OS-88000-K-1200

Handheld Infrared Thermocouple

OMEGA®

An OMEGA Technologies Company

Operator's Manual
M1624/0793

TABLE OF CONTENTS

	Page
SECTION 1. INTRODUCTION	3
SECTION 2. UNPACKING	3
SECTION 3. EASY START OPERATION	4
SECTION 4. OPERATION	6
4.1 AECS REFLECTIVE CUP	6
4.2 HELPFUL HINTS	6
4.3 PRODUCTION PROCESSES and MOVING MATERIALS	7
4.4 BARE METAL AND TRANSPARENT SURFACES	8
4.5 METER-GENERATED CURRENT OFFSETS	9
SECTION 5. CUSTOM CALIBRATION	10
5.1 CALIBRATION PROCEDURE	10
5.2 CHECKING STEAM TRAPS	13
5.3 CHECKING INTEGRATED CIRCUIT COMPONENTS (IC'S)	14
SECTION 6. EMISSIVITY	14
SECTION 7. SPECIFICATIONS	16
APPENDIX	
BOILING WATER CALIBRATION CHECKING TECHNIQUE	
FACTORY CALIBRATION DATA TABLES AND GRAPHS	
CUSTOM CALIBRATION EXAMPLES	

SECTION 1. INTRODUCTION

The OS-88000-K-1200 Handheld Infrared Probe provides low cost, non-contact measurements from -60 F to 1200 F (-50 to 650 C) that are independent of emissivity over the range .8 to 1.0. As with thermocouples, a chart of either millivolt output or equivalent temperatures as read on a typical thermocouple meter is provided for the full temperature range.

In addition, a calibration adjustment screw allows shifting of the linear range to set the unit for correct point reading of temperatures between 0 and 1200 F (-18 and 650 C).

The handheld infrared probe is ideal for applications where:

- The object to be measured is moving.
- Contact will alter the object.
- Contact will compromise a sterile environment.
- A contact device will be inaccurate or too slow.
- A wide area must be monitored.

SECTION 2. UNPACKING

Remove the packing list and verify that you have received all equipment. 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 any 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 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.

SECTION 3. EASY START OPERATION

Using the OS-88000 with Factory Calibration

1. Plug the OS-88000 into a Type K thermocouple meter.

2. Turn the power "on".

3. Aim the probe at your hand, the table, etc. to make sure the probe is working.

The display on the meter should respond accordingly. The speed of the display will vary depending on the meter you plug the IR t/c probe into. The IR probe has an 80 msec response time, and is usually much faster than the meter.

4. Read the Display: "Actual vs. Indicated" Table

From 0° to 90°F (-20° to 32°C) you can read the temperature directly from the display of your meter.

(IMPORTANT NOTE: If your display readings in the room temperature range appear much too high, or too low, refer to Section 4.4, "METER-GENERATED CURRENT OFFSETS" before proceeding.)

Use the **FACTORY CALIBRATION DATA** look-up table or chart in the APPENDIX to obtain the correct temperatures for the full sensing range of the infrared thermocouple probe, up to 1200°F (650°C).

For example, if your meter INDICATES 278° F, the ACTUAL surface temperature is 212°F (if display INDICATES 137°C, the ACTUAL temperature is 100°C), and so on, as shown in the table.

Please note that accuracy specifications for the probe (±2%) are stated for ACTUAL surface temperature, not INDICATED.

5. Measure Temperature of coated metals, non-metals, non-transparent materials

(a) Bring the probe close to your target, (no more than 1/4" [6 mm] away), and aim it for a few seconds while looking at the meter display.

(b) For best results, you can actually touch the nosepiece of the probe flush to the surface for a few seconds. The display will quickly stabilize on the correct temperature, and will automatically compensate for emissivity variations.

(The nosepiece of the probe can touch surfaces up to the rated temperature measurement range, 1200°F (650°C), for **brief** periods of time with no harm to the probe. When touching high temperature surfaces for 3 seconds or longer, and then aiming at room temperature surfaces, the reading may be a few degrees too high for a short period of time. Wait a few minutes for the probe to cool down.)

(c) For target temperatures above 90°F, use the ACTUAL vs. INDICATED TABLE

6. Measure Temperature of shiny, uncoated metals or transparent surfaces

(a) Use the solid paint marker supplied to cover a 1/2 in (1.5 cm) minimum diameter on your target.
(b) Measure the temperature by aiming at, or touching, the mark.
(c) For temperatures above 90°F, use the ACTUAL vs. INDICATED TABLE.

SECTION 4. OPERATION

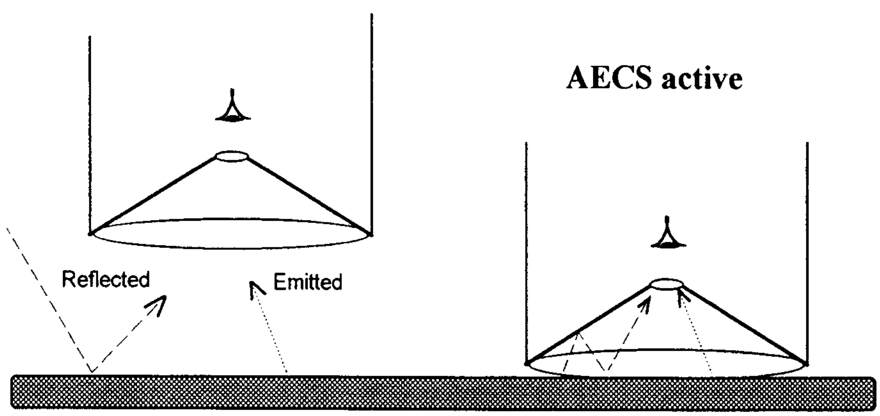
4.1 AECS REFLECTIVE CUP

The OS-88000 uses a patented method to eliminate errors due to emissivity variations in the range of 0.8 to 1.0. The reflective cup on the end of the probe automatically compensates for emissivity when it is touching, or brought to within approximately 1 mm of the surface. By excluding ambient radiation, and replacing it with reflections of emitted radiation, the emissivity is corrected, and accurate temperature indicated.

How AECS Works

No AECS

AECS active



When AECS is active ambient radiation is excluded, and replaced by reflections of emitted radiation

4.2 HELPFUL HINTS

- The OS-88000 probe will operate properly in any environment as long as the probe itself is within a comfortable temperature range. As a rule, if it feels comfortable in your hand (without gloves), it will operate properly. If the OS-88000 was stored in a cold or hot area, wait until it feels comfortable in your hand before using. Best results are obtained when the probe itself has been stored in a normal ambient temperature for 20 minutes.

- Some surfaces do not have to be touched. You can judge if you need to touch a particular surface by simply watching to see if the readings change as you move the probe nosepiece close to and briefly touch the surface. If the readings do not change significantly during the last .25 inches (6 mm) of movement before touching, that surface can be measured without touching under those conditions.

- Wet or Icy Surfaces. If a surface has visible ice or moisture on it, the OS-88000 will measure the temperature of the ice or moisture, not the surface it covers. To measure the surface, simply wipe off the moisture or scrape off the ice before measuring. For example, if you want the actual surface temperature of a cold pipe with visible condensation on it, wipe the spot and then measure.

- For best accuracy, keep the OS-88000 sensor "window" clean. The "window" inside the reflective cup of the OS-88000 is made of a special crystal that allows heat energy to pass through. Dirt, grease or moisture will reduce the amount of infrared energy allowed to pass through and will affect accuracy. Use alcohol and a cotton swab to keep both the window and the reflective cup clean. Let dry before using.

