MANUAL

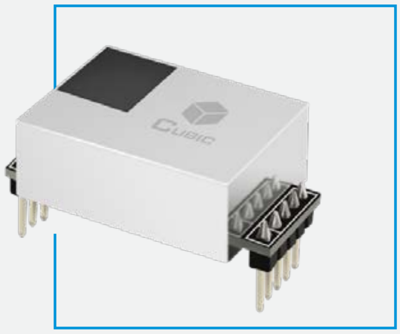
Product Name: Dual Beam NDIR CO_2 Sensor Module

Item No.: CU-1107

Version: V0.1

Dual Beam NDIR CO_2 Sensor Module

CU-1107



Applications

- HVAC industry
- IAQ monitor
- Air purifier
- Automotive
- IoT devices
- Intelligent agriculture
- Cold-chain

Description

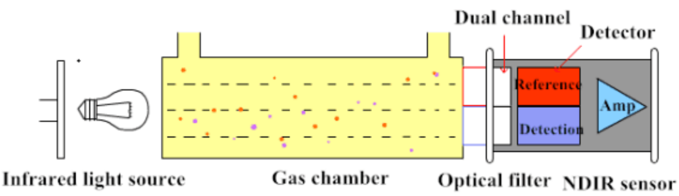
CU-1107 CO2 Sensor Module is a dual beam (single light source, dual channel) NDIR CO_2 sensor, based on non-dispersive infrared (NDIR) technology, which can detect CO_2 concentration in ambient, indoor environments. With higher accuracy and superior long-term stability, it is widely used in HVAC systems, IAQ Indoor Air Quality, Agriculture, MAP Modified Atmospheric Packaging and many other applications.

Features

- NDIR technology with independent intellectual property
- Dual beam detection for superior stability and better accuracy
- High accuracy, long term stability, long life (>10years)
- Temperature calibration within whole measurement range
- Signal output PWM/UART/I^2C
- Small size and compact structure, easy to install

Working Principle

The main components of an NDIR CO_2 sensor are an infrared source, a sample chamber, a filter and two detectors. The infrared light is directed by the infrared source passing through the gas chamber towards the detector.



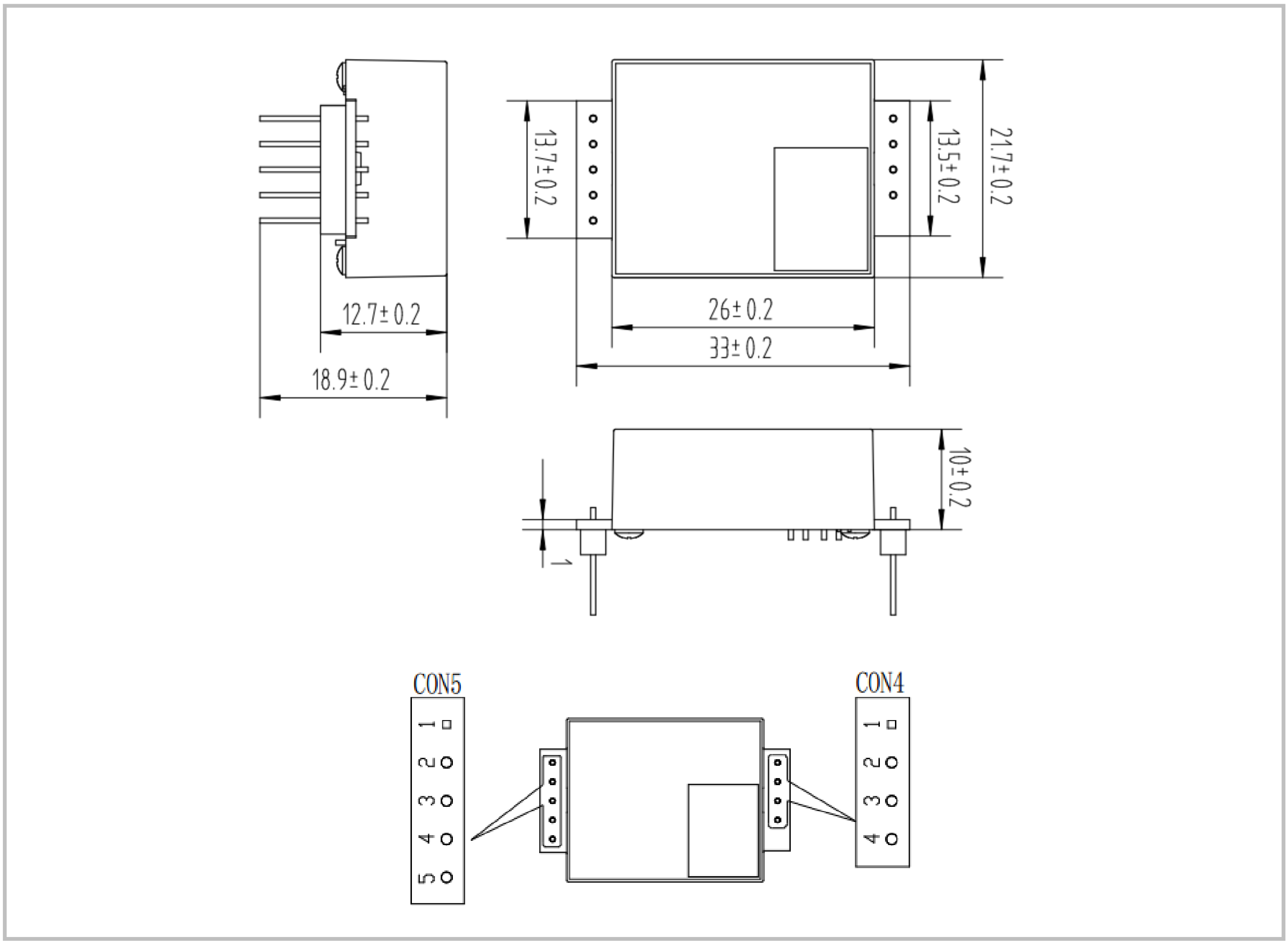
CO_2 molecules inside the gas chamber will only absorb a specific wavelength of the light. The filter allows only the specific wavelength corresponded to pass through it. One detector measures the intensity of infrared light that is related to the intensity of CO_2 and can be described through the Lambert-Beer's Law. The other detector is as for reference. The change in sensor signal reflects the change in gas concentration.

