User's Guide

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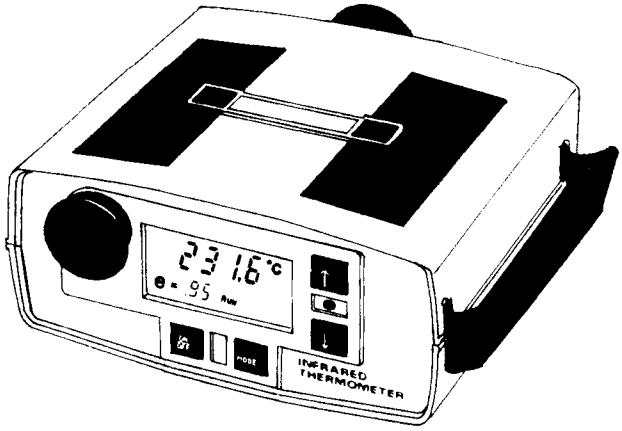

OS3700 Series
Portable Infrared Thermometers

MADE IN USA

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **25 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **two (2) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit should malfunction, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

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Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. P.O. number to cover the COST of the repair,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible, This affords our customers the latest in technology and engineering.

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FCC NOTICE

WARNING: This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

Shielded cables should be used with this unit to insure compliance with the Class A limits.

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It is the policy of OMEGA to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA® OS3700 Series Portable Infrared Thermometer offers convenient handheld temperature measurements in a variety of applications. Temperature readings are provided on a large display in the viewfinder and in a window on the rear of the instrument. Features include Peak, Valley, and Average modes; data hold function; RS-232C communication for printer, computer or datalogger; mV or 0-1 V output; microprocessor-controlled calibration functions and diagnostics; digital emissivity control; built-in tripod socket; wrist strap and rubber hand grips; datalogging software; optional line printer; optional digital datalogger.

In addition to the features listed, two of the models (OS3721 and OS3722) are two-color systems. These allow measurements of black bodies where emissivity is randomly changing with time, as encountered in pouring of metals, or where particulate material partially opaques radiation to the detector. The guide is to always use a single color pyrometer unless it's not suitable for the application, then consider a two-color unit.

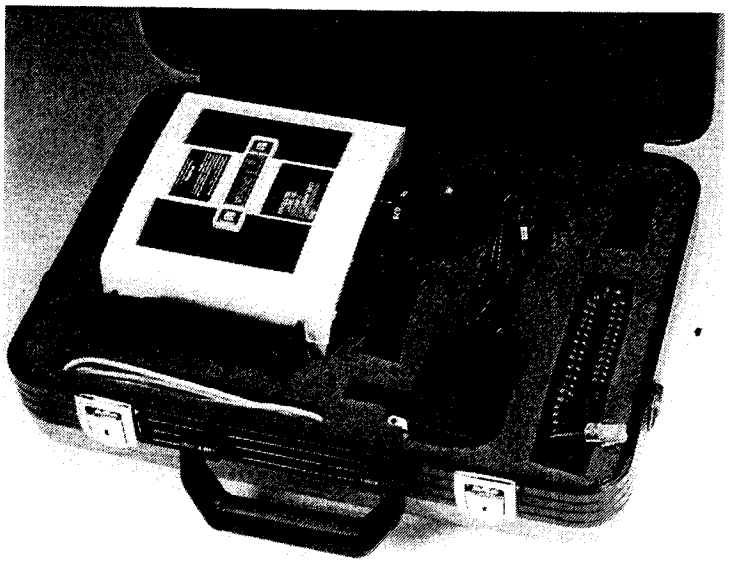


Figure 1-1. OS3700 Series

1.2 AVAILABLE MODELS

Model No.	Temperature Range °C/°F (Field Selectable)	Spectral Response (μm)	Field of View Beyond 1 m (min. focus distance 20") [min. spot size]	Accuracy	Response Time
OS3701	−50 to 1000°C −58 to 1832°F	8-14	40:1 (1½°) [0.6"]	±0.8% of reading in °K	0.75 sec.
OS3702	0 to 500°C 32 to 932°F (0.1° resolution)	8-14	20:1 (2½°) [1.2"]	±0.8% of reading in °K	1.0 sec.
OS3703	50 to 600°C 122 to 1112°F	7.9	40:1 (1½°) [0.6"]	±1% of reading in °K	1.0 sec.
OS3704	300 to 1500°C 572 to 2732°F	4.8-5.2	60:1 (1°) [0.4"]	±1% of reading	1.0 sec.
OS3706	500 to 1500°C 932 to 2732°F	3.86	90:1 (⅔°) [0.27"]	±1% of reading	1.0 sec.
OS3707	250 to 2000°C 482 to 3632°F	1.0-1.60	60:1 (1°) [0.4"]	±0.50% of reading	0.5 sec.
OS3708	600 to 3000°C 1112 to 5432°F	0.78-1.06	180:1 (⅓°) [0.14"]	±0.40% of reading	0.5 sec.
OS3709	900 to 3000°C 1652 to 5432°F	0.65 (same as optical pyrometers)	300:1 (⅕°) [0.08"]	±0.25% of rdg. (NIST Traceable)	
OS3721	700 to 2000°C 1112 to 3632°C	2-color near 0.9μm	60:1 [0.4"]	±1% of reading	
OS3722	900 to 3000°C 1652 to 5432°F		180:1 [0.14"]		

SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call OMEGA Customer Service Department.

Upon receipt of the shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

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

The standard items included with the unit are: OS3700 Infrared Thermometer with batteries installed, OS3700 charger unit (115, 220 or 100 VAC), instruction manual, analog output cable, digital communication cable (to DB-25M standard), data logging software, and custom carrying case. Other accessories may be packed in the carrying case, or separately. See "Accessories", Section 9.2 for a complete listing.

2.2 CHARGING THE BATTERIES

All units are shipped with the batteries installed in the unit, with a battery charger, printer cable and DC output cable. Optional accessories may also be packed in the carrying case.

IMPORTANT: PLEASE READ BEFORE USING

There are rechargeable batteries contained within the instrument which may not be fully charged when received. We recommend at least an overnight charging (12 hours) prior to initial use. The instrument may be operated from the supplied charging module only when the rechargeable batteries are installed.

DO NOT ATTEMPT TO CHARGE CARBON, ALKALINE OR LITHIUM BATTERIES AS SEVERE DAMAGE TO THE INSTRUMENT AND USER MAY RESULT.

The instrument may be operated from alkaline batteries if necessary, without a charger connected.

The OS3700 may be operated with a battery charger (115, 220 or 100 VAC), or an isolated, regulated DC power supply capable of supplying 12 VDC at 200 milliamperes. If erratic behavior is observed with a user-furnished power supply, immediately discontinue its use!

2.3 STORAGE

When the instrument is not used, replace it in its carrying case and keep it closed. Store in a dry area, out of direct sunlight. The storage temperature should be between -5 to 140°F (-20 to +65°C). Allow the unit to reach ambient temperature before operating in order to achieve maximum accuracy. The instrument contains Nickel Cadmium rechargeable batteries, which if charged, will remain charged from one to four months. Be certain that the unit is OFF when stored in its carrying case, or the batteries will discharge.

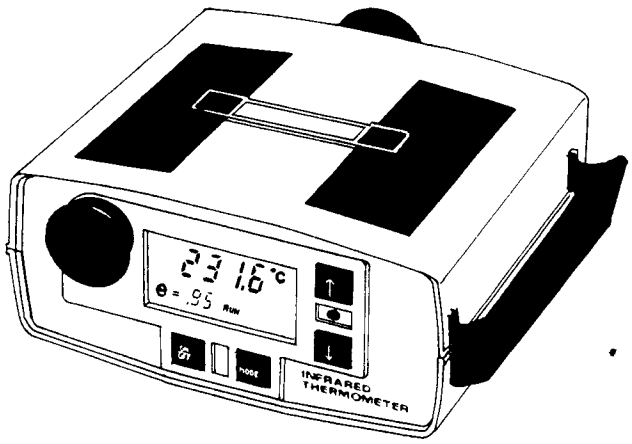


Figure 2-1. Overall View

SECTION 3 OPERATING FEATURES

3.1 KEYS AND CONNECTORS

Figures 3-1 and 3-2 show the keys and connectors on OS3700 units.

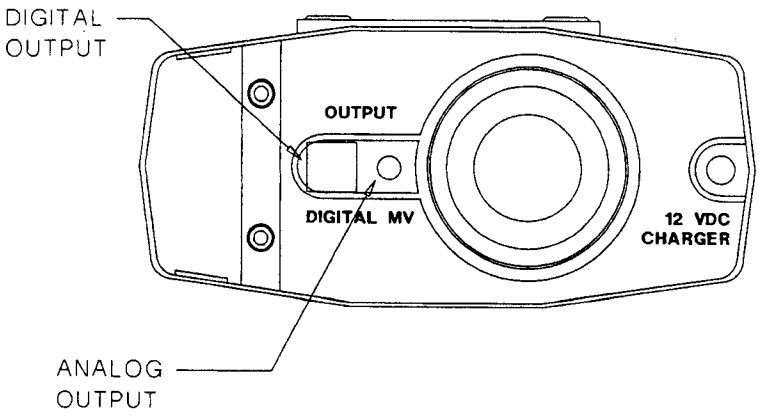


Figure 3-1. Front View of OS3700

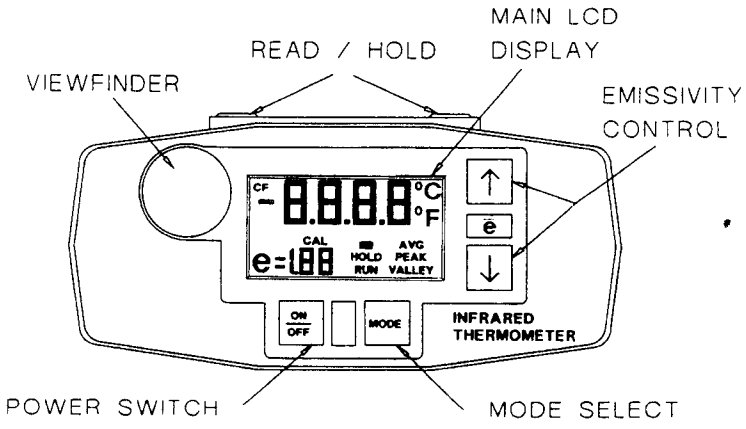


Figure 3-2. Rear View of OS3700

3.2 OPERATING MODES

The OS3700 may be operated in either of two distinct modes: the Continuous mode, or the Momentary mode.