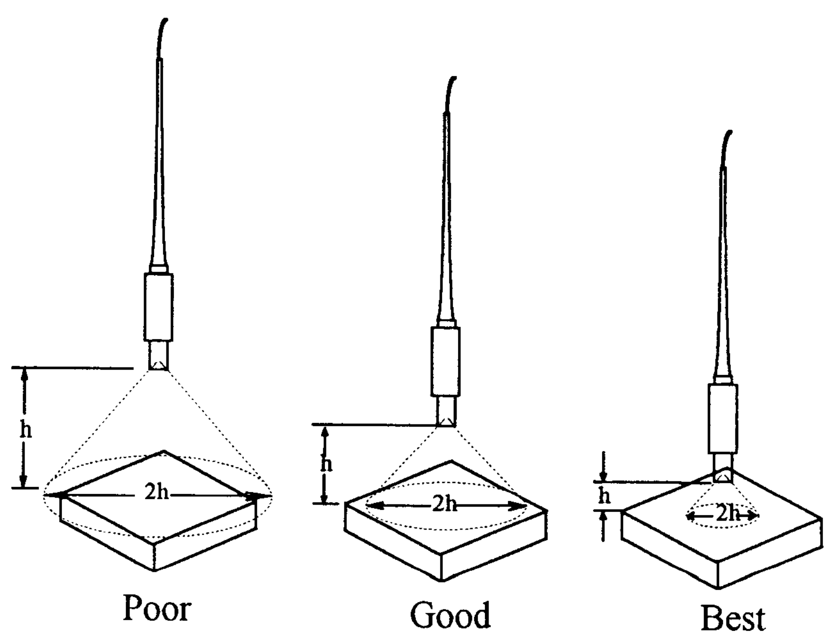
- If you question a measurement: clean the reflective cup, the sensor window, and re-measure.

4.3 PRODUCTION PROCESSES and MOVING MATERIALS

The OS-88000 can be used to measure the temperature of moving materials. The accuracy of the reading will depend on the emissivity of the surface and the stability of background infrared reflections in the environment. There are two ways to remove the uncertainty of these variables:

1. Bring the nosepiece as close as possible to the surface, less than .05 inches (1 mm) away, or
2. Calibrate the probe for the particular material target under the given environmental thermal conditions.

At non-contact distances from it's target, the OS-88000 has a field-of-view of 90°. This means that at a distance of 1 unit, the probe sees a diameter of 2 units. For example, at 1 ft distance, it "sees" a 2 ft diameter target area. At 1 meter distance, it "sees" a 2 meter target diameter. Make certain you are close enough to "see" only your target.



To calibrate for a moving target at greater than .05 inches (1 mm), measure the temperature of the target with the best means available (you can even use your OS-88000 by briefly touching). Note the reading. Move your OS-88000 probe back to the distance you wish to measure from, and use the adjustment pot to adjust your thermometer reading to the reading you previously obtained. Your temperature readings will now be valid for the given surface temperatures under the environmental conditions measured.

4.4 BARE METAL AND TRANSPARENT SURFACES

The AECS (Automatic Emissivity Compensation System) on the IR probe works only when the reflective cup nosepiece is touching, or very close to, the surface you wish to measure. In general, the cup will not have enough emissivity compensation when held greater than approximately 1/4 inch (6.4 mm) away from a target surface. The AECS works best when the nosepiece touches a flat surface. Keeping this in mind, bring the nosepiece as close as possible to measure materials that cannot be touched, for best accuracy.

The AECS will work with an accuracy range stated in the specifications on any surface with an emissivity of 0.8 or higher.

Careful evaluation of a good emissivity table, listing the various emissivities of different types of materials, reveals an interesting phenomena: all metals have a very low emissivity (.03 to .2 for example) while most other materials have a very high emissivity (.8 to .99). Materials with emissivity values in between metals and non-metals, have exposed metal as part of their surface make-up and should be treated as bare metals when using the AECS. Non-metallic and non-transparent surfaces are well within the .8 to .99 emissivity range, which the AECS handles quite readily.

The AECS will boost the emissivity of bare metal surfaces, but not enough for accurate temperature measurements within the ±2% specifications. A convenient solid paint "marker" is supplied with the probe to eliminate this problem.

- Put a "mark" on all bare metal and transparent surfaces
- Take your temperature measurement on the mark.

A small mark, slightly larger than the diameter (.5 inches, 12.5 mm) of the nosepiece of the probe is enough.

You may also use non-transparent tape, grease pencil, paint stick, or other markers. Do not use ink type markers - their coating is too thin. Do not use shiny metallic paint for marking.

Transparent materials have a variable which can influence your infrared sensor: the amount of heat energy that can pass through a transparent material. This varies depending on the type of material, thickness, and type of infrared radiation on the other side. This is a complex science. It is best to mark a transparent surface with your paint marker if you are unsure of it.

Not all **visibly transparent materials** require marking. Ordinary window glass can be measured accurately with the OS-88000 as long as there are no very high heat sources (direct sunlight, strong reflected sunlight, etc.) that the sensor will "see" in it's field of view on the other side of the glass. This is valid for many transparent plastics also.

The best way to check whether a transparent surface, or any other surface, should be marked or not, is to take a temperature measurement with and without a paint mark. If there is little or no difference, then the surface can be measured without marking **under those conditions.**

4.5 METER-GENERATED CURRENT OFFSETS

Some thermometers and readout devices send a small amount of current through the OS-88000. This current is usually generated to test for broken thermocouples. The meter can determine that the thermocouple is broken when an open circuit of the leakage current is detected.

The OS-88000 has an internal resistance of about 3K ohms. The "leakage current" acting on the OS-88000 generates a constant "offset" (shift in temperature reading) depending on the amount of current the meter generates. For many meters, the offset is small, almost undetectable. A few instruments, however, produce offset errors that can be high. In all cases, this offset is constant and usually is easily calibrated out with the meter's offset adjustment. An alternative is to select an instrument or meter that has a very high input impedance specification.

CHECKING FOR METER OFFSET

1. Cover the OS-88000 with aluminum foil and place it next to the meter so both are at the same temperature.

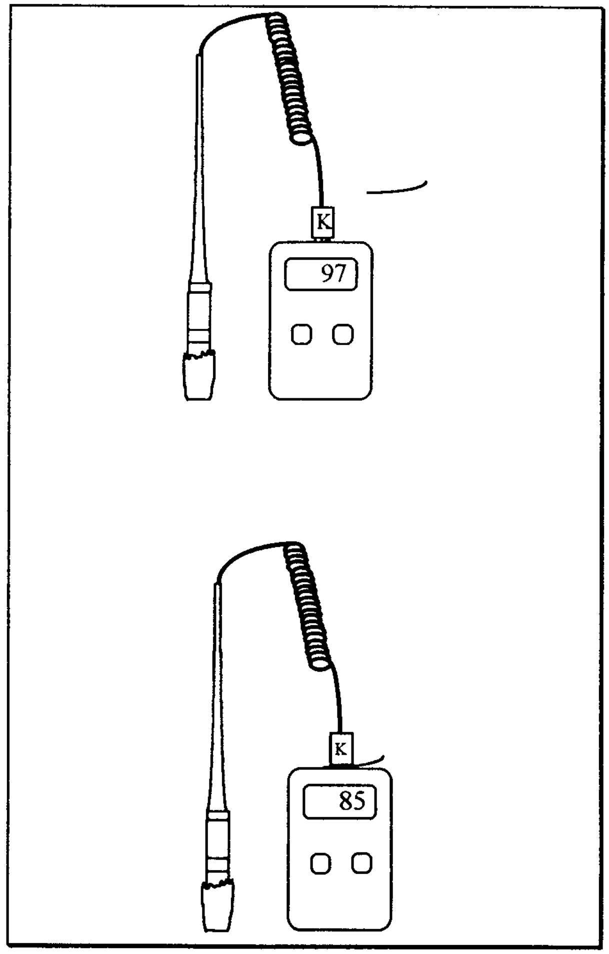
2. Allow the sensor and meter to stabilize for 10 minutes so both are at the same temperature.

3. With the OS-88000 connected to the meter, short circuit the input terminals. Write down the display reading on your meter.

4. Remove the short circuit. Leave the OS-88000 connected to the meter. Write down the new display reading on the meter. The difference between the two readings is the meter's "offset".