Specifications

Dual Beam NDIR CO_2 Sensor Specification	
Target gas	Carbon Dioxide (CO_2)
Operating principle	Non-dispersive infrared (NDIR)
Measurement range	0-5000ppm
Working temperature	-10°C ~ 50°C
Working humidity	0-95%RH (non-condensing)
Storage temperature	-20°C ~ 60°C
Storage humidity	0-95%RH (non-condensing)
Accuracy	± (50ppm+3% of reading) @25±2℃, 50±10%RH
Sampling frequency	1s
Time to first reading	≤120s
Power supply	DC 5V±0.1V
Ripple wave	<50mV
Working current	<70mA
Dimensions	33x21.7x18.9mm
Weight	6.3g
Signal output	UART: TTL (3.3V/5V electrical level) PWM: linear output I^2C (3.3V/5V electrical level)
PWM output	Output high level minimum duration: 2ms (0ppm)
	Output high level maximum duration: 1004ms (5000ppm)
Alarm output	Reserved
Life span	≥10 years

Dimensions and Connector

1. Dimensions (Unit mm, tolerance ±0.2 mm)

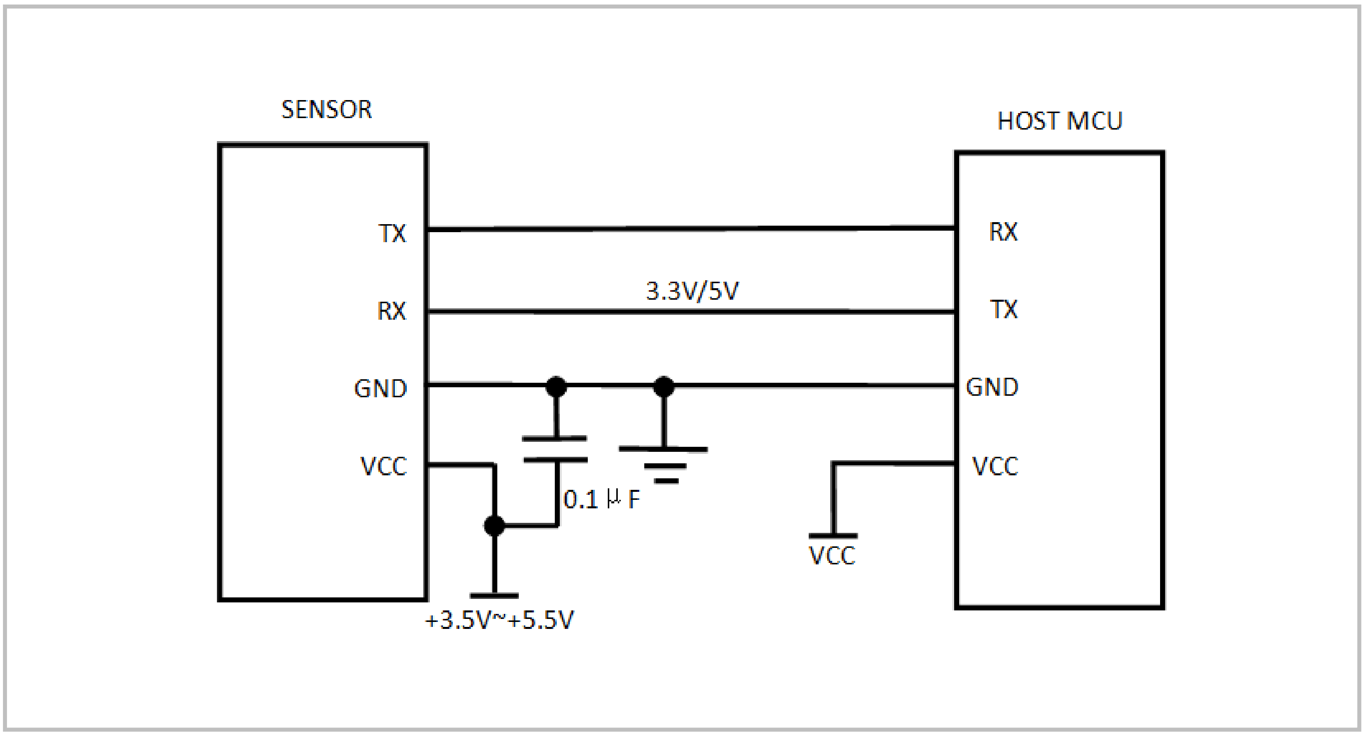


2. I/O Connector Pinout

CON5			CON4		
Pin	Name	Description	Pin	Name	Description
1	+3.3V	Power supply output (+3.3V/100mA)	1	+5V	Power supply input voltage,
2	RX/SDA	UART-RX (Receiving)/I²C data, compatible with 3.3V and 5V communication	2	GND	Power supply input (GND)
3	TX/SCL	UART-TX (Sending)/I²C Clock, 3.3V communication	3	A	Alarming
4	R/T	UART/ I²C Switch (Output mode exchange TTL level @3.3V High level or floating is UART communication mode, low level is I²C communication mode)	4	PWM	PWM output
5	CA	Manual calibration			

Typical Application Circuit

Application scene: UART TTL serial port output



Description of Calibration

Rough installing, non-correct soldering and transportation might result in a reducing of sensor reading accuracy and zero drift. If need to recover accuracy quickly after installing, you can do manual calibration. To put the sensor in the environment where the CO_2 concentration level can reach 400ppm, and to ensure the CO_2 concentration in this environment is stable before calibration. The CA pin of sensor should be well connected at least 2 seconds when doing the manual calibration. Sensor will activate the calibration program after 6 seconds. In addition, sensor also can do manual calibration by sending command, please refer to the communication protocol for more details.

