

## Infrared vs. Thermal Conductivity Sensors

Feature  
Note

### Comparative Analysis



MCO-230AICUV / MCO-230AICUVL



MCO-170AICUV / MCO-170AICUVL

### Importance of Maintaining CO<sub>2</sub> Levels

One of the greatest challenges scientists face is the reproducibility and accuracy of data.<sup>1)</sup> In life science research, this data often rests on the integrity of cell cultures. Cell cultures require proper CO<sub>2</sub> control to maintain pH values in the media essential to cell growth. The pH value in the cell culture medium is regulated by the supply of CO<sub>2</sub> in the chamber. In order to maintain proper cell health, the incubator should ideally keep pH at a neutral level.

### CO<sub>2</sub> Incubator Sensors

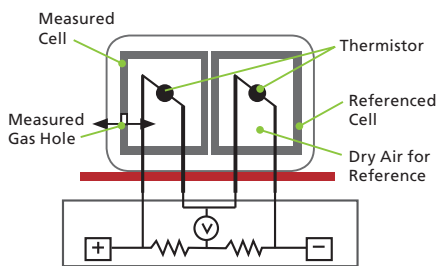
CO<sub>2</sub> incubators use gas sensors to detect and regulate the CO<sub>2</sub> levels within the chamber. CO<sub>2</sub> levels often fluctuate throughout the day as people open and close their incubator door, so it is important that CO<sub>2</sub> recovers quickly without overshoot following door closing. Failure to re-establish CO<sub>2</sub> levels results in a disrupted cell culture due to changes in the pH level. There are two main types of sensors commonly used in CO<sub>2</sub> incubators today to detect changes and regulate CO<sub>2</sub>: (1) thermal conductivity (TC) sensors and (2) infrared (IR) sensors.

1. Baker, Monya. "1500 scientists lift the lid on reproducibility." Nature, no. 533 (May 26, 2016): 452-54. Doi:10.1038/533454a.



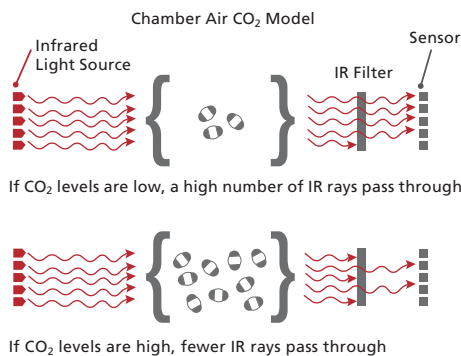
## Thermal Conductivity (TC) Sensors

These sensors operate on the theory of measuring the resistance of a certain gas (CO<sub>2</sub>) to a reference gas (in this case usually the ambient room air). Based on the input flow of CO<sub>2</sub>, the sensor is then able to detect changes in the resistance (hence thermal conductivity of the gas) to induce the necessary changes, compensating for loss or excess CO<sub>2</sub>. Due to the nature of thermal conductivity sensors, they are often affected by humidity and temperature. Air resistance is affected by both these factors. Thus, TC sensors are prone to the effects of door openings, often leading to inaccurate CO<sub>2</sub> readings.



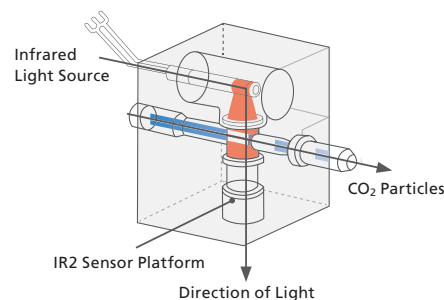
## Infrared (IR) Sensors

IR sensors operate on the principle that gas absorbs light at a specific frequency. CO<sub>2</sub> gas absorbs light at 4.3 μm within the IR band of the electromagnetic spectrum. IR light is directed through the CO<sub>2</sub> gas to be measured by a sensor. A filter prevents wavelengths other than those specific to CO<sub>2</sub> from hitting the sensor. If CO<sub>2</sub> levels are high, fewer IR rays pass through to the detector. IR sensors need to be calibrated periodically because light sources will drift over time and the output of the light at the desired frequency will change.



## Infrared (IR) Sensor Types

IR sensors are available in both single beam and dual beam formats. With a single beam IR sensor, the calibration of CO<sub>2</sub> levels is performed at regular time intervals using pumps that draw in room air as a reference. This is a slower process compared to the dual beam method. Dual beam IR technology takes this concept one step further by removing the pumps and adding in an extra filter that can auto-calibrate CO<sub>2</sub> levels in real time. The second filter serves as a consistent reference point that the sensor is able to read in order to calibrate CO<sub>2</sub> levels. Thus, with this technology frequent calibration can occur behind the scenes and provide improved accuracy without the need for air pumps.



## Dual Beam IR Sensor

Why does this matter to the scientist? Regulating the CO<sub>2</sub> level in your cell cultures is one of the most important features of your incubator. Abnormal CO<sub>2</sub> levels put your cell cultures under stressful conditions, which matter for applications involving sensitive cell lines, such as stem cells or embryos. Choosing an incubator that has an infrared sensor is a superior choice compared to one with a thermal conductivity sensor, especially if your incubator door is opened more than once per day. Dual beam IR sensors allow scientists to track the actual reading of their CO<sub>2</sub> levels more accurately. The display panel of an incubator using a TC sensor may not reflect the change in CO<sub>2</sub> levels following a door closing, while that of a dual beam IR sensor would reflect changes in real time, giving scientists a more accurate reading and control of internal conditions. Furthermore, in an incubator with a dual beam infrared sensor, CO<sub>2</sub> levels will recover even faster, preventing your cells from being exposed to stressful conditions.

Specifications are subject to change without notice.

	Thermal Conductivity Sensor	Single Beam Infrared Sensor	Dual Beam Infrared Sensor
<b>Affected by variations in humidity</b>	<b>YES</b> TC sensors measure the air resistance, which is affected by humidity	<b>NO</b> Relies on gas absorption; humidity has no effect on readings	<b>NO</b> Relies on gas absorption; humidity has no effect on readings
<b>Provides rapid CO<sub>2</sub> recovery upon door opening</b>	<b>NO</b> TC sensors are slower to respond until humidity has stabilized	<b>YES</b> Variances in light source levels require periodic calibration, incubators employing automatic calibration often require moving components which can increase the potential for failure	<b>YES</b> Fastest in the industry due to dual detectors to ensure calibration accuracy without additional moving parts
<b>Provides accurate CO<sub>2</sub> readings</b>	<b>NO</b> TC sensor readings are affected by humidity, especially with multiple door openings. Accuracy is obtained only once unit stabilizes, but still requires periodic manual calibration	<b>YES</b> Measures the absorption of IR radiation by CO <sub>2</sub>	<b>YES</b> Measures the absorption of IR radiation by CO <sub>2</sub>
<b>Recovers CO<sub>2</sub> to setpoint without overshoot</b>	<b>NO</b> Due to unreliable readings, TC sensors are more likely to compensate too much and overshoot the setpoint especially in economy models with ON/OFF style control	<b>YES</b> IR sensors are much more accurate, stable, unaffected by variations in humidity, and typically coupled with PID control	<b>YES</b> IR sensors are much more accurate, stable, unaffected by variations in humidity, and typically coupled with PID control
<b>Has a reliable design</b>	<b>NO</b> TC sensors are prone to drift over time requiring frequent manual calibration	<b>NO</b> Many IR sensors utilize light sources prone to failure necessitating the replacement of the entire sensor	<b>YES</b> Dual beam IR sensors are built with a reliable, time tested ceramic IR light source that is robust and long lasting