

## Non-contact temperature measurements using IR thermometers

### Application Note

Infrared (IR) thermometers allow non-contact measurement of surface temperatures by analyzing the invisible, infrared spectrum emitted from an object.

IR measurement devices, like the Fluke 61 and 65, make it safe to take surface temperature readings of items like rotating, hard-to-reach, electrically live, or dangerously hot targets. For preventative maintenance tasks, they cut measurement time to almost zero with the ability to take a surface temperature reading in less than one second.

IR thermometers can be used to conduct thousands of different types of measurements, including:

- **Electrical:** IR thermometers can be used to troubleshoot problems with electrical connections and verify uninterrupted power supplies by locating hot spots in the output filters or dc battery connections. They can also be used to check components in battery banks, power panel terminations, ballasts, switch gears, circuit breaker and fuse connections that could be draining energy due to the heat created by loose connections or corrosion buildup.
- **Preventive maintenance:** Using IR thermometers for preventive maintenance measurements of hard-to-reach equipment such as HVAC supply diffusers or dangerous equipment like motors, generators, and bearings helps identify potential problems.

- **HVAC:** It's estimated up to 30 percent of air conditioning leaks are due to faulty ducting, which can be quickly and easily detected with an IR thermometer.
- **Steam:** IR thermometers are particularly useful in taking surface temperature measurements of uninsulated steam lines, steam valves, fittings, receiver tanks, and condensate return lines, which pose a large safety hazard due to the potential presence of live steam.



- **Food processing:** IR temperature measurement is the fastest, most efficient, and FDA-recommended method of monitoring food safety along the critical control points in Hazard Analysis and Critical Control Point (HACCP) standards. IR thermometers provide a fast and easy method of monitoring temperature on the surface of food where bacteria begin to grow, ensuring that food is safe at every step of food processing and preparation.



- **Fast test of multiple targets:** IR thermometers are excellent for checking multiple points easily from one location, saving time and money.

## Proper use of IR technology

Although IR temperature measurement is not as accurate as a calibrated contact temperature device, a typical reading will be within 1 °C of the actual temperature when the instrument is properly applied. For scanning applications, like those mentioned above that do not require precise measurement, this level of accuracy is more than adequate.

Putting IR technology to use is easy, but there are two critical parameters that must be understood to ensure proper and consistent temperature measurements with infrared type devices. They are:

- Optical resolution
- Emissivity

### Optical resolution

Optical resolution refers to the sample area the IR meter is measuring at a given distance. Optical resolution is also referred to as the "distance-to-spot-size ratio" or "field-of-view."

Know your application! A device with a 4:1 optical resolution cannot effectively be used to measure the temperature of an object 1.5 m away – even if the laser beam sight projects that far.

Try to determine how you are going to apply the IR thermometer before purchasing, and then buy a tool that provides the appropriate optical resolution for the application. Many erroneous readings are taken because the technician unknowingly samples a larger area than the object that's being measured.

### Emissivity

Emissivity indicates the ability of an object to emit infrared energy. Emissivity is determined by the material from which the object is constructed and its surface finish. Values can range from less than 0.1 for a highly reflective body like polished metal, to 1.0 for an ideal black body.

In simple terms, emissivity can be likened to the reflectivity—or shininess—of an object. Items such as soft-drawn copper are very smooth and shiny even under a microscope, while other objects such as lacquer paint appear quite porous under the microscope. The porous object will have a relatively high emissivity (typically 0.7 to 0.98), while new soft-drawn copper (shiny, not oxidized) will have a low emissivity (typically below 0.2). Shiny objects reflect IR energy from objects surrounding them, which dilutes the IR energy from the measured object. A porous body tends to absorb surrounding IR energy, thus emitting its IR energy without dilution (like a black body).

### Optical resolution

Ratio of the distance from the measured object vs. the sampling spot size.

#### Examples:

- 4:1 optical resolution: 10 cm away from measured object ± 2.5 cm diameter sampling size.
- 10:1 optical resolution: 50 cm away from measured object ± 5 cm diameter sampling size.

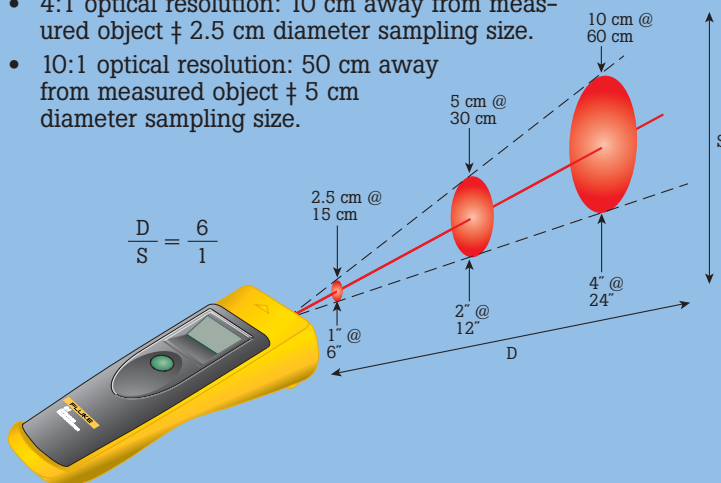


Figure 1.