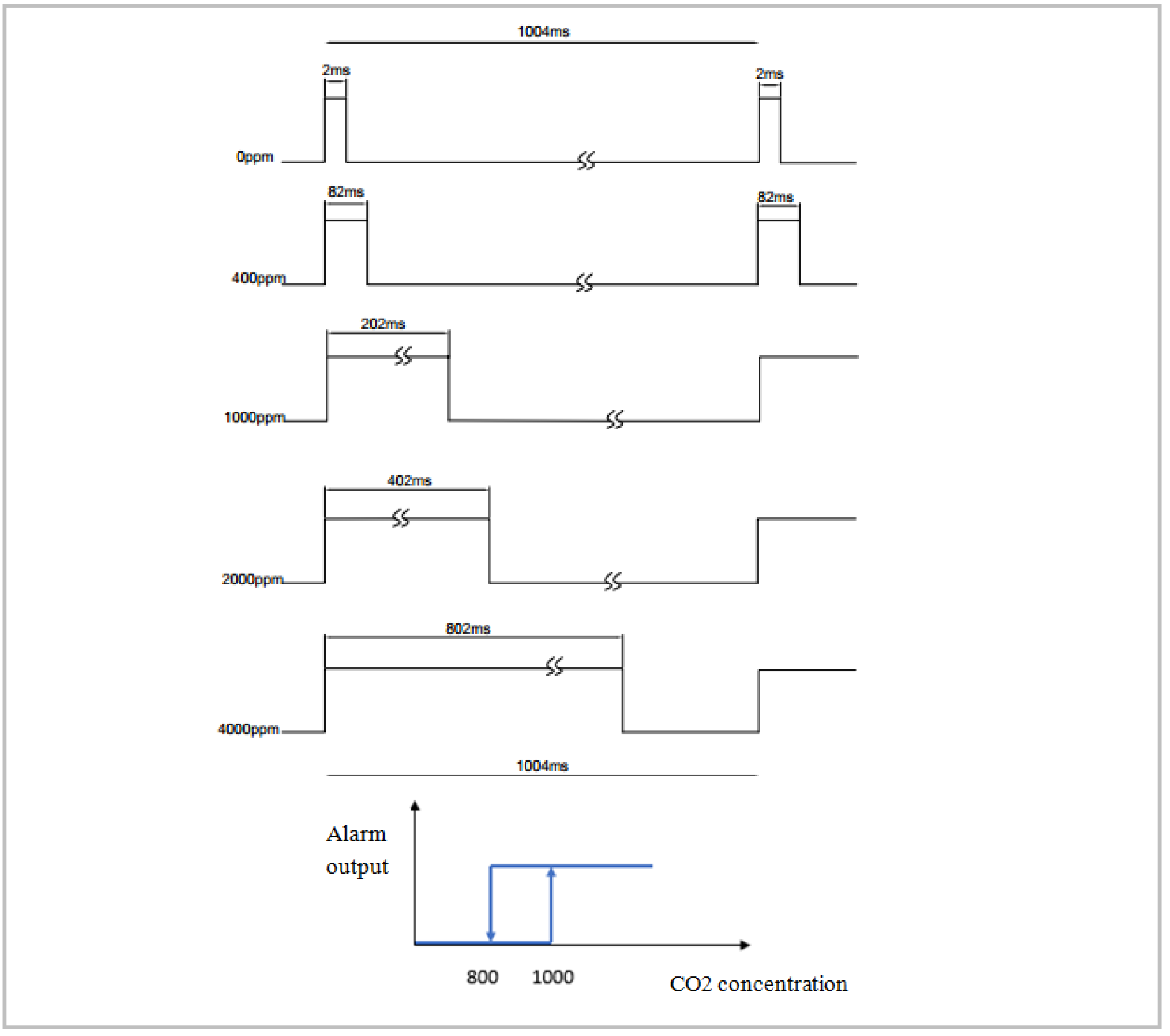
PWM output

Measurement range: 0-5000ppm

PWM cycle: 1004ms

Positive pulse width: (PPM/5)+2ms

PWM output schema:



Alarm Output

If the CO_2 concentration rises up to more than 1000ppm, the alarming will be triggered and output high level. When the CO_2 