation is accurate for a limited period of time (refer to the specifications). However, the AVG temperature function can be used indefinitely when the thermometer is operating intermittently.

"AVG ---" is displayed when either of the following conditions occur:

1. When the average temperature measurement reaches its time period as stated in the specifications.
2. When the thermometer is trying to measure a target temperature which is outside of its measuring temperature range.

To clear the "AVG ---" display, turn off the thermometer.

NOTE

Every time the thermometer goes from the sleep mode to the Real Time mode (by pulling the trigger) the MAX, MIN, dIF, AVG and TC temperatures are updated.

2.3.4 Changing the Temperature from ¡F to ¡C (or vice versa)

During the time that the thermometer displays either MAX, MIN, dIF, AVG or thermocouple temperatures, press the °F·°C key to change all the temperatures from °F to °C or vice versa.

2.3.5 Turning on the Display Backlighting

During the time that the thermometer displays either MAX, MIN, dIF, AVG or thermocouple temperatures, press the key to turn the display backlighting ON/OFF. In addition, the display backlight turns on when the trigger is pulled.

2.3.6 Thermocouple Input (OS532, OS533, OS534)

The thermometer accepts thermocouple input. It displays thermocouple temperature and the target temperature (via infrared) simultaneously. This function provides an accurate method of determining an unknown emissivity.

- To Determine an unknown target emissivity

1. Connect a contact thermocouple probe (Type K) to the thermometer as shown in Figure 1-3.
2. Measure the object temperature using the thermocouple probe.
3. Aim at the object and measure the temperature via infrared.
4. Press and hold the FUNC key until the Emissivity Display mode (E) appears.
5. Set the emissivity by pressing the ☼ or °F/°C keys until the temperature reading matches the thermocouple temperature measurement.
6. The thermometer now displays the correct object emissivity.

"TC--- is is displayed when the thermocouple input is open or out of range (0 to 1600¡F).

2.3.7 Using the Alarm Functions

The thermometer provides audible and visible alarm indications.

- To set the high alarm value:

1. Pull the trigger. Then press and hold the FUNC key until the High Alarm Display Mode (HAL) appears.
2. Press the ☼ key to increment the high alarm value. Press the °F/°C key to decrement the high alarm value.
3. Press the LOCK key to enable the high alarm function. The HAL icon appears.

   If the temperature exceeds the high alarm setpoint, you will hear a beep and the HAL icon on the display flashes.
4. To disable the high alarm, press the LOCK key again, and the HAL icon disappears.

NOTE

If you are not in High Alarm Display Mode (HAL) when the high alarm goes off, you must press the FUNC key to get into the High Alarm Display Mode. Then press the LOCK key to disable the high alarm.

NOTE

The high alarm setpoint does not change when the thermometer is turned off. However, when the batteries are replaced, it is reset to the default value as follows:

OS531:	750¡F
OS532, OS533:	1000¡F
OS534:	1600¡F

- To set the low alarm value: (OS533, OS534):

1. Pull the trigger. Then press and hold the FUNC key until the Low Alarm Display Mode (LAL) appears.
2. Press the ▲ key to increment the low alarm value. Press the °F/°C key to decrement the low alarm value.
3. Press the LOCK key to enable the low alarm function. The LAL icon appears.

   If the temperature drops below the low alarm setpoint, you will hear a beep and the LAL icon on the display flashes.
4. To disable the low alarm, press the LOCK key again, and the LAL icon disappears.

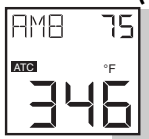
NOTE

If you are not in Low Alarm Display Mode (LAL) when the low alarm goes off, you must press the FUNC key to get into the Low Alarm Display Mode.Then press the LOCK key to disable the low alarm.

NOTE

The low alarm setpoint does not change when the thermometer is turned off. However, when the batteries are replaced, it is reset to the default value of 0¡F.

2.3.8 Using Ambient Target Temperature Compensation (OS533, OS534)



Use the Ambient Target Temperature Compensation (AMB) Display Mode when high accuracy readings under both of these conditions are required:

- The target has a low emissivity.
- The ambient temperature around the target is much higher than the ambient temperature around the infrared thermometer.

To set and activate the Ambient Target Temperature Compensation Mode:

1. Pull the trigger and press the LOCK key to lock the trigger. Set the emissivity to 1.0 (refer to Section 2.3.1).
2. Press and hold the FUNC key until the Average Display Mode (AVG) appears.
3. Slowly move the thermometer so that the line of sight sweeps across the area surrounding the target. The thermometer measures the temperature at each point on the surrounding area.
4. Read the average temperature value from the upper display and record it here _____.
5. Press and hold the FUNC key until the Ambient Temperature Display Mode (AMB) appears.
6. Set the AMB temperature found in Step 4 by pressing the ▲ key or the °F/°C key.
7. Press the LOCK key to enable the ambient target temperature compensation. The ATC icon appears on the display.

NOTE

To disable this mode, press the LOCK key again. The ATC icon disappears.

8. Press and hold the FUNC key until the Emissivity Display Mode (E) appears.
9. Change the emissivity to the proper value for the target being measured (refer to Section 2.3.1).
10. Aim at the target. The target temperature and emissivity are displayed on the LCD.
11. After all data is taken, press the LOCK key to release this mode

NOTE

To disable the Ambient Target Temperature Compensation at a later time, you must press the FUNC key to get into the Ambient Target Temperature Display Mode. Then press the LOCK key to disable it.

NOTE

The target ambient temperature does not change when the thermometer is turned off. However, when the batteries are replaced, it is reset to the default value of 75¡F.

2.3.9 Sending Temperature Data to a Serial Printer (OS533, OS534)

The thermometer can transmit temperature data to a Serial Printer via the RS-232 phone jack and the RS-232 cable.

1. Turn on the Serial Printer and set the following parameters:

   Speed: 4800 BPS One Stop Bit
   Data: 8 Bits No Parity

2. Connect the RS-232 cable between the thermometer and the printer as shown in Figure 2-10.

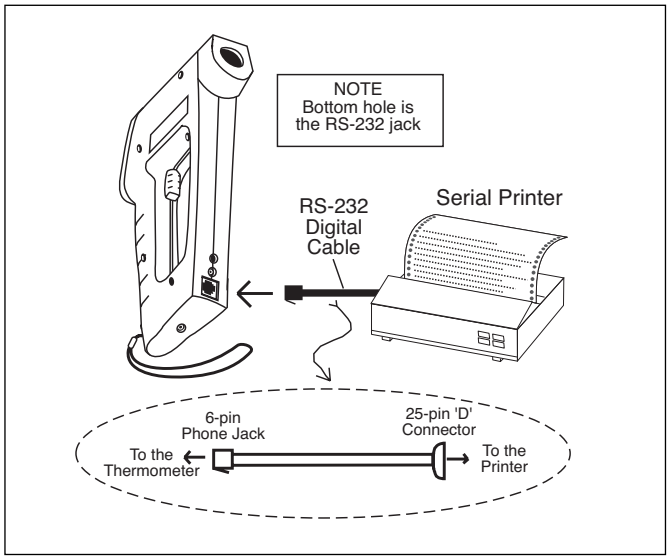


Figure 2-10. Serial Printer Hookup

3. Pull the trigger and press the LOCK key to lock the trigger. The LCK icon will appear on the display.
4. Press and hold the FUNC until the Print Data display Mode (PRN) appears.
5. Press the ▲ key to increment the printing interval. Press the °F/°C key to decrement the printing interval. The printing interval (from 1 to 1999 seconds) is the time between data points. The default value is 2 seconds.
6. Press the LOCK key to start sending data. The PRN icon appears on the display.

