

CO₂ Sensors

Murata Manufacturing Co., Ltd.



CO₂ sensor application examples

Smart Agriculture

Used in greenhouses and plant factories for the purpose of promoting photosynthesis and increasing yields by controlling the CO₂ concentration.



Challenges found in agriculture and greenhouse

- Measurement value fluctuations due to the impact of humidity and aging degradation
- Yield decrease when the measurement value is higher than the true value
- Energy (energy cost) loss when the measurement value is lower than the true value
- Manually calibrated CO₂ sensors must be removed and taken out of the housing

Murata's strengths in CO₂ sensors

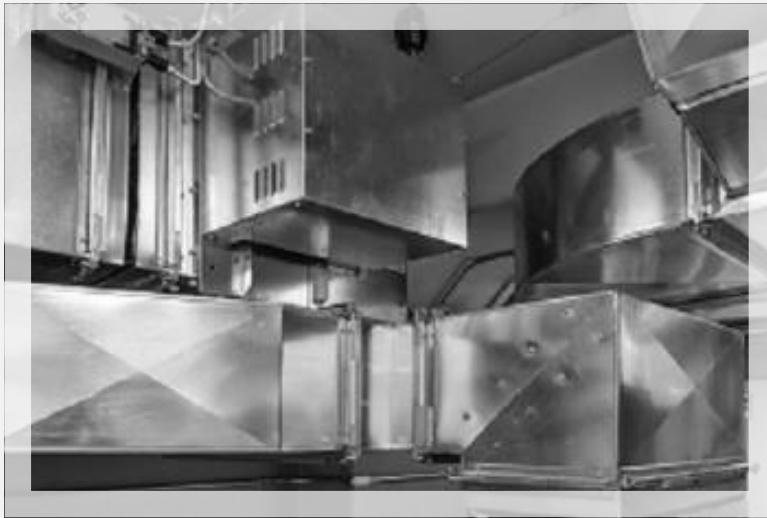
Excellent temperature characteristics make them well suited to high-humidity environments, such as greenhouses with large daytime temperature fluctuations. The low drift inhibits excessive petroleum fuel usage and is able to achieve increased yields through stable CO₂ application. Environmental durability has been improved through the use of a moisture-proof coating and a high-performance air filter, and it includes a built-in surge protection power circuit.

CO₂ sensor application examples

BEMS (Building and Energy Management System)

Used for the purpose of contributing to energy savings through ventilation control corresponding to CO₂ concentrations.

(Measurement criteria for air quality according to the Building Management Law: CO₂ concentration of 1,000 ppm)



Challenges found in building ventilation control and BEMS

- Measurement value fluctuation due to aging degradation
- CO₂ concentration control criteria according to the Building Management Law (1,000 ppm)
- Ventilation energy loss due to settings which assume drift
- CO₂ sensors are installed in high places and other locations which are difficult to access. This makes the calibration work difficult because calibration requires reference gases

Murata's strengths in CO₂ sensors

Due to low drift, they do not require a significant margin for the CO₂ concentration control setting, which enables maximum energy savings. Uses a high-performance air filter with a design life of ten years and is equipped with a built-in surge protection power circuit. Models with special cases for easy duct installation are also available.

Concept of Murata CO₂ sensor

NDIR-based CO₂ sensor which achieves “long-term stability”

Automatic calibration feature using the reference light

[patent registered]

CO₂ sensors are essential for BEMS and Agriculture market.
With unique algorithm and structure, Murata's CO₂ sensors calibrate measurement value fluctuation due to aging degradation automatically.
We provide maintenance-free products which achieve long-term stability.

