



## Data Sheet

# Infra-red Temperature Measurement

### Method of operation

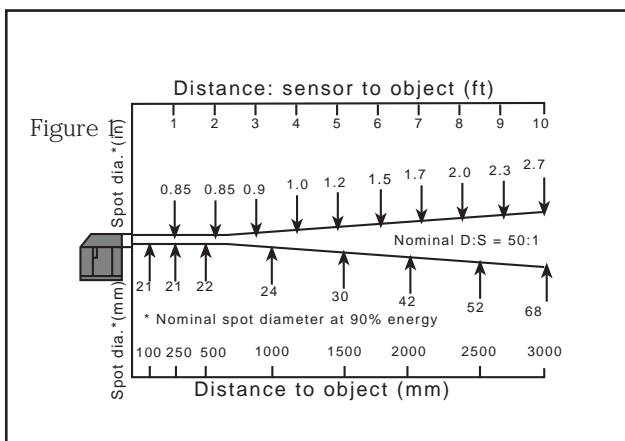
Infra-red energy is emitted by all objects having a temperature above absolute zero. The emitted energy increases as the object increases in temperature.

The optical system of the instrument focuses this infra-red energy onto a thermopile. The resulting signal is amplified and then linearised.

### Advantages of non-contact temperature measurement over contact

- There is no heat abstraction, therefore the material being measured doesn't have its temperature influenced by the measurement.
- Because there is no direct contact there is no risk of contamination. (i.e. ideal for the food industry)
- Higher temperature measurement is made easier, because measurements can be made from a distance.
- IR thermometers themselves are suitable for applications that are difficult or dangerous to access by hand; i.e. moving parts in machinery, live power cables/distribution panels, inaccessible HVAC vents.
- IR thermometers are ideal in applications where the material being measured is fragile or delicate.

### Measurement area



The diagram above details an example measurement area (PM30.RS stock no. 263-9688). If a high temperature is to be measured, the instrument should not be less than 1 metre from the heat source as the reading may be distorted and thermal damage may occur to the instrument. Temperature measurement of very hot objects should be taken quickly without allowing the front face of the instrument to become warm. This has a negligible effect when measuring high temperatures but increases the time taken for the reading to return to ambient. When measuring low temperatures the instrument can be as close as is practical.

### Emissivity

Emissivity ( $\epsilon$ ) is defined as the ratio of the energy radiated by an object at a given temperature to the energy emitted by a perfect radiator, or 'black body' at the same temperature. The emissivity of a black body is 1.0, whilst a highly polished metal surface (poor radiator) has an emissivity of typically 0.1 or less. All values of emissivity fall between 0.0 and 1.0.

The 'poor radiator' type of object can result in serious measurement accuracy problems because most IR thermometers mathematically translate measured IR energy into temperature. As an object with an emissivity of 0.6 emits only 60% of the available energy, this would cause the indicated temperature to read lower than actual. This problem can be overcome by including an emissivity potentiometer. This is a gain adjustment to increase the amplification of the detected signal to compensate for the energy lost due to an emissivity less than 1.0. Therefore for applications measuring materials with low emissivity, i.e. metals, an instrument with adjustable emissivity is required.

As emissivity is a function of temperature and subject to variation due to the surface condition of the material the table overleaf should be used as a guide only.

### Determination of an unknown emissivity

The emissivity of most organic materials (e.g. cloth, wood, plastics, most paints) equals approximately .95. Metals with polished surfaces can have emissivities which are very low. Typical values of emissivity for some common materials are shown in the following table. If the emissivity of a material is questionable, determine its value by using one of the following methods:

#### Method A

1. Heat a sample of the material on a hotplate to a known temperature as measured with a calibrated, precision sensor. The surroundings should be at ambient temperature, except for the hotplate.
2. Measure the surface temperature of the sample with the infrared thermometer. Press the emissivity adjustment arrows up or down during the measurement until the display indicates the sample's actual temperature. Note and record the corresponding emissivity value as shown on the display. Use this value whenever the same material is measured again.

#### Method B

1. For temperatures up to approximately 260°C (500°F), place a piece of common masking tape on the object to be measured.
2. Allow sufficient time for the masking tape to reach thermal equilibrium with the object.
3. With emissivity set to .95, measure and note the temperature of the masking tape. This process establishes the actual temperature of the object.
4. Proceed as in step 2 in METHOD A, above.

**Method C**

- For very high temperatures and if practical, drill a hole approximately 35mm (1.5 in) in diameter and approximately 100mm (4 in) deep in a sample of the object. This hole will act as a blackbody with emissivity of approximately .97.
- Set emissivity to .97 and measure the temperature of the blackbody hole.
- Proceed as in step 2 in METHOD A, above.