1. In the Continuous mode, the OS3700 continuously takes temperature measurements and updates the LCD display. It also recalculates data for each new reading. This mode is used for continuous temperature monitoring.

2. In the Momentary mode, the OS3700 takes one reading, then holds that reading. The Momentary mode is used for one-time measurements, or for multiple discrete measurements. The Momentary mode features auto-shutoff for saving battery power.

3.2 EMISSIVITY

When making temperature measurements of any object, it is necessary to know its emissivity. Emissivity values range from 1.00 for a perfect "blackbody" to .02 for a highly reflective surface, such as that of gold. All instruments are calibrated with sources that have an effective emissivity of 0.99 or better. The OS3700 provides an easy way to set the emissivity of the unit to match the emissivity of the target. This is covered in Section 5. When using the OS3700, be sure that the emissivity is properly set, to insure accurate results.

3.3 SIGHTING

The OS3700 has focusable, through-the-lens, sighting. The viewfinder has an adjustable eye piece, and an internal temperature readout. The OS3700 can focus from 21 inches. With the use of accessory snap-on lenses, the OS3700 can focus down to as close as 7.5 inches (19 cm). See Section 5.12. Accurate readings may be obtained at closer distances, although the target cannot be visibly focused. A circular reticle in the center of the viewfinder defines the exact area of measurement when the unit is in focus. Very high temperature models have a built-in filter to protect the eyes when viewing a bright, high-temperature target.

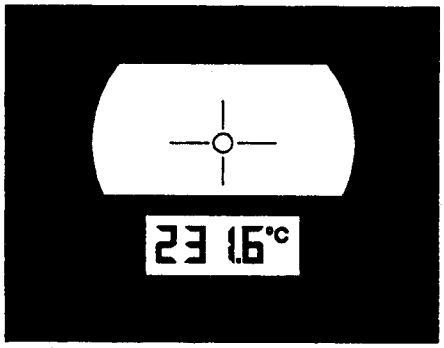


Figure 3-3. Viewfinder with Back-Lit Temperature Display

3.4 OUTPUTS

The OS3700 has two outputs that are useful for measurement processing - a digital output utilizing a mini-DIN connector, and an analog output, which uses a 1/8 inch phone plug.

The DIGITAL output may be configured in either of two ways during the set-up procedures found in Section 4. One configuration is for use with a serial printer; the other is for use with a computer (IBM or compatible).

PRINTER: In the printer (P) mode, the OS3700 can operate an RS-232 (serial) line printer at 2400 baud. Units are shipped with this mode selected. The baud rate is fixed.

DATALOGGER (Computer): When in the datalogger (L) mode, the OS3700 continuously sends data to its serial port, provided the instrument is in the CONTINUOUS operating mode. If the datalogging computer is used in the MOMENTARY operating mode, the OS3700 will send only the initial reading. Additional data will not be sent unless another READ/HOLD sequence is initiated (by pressing and releasing the READ/HOLD button), or the display mode is changed (by pressing the MODE button).

The ANALOG output of the OS3700 is designed to interface with an analog data logger, chart recorder, remote indicator, or multimeter. The output impedance is 100 ohms.

WARNING: Do not apply power to the analog output, or you may damage the instrument. Do not short the output or apply less than 10,000 ohm load.

The analog output may be set in either of two ways during the set-up procedures found in Section 4.

a. The output can be set for 1 millivolt per degree F or C, corresponding to the display set-up.

b. The output can be set for 0 to 1 volt full scale, often used for chart recorders.

SECTION 4 SETTING UP THE OS3700

4.1. ENTERING THE SET-UP MODE

To enter the set-up mode, hold both the UP and DOWN arrows while the OS3700 is turned on. Releasing the arrows after power-on will enable the set-up mode display (see Figure 4-1).

Figure 4.1 Set-up Mode Display

This mode allows the following choices to be made:

Printer Mode (P) or Logger Mode (LH or LL),
(LH = single reading, LL = continuous logging)

mv/deg (1) or 0-1 volt (0)

Degrees F (F) or Degrees C (C)

The current status will be displayed on the main LCD display. If no changes are needed, turn the unit off to exit the set-up mode. If changes are needed, use the procedures in Sections 4.2 through 4.5.

4.2 SELECTING (F) OR (C)

F or C will flash on the LCD, depending on which one is selected. Pressing READ/HOLD will change the F to a C, or vice versa. Once the desired selection is on the display, pressing the MODE button will move the cursor to the next selection.

4.3 SELECTING (P), (LH), or (LL)

After the MODE button is pressed from selecting F/C, "P, LH, or LL" will flash on the LCD, depending on which is selected. Press the READ/HOLD button until the desired choice is flashing. If you are in the printer mode, select the interval as described below. If you are using the logger modes, press the MODE button to move the cursor to the next selection.

4.4 SELECTING THE INTERVAL

When using the OS3700 with a printer, the printing interval is selectable on the OS3700. To select the interval, use the UP and DOWN arrows. The interval is selectable from 5 to 195 seconds, in 5-second steps. The interval selection only applies to the printer mode. Attempting to change the interval in either logging mode will automatically put the OS3700 into the printer mode. The interval selection for the logging mode is done on the logging device, not the OS3700. Once the correct interval is selected, press the MODE button once to move the cursor to the next selection.

NOTE: Attempting to select the interval (pressing the UP or DOWN arrow) at any point in the set-up mode will automatically move the cursor to the Printer/Logger position and place the OS3700 in the printer mode.

4.5 SELECTING (1) OR (0)

The 1 or 0 will flash after the selection of P/L. Pressing the READ/HOLD button will change 1 to 0 and vice versa. Pressing the MODE button will move the cursor back to F/C. The selection process should now be complete.

If the selection is not complete, or additional changes are to be made, pressing the MODE button will scroll the flashing cursor through the selections. If selection is complete, the set-up is stored by turning off the OS3700.

SECTION 5 OPERATING PROCEDURES

5.1 CONTINUOUS MODE

The Continuous mode is entered by pressing the ON/OFF button once. The LCD will go through a self-test procedure (Figure 5-1). The OS3700 will also check the digital interface for any connected devices. The unit will be ready to operate within 8 seconds. (If the low battery indicator comes on, recharge the batteries before continuing use, or run OS3700 with charger.) The LCD will then indicate RUN and the first reading will be displayed. To turn the unit off in the Continuous mode, press the ON/OFF button once.

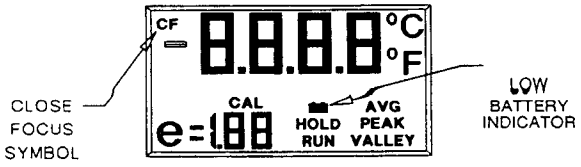
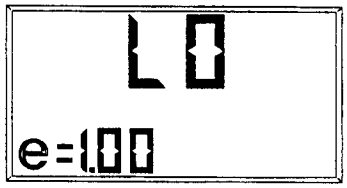


Figure 5-1. LCD Self-Test

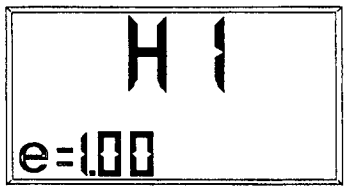
5.2 MOMENTARY MODE

The Momentary mode is entered by pressing and holding the READ/HOLD button when the unit is off, while sighting in the target. The unit will turn on, but some units will not go through the display test. (If low battery indicator comes on, recharge batteries before continuing use, or run OS3700 with charger.) The OS3700 will take a reading within one second, display the reading, and check the digital output. Releasing the READ/HOLD button will hold the reading. Once in the momentary mode, every time the READ/HOLD button is depressed, the OS3700 will take a new reading. When the button is released, it will hold the new reading. If no button is pressed for 30 seconds, the OS3700 will turn itself off to conserve power. Every time a button is pressed, the 30 second timer will reset. The OS3700 may be turned off before the 30 seconds by pressing the ON/OFF button twice.

NOTE: In both the Continuous and the Momentary modes, if the reading is not in the OS3700's range, the display will show "LO" for under range, and "HI" for over range. See Figure 5-2.



A. Under Range Display



B. Over Range Display

Figure 5-2. LO and HI Displays

5.3 SETTING THE EMISSIVITY

The emissivity value displayed on the rear LCD is the value used by the OS3700's microprocessor to perform its calculations. To change the emissivity value so it matches the target, the following steps should be taken:

1. Press either the UP arrow or the DOWN arrow, depending on whether the value must be increased or decreased. Holding either arrow for longer than three seconds will begin rapid increment or decrement.

2. When the arrows are released, and the user is no longer changing the emissivity, the "e" on the left side of the display will flash, indicating that the displayed value has not been saved. To save the value, press the READ/HOLD button once. The "e" will stop flashing. The saved value will be retained after the power is turned off, and will be used and displayed on the next power-up.

3. The OS3700's microprocessor will always use the displayed value, even if it is not saved ("e" continues flashing). However, if the OS3700 is turned off before the value is saved, and then turned on, the old emissivity value will be used and displayed.

