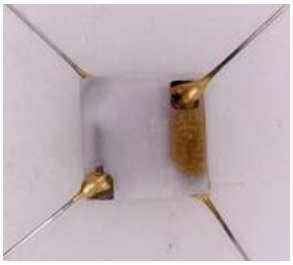
The AR-5000 CO_2 Sensor Module is a compact and accurate solid-electrochemical gas sensor for indoor air quality monitoring

AR-5000 CO_2 sensor module is the compact electrochemical type gas sensor using solid electrolytes where the EMFs are measured proportional to the logarithm of the CO_2 concentration in the ambient (Nernst equation). The circuit measures the EMF of the sensor and automatically converts it into CO_2 concentration. It provides I^2C output (slave up to 50 kHz) for digital interface. Since the sensing element is made of dense ceramics, it is quite durable and is generally resistant to hostile environments.

AR-5000 CO_2 sensor modules are pre-calibrated in the factory providing the system designer easy use. AR-5000 CO_2 sensor may be a smallest and cheapest CO_2 sensor module ever found in the world. It is certainly a good solution to farm plants, monitor indoor air quality, and so on.



Features:

High Sensitivity, Small Size, Low Power Consumption, Fast Response, Good Selectivity, High Accuracy, Long Life-Time, Self-Diagnostics

Applications:

Air Quality Monitoring, Agricultural CO_2 Detection, Process Control, Ventilation (house, classroom, industry, office, etc.), Early Fire Detection, Air Conditioner, Hood Air Cleaner, Boiler

How to Use:

Please start the sensor in a clean environment for an accurate measurement. AR-5000 assumes that the air contains 400 ppm CO_2 for the first 5-minutes which becomes the reference status for the next measurement. It takes about 3-5 minutes for AR-5000 to start measuring.

Electrical Characteristics:

Item	Contents			
	Min.	Typ.	Max.	Units
Supply Voltage		5.0±0.5		V
Power Consumption	<600	<700		mW
Inrush Current			140	mA
Warming-up Time		<3	<5	minutes
Resolution	1			ppm
Data Acquisition Time	0.1	1		seconds
Output	I^2C slave up to 50 kHz			

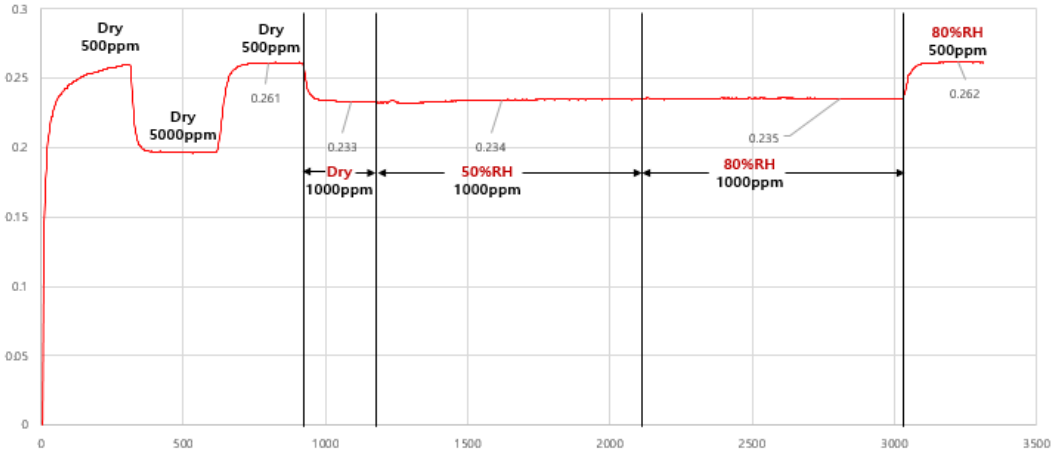
Sensor Characteristics:

Item	Contents			
	Min.	Typ.	Max.	Units
Detection Range	0		5000	ppm
Operating Temperature	0		60	ºC
Operating Humidity	5		90	%RH
Storage Temperature	-10		70	ºC
Life Expectation		5		year
Response Time		3	10(diffusion)	seconds
Size	13x25x11			mm
Weight	2			g
Temperature Coefficient	5 ppm/ºC (or <0.5%/ºC)			
Accuracy	±5% (or ±50 ppm)			
Packaging Type	Glass Polyvinyle Plastic Custom			

IMPORTANT: This product is not designed and authorized for use as a critical component in life support applications wherein a failure or malfunction of the products may result in injury or threat to life or in a chemical process wherein an accurate measurement is necessary. Avoid heavy exposure to humid, alcohol or volatile organic vapors. PSS Inc. reserves the right to make changes without notice to this product to improve reliability, functioning or design.

Humidity Effect:

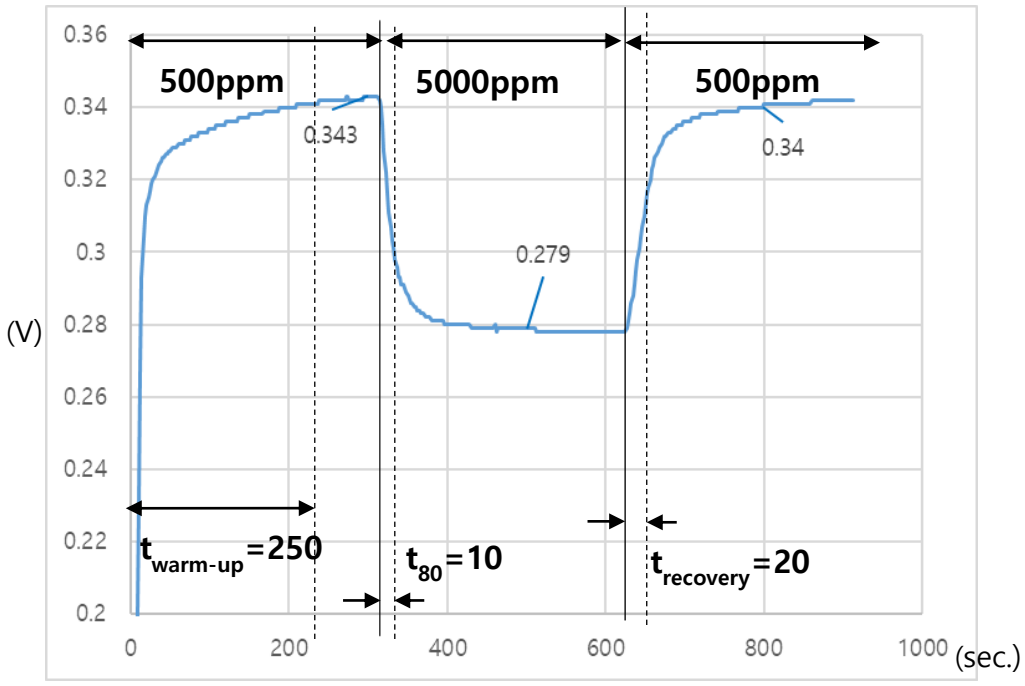
As shown below, EMFs from AR-5000 was not much changed upon adding humidity in 1000 ppm CO_2-contaning air from 50%RH to 80%RH. It instantaneously recovered to EMF value close to dry 500 ppm CO_2 even in the 80%RH.



[EMF behavior under humid condition]