(Ex: approximately ten years for building ventilation
*Depends on the usage environment)

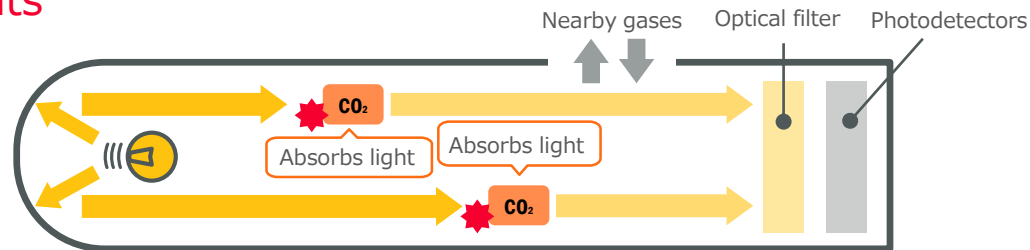
CO₂ sensor module ►



Because it adopts a calibration method which does not use atmospheric concentration (approximately 400 ppm), it can be used in fields such as “agriculture (greenhouses)” and “BEMS (building ventilation control)” where atmospheric concentration cannot be accurately measured.

Principles of NDIR

Main Components

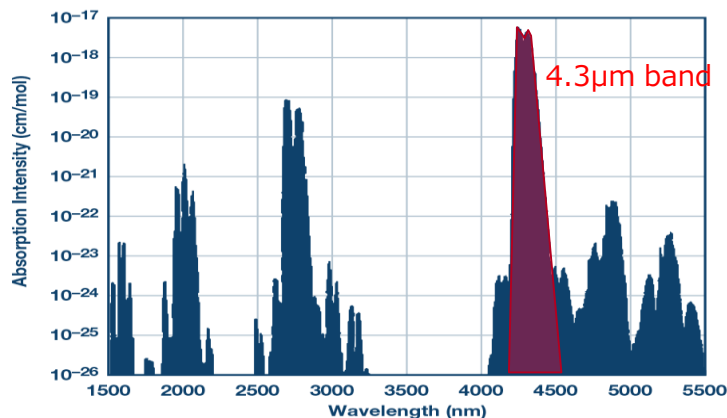


CO₂ absorption spectrum and measurement formula

CO₂ absorbs the specific spectrum of infrared light.

Amount of infrared light to photodetector will change due to CO₂ concentration.

[CO₂ absorption spectrum]



[Lambert-Beer law]

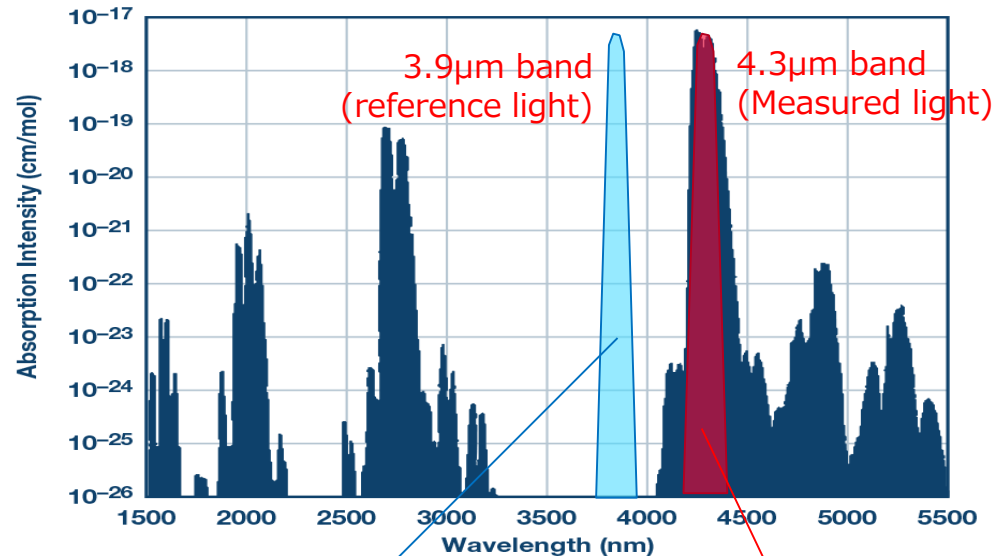
$$\Delta I = I_0 \times [1 - \text{EXP}(-\alpha c L)]$$

I_0 : The Infrared light intensity in the case of the CO₂ that concentration is 0ppm.
 α : CO₂ absorption coefficient
 c : CO₂ concentration
 L : Light path length

The drift of I_0 intensity cause the degradation of calculation result.