**Emissivity table****Metals**

Material	ε Emissivity	Material	ε Emissivity
<b>Alloys</b>		<b>Nickel</b>	
20-Ni, 24-CR, 55Fe, oxidised	0.90	Polished	0.10
80-Ni, 20-0Cr, oxidised	0.87	Oxidised (+37°C-+260°C)	0.31-0.46
<b>Aluminium</b>		Unoxidised	0.10
at ambient	0.10	Electrolytic	0.10
at 100°C and above	0.10	<b>Platinum</b>	0.10
Oxidised	0.11	<b>Silver</b>	0.10
Heavily oxidised	0.20	<b>Steel</b>	
Highly polished	0.10	Cold rolled	0.75-0.85
Roughly polished	0.18	Polished sheet	0.10
Commercial sheet	0.10	Mild steel polished	0.10
Highly polished plate	0.10	Smooth	0.12
Bright rolled plate	0.10	Oxidised steel	0.80
Alloy 1100-0	0.10	Unoxidised	0.10
Alloy 24ST	0.10	<b>Tin</b>	0.10
Alloy 75ST	0.11	<b>Gold</b>	
Alloy polished	0.10	Enamel	0.37
<b>Bismuth</b>		Plate	0.10
Bright	0.34	<b>Iron</b>	
Unoxidised (ambient)	0.10	Oxidised	0.74
100°C and above	0.10	Unoxidised	0.10
<b>Brass</b>		Red rust	0.70
73%Cu, 27%Zn polished	0.10	Rusted	0.65
62%Cu, 37%Zn polished	0.10	<b>Cast iron</b>	
83%Cu, 17%Zn polished	0.10	Oxidised	0.64
Matte	0.10	Unoxidised	0.21
Burnished to a brown colour	0.40	<b>Wrought iron</b>	
Cu-Zn oxidised	0.61	Dull	0.94
Cu-Zn unoxidised	0.10	Smooth	0.35
<b>Cadmium</b>		Polished	0.35
<b>Carbon</b>	0.10	<b>Lead</b>	
Lampblack	0.95	Polished	0.10
Unoxidised	0.81	Rough or oxidised	0.43
Filament	0.95	<b>Magnesium</b>	
Graphitised	0.76	Oxide 0.20	0.10
<b>Chromium</b>		<b>Mercury</b>	0.1
Polished	0.10	<b>Molybdenum</b>	0.1
<b>Copper</b>		Oxidised	0.80
Cuprous oxide	0.87	<b>Titanium</b>	0.10
Black oxidised	0.78	<b>Tungsten</b>	0.10
Etched	0.10	Filament	0.10
Matte	0.22	<b>Zinc</b>	
		Bright	
		galvanised	0.23
		Galvanised	0.28
		Oxidised	0.11
		Polished	0.10

**Non-metallic materials**

Material	ε Emissivity	Material	ε Emissivity
<b>Adobe</b>	0.90	<b>Silk cloth</b>	0.78
<b>Asbestos</b>		<b>Slate</b>	0.67-0.80
Board	0.96	<b>Snow</b>	
Cement	0.96	Fine	0.82
Cement red	0.67	Granular	0.89
Cement white	0.65	<b>Soil</b>	
Cloth	0.90	Surface	0.38
Paper	0.93	Black loam	0.66
Slate	0.97	Ploughed field	0.38
<b>Asphalt</b>	0.93	<b>Soot</b>	
<b>Basalt</b>	0.72	Acetylene	0.97
<b>Brick</b>	0.93	Camphor	0.94
<b>Ceramic</b>		Candle	0.95
	0.90	Coal	0.95
<b>Clay</b>		<b>Stonework</b>	
Fired	0.91		0.93
Shale	0.69	<b>Water</b>	
			0.67
<b>Concrete</b>		<b>Wood</b>	0.80-0.90
	0.94	Beech planed	0.94
<b>Cotton cloth</b>		Oak planed	0.91
	0.77	Spruce sanded	0.89
<b>Glass</b>		<b>Granite</b>	
	0.80		0.45
<b>Paints</b>		<b>Gravel</b>	
All colours	0.92-0.96		0.28
<b>Red lead</b>	0.93	<b>Ice</b>	
<b>Rubber</b>		Smooth	0.97
Hard	0.94	Rough	0.98
Soft, grey	0.86	<b>Lacquer</b>	
<b>Sand</b>	0.76	Clear on:	
		Aluminium foil	0.10
<b>Sandstone</b>	0.67	Bright copper	0.66
Red	0.60-0.83	<b>Limestone</b>	
<b>Sawdust</b>	0.75		0.95
<b>Shale</b>	0.69	<b>Mica</b>	0.75
		Human skin	0.92

### Alternative methods of measuring the surface emissivity

- Measure the surface temperature using a thermocouple and then adjust the emissivity setting on the IR Thermometer to give the same temperature reading.
- Apply black tape or paint to part of the surface. Measure the temperature of the blackened area using an emissivity of 0.95. Then adjust the emissivity setting when measuring an adjoining area until the same temperature reading is obtained.