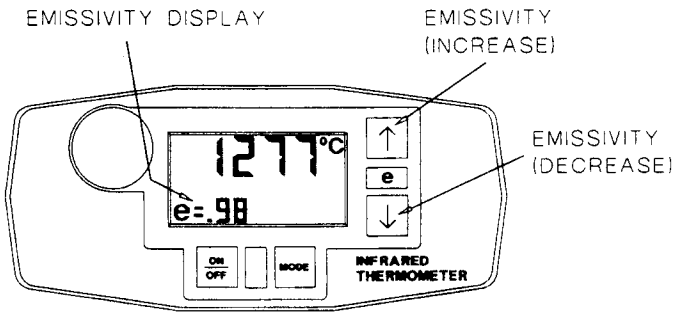


Figure 5-3. Emissivity Controls and Indicator

5.4 OS3721/OS3722 TWO-COLOR MODELS

The OS3721 and OS3722 models use the two-color principle for determining target temperature. Two-color pyrometry measures temperature by processing the ratio of two levels of infrared radiation at nearby wavelengths. The spectral bands for these units are 0.78 to 1.06 microns and 0.9 to 1.06 microns. Since the instrument measures the ratio of energies, and not the absolute value of the energy reaching the detector (as in single-color instruments such as the OS3708), the OS3721/OS3722 is virtually unaffected by errors due to emissivity or a partially obstructed field of view.

For the measurement to be accurate, though, the target material must act as a greybody. This means that the ratio of emissivities for the two spectral bands follows the blackbody radiation laws. Many materials are very close to greybody, but need a slight adjustment of the ratio to correct for any differences. The OS3721/OS3722 provides an easy method of adjusting the ratio, called Slope adjustment.

Slope Adjustment - To adjust the slope (the ratio of emissivities of the two spectral bands), use the UP and DOWN buttons on the right side of the display. The slope setting is displayed in the same place on the display as the emissivity setting for the single color units. When the slope is changed, the temperature display of the OS3721/OS3722 will display the slope, so the resolution of .001 can be obtained. Once the slope is no longer being changed, the display will return to temperature, and the new slope setting will be displayed as "e=x.xx". The "e" will continue to flash until the new slope setting is saved by pressing the READ/HOLD button on the top of the unit.

Determining Slope - To determine the proper slope setting for materials that are not greybodies, heat the material to a known temperature and then adjust the slope until the unit reads the expected temperature. This slope setting should be used any time this material is to be measured.

5.5 FOCUSING THE OS3700

The eye piece should first be focused to obtain a sharp image of the reticle in the view finder. The lens should then be adjusted to get a sharp image of the target.

NOTE: The distance markings on the lens are only approximate. Focusing should be done by eye.
The target must be equal to, or larger than, the defined field of view (fill the reticle), or errors will be introduced.
The field of view specification of this instrument will be met when the unit is in focus. Accurate readings will be obtained from objects that are not in focus as long as they fill the reticle. When exceptionally long distances are involved, errors may be introduced due to atmospheric absorption. Section 6.6 provides details on target size versus distance.

TABLE 5-1
FIELD OF VIEW

FIELD OF VIEW X:1

DISTANCE (CM)	20	40	60	90	120	180	300
	Minimum focusable target sizes in centimeters						
17.8 CF1+CF2	---	---	0.34	---	---	0.18	0.13
21.5 CF2	---	---	0.4	---	---	0.13	0.13
35.5 CF1	---	---	0.63	---	---	0.21	0.16
50	2.50	1.25	0.83	0.56	0.42	0.28	0.17
100	5.00	2.50	1.67	1.11	0.83	0.56	0.33
200	10.00	5.00	3.33	2.22	1.67	1.11	0.67
300	15.00	7.50	5.00	3.33	2.50	1.67	1.00
400	20.00	10.00	6.67	4.44	3.33	2.22	1.33
500	25.00	12.50	8.33	5.56	4.17	2.78	1.67
600	30.00	15.00	10.00	6.67	5.00	3.33	2.00
700	35.00	17.50	11.67	7.78	5.83	3.89	2.33
800	40.00	20.00	13.33	8.89	6.67	4.44	2.67
900	45.00	22.50	15.00	10.00	7.50	5.00	3.00
1000	50.00	25.00	16.67	11.11	8.33	5.56	3.33
2000	100.00	50.00	33.33	22.22	16.67	11.11	6.67
3000	150.00	75.00	50.00	33.33	25.00	16.67	10.00

NOTES:

1. CF1 and CF2 are close focus lenses that are attached to front of lens barrel.

2. Multiply the emissivity according to the following correction factor:

Lens Part No.	Correction Factor
OS3700-CF1	0.96
OS3700-CF2	0.96
BOTH ABOVE	0.92

5.6 NEUTRAL DENSITY FILTER

OS3700 units which measure very high temperatures have a neutral density filter built in. To move this filter into the visible path, turn the lever on the bottom of the OS3700 case. See Figure 5-4.

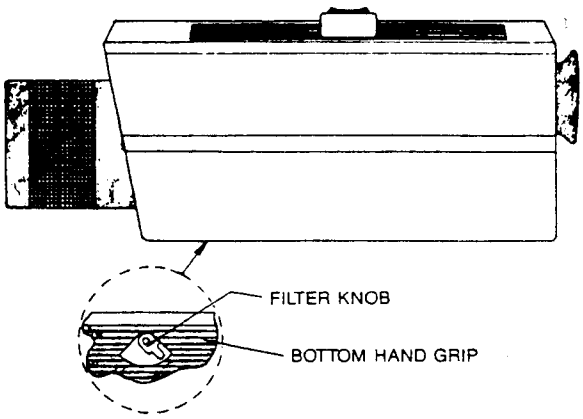


Figure 5-4. Location of Filter Knob

5.7 RUN AND HOLD STATES

RUN: When RUN is displayed, the OS3700 is taking readings every 0.5 seconds (every second for some models) and updating the display at this rate. This allows the user to scan or monitor a process. When using the special display modes in the RUN state, they will be continuously updated as the OS3700 takes new readings.

HOLD: When HOLD is displayed, the OS3700 freezes the last reading before the HOLD state was entered. The display is not updated with new readings as long as the OS3700 remains in this condition. The HOLD function is used to process readings individually, or in small "packets".

When using the special display modes in the HOLD state, the values contained in their registers will be frozen for as long as the HOLD state is maintained. Once the HOLD state is exited (by pressing READ/HOLD button), the registers will be cleared. This allows data to be taken and analyzed in small "packets" - readings are taken, HOLD state entered, AVERAGE, PEAK, and VALLEY analyzed, then registers are cleared when the HOLD state is exited, and the cycle begins again.

CONTINUOUS MODE- RUN is entered automatically when the unit is turned on. To enter the HOLD state, press the READ/HOLD button once. To exit HOLD and return to RUN, press the READ/HOLD button again.

MOMENTARY MODE- RUN state exists as long as the READ/HOLD button is depressed. Once the READ/HOLD button is released, the OS3700 will automatically enter the HOLD state, and remain in this condition until READ/HOLD is pressed again, or the timer turns the unit off.

5.8 SPECIAL DISPLAY MODES

The OS3700 provides data capture modes which enable the user to easily resolve temperature fluctuations in a process. These special display modes, AVERAGE, PEAK, and VALLEY, may be entered and used in either the RUN or the HOLD states (explained above). AVERAGE, PEAK, and VALLEY should be used in the CONTINUOUS mode, since they are not practical for the single readings taken in the MOMENTARY mode.

AVERAGE: AVERAGE provides a means of reducing the fluctuations in a reading caused by variations in the target temperature or emissivity. A buffer memory is continuously updated with the six most recent measurements. These six readings are averaged together.

AVERAGE increases the resolution of the instrument by reducing any noise inherent in the infrared detection process. The AVERAGE reading will "lag" the process (see Figure 5-6).

To enter the AVERAGE mode, press the MODE button until "AVG" is displayed on the right side of the LCD display.

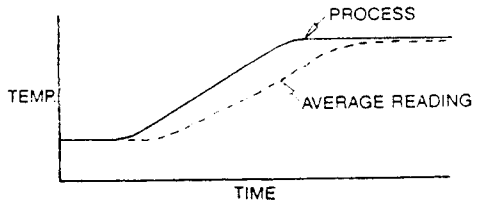


Figure 5-6. AVERAGE Reading Lag

PEAK stores and displays the highest reading since the power was turned on, or since the last RUN/HOLD sequence. If a process is being monitored, PEAK will store the highest temperature detected by the OS3700. If an object is being scanned, such as a wall or a slab of steel, PEAK will hold the highest reading. To enter PEAK, press the MODE button until "PEAK" is displayed on the right side of the LCD display.

VALLEY represents the lowest reading since power on or a RUN/HOLD sequence. If the instrument was turned on and it was not viewing the target, then VALLEY will display either under range ("LO"), or a non-meaningful reading. In this case, it would be important to sight the target and sequence the unit through a HOLD and RUN cycle to reset the memory.

To enter the VALLEY mode, press the MODE button until "VALLEY" is displayed on the LCD display.

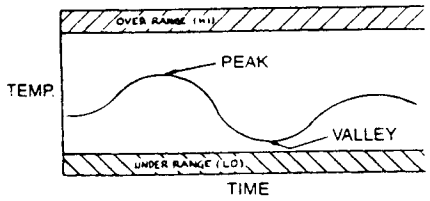


Figure 5-7. PEAK and VALLEY of Temperature Fluctuations

5.9 USING THE PRINTER

When using OMEGA's printer with the OS3700, it must be connected (using the cable included with the printer) and turned on prior to turning on the OS3700. The OS3700 must be in the printer (P) mode. The OS3700 will check the serial port for a "ready" signal. If no "ready" signal is found within 5 seconds, the OS3700 will no longer check, or transmit to, the serial port.

In the CONTINUOUS mode, if a "ready" signal is found, the OS3700 will send "OMEGA OS3700 SERIES" and then the first reading. It will then print new readings at the specified interval, although the display is continuously updated. When the display mode is changed during operation (see Section 5.7), the OS3700 will immediately print the new mode and the reading and then resume the interval rate.