NOTE

To stop sending data, press the LOCK key again, and the PRN icon disappears.

7. After all data is taken, press the LOCK key again and the. PRN icon disappears.

8. Press and hold the FUNC until the Emissivity display Mode (E) appears.

9. Press the LOCK key to unlock the trigger.

2.3.10 Sending Temperature Data to a Personal Computer (OS533, OS534)

The thermometer can transmit temperature data to a Personal Computer via the RS-232 phone jack and the RS-232 cable.

1. Turn on the Personal Computer.
2. Connect the RS-232 cable between the thermometer and the serial port (RS-232 of the Personal Computer as shown in Figure 2-11.

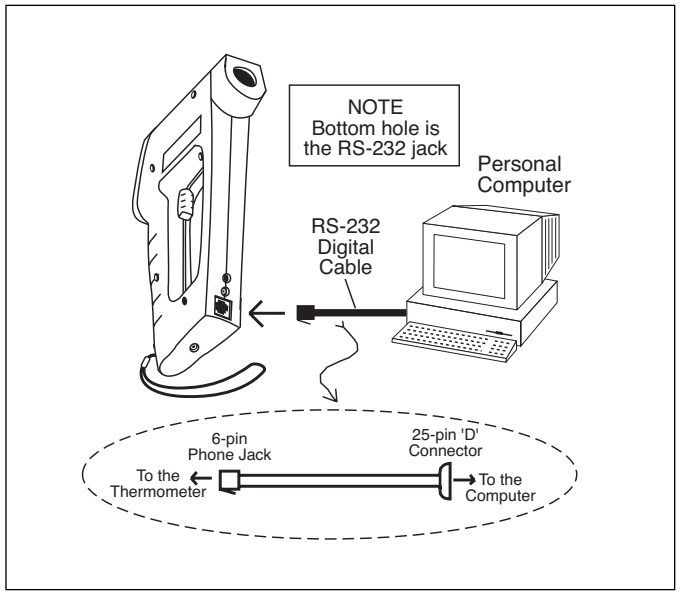


Figure 2-11. Personal Computer Hookup

3. Press the trigger and press the LOCK key to lock the trigger. The LCK icon will appear on the display.

4. Press and hold the FUNC key until the Print Data Display Mode (PRN) appears.

5. Press the ▲ key to increment the printing interval. Press the ▼ °F/°C key to decrement the printing interval. The printing interval (from 1 to 1999 seconds) is the time between data points. The default value is 2 seconds.

6. Run the communications program IRP.EXE that is provided on the 3.5 floppy disk.
The following screen will appear:

```
Infrared Thermometer PC Communication Program

Select one of two COM ports for your PC serial input/output:
Type '1' for COM1 (default) or '2' for COM 2: 1

Depending on the model of thermometer, this
program performs one of the following two
functions:
1- Logging temperature data in real time
      (OS533, OS534)
2- Downloading of previously stored temp data
      (OS534)

Enter Filename <ret> (3 characters min)
Enter N/n <ret> for screen display only
Enter Q/q <ret> to quit now

(If the selected file exists, data will be appended)

Filename . . .
```

Figure 2-12. Computer Screen Display

Select the serial COM port of your PC by entering 1 or 2. Then type in IRDATA for the file name and press the Return key (<ret>).

7. Press the LOCK key on the thermometer to begin transmitting data. The PRN icon appears on the display.

The following is a typical data that appears on the screen.

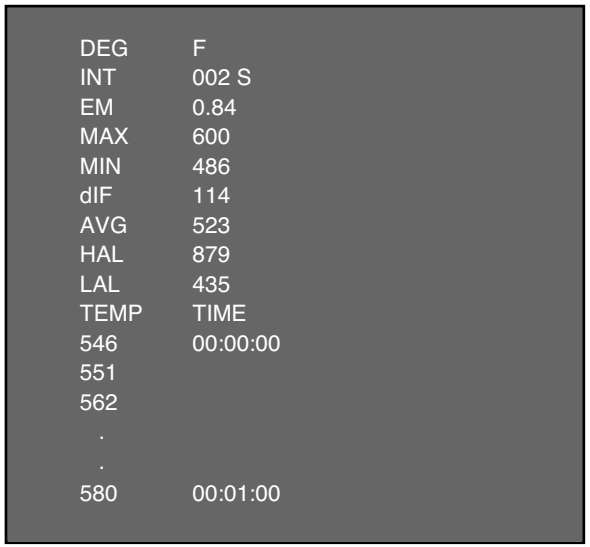


Figure 2-13. Computer Screen Showing Typical Data

8. Press the [LOCK] key on the thermometer to stop transmission of temperature data to the Personal Computer. The PRN icon disappears.
9. Press the [ESC] key on the keyboard to quit the IRP program.
10. The temperature data from the computer screen is saved in IRDATA file, for example. The temperature data file can be reviewed and analyzed at a future time.
11. After all data is taken, press and hold the [FUNC] key until the Emissivity Display Mode (E) appears.
12. Press the [LOCK] key to unlock the trigger.

NOTE

The transmitter temperature data is the average temperature for every printing interval period.

2.3.11 Storing the Temperature Data on Command (OS534)

The thermometer can store up to 100 temperature data points on command. Each set of temperature data is broken down into the temperature value, emissivity, and high alarm setpoint for that temperature. This data is stored in non-volatile memory, so removing the batteries will not affect this data. To store temperature data:

1. Aim at the target and pull the trigger and press the [LOCK] key to lock the trigger. The LCK icon will appear on the display.
2. If necessary, press the [▲] key to increment the target emissivity or press the [▼ °F/°C] key to decrement the target emissivity.
3. Press and hold the [FUNC] key until the Memory Display Mode (MEM) appears.
4. Press the [▲] key to increment the memory location or press the [▼ °F/°C] key to decrement the memory location. The memory location can be from 001 to 100.
5. Press the [LOCK] key to store the target temperature at the memory location indicated. You will hear a beep to verify that the data is stored.

NOTE

You can write over any previously stored memory locations.

6. After all data is taken, press and hold the [FUNC] key until the Emissivity Display Mode (E) appears.
7. Press the [LOCK] key to unlock the trigger.

2.3.12 Erasing the Temperature Data from Memory

The user can erase all 100 temperature data points in memory at any time by using the following procedure:

1. Pull the trigger and press the LOCK key. The LCK icon will appear.
2. Press the LOCK and ▲ keys in rapid sequence.

NOTE

If the LCK icon disappeared, repeat steps 1 and 2

The display freezes momentarily, and a beep sounds for about 1 second. Now the memory is cleared. The thermometer reverts to real time mode.