5. Find the "offset" adjustment on your meter and adjust the display down (or up) the exact amount of what you had noted as "offset". Calibration is now complete.

(Important note: Do not use the OS-88000 calibration screw for this adjustment)



SECTION 5. CUSTOM CALIBRATION

5.1 CALIBRATION PROCEDURE

- If your use of the probe on an everyday basis is to measure a wide range of temperatures, we recommend simply using the ACTUAL vs. INDICATED TABLE for look-up.

- If you mainly use the probe to measure in a temperature range spanning approximately 80°F (±40°F) or 50°C (±25°C), from 250° to 330°F, or from 110° to 160°C, as examples, then we recommend Custom Calibration.

When your OS-88000 is custom calibrated, you literally shift the "linear range" from it's factory calibration to any range you choose, up to 1120° to 1200°F (600° to 650°C). The ACTUAL temperature can then be displayed on your meter.

To adjust the probe, remove the small plastic cap at the front of the probe and use a small screwdriver to turn the pot to the desired reading. Some examples follow.

Custom Calibration of your OS-88000 allows you to "shift" the linear response of your infrared thermocouple to another range. The linear range, when it is custom calibrated will cover a span of approximately 80°F (40°C) up to the stated sensing range of the OS-88000. Calibrate at the center of the temperature range desired.

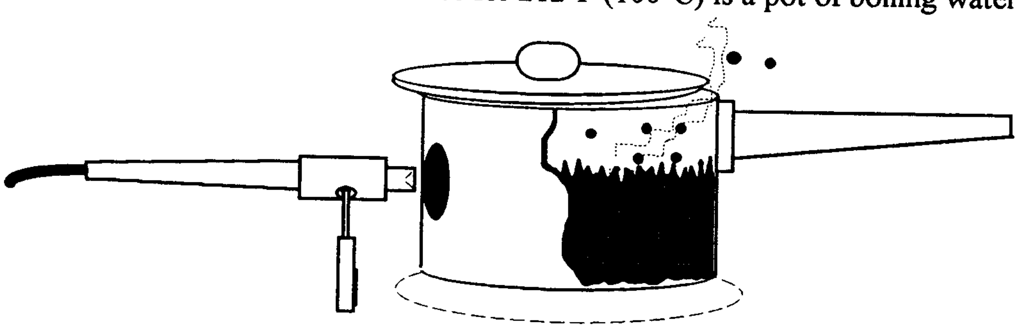
For example, calibration at 100°F (38°C) will move the linear range to give you accurate direct meter readings from approximately 60°F to 140°F (13°C to 63°C).

The OS-88000 is custom calibrated by using the calibration potentiometer. To access the pot and adjust the readings, pry off the small round plastic cap on the body of the probe. Use a small screwdriver.

In order to go to a custom calibration, you will need a known surface temperature calibration reference.

For example, if you make repeated measurements at boiling point, 212°F (100°C), you can calibrate the OS-88000 probe to read correctly when used on 212°F (100°C) surfaces.

A convenient calibration reference for 212°F (100°C) is a pot of boiling water.



(a) Fill a metal pot with water 1/2 to 3/4 full.

(b) Use the black paint marker supplied with the probe, or a piece of tape greater than .5 inches (13 mm) size, and put a mark on the outside of the pot just slightly below the inner water level.

(c) Bring the pot to full boil. Loosely cover the pot.

(d) Measure the surface temperature on the mark you made on the outside of the pot.

(e) Adjust the probe via the calibration pot so your display reads 212°F (100°C).

The OS-88000 will now directly read correctly for 212°F (100°C) surfaces. For a more precise explanation of this procedure please see the Appendix.

The open boiling point of water is affected by only one factor: barometric pressure. The standard 212°F (100°C) boiling point is for a barometric pressure of 30.00 inches of Hg (mercury), or in metric terms, 1 Bar (1000 millibars). This is "normal" at sea level. To correct for barometric pressure use the following:

2° F / 1 inch Hg (1° C / 30 millibars) change from 30.00 in Hg (1 Bar)

(Brief explanation of this boiling point calibration: when water is brought to a full boil inside the pot, the heat transfer to the outer surface of the pot is very high, and the surface temperature of the pot just below the water line will be boiling point within a small fraction of a degree. This 212°F (100°C) reference applies for boiling water at sea level, normal barometric pressure. Adjust accordingly if you live in a very high altitude, the boiling point can be significantly lower.)

Caution: whenever you custom calibrate, the look-up chart provided cannot be used until you return the probe to the factory calibration. (For background understanding of what happens when your probe is custom calibrated, please refer to the graph: **Custom Calibration Examples**. As you can see, the readings on your meter will decrease non-linearly on target temperatures lower than your linear range until the curve intersects with the probe ambient temperature (not shown). They will increase non-linearly on target temperatures greater than your linear range.)

To return to the original factory calibration, use the **FACTORY CALIBRATION DATA.**

(a) Use a known **actual** surface temperature reference. Use a reliable blackbody or known high emissivity surface for best calibration.

(b) Aim the OS-88000 at it and turn the adjustment pot so the thermometer display **indicated** reading matches the **indicated** shown on the supplied table for your calibration reference **actual** temperature. The look-up table can now be used again.

For example, going back to the "pot of boiling water" known reference of 212°F (100°C) used above. Look at the ACTUAL vs. INDICATED table supplied. For an **actual** surface temperature of 212°F (100°C) the **indicated** reading on the factory calibration look-up chart is 278°F

(137°C). Therefore, to return the OS-88000 to factory calibration, aim the probe at the actual known reference of 212°F (100°C) and turn the adjustment screw so the display reads 278°F (100°C).

Please note: If you ever change from the factory calibration, and wish to return to factory calibration, re-calibrate the probe to the **highest** temperature you will be measuring. The ±2% accuracy specification for ACTUAL vs. INDICATED will only hold to the highest temperature range at which you calibrate it. Higher temperature ranges may not necessarily be within the accuracy specifications because you have not "fine tuned" the adjustment pot at the proper high temperature range.

5.2 CHECKING STEAM TRAPS

For example, if the OS-88000 is regularly used to check for leaking or blown steam traps in your facility, you can adjust the probe to display accurately at 212°F (100°C) can read the correct pipe temperatures without having to use the "look-up table".

To adjust the probe, simply go to some steam pipes and measure their temperature. Pick a spot just a few feet (a meter) downstream from a steam trap. If the steam trap is functioning properly, the temperature of the piping at that location should be a few degrees under 212°F (100°C). For calibration purposes, make sure you use the supplied black paint marker to put a spot on the piping.

(a) Measure the temperature a few times to be certain the temperature isn't changing dramatically.

(b) Note the INDICATED and ACTUAL temperature readings from the table.

(c) While holding the probe close to the paint mark on the surface, turn the adjustment pot so the meter display now reads an ACTUAL temperature in the 212°F (100°C) range.

Calibration complete!

Your probe will now read correctly over an approximately 80°F (40°C) range centered at 212°F (100°C).

You can now survey steam traps quickly and easily by simply measuring pipe temperature a few feet downstream from the traps. If any temperature readings are above 212°F (100°C), then almost certainly you have a case of a leaking or blown steam trap. The higher above 212°F (100°) it reads, the more steam is passing through and possibly wasted, costing your facility a lot of money.

5.3 CHECKING INTEGRATED CIRCUIT COMPONENTS (IC'S)

Another common application is checking the temperature of integrated circuit (IC) components on circuit board. For example, a common limit of the operating temperature range for IC's is 125°C. By calibrating the OS-88000 to read correctly at 100°C, your meter display will be linear from 75° to 125°C. You can now check circuit boards and components quickly, easily, and most importantly, with great consistency!