concentration goes down to below 800ppm, the alarming will stop and output low level.

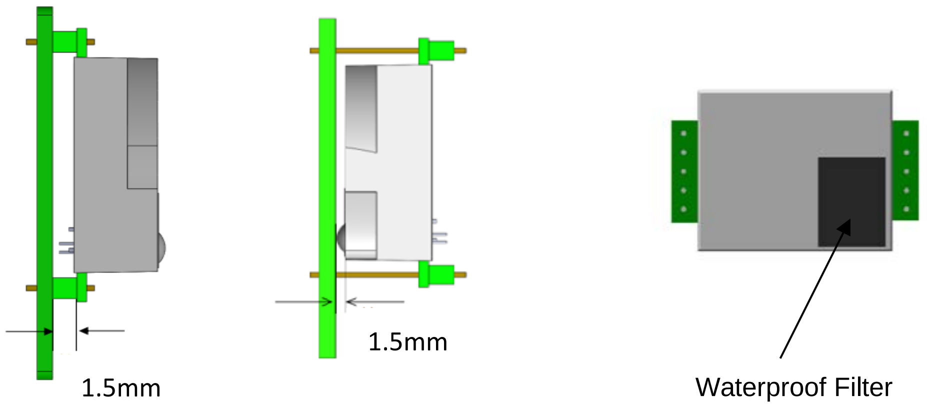
Note

Connect the pin of PWM to the oscilloscope.

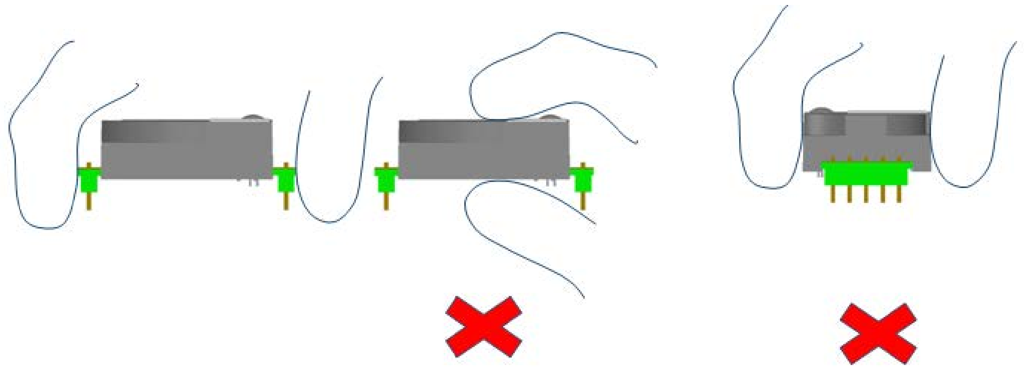
Add a pull-up resistor around 5K-10K between the pin of PWM and power supply.