NOTE

Erasing the temperature data does not erase or reset Emissivity, High and Low Alarm setpoints, printing interval and Ambient Target Temperature compensation

3. After all data is erased from memory, press the LOCK key to unlock the trigger.

2.4 Recall Mode (Passive Operation)

Definition: Recall Mode is the passive operational mode of the thermometer. In this mode, you may review the most recently stored temperature data and parameters.

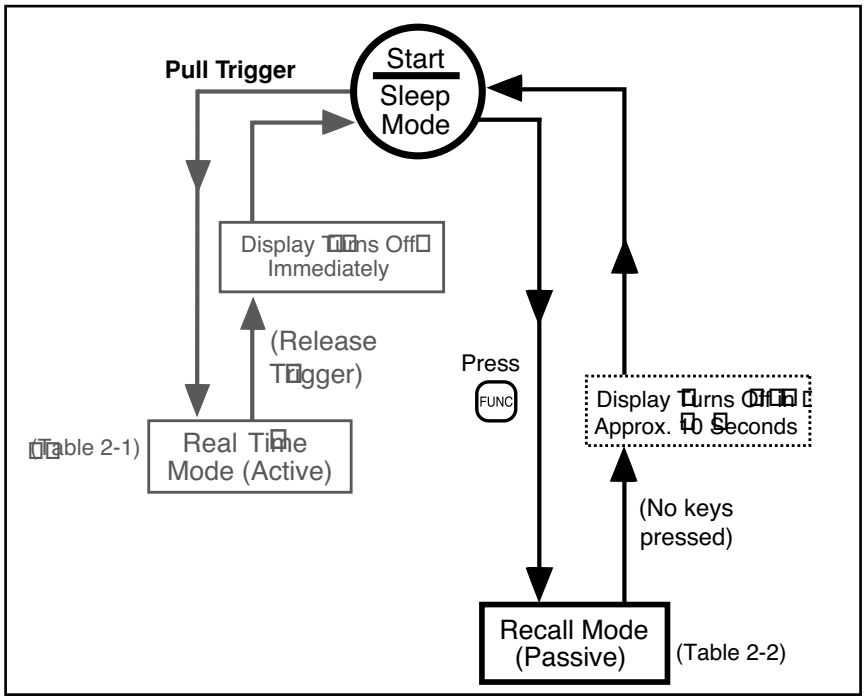
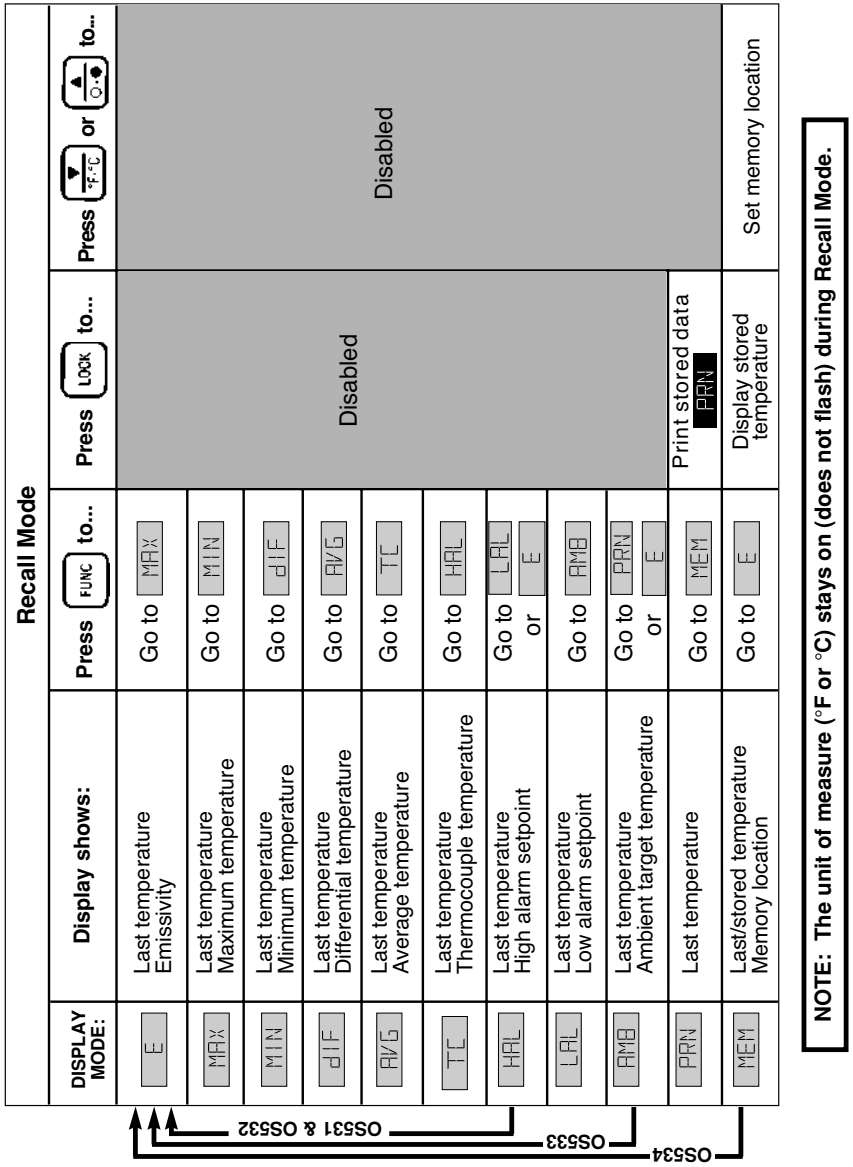


Figure 2-14. General Operational Block Diagram

NOTE

In order to get into the Recall Mode of operation, press the FUNC key only. Do not pull the trigger; otherwise, you will get into the Real Time (Active) Mode of operation.

Table 2-2. Functional Flow Chart (Recall Mode)



NOTE: The unit of measure (°F or °C) stays on (does not flash) during Recall Mode.

2.4.1 Reviewing the Last Parameters

The thermometer stores the last temperature measured in the real time mode (refer to Table 2-1). This temperature can be recalled by pressing the FUNC key.

- Press the FUNC key to review the most recently stored temperature data and parameters. You may review:
  - ¥ MAX temperature
  - ¥ MIN temperature
  - ¥ dIF temperature
  - ¥ AVG temperature
  - ¥ TC temperature

  Calculated values

  - ¥ HAL temperature
  - ¥ LAL temperature
  - ¥ AMB temperature
  - ¥ MEM location

  Set values

3.6.2 Downloading Previously Stored Temperature Data (OS534)

Up to 100 sets of stored temperature information can be downloaded to a serial printer or a personal computer. Each set of temperature information is broken down to the temperature value, the Emissivity, and the high alarm setpoint for that temperature.

1a. Turn on the Serial Printer and set the following parameters:

Speed: 4800 BPS
Data: 8 Bits
One Stop Bit
No Parity

or

1b. Turn on the Personal Computer.