In the MOMENTARY mode, if a "ready" signal is found after the first reading is displayed, the OS3700 will print only that first reading. If no buttons are pressed, it will not print again. Every time READ/HOLD is pressed and released, the OS3700 will take and print out a new reading. This allows the user to take "snap shot" temperature measurements: Aim at the target, press and release READ/HOLD, OS3700 prints out reading; aim at new target, etc. The OS3700 will also print out every time the display mode is changed (by pressing the MODE button).

NOTE: If a printer other than the OMEGA printer is used, refer to Section 9 for the communication format and pin-outs on the Serial Interface Cable.

5.10 USING A COMPUTER AS A DATALOGGER

The computer to which the OS3700 is interfaced must have an RS-232 serial port. The data logging software supplied must be installed on an IBM AT or XT compatible personal computer. The OS3700 must be in one of the logging conditions described below (LH or LL). Connect the OS3700 digital output to the computer's serial input with the Serial Interface Cable supplied.

Section 9 describes the digital output format and cable wiring. Appendix B contains the instructions for installation and use of the OS3700 communications software.

5.11. LOGGING MODES

The OS3700 has two different logging modes: LL and LH. Either mode may be used with the computer or the data logger. The LH mode is a single-shot mode. When the READ/HOLD button is pressed, the OS3700 will transmit the reading, then go into the HOLD mode, with the reading flashing to indicate HOLD mode. Before taking another reading, press the READ/HOLD button again. The OS3700 will go back to the RUN state. When you have a reading that you want, press READ/HOLD, and the process starts again.

The LL mode is a continuous logging mode. The OS3700 transmits readings as fast as it takes them. The reading interval of the logging device may be changed to a rate that is appropriate. To change the interval when using a computer, refer to the software instructions in Appendix B. To change the interval when using the OS3700-DL, refer to the instructions for that unit.

5.12 CLOSE-FOCUS OPTION OF THE OS3707, OS3708, OS3709, OS3721, OS3722

Using the two-lens close-focus combination, the OS3700 can be focused from 21" to 7.5", depending on which combination of lenses is used. The lenses simply screw to the front of the existing OS3700 lens, and are stackable by screwing one on top of the other. The emissivity setting on the OS3700 must be changed according to the chart below to maintain its accuracy. The chart shows the focus range for each lens, used alone and in combination, and the required emissivity setting, assuming the emissivity setting would be 1.00 without the close-focus attachment.

NOTE: If the emissivity required for your application is other than 1.00, that number should be multiplied by the value from the table to obtain the correct setting for the OS3700.

MODEL	FOCUS RANGE	EMISSIVITY
OS3700-CF1	21" to 14"	0.96
OS3700-CF2	13" to 8.5"	0.96
BOTH	9.5" to 7.5"	0.92

SECTION 6 SPECIAL MEASUREMENT CONSIDERATIONS

6.1 EMISSIVITY

The accuracy of the reading of all monochromatic (single color) infrared thermometers is influenced by the emissivity of the target and the size of the object being measured. The emissivity is a function of the material, the material surface finish, the geometry of the object, and the wavelength at which the measurement is being taken. The emissivity of a material may be determined by measuring its surface temperature with a thermocouple thermometer, and then by aiming an infrared thermometer at the object, and adjusting the emissivity control to give an equal reading.

Emissivity may also be determined by painting a small area of the material to be measured with flat black paint, heating the object above ambient, and measuring its temperature with the OS3700's emissivity set to 1.00. The unpainted portion of the object is then measured and the emissivity adjusted to obtain the same reading. The emissivity value displayed should be recorded for future reference.

6.2 WINDOWS

If there is any material between the infrared thermometer and the object being measured, it can attenuate or block the infrared radiation being emitted.

Windows that transmit visible light, such as glass and quartz, will also transmit some infrared energy in the 0.7 to 2.0 micron band, enabling both the OS3707 and OS3708 spectrum instruments to take readings. The accuracy of the reading, however, will be affected. Attenuation of energy by a window may be compensated for by using the emissivity control. If, for example, the target has an emissivity of 0.5, and the window has a transmission of 90% (0.9), the emissivity control can be set for 0.5 x 0.9 = 0.45.

Should it be necessary for certain processes such as vacuum chambers or furnaces to have a window, Table 6-1 suggests some materials that may be used for different spectral bands.

Long wavelength infrared used for the 8-14 micron spectrum units does not pass through most visible windows without significant energy and spectral effects. These units may look through thin polyethylene plastic films, 1-3 mils thick. Materials such as KRS-5 and ZnSe will transmit both visible and long wavelength IR, and may be necessary in certain applications. Table 6-1 shows a table of window materials and the OS3700 models that may be used with each. Consult OMEGA if you need specific information.

TABLE 6-1
TABLE OF WINDOW MATERIALS

MATERIAL	CONSISTENT WITH SPECTRAL RESPONSE CODE
Pyrex	OS3707, 3708
Quartz	OS3707, 3708, 3721, 3722
Sapphire	OS3704, 3706, 3721, 3722
Calcium Fluoride	OS3706, 3703
Coated Zinc Selenide	OS3701

6.3 REFLECTIONS

A reflective object will emit its own infrared radiation, as well as reflect any IR sources that surround it. Should there be bright lights or radiant heaters surrounding a reflective target, the OS3700 will read the total radiation. Errors in the reading can occur if the user does not take care to avoid these effects. Readings taken out of doors in bright sunlight will cause large errors in the OS3707, OS3708, and OS3709 models. Incandescent and fluorescent lights indoors will generate errors on the model at lower temperatures (250 to 400°C).

6.4 FIELD OF VIEW

The specified Field of View of the OS3700 occurs when the lens is focused for the object distance. The Field of View is specified to collect 98% of the target energy at the rated distance and target size.

For example, the OS3708 model is rated as 180:1. This means that the **minimum** target size can be the sensor-to-target distance divided by 180. So at 0.75 meter (29.5 in.) for example, the **minimum** target size would be 0.75/180 or .0042 meter (0.42 cm or 0.164 in.). The beam must have an unobstructed view of the target to get accurate measurements.

If the target is cooler than the background, be certain that it is larger than the minimum diameter. It is possible for energy from a very hot background to contribute significant stray radiation.

6.5 AMBIENT EFFECTS

The components in an infrared thermometer are designed to operate over a temperature of 0 to 50°C. The detector sensitivity is a function of temperature, and is compensated. Instruments which measure within the ambient temperature range (8-14 microns spectra) are also affected by secondary effects such as the lens and instrument temperature. Although the instrument is compensated, rapid changes in its ambient temperature will introduce errors. Ambient changes should not exceed 3°C per minute for the OS3701 and OS3703 versions.

6.6 DISTANCE EFFECTS

The OS3700 should be focused for the operating distance to insure accurate measurements. If the OS3700 is used at closer distances than it is focused for, the reading may be slightly higher than the actual temperature. Conversely, if the OS3700 is used at a distance that is longer than that for which it is focused, the reading may be slightly lower that the actual temperature.

SECTION 7 MAINTENANCE

GENERAL NOTE: Care should be taken to prevent liquids from coming into contact with the OS3700, as with all electrical equipment. The OS3700 should also be protected from extremes of temperature. Due to the critical optical alignment, the OS3700 should also be protected from heavy shocks.

7.1 CLEANING THE OPTICS

The lens of the OS3700 must be kept free from dust, fingerprints, and other obstructions, or the accuracy may be affected. The dust cap provided should be used when the unit is not in use. The lens may be cleaned with alcohol or optical cleaning solution, and optical tissue. Dry tissue should not be used, as this will scratch the lens coating.

7.2 CLEANING THE HOUSING

The housing of the OS3700 is plastic, and as such, should never be cleaned with acetone or other harmful cleaning agents. Safe cleaning of the housing may be done with alcohol or a damp, soapy cloth.

7.3 CHANGING THE BATTERIES

The six rechargeable, type AA batteries used in the OS3700 have a life of approximately 1000 recharge cycles, after which they will need to be replaced. To replace the batteries, loosen the two screws in the battery door on the front of the OS3700 (see Figure 7-1).

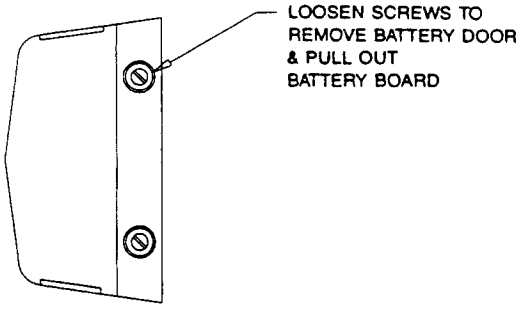


Figure 7-1. Battery Door

Carefully slide out the battery holder by pulling on the pull-tab. Lift out the old batteries, and install new rechargeable batteries according to the polarities marked on the holder. Slide the battery holder back in, and replace the door (see Figure 7-2).

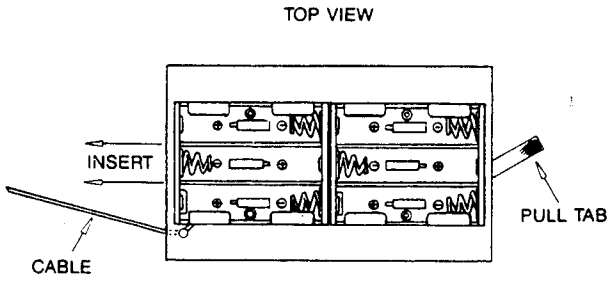


Figure 7-2. Battery Holder

7.4 CHARGING THE BATTERIES

The OS3700 batteries charge automatically when the 12 volt power supply is plugged in, even if the OS3700 is operating. The batteries should, however, be allowed to fully discharge before recharging, as overcharging NiCad batteries rapidly deteriorates their charge-retention qualities.

