

Vaisala CARBOCAP® measurement sensor for demanding environments



First launched in 1997, the Vaisala CARBOCAP® carbon dioxide (CO₂) sensor features a groundbreaking innovation – the micromachined, electrically tunable Fabry-Pérot Interferometer (FPI) filter for built-in reference measurement. This reliable and stable sensor has been delivering accurate measurements since the late 1990s across a wide range of industries and applications, from building automation and safety to life sciences and ecological research.

How it works

Gases have a characteristic absorbance band in the infrared (IR) region, each at a unique wavelength. When IR radiation is passed through a gas containing another gas we are measuring, part of the radiation is absorbed. Therefore, the amount of radiation passing through the gas depends on the amount of the measured gas present, and this can be detected with an IR detector.

The Vaisala CARBOCAP® sensor features an electrically tunable FPI filter. In addition to measuring gas absorption, the micromechanical FPI filter enables a reference measurement at a wavelength where no absorption occurs. When taking the reference measurement, the FPI filter is electrically adjusted to switch the bypass band from the absorption wavelength to a non-absorption

wavelength. The reference measurement compensates for any potential changes in the light source intensity, as well as for contamination and dirt accumulation in the optical path. This feature means that CARBOCAP® sensor operation is highly stable over time.

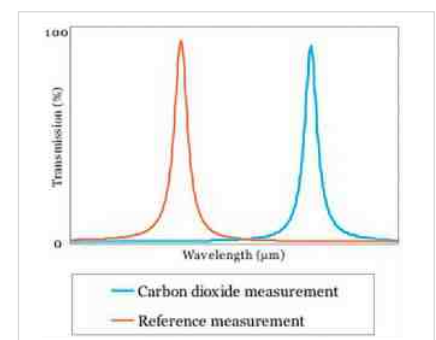
Instruments measuring at several absorption and reference wavelengths with a single light source are known as single-beam multi-wavelength instruments. The technology is widely applied in costly analyzers. The unique feature of the CARBOCAP® sensor is its micromachined FPI filter, which performs a multi-wavelength measurement using a single detector. The compact size of the sensor means that this advanced technology can be incorporated into small probes, modules, and transmitters.

CARBOCAP® in brief

- A silicon-based infrared (IR) absorption sensor
- Enables continuous internal reference measurement & multiband absorption measurement
- Depending on the product, enables both ppm and percentage level measurement
- Providing accurate measurements since the late 1990s

CARBOCAP's unique benefits

- Superior stability enabled by autocalibration
- Insensitive to harsh conditions
- Minimal maintenance and calibration requirements



Example of carbon dioxide measurement. Both reference and CO₂ absorption are measured in the same optical path.

Typical applications

Vaisala CARBOCAP® sensor technology is well suited to a wide range of applications, but since the final customer value for each industrial application is unique, it depends on the product line how the CARBOCAP® sensor technology is implemented.

In carbon dioxide measurement products, the technology is utilized for both ppm (parts per million) and percentage level measurements. Since CO₂ replaces oxygen, it can be harmful to people in very high concentrations. CO₂ is present at percentage levels only within closed processes such as fermentation and controlled-atmosphere storage environments. Percentage-level measurements are also typical in life-science applications such as CO₂ incubators.

Normal atmospheric air includes CO₂ at ppm levels. Typical CARBOCAP® applications include ventilation control in buildings occupied by people, animal shelters, and greenhouses.

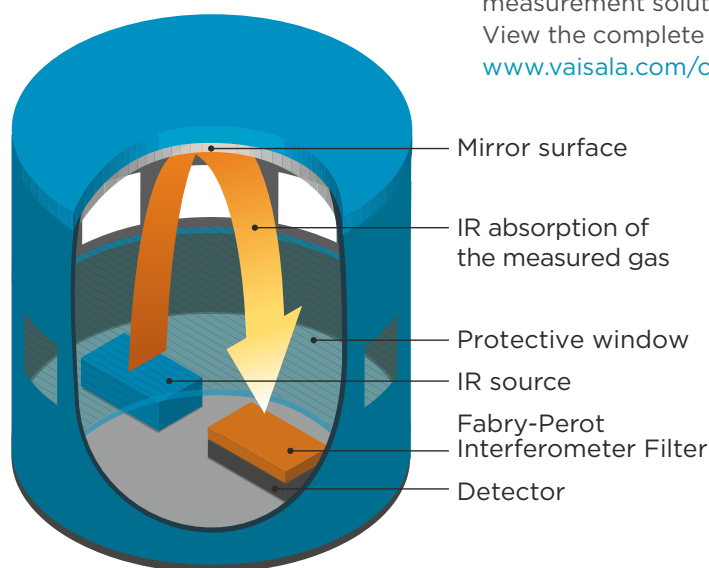
In areas where large volumes of CO₂ are handled, reliable CO₂ measurement with alarm control is an important safety precaution. The CARBOCAP® sensor is also a popular choice in ecological measurement applications such as biogas process lines, where excellent long-term stability and tolerance to harsh conditions are important requirements. For biogas applications, the technology is

applied for multigas measurements, as it also helps improve the methane quality in the process.

Product examples

Vaisala's instruments including the CARBOCAP® sensor technology range from hand-held meters, measurement modules, and industrial transmitters for CO₂ measurements to multigas measurement solutions.

View the complete range at www.vaisala.com/carbondioxide.



Structure of the CARBOCAP® sensor.

The CARBOCAP® Story

The CARBOCAP® story began in 1992, when micromechanical sensors were being intensively researched at Vaisala. The groundbreaking idea of miniaturizing the Fabry-Pérot Interferometer (FPI) was born, leading to collaborative development work with VTT Technical Research Center of Finland. Later, a patent application was submitted for a single-channel gas concentration measurement method using the FPI.

The driving force behind the innovation of the CARBOCAP® sensor was Vaisala's commitment to developing superior technologies for environmental measurements. And indeed, Vaisala's pioneering work in the field of silicon-based NDIR technology and electrically tunable filters resulted in the compact, simple and high-performance CARBOCAP® sensor. To this day, the long-term stability and reliability of the measurement provided by the FPI is unrivaled.

The first commercial CARBOCAP® products, launched in 1997, were developed for measuring ppm-level CO₂ in ventilation applications. They were soon followed by percentage-level measurement products. Since 2011, Vaisala has developed its 2nd generation CARBOCAP® sensor technology with improved features. The new sensor technology is incorporated in several product lines that are targeted for demanding applications. Typical examples are greenhouses, air control units, biogas lines and life science incubators.

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