2. Connect the RS-232 cable between the thermometer and the Serial Printer or Personal Computer as shown in Figure 2-10 or Figure 2-11.

3. Run the communications program IRP.EXE that is provided on the 3.5 floppy disk on your Personal Computer. This procedure is also described in Step 6 of Section 2.3.10.

4. Press and hold the FUNC key until you see the Print Display Mode (PRN) appear.

5. Press the LOCK key to start downloading the stored data to the Serial Printer or Personal Computer.

   The PRN icon appears on the thermometer display. When the stored data is completely downloaded, you will hear a beep and the PRN icon disappears.

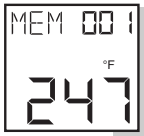
6. The following is typical data that appears on the computer screen or a printer:

```
#01
   EM     0.60
   TMP    400F
   HAL    617F

#02
   EM     0.83
   TMP    290F
   HAL    576F

#03
   EM     0.90
   TMP    242F
   HAL    400F
```

Figure 2-15. Typical Data Downloaded

7. Press the ESC key on the keyboard to quit the IRP program on the personal computer.

2.6.3 Reviewing Previously Stored Temperature Data (OS534)



You can review all 100 stored temperature values on the thermometer display using the following procedure:

1. Press and hold the FUNC key until you see the Memory Display Mode (MEM) appear.

2. Press the ▲ key to increment the memory location or press the ▼ °F/°C key to decrement the memory location.

   The memory location can be from 001 to 100.

3. Press the LOCK key. The stored temperature is shown in the lower portion of the display. If there is no data stored in a memory location, the display shows ----.

4. To review other stored temperatures, repeat Steps 2 and 3.

NOTE

If no keys are pressed, the thermometer goes into sleep mode in approximately 10 seconds.

Notes

3.1 Warnings and Cautions

CAUTION

You may receive harmful laser radiation exposure if you do not adhere to the warnings listed below:

- **¥ USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HERE MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.**
- ¥ DO NOT LOOK AT THE LASER BEAM COMING OUT OF THE LENS OR VIEW DIRECTLY WITH OPTICAL INSTRUMENTS - EYE DAMAGE CAN RESULT.
- ¥ USE EXTREME CAUTION WHEN OPERATING THE LASER SIGHT MODULE.
- ¥ NEVER POINT THE MODULE AT A PERSON.
- ¥ KEEP OUT OF REACH OF ALL CHILDREN.

WARNING

DO NOT ATTEMPT TO OPEN THE LASER SIGHT MODULE. (There are no user-serviceable parts in the module.)

Refer to the inside back cover for product warning label.

3.2 Description

The Laser Sight Module is built into the thermometer. It provides a visual indication of the field of view of the thermometer. Aiming at distant targets (up to 75 feet) becomes much easier by using the Laser Sighting. It is offered in two different models, laser dot, and laser circle.

OS53x Thermometer with built-in Laser Circle

OS53xLD Thermometer with built-in Laser Dot

Figures 3-1 and 3-2 show the rear and front view of the thermometer with the built-in laser sight module.

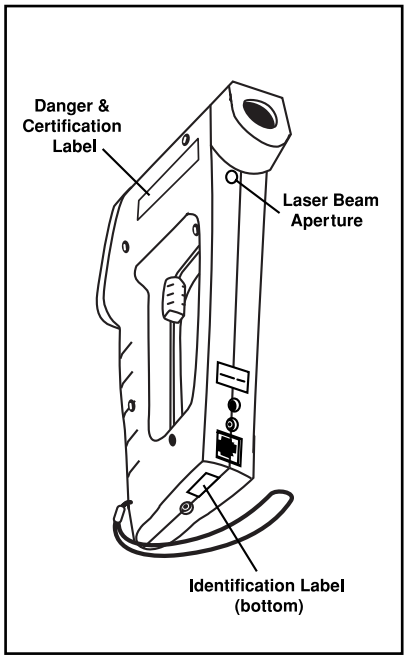


Figure 3-1. Rear View of the Thermometer

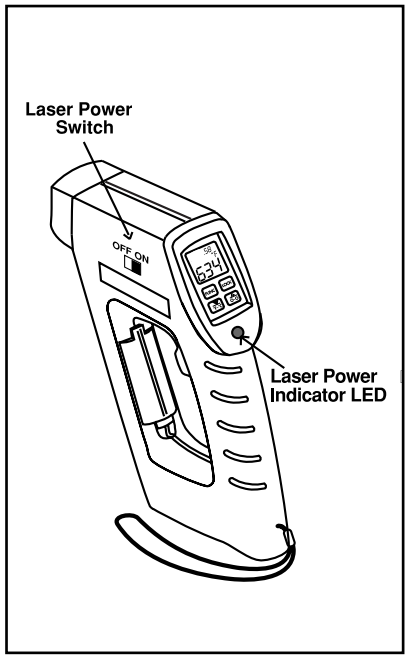


Figure 3-2. Front View of the Thermometer

3.3 Operating the Laser Sight Module

1. Set the laser power switch to the ON position as shown in Figure 3-2.
2. Aim at the target and pull the trigger.
3. The laser beam and the red power indicator LED will turn on. Refer to Figure 3-1 and Figure 3-2.

   The laser beam will stay on as long as the trigger is pulled. If the trigger is locked (the LOCK key is previously pressed) or released, the laser beam will turn off. In order to turn on the Laser Sight Module again, pull the trigger again.

Figure 3-3 shows the two different laser configurations. The laser Dot indicates the center of the field of view of the thermometer. The laser Circle indicates the perimeter of the thermometer's field of view.

The visibility of the laser beam depends on the ambient light levels.

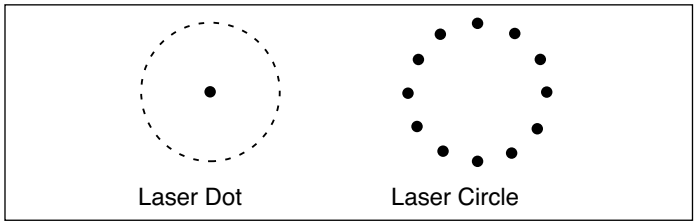


Figure 3-3. Two Laser Configurations

NOTE

The Laser Sight Module turns on only when used with the thermometer. The module does not turn on by itself.

The line of sight of the thermometer does not coincide with that of the Laser Sight Module, as shown in Figure 3-4. The two lines of sight become less critical when measuring distant targets. For example, at 30 feet from the target and a 3 foot diameter target size, there is a 2.7% offset error with respect to the target size. For close-up targets, first make sure the target fills the laser circle, then point it with the center of the beam approximately 1" below the center of the target. A simple method to make infrared measurements is to scan the laser beam across the target area vertically and horizontally and recall measurements of maximum for hot and minimum for cold target (compared to the background) to obtain the correct temperature.