7.5 CHECKING CALIBRATION

To check the calibration of the OS3700, a blackbody calibration source should be used. The following steps should then be taken:

1. Mount the OS3700 on a tripod to ensure proper alignment (aiming by hand may alter the results).
2. Allow the instrument to stabilize for 1/2 hour (no substantial ambient changes).
3. Set the emissivity on the OS3700 to 1.00.
4. Aim the OS3700 at a target which is at least twice the size of the minimum target (figured from field of view), at a distance of 1.5 meters. The source should have an emissivity of almost unity (use flat black paint on the target if necessary). The source temperature should be the low temperature given in Table 7-1 for your OS3700 model. Check that the OS3700's reading matches the source temperature, within the defined accuracy specification.

5. Aim the OS3700 at the next higher temperature from the table. When the source is stable, check to see that the OS3700's reading matches the source temperature. If the table suggests an additional test temperature, repeat step 5 for the new temperature.

TABLE 7-1
CALIBRATION TEST TEMPERATURES

MODEL	SOURCE TEMPERATURE (°C)		
OS3708	780	1260	1700
OS3707	375	695	1060
OS3701	100	580	
OS3709	1100	1500	2000
OS3703	200	300	
OS3704	400	1020	
OS3706	500	1060	
OS3721	900	1500	
OS3722	1100	1500	

If after checking calibration, it is determined that the unit is out of calibration, it will have to be returned to OMEGA for recalibration.

SECTION 8 TROUBLESHOOTING

SYMPTOM	SOLUTION
Unit does not turn on / Low battery indicator displayed	Charge batteries or use unit with charger plugged in.
Batteries do not hold charge	Replace rechargeable batteries.
Some segments of either digital readout do not come on	Return to OMEGA.
Reads low	Check emissivity value. Check target distance. Check minimum target size. Check that lens is clean
Reads high	Check emissivity value. Check target distance. Check for stray radiation nearby. Check background temperature.
Reticle image not sharp	Adjust eye piece. (See Section 5.5)
Digital output not working	Read set-up procedures, and Sections 5.8, 5.9. Check cabling scheme.
Display shows "EEEE" in AVE, PEAK, or VALLEY modes.	Not enough data, or invalid data in register(s).

TROUBLESHOOTING (Continued)

Display shows "LO"	Target temperature below beginning of temperature range for that OS3700 model. Check target emissivity. Check target distance. Check minimum target size.
Display shows "HI"	Target temperature above end of temperature range. Check target distance. Check emissivity value. Check for stray radiation. Check background temperature.

SECTION 9 SPECIFICATIONS

9.1 GENERAL SPECIFICATIONS

FOCUSING:	21" to 7.5"
VIEWFINDER:	9° sighting, eye piece adjustable, illuminated temperature display in viewfinder
OPERATING MODES:	Run, Peak, Valley, Average, Hold
RESOLUTION:	1° for all models
EMISSIVITY RANGE:	0.1 to 1.00 in 0.01 steps, digitally set
RESPONSE TIME:	2 readings per second; 1 per second on some units
DIGITAL OUTPUT:	RS-232, 2400 baud, to printer or computer, mini DIN connector
ANALOG OUTPUT:	1 mv/°C, 1 mv/°F or 0-1 volt, externally selectable, 1/8 in. phone plug, output impedance 100 ohms
AMBIENT OPERATING TEMPERATURE:	32 to 122°F (0 to 50°C) 0 to 90% RH non-condensing
STORAGE TEMPERATURE:	-5 to 150°F (-20 to 65°C)
BATTERY TYPE:	Rechargeable Ni-Cad, type AA 12 Vdc at 200 mA
BATTERY CHARGE LIFE:	8 to 16 hours, depending on model
WEIGHT:	2.5 lbs (1.1 kg) with lens and batteries
MOUNTING:	Built-in tripod socket 1/4-20 tapped hole

OS3700-DL DATALOGGER SPECIFICATIONS

MEMORY CAPACITY:	5200 readings, temperature °C/°F, date, time, battery condition
DISPLAY:	2-line LCD, 16 alphanumeric characters
SAMPLING INTERVAL:	Continuous to 999 seconds in 1 second intervals
LOG MODE:	Manual or Automatic. In Manual mode, data is logged only when the Read button is pressed
SOFTWARE:	Supplied for IBM PC or compatible (data file compatible with Lotus 1-2-3®)
INPUT:	RS-232C from OS3700 unit
OUTPUT:	RS-232C to computer (3.5' cable supplied)
BATTERY TYPE:	Four rechargeable NiCad AA, 8 continuous hours life (included)
BATTERY CHARGER:	115 VAC input, 12 VDC output at 200 mA
OPERATING TEMPERATURE:	0.14 to 140°F (-10 to 60°C)
DIMENSIONS:	7.1"H x 3.9"W x 1.4"D (180 x 100 x 35 mm)

OS3700-PRT PRINTER

PAPER:	2.25" (70mm) wide
MECHANISM:	Impact dot matrix
INPUT:	RS-232, 2400 baud, Clear to Send (CTS) from OS3700
FORMAT:	24 column (measurement mode and temperature)

OS3700-PRT SPECIFICATIONS (Cont'd)

CONTROL:	Off/On/Paper Feed
OPERATING TEMPERATURE:	32 to 122°F (0 to 50°C)
POWER:	115 VAC converter supplied, 8 VAC output
DIMENSIONS:	4.5"H x 4"W x 2"D (114 x 100 x 51 mm)
WEIGHT:	1 lb (450 g)

9.2 STANDARD ACCESSORIES

PART NO.	DESCRIPTION
OS3700-DL	Digital datalogger (110 VAC)
OS3700-PRT	Digital printer (110 VAC)
OS3700-PRT-RP	Five rolls replacement printer paper
OS3700-CF1*	Close focus lens attachment for working distance of 21" to 14"
OS3700-CF2*	Close focus lens attachment for working distance of 13" to 8.5"

*May be used only with OS3707, OS3708, OS3709, OS3721, and OS3722. When both close focus attachments are used together, working distance is 9.5 to 7.5 inches.

9.3 DIGITAL INTERFACE SPECIFICATIONS

The OS3700 is capable of generating a 2400 Baud, RS-232 signal. The format is one start bit, eight data bits and two stop bits.

The data may be transmitted in the printer mode (P), in which case the ASCII code will be printed as transmitted, and formatted for the printer.

In the datalogging mode (L), the data is coded for storage by the program supplied with the OS3700. The program operates on MS-DOS compatible computers. The format of the data is:

,S D4 D3 D2 D1 X B

Where: X = C for °C, F for °F
S = - for Negative, Space for Positive
DP = Decimal Point or Space
B = B for Low Battery, Space for Batt.

Under range	,L L L L L L L
Over range	,H H H H H H H
Invalid Data	,D D D D D D D

The Serial Interface Cable supplied with this instrument is a 5-pin mini-DIN connector, 10 foot long coil cord, terminated in a 25-pin female D connector, and is configured to be RS-232C compatible. Wiring is as follows:

Color	DB-25F pin	Signal Name	Direction
Shield	Shell	Shield	
Blue	1	Protective Ground	Common
Red	2	Transmit Data	To OS3700
Brown	3	Receive Data	From OS3700
Yellow	7	Signal Ground	Common
Orange	20	Data Term Ready	To OS3700 *

DTR is used in printer mode only. Transmit Data is not currently in use.

APPENDIX A TEMPERATURE ERRORS CAUSED BY A 1% EMISSIVITY ERROR

The magnitude of temperature error created by a given emissivity uncertainty depends on the spectral range of the infrared thermometer, and the temperature of the target. The error table shows temperature errors caused by a 1% emissivity error, for different spectral bands at different target temperatures. The error is given in degrees Celsius.

OS-	3709	3722	3708 3721 3707	3706	3704	3703	3701 3702
SPECTRAL RESPONSE (µm)	0.65	0.78 to 1.06	1.0 to 1.6	3.86	4.8 to 5.2	7.9	8 to 14
TARGET TEMP. (°C)				ERRORS (°C)			
-50.0						1.8	1.3
-40.0						1.3	1.0
-30.0						1.0	0.8
-20.0						0.7	0.6
-10.0						0.5	0.4
0.0						0.3	0.3
10.0						0.2	0.2
20.0						0.0	0.0
30.0						0.0	0.0
40.0				0.1	0.1	0.1	0.1
50.0				0.2	0.2	0.2	0.2
60.0				0.2	0.2	0.3	0.3
70.0				0.3	0.3	0.4	0.4
80.0				0.3	0.3	0.4	0.5
90.0				0.3	0.4	0.5	0.5
100.0			0.9	0.3	0.4	0.5	0.6
120.0			0.2	0.4	0.5	0.6	0.7
140.0			0.2	0.4	0.5	0.8	0.9
160.0			0.2	0.5	0.6	0.9	1.0
180.0			0.2	0.5	0.7	1.0	1.1
200.0			0.2	0.6	0.8	1.1	1.2
220.0			0.3	0.7	0.8	1.2	1.4
240.0			0.3	0.7	0.9	1.3	1.5
260.0			0.3	0.8	1.0	1.4	1.6
280.0			0.3	0.8	1.0	1.5	1.8
300.0			0.3	0.9	1.1	1.6	1.9
320.0			0.4	0.9	1.2	1.8	2.0
340.0			0.4	1.0	1.3	1.9	2.2
360.0			0.4	1.1	1.4	2.0	2.3
380.0			0.4	1.1	1.4	2.1	2.4
400.0		0.3	0.5	1.2	1.5	2.2	2.6
420.0		0.3	0.5	1.3	1.6	2.4	2.7
440.0		0.4	0.5	1.4	1.7	2.5	2.9
460.0		0.4	0.5	1.4	1.8	2.6	3.0
480.0		0.4	0.6	1.5	1.9	2.8	3.2

