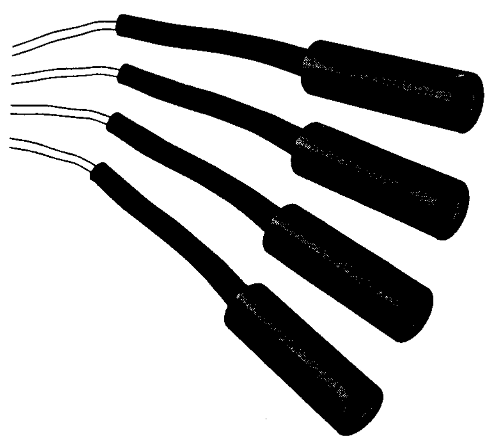
IRt/c™ Series
OS36, OS37, OS38
Infrared Thermocouples



OMEGA®
An OMEGA Technologies Company

Operator's Manual

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1 Introduction

1.1 Unpacking

Remove the Packing List and verify that you have received all equipment including the items listed on the next page.

If you have any questions about the shipment, please call the OMEGA 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.

Make sure the following is in the packing box for the model ordered:

Model	Contents
OS36	OS36, operator's manual and Application Notes Book
OS36-01	OS36-01, operator's manual and Application Notes Book
OS36-RA	OS36-RA, operator's manual and Application Notes Book
OS36-2	OS36-2, air fitting, hardware pack*, 1/4" tubing**, operator's manual and Application Notes Book
OS36-2RA	OS36-2RA, 1/4" tubing**, operator's manual and Application Notes Book
OS36-5, OS36-10	respective thermocouple type, air fitting, 3 pan head screws 1/2", 3 pan head screws 1/4", 1/4" tubing**, operator's manual and Application Notes Book
OS37-10, OS38-10, OS37-20, OS38-20, OS37-60CF, OS38-60CF, OS37-100, OS38-100, OS37-CF, OS38-CF	respective thermocouple, screw driver, 3 pan head screws 1/2", 3 pan head screws 1/4", aperture kit, 1/4" tubing**, operator's manual and Application Notes Book

* hardware pack includes straight air fitting, hex nut, air purge hex nut

** 3.3 feet of tubing

NOTE: The manual number is M1973.
The Applications Note Book number is M1975.

1.2 Description

The IRt/c™ Infrared Thermocouple is a self-powered measurement instrument which can be substituted directly for standard Type J, K, T, or E thermocouples to make noncontact temperature measurements.

The Infrared Thermocouple should be used whenever:

- The object to be measured is moving.
- Contact will alter the object.
- Contact will compromise a sterile environment (biomedical applications).
- A contact device will be inaccurate.
- A contact device will wear too quickly because of friction or vibration.
- A contact device is too slow.
- A much wider area must be monitored than can be done with contact devices.

The Infrared Thermocouple combines the latest in infrared technology with an entirely new concept in thermoelectric principles to determine an objects temperature by measuring its emitted infrared radiation.

Use the Infrared Thermocouple just like any thermocouple, keeping in mind that it is an infrared device, with three distinct characteristics:

- The target must fill the field of view. See also Section 8.

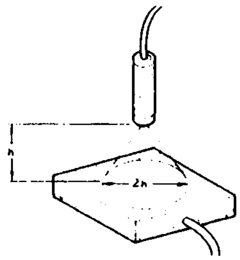


Figure 1-1. Correct Position

- The IRt/c works most accurately on high emissivity surfaces.

Good applications: All non-reflective materials: Food, paper, plastics, coated metals, stone, clay, glass, liquids, fabrics.

Poor applications: Reflective materials: shiny metals (must use OS38 models only)

"Maybe" applications: Dull metals, thin plastics. See also Section 5.

- Some instruments will generate an offset. See also Section 12.

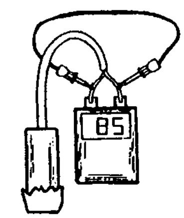


Figure 1-2. Offset Caused

The following models are available from OMEGA Engineering:

Part Number	Thermocouple Type	Range^
OS36*	J, K, T, E	-50°F to 1200°F (-45°C to 650C)
OS36-01	J, K, T, E	-50°F to 550°F (-45°C to 290C)
OS36-RA (right angle view)	J, K, T, E	-50°F to 1200°F (-45°C to 650C)
OS36-2	J, K, T, E	-50°F to 2000°F (-45°C to 1100C)
OS36-2RA (right angle view)	J, K, T, E	-50°F to 2000°F (-45°C to 1100C)
OS36-5	J, K, T, E	-50°F to 2000°F (-45°C to 1100C)
OS36-10	J, K, T, E	-50°F to 2500°F (-45°C to 1370C)
OS37-10	J, K	-50°F to 2500°F -50°C to 1370°C
OS37-20	J, K	500°F to3000°F 260°C to 1650°C
OS37-100	R, S	1000°F to 5000°F 540°C to 2760°C
OS37-CF	J, K, T, E	0°F to 2000°F -18°C to 1100°C

Part Number	Thermocouple Type	Range^
OS37-60CF	R, S	1000°F to 4000°F 540°C to 2200°C
OS38-10	J, K	500°F to 2500°F 260°C to 1370°C
OS38-20	J, K	1000°F to 3500°F 540°C to 1930°C
OS38-100	R, S	1500°F to 5000°F 820°C to 2760°C
OS38-CF	J, K, T, E	500°F to 2500°F 260°C to 1370°C
OS38-60CF	R, S	1500°F to 4500°F 820°F to 2500°F

*with one of the following ranges

"50F" (range of 0° to 80°F (–18° to 27°C))
"80F" (range of 50° to 120°F (10° to 49°C))
"98.6F" (range of 60° to 102°F (16° to 39°C))
"140F" (range of 80° to 180F (25° to 80°C))
"180F" (range of 160° to 220°F (70° to 104°C))
"240F" (range of 200° to 270°F (95° to 130°C))
"280F" (range of 260° to 310°F (125° to 155°C))
"340F" (range of 290° to 350°F (145° to 175°C))
"440F" (range of 340° to 480°F (170° to 250°C))

^ Measurements above thermocouple table values are possible using radiation laws. Polynomials available on request.

2 Model Selection Guide and Installation Procedure

2.1 Selecting the Correct Model for Your Application

HOW LARGE IS YOUR TARGET?

- If it is smaller than 0.8" (2 cm), you must select the OS36, OS36-2, or OS37-CF.
- If it is smaller than 0.3" (8 mm), you must select the OS36-2 or OS37-CF.

HOW CLOSE CAN THE SENSOR BE MOUNTED?

- See Chapter 8 and Appendix B (specifications) and use the field-of-view drawing showing the diameters from the sensor versus the approximate diameters of the spot size.
- For example, the OS36-2, at a distance of 2X has a spot size of 1X (at a distance of 1 foot, the spot size is 6", at a distance of 1 meter, the spot size is 0.5 meter).
- See Application Notes Book - IRt/c can measure obliquely if you wish to position an IRt/c at an angle other than 90° from your target surface.

WHAT IS THE AMBIENT TEMPERATURE WHERE THE SENSOR IS TO BE PLACED?

- If the ambient is less than 212°F (100°C) choose any sensor.
- If the ambient is greater than 212°F (100°C), see Application Notes Book - Chapter entitled Air Purge and Air Cooling Requirements for air cooling flow requirements for the Air Purge Collar/Cooling Jacket (OS36-APC) and OS36-5 built-in air purge/cool system.

- If ambient is greater than 500°F (260°C), it is usually best to specify an OS36 or OS36-2 sensor along with the Cooling Jacket and utilize the water cooling feature. (Cooling the smaller sensors with water is less expensive over time, compared to cooling the OS36-5 with air).

WHAT IS YOUR TARGET TEMPERATURE?

- Use the Temperature Selection Guide (see Chapter 6) or select OS37 or OS38 models, which are adjustable.

CHOOSING A TEMPERATURE CONTROLLER/INPUT DEVICE

- See Application Notes Book - Chapters entitled Multiplexed Datalogging Applications and Selecting Temperature Controllers for help in selecting or using available thermocouple input devices.

2.2 Installing the Thermocouple

1. Use on materials with high emissivities (unless using OS38, which is adjustable).

   Examples of high-emissivity materials include food, paper, plastics, coated metals, stone, clay, glass, liquids, fabrics. Dull or corroded metals and thin plastic films should be tested to determine suitability. See also Section 5.

2. Select optimum location.

   Install as close to target as possible, in a clean location with an ambient temperature of 200°F (93°C) or less. See also Chapter 8, and Sections 13.3 and 13.4.

3. Mount securely.

   The IRt/c is fully encapsulated and can be clamped firmly. Do not drill into housing.

4. Connect leads to output device.

   - IRt/c leads are actual thermocouple leads. By convention, red is always the negative lead. For color codes, see the color code information.
   - Use IRt/c cables like any thermocouple cable: extension cables and connectors must be of same type as IRt/c to maintain proper thermoelectric circuit.
   - For electrically noisy environments, use shielded extension cables and connect shield to a suitable signal common at output device.
   - Use standard thermocouple practice for splicing, cable lengths, and thermocouple transmitters.

5. Check for response.

   Wave hand or hot object in front of IRt/c to check proper connection with readout device.

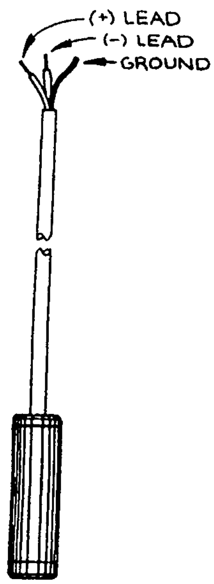


Figure 2-1.
Thermocouple

IRt/c Lead Materials

T/C Type	Positive Lead	Negative Lead
J	Iron	Constantan
K	Chromega	Alomega
E	Chromega	Constantan
T	Copper	Constantan

IRt/c Lead Color Codes

T/C Type	Positive Lead	Negative Lead	Ground Lead
J	White	Red	Metallic
K	Yellow	Red	Metallic
E	Purple	Red	Metallic
T	Blue	Red	Metallic

3 Calibration

3.1 Calibrating the Non-Adjustable Thermocouple

1. Cover the IRt/c with foil and place it next to the readout instrument so both are at the same temperature.
2. Allow the sensor to stabilize for at least 10 minutes before running the test so that it generates no signal.

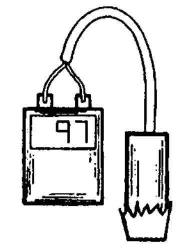


Figure 3-1. Using Foil

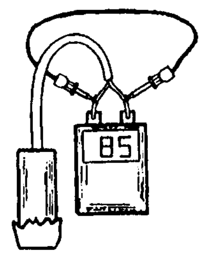


Figure 3-2. Shorting Terminals

3. With the IRt/c still connected, short circuit the input terminals and note the display reading.
4. Then remove the short and note the new reading. The difference between the two readings is the offset.

Repeat this procedure as needed to accurately determine the instrument's offset. The offset can be eliminated by recalibrating the instrument to compensate for the offset current.

3.2 Calibrating the Adjustable Thermocouple

CAUTION

Keep the OS37 and OS38 lens covered when installing. Inadvertent view of higher temperatures (or high emissivity targets with the OS38 models) can cause permanent damage to sensor. Remove cover only when viewing intended target.

1. Connect the OS37 or OS38 to readout device (controller, PLC, etc.) to be used. Install aperture if one is to be used (refer to Aperture Kit Instructions) and re-attach lens cover.
2. With OS37 or OS38 viewing room ambient temperature (or cover OS37 or OS38 with aluminum foil to block its view) set the readout device ZERO or SPAN adjustments to the approximate temperature indicated in Table 3-1. (This procedure maximizes the linear range.)
3. Connect air purge first if installing in process already at operating temperature. Provide minimum 5 PSIG (30kPa) air pressure.

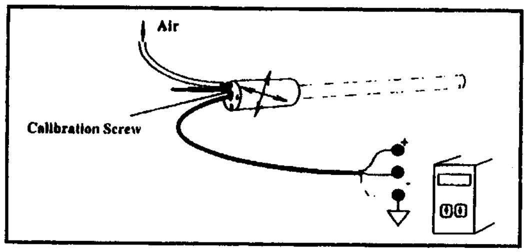


Figure 3-3. Connection Diagram

4. Install OS37 or OS38 and align to view the desired target. Bring target to operating temperature if not already there. Connect leads to readout device (controller, PLC, etc.). Remove lens covering.

5. If the target temperature is not known, measure the target temperature with an accurate reference. Remove the setscrew to expose the calibration screw. Adjust the calibration screw to obtain reading desired. If readout device leakage current is excessive, 'adjust OFFSET on readout device as required (see Application Notes Book - Chapters entitled Multiplexed Datalogging Applications and Why Offsets are Caused by Leakage Currents with some Readout Devices). If screw adjustment is too coarse for the setting desired, fine tune with the readout's OFFSET adjustment. Replace the setscrew cover when complete.

OS37-10, OS38-10, OS37-20, OS38-20, OS37-100 and OS38-100 are equipped with a calibration adjustment feature that makes it possible to precisely calibrate the unit to the temperature control requirements. However, for installations in which monitoring of temperature as well as control is desired, a wide linear range is convenient. Accordingly, the procedure described below can be used to produce a very wide linear range when using controllers, meters, PLCs, transmitters, etc. for temperature monitoring. The only requirement is that an ZERO and SPAN or equivalent adjustment be available to offset the reading.

The method involves simply "rotating" the output curve of the OS37 or OS38 to better fit the linear thermocouple requirement over a wider temperature range, as shown in Figures 3-4 and 3-5.

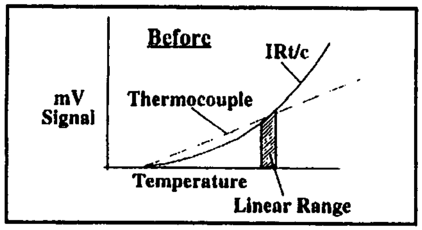


Figure 3-4. Before

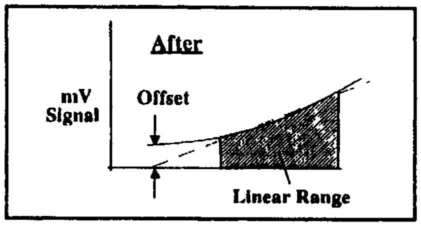


Figure 3-5. After

The steps are as follows:

1. Set the readout device to the offset value shown in Table 3-1.
2. Adjust the calibration screw on the IRt/c to the correct target temperature.