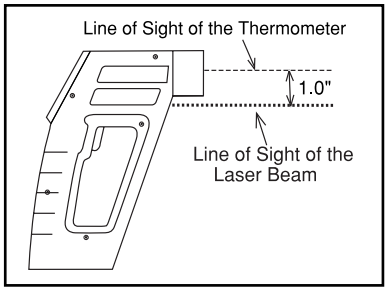


Figure 3-4 Lines of Sight of the Laser Sight Module and Thermometer

4.1 Replacing the Batteries

NOTE

When you change the batteries, all of the set parameters (i.e. emissivity, high alarm, low alarm, Target Ambient Temperature) will be reset to the default values. For your convenience, you may want to write down all of the set parameters BEFORE replacing the batteries.

The thermometer is powered by 4 standard AA size lithium batteries. To replace the batteries:

1. Invert the thermometer and open the cover of the battery compartment.
2. Remove the old batteries.
3. Install 4 fresh AA size (lithium or alkaline) batteries as shown in Figure 2-1.
4. Close the battery compartment cover.

NOTE

When the battery power is so low that accurate measurements are no longer possible, the thermometer shuts down and you must replace the batteries immediately.
You will see and hear the following:

- The LOBAT icon flashes
- The thermometer beeps intermittently
- The thermometer flashes OOO in the main display.

Safety Warning

Do not open batteries, dispose of in fire, heat above 100°C (212°F), expose contents to water, recharge, put in backwards, mix with used or other battery types – may explode or leak and cause personal injury.

4.2 Cleaning the Lens

Although all lenses are quite durable, take care to prevent scratching when cleaning them. To clean the lens:

1. Blow off loose particles, using clean air.
2. Gently brush off remaining particles, using a camel hair brush. Alternatively, clean any remaining contaminants with a damp, soft, clean cloth. Be careful not to rub too hard.

CAUTION

Do not use any ammonia or cleaners with ammonia on the lens, as damage may result. Do not wipe the surface dry, as this may cause scratching.

4.3 Calibrating the Thermometer

The thermometer can not be calibrated by the user. For precise calibration of the thermometer, call our Customer Service Department. It is recommended that the Infrared Thermometer to be sent to the factory once a year for recalibration.

4.4 Servicing the Laser Sight Module

Servicing and maintenance is not required to keep the laser sighting in proper operating condition. In the event of a malfunction, the unit should be returned to the manufacturer for repair.

THERMOMETER

Problem	Solution
The thermometer does not turn on (No Display)	1a. Properly install fresh batteries. 1b. If operating under ac power, check that the ac adapter is plugged in properly to the ac wall outlet and to the thermometer. 1c. Make sure the batteries make good contact - remove and reinstall the batteries. 2. Make sure that the trigger is pulled completely.
	1. Reset the thermometer. It sets all of the parameters to the default values and restores calibration. The procedure is as follows, when the thermometer is in sleep mode: a. Press and hold the °F·°C key. b. Pull the trigger. c. Release the trigger. d. Release the °F·°C key. e. The version of the software is displayed for about 1 second. The emissivity display mode immediately follows with the emissivity of 0.95.
- The LOBAT icon flashes. - The thermometer beeps intermittently. - The thermometer flashes 000 in the Main Display.	1. Properly install fresh batteries.

Problem	Solution
The thermometer is locked up (the display is frozen).	Remove and reinstall the batteries or disconnect and reconnect the ac adapter.
The display is either erratic or stays at one reading.	1. Clean the thermometer lens. Refer to Section 4.2. 2. Activate the Diagnostic Program in the thermometer as follows: a. Pull the trigger and press the LOCK key to lock the trigger. b. Hold down the FUNC key and press the °F-°C key until VER X.X is displayed. You can expect to see and hear the following: ¥ You will see the version number VER X.X of the software for about 1 second. ¥ You will hear a beep, TST is displayed and ¡F flashes. ¥ Soon after, all of the segments of the display including the backlighting will light up for about 1 second. ¥ The display will clear and a PAS (pass) or ERR (error) code may be seen on the display.

Problem	Solution
	If you see an error code, either ERR1 , ERR2 , or ERR3 , record the code and call our Customer Service Department. Provide Customer Service with the error code that is displayed in the upper left corner of the display. The Customer Service Department representative may ask you to return the thermometer to the factory. ¥ The display will go back to the Real Time Mode (Emissivity Display Mode). c. After running the diagnostic program, press the LOCK key to unlock the trigger.
The temperature reading is erratic. The thermometer has just been moved from one extreme temperature to room temperature [0¡C or 50¡C (32¡F or 122¡F)] or vice versa.	1. The thermometer has to stabilize before taking temperature measurements. It takes up to 40 minutes for the thermometer to stabilize.
The temperature reading is erratic. The thermometer has just been moved from room temperature (ambient temperature) to a temperature 10¡C colder or warmer.	1. The thermometer has to stabilize before taking temperature measurements. It takes up to 20 minutes for the thermometer to stabilize.

Problem	Solution
The thermometer resets itself unexpectedly. The emissivity has been reset to .95. All other parameters are reset to the default values.	The trigger is pulled two times in rapid sequence. Wait at least 2 seconds between two successive trigger pulls. You may need to set the emissivity, low alarm, high alarm, target ambient temperature values again.

Laser Sight Module

Problem	Solution
No Laser Beam	1. Make sure the trigger is pulled and the laser power switch is turned on. (The red power LED should be lit).
The Laser "line of sight" does not coincide with the center of the target.	1. The line of sight and the center of the target are offset by design. (refer to Figure 3-4 and the explanation above it for how to compensate for this).

(Specifications are for all models except where noted)

THERMOMETER

Measuring: Temperature Range:	OS531:	0¡F to 750¡F (—18¡C to 400¡C)
	OS533,OS532:	0¡F to 1000¡F (—18¡C to 538¡C)
	OS534	0¡F to 1600¡F (—18¡C to 871¡C)
Accuracy (24¡C or 75¡F Ambient Temperature and at emissivity of 0.95 or greater):	OS531:	–2% of reading or 3¡F whichever is greater
	OS532, OS533, OS534	–1% of reading or 3¡F whichever is greater
Distance to Spot Size Ratio:	OS531, OS532	10:1
	OS533:	20:1
	OS534	30:1
Repeatability:	– (1% rdg + 1 digit)	
Resolution:	1¡F or 1¡C	
Response Time:	250 msec	
Spectral Response:	8 to 14 microns	
Thermocouple Input	Type K, 0 to 1600¡F (-18 to 871¡C) (OS532, OS533, OS534 std.)	
Input Connection	SMP Connector	
Thermocouple Display Accuracy @ 75¡F (24¡C) Ambient Temperature	–5¡F (–3¡C)	
Thermocouple Display Response Time	2 seconds	
Operating Ambient Temperature:	32¡F to 122¡F (0¡C to 50¡C)	
Operating Relative Humidity:	95% or less without condensation	
Display:	Backlit LCD dual display	
Keypad:	4 position, tactile feed-back membrane switch	
Average Temperature Accuracy Time Period (under continuous operation):	11½ days	
Emissivity:	0.10 to 1.00 in 0.01 increments, set via keypad	