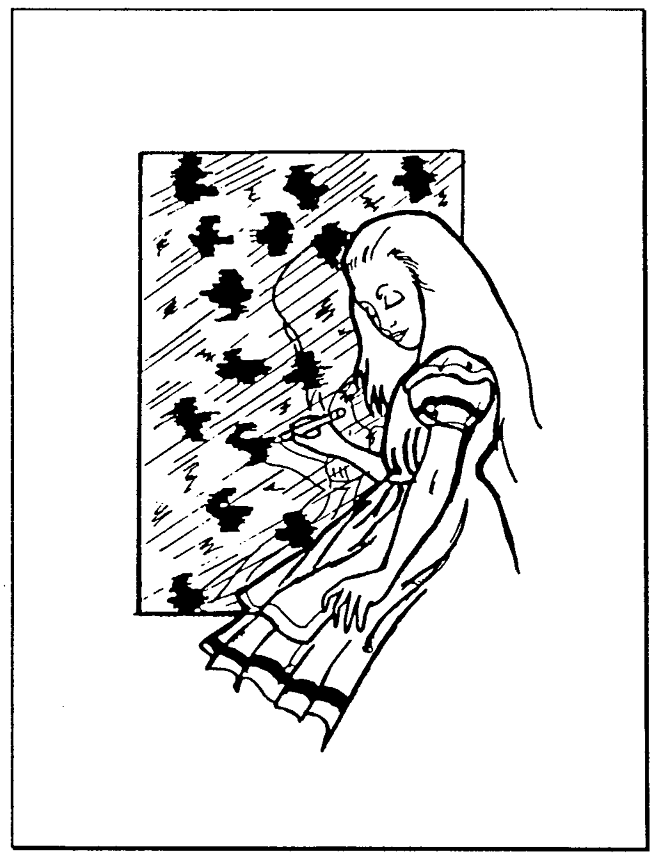
SECTION 6. EMISSIVITY

Emissivity is a surface property which determines how well an object's temperature can be measured using an infrared device. Emissivity (along with background thermal radiation) is primary source of errors in infrared temperature measurement. Emissivity can be more easily understood if it is realized that infrared has similar properties to visible light.

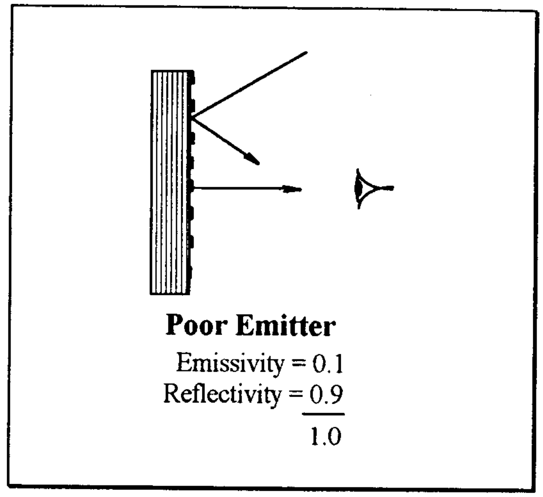
Is it possible to see a mirror?
When the mirrors looked at. all other objects in the room are seen.
Is it invisible? No, if it were, the wall would show behind it. So how can it be seen?

If crayon spots are painted on the mirror, now
the mirror can be seen! Of course, it can only
be seen where there are spots.
Everywhere else
still reflects. Thus, light is emitted from the spots
and reflected from the non-spots.

Mirrors figure prominently in the discussion of heat radiation and emissivity. Since heat and light radiation behave the same way, we can use what we see with our eyes as examples of what the infrared thermocouple sees.



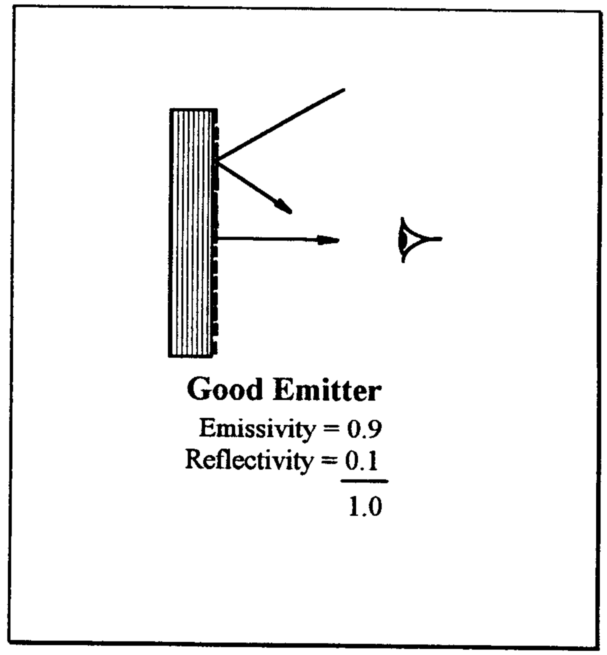
When you look in the mirror with your eyes, you see only reflections, nothing of the mirror itself. If the mirror is perfect, it has 100% reflectivity. Therefore, it emits nothing because it reflects everything. For this condition, the emissivity is zero.



If we consider an imperfect mirror, the eye then sees mostly reflection, but also some of the imperfections on the mirror surface. If, for example, we saw 90% of the mirror as a perfect reflector and 10% as imperfections, 90% of the mirror would reflect; the remaining 10% would emit. Therefore, the emissivity equals 0.1.

Consider for a moment the exact opposite of a perfect mirror, which is a perfect emitter. The eye looks at a perfect emitter and sees no reflection at all, only the emitting surface. Since 100% of the surface emits, and 0% reflects, the emissivity equals 1.0.

And finally, consider a good emitter. The eye sees a small amount of reflection interspersed with the large amount emitting. If, for example, 10% of the surface did not emit, and instead reflected, then we would have 10% reflecting and the remaining 90% emitting. Therefore, the emissivity equals 0.9

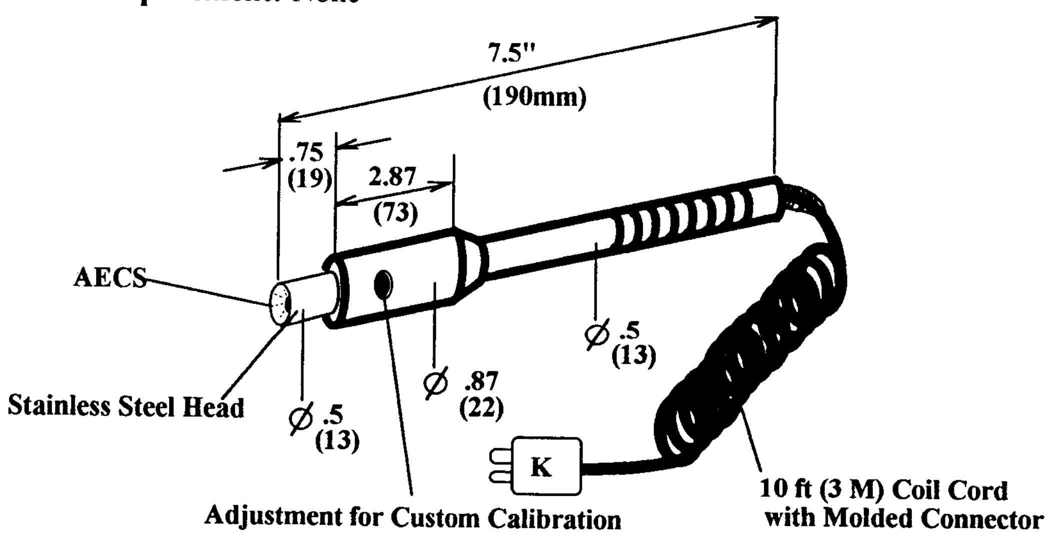


Accordingly, we can state the following rule of emissivity:

The emissivity of a surface is simply the percentage of the surface that emits. The remaining percentage of the surface reflects.