Calibration complete.

Models	Target Temperature °F (°C)	Table 3-1 Optimum Offset (% of Target Temperature)	Approximate 2% Linear Range (from Target Temperature) °F (°C)
OS38-10	800 (425)	~ 75%	±100 (60)
OS38-20	1000 (540)	~ 75%	±150 (80)
OS38-100	1600 (870)	~ 75%	±200 (110)
	2000 (1100)	~ 75%	±300 (170)
	2800 (1540	~ 75%	±400 (220)
	3600 (2000)	~ 75%	±400 (220)
OS37-10	200 (90)	~ 60%	±25 (15)
OS37-20	500 (260)	~ 60%	±50 (30)
OS37-100	1000 (540)	~ 60%	±200 (110)
	1500 (820)	- 60%	±500 (280)
	2100 (1150)	~ 60%	±600 (330)
	3000 (1650)	~ 50%	±800 (440)

Example:

Apply an OS38 to monitor steel at 1800°F (980°C). Cover the OS37 or OS38 with aluminum foil such that it cannot see the target, then set the readout device offset so that the display reads approximately 75% of target temperature:0 .75 x 1800 = 1350°F (0.75 x 980 = 735°C).

Remove foil, point OS37 or OS38 at intended target, and adjust the calibration screw on the back of the OS37 or OS38 until the readout display reads the correct temperature. The calibration is complete, and the linear range over which the reading will be within 2% of actual is approximately 1350°F ±250°F (730°C ±140°C).

*For full range linearization (with PLC, computer, etc.), Signal Output Polynomial available from OMEGA.

3.3 On-Line Calibration and Emissivity Adjustment

For non-adjustable thermocouples,to adjust for emissivity, attain greater accuracy, for use outside specified accuracy ranges, or to measure through infrared transmitting windows, the IRt/c installation can be calibrated using a simple three-step procedure.

1. Mount the IRt/c In the desired operating position and connect to the thermocouple readout device.

   Follow the directions in Section 2.2 and make sure that it is operating correctly.

2. Using a calibrated Infrared instrument or other thermometer, measure the target temperature.

3. If available, adjust the readout so that the indicated temperature is equal to the temperature measured. If not, develop a correction curve.

3.4 Calibrating by Temperature Control

As in all infrared temperature control systems, IRt/c installations should be calibrated to the characteristics of the materials and the process being controlled, in order to insure that the control temperature is accurate. Accordingly, the calibration reference must be selected such that its accuracy is independent of the variables that influence the temperature control accuracy. In the case of infrared temperature control, the major variables are emissivity and ambient reflections.

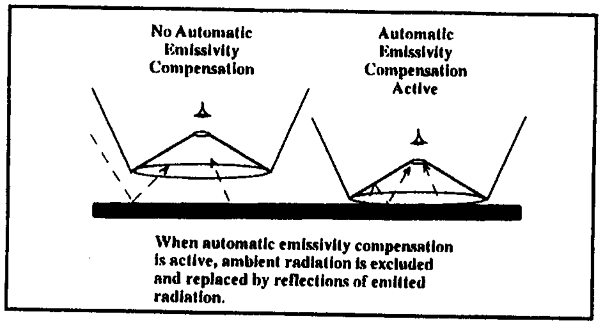


Figure 3-6. Automatic Emissivity Compensation

The OS91 and OS92 Digital Infrared Temperature Scanners have the necessary accuracy and independence from emissivity and reflection errors, due to its automatic emissivity compensation feature. The reflective cup configuration of the sensing head automatically corrects for emissivity by creating a tiny blackbody at its point of measurement.

By "trapping" the emitted radiation, and excluding the ambient radiation (thereby replacing the reflected ambient radiation with reflected **emitted** radiation) the sensing eye sees a blackbody; and thus can report the temperature precisely.

The result of automatic emissivity compensation is shown in Figure 3-7.

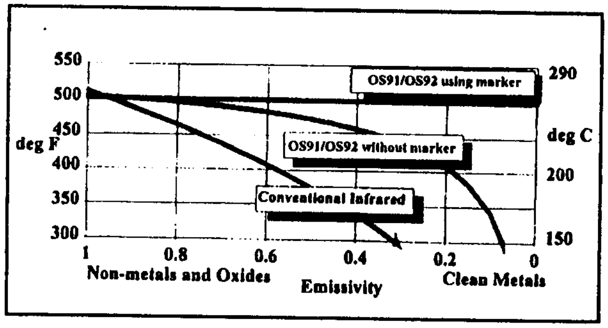


Figure 3-7. Effect of Emissivity on Temperature Reading for 500°F (260°C) Target in 70°F (21°C) Ambient Temperature

Conventional infrared devices are strongly influenced by both emissivity and ambient variation, while the OS91 and OS92 Digital Infrared Temperature Scanners remain accurate.

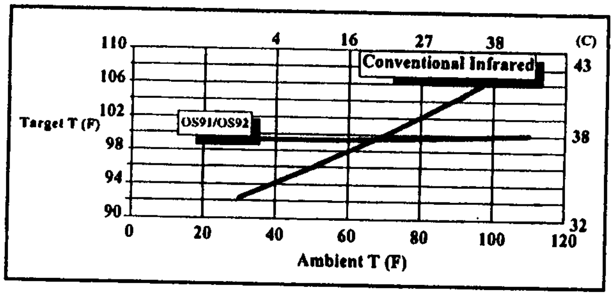


Figure 3-8. Effect of Emissivity on Temperature Reading for 100°F (38°C) Target with 0.8 Emissivity

Additional factors in calibration accuracy are speed and contact error when using conventional thermocouples. The OS91 and OS92 Digital Infrared Temperature Scanners overcome both problems, and makes it possible to complete the temperature control set-up very quickly and accurately.

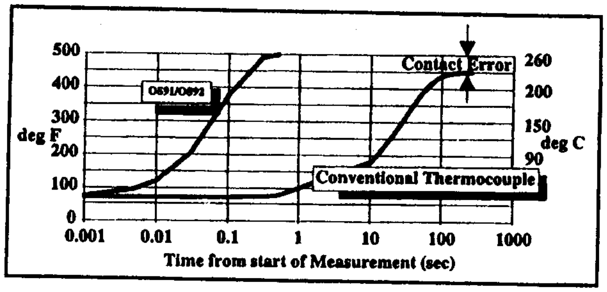


Figure 3-9. Time Comparison between OS91 and OS92 Digital Infrared Temperature Scanners and Contact Thermocouple for Measuring a 500°F (260°C) Surface

OS91 and OS92 Digital Infrared Temperature Scanners are available in the compact 1-piece standard model.

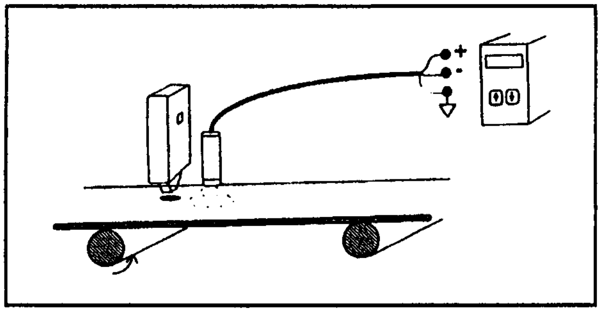


Figure 3-10. OS91/OS92 Scanning

3.5 Calibrating with Thermocouple Simulators

A common standard practice in thermocouple transmitter calibration is to set the 4 to 20 mA range on the bench before installation. The usual procedure is to employ a thermocouple simulator which can be programmed to produce a thermocouple equivalent signal of the desired type and temperature range. In this fashion, the 4 mA is set with the ZERO, and the 20 mA with the SPAN for the desired range.

A bench calibration of a transmitter can be performed to operate with any IRt/c model by adding the following step to the normal method.

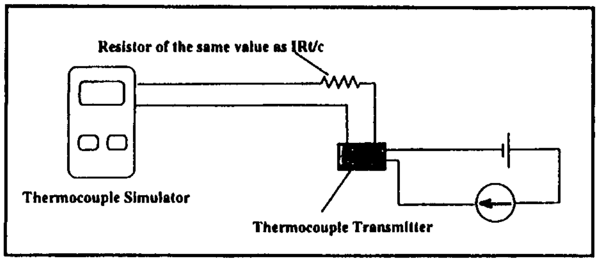


Figure 3-11. Simulator Calibration

Measure the electrical resistance of the IRt/c to be used with the transmitter, and add a resistor of the same value in series with the simulator.

With this step, the simulator "looks" to the transmitter exactly the same as the IRt/c, and any offsets caused by transmitter leakage currents can be calibrated out. Good practice is to check to make sure that the calibration remains stable on the bench, in case the transmitter leakage current is not constant. As always with infrared devices, a final trim calibration should be performed in actual operation (see the Installation Procedure in Section 3.2).

NOTES

4 Principles of Infrared Measurement

In 1665, Sir Isaac Newton became the first to split sunlight into colors with a prism, thus demonstrating the existence of light as radiated energy of differing wavelengths.

About 135 years later, another great English astronomer-scientist, William Herschel, measured the heat content at each of the colors of Newton's spectrum. Herschel was shocked to discover that his thermometer registered the greatest heat beyond the red -in an area of the spectrum he could not see.

He coined the term "infrared" to describe this heat energy "beyond the red."

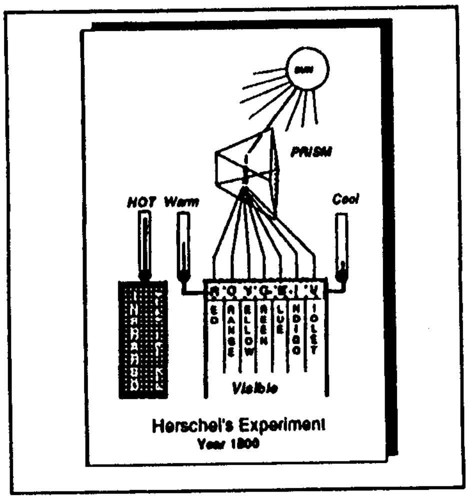


Figure 4-1. Infrared Measurement

One hundred years later, a German scientist by the name of Max Planck solved the problem of quantifying heat radiation, making it possible to apply radiation physics as a tool. To reach this goal, Planck had to resort to probably the most significant "guess" in the history of science! He invented "quanta" to explain heat radiation. This led directly to the creation of quantum physics, arguably the most useful of all physics models of the way the universe works.

An object emits heat directly as a function of its temperature, as determined by the Stefan-Boltzmann equation:

$$e = ST^4$$

where e is the total emitted energy by radiation, T is the object's temperature on the absolute scale, and s is the Stefan-Boltzmann constant.

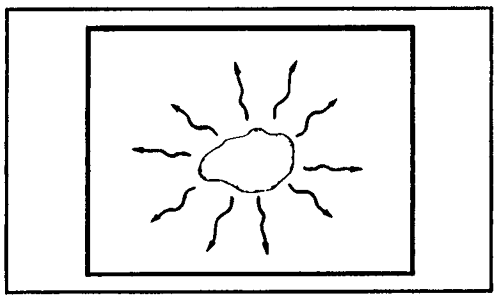


Figure 4-2. Emissivity

The infrared thermocouple measures this energy and produces a signal proportional to the amount of energy radiating from the object it is looking at, which includes both emitted and reflected energy. Unfortunately, few objects are perfect emitters and reflect, to varying degrees based on their surface properties, radiation from nearby objects. To make good infrared measurements, it is important to understand the proportion of radiation that an object emits as compared to the radiation it reflects. This property is called emissivity.

NOTES

5 Emissivity

Table 5-1. Emissivity Ranges

	Emissivity Range	OS Selection
Metals		
Aluminum:		
Highly polished plate, pure	0.04-0.06	OS38
oxidized at 1110°F (600°C)	0.11-0.19	OS38
commercial sheet	0.09	OS38
Brass:		
Highly polished plate, pure	0.10	OS38
oxidized at 1110°F (600°C)	0.59-0.61	OS38
Chromium, polished	0.08-0.36	OS38
Copper:		
polished	0.05	OS38
heated at 1110°F (600°C)	0.57	OS38
Gold, pure, highly polished	0.02-0.03	OS38
Iron and steel (excluding stainless):		
iron, polished	0.14-0.38	OS38
cast iron, polished	0.21	OS38
oxidized at 1110°F (600°C)	0.64-0.78	OS38
wrought iron, polished	0.28	OS38
dull oxidized	0.94	OS36/OS37
iron plate, rusted	0.69	OS38
steel, polished	0.07	OS38
oxidized at 1110°F (600°C)	0.79	OS38

Table 5-1. Continued	Emissivity Range	OS Selection
Metals (cont'd)		
rolled sheet steel	0.66	OS38
steel plate, rough	0.94-0.97	OS36/OS37
Lead, gray oxidized	0.28	OS38
Mercury	0.09-0.12	OS38
Molybdenum filament	0.10-0.20	OS38
Nickel:		
polished	0.07	OS38
plate, oxidized at 1110°F (600°C)	0.37-0.48	OS38
Platinum:		
polished plate, pure	0.05-0.10	OS38
wire	0.07-0.18	OS38
Silver, pure, polished	0.02-0.03	OS38
Stainless steel:		
polished	0.07	OS38
type 310, oxidized from furnace service	0.90-0.97	OS36/OS37
Tin, bright	0.06	OS38
Tungsten, filament, aged	0.03-0.35	OS38
Zinc:		
commercial pure, polished	0.05	OS38
galvanized sheet	0.21	OS38
Nonmetals		
Asbestos	0.93-0.94	OS36/OS37

Table 5-1. Continued	Emissivity Range	OS Selection
Brick:		
red, rough	0.93	OS36/OS37
fire clay	0.75	OS36/OS37
Carbon:		
filament	0.53	OS36/OS37
lampblack, rough deposit	0.78-0.84	OS36/OS37
Glass (Pyrex, lead, soda)	0.85-0.95	OS36/OS37
Marble, light gray, polished	0.93	OS36/OS37
Paints, lacquers, and varnishes:		
white enamel	0.91	OS36/OS37
flat black lacquer	0.96-0.98	OS36/OS37
aluminum paints	0.27-0.67	OS38
oil paints, 16 colors	0.92-0.96	OS36/OS37
Porcelain, glazed	0.92	OS36/OS37
Quartz, opaque	0.68-0.92	OS36/OS37
Water	0.95-0.96	OS36/OS37
Wood, oak, planed	0.90	OS36/OS37

NOTE

Lower emissivity surfaces require more stable conditions than high emissivity surfaces for accurate temperature control. Above are approximate values and can vary significantly with surface condition. Best to install an IRt/c and test. Emissivity data from Heat, Mass, and Momentum Transfer by Rohsenow and Choi, Prentice-Hall, 1961.