Calculated Temperature Values:	Maximum (MAX), Minimum (MIN), Average (AVG), Differential (dIF), Thermocouple (TC)
Ambient Target Temperature Compensation:	OS533: set and enabled via keypad OS534: set and enabled via keypad
RS232 Output (for personal computers and serial printers):	OS533: standard OS534 standard 4800 bits per second, 8 bits of data, 1 stop bit, no parity
RS-232 Cable:	RJ12 to 25 pin D connector, Female RJ12 Pin # — 25 pin D connector Pin # 3 — 3 5 — 7 4 & 5 jumpered 6 & 20 jumpered
Analog Cable:	6 feet long; 2-conductor, 22 AWG 3.5mm male plug
Alarm:	Set and enabled via keypad All models: High alarm standard, with audible and visual indication OS533, OS534: Low alarm standard, with audible and visual indication
Data Storage:	OS534 Up to 100 sets of data points on command. Each set of data consists of the temperature, the Emissivity and the high alarm value.
Aiming Feature:	V groove on top of the thermometer or use Laser Sighting
Analog Output:	1 mV/¡F or 1 mV/¡C, set via keypad
Analog Output Accuracy:	–2mV reference to temperature display
Power:	4 AA size 1.5 volt batteries (lithium or alkaline)
Battery Types Alkaline:	general brand

Lithium:	Eveready Energizer, model number L91
Battery Storage Temperature	—40¡C to 50¡C (-40¡F to 122¡F)
ac adapter:	Optional - available in 120 Vac or 220Vac Class 2 Transformer, UL & CSA Listed
(Input voltage):	120Vac or 220Vac at 60 or 50 Hz
(Output voltage):	9Vdc at 200 mA
(Output plug [female]):	Center positive, coax 2.5/5.5/12mm
	
Low Battery Indicator:	LOBAT icon and intermittent beep
Alkaline Battery Life at 24¡C (75¡F) ambient temperature	
(Without Laser Sighting):	60 hours (continuous operation)
(With Laser Sighting Dot or Circle):	6 hours (continuous operation)
(With LCD backlighting and no Laser Sighting):	17 hours (continuous operation)
Lithium Battery Life at 24¡C (75¡F) ambient temperature	
(Without Laser Sighting):	10 days (continuous operation)
(With Laser Sighting Dot or Circle):	30 hours (continuous operation)
(With LCD backlighting and no Laser Sighting):	3 days (continuous operation)
Tripod Mount:	$^{1}/_{4}$ -20 UNC
Wrist Strap:	Attached to the thermometer case
Soft Carrying Case:	Standard
Dimensions:	8.6" x 6.6" x 2.0" (218.4 x 167.6 x 50.8 mm)
Weight:	1.3 lbs (0.585 kg)

LASER SIGHT MODULE

Wavelength (Color):	670 nanometers (red)
Operating Distance:	
Laser Dot	2 to 75 ft.
Laser Circle	2 to 25 ft.
Max. Output Optical Power:	<5mW at 75¡F ambient temperature, Class IIIa Laser Product
Safety Classification:	Class 3A
Maximum Operating Current:	50mA at 5.5 V
FDA Classification:	Complies with 21 CFR Chapter 1, Subchapter J
Beam Diameter:	5 mm
Beam Divergence:	<1mrad
Operating Temperature:	32¡F to 122¡F (0¡C to 50¡C)
Operating Relative Humidity:	95% or less without condensation
Power Switch:	Slide switch, ON - OFF
Power Indicator:	Red LED
Power:	Supplied by the thermometer
Identification Label:	Located on the bottom of the thermometer
Danger & Certification Label:	Located on the right side of the thermometer (for the label layout, refer to the inside back cover)

Key(s)	Key(s) Functions
FUNC	• Selects one of the following Display Modes: E , MAX, MIN, dIF, AVG, TC, HAL, LAL, AMB, PRN or MEM.
LOCK	• Locks/unlocks the trigger. • Enables/disables High Alarm. • Enables/disables Target Ambient Temperature Compensation. • Enables/disables sending data to the personal computer or serial printer. • Stores temperature data on command. • Displays previously stored data.
☼ ▲	• Increments the data or value displayed. • Turns on or off the backlighting (only in MAX, MIN, dIF, TC or AVG Display Modes).
°F·°C ▼	• Decrements the data or value displayed. • Changes the unit of measure from °F to °C or vice versa (only in MAX, MIN, dIF, TC or AVG Display Modes).
Press and hold down the FUNC key & then press the °F·°C key	• Allows you to go to the Diagnostic Routine.
LOCK and ☼ ▲ keys	• Allows you to erase all 100 stored temperature data from the

Notes

Thermal Radiation

Heat is transferred from all objects via radiation in the form of electromagnetic waves or by conduction or convection. All objects having a temperature greater than absolute zero (-459°F, -273°C, 0 K) radiate energy. The thermal energy radiated by an object increases as the object gets hotter. Measurement of this thermal energy allows an infrared thermometer to calculate the object's temperature if the emissivity (blackness) is known. Generally, it is convenient to measure the amount of radiated energy in the infrared part of an object's radiation spectrum.

Figure A-1 shows a block diagram of an infrared radiation thermometer. Energy from the object is focused by the lens onto the detector. As the detector heats up, it sends out an electrical signal, which in turn is amplified and sent to the circuitry of the thermometer. The thermometer software then calculates the temperature of the object.

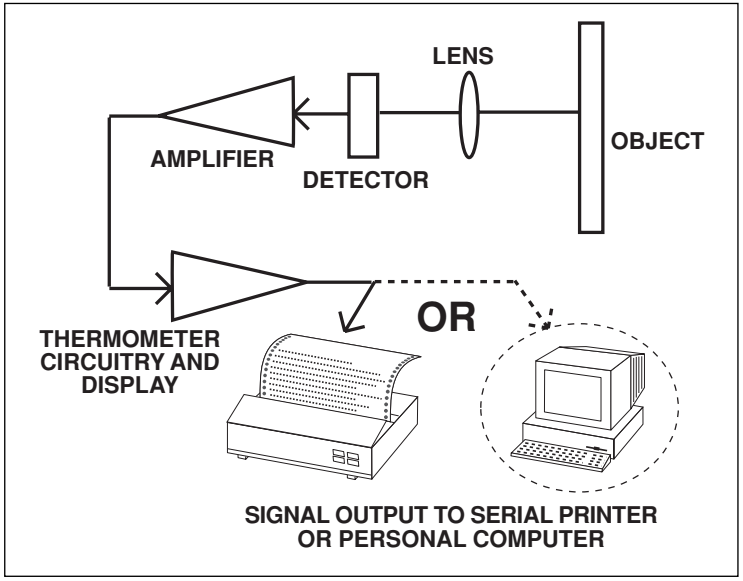


Figure A-1. Infrared Thermometer Block Diagram

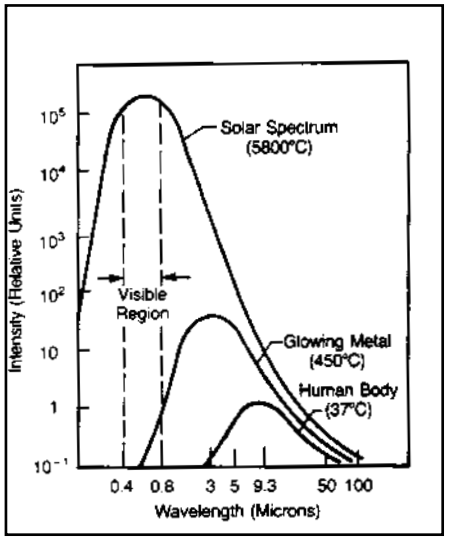
Blackbody

When thermal radiation falls on an object, part of the energy is transmitted through the object, part is reflected and part is absorbed. A blackbody is defined as an ideal object that absorbs all the radiation incident upon it. The best example of a real object that acts like a blackbody is a small hole drilled deep into a large opaque cavity. Thermal radiation entering the cavity is internally reflected and has little chance of escaping the cavity before it is fully absorbed.