Murata CO₂ sensor

Murata's automatically calibration

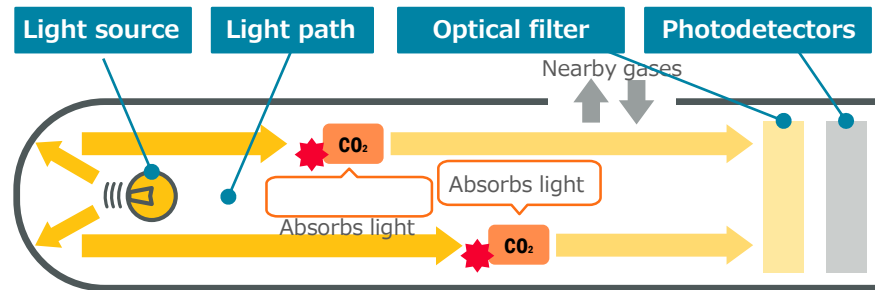


Measure drift information about light source, optical path, and photodetectors

- CO₂ concentration information
- Including drift information about light source, optical path, and photodetectors

Murata's CO₂ sensor can figure out the causes of the drift by unique mechanical structure and reference light. Therefore, Murata's CO₂ sensor can calculate accurate CO₂ concentration.

Features of Murata's dual wavelength CO₂ sensor



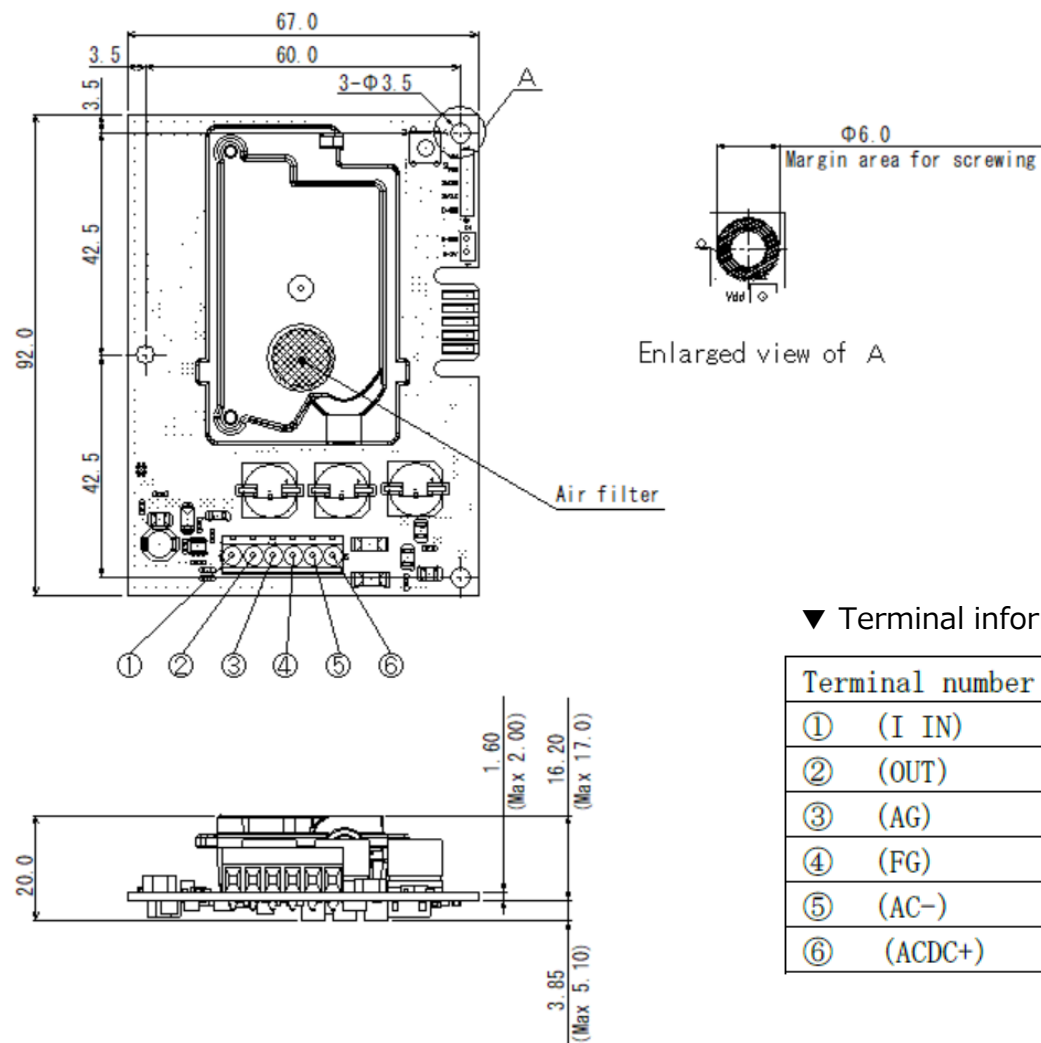
Components				Features	
Light source	Light path	Optical filter	Photodetectors		
Murata's dual wavelength method					
1	1	2	1	◎	•Correctable the degradation of the light source, the light path, the photodetector. •It is possible to protect the disturbance influence (and temporary external force) using common optical path.
Dual wavelength methods from other companies					
1	2※	2	2	△	•Uncorrectable the degradation of the light source, the light path, the photodetector. •It is impossible to protect the disturbance influence (and temporary external force), because of using two optical path.
Single wavelength method					
1	1	1	1	△	•It is impossible to correct the degradation of the light source, the light path, the photodetector. •It is possible to correct roughly the degradation using calibration by open air.