Emissivity is a surface property which determines how well an object's temperature can be measured. 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 mirror is 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.

Figure 5-1. Reflections

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 IRt/c sees.

When you look in the mirror with your eyes, you see only reflection, nothing of the mirror itself. I1 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 the 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.

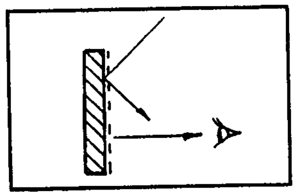


Figure 5-2. Poor Emitter (Emissivity = 0.1 Reflectivity = 0.9 Total = 1.0)

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 as the rule of emissivity:

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

Shiny metal surfaces act like mirrors: they reflect more ambient radiation than they emit on their own. The IRt/c is specially designed to accurately measure all but shiny metal surfaces, including all plastics, paper, and coated metal surfaces. Any shiny metal surface will require preparation to make a good measurement. Painting the surface black or covering the surface with tape, substantially reduces the reflection of ambient radiation, allowing the IRt/c to read only the target's emitted radiation. Alternatively, if the surface is wet with a thin layer of liquid, the liquid will be at the same temperature as the surface and will allow high-emissivity measurements.

WARNING

Black felt-tip marker will not cover the surface well enough to reduce reflections; use a pigment black paint.

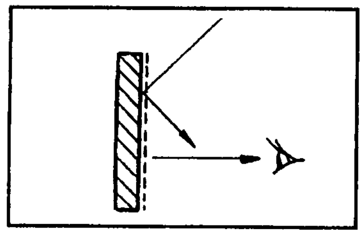


Figure 5-3. Good Emitter
Emissivity = 0.90
Reflectivity = 0.1
Total = 1.0

Consider the 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, 0% reflects, the emissivity equals 1.0. This type of object is called a black body.

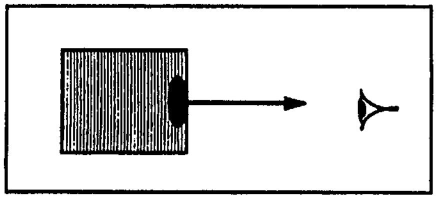


Figure 5-4. Poor Emitter
(Emissivity = 1.0
Reflectivity = 0.0
Total = 1.0)

Some applications may require measuring objects which change surface characteristics appreciably, affecting the emissivity, and therefore, the temperature indicated by the IRt/c. Testing under actual operating conditions is recommended to determine suitability.

Some thin plastic films, especially polyethylene and polypropylene are transparent to infrared wavelengths. This means that the IRt/c will "see through" the film and not measure its temperature. The recommended procedure is to simply install the IRt/c in place and monitor results.

Dull metals have emissivities between 0.1 and 0.9. At the higher end, the results will be satisfactory, but at the lower end they will not. Again, the best procedure is to install an IRt/c in place and monitor results. Refer to Section 3.3 for procedure. For low emissivities, the OS38 models are recommended due to their superior filtering characteristics for emissivity variations.

NOTE

Emissivity calibration for the IRt/c is accomplished by adjusting the readout device. No adjustment of the IRt/c is required (except for OS37, OS38).

6 Operation

Like all thermocouples, the IRt/c generates a signal by utilizing the thermoelectric properties of dissimilar metals. This means the electrical connections to the IRt/c are actual thermocouple wires. Thermocouple wire must be used to extend the cable length, and the IRt/c must be connected to a readout device with cold junction compensation.

Each IRt/c model is optimized for performance in the temperature range indicated in the Temperature Selection Chart as "2% Accuracy." This applies to all IRt/c types (J, K, etc.) and is the recommended selection. Outside the 2% range, the signal output matches a standard thermocouple less precisely (5% accuracy and >5% accuracy) but maintains repeatability. Each can be used for control to temperatures from 0°F (-17.7°C) to 1200°F (648.8°C).

The accuracy specification of the IRt/c refers to how well it matches the equivalent signal produced by a standard thermocouple. The temperature ranges specified are those in which the non-linear signal from the IRt/c matches the relatively linear signal from a thermocouple, within 2%, 5%, or >5%. Outside of these ranges, the IRt/c retains its repeatability, and the readout device can be calibrated to the IRt/c output.

The accompanying charts: J, K, T, or E give typical temperature output (y-axis) relative to actual (x-axis) temperature, and can be used to estimate suitability for application.

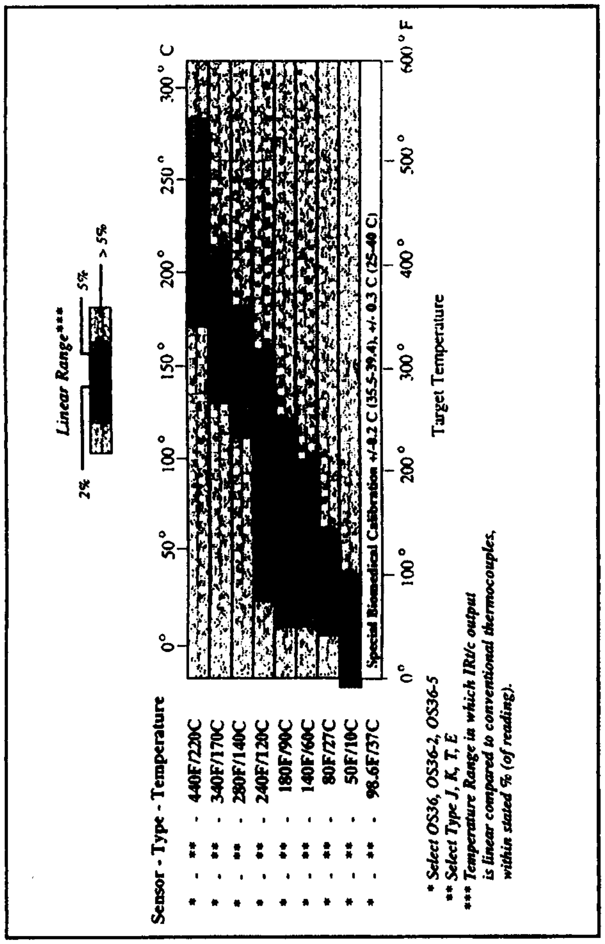


Figure 6-1. IRt/c Temperature Selection Guide

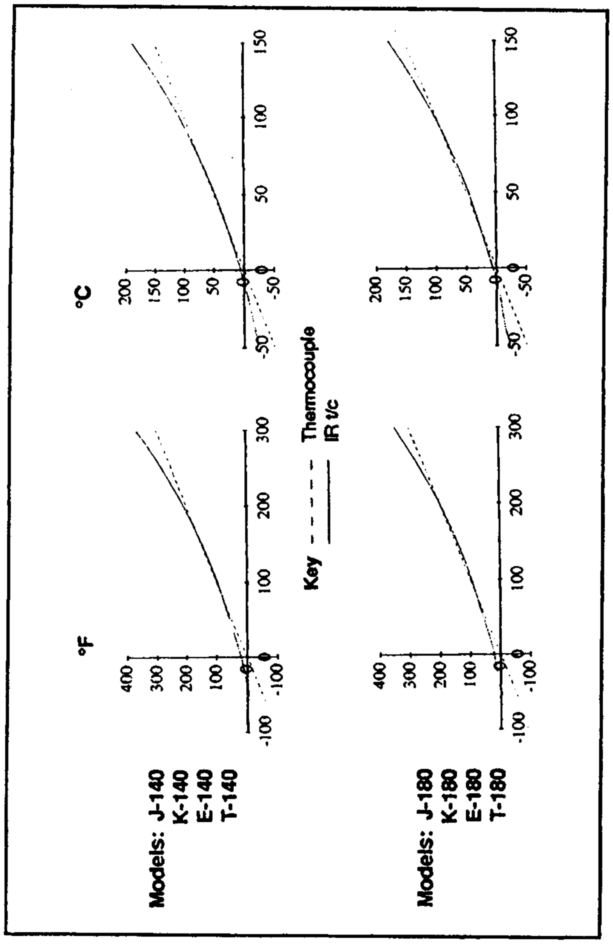


Figure 6-2. "-140" and "-180" Models

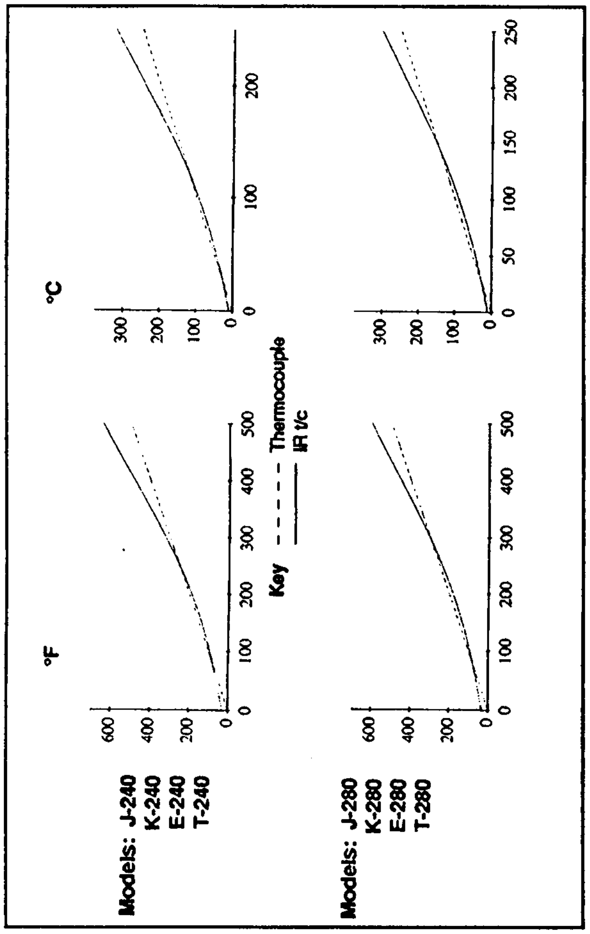


Figure 6-3. "-240" and "-280" Models

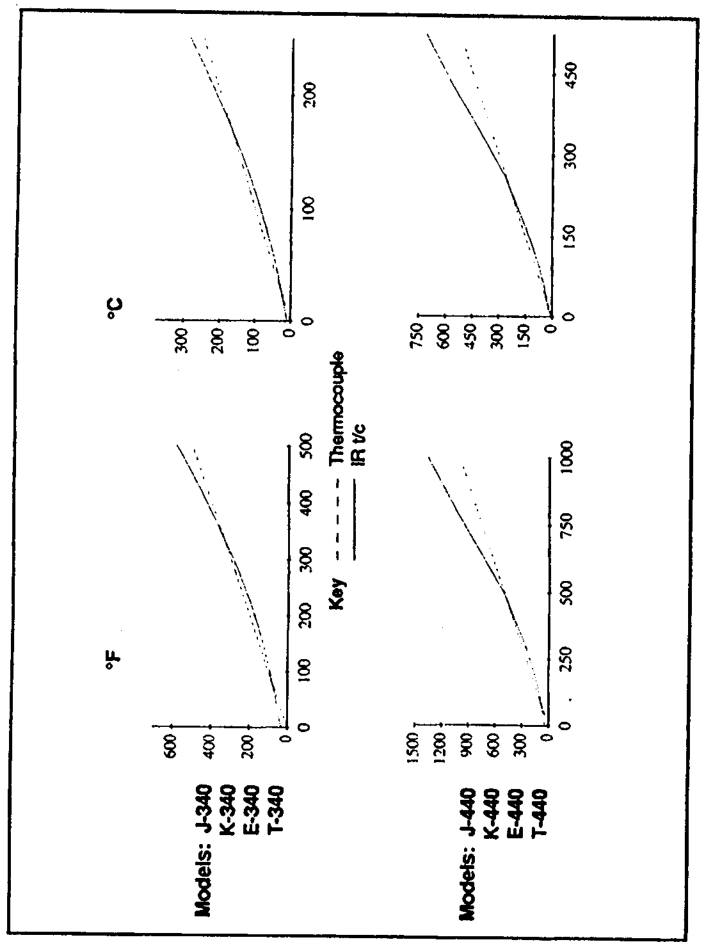


Figure 6-4. "-340" and "-440" Models

NOTES

7 Differential Measurements

Since the IRt/c is truly a thermocouple, complete with thermocouple wire leads, it can be used in series or parallel circuits. For example, several thermocouples can be mounted across a web and wired in parallel to give the average temperature across the web. Also, two infrared thermocouples can be mounted side-by-side and wired differentially to make precise relative measurements. This is a powerful tool in adhesive applications for example, where it is desired to measure the amount of hot melt which is placed on the substrate. If a small bead of hot melt adhesive is being used, small changes in quantity will give small changes in IRt/c output, which could easily be masked by small changes in substrate temperature. However, if two sensors are used in a differential arrangement, one is used to measure the substrate, while the other measures the applied hot melt. If there is no hot melt, the outputs of each sensor are the same (since they are both looking at the same target) and the resulting output of the differential pair is zero. As hot melt is applied, one IRt/c measures the slightly higher temperature independent of substrate temperature changes, and the differential output is a positive signal. This differential signal is directly a function of the amount of applied adhesive.

This method can be used for many other differential temperature inspection tasks in a similar fashion.

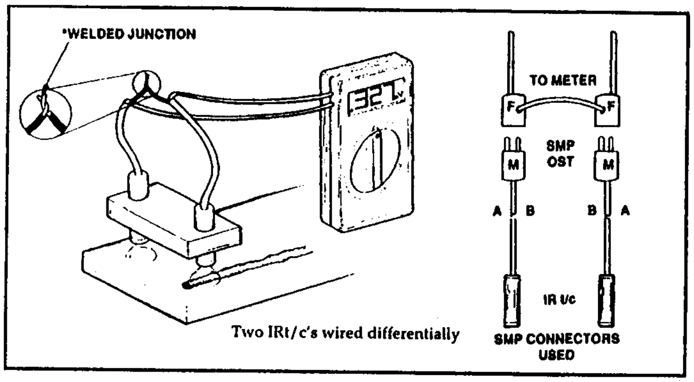


Figure 7-1. Wiring for Differential Measurement

*If it is not convenient to weld this junction, use SMP connectors as shown in Figure 7-1 to connect two common polarity wires.