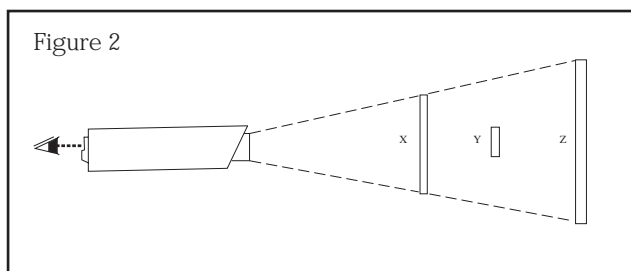
### How far away can I be and still take a reading?

The models listed are general purpose thermometers which measure infra-red radiation in the wavelength region 6-18 microns. The atmosphere is transparent to radiation in this waveband so the target can be many metres away (30 or 40, say) and the thermometer will still receive its radiation.

However in measuring objects at a distance, it is important that the target surface is sufficiently large to fill the field of view of the IR Thermometer otherwise the instrument will receive radiation from the background.

### Optics

Target sizes and distance are critical to accuracy for most IR thermometers. Every instrument has a field of view, an angle of vision in which it will average all of the temperatures it sees.



In the diagram above object x fills the field of view. The only temperature seen will be that of object x and therefore will be accurately indicated. However if object x is removed object y and object z will share the field of view. The indicated temperature will be somewhere between that of objects y and z dependent on the relative areas of each filling the circular field of view. To compensate for this such that object y only is measured, either increase the size of object y or move the pyrometer closer.

### Combination Thermometers

There are circumstances under which a non-contact IR reading and a core or surface temperature reading must be taken. Core readings may be necessary for foods, surface readings for shiny surfaces or materials of unknown emissivity.

Combination thermometers offer 2 instruments in 1, refer to the selection tables

### Applications for portable IR

Main areas of application for the handheld units are in test, inspection maintenance, and general troubleshooting activities. Some industries are:

#### Food

- Food manufacturers and retailers
- Hotels
- Restaurants
- Shops etc
- Distribution
- E.H.O.S.

#### Electronics

- PCB testing for overheated components
- Wave soldering
- Semi-conductor wafer polishing.

#### Automotive

- Engine maintenance/diagnostics radiators
- Tyres
- Brakes
- Road surfaces (asphalt, tar mix)

#### Glass

- Annealing/tempering
- Furnace exteriors for hotspots
- Vacuum flask checking.

#### Metals

- Heat treating
- Casting mould temperatures
- Annealing
- Induction heating

#### Maintenance

- Boiler hot spots
- Electrical connections
- Motors compressors
- Water/Oil cooling equipment
- Energy auditing
- Thermal insulation
- Heat exchangers