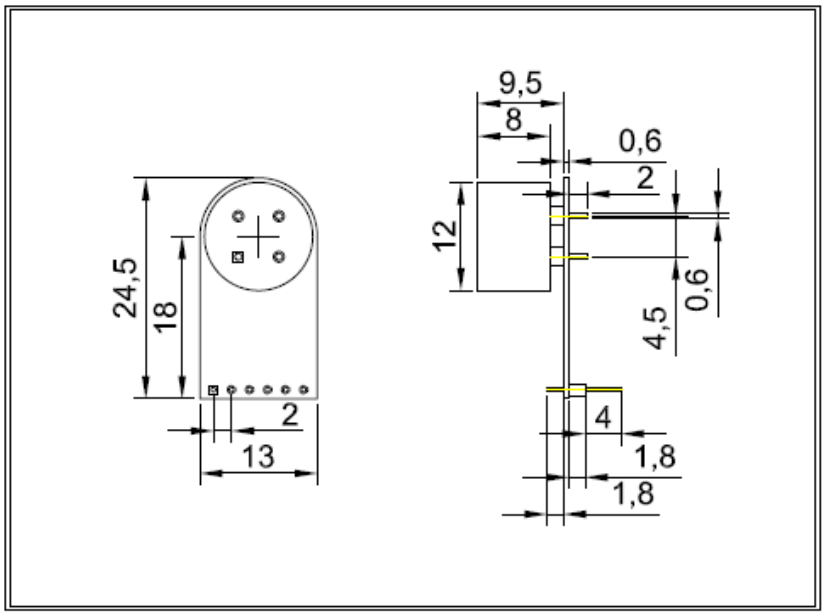
Typical Sensor Characterisitics:

The warming-up behavior, gas response and recovery characteristics of AR-5000 are shown below.



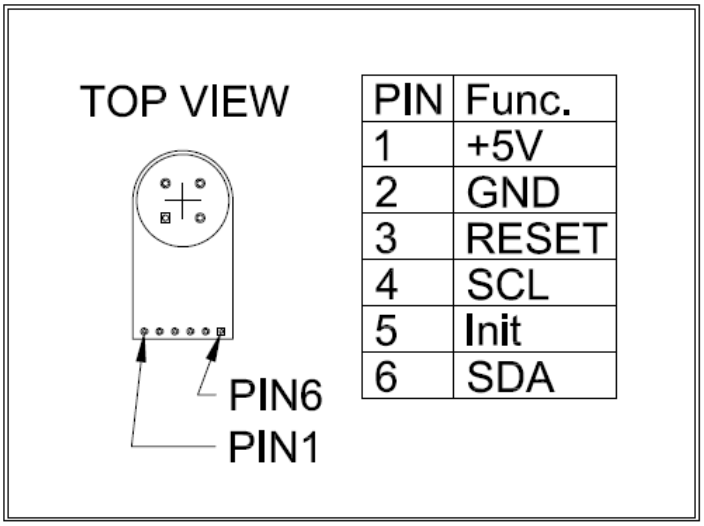
[Typical gas response of the Sensor]

Dimension



Pin Assignment

AR-5000 has 6 pins and their description is shown in the table below.



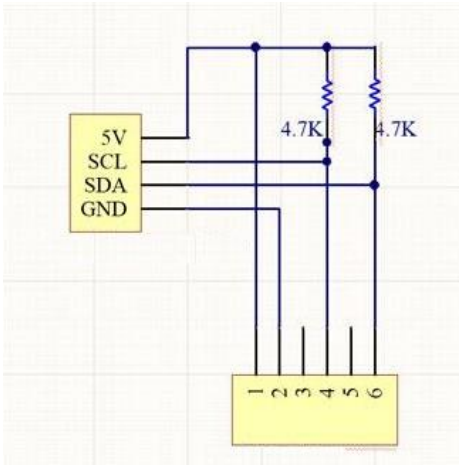
PIN	Func.
1	+5V
2	GND
3	RESET
4	SCL
5	Init
6	SDA

* **Important** : ① Init PIN should be either tied to VCC PIN or OPEN.
② SCL and SDA pin should be connected with VCC through a pull-up resistor of 1k~10kΩ
③ RESET is activated when low and normal when high

Pin Function Description

Pin No.	Mnemonic	Function
1	VDD	Driving POWER Input 5V
2	GND	Common GROUND
3	RESET	Reset
4	SCL	I²C Serial Clock
5	Init	Not Connect (Factory Purpose)
6	SDA	I²C Serial Data

Reference Diagram



SENSOR(AR-5000)

The AR-5000 communicates with the host controller over a digital I²C interface. The 7-bit base slave address is 0x50.