Product Installation

1. In order to ensure airflow diffusion into the sensor inner, make sure the minimum distance between the area of waterproof filter and the other components is 1.5 mm, otherwise, quick response time of the sensor will be affected. Reference as below:



2 .To avoid the influence of stress on sensor, please soldering by hand as much as possible when mounting the sensor to the PCB. Reference as below:



1. General Statement

1). The data in this protocol is all hexadecimal data. For example, “46” for decimal [70].

2). Baud rate: 9600, Data Bits: 8, Stop Bits: 1, Parity: No, Flow control: No.

3). [xx] is for single-byte data (unsigned, 0-255); for double data, high byte is in front of low byte.

2. Format of Serial Communication Protocol

Sending format of upper computer:

Start Symbol	Length	Command	Data 1	…	Data n.	Check Sum
HEAD	LEN	CMD	DATA1	…	DATAn	CS
11H	XXH	XXH	XXH	…	XXH	XXH

Detail description on protocol format:

Protocol Format	Description
Start Symbol	Sending by upper computer is fixed as [11H], module respond is fixed as [16H]
Length	Length of frame bytes= data length +1 (including CMD+DATA)
Command	Command
Data	Data of writing or reading, length is not fixed
Check Sum	Cumulative sum of data = 256-(HEAD+LEN+CMD+DATA)

3. Command Table of Serial Protocol

Item No.	Function Name	Command
1	Read measured result of CO_2	0x01
2	Open/ Close ABC and set ABC parameter	0x10
3	Calibrate concentration value of CO_2	0x03
4	Read the serial number of the sensor	0x1F
5	Read software version	0x1E

4. Detail Description of RS232 Protocol

4.1 Read Measured Result of CO_2

Send: 11 01 01 ED
Response: 16 05 01 DF1- DF4 [CS]
Function: Read measured result of CO_2 (Unit: ppm)

Note:
CO_2 measured result = DF1*256+DF2; DF3,DF4 is reserved

Example:
Response: 16 05 01 02 58 00 00 8B

Explanation:
Hex is converted to decimal: 02 is 02; 58 is 88
CO_2 concentration=02*256+88 = 600ppm

4.2 Open/Close ABC and Set ABC Parameter

Send: 11 07 10 DF1 DF2 DF3 DF4 DF5 DF6 CS
Response: 16 01 10 D9

Explanation:
DF1: Reserved, default 100 (0x64)
DF2: Open/close auto calibration (0: open; 2: close)
DF3: Calibration cycle (1-30 days optional, default is 7 days)
DF4: High base value (2 bytes)
DF5: Low base value (2 bytes)
DF6: Reserved, default is 100 (0x64)

Note:
The auto calibration function is open with 7 days calibration cycle by default.
The default value of DF4 and DF5 is 400, that is DF4: 01; DF5: 90

4.2.1 Open ABC and Set Calibration Cycle

When ABC function is closed and you want to re-open ABC function, you should set the DF2=0.

Example: You could send below command to open ABC function and set the calibration cycle 7 days.
Send: 11 07 10 64 00 07 01 90 64 78
Response: 16 01 10 D9

4.2.2 Close ABC

The ABC function is default closed. If you want to close the ABC function after open it, you should set the DF2=2.
Send: 11 07 10 64 02 07 01 90 64 76
Response: 16 01 10 D9

4.2.3 Change the Calibration Cycle

If you want to change the calibration cycle to 10 days, you should set the DF3=10.

Send: 11 07 10 64 00 0A 01 90 64 75

Response: 16 01 10 D9

4.3 Calibration of CO_2 Concentration

Send: 11 03 03 DF1 DF2 CS

Response: 16 01 03 E6

Function: Calibration of CO2 concentration

Note:

1. Calibration target value = DF1*256+DF2 Unit: PPM, range (400-1500ppm)
2. Before calibration, please make sure CO_2 concentration in current ambient is calibration target value. Keeping this CO_2 concentration for two 2 minutes, then began calibration.

Example:

When you need to calibrate CO_2 concentration of the sensor to 600ppm, send command:

Send: 11 03 03 02 58 8F

Hex is converted to decimal: 02 is 02; 58 is 88

CO_2 concentration =02*256+88 = 600ppm

4.4 Read the Serial Number of the Sensor

Send: 11 01 1F CF

Response: 16 0B 1F (SN1) (SN2) (SN3) (SN4) (SN5) [CS]

Function: Read the serial number of the sensor

Note: Read the serial number of the sensor. SNn: 0~9999, 5 integer form 20-digit number.