※Because light pathing is deferent due to refrecting surface enter two sensors.

Specifications

Item	Specifications
Operating temperature	0 ~ 50℃
Storage temperature	-20 ~ 50℃
Measured concentration range	0 ~ 2,000ppm / 0 ~ 3,000ppm
Measurement accuracy	±(50ppm + 5% of reading)
	Typ. ±(30ppm + 2.5% of reading)
Long-term stability (drift)	±50ppm/Year @1000ppm
Input voltage	AC/DC 24V , DC 12V
Power consumption	Avg. 0.5W / Max. 2.0W
Output interface	Analog 0 ~ 5V
Measurement interval	5s

Dimensions and terminal information



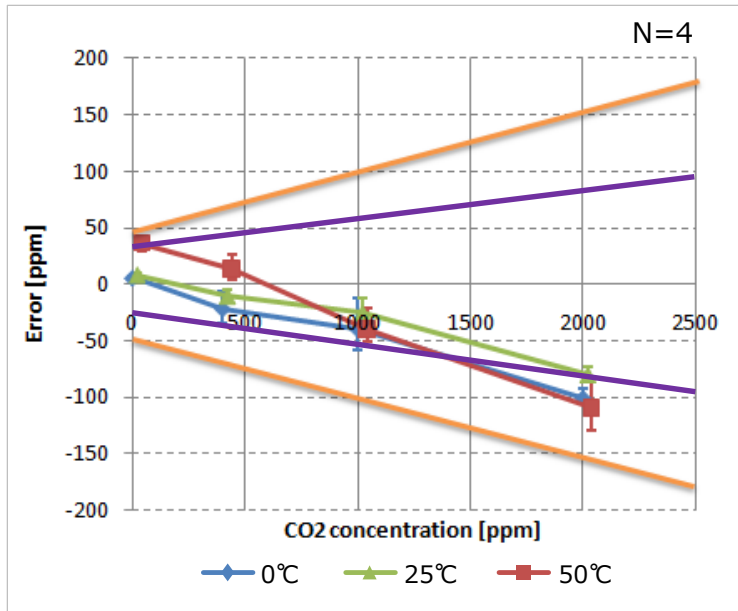
▼ Terminal information (In case of using DC power)

Terminal number	Item
① (I IN)	Unused
② (OUT)	Output (+)
③ (AG)	Output (-)
④ (FG)	Input Power (-)
⑤ (AC-)	Unused
⑥ (ACDC+)	Input Power (+)