I²C READ Protocol

I²C Slave Address Byte

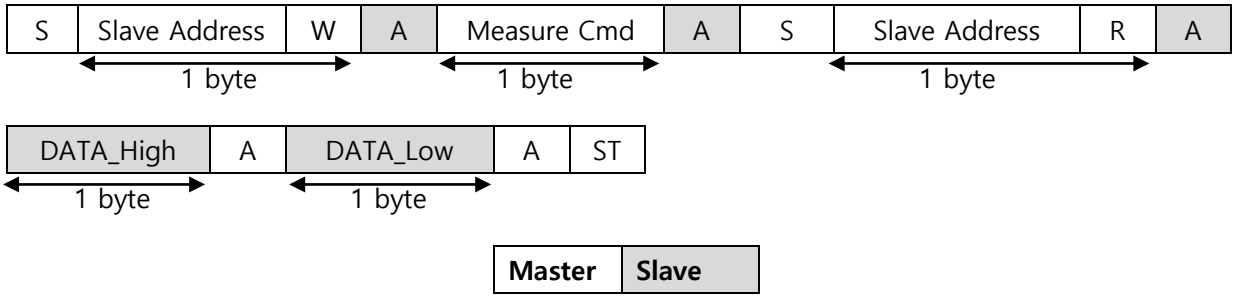
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
A6	**A5**	**A4**	**A3**	**A2**	**A1**	**A0**	**R/W**
1	0	1	0	0	0	0	0

— AR-5000 supports I²C Communication
— SLAVE address is 0x50
— "Bit 0" is set according to Read purpose as in I²C standard
— 0 : Write signal / 1 : Read signal

I²C Commands

Command Description	Command Code
CO2 data read	0x01

I²C Data Read Process



I²C Bit Description

Symbol	Name	Description
S	Start	SDA goes low while SCL high
ST	Stop	SDA goes high while SCL high
R	Read	Read bit=1
W	Write	Write bit=0
A	Acknowledgement	
Cmd	Command	
DATA_High	Data MSB	
DATA_Low	Data LSB	

EXAMPLE PROGRAM

SLAVE Address	0x50

DATA FORM	unsigned int (High 8 bit + Low 8 bit)

Start Condition	ADDR+R/W								ACK
	1	0	1	0	0	0	0	0	0
MASTER>>								WRITE	<<SLAVE
	Command								ACK
	0	0	0	0	0	0	0	1	0
								ADDR/DATA	<<SLAVE
Start Condition	ADDR+R/W								ACK
	1	0	1	0	0	0	0	1	0
MASTER>>								Read	<<SLAVE
	DATA_High 8 bit								ACK
	D	D	D	D	D	D	D	D	0
									MASTER>>
	DATA_Low 8 bit								ACK
	D	D	D	D	D	D	D	D	**1**
									MASTER>>
Stop Condition									
MASTER>>									

※ Last ACK should be “1” issued from master

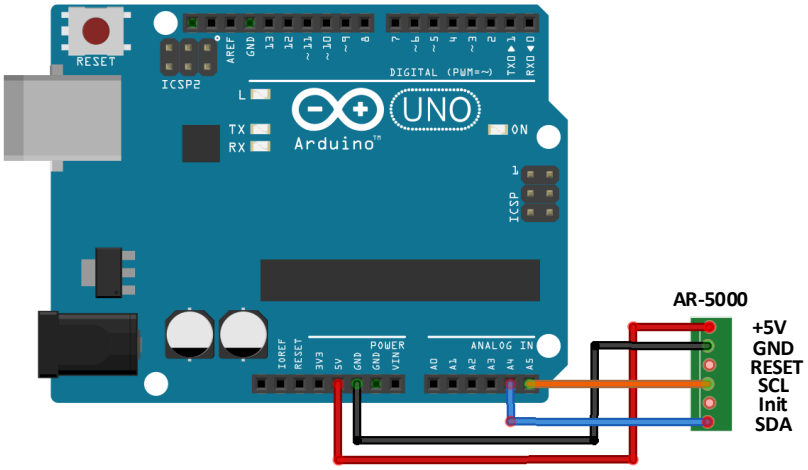
*EX PGM(Codevision AVR Source Code)

```
unsigned int SENSOR_READ(unsigned char SLAVE_ADDR, unsigned char Cmd)
      {
      unsigned int DATA_High,DATA_Low;
      unsigned int Data=0;
      i2c_start();
      i2c_write(SLAVE_ADDR<<1);
      i2c_write(Cmd);                    //Cmd 0x00->SLAVE ADDR/Cmd 0x01->CO2 DATA
      i2c_start();
      i2c_write((SLAVE_ADDR<<1)|0x01);
      DATA_High=i2c_read(1);
      DATA_Low=i2c_read(0);
      i2c_stop();
      Data=(DATA_High<<8)|DATA_Low;
      return (Data);
      }
CO2_VALUE = SENSOR_READ(0x50,1);
```