4.5 Read Software Version

Send: 11 01 1E D0

Response: 16 0C 1E DF1-DF11 CS

Function: Read software version

Note:

DF1-DF10: stand for ASCII code of software version, DF11 is reserved.

Example:

When the sensor version is CM V0.0.20, respond data as follows:

Hexadecimal converted to ASCII code:

Note: when 20 converted to ASCII code, it equals to blank space.

16 0C 1E **43 4D 20 56 30 2E 30 2E 32 30**

⇩

CM V0.0.20

I²C Communication Protocol

1. Timing Diagram Introduction

1.1 Common Description

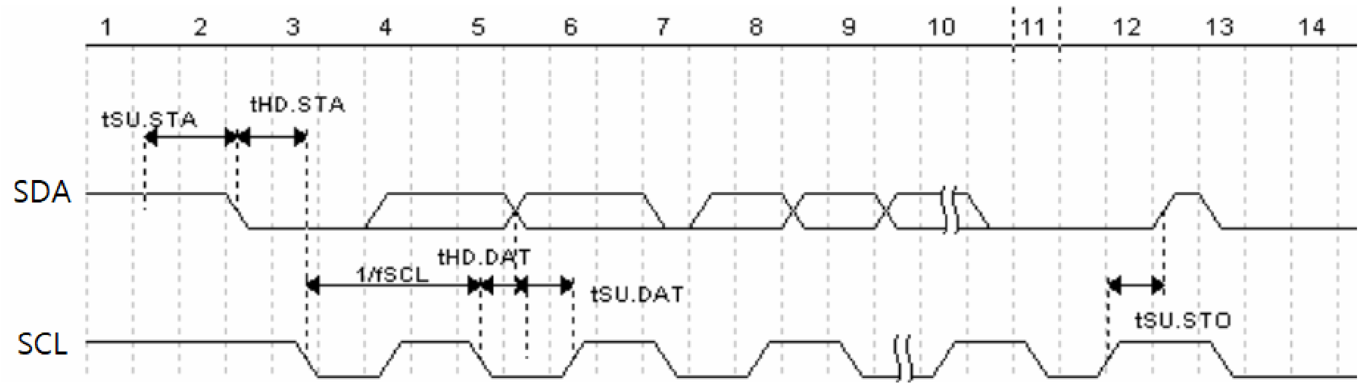
a. This protocol is based on standard I²C timing sequence, the clock frequency is 10kHz～400kHz.

b. Use big-endian format, the most significant bit to be sent first.

1.2 I²C Sequence Diagram Introduction

Item	Parameter			Unit
	Min	Type	Max	
fSCL (SCL clock frequency)	10		400	KHz
tHD.STA (hold time of the starting		0.6		us
tSU.STA (setup time of the starting		0.6		us
tHD.DAT (hold time of the data)		0		ns
tSU.DAT (setup time of the data)		250		ns
tSU.STO (setup time of the stop bit)		4		us

Note: SCL clock frequency is generated by the master device with the range 10khz～400khz.



Picture 1: I²C clock introduction

1.3 Basic Data Transmission Formats

S	SA	W	A	D	A	D	…	D	A/~A	P

Picture 2: The general data format sends from the master device to the slave

S	SA	R	A	D	A	D	…	D	A/~A	P

Picture 3: The general data format received from the slave device to the master device

The meaning of the symbol in picture 1.2 and picture 1.3:

S: start condition

SA: slave address

W: write bit

R: read bit

A: acknowledge bit

~A: not acknowledge bit

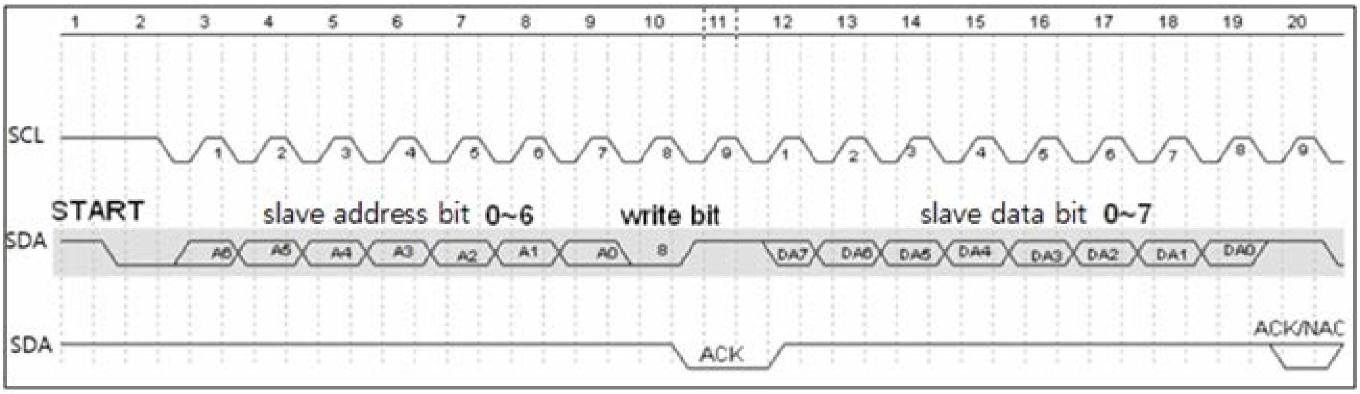
D: data, each data is 8bit

P: stop condition

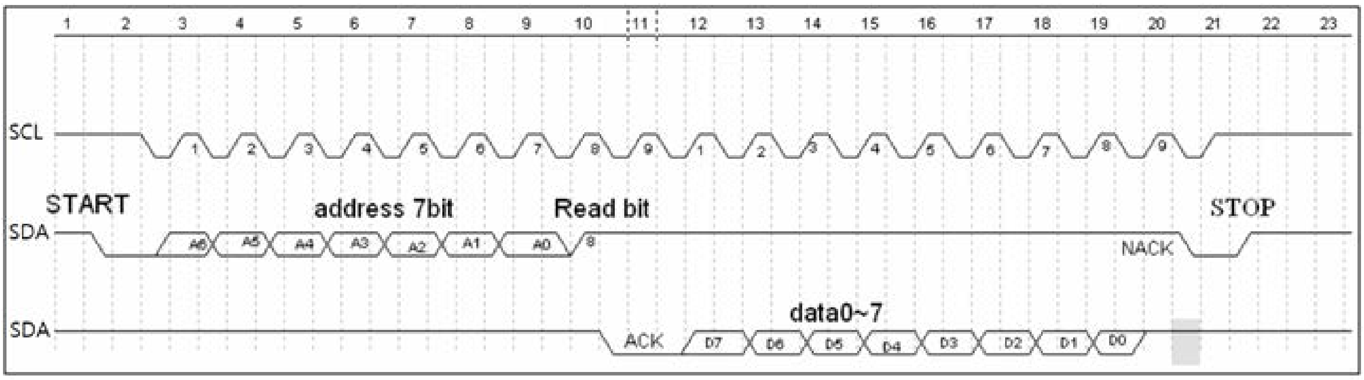
Shadow: The signal generated from the master device

No Shadow: The signal generated from the slave device

1.4 Timing Diagram



Picture 4: The address byte send from the master device



Picture 5: The master device read a byte from the slave device

1.5 Notes

The performance of the MCU which is used in the sensor is not very high. If you use I/O port to simulate IIC master device, it is suggested to reserve a period before and after ACK signal (such as 100 us), after sending every byte (8 bit) to leave enough time for the SCM to process the data. Within requirements of speed, it is recommended to lower the reading speed as much as possible.

2. Measuring Function

Format of Command

Format of Sending: [CMD][DF0]……[DFn]

[CMD] Command number, for distinguishing different command.

[DF0] … [DFn] The command with parameter item and optional items

Format of Response: [CMD][DF0]……[DFn]［CS］

[CMD] Command number

[DF0]… [DFn] Effective data

[CS] Data check bit = -([CMD]+ [DF0]+……[DFn]) Only use the lowest bit

2.1 Statement of Measuring Command

The slave address is 0x31, the data command of the slave device is as below:

No.	Function Name	CMD	Function Description
1	Measure result	0x01	Read measuring result
2	Auto calibration specification setting	0x10	Set auto calibration specification (Open or not, calibration period)
3	Calibration	0x03	Zero setting of CO_2
4	Read the serial number of the sensor	0x1F	Read the serial number of the sensor
5	Check software version	0x1E	Read software version

2.2 Measuring Result

The master device should send command of measuring result.

Send: 0x01

Response: [0x01][DF0][DF1] [DF2][CS]

Note:

1. Sensor starts measuring result status once receiving the command 0x01. After this, all the data which I^2C read will be such status format data, until the sensor receives new command or re-powering on.

2. Data format, master device receives DF_0 first, and then receives CS at last.

Remark	Status Bite	Decimal Effective Reading Value Range	Relative	Multiple
CO_2 measuring result	[DF0] [DF1]	0 ~ 5,000 ppm	0 ~ 5,000 ppm	1
Status bit	[DF2]			1

CO_2 measuring result: DF0*256+DF1, Fixed output is 550ppm during preheating period.

Status bit: 0: Preheating; 1: Normal operation; 2: Operating trouble; 3: Out of FS,5: Non-calibrated.

Example:

The master device reads some data: Read 3 bit.