Initial characteristics

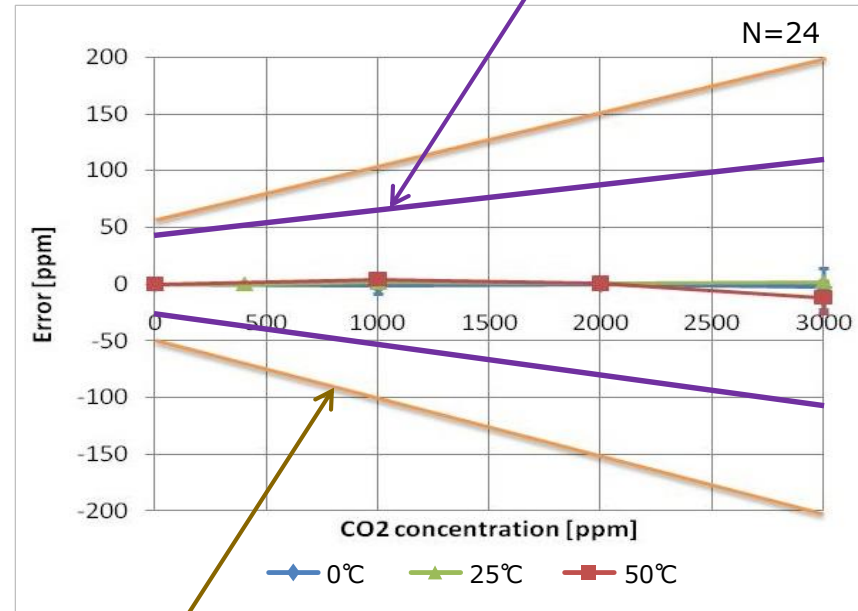
Typical CO₂ sensor

(By Murata's measurement environment)



Murata CO₂ sensor

$\pm(30+2.5\% \text{ reading})$ [ppm]



$\pm(50+5\% \text{ reading})$ [ppm]

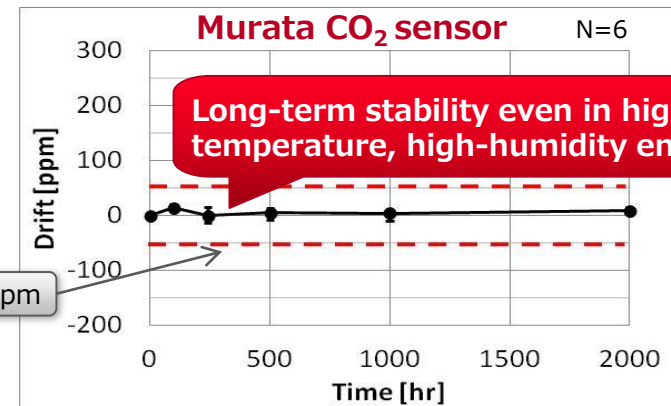
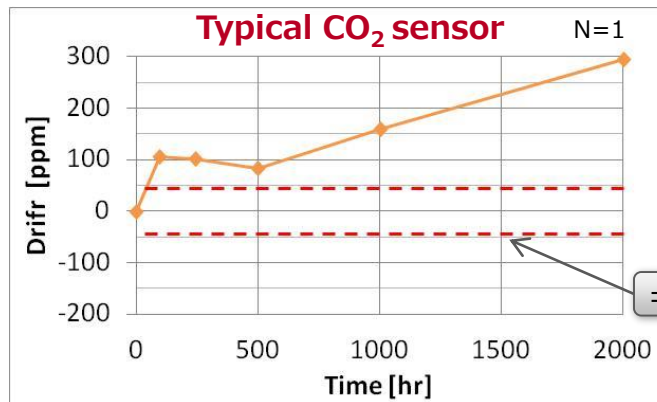
Achieved a high-accuracy CO₂ sensor
with superior temperature stability