TEMPERATURE ERRORS CAUSED BY 1% EMISSIVITY ERROR

OS-	3709	3708 3721 3722	3707	3706	3704	3703	3701 3702
SPECTRAL RESPONSE (μm)	0.65	0.78 to 1.06	1.0 to 1.6	3.86	4.8 to 5.2	7.9	8 to 14
500.0		0.4	0.6	1.6	2.0	2.9	3.3
550.0		0.5	0.7	1.8	2.3	3.2	3.7
600.0		0.5	0.8	2.0	2.5	3.6	4.1
650.0		0.6	0.8	2.3	2.8	4.0	4.5
700.0		0.6	0.9	2.5	3.1	4.3	4.9
750.0		0.7	1.0	2.8	3.4	4.7	5.3
800.0	0.5	0.8	1.1	3.0	3.7	5.1	5.7
850.0	0.6	0.8	1.2	3.3	4.0	5.5	6.1
900.0	0.6	0.9	1.3	3.5	4.3	5.9	6.5
950.0	0.7	1.0	1.4	3.8	4.7	6.3	6.9
1000.0	0.7	1.1	1.5	4.1	5.0	6.7	7.4
1100.0	0.9	1.3	1.8	4.7	5.7	7.5	8.2
1200.0	1.0	1.4	2.0	5.4	6.4	8.4	9.1
1300.0	1.1	1.6	2.3	6.0	7.2	9.2	10.0
1400.0	1.3	1.8	2.6	6.7	7.9	10.1	10.9
1500.0	1.4	2.0	2.8	7.4	8.7	11.0	11.9
1600.0	1.6	2.3	3.1	8.1	9.5	11.9	12.7
1700.0	1.8	2.5	3.5	8.9	10.3	12.8	13.7
1800.0	1.9	2.8	3.8	9.6	11.1	13.7	14.6
1900.0	2.1	3.0	4.2	10.4	12.0	14.6	15.5
2000.0	2.3	3.3	4.5	11.2	12.8	15.5	16.5
2100.0	2.5	3.6	4.9	12.0	13.6	16.4	17.4
2200.0	2.8	3.9	5.3	12.7	14.5	17.3	18.3
2300.0	3.0	4.2	5.7	13.6	15.3	18.3	19.3
2400.0	3.2	4.5	6.1	14.4	16.2	19.2	20.3
2500.0	3.5	4.9	6.6	15.2	17.1	20.2	21.2
2600.0	3.7	5.2	7.0	16.1	18.0	21.1	22.2
2700.0	4.0	5.6	7.5	16.9	18.9	22.1	23.1
2800.0	4.2	5.9	8.0	17.8	19.8	23.0	24.1
2900.0	4.5	6.3	8.4	18.6	20.7	24.0	25.1
3000.0	4.8	6.7	8.9	19.5	21.6	24.9	26.0

TEMPERATURE ERROR IN 2-COLOR MODELS

(When emissivity of one wavelength is 1% different from the other wavelength)

TEMPERATURE (°F)	ERROR (°F)
1300	16
1500	19
1700	23
1900	27
2100	32
2300	39
2500	46
3000	135
3500	177
4000	225
5000	349
6000	490

APPENDIX B OS3700 LOGGING SOFTWARE INSTRUCTIONS

SOFTWARE INSTALLATION:

Software must be installed on an IBM computer or an IBM compatible.

Turn the computer on and boot as usual.

Hard Disk Operation
Make a backup copy of the distribution disk, and store the original in a safe place. Refer to DOS DISKCOPY command in the DOS Reference Manual for more on this operation.

We will assume the hard disk is called C:

Create a subdirectory on C: called \OS3700, and move into it.

md\OS3700 <ENTER>
cd\OS3700 <ENTER>

Insert the distribution disk in drive A: and copy the contents of the disk to the new directory.

copy a:*.* c: <ENTER>

To run the program, type:

OS3700 <ENTER>

Floppy Disk Operation
Make a working copy of the distribution disk and store the original in a safe place. Refer to DOS DISKCOPY command in the DOS reference manual for more on this operation.

HARDWARE INSTALLATION

Make sure the OS3700 is in Logger Mode LL, before using the communication software. See Set-Up procedure in Section 4.

Connect the round end of the Serial Interface Cable to the OS3700 Digital Output. Connect the modular plug end of the Serial Interface Cable to the RJ-11 to DB-25 adapter. Connect the adapter to the serial port (COM:1) of IBM PC, XT, or compatible computer. If you are using an IBM AT or other computer which uses a DB-9 connector for its serial port, you must use an adapter cable to remap the DB-9 pins into the standard DB-25 configuration. One such cable is available from IBM or from local computer dealers. Apply power to the OS3700 using batteries or the AC adapter.

SOFTWARE OPERATION

To start the program, type:
OS3700 <ENTER>

DISPLAY:

LOGGING STATUS may be either ON or OFF. Logging only takes place when the logging status is ON. When LOGGING is turned OFF again, the log file will be stored.

LOG FILE NAME is the name of the current file to which data is logged. When LOGGING is turned on, the log file will be opened (or appended) and logging will begin. Although logging is normally done to a disk file, it is possible to log data to a parallel printer by setting the log file name to LPT1:. This refers to the first parallel printer interface on the computer.
NOTE: If data is logged to the printer, it will not be stored on the disk.

APPEND refers to a Yes or No flag associated with the current log file. If the Append flag is Y, new data is added (appended) to the end of the current log file. If Append flag is N, then any file with the same name as the current log file is overwritten when logging begins.
NOTE: All data in the current FILENAME will be lost if logging takes place with the APPEND option set to N.

INTERVAL refers to the time interval between measurements, in seconds.

LOG FORMAT is the current specification of the output format. See definition of output format.

TEMPERATURE shows the current temperature reading being measured with the OS3700.

COMMAND KEYS:

L - Data LOGGING (ON/OFF)

To start or stop logging temperature data, use the L command key. If logging is off and the L key is pressed, the computer will ask for the ambient temperature and the current emissivity setting.

NOTE: The ambient temperature and emissivity settings entered should be as accurate as possible so errors will not be introduced if the emissivity is changed with the OS3700 software.

Once these two items are entered, the program will begin logging data. If logging is on and the L key is pressed, the program will stop logging, and store the log file. When LOGGING is ON, data is saved at the current time INTERVAL, and to the current FILE NAME.

F - Enter LOG NAME (5 or more characters)

To change the name of the current log file, use the F command key. A window will appear on the screen, prompting for a new file name.

NOTE: The log file name must be more than five (5) characters long.

Once the file name is set, subsequent logging is done to that file. The log file name cannot be changed while logging is on; you must first discontinue logging, change the file name, and then resume logging to the new file.

V - View/List LOG FILE

When the V key is pressed, the screen will change from the main menu screen to a blank screen. The computer will ask if you wish to view (V) or list (L) files. The view option allows you to see the data in any log file. If the V key is pressed, the computer will ask if you wish to view the current FILE NAME from the main menu. If you do, press Y for 'yes'. If you wish to view a different file, press N for 'no' and the computer will ask for a new file name. The List option lists the names of all the files in the OS3700 directory.

A - Set APPEND option (Y/N)

To change the APPEND setting of the current log file, use the A command key. A window will appear on the screen, prompting for a new value. The APPEND status flag determines what the computer will do when logging begins and a file with the same name as the current log file already exists. If APPEND is N, the old file is overwritten. The old data is destroyed, and a new empty file is created to take its place. Logging then starts over. If APPEND is Y, the old file is appended. The old data is retained, and new log data is added to the data already in the file. The APPEND flag cannot be changed while logging is on. You must first discontinue logging, change the APPEND setting, and then resume logging.

I - Set Measurement INTERVAL

To change the measurement INTERVAL, use the I command key. A window will appear, prompting for the new value. While LOGGING is ON, the computer records temperature measurements periodically. The INTERVAL between measurements is adjustable from 1 to 32,768 seconds. The INTERVAL may be changed while logging is on.

O - Set LOG FORMAT

To change the current output format, use the O command key. A dialogue box will appear on the screen, prompting for the new output format. By setting the output format, you choose what data to log, the sequence of the items, and how it should be punctuated. See Definition of Output Format.

DEFINITION OF OUTPUT FORMAT

It is very important that the data being logged is in a convenient format for what you are doing. If you want to import data to LOTUS 1-2-3 or another spreadsheet program to create graphs, you need a simple data format. If you have other applications, you may want a more elaborate data format. The output format is highly flexible. Choose the data items you need from the available list. Select the order in which you want them to appear, then insert spaces and other punctuation to make the output more readable.

The output format is composed from this list of data items:

Data Items

N - Measurement sequence NUMBER. A counter starts at 1, and is incremented by 1 for each measurement that is logged.

H - HOUR (Time of day). The time the measurement is taken, given in 24 hour notation, HH:MM:SS.

M - MEASUREMENT. The temperature reading for the current measurement.

U - UNIT (Degrees). Either °F or °C, depending on how the OS3700 is set.

D - DATE. Date the measurement is taken, given in MM/DD/YY notation.

T - TIME Elapsed. The number of seconds since the logging was started.

F - FLAGS. There are 4 flags used to indicate unusual conditions with the OS3700. They are BLHD. B: Low Battery, L: Under Range, H: Over Range, D: Data Invalid. If the condition is true, the corresponding letter appears in the output, otherwise, that position is blank. For example, "BL" means low battery and under range. Normally all 4 positions are blank.

E - EMISSIVITY. The current emissivity setting on the computer. See E command key.

C - COMMENT. Real-time comments entered while logging is on are placed at this position. See C command key. NOTE: If C is not present in the output format, no real-time comments will appear in the log, even if they are entered.

The capital letters N, H, M, U, D, T, F, E, and C are replaced with the corresponding data items they represent.

Any other characters in the output format, including a blank space and all lower case letters, are interpreted literally, and can be used to punctuate the data in the file.

The output format is formed by combining selected data items, in any order, with other characters for spacing and punctuation.