8 Field of View

IRt/c's are rated optically for their field-of-view by the actual dimensional equations describing their construction. However there are, in practice, some secondary effects which can influence performance, including optical scatter, unwanted reflections, atmospheric scatter, and others.

Figure 8-1 illustrates the relative contribution to the signal produced by the target and by the area surrounding the target due to these effects. Note that the sum of radiation from the target and radiation from the surroundings is always one, and as the sensor is placed further away than its rated field-of-view, there is less target signal and more surroundings signal. Mathematically this effect is identical to a reduction in emissivity, and can be calibrated out the same way, as long as the temperature of the surroundings is repeatable. Under typical conditions, placing the IRt/c such that the target exactly fills the field of view results in approximately 80 to 90% target signal, and 10 to 20% surroundings signal.

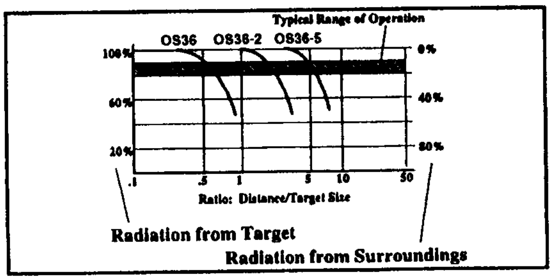


Figure 8-1. Relative Contribution to the Signal Produced by the Target

As always, if it is possible to do so, closer is best.

The OS36, for example, has a **field of view** of 1:2. Also referred to as a distance-to-target size ratio, a 1:2 field of view means that the sensor sees a circular area with a diameter equal to two times the distance between the sensor and target. For example, at a 2-inch distance, the sensor sees a 4-inch diameter spot.

The IRt/c should be mounted as close as possible to the target being measured. This ensures that the target completely fills the field of view. In addition, it minimizes the amount of radiation, emitted by other objects in the room and reflected off the target and into the sensor.

The curve below shows the actual performance. Note that as distance is increased, target signal is replaced by ambient signal, which is exactly analogous to a reduction in emissivity. The best practice is to simply mount the IRt/c as close as practical.

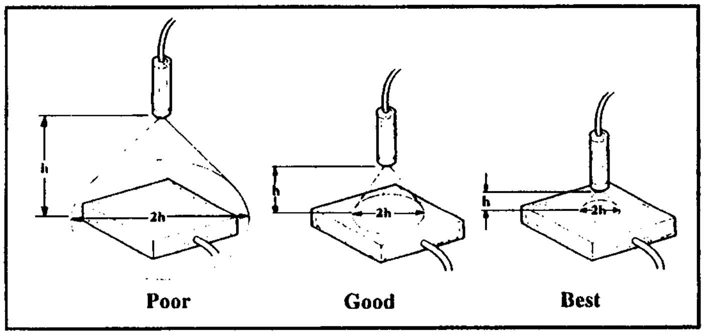


Figure 8-2. Placement of IRt/c

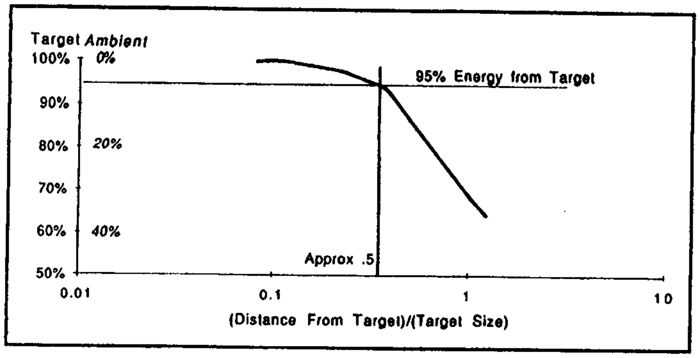


Figure 8-3. OS36 Optical Characteristics
Effect of Distance on Temperature Signal

NOTES

9 Repeatability

Within the specified accuracy band for each model, the device-to-device repeatability is 2%. The repeatability for a given instrument is 1% of the reading on the readout device.

Because of the fact that an object emits energy as a function of its temperature to the fourth power, significant non-linearities can result for temperatures outside the specified range. For applications outside the specified operating ranges, the IRt/c is suitable for recalibration to ensure accuracy at a required setpoint (See Chapter 3). The IRt/c provides a continuous but unspecified signal up to 1200°F (648.8°C) with a 1% repeatability under normal use. If the IRt/c housing temperature is held constant, repeatability is better than 0.01% of reading.

NOTES

10 Response

The time constant for the Infrared Thermocouple is 80 milliseconds, allowing fast temperature measurements to be made. Most controllers and thermocouple readout devices, however, are quite slow, taking readings about once every second. Often the response of the IRt/c appears to be slow because it is connected to a slow readout device.

The fast response of the IRt/c allows it to be connected to an oscilloscope or spectrum analyzer to study the frequency domain of temperature phenomena.

While neither an oscilloscope or spectrum analyzer has cold junction compensation for the thermocouple, it is not necessary when working in the frequency domain because cold junction compensation is a dc or extremely low frequency effect.

NOTES

11 Effect of Changing Ambient Temperatures

The internal compensation system allows the IRt/c to operate in any ambient temperature between 80° and 200°F (27° to 93°C) and still maintain accuracy equivalent to ASTM specifications for thermocouples. However, as the housing temperature changes, the output of the instrument may vary slightly. Typical variation is 0.02% of the reading per °F change, with a maximum variation for any model of 4°F (2°C) over an ambient change of 20°F (10°C). if greater stability is required, variations in the housing temperature of the IRt/c should be minimized. The IRt/c housing has been designed so that it conducts heat readily, so that the IRt/c can be heatsunk to a machine chassis or some other object which experiences little temperature variation.

NOTES

12 Readout-Generated Current Offsets

Many thermocouple instruments and read-out devices generate a small amount of leakage current which is usually generated to test for broken thermocouples. The instrument can determine that the thermocouple is damaged if an open circuit results.

Most thermocouples have small internal resistances, usually well below 100 ohms. The IRt/c, however, has an internal resistance of several Kohms, which can cause a constant offset on the instrument's output. For most instruments, the offset is less than 20°F (11°C). A few instruments, however, produce offset errors of 100°F (56°C). In all cases, this offset is constant, and does not affect the operation of the IRt/c, and can be calibrated out with the instrument's offset adjustment. An alternative solution is to select an instrument with a smaller "leakage" current, normally indicated by a higher input impedance specification.

To understand the instrument generated offset, perform the simple bench-check that follows. Once the IRt/c is installed and removal is inconvenient, follow the steps in the on-line calibration procedure to eliminate any instrument generated offset.

NOTES

13 Troubleshooting & Special Environment Operation

13.1 Troubleshooting Guide

Problem	Solution
IRt/c does not respond	1. Check wiring for correct connections. 2. Check electrical resistance of IRt/c to be about 3 Kohms. If short or open circuit is found, replace IRt/c. 3. Check window for blockage. Clean with alcohol or other common cleaner.
IRt/c reads too high	1. Check read-out device for offset. 2. Check rating of IRt/c. Be sure proper model is used for the target temperature and t/c type.
IRt/c reads too low	1. Check IRt/c model to make sure it is in the proper range. 2. Check for lens cleanliness. If dirt builds up, provide air jet. See also Section 13.3.
IRt/c seems inaccurate or erratic	1. Check to be sure target does not have a shiny metal surface. See also Section 5. 2. Dull metal will give low readings. Recalibrate for greater accuracy.See also Chapter 3. 3. Check for high ambient temperature. Provide cooling or heat sinking, if necessary. See also Section 13.4.

13.2 Failure Modes

The IRt/c has three possible failure modes which should be considered when using the instrument. Careful use is required to prevent damage and maintain safety.

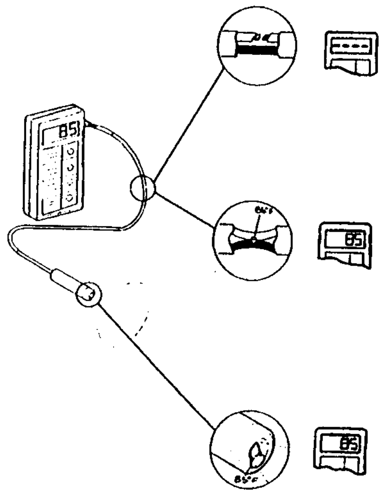


Figure 13-1. Three Possible Failure Modes

1. The IRt/c will show an electrical open circuit if a lead is severed either inside or outside the device, thus allowing open circuit detection circuits in instruments to respond.

2. A short in the external connecting leads will cause a failure that is undetectable by the instrument. The indicated temperature will be that of the short circuit.

3. The IRt/c will produce a signal indicative of the IRt/c housing temperature and not the target temperature if the sensor is blocked or damaged.

13.3 Operation in Dirty Environments

Just like eyeglasses, which must let light through for the eye to see, the window of the IRt/c must be kept clean to allow infrared radiation to pass through to the infrared sensor inside. Dust, splattering liquids, or condensing moisture can settle on the window and prevent proper operation of the IRt/c.

For applications where excessive dust, debris, or airborne particles are present, use an air purge collar/cooling jacket (Part Number OS36-APC, shown below) supplied with approximately 0.1 cfm of clean (instrument-grade) air. For particularly dirty environments, higher airflows may be required.

All IRt/c models except OS36, OS36-RA, OS36-01 have built-in air purge. See individual specifications.

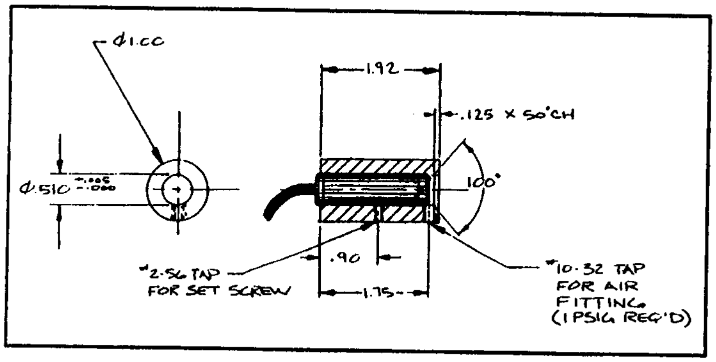


Figure 13-2. OS36-APC

13.4 Operation in High Ambient Temperatures

The internal temperature of the IRt/c should not exceed 212°F (100°C). For use in oven applications where the product travels on a conveyor through the chamber, the IRt/c can be mounted at the outlet to monitor the temperature of the product as it emerges from this particular processing step. To mount inside the chamber, the IRt/c must be heatsunk, using a copper tube, for example, to a cooler part of the machinery outside. Alternatively, an air cooling jacket can be employed.

To test whether the operating environment exceeds the specification of the IRt/c, use the following simple procedure:

1. Cover the IRt/c with aluminum foil so that it is "blinded."
2. Place the IRt/c in its proper operating position, connect the IRt/c to a readout instrument, and allow it to stabilize.

The reading of the instrument is the ambient temperature of the IRt/c during operating conditions. Be sure that this temperature is below 212°F (100°C).

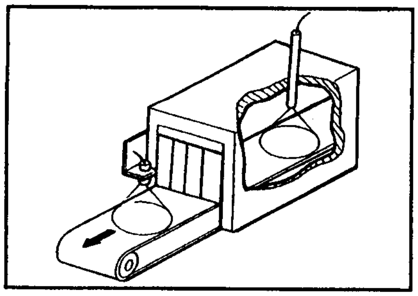


Figure 13-3. High Ambient Operation

14 Accessories

14.1 General List

The following accessories are available from OMEGA Engineering, Inc.

Part Number	Description
OS36-(#)-KIT	6 Unit kit, includes one IRt/c of each temperature range
OS36-MB	Aluminum mounting bracket
OS36-MB2	Stainless steel mounting bracket for OS36-5, OS36-10, OS37-10, OS38-10, OS37-100, OS38-100 Series Infrared Thermocouples
OS36-MR	Mounting Ring
GMP	Low noise miniature connector [1]
GST	Low noise standard connector [1]
OS36-APK-120	Air pump kit for air purge supply for OS36-2 and OS36-5 Series Infrared Thermocouples, 120Vac, 120 cu. in./min (1960 cc/min.)
OS36-APK-12	Air pump kit for air purge supply for OS36-2 and OS36-5 Series Infrared Thermocouples, 12Vdc, 120 cu. in./min (1960 cc/min.)
OS36-GMK	Gooseneck Mounting Kit

Part Number	Description
OS36-APC	Air purge collar/cooling jacket for IRt/c and OS36-2 Series infrared thermocouples
OS36-PK	Periscope kit

#: specify J, K, T or E
I: see below for various connector

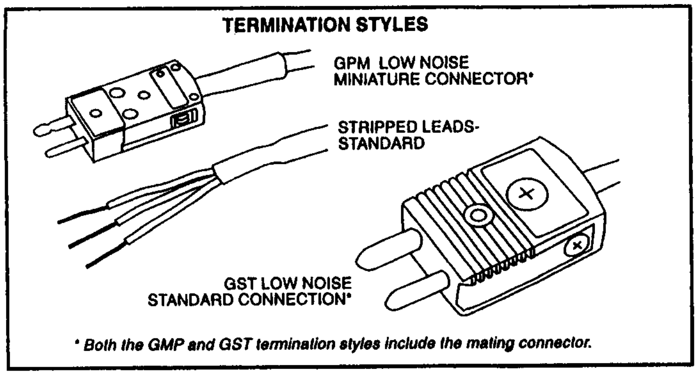


Figure 14-1. Low Noise Alternative Outputs

14.2 Thermocouple Extension Cable

- Twisted shielded pair for high noise rejection
- Can be used up to 1000 feet (300m) in length
- FEP Teflon Jacket/insulators - service temp. to 392°F (200°C)
- Highest accuracy - thermocouple grade wire
- Available in J, K, T and E type (special order R, S extension cable)

Although commonly available thermocouple extension wire may be used with IRt/c's, twisted shielded pair wire is preferred due to its much superior noise rejection characteristics. This feature is particularly important when using IRt/c's with long extensions in electrically noisy environments, due to relatively high impedance of IRt/c's compared to ordinary thermocouples..