#### Ovens & Dryers

- Paint curing
- Coating/laminating

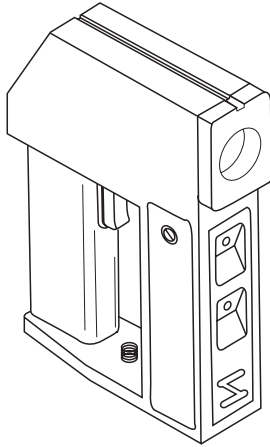
#### Paper & Textiles

- Web monitoring
- Heating rollers
- Laminating
- Curing
- Leather forming

#### Chemical

- Powers/liquids
- Sintering
- Product flow
- Refractory & Insulation

Facility Maintenance Checklist

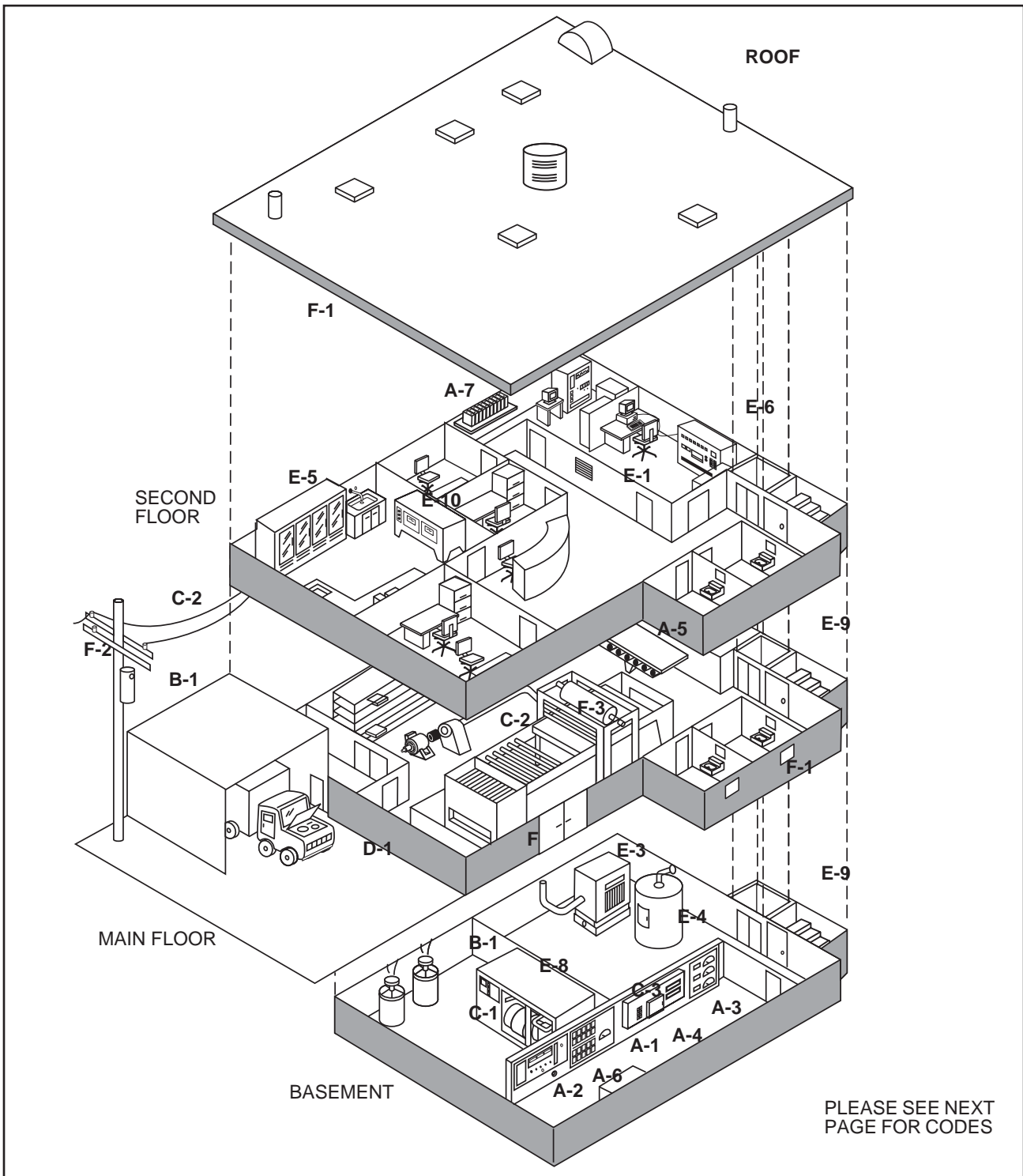


LOBAT	°F
	106
HI ALARM	LOW ALARM
	E = 9 5
MIN	57

	°C
	180
LOCK	
	E = 9 5
MAX	214

Hi and lo temperature limits may be set and an audible and visible alarm activated when these limits are exceeded. Lo Bat indicates a low battery

The Lock function allows you to lock the trigger in the on position. The PM will also store Last Temperature Read and Max temperature for instant recall.



PLEASE SEE NEXT PAGE FOR CODES

**Facility  
Maintenance  
Checklist**

	Benchmark	January	February	March	April	May	June	July	August	September	October	November	December
<b>I. Electric Maintenance Checklist</b>													
<b>A. Connections</b>													
A-1 Circuit Breakers													
A-2 Power Panel Terminators													
A-3 Bus Bars													
A-4 Fuse Connections													
A-5 Ballasts													
A-6 Switch Gear, Wall Switches													
A-7 Battery Bank Terminators													
<b>B. Transformers</b>													
B-1 Cable Terminators													
<b>C. Electric Motors</b>													
C-1 Compressors													
C-2 Cable Terminators													
C-3 Circuit Breakers/Fuses													
<b>II. Vehicle Fleet Maintenance Checklist</b>													
D-1 Engines, Cooling Systems, Hydraulics, Tires & Bearings													
<b>III. Equipment Checklist</b>													
E-1 HVAC													
E-2 Rooftop AC & Other Equipment													
E-3 Heater/Furnace													
E-4 Boiler													
E-5 Freezers, Stored Food Temperatures													
E-5 Uninterruptable Power Supply													
E-7 Bearings													
E-8 Diesel Generators													
E-9 Elevators													
E-10 Ovens													
<b>IV. Other Facilities HotSpots</b>													
F-1 Energy Audit: Insulation, Doors, Windows, Roofs and Steam Traps													
F-2 Power Transmission: Insulators and Transformers													
F-3 Product/Process Temperature													

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