### Emissivity

A numerical value between 0 and 1 that indicates the ability of an object to emit infrared energy. To ensure the optimal measurement accuracy, the target being measured should have an emissivity in the vicinity of 0.95. Emissivity is determined primarily by the material from which an object is constructed and its surface finish.

#### Examples:

- Polished Brass: 0.03
- Oxidized Brass: 0.61
- Roughly Polished Copper: 0.07
- Black Oxidized Copper: 0.78
- Black Lacquer Paint: 0.96
- Commercial Sheet Aluminum: 0.09
- Oxidized Lead: 0.43
- Rusted Iron: 0.78
- Oxidized Iron: 0.84

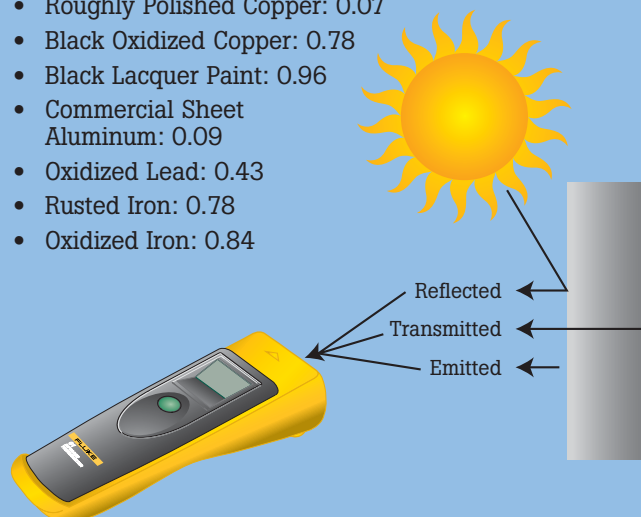


Figure 2.

Low-cost IR measurement instruments (under €425) are typically fixed at 0.95 emissivity (the Fluke 61 and 65 are set to measure 0.95 emissivity). To get an effective actual temperature reading, the surface being measured must have an emissivity close to 0.95. In other words, measuring a surface that is not highly reflective will provide an accurate reading. For shiny surfaces, use a coat of black paint, electrical tape, or magic marker to reduce reflection. If a 0.95 fixed emissivity IR instrument is used to measure an object that is not close to 0.95, the reading will be incorrect as follows:

- If the measured object is warmer than ambient temperature, the reading will be erroneously lower than the actual temperature;
- If the measured object is colder than ambient temperature, then the reading will be erroneously higher than the actual temperature.

### The effect of incorrect application

Understanding the optical resolution and emissivity ratings of your IR thermometer and the target you plan to measure will help you avoid inaccurate measurements. The example below illustrates how an incorrect application can lead to inaccurate results.

### The task

A technician needs to take a temperature measurement on a new, shiny copper refrigerant line located between the evaporator and the compressor to help determine the superheat in the system. The technician has just purchased his first IR thermometer and is anxious to put it to use. He decides to compare it against his digital contact thermometer. Here are the facts:

- IR thermometer: Fixed at 0.95; Optical resolution of 4:1
- Target size: 34.9 mm diameter copper pipe (*Hint: This pipe will provide a little over a 25.4 mm diameter sample area from the side.*)
- Ambient temperature: 25 °C
- Refrigeration line temperature as measured with the calibrated "contact" thermometer: 13 °C. (This is the correct temperature)

### Attempt # 1:

The technician already knows the proper line temperature is around 13 °C. He holds the IR thermometer 12 inches away from the line and reads a temperature of 22 °C. He moves the thermometer to within 7 cm of the target and the measurement on the IR thermometer lowers to 20 °C. A slight improvement, but still not close to the expected value.

In this first attempt, the technician has adjusted his distance from the target to fall within the instrument's optical resolution, but has not accounted for emissivity differences between the instrument rating and the material.

### Attempt # 2:

Ten minutes later, the technician returns to the refrigeration unit with his IR instruction sheet and some black electrical tape in hand. He applies a few pieces of the electrical tape to cover the shiny copper refrigerant line. Upon re-measuring at a distance of 7 cm with the IR thermometer targeted at the electrical tape, the thermometer registers 14 °C, which is within the accuracy specifications for the instrument.

The technician leaves the job-site with a better understanding of IR technology and the constraints of optical resolution and fixed emissivity.

### Fluke IR thermometers

Fluke's 61 and 65 IR thermometers are designed to meet the needs of electrical, process, plant maintenance, facility maintenance, HVAC/R and automotive professionals. Their targeting laser makes aiming precise while the single front button and sleek ergonomic design make them easy to use. They're ideal for measuring rotating, electrically live, dangerously hot, or hard-to-reach objects.

**Fluke.** *Keeping your world  
up and running.*

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