SECTION 7. SPECIFICATIONS

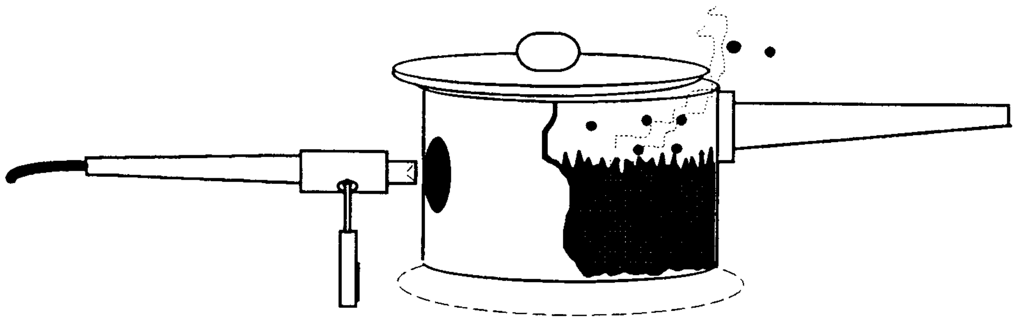
- **Temperature Range:** -60°F to 1200°F (-50°C to 650°C)
- **Signal Output:** Type K
- **Automatic Emissivity Compensation System (AECS):** ±1% of difference between target temperature and sensor temperature when touching surfaces of 0.8 emissivity or higher.
- **Accuracy:** ±2% or ±2°F (±1°C) of actual temperature including use of AECS.
- **Linearity Error:** Look-up chart provided (see Table, Indicated vs. Actual), User Adjustable
- **Repeatability:** ±1% of actual over temperature range
- **Time Constant:** 80 ms
- **Field of view:** 90°
- **Minimum spot size:** 0.45 in (1.14 cm) at 1 mm distance
- **Spectral Sensitivity:** 6.5 to 14 microns
- **Pot Adjustment Sensitivity:** 22°F per turn @ 212°F (12°C per turn @ 100°C), 5°F per turn @ 32°F (3°C per turn @ 0°C)
- **Weight:** .23 lb (104 g)
- **NIST traceable**
- **Power Requirement:** None



APPENDIX

BOILING WATER CALIBRATION CHECKING TECHNIQUE
FACTORY CALIBRATION DATA TABLES AND GRAPHS
CUSTOM CALIBRATION EXAMPLES

BOILING WATER CALIBRATION CHECKING TECHNIQUE



Unless you have extensive technical experience using laboratory infrared "blackbodies", this calibration checking technique is recommended by the factory. Boiling water is a physical constant, easily used, and requires no technical set-up of elaborate equipment or checking of traceable standards.

Boiling Point of Water.

The open boiling point of water is affected by only one factor: barometric pressure. The standard 212°F (100°C) boiling point is for a barometric pressure of 30.00 inches of Hg (mercury), or in metric terms, 1 Bar (1000 millibars). This is "normal" at sea level. Barometric pressure can be affected by:

(1) Elevation Above Sea Level
(2) Weather Conditions

Elevation Correction: The boiling point of water is lowered by approximately 2°F (1°C) for every 1000 ft (300 m) above sea level with normal weather conditions. If your weather is "normal" and you are not using the barometric pressure method, you can simply use the following corrections.

Elevation	Boiling Temperature	
Sea level	212 deg F (100 deg C)	
1000 ft (300 meters)	210	99
2000 ft (600 m)	208	98
3000 ft (900 m)	206	97
4000 ft (1200 m)	204	96
5000 ft (1500 m)	202	95

Weather Conditions: If you use this method, you do not need to put in a correction for elevation above sea level. It will be automatic by using the current barometric pressure dominating your area. Barometric pressure can be much lower during especially stormy conditions (low pressure areas), and much higher during extremely cool and dry conditions (high pressure areas). Consult the weather reports on TV, in your local newspaper, or call a weather service office for current barometric conditions in your area. Barometric pressure correction factors:

2° F / 1inch Hg (1° C / 30 millibars) change from 30.00 in Hg (1 Bar)

-Add to the boiling temperature for higher than normal pressure.
-Subtract for lower than normal pressures.

Checking Calibration

Equipment necessary: Metal pot with cover, minimum 4" (10 cm) tall
Solid paint marker or thin opaque tape

1. Use a metal pot, with cover, for boiling water.
2. Fill the pot at least 1/2 full with water.
3. Use the solid paint marker supplied with your OS-88000, or a piece of opaque (non-see through) tape, or a thin electrical tape, to put a measuring spot at least 0.5 in (13mm) in diameter on the outside surface of the pot. Make sure the measuring spot is at, or slightly below, the water level.
4. Bring the water to a RAPID boil.
5. Tilt the cover SLIGHTLY so that the water does not boil over.
   The condensing steam on the inside of the pot along with the rapidly boiling water will force the outside surfaces of the pot to be within a fraction of a degree of the temperature of the boiling water. (The temperature drop through the wall thickness of the average pot for boiling water is very small and can be ignored.)
6. Briefly touch the nosepiece flat onto the black mark and note the INDICATED temperature reading (or millivolt reading) on your meter.

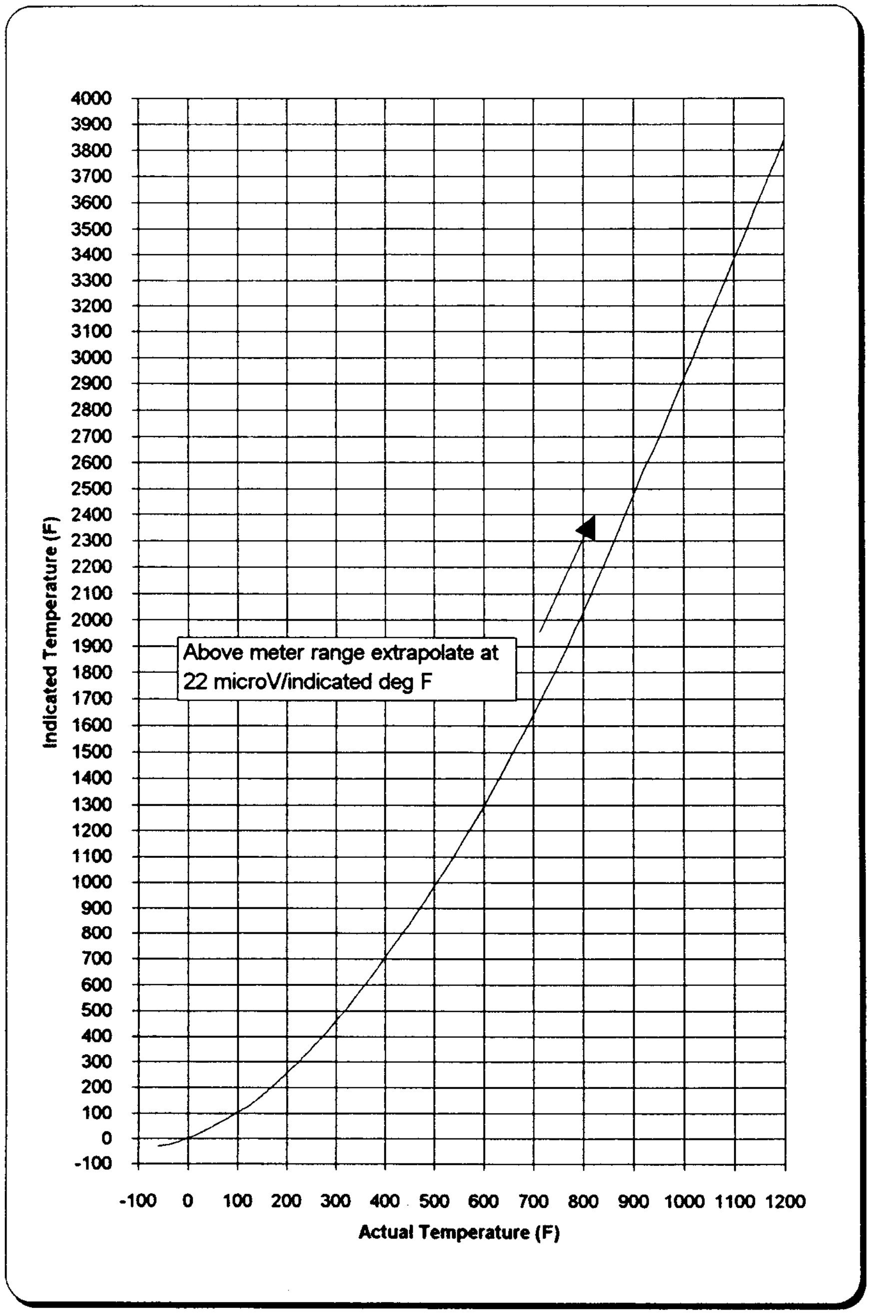
For normal barometric pressure conditions at sea level, it should read between 269 to 288° F (132 to 142° C), or, in absolute millivolts (referenced to ice point), it should read between 5.395 mv to 5.823 mv. Any reading within this range is within the ±2% accuracy specification for the probe for surfaces of 0.8 emissivity or higher.