C - Enter COMMENT in Real Time

To enter a real-time comment, use the C command key. A window will appear on the screen, prompting for the comment. While logging is on, comments may be added to the logging output. Using comments to annotate the log file can be useful to indicate events occurring during a process or experiment. For example, "Fan #2 turned on" or "Pressure now 100 psi".

E - Change EMISSIVITY

This feature allows you to recalculate logged data for different emissivity values. This is helpful if you determine that your process emissivity is different than the emissivity setting on the OS3700, or if you want to see what the readings would be if the emissivity changed. This feature is also useful if the OS3700 is in a remote or inaccessible location and the targets have a variety of emissivities. The OS3700 can be set to one emissivity setting (e.g. -0.98) and the data corrected for the emissivity of each target material.

To change the emissivity setting of a logged file, press the E key. The screen will change from the main menu to a blank screen. The computer will ask for the OS3700 model type, the log file name (called the source file), the temperature unit (°C or °F), the ambient temperature of the OS3700 at the time of logging, the original emissivity setting, the new emissivity setting, and the name of the file to store the converted data.

The ambient temperature and the emissivity setting at the time of logging may be found by viewing the source file. They will be located in the header of the file.

The new data based on the new emissivity setting may be reviewed by viewing or printing the file that you entered as the storage file.

NOTE: Files used to store converted data will not retain the output format that was used to originally log the data. Real-time comments and other options of the LOG FORMAT will not be found in the storage file. They will remain in the source file, provided that the new emissivity data is not saved to the source FILE NAME, but is written to a new file name (by specifying a different name for the storage file than the source file name).

P - PRINT Log File

Pressing P allows you to get a printout of your log file. The screen will go blank and the computer will ask if you want to print out the current LOG FILE NAME that is on the main menu. Press Y for 'yes' or N to print a different log file name. If you press N, the computer will ask for the name of the log file to print.

APPENDIX C TABLE OF EMISSIVITY OF VARIOUS SURFACES

Emissivity is a modifying factor used in single color thermometry to achieve a correct temperature reading. Emissivity, or radiating efficiency, of most materials is a function of surface condition, temperature, and wavelength of measurement.

Values for the total emissivity of various surfaces, as well as spectral emissivity at a given temperature, have been tabulated and are shown on the following pages. Total emissivity is defined as the resultant value when the individual emissivity factors are averaged over the total radiation spectrum being utilized.

For a particular application, a different emissivity setting than the one tabulated may be required. These tables, however, will provide the best initial setting. A more refined value should be determined experimentally.

References:

1) Handbook of Chemistry and Physics, Chemical Rubber Publishing Co., Cleveland, Ohio.

2) DMIC Report 177, Battelle Memorial Institute

3) Thermal Radiation Properties Survey, Honeywell Research Center 1960

*When range of values for temperature and emissivity are given, end points correspond and linear interpolation of emissivity is acceptable.

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Alloys		
20 Ni-25Cr-55Fe, oxidized	200	0.90
	500	0.97
60 Ni-12Cr – 28Fe, oxidized	270	0.89
	560	0.82
80 Ni-20Cr, oxidized	100	0.87
	600	0.87
	1300	0.89
Aluminum		
Polished	100	0.095
Highly Polished	50-500	0.04-0.06
Unoxidized	25	0.022
	100	0.028
	500	0.060
Oxidized	200	0.11
	600	0.19
Commercial Sheet	100	0.090
Anodized Sheet, Chromic Acid Proc	100	0.55
Heavily Oxidized	93-504	0.2-0.31
Aluminum Oxide	500-827	0.42-0.26
Asbestos		
Board	20	0.96
Cement	0-200	0.96
Cloth	93	0.90
Paper	0-100	0.95
Asphalt	Ambient	0.90-0.98
Oil, on polished metal		
.001" Thick	Ambient	0.27
.002" Thick	Ambient	0.46
.005" Thick	Ambient	0.72
Bismuth, Unoxidized	25	0.048
	100	0.061
Brass		
Polished	200	0.03
Unoxidized	25	0.035
	100	0.039
Oxidized	200	0.61
	600	0.59
Rolled Sheet	20	0.06
Brick		
Building	1000	0.450
Red, rough, no gross irregularities	20	0.930
Grog Brick, glazed	1100	0.750
Silica Brick	1000	0.80
	1100	0.85
Fire Brick	1000	0.750

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Bronze, Polished	50	0.10
Carbon		
Filament	1000-1400	0.53
Graphite	0-3600	0.70-0.80
Lamp Black, water glass coating	20-400	0.96
Soot applied to solid	50-1000	0.96
Soot with water glass	20-200	0.96
Candle Soot	97-271	0.952
Graphite, pressed, filed surface	250-510	0.980
Unoxidized	25	0.81
	100	0.81
	500	0.81
Carborundum 87SiC; 2.3 density	1010-1400	0.920-0.820
Ceramic		
Earthenware	20	0.90
Porcelain, Glazed	20	0.92
Refractory Black	93	0.94
Refractory White	93	0.90
Chromium		
Polished	50	0.10
	500-1000	0.28-0.38
Unoxidized	100	0.08
Oxidized	316	0.08
	482	0.18
	650	0.27
	816	0.36
	982	0.66
Cobalt, Unoxidized	500	0.13
	1000	0.23
Columbium		
Polished	1500	0.19
	2000	0.24
Oxidized	816	0.73
	927	0.70
Concrete	0-100	0.94
Concrete Tiles	1000	0.630

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Copper		
Commercial, Scoured to a shine	20	0.07
Calorized	100	0.26
Calorized, oxidized	200	0.18
	600	0.19
Plate, heated long time, covered with thick oxide layer	25	0.78
Plate, heated at 600°C	200-600	0.570
Cuprous Oxide	800-1100	0.66-0.54
Polished	50-100	0.02-.05
Oxidized	50	0.6-0.7
	200	0.60
	500	0.88
Unoxidized	100	0.02
	Liquid	0.15
Dow Metal	232-400	0.24-0.20
Enamel, White, fused on Iron	19	0.900
Glass		
Smooth	0-200	0.95
	250-1000	0.87-0.72
	1100-1500	0.70-0.67
Fused Quartz	320	0.75
Covex D Glass	320	0.76
Nonex Glass	320	0.82
Pyrex	0-300	0.90
Gold		
Pure, highly polished	100	0.02
Carefully Polished	200-600	0.02-0.03
Unoxidized	100	0.02
	500	0.03
Enamel	100	0.37
Graphite	0-3600	0.70-0.80
Gypsum 0.02" thick on smooth or blackened plate	20	0.93
Human Skin	36-7-37.2	0.985
Inconel		
Type X		0.550-0.780
Type B	450-1620	0.350-0.550

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Iron		
Cast		
Oxidized	200-600	0.64-0.78
Strongly Oxidized	40	0.95
	250	0.95
Unoxidized	100	0.21
Polished	200	0.210
Newly Turned	22	0.440
Turned and Heated	882-990	0.600-0.700
Liquid Unoxidized	–	0.29
Rusted	25	0.65
Wrought, Dull	100	0.50
Wrought Iron, dull oxidized	21-360	0.940
Wrought, highly polished	38-250	0.280
Oxidized	100	0.74
	500	0.84
Unoxidized	1200	0.89
Plate, pickled, then rusted red	20	0.610
Plate, completely rusted	19	0.690
Smooth oxidized eletrolytic iron	127-527	0.780-0.820
Iron Oxide	500-1200	0.85-0.89
Rough-ingot iron	927-1116	0.870-0.950
Cast Plate, oxidized, smooth	23	0.8
Cast Plate, oxidized, rough	23	0.82
Molten Pure Iron	1516-1771	0.420-0.450
Molten Armco Iron	1521-1689	0.400-0.410
Lead		
Pure (99.96%) Unoxidized	127-227	0.057-0.075
Oxidized	200	0.63
Oxidized, Gray	24	0.280
Magnesium		
Magnesium Oxide	227-826	0.550-0.200
Magnesium Oxide	900-1704	0.200
Magnesite		
Refractory Brick	1000	0.380

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Marble, Light Grey Polished	0-100	0.903
Mercury, Unoxidized	0	0.09
	25	0.10
	100	0.12
Molybdenum		
Polished	538	0.05
	1482	0.17
Oxidized	538	0.82
Unoxidized	1000	0.13
	1500	0.19
	2000	0.24
Filament	827-2593	0.096-0.202
Monel Metal, Oxidized	200	0.43
	600	0.43
Nichrome Wire		
Clean	50	0.65
	500-1000	0.71-0.79
Oxidized	50-500	0.95-0.98
Nickel		
Polished	low	0.12
	1204	0.32
Oxidized	200	0.37
	871	0.85
	1200	0.85
Unoxidized	25	0.045
	100	0.06
	500	0.12
	1000	0.19
Electroplated, Polished	23	0.045
Electroplated, not Polished	20	0.110
Wire	187-1007	0.096-0.186
Plate, oxidized by heating at 600°C	200-600	0370-0.480
Nickel Oxide	650-1254	0.590-0.860
Chromnickel	52-1034	0.640-0.760
Nickel-Silver Polished	100	0.135
Oak, Planed	21	0.900
Oil Layers on Aluminum Foil		
(Linseed Oil)	100	0.087
Aluminum Foil	100	o.561-0.574
+ 1, 2 coats oil		