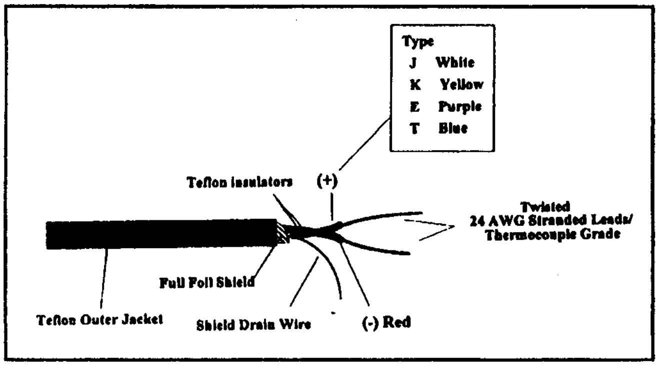


Figure 14-2. Thermocouple Wire

14.3 Thermocouple Connector

- Easy installation of IRt/c, with up to 1000 feet (300m) extension cable
- Connector ground protects against electrical noise errors
- Write-on area for easy identification
- Superior mechanical connection prevents signal loss due to vibration or wire movement
- Rugged glass-filled nylon shell rated to 425°F (218°C)
- High purity thermocouple alloy pins and sockets

The IRt/c miniature low noise connectors are designed to provide an easy connection of ground wires to IRt/c's and extension wire. The drain wire of a 20AWG twisted shield cable or the shield of the overbraided wire is crimped and held in place by the internal hardware. They have excellent thermal and electrical characteristics to assure high accuracy. Each connector includes a write-on insert and an external ground strap to maintain the electrical connection of the ground wire and strengthen the mechanical connection between connectors.

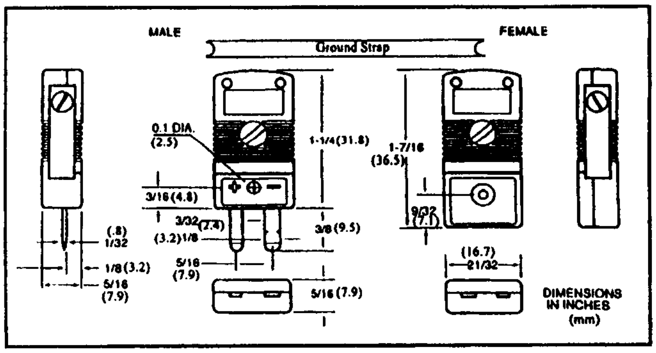


Figure 14-3. Connector Dimensions

14.4 OS36-APK (Air Pump Kit for Air Purge Supply)

The convenient Air Pump Kit allows for fast and easy installation of an air source suitable for maintaining optical cleanliness of IRt/c's in dirty, dusty environments. Its air flow is sufficient to keep up to five OS36-2, or one OS36-5 clean. Additionally, the air flow is sufficient to allow an OS36-2 to operate in ambient temperature up to 240°F (115°C). The pump can be mounted on either horizontal or vertical surfaces. Install particulate filter on pump inlet to maintain clean air supply.

Specifications

Air pump:	120Vac, 120 cu. in./min (1960 cc/min.)
Vinyl Tubing:	10 ft (3m), 0.25" (6mm) OD, 0.7" (4mm) ID
Standoff Mounts:	allow pump to be secured vertically or horizontally

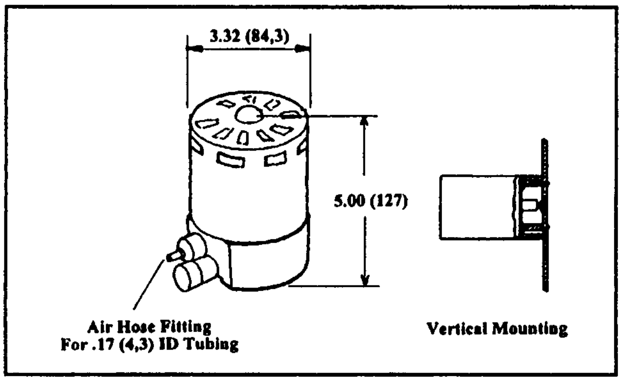


Figure 14-4. Air Pump Kit Dimensions

14.5 OS36-PK (Periscope Kit)

For tight installations, where the IRt/c will not physically fit to view the desired target, the Periscope Kit accessory attaches to the OS36-2 to provide a right-angle view. The periscope is constructed entirely of stainless steel, including a polished stainless steel mirror. The periscope is designed in such a way that the air purge of the OS36-2 automatically keeps the mirror clean when used in harsh environments. The air pressure may be adjusted to clear an optical path to the target, as well as keep the mirror clean (see Application Notes Book - Chapter entitled IRt/c Temperature Measurement in Steaming Environments).

Since there is a small reflection loss from the mirror assembly, the set-up calibration setting is slightly different from the setting for the bare OS36. The difference is approximately the same as a change in target emissivity from 0.9 to 0.8. The normal installation set-up (provided in Section 2.2) should be performed with the periscope in place.

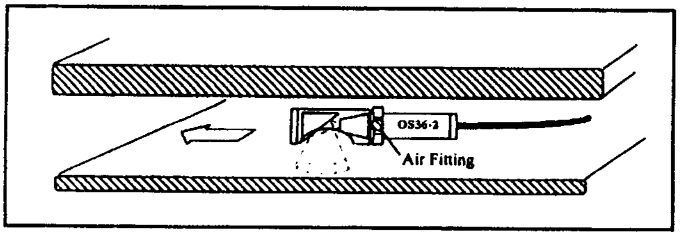


Figure 14-5. How the Periscope Works

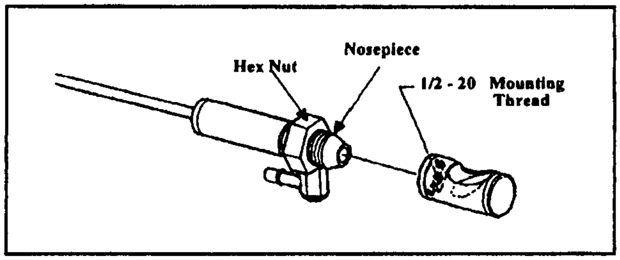


Figure 14-6. Parts of the Periscope Assembly

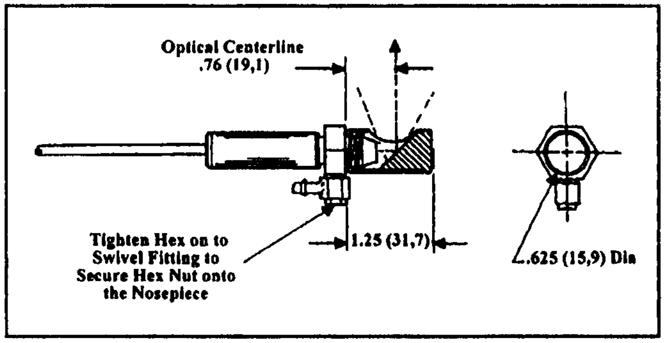


Figure 14-7. Dimensions

14.6 OS36-GMK (Gooseneck Mounting Kit)

For fast and convenient mounting of IRt/c's, especially for testing, the Gooseneck Mounting Kit provides an inexpensive method to quickly install an IRt/c directly on the production line. Its heavy duty design provides excellent stiffness for reliable positioning. Clamps are fabricated of aluminum for durable performance. The sensor clamp fits all IRt/c models.

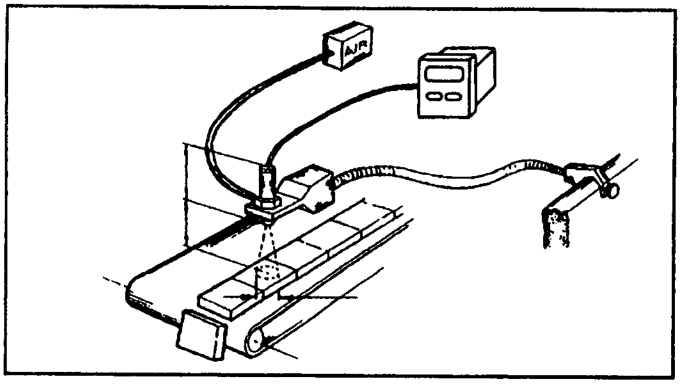


Figure 14-8. Gooseneck Location

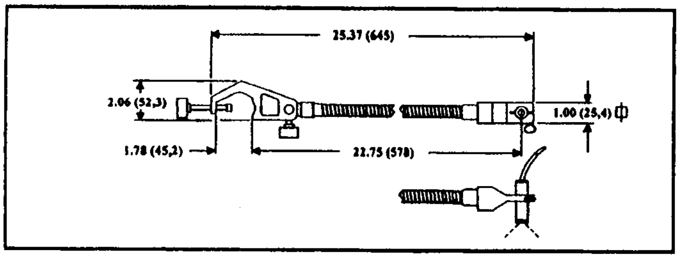


Figure 14-9. Dimensions

14.7 OS36-APC (Air/Water Cooling Jacket)

The air/water cooling jacket can be used with either the OS36 or OS36-2 with air, water, or both for service in harsh environments. Measuring only 4" x 1" (25 x 100 mm) overall, the cooling jacket is physically small enough to fit into tight areas and closely monitor process temperatures from the optimum position - up close. With its all stainless steel housing, it can withstand the harshest environments.

Extraordinarily efficient in design, the cooling jacket requires only 0.05 GPM (190 cc/min) to protect an IRt/c at 1000°F (540°C).

Features:

- Small size - 1" dia x 4.16" long (25 x 106mm)
- Stainless steel housing
- Seamless copper monotube cooling coil
- Complete equipment for air cooling and/or water cooling
- Air purge included
- Super-efficient design for low air or water use
- Fits both OS36 and OS36-2
- Air only to 450°F (230°C)
- Water cooling to 1000°F (540°C) with as little as 0.05GPM (190 cc/min)
- Enhances the IRt/c performance outside linear range

The water cooling system consists of a seamless monotube, in order to eliminate the possibility of leaking joints. For convenience, the seamless tubing extends 3 feet (1 meter) from the rear of the housing.

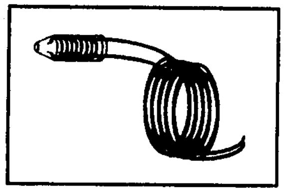


Figure 14-10. Cooling Jacket

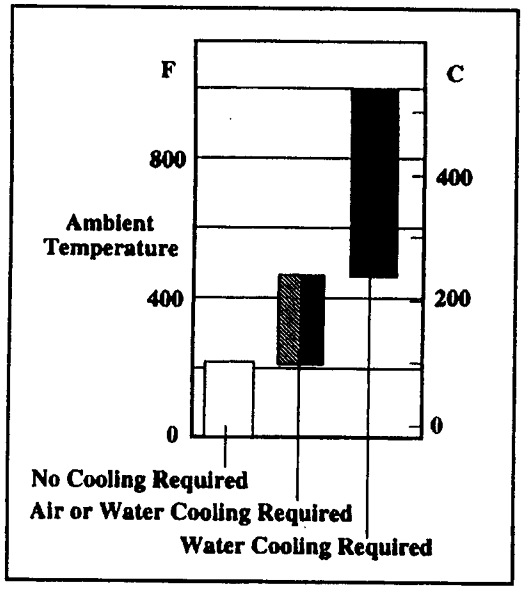


Figure 14-11 Temperature Chart

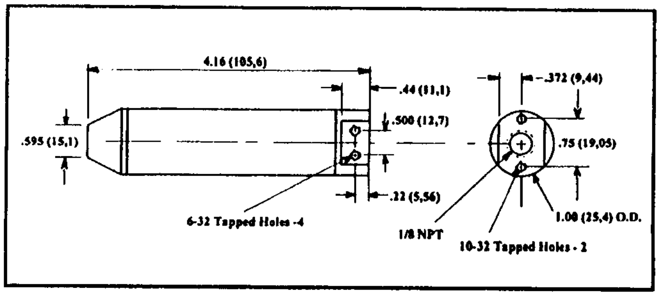


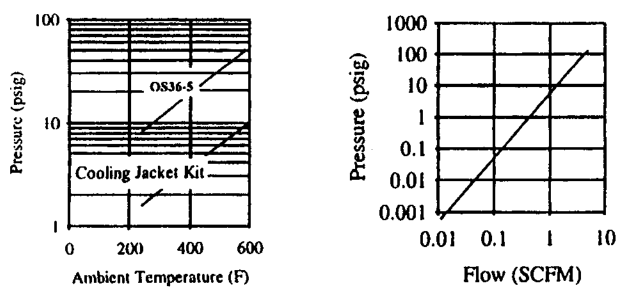
Figure 14-12. Housing Dimensions

14.8 Air Cooling Requirements

Up to 450°F (230°C), air alone can provide sufficient cooling with the Cooling Jacket. Note from the Air Cooling Chart (see Figure 14-13), the air required to cool an OS36 or OS36-2 is considerably lower than that required for OS36-5. For this reason, the OS36 and OS36-2 are recommended for hot areas if it is possible to bring the sensor close to the target.

The cooling chart extends above the recommended 450°F (230°C), and can be used here, but caution is advised due to the possible effects of hot spots.

If air consumption is of concern, or if ambient temperatures are above 450°F (230°C), water cooling is recommended. A small amount of purge air is also recommended when water cooling (see Application Notes Book - Chapter entitled Air Purging is Recommended When Using Water Cooling).



Air pressure required to cool OS36 and OS36-2 with cooling jacket at various ambient temperatures, compared to requirement for OS36-5.

To estimate air flow requirements, select the pressure required from the Air Cooling Chart, and read air flow above.