Emissivity is defined as the ratio of energy radiated by an object to that of the energy radiated by a blackbody. By definition, the emissivity of a blackbody is 1. Most objects are considered *gray objects* with an emissivity between 0 and 1. Various emissivities for common materials are shown in Appendix B.

Spectral Distribution

Objects radiate energy at different wavelengths, but not with constant intensity at each wavelength. Figure A-2 shows the energy radiated by a blackbody at various temperatures as a function of wavelength. As a body is heated, the intensity of the radiated energy increases and the peak of the curve shifts towards the shorter wavelength end of the spectrum. The total area under a spectral distribution curve is proportional to the total energy radiated by the blackbody at a given temperature.



Relative emission from a blackbody versus wavelength. The area under the curve corresponds to the total energy, and is proportional to the absolute temperature to the 4th power. The peak of the spectral distribution curve shifts to shorter wavelengths as the temperature increases.

Figure A-2. Blackbody Spectral Distribution

Wien's Displacement Law describes the exact mathematical relationship between the temperature of a blackbody and the wavelength of the maximum intensity radiation.

$$\lambda_m = \frac{2.898}{T}$$

where λ_m = wavelength measured in microns
T = temperature in Kelvin

Calculating Temperature

The net thermal power radiated by an object has been shown to depend on its emissivity, its temperature and that of the ambient temperature around the object. A very useful equation known today as the Stefan-Boltzmann Law has been shown both theoretically and empirically to describe the relationship.

$$I = \varepsilon\sigma\left(T^4 - T_a{}^4\right)$$

I = thermal power in watts/meter^2
ε = Emissivity
σ = 5.6703 x 10^{-8} watts/meter^2 x K^4 (Stefan's constant)
T = temperature of object in Kelvin
T_a = temperature of ambient surroundings in Kelvin

The infrared thermometer uses this equation directly in calculating the temperature of an object. The incident power is measured by the infrared detector. The emissivity of the object is determined by the user. The ambient temperature is measured by a sensor inside the thermometer. With all quantities known, the thermometer uses the Stefan-Bolzmann Law to calculate and output the temperature of the object.

Optics Field of View

Accurate measurement of temperature via infrared means depends strongly on the size of the object and the distance between the thermometer and the object. All optical devices (e.g. cameras, microscopes, infrared thermometers) have an angle of vision, known as a field of view or FOV, within which they see all objects. In particular, the thermometer will measure a fixed proportion of the energy radiated by all objects within its FOV. The user must guarantee that the distance between the thermometer and the object is defined so that only that object fills the FOV of the instrument.

Referring to Figure A-3, Objects "X" and "Y" are within the FOV of the thermometer. The measured temperature would fall somewhere between the actual temperatures of the two objects. In order to measure the temperature of Object "X" accurately, Object "Y" would need to be removed. In order to measure the temperature of Object "Y" accurately, the user would need to move closer to Object "Y" until it completely filled the FOV of the thermometer. Alternatively, the user could measure the temperature of Object "Y" with a thermometer with a smaller FOV.

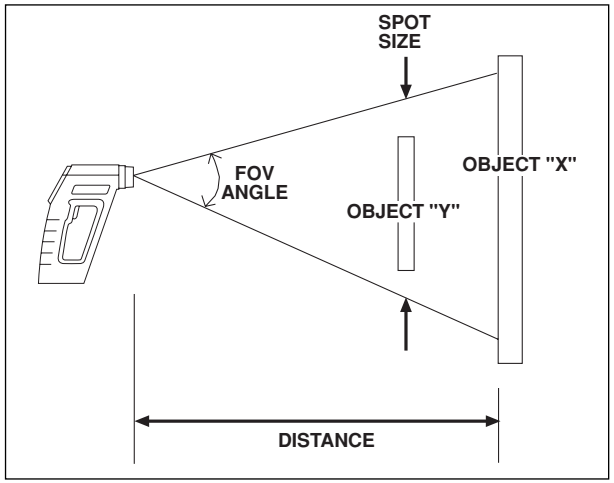


Figure A-3. Field of View of a Thermometer

The distance-to-spot size ratio (D/S) defines the field of view (FOV). Thus, a D/S = 10 gives you approximately a 1 foot spot size at a distance of 10 feet. For accurate spot size values, refer to the Field of View diagrams shown in Figures 2-4 through 2-6.

Table B-1 provides *guidelines for estimating the emissivity* of various common materials. Actual emissivity, especially of metals, can vary greatly depending upon surface finish, oxidation, or the presence of contaminants. Also, emissivity or infrared radiation for some materials varies with wavelength and temperature. To determine the *exact emissivities* for most applications, follow the procedures in Appendix C.

Table B-1. Emissivity Table

METALS

Material	Emissivity (e)
Aluminum — pure highly polished plate	0.04 — 0.06
Aluminum — heavily oxidized	0.20 — 0.31
Aluminum — commercial sheet	0.09
Brass — dull plate	0.22
Brass — highly polished, 73.2% Cu, 26.7% Zn	0.03
Chromium — polished	0.08 — 0.36
Copper — polished	0.05
Copper — heated at 1110¡F (600¡C)	0.57
Gold — pure, highly polished or liquid	0.02 — 0.04
Iron and steel (excluding stainless) — polished iron	0.14 — 0.38
Iron and steel (excluding stainless) — polished cast iron	0.21
Iron and steel (excluding stainless) — polished wrought iron	0.28
Iron and steel (excluding stainless) — oxidized dull wrought iron	0.94
Iron and steel (excluding stainless) — rusted iron plate	0.69
Iron and steel (excluding stainless) — polished steel	0.07
Iron and steel (excluding stainless) — polished steel oxidized at 1110¡F (600¡C)	0.79
Iron and steel (excluding stainless) — rolled sheet steel	0.66
Iron and steel (excluding stainless) — rough steel plate	0.94 — 0.97
Lead — gray and oxidized	0.28
Mercury	0.09 — 0.12
Molybdenum filament	0.10 — 0.20
Nickel — polished	0.07
Nickel — oxidized at 1200¡F — 2290¡F	0.59 — 0.86
Platinum — pure polished plate	0.05 — 0.10
Platinum — wire	0.07 — 0.18
Silver — pure and polished	0.02 — 0.03
Stainless steel — polished	0.07
Stainless steel — Type 301 at 450¡F — 1725¡F	0.54 — 0.63
Tin — bright	0.06
Tungsten — filament	0.39
Zinc — polished commercial pure	0.05
Zinc — galvanized sheet	0.23