Reliability testing

Load test in a high temperature, high humidity environment

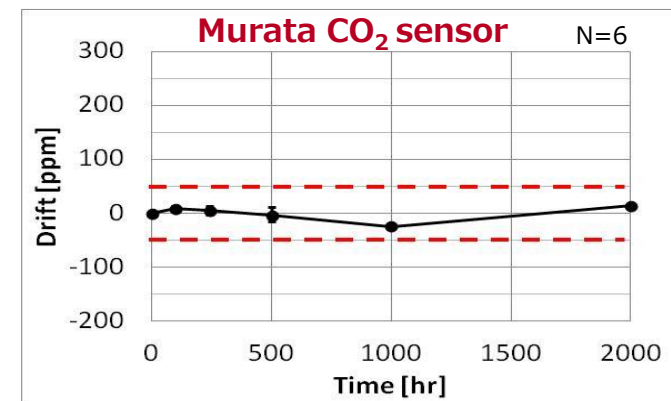
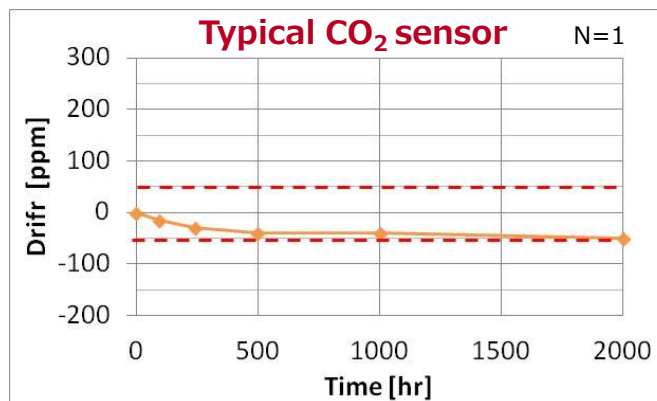
(By Murata's measurement environment)

50°C, 95%RH, 12V



Load test in a high temperature environment

50°C, 12V

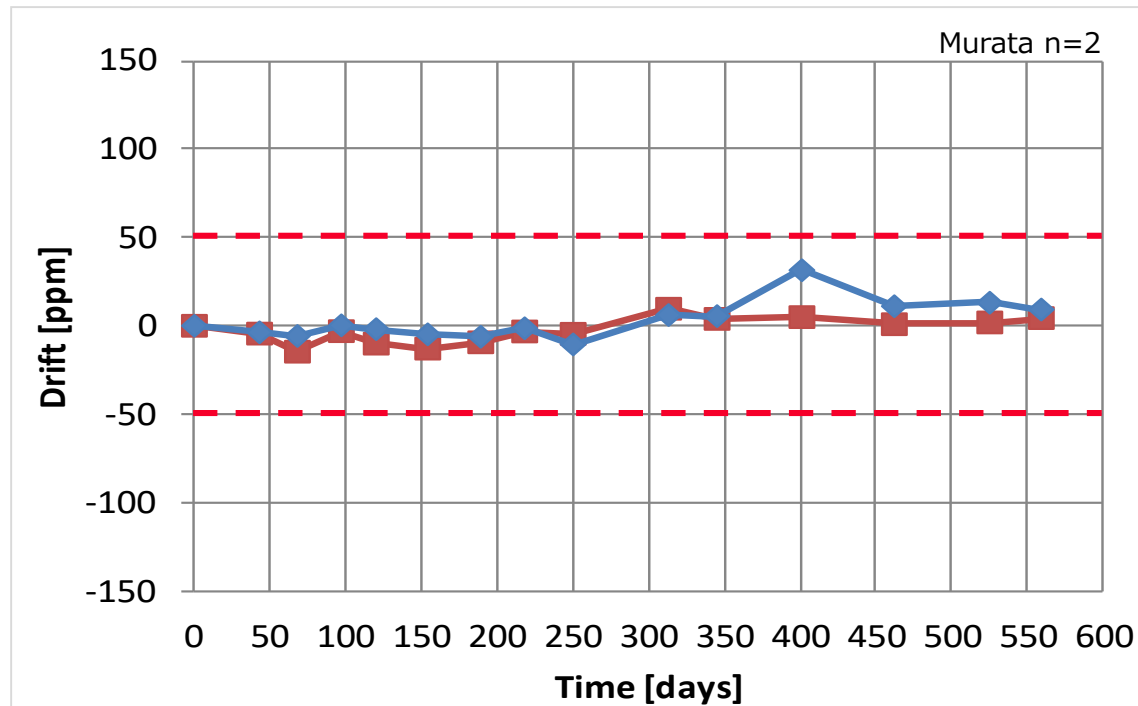


Murata CO₂ sensor achieves **“Long-term stability”**

Actual long-term stability test in the field

Installation environment: building ventilation duct

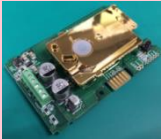
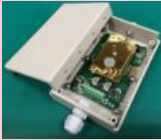
Measured using a reference gas with a CO₂ concentration of 1,000 ppm (including measurement error)