Figure 14-13. Air Cooling and Air Flow Charts

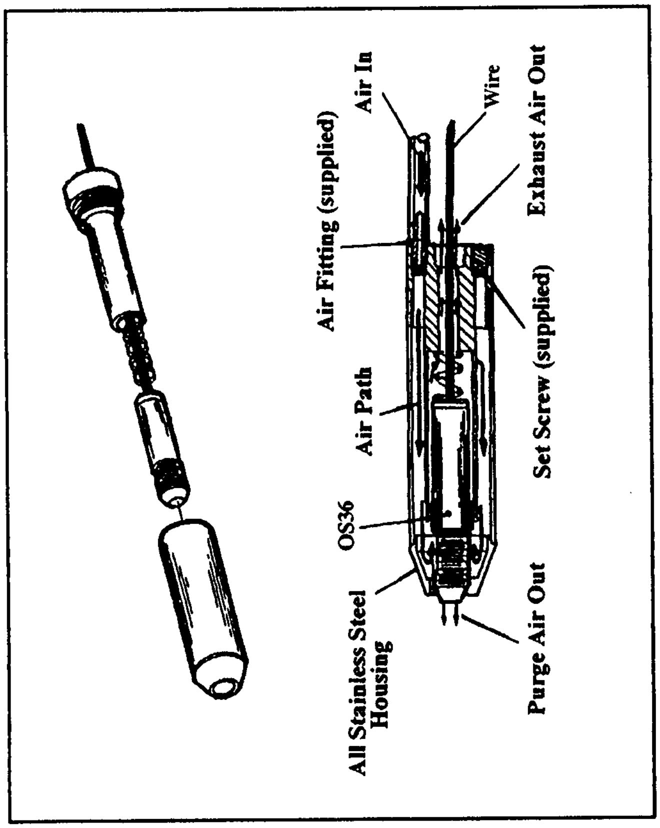


Figure 14-14. Air Cooling Configuration

(All fittings are supplied to use the OS36-APC (cooling jacket) in its air cooling configuration. Fits the OS36 and OS36-2.

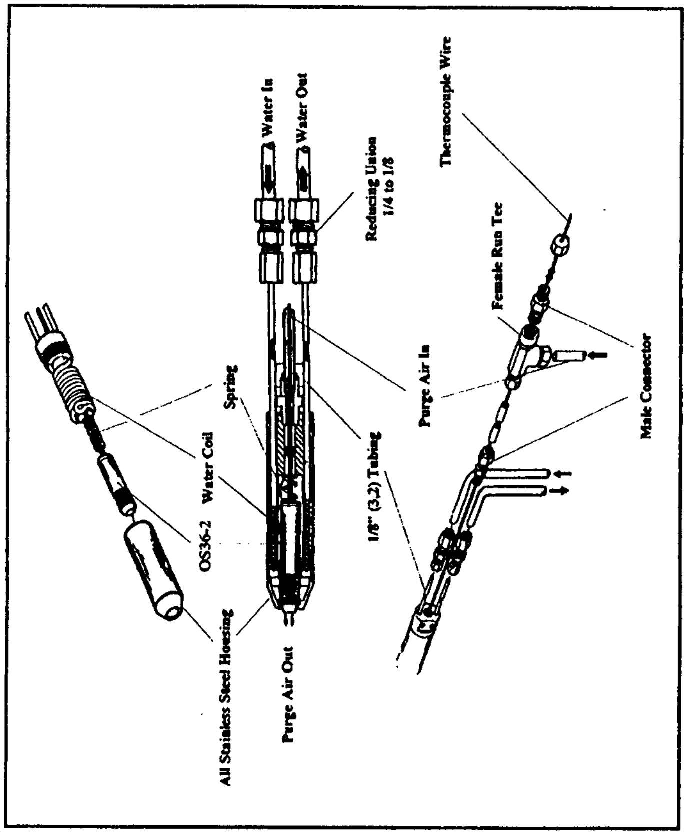


Figure 14-15. Water Cooling Configuration

(All fittings required are supplied.
Water flow greater than 0.05 GPM (190 cc/min.).
Fits the OS36 and OS36-2.)

14.9 OS36-MB (Mounting Bracket)

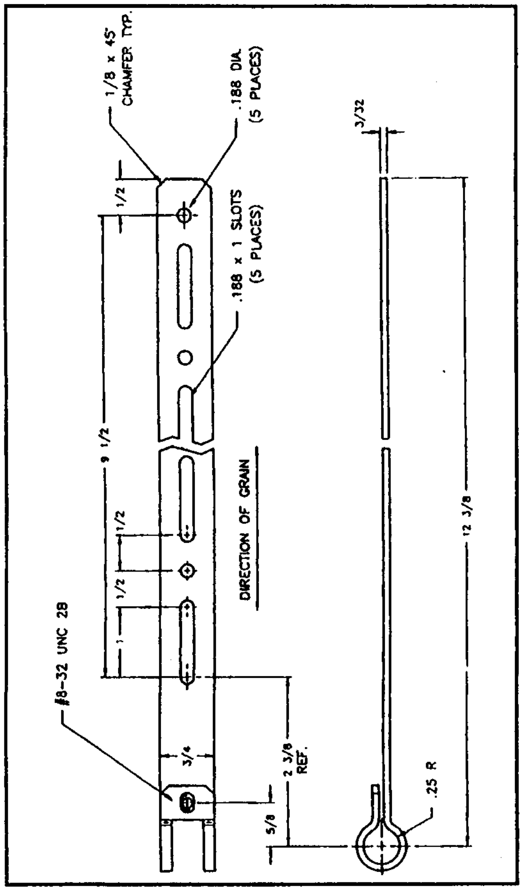
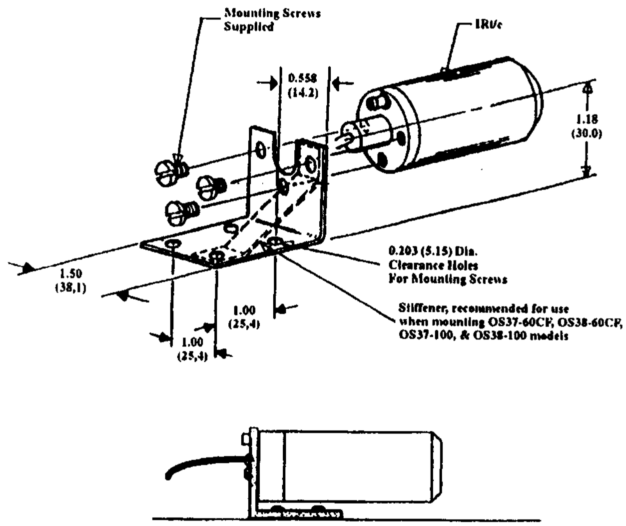


Figure 14-16. Aluminum Mounting Bracket

14.10 OS36-MB2 (Mounting Bracket)



Alternate Mounting Method

NOTE: *Use shims to fine tune alignment as necessary.*

Figure 14-17. Stainless Steel Mounting Bracket

14.11 OS36-MR (Mounting Ring)

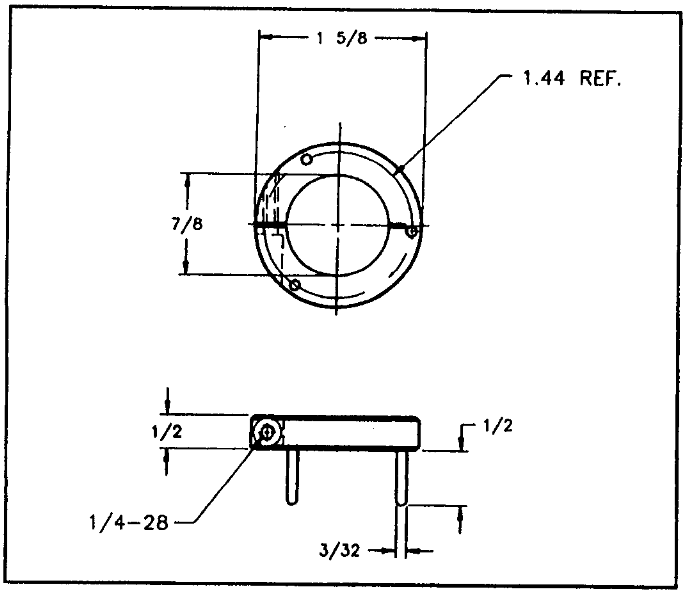


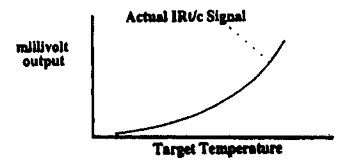
Figure 14-18. Mounting Ring

NOTES

Infrared Thermocouples - What They Are All About

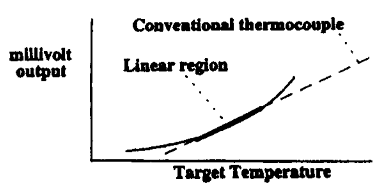
A.1 Introduction

The IRt/c sensors are unpowered and can measure surface temperatures of materials without touching. They can be directly installed on conventional thermocouple controllers, PLCs, transmitters, and other readout devices.



The actual signal generated by the IRt/c can be approximated with a fourth order polynomial function of target temperature. This fourth power dependence is due to radiation physics, and not a limitation of the IRt/c.

Figure A-1. IRt/c Signal vs Temperature



The linear region matches the conventional thermocouple to a specified tolerance.

Figure A-2. IRt/c vs Temperature Linear Region

A.2 How Do They Measure Temperature?

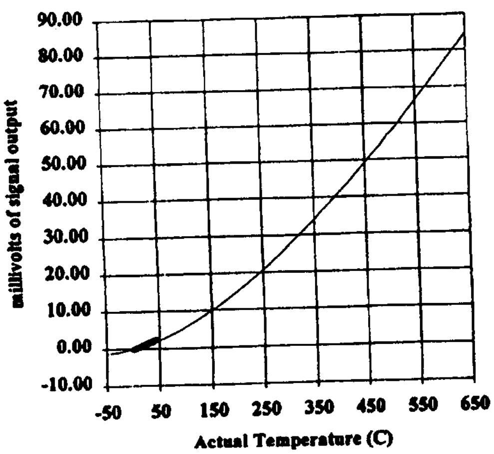
All IRt/c's have a proprietary infrared detection system which receives the heat energy radiated from objects the sensor is aimed at, and converts the heat passively to an electric potential. A millivolt signal is produced, which is scaled to the desired thermocouple characteristics.

Since all IRt/c's are self-powered devices, and rely only on the incoming infrared radiation to produce the signal through thermoelectric effects, the signal will follow the rules of radiation thermal physics, and thus be subject to the non-linearities inherent in the process.

However, over a range of temperatures, the IRt/c output is sufficiently linear to produce a signal which can be interchanged directly for a conventional t/c signal. For example, specifying a 2% match to t/c linearity results in a temperature range in which the IRt/c will produce a signal within 2% of the conventional t/c operating over that range. Specifying 5% will produce a somewhat wider range, etc.

The OS36-K-80F has its 2% linear range centered at 80°F (27°C), but produces a repeatable signal to 1200°F (650°C).

Each IRt/c model is specifically designed for optimum performance in the region of best linear fit with conventional t/c's, but can be used outside of those ranges by simply calibrating the readout device appropriately. The output signal is smooth and continuous over its entire rated temperature range, and maintains 1% repeatability over its entire range.



The OS36-K-80F has its 2% linear range centered at 80°F (27°C), but produces a repeatable signal to 1200°F (650°C).

Figure A-3. Full Range of IRt/c vs Temperature

A.3 Temperature Selection Guide

The Temperature Selection Guide is a summary of the linear range performance of each IRt/c model. The user selects the IRt/c model and type, and the target temperature range for the application. The normal offset adjustments on the thermocouple readout device are used to calibrate the installation for emissivity and background effects.

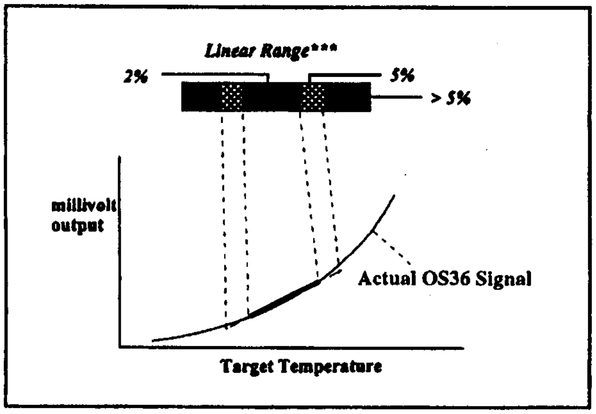


Figure A-4. IRt/c Linear Ranges

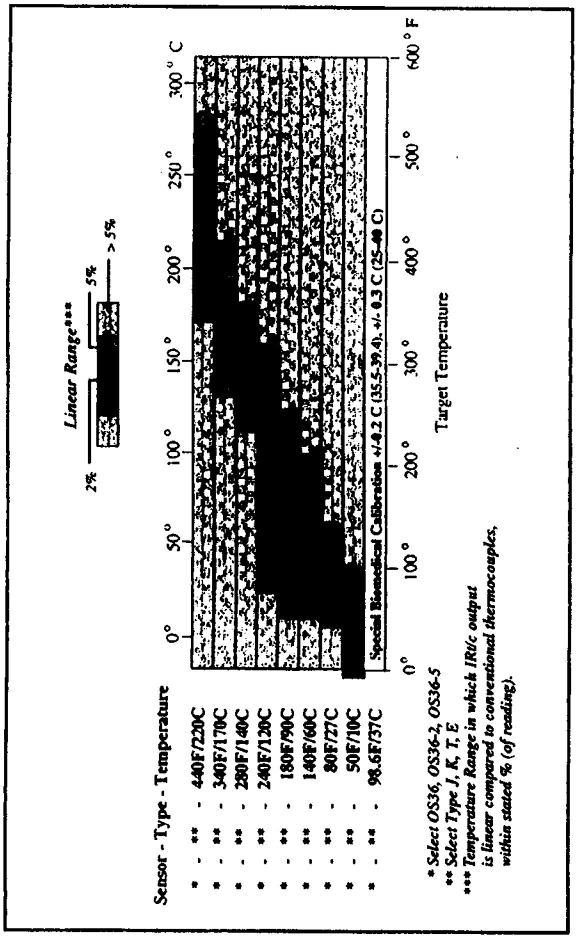


Figure A-5. Temperature Selection Guide

A.4 How Reliable are These Devices?

Of fundamental interest in temperature control is the ability of the measuring device to maintain its calibration under service conditions, and over a long period of time. The IRt/c is rated at 1% (of reading) repeatability and to have no measurable long term calibration change, which makes it well suited for reliable temperature control. These attributes are inherent in the basic design and construction of each IRt/c.