Factory Calibration Data (F)

Table of Indicated vs Actual

Actual F	Indicated F
-60	-31
-40	-26
-20	-13
0	2
20	18
40	37
60	59
80	80
100	103
120	127
140	154
160	187
180	220
200	256
212	278
220	294
240	333
260	374
280	417
300	462
320	508
340	556
360	605
380	656
400	707
420	760
440	815
460	870
480	927
500	985
520	1045
540	1105
560	1167
580	1231
600	1295
620	1361
640	1429
660	1498
680	1568
700	1640
720	1714
740	1790
760	1868
780	1948
800	2030
820	2114
840	2200
860	2290
880	2382
900	2476
920	2574
940	2644
960	2736
980	2828
1000	2920
1020	3012
1040	3104
1060	3196
1080	3288
1100	3380
1120	3472
1140	3564
1160	3656
1180	3748
1200	3840

Graph of Indicated vs Actual



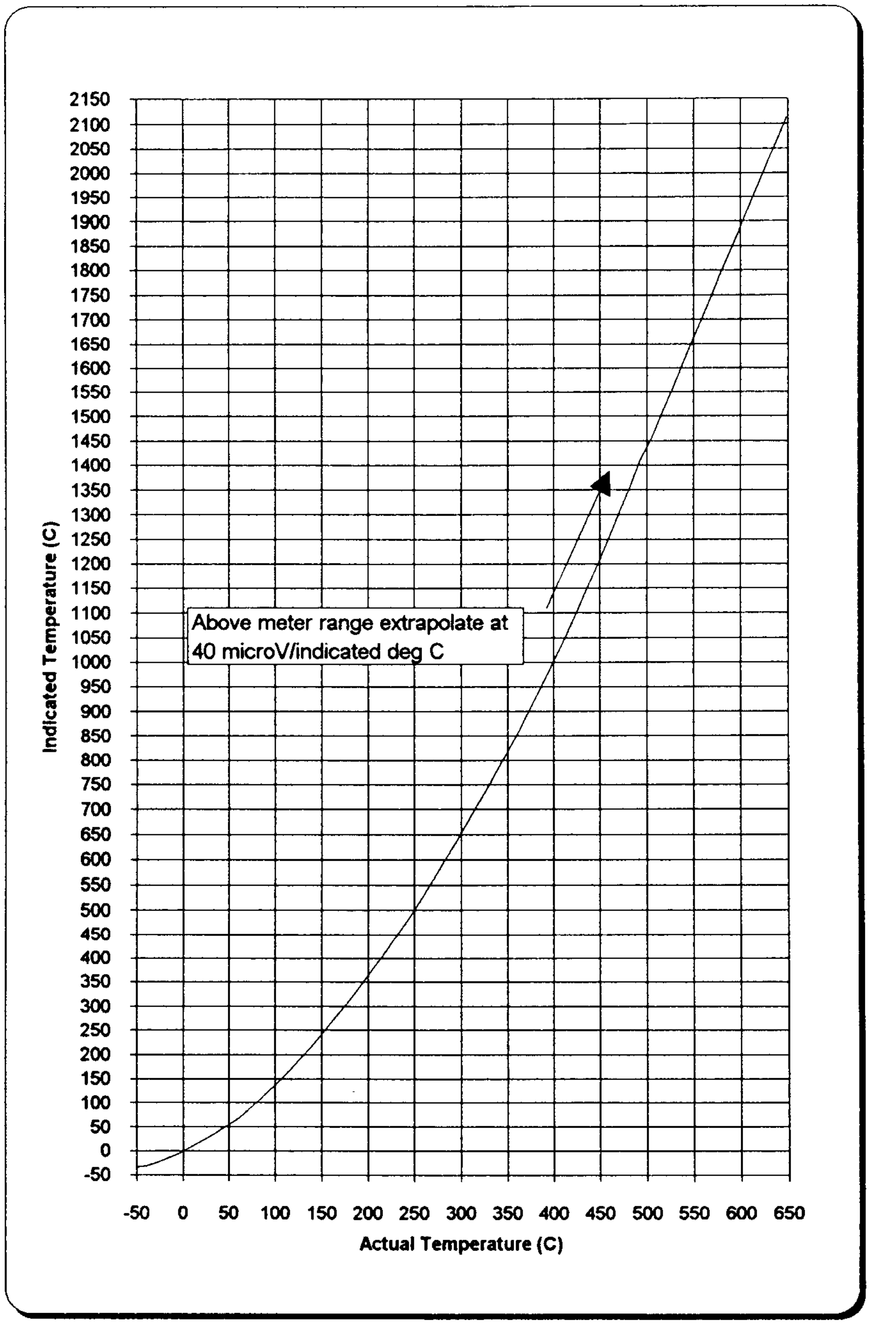
Note: Some Type K thermocouple meters may not indicate above approximately 2000 F. The IR thermocouple output may be taken as 22 microvolts per indicated deg F when measured with a voltmeter above the range of a type K meter.

Factory Calibration Data (C)

Actual C	Indicated C
-51	-35
-40	-32
-29	-25
-18	-17
-7	-8
4	3
16	15
27	27
38	39
49	53
60	68
71	86
82	105
93	124
100	137
104	145
116	167
127	190
138	214
149	239
160	265
171	291
182	318
193	346
204	375
216	405
227	435
238	466
249	497
260	530
271	563
282	596
293	631
304	666
316	702
327	738
338	776
349	814
360	853
371	894
382	935
393	977
404	1020
416	1064
427	1110
438	1157
449	1205
460	1254
471	1306
482	1358
493	1412
504	1451
516	1502
527	1553
538	1604
549	1656
560	1707
571	1758
582	1809
593	1860
604	1911
616	1962
627	2013
638	2064
649	2116