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Paint, Lacquers, Varnishes		
Alum. Paint	0-100	0.55
Bronze Paint	0-100	0.80
Black Glass Paint	0-100	0.90
White Lacquer	0-100	0.95
Green Paint	0-100	0.95
Gray Paint	0-100	0.95
Lamp Black	0-100	0.95
Gold Enamel	0-100	0.37
Snow White Enamel varnish on rough iron plate	23	0.906
Black Shiny Lacquer, sprayed on iron	24	0.875
Black Shiny shellac on tinned iron sheet	21	0.821
Black Matte shellac	77-146	0.910
Black on White Lacquer	38-93	0.800-0.950
Flat Black Lacquer	38-93	0.960-0.980
Oil Paints, 16 diff. (all colors)	100	0.920-0.960
Aluminum Paints & Lacquers		
10% Al 22% lacquer body, on rough or smooth surface	100	0.520
Other Al paints, varying age and Al content	100	0.270-0.670
Al Lacquer, Varnish binder on rough plate	21	0.390
Al Paint after heating to 326°C	150-316	0.350
Radiator Paint: White, Cream, Bleach	100	0.790, 0.770, 0.840
Radiator Paint, bronze	100	0.510
Lacquer coatings, 0.001-0.015" thick on Alum. alloys	38-150	0.870-0.970
3M Nextel101-C10	0-300	*.98
Clear Silicone Vehicle Coating 0.001-0.150" thick:		
On mild steels	260	0.660
On stainless steels 316, 301, 347	260	0.680, 0.750, 0.750
On Dow Metal	260	0.740
On Al Alloys 24ST, 75ST	260	0.770, 0.820

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Aluminum Paint with silicone vehicle paint on Inconel	260	0.290
Dull Black Varnish	40-100	0.80-0.95
Glossy Black Varnish sprayed on iron	20	0.87
	40	0.96-0.98
Paper, Any Color	0-100	0.94
Thin pasted on Tinned or Blackened Plate	19	0.920-0.940
Plaster	0-200	0.91
Plastics, Opaque, any color	25	0.950
Platinum		
Cleaned Polished	200-600	0.05-0.10
Filament	27-1227	0.036-0.192
Unoxidized	25	0.037
	100	0.047
	500	0.096
	1000	0.152
	1500	0.191
Wire	50-200	0.06-0.07
	500-1000	0.10-0.16
	1400	0.18
Propellant: liquid rocket engine	600-4500	0.900
Quartz		
Rough, fused	21	0.930
Glass, 1.98mm Thick	282-838	0.900-0.410
Glass, 6.88mm Thick	300-838	0.930-0.470
Opaque	300-838	0.920-0.680
Roofing Paper	21	0.910
Silica (98 Si O2, Fe-free) effect of grain size, microns		
10 microns	1010-1566	0.420-0.330
70-600 microns	1010-1566	0.620-0.460

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Silver		
Polished	100	0.052
Cleaned Polished	200-600	0.02-0.03
Unoxidized	100	0.02
	500	0.035
Stainless Steel 18-8		
Buffed	20	0.160
Polished	93	0.16
	371	0.19
Oxidized	93-371	0.83
Stainless Steel 303		
Oxidized	316	0.74
	1093	0.87
Stainless Steel 304 (8Cri 18 Ni) light silvery, rough brown, after heating	216-490	0.440-0.360
After 42 hours of heating at 527°C	216-527	0.620-0.730
Stainless Steel 310 (25Cr, 20Ni) Brown, splotched, oxidized from furna ce service	216-527	0.900-0.970
Stainless Steel		
Allegheny metal No. 4, polished	100	0.130
Alleghen y metal No. 66, polished	100	0.110
Steel		
Alloyed (8%Ni, 18%Cr)	500	0.35
Aluminized	50-500	0.79
Dull Nickel Plated	20	0.11
Flat, Rough Surface	50	0.95-0.98
Cast, Polished	750-1050	0.52-0.56
Calorized, Oxidized	200	0.52
	600	0.57
Sheet Steel, Ground	938-1100	0.550-0.610
Sheet Steel, Rolled	21	0.660
Sheet Steel, Strong, Rough Oxide Layer	24	0.800
Sheet with Shiny layer of oxide	20	0.82
Oxidized	25	0.80
	200	0.79
	600	0.79
Unoxidized	100	0.08

TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	* EMISSIVITY
Molten Steel	1500-1650	0.420-0.530
	1520-1650	0.430-0.40
Molten Mild Steel	1600-1800	0.280
Molten Steel, various with 0.25-1.2%C (slightly oxidized surfaces.)	1560-1710	0.270-0.390
Molten Steel, unoxidized	Liquid	0.280
Steel Plate, Rough	40	0.94
	400	0.97
	600	0.57
Tantalum		
Unoxidized	1500	0.21
	2000	0.26
Filament	1327-3000	0.190-0.310
Thorium Oxide	277-500	0.580-0.360
Tin		
Unoxidized	25	0.05
Commercial tin-plated sheet iron	100	0.070-0.080
Tungsten		
Filament, aged	27-3316	0.320-0.350
Filament	3316	0.390
Unoxidized	25	0.024
	100	0.032
	500	0.071
	1000	0.15
	1500	0.23
	2000	0.28
Turbojet Engine Operating	350-600	0.900
Water	Ambient	0.96
Wood		
Spruce, sanded	93	0.82
Oak, Planed	0-200	0.89
Zinc		
Highly Polished	200-300	0.04-0.05
Unoxidized	300	0.05
Oxidized by heating at 399°C	399	0.110
Galvanized Sheet Iron, fairly bright	28	0.230
Galvanized Sheet Iron, gray oxidized	24	0.280
Zinc, galvanized Sheet	100	0.210
Zirconium Silicate	238-500	0.920-0.800
	500-832	0.800-0.520

TABLE I

Spectral Emissivities of Materials, Surface Unoxidized

MATERIAL	EMISSIVITY AT .65 μ	
	Solid State	Liquid State
Beryllium	0.61	0.61
Carbon	0.80-0.93	
Chromium	0.34	0.39
Cobalt	0.36	0.37
Columbium	0.37	0.40
Copper	0.10	0.15
Erbium	0.55	0.38
Gold	0.14	0.22
Iridium	0.30	
Iron	0.35	0.37
Manganese	0.59	0.59
Molybdenum	0.37	0.40
Nickel	0.36	0.37
Palladium	0.33	0.37
Platinum	0.30	0.38
Rhodium	0.24	0.30
Silver	0.07	0.07
Tantalum	0.49	
Thorium	0.36	0.40
Titanium	0.63	0.65
Tungsten	0.43	
Uranium	0.54	0.34
Vanadium	0.35	0.32
Yttrium	0.35	0.35
Zirconium	0.32	0.30
Steel	0.35	0.37
Cast Iron	0.37	0.40
Constantan	0.35	
Monel	0.37	
Chromel P (90 Ni-10 Cr)	0.35	
80 Ni-20 Cr	0.35	
60 Ni-24 Fe-16 Cr	0.36	
Alumel (95 Ni; Bal. Al, Mn. Si)	0.37	
90 Pt-10 Rh	0.27	

TABLE II

Spectral Emissivities of Oxides

MATERIAL	EMISSIVITY AT .65 μ	
	Range of Observed Values	Probable Value of the Oxide Formed on Smooth Metal
Aluminum Oxide	0.22 to 0.40	0.30
Beryllium Oxide	0.07 to 0.37	0.35
Cerium Oxide	0.58 to 0.80	
Chromium Oxide	0.60 to 0.80	0.70
Cobalt Oxide	to	0.75
Columbium Oxide	0.55 to 0.71	0.70
Copper Oxide	0.60 to 0.80	0.70
Iron Oxide	0.63 to 0.98	0.70
Magnesium Oxide	0.10 to 0.43	0.20
Nickel Oxide	0.85 to 0.96	0.90
Thorium Oxide	0.20 to 0.57	0.50
Tin Oxide	0.32 to 0.60	
Titanium Oxide		0.50
Uranium Oxide		0.30
Vanadium Oxide		0.70
Yttrium Oxide		0.60
Zirconium Oxide	0.18 to 0.43	0.40
Alumel (oxidized)		0.87
Cast Iron (oxidized)		0.70
Chromel P (90 Ni-10 Cr) (oxidized)		0.87
80 Ni-20 Cr (oxidized)		0.90
60 Ni-24 Fe-16 Cr (oxidized)		0.83
55 Fe-37.5 Cr-7.5 Al (oxidized)		0.78
70 Fe-23 Dr-5 Al-2 Co (oxidized)		0.75
Constantan (55 Cu-45 Ni) (oxidized)		0.84
Carbon Steel (oxidized)		0.80
Stainless Steel (18-8) (oxidized)		0.85
Porcelain	.025 to 0.50	

TABLE III
Additional Emissivities at .65μ

Material		Temperature (°C)	Emittance	
			Polished surface	Coarse surface
Steel	Not oxidized	100-1200	0.35	0.35
	Lightly oxidized	100-1200	0.45	0.5
	Severely oxidized	100-1200	0.8-0.95	0.8-0.95
	Molten	1500	0.38	0.38
Copper	Not oxidized	100-1000	0.06	0.2
	Lightly oxidized	100-1000	0.4	0.5
	Severely oxidized	100-1000	0.8	0.8
	Molten	1080	0.15	0.15
Lead	Not oxidized	50-300	0.3	0.4
	Lightly oxidized	50-300	0.4	0.55
	Severely oxidized	50-300	0.6-0.7	0.6-0.7
	Molten	330		
Brick	White brick	1000	0.3	
	Sillimanite brick	1000	0.5-0.6	
	Silica brick	1000	0.45-0.75	

Material		Temperature (°C)	Emittance	
			Polished surface	Coarse surface
Zinc	Not oxidized	20-400	0.2	0.3
	Lightly oxidized	20-400	0.3	0.5
	Severely oxidized	20-400	0.6	0.6
Alumina		1500	0.2-0.4	
Aluminum	Not oxidized	25-600	0.05	0.25
	Lightly oxidized	25-600	0.2	0.3
	Severely oxidized	25-600	0.4	0.4
	Molten	660		
Gold	Not oxidized	100-1000	0.04	0.15
	Molten	1100		
Ceramic		100-1200	0.25	
		1500	0.3	
		1800	0.4	

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- 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
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pH/CONDUCTIVITY

- pH Electrodes, Testers & Accessories
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- Controllers, Calibrators, Simulators & Pumps
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