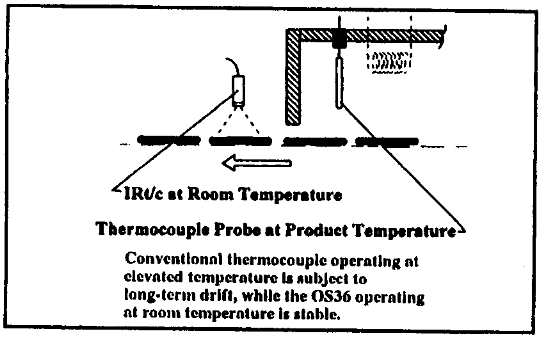


Figure A-6. IRt/c Stability

Repeatability is defined as the ability of a measuring device to reproduce its calibration under identical conditions. The IRt/c is a solid, hermetically sealed, fully potted system that does not change either mechanically or metallurgically during service. There are no active electronic components and no power source to produce the signal - only the thermoelectric effects that produce a thermocouple signal. The 1% rating is a conservative value based on the practical difficulty of demonstrating tighter tolerances under test conditions, rather than a true limitation of the device.

Long term accuracy is influenced by the same things that influence repeatability: mechanical changes and metallurgical changes. It is well known that thermocouples can change calibration over time due to these effects. Mechanical changes occur because conventional thermocouples are constructed generally as small and light as possible to enhance response time, thus making them vulnerable to deformations that can change the thermoelectric properties. More importantly, **the conventional thermocouple must operate at elevated temperature since it merely measures its own temperature.**

Dirt on the window will cause a calibration change. Use air purge collar/cooling jacket and routinely clean the window.

The metallurgical changes which affect thermoelectric properties are a strong function of temperature, being negligible at room temperature, and of serious concern at high temperature.

The IRt/c gives repeatable static and dynamic readings. See Figure A-7.

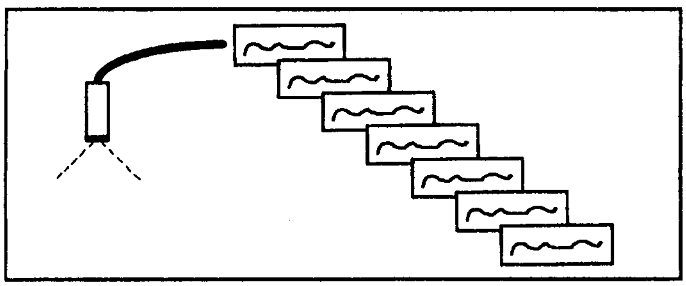


Figure A-7. IRt/c Repeatability

The IRt/c solves both problems by its design and basic operation. Its solid fully potted construction in a mechanically rigid stainless steel housing, and operation at near room temperature conditions, essentially eliminates the classical drift problems of conventional thermocouples. Every IRt/c is double annealed at temperatures above 100°C to ensure long term stability, and tested 5 times prior to packaging. Barring a very small percentage of failure, the IRt/c has essentially unlimited long-term calibration accuracy.

B Specifications

B.1 General Specifications

Specifications for All Models of OS36, OS37 and OS38	
Signal Output:	Thermocouple
Power requirements:	None
Cold Junction Compensation:	By measuring instrument, as with conventional thermocouples
Accuracy (Linearity):	the larger of ±2% of nominal value (target with emissivity of 0.9) or ±2°F(1°C)
Repeatability:	±1% of reading
Ambient Temperature Coefficient:	0.02% of reading/°F (0.04% of reading/°C)
Ambient Temperature Compensation Range:	Complies with ASTM standards over 80° to 200°F (27° to 93°C)
Operating Ambient/Case Temperature Range:	0° to 212°F (−18° to 100°C)
Response Time Constant:	80 milliseconds approximately
Resolution:	0.0001°C approximately
Spectral Response:	range of 0.1 to 14μ
Housing:	Stainless steel or ABS non-shielded plastic
Sealing:	Hermetic, air and water tight, exceeds all applicable NEMA ratings
Output Cable:	Twisted shielded pair of base thermocouple material (J,K,etc.), 8 ft (2.4m) std length, Teflon sheathed rated to 392°F (200°C) continuous service

B.2 OS36

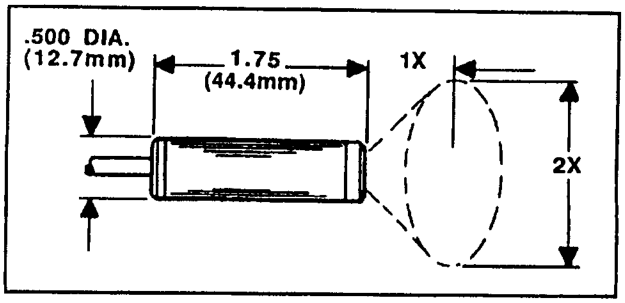


Figure B-1. OS36 Dimensions

Sensing Range:	–50° to 1200°F (–45° to 650°C)
Linear Range Selections:	8 models per thermocouple type (see Temperature Selection Guide)*
Field-of-View:	90° approximately
Minimum Spot Size:	0.3" (8 mm)
Output Impedance:	3 KΩ approximately
Dimensions:	1.75"x 0.5" Dia. (44 x 13 mm)
Weight:	1.4 oz (40 g) with cable
Air Purge:	None

* see Figure 6-1

B.3 OS36-01

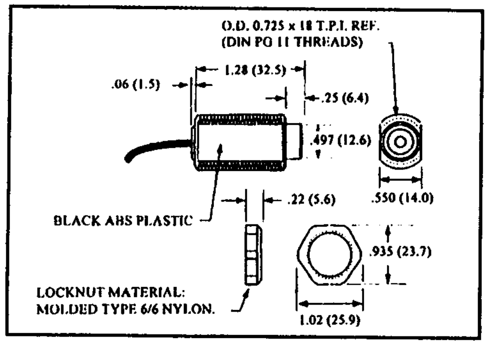


Figure B-2. OS36-01 Dimensions

Sensing Range:	−50° to 550°F (−45° to 290°C)
Ambient Temperature Range:	0° to 160°F (−18° to 70°C)
Linear Range Selections:	8 models per thermocouple type (see Temperature Selection Guide)*
Field-of-View:	90° approximately
Minimum Spot Size:	0.3" (8 mm)
Spectral Response:	6.5 to 14μ
Output Impedance:	3 KΩ approximately
Cable:	Thermocouple extension grade, PVC jacket, unshielded
Dimensions:	1.28"x 0.71" Dia. (32.5 x 20 mm)
Weight:	1.4 oz (40 g) with cable
Housing:	High strength ABS, hermetically sealed, meets or exceeds all applicable NEMA rating, intrinsically safe

*see Figure 6-1

B.4 OS36-RA

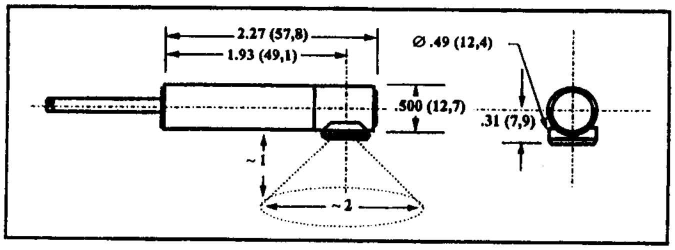


Figure B-3. OS36-RA Dimensions

Sensing Range:	-50° to 1200°F (-45° to 650°C)
Linear Range Selections:	8 models per thermocouple type (see Temperature Selection Guide), signal output equations available for programming complete range*
Field-of-View:	90° approximately
Minimum Spot Size:	0.3" (8 mm)
Spectral Response:	6.5 to 14μ
Output Impedance:	3KΩ approximately
Dimensions:	2.27"x 0.5" Dia. (57.8 x 13 mm)
Weight:	1.4 oz (40 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe, housing and shield electrically isolated from measurement
Air Purge:	None

*see Figure 6-1

B.5 OS36-2

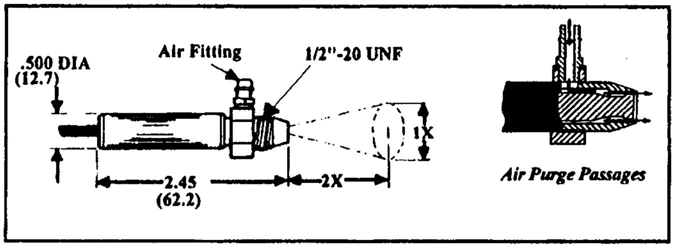


Figure B-4. OS36-2 Dimensions

Sensing Range:	–50° to 2000°F (–45° to 1100°C)
Linear Range Selections:	8 models per thermocouple type (see Temperature Selection Guide)*
Field-of-View:	35° approximately
Minimum Spot Size:	0.16" (4 mm) at detector
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	2.45"x 0.5" Dia. (62 x 13 mm)
Weight:	1.6 oz (44 g) with cable
Air Purge:	Built-in

*see Figure 6-1

B.6 OS36-2RA

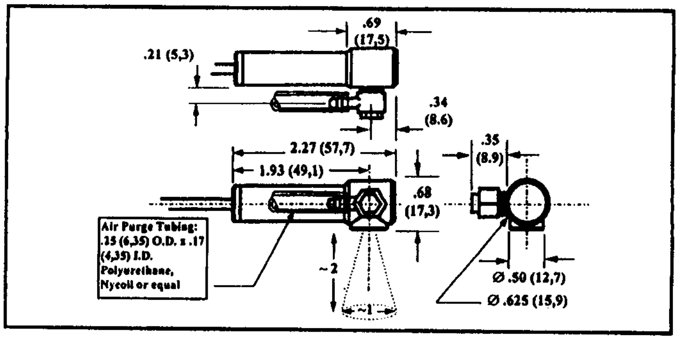


Figure B-5. OS36-2RA Dimensions

Sensing Range:	−50° to 2000°F (−45° to 1100°C)
Linear Range Selections:	8 models per thermocouple type (see Temperature Selection Guide), signal output equations available for programming complete range*
Field-of-View:	35° approximately
Minimum Spot Size:	0.2" (5 mm)
Spectral Response:	6.5 to 14μ
Output Impedance:	4 to 8 KΩ approximately
Dimensions:	2.27"x 0.625" Dia.(57.8 x 15.9 mm)
Weight:	1.6 oz (44 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe, housing and shield electrically isolated from measurement
Air Purge:	Built-in, designed for severe paint or ink environment

*see Figure 6-1

B.7 OS36-5

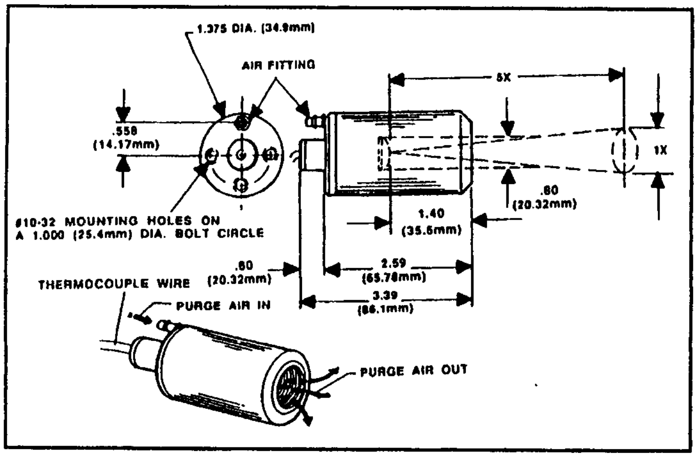


Figure B-6. OS36-5 Dimensions

Sensing Range:	–50° to 2000°F (–45° to 1100°C)
Linear Range Selections:	8 models per thermocouple type (see Temperature Selection Guide)*
Field-of-View:	11° approximately
Minimum Spot Size:	0.8" (20 mm) at 2.6"
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	3.3" x 1.375" Dia. (85 x 35 mm)
Weight:	6.5 oz (184 g) with cable
Air Purge:	Built-in

*see Figure 6-1

B.8 OS36-10

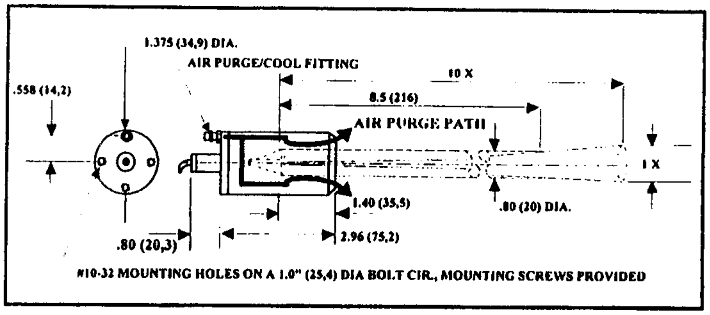


Figure B-7. OS36-10 Dimensions

Sensing Range:	–50° to 2500°F (–45° to 1370°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	8 models per thermocouple type (see Temperature Selection Guide)*
Field-of-View:	6° approximately
Minimum Spot Size:	0.8" (20 mm)
Spectral Response:	6.5 to 14μ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	3.76" x 1.375" Dia. (96 x 35 mm)
Weight:	6.5 oz (184 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe
Air Purge:	Built-in

*see Figure 6-1

B.9 OS37-10

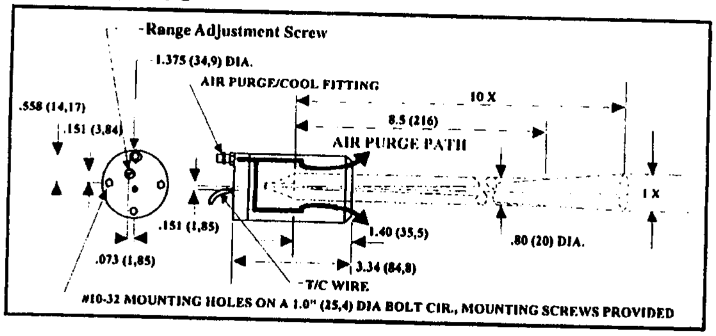


Figure B-8. OS37-10 Dimensions

Sensing Range:	−50° to 1500°F (−45° to 815°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each J, K,: adjustable over entire sensing range
Field-of-View:	6° approximately
Minimum Spot Size:	0.8" (20 mm)
Spectral Response:	2 to 20μ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	3.76" x 1.375" Dia. (96 x 35 mm)
Weight:	6.5 oz (184 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe
Air Purge:	Built-in