Table of Indicated vs Actual

Graph of Indicated vs Actual



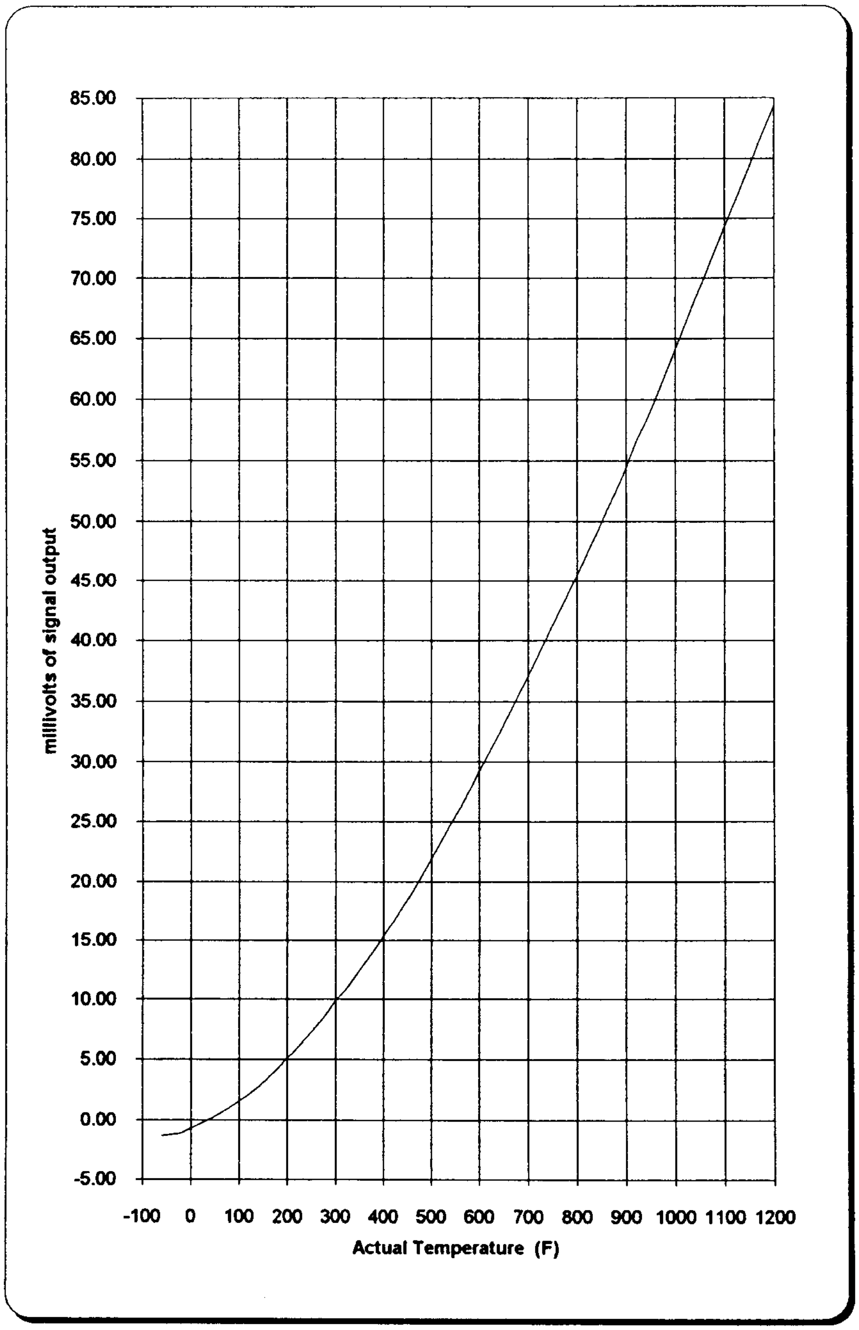
Note: Some Type K thermocouple meters may not indicate above approximately 1100 C. The IR thermocouple output may be taken as 40 microvolts per indicated deg C when measured with a voltmeter above the range of a type K meter.

Factory Calibration Data (mV/F)

Table of mV Output vs Actual T

Actual F	mV Output*
-60	-1.34
-40	-1.24
-20	-1.11
0	-0.69
20	-0.31
40	0.11
60	0.60
80	1.07
100	1.59
120	2.14
140	2.76
160	3.52
180	4.28
200	5.10
212	5.60
220	5.96
240	6.83
260	7.74
280	8.70
300	9.93
320	10.74
340	11.84
360	12.97
380	14.13
400	15.34
420	16.58
440	17.88
460	19.17
480	20.52
500	21.90
520	23.32
540	24.74
560	26.20
580	27.70
600	29.20
620	30.73
640	32.29
660	33.87
680	35.45
700	37.06
720	38.70
740	40.36
760	42.05
780	43.71
800	45.49
820	47.23
840	48.99
860	50.79
880	52.59
900	54.39
920	56.55
940	58.09
960	60.11
980	62.13
1000	64.16
1020	66.18
1040	68.21
1060	70.23
1080	72.25
1100	74.28
1120	76.30
1140	78.33
1160	80.35
1180	82.37
1200	84.40

Graph of mV Output vs Actual T



Note: Some Type K thermocouple meters may not indicate above approximately 2000 F. The IR thermocouple output may be taken as 22 microvolts per indicated deg F when measured with a voltmeter above the range of a type K meter.

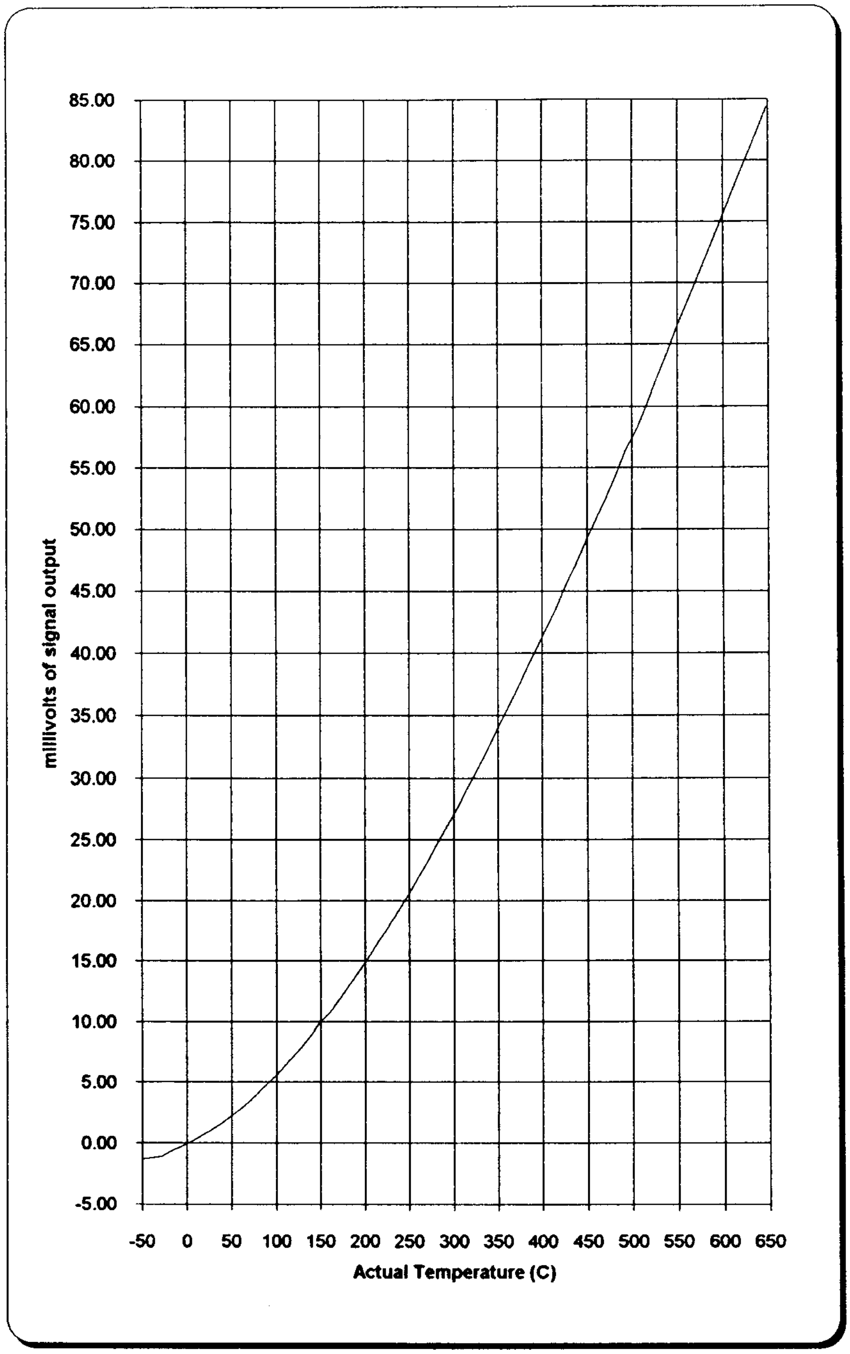
* Ice point reference.