NONMETALS

Material	Emissivity (e)
Asbestos Board	0.96
Asphalt, tar, pitch	0.95 — 1.00
Brick — red and rough	0.93
Brick — fireclay	0.75
Carbon — filament	0.53
Carbon — lampblack - rough deposit	0.78 — 0.84
Glass - Pyrex, lead, soda	0.85 — 0.95
Marble — polished light gray	0.93
Paints, lacquers, and varnishes — Black matte shellac	0.91
Paints, lacquers, and varnishes — aluminum paints	0.27 — 0.67
Paints, lacquers, and varnishes — flat black lacquer	0.96 — 0.98
Paints, lacquers, and varnishes — white enamel varnish	0.91
Porcelain — glazed	0.92
Quartz — opaque	0.68 — 0.92
Roofing Paper	0.91
Tape — Masking	0.95
Water	0.95 — 0.96
Wood — planed oak	0.90

Appendix: Determining an Unknown Emissivity

In Appendix A, we showed how emissivity is an important parameter in calculating the temperature of an object via infrared means. In this section we discuss how to determine a specific emissivity value. If you know the material of the object, use Table B-1 in Appendix B to look up its approximate emissivity. Most organic materials such as plastics, cloth, or wood have an emissivity of about 0.95. For this reason, we use 0.95 as the default emissivity setting in the OS530 Series Thermometer.

For objects of unknown material or for very precise measurements, use one of the following methods to determine a specific emissivity value.

Method 1

1. Measure and record the temperature of the object using a contact temperature probe such as a thermocouple or RTD.
2. Aim the thermometer at the object.
3. Adjust the emissivity until the temperature reading of the thermometer equals the temperature measured in Step 1.

Method 2

1. Heat the object (or at least a sample of the object material) on top of a heating plate to a known temperature. Make sure the thermometer and the air surrounding the heating plate are at the same temperature.
2. Measure the temperature of the object material with the thermometer. Make sure that the object fills the FOV of the thermometer.
3. Adjust the emissivity until the temperature reading of the thermometer equals the known temperature of Step 1.

Method 3

1. Use this method to measure objects at temperatures below 500¡F (260¡C).
2. Place a large piece of masking tape on the object (or at least a sample of the object material). Allow time for the masking tape to reach the object temperature.
3. Set the emissivity of the thermometer to 0.95. Use the thermometer to measure and record the temperature of the masking tape - Area A in Figure C-1. Make sure that the area of the object covered with masking tape fills the FOV of the thermometer.

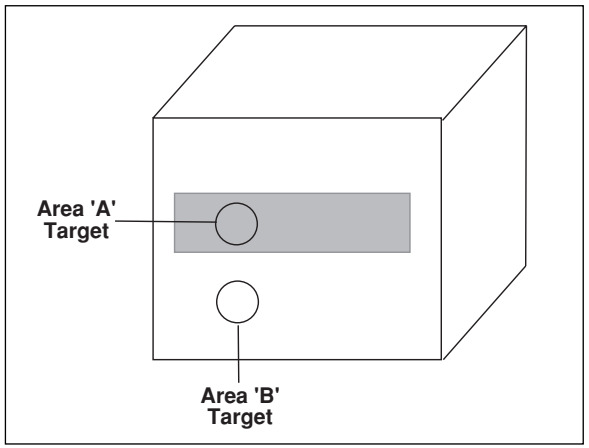


Figure C-1. Determining Emissivity

4. Aim the thermometer at Area B as shown in Figure C-1 Make sure that Area B is as close as possible to Area A .
5. Adjust the emissivity of the thermometer until the temperature reading equals the temperature found in Step 3.

Method 4

1. Paint a sample of the object material with flat black lacquer paint.
2. Set the emissivity to 0.97 and measure and record the temperature of the painted portion of the sample material - Area A in Figure C-1. Make sure that the painted area of object material fills the FOV of the thermometer.
3. Aim the thermometer at another spot on the target - Area B in Figure C-1.
4. Adjust the emissivity of the thermometer until the temperature reading equals the temperature found in Step 2.

Method 5

1. Use this method where practical to measure objects at temperatures above 500¡F (260¡C).
2. Drill a 1.5 (35 mm) diameter hole in a sample of the object material to a depth of 5 (127 mm). This hole closely resembles a blackbody (refer to Appendix A).

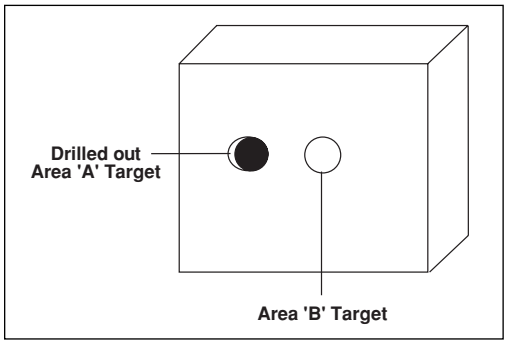


Figure C-2. Determining Emissivity with a Drilled Hole

3. Set the emissivity to 0.97 and measure and record the temperature of the hole in the sample material - Area A in Figure C-2. Make sure that the hole fills the FOV of the thermometer.
4. Aim the thermometer at another spot on the target as close as possible to Area A (Area B in Figure C-2).
5. Adjust the emissivity of the thermometer until the temperature reading equals the temperature found in Step 3.

Notes

Where Do I Find Everything I Need for Process Measurement and Control? OMEGA Of Course!

TEMPERATURE

- Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- Wire: Thermocouple, RTD & Thermistor
- Calibrators & Ice Point References
- Recorders, Controllers & Process Monitors
- Infrared Pyrometers

PRESSURE, STRAIN AND FORCE

- Transducers & Strain Gauges
- Load Cells & Pressure Gauges
- Displacement Transducers
- Instrumentation & Accessories

FLOW/LEVEL

- Rotameters, Gas Mass Flowmeters & Flow Computers
- Air Velocity Indicators
- Turbine/Paddlewheel Systems
- Totalizers & Batch Controllers

pH/CONDUCTIVITY

- pH Electrodes, Testers & Accessories
- Benchtop/Laboratory Meters
- Controllers, Calibrators, Simulators & Pumps
- Industrial pH & Conductivity Equipment

DATA ACQUISITION

- Data Acquisition & Engineering Software
- Communications-Based Acquisition Systems
- Plug-in Cards for Apple, IBM & Compatibles
- Datalogging Systems
- Recorders, Printers & Plotters

HEATERS

- Heating Cable
- Cartridge & Strip Heaters
- Immersion & Band Heaters
- Flexible Heaters
- Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- Metering & Control Instrumentation
- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

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