B.10 OS38-10

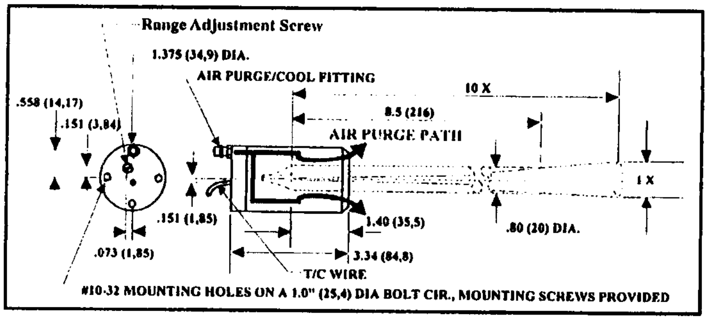


Figure B-9. OS38-10 Dimensions

Sensing Range:	500° to 2500°F (260° to 1370°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each J, K: adjustable over entire sensing range
Target Emissivity:	<0.7
Field-of-View:	6° approximately
Minimum Spot Size:	0.8" (20 mm)
Spectral Response:	0.1 to 5μ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	3.76" x 1.375" Dia. (96 x 35 mm)
Weight:	6.5 oz (184 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe
Air Purge:	Built-in

B.11 OS37-20

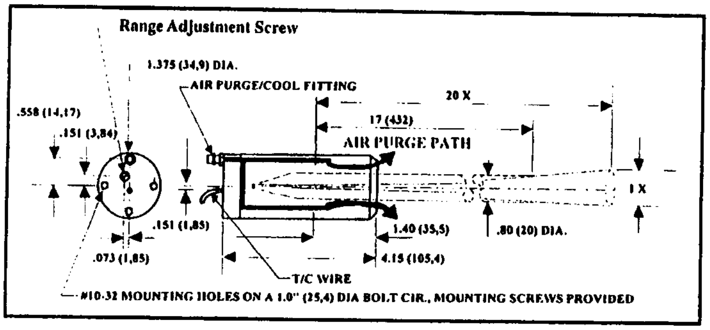


Figure B-10. OS37-20 Dimensions

Sensing Range:	500° to 3000°F (260° to 1650°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each J, K: adjustable over entire sensing range
Field-of-View:	3° approximately
Minimum Spot Size:	0.8" (20 mm)
Spectral Response:	2 to 20µ
Output Impedance:	4 to 8 KΩ
Dimensions:	4.15" x 1.375" Dia. (105.4 x 35 mm)
Weight:	8.0 oz (230 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe
Air Purge:	Built-in

B.12 OS38-20

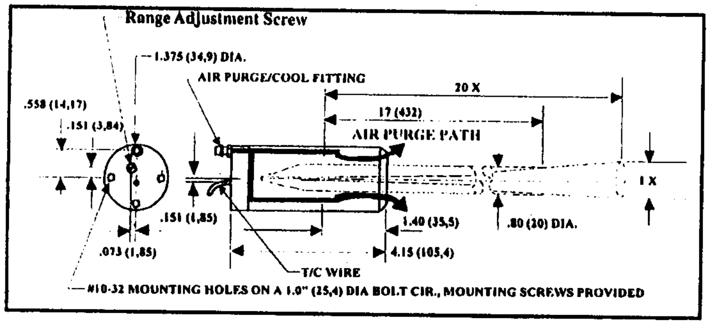


Figure B-11. OS38-20 Dimensions

Sensing Range:	1000° to 3500°F (540° to 1930°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each J, K: adjustable over entire sensing range
Target Emissivity:	<0.7
Field-of-View:	3° approximately
Minimum Spot Size:	0.8" (20 mm)
Spectral Response:	0.1 to 5μ
Output Impedance:	4 to 8 KΩ
Dimensions:	4.15" x 1.375" Dia. (105.4 x 35 mm)
Weight:	8.0 oz (230 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe
Air Purge:	Built-in

B.13 OS37-100

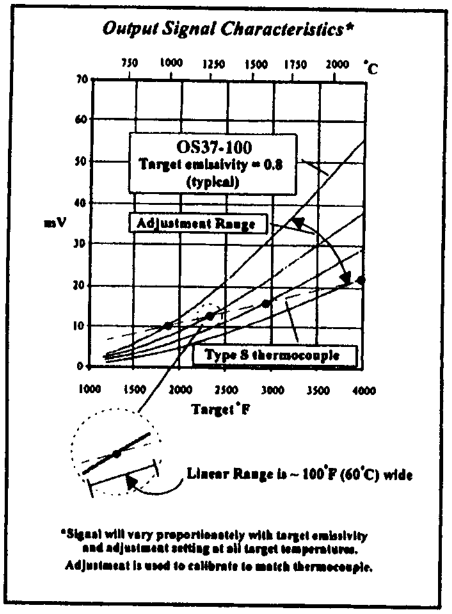


Figure B-12. OS37-100 Output Signal Characteristics

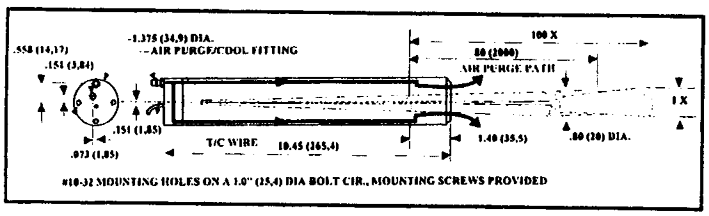


Figure B-13. OS37-100 Dimensions

OS37-100 Specifications (Cont'd)

Sensing Range:	1000° to 5000°F (540° to 2760°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each R, S: adjustable over entire sensing range
Field-of-View:	0.6° approximately (100:1 distance:spot)
Minimum Spot Size:	0.8" (20 mm)
Spectral Response:	2 to 20μ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	10.5" x 1.375" Dia. (265 x 35 mm) (see next page)
Weight:	20 oz (570 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe
Air Purge:	Built-in

B.14 OS38-100

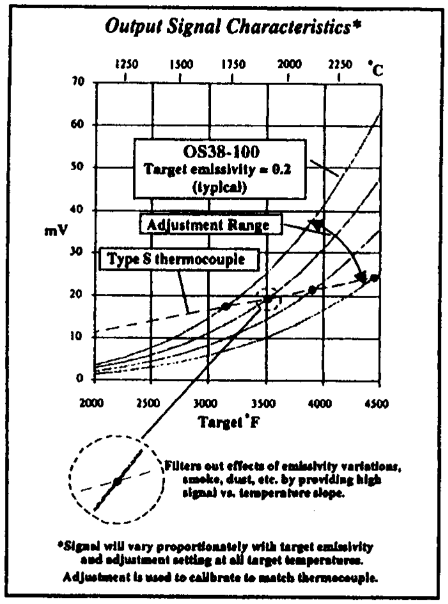


Figure B-14. OS38-100 Output Signal Characteristics

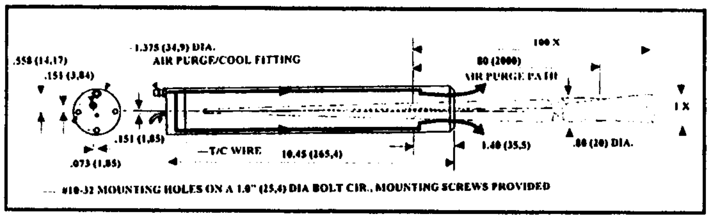


Figure B-15. OS38-100 Dimensions

OS38-100 Specifications (Cont'd)

Sensing Range:	1500° to 5000°F (820° to 2760°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each R, S: adjustable over entire sensing range
Target Emissivity:	<0.7
Field-of-View:	0.6° approximately (100:1 distance:spot)
Minimum Spot Size:	0.8" (20 mm)
Spectral Response:	0.1 to 5μ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	10.5" x 1.375" Dia. (265 x 35 mm) (see next page)
Weight:	20 oz (570 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe
Air Purge:	Built-in

B.15 OS37-CF

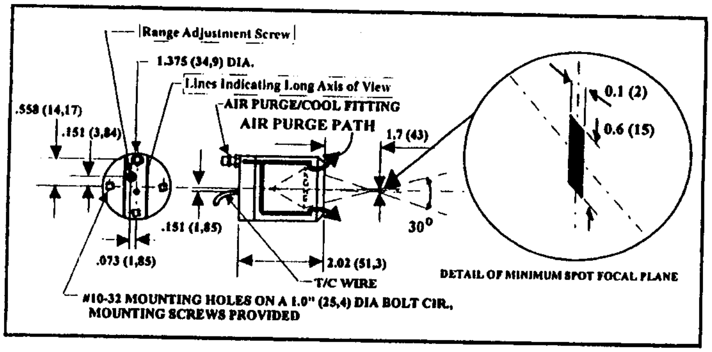


Figure B-16. OS37-CF Dimensions

Sensing Range:	0° to 2500°F (−18° to 1370°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each J, K, T, E: adjustable over entire sensing range, output polynomials available
Field-of-View (non focus):	30° approximately
Minimum Spot Size at focus:	0.1" x 0.6" (2 x 15 mm) @ 1.7" (43mm) from sensor
Spectral Response:	2 to 20μ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	2.3" x 1.375" Dia. (58.4 x 35 mm)
Weight:	6.5 oz (184 g) with cable

OS37-CF Specifications (Cont'd)

Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe, twisted shielded-pair cable grounded to housing and electrically isolated from signal
Air Purge:	Built-in

B.16 OS38-CF

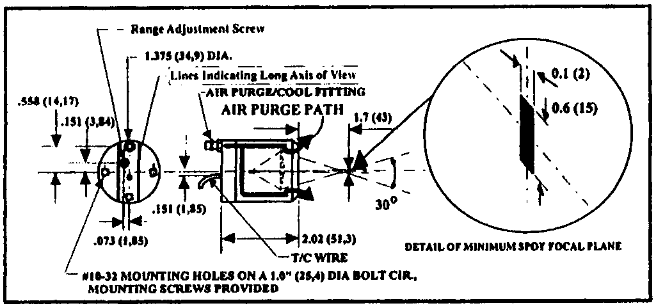


Figure B-17. OS38-CF Dimensions

Sensing Range:	500° to 2500°F (260° to 1370°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each J, K, T, E: adjustable over entire sensing range, output polynomials available
Field-of-View (non focus):	30° approximately
Minimum Spot Size at focus:	0.1" x 0.6" (2 x 15 mm) @ 1.7" (43mm) from sensor
Spectral Response:	0.1 to 5µ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	2.3" x 1.375" Dia. (58.4 x 35 mm)
Weight:	6.5 oz (184 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe, twisted shielded-pair cable grounded to housing and electrically isolated from signal
Air Purge:	Built-in

B.17 OS37-60CF

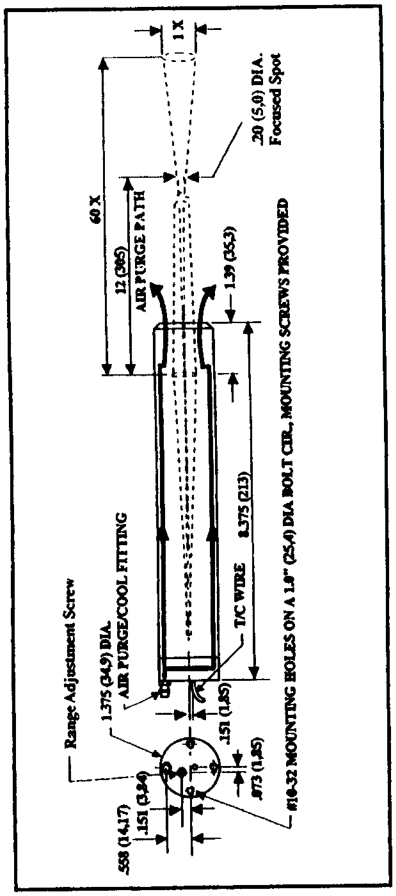


Figure B-18. OS37-60CF Dimensions

OS37-60CF Specifications (Cont'd)

Sensing Range:	1000° to 5000°F (540° to 2760°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each R, S: adjustable over entire sensing range
Field-of-View:	1° approximately (60:1 distance:spot)
Minimum Spot Size:	0.20" (5 mm) @ 12" (305mm) distance
Target Emissivity:	>0.7
Spectral Response:	2 to 20µ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	8.375" x 1.375" Dia. (213 x 35 mm)
Weight:	20 oz (184 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe, electrically isolated from measurement elements and grounded to shield
Air Purge:	Built-in

B.18 OS38-60CF

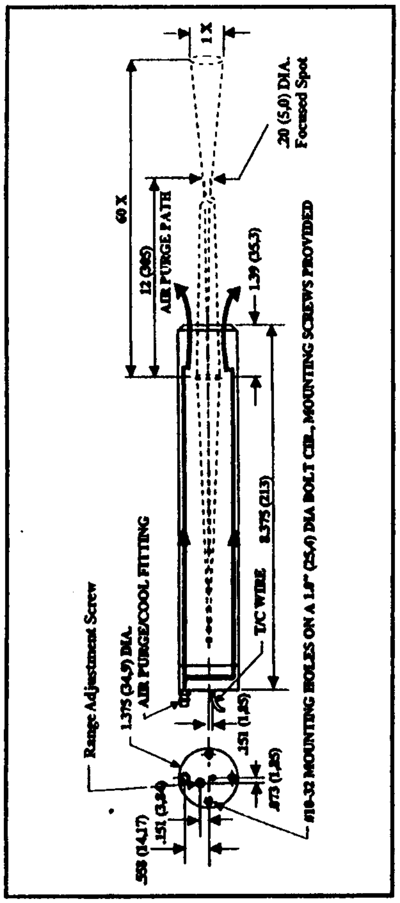


Figure B-19. OS38-60CF Dimensions

OS38-60CF Specifications (Cont'd)

Sensing Range:	1500° to 4500°F (820° to 2500°C)
Power Requirements:	None - rated intrinsically safe
Linear Range Selections:	1 model each R, S: adjustable over entire sensing range
Field-of-View:	1° approximately (60:1 distance:spot)
Minimum Spot Size:	0.20" (5 mm) @ 12" (305mm) distance
Target Emissivity:	<0.7
Spectral Response:	0.1to 5μ
Output Impedance:	4 to 8 KΩ (varies by model)
Dimensions:	8.375" x 1.375" Dia. (213 x 35 mm)
Weight:	20 oz (184 g) with cable
Housing:	Stainless steel, hermetically sealed, meets or exceeds all applicable NEMA ratings, intrinsically safe, electrically isolated from measurement elements and grounded to shield
Air Purge:	Built-in

NOTES

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 **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. 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.

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

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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.

SPECIAL CONDITION: Should this equipment be used in or with any nuclear installation or activity, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the equipment in such a manner.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA ENGINEERING 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.

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

1. P.O. number to cover the COST of the repair/calibration,
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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