(Provided by TODA CORPORATION)

Check that it is “ ± 50 ppm/year at 1,000 ppm” in the duct installation environment

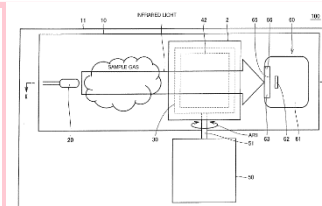
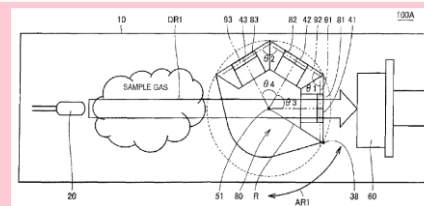
CO₂ sensor lineup

Series	Configuration	CO ₂ measurement range	Mass production part number	Non-gratuitous sample part number
IMG-CA series (Agriculture)   Module unit With case, and cable	Module unit 67 x 92 x 20mm	0 - 2000ppm	IMG-CA0011-00	IMGXCA0006-00BA
		0 - 3000ppm	IMG-CA0012-00	IMGXCA0006-00BB
	With case, and cable 80 x 125 x 32mm (Excluding protrusions.)	0 - 2000ppm or 0 - 3000ppm	IMG-CA****-11 We'll decide the part number after telling us specification, such as attached the case or not and the length of the cable.	We'll decide the part number after telling us specification, such as attached the case or not and the length of the cable.
IMG-CB series (BEMS) 	Case, cable, and probe included 81 x 134 x 51mm (Excluding the protruding portion)	0 - 2000ppm or 0 - 3000ppm	IMG-CB****-11 We'll decide the part number after telling us specification, such as attached the case or not and the length of the cable.	We'll decide the part number after telling us specification, such as attached the case or not and the length of the cable.

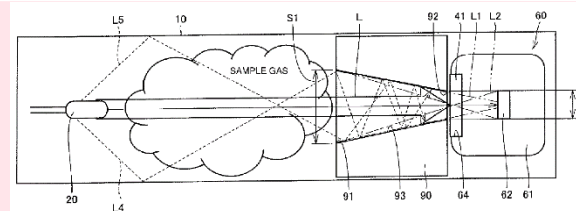
Patent information

Features and effects

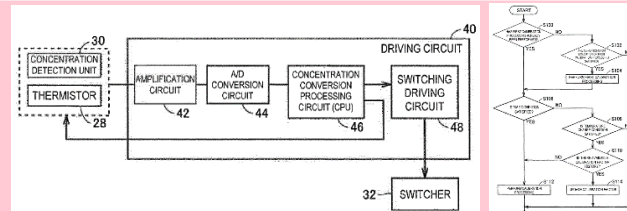
- Automatic calibration
- Built-in automatic calibration by miniaturization



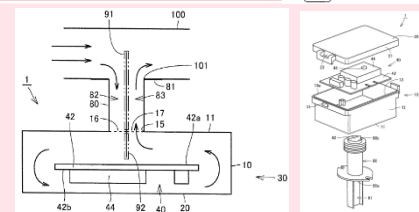
- Reduction of stray light for using NDIR technology
- Improvement of measurement accuracy



- Generation of calibration curve
- Calculation of CO₂ concentration
- Calculation of automatic calibration parameter



- Casing structure of gas sensor
- Improvement of reaction speed



Registration number

6187696(JP),
6278114(JP),
9915604(US),
9939375(US),
and so on.
※Applying for Europe

6245366(JP),
10254222(US),
and so on.
※Applying for Europe

6428779(JP),
and so on.
※Applying for US
and Europe

6481764(JP),
and so on.
※Applying for US
and Europe