ADUINO INTERFACING

- Connect A4 (Arduino-UNO) to SDA (AR-5000) and A5 (Arduino-UNO) to SCL (AR-5000).

- Arduino-UNO has pull up resistors. It works even when SCl and SDA pins are connected directly.



*Due to the high power consumption of the heater in the sensor, separate power supply is recommended for AR-5000 other than Aduino power. Using Aduino's power line in common may result in an overheat of regulator to destruct Aduino board.

***EX. Read Co2module (Arduino Code)**

```
#include <Wire.h>
#define SLA_ADDR    0x50
#define DEV_ADDR    0x00
#define DATA_ADDR    0x01

void setup() {
     Serial.begin(9600);
     Serial.println("I2C communication Test");
     Wire.begin();
     Wire.setClock(50000);         //Set the clock frequency of I2C
}

void loop() {
   unsigned int DATA_H, DATA_L, DATA;

   Wire.beginTransmission(SLA_ADDR);
   Wire.write(DATA_ADDR); // DEV_ADDR : read device address, DATA_ADDR : read ppm data
   Wire.endTransmission(false); //(TRUE): true will send a stop message (FALSE) : send a restart
   Wire.requestFrom(SLA_ADDR,2);

   DATA_H=Wire.read();
   DATA_L=Wire.read();

   DATA = (DATA_H<<8) | DATA_L;
   Serial.print("DATA : "); Serial.println(DATA);
   delay(1000);
}
```

Cautions: Following conditions must be observed.

1) Remove Cover before Service
The sensor is normally covered with sealing tape for the protection of the sensing element when it is produced in the factory. It blocks the incoming of the environmental gas so that it should be removed for the measurement.

2) Avoid from Organic Silicon Steam
Sensor will lose its reversibility to CO2 gas if it is heavily exposed to organic silicon steam. Thus, it must be avoided exposing to silicon containing environment such as silicon bond, fixture, silicon latex, putty or plastics.

3) Avoid from High Corrosive Gas
If the sensors are exposed to high concentration of corrosive gas (such as H2S, SOX, Cl2, HCl, etc.), then it will cause a serious damage, losing its sensitivity.

4) Avoid from Alkali, Alkali Metals Salt, Halogen Compounds
The sensors property will change badly if sensors are under alkali metals salt fog, like brine, or under halogen compounds like fluorine gas.

5) Avoid from Tough Humidity
Sensitivity of the sensors will decrease if they are under high humidity over 90%RH. Water condensation on sensors surface will damage the sensor permanently.

6) Do Not Apply Voltage Higher than 5.5 V
Applying the voltage higher than 5.5 V will kill the MCU, which result in a stop of functioning.

7) Avoid from Shock or Heavy Vibration
The mechanical shock or vibration higher than certain level will break the suspending wire to stop functioning the sensing.

Trouble Shooting

Symptom	Source	Remedy
Show a high value (e.g. 65535 ppm…)	Communication is stopped due to program evaporation or hardware problem	RESET the sensor using RESET function
Abnormal value	Initial calibration failure	Wait a day. It will adjust itself. Or start it again in clean air.

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