Factory Calibration Data (mV/C)

Table of mV Output vs Actual T

Actual C	mV Output*
-51	-1.34
-40	-1.24
-29	-1.11
-18	-0.69
-7	-0.31
4	0.11
16	0.60
27	1.07
38	1.59
49	2.14
60	2.76
71	3.52
82	4.28
93	5.10
100	5.60
104	5.96
116	6.83
127	7.74
138	8.70
149	9.93
160	10.74
171	11.84
182	12.97
193	14.13
204	15.34
216	16.58
227	17.88
238	19.17
249	20.52
260	21.90
271	23.32
282	24.74
293	26.20
304	27.70
316	29.20
327	30.73
338	32.29
349	33.87
360	35.45
371	37.06
382	38.70
393	40.36
404	42.05
416	43.71
427	45.49
438	47.23
449	48.99
460	50.79
471	52.59
482	54.39
493	56.55
504	58.09
516	60.11
527	62.13
538	64.16
549	66.18
560	68.21
571	70.23
582	72.25
593	74.28
604	76.30
616	78.33
627	80.35
638	82.37
649	84.40

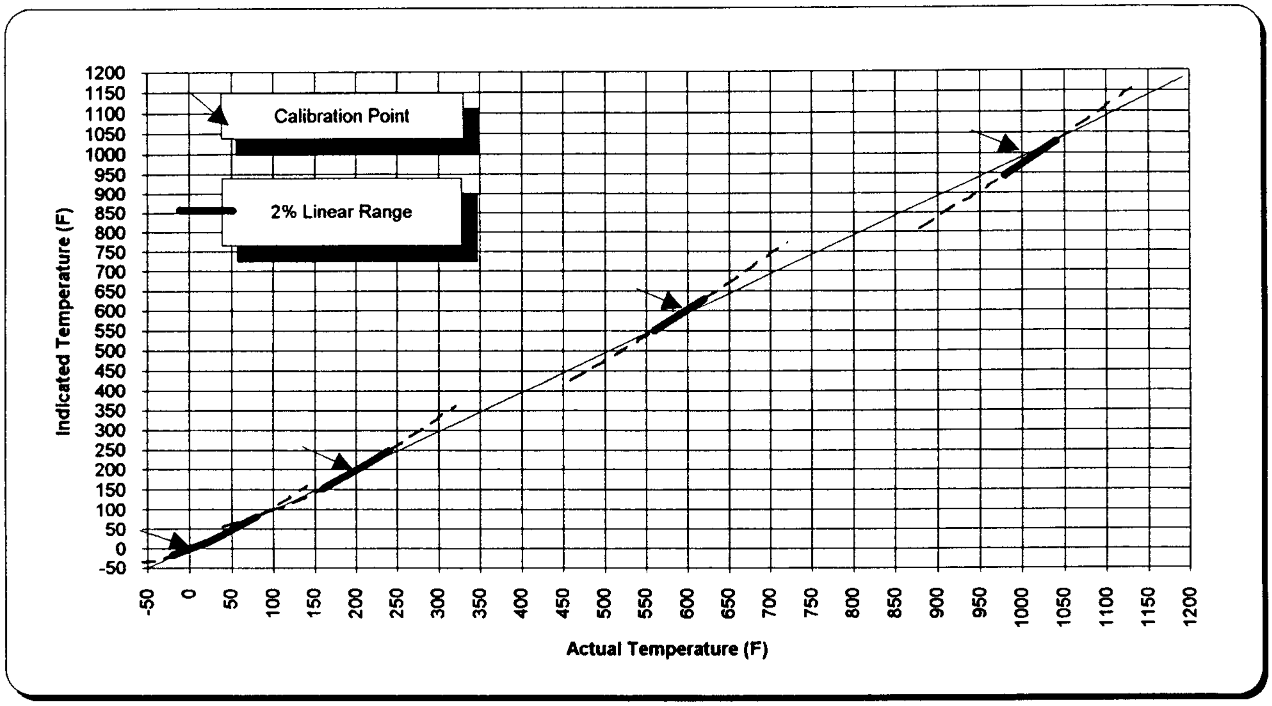
Graph of mV Output vs Actual T

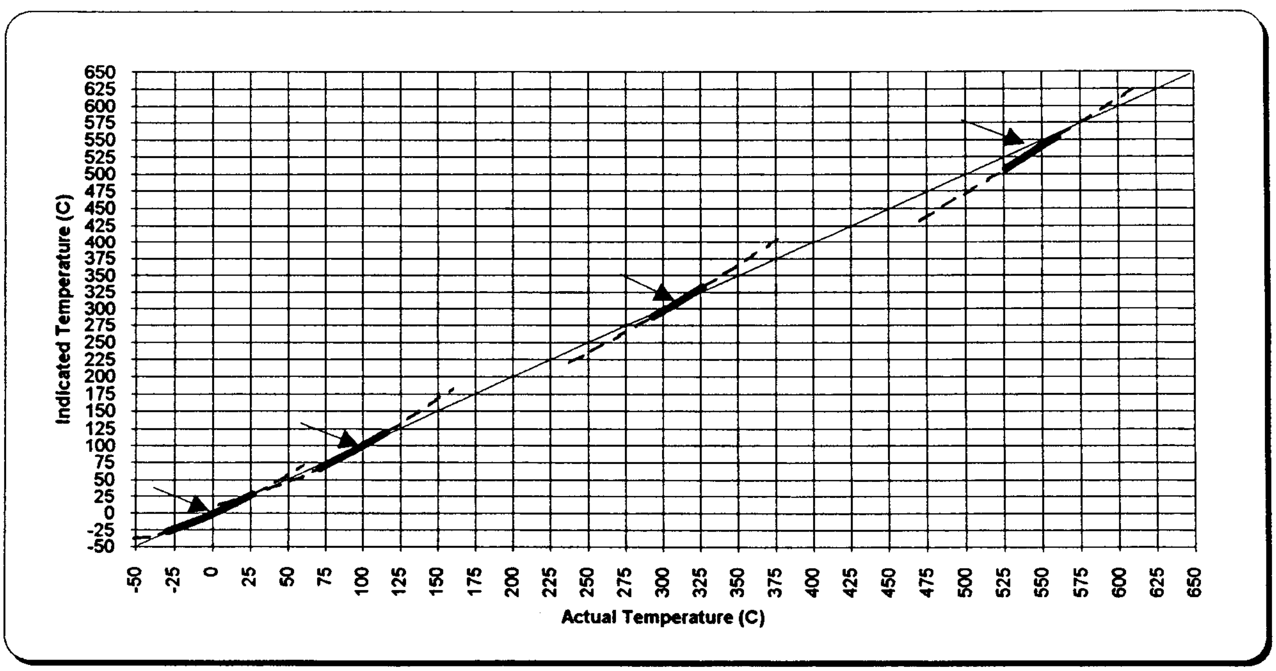


Note: Some Type K thermocouple meters may not indicate above approximately1100 C. The IR thermocouple output may be taken as 40 microvolts per indicated deg C when measured with a voltmeter above the range of a type K meter.

* Ice point reference.

Custom Calibration Examples





MADE IN USA

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that our customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our 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. However, 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 or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

We are glad to offer suggestions on the use of our various products. Nevertheless OMEGA only warrants that the parts manufactured by it will be as specified and free of defects.

OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

LIMITATION OF LIABILITY: The remedies of buyer set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

Every precaution for accuracy has been taken in the preparation of this manual; however, OMEGA ENGINEERING, INC. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that result from the use of the products in accordance with the information contained in the manual.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA ENGINEERING Customer Service Department. Call toll free in the USA and Canada: 1-800-622-2378, FAX: 203-359-7811; International: 203-359-1660, FAX: 203-359-7807.

BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, YOU MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OUR 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.

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 you are having with the product.

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

1. Your P.O. number to cover the COST of the of the repair/calibration,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems you are having with the product.

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

OMEGA®... Your Source for Process Measurement and Control

TEMPERATURE

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

PRESSURE/STRAIN 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 and 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