0x01 0x03 0x20 0x01 0xDB

CO_2 measuring result = (0x03 0x20) $_{hexadecimal}$ = (800) $_{decimal}$ = 800 ppm

Status bit: 0x01 means working normally

[CS]= -(0x01+0x03+0x20+0x01) Only keep the lowest bite.

2.3 Auto Zero Specification Setting

Send: 0x10 [DF0] [DF1] [DF2] [DF3] [DF4] [DF5]

Response: [0x10] [DF0] [DF1] [DF2] [DF3] [DF4] [DF5] [CS]

Format description:

1. Sensor will be auto calibration specification setting status after receiving command 0x10. After this, all the data which I^2C read are the data in this status format, until sensor receives new command or repowering on.
2. Data format, the master will receive [DF0] firstly, and receive [CS] at last.

The result is calculated by high bit in front

Remark	Data Bite	Decimal Effective Reading Value Range	Relative Value	Multiple
Wrong code accelerate value	[DF0]	By default: 100	100	1
Zero setting switch	[DF1]	0 or 2	0: Open, 2: Close	1
Calibration period	[DF2]	1 ~ 15	1 ~ 15	1
Calibration concentration value	[DF3] [DF4]	400 ~ 1499	Suggest 400 ~ 1499	1
Reserved byte	[DF5]	By default: 100	100	1

2.4 Calibration

The master device should send command of zero setting.

Send: 0x03 [DF0] [DF1]

Response: [0x03] [DF0] [DF1] [CS]

Note: 1. Sensor starts zero setting status once receiving command 0x03. After this, all the data which I^2C read will be such status format data, until the sensor receives new command or re-powering on.

2. Data format, master device receives DF0 first, and then receives CS at last. The result is calculated by high bit in front: [DF0] * 256 + [DF1].

Remark	Data Bite	Decimal Effective Reading Value Range	Relative value	Multiple
Adjust value	[DF0] [DF1]	400 ~ 1,500	400 ~ 1,500 ppm	1

2.5 Read the Serial Number of the Sensor

Send: 0x1F
Response: [0x1F] [DF0] [DF1] [DF2] [DF3] [DF4] [DF5] [DF6] [DF7] [DF8] [DF9] [CS]

Note:
1. Sensor starts device code output status once receiving the command 0x1F. After this, all the data which I^2C read will be such status format data, until the sensor receives new command or re-powering on.
2. Data format, the master device receives [DF0] first, and then receives [CS] at last. The result is calculated by hig h bit in front.

Remark	Data Bit	Decimal Effective Reading Value Range	Relative Value	Multiple
Integer type 1	[DF0] [DF1]	0 ~ 9999	0 ~ 9999	1
Integer type 2	[DF2] [DF3]	0 ~ 9999	0 ~ 9999	1
Integer type 3	[DF4] [DF5]	0 ~ 9999	0 ~ 9999	1
Integer type 4	[DF6] [DF7]	0 ~ 9999	0 ~ 9999	1
Integer type 5	[DF8] [DF9]	0 ~ 9999	0 ~ 9999	1

3. The five-integer type makes 20 codes.

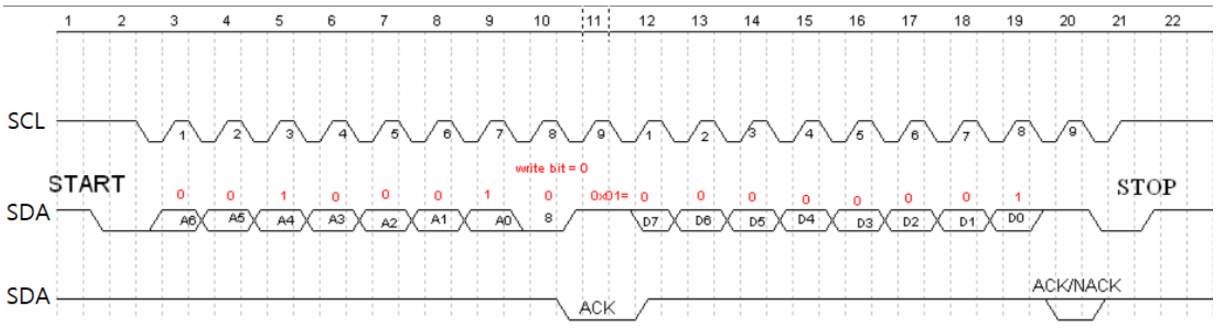
2.6 Read Software Version

Send: 0x1E
Response: [0x1E] [DF0] [DF1] [DF2] [DF3] [DF4] [DF5] [DF6] [DF7] [DF8] [DF9] [CS]

Note: 1. Sensor starts software version output status once receiving the command 0x1E. After this, all the data which I^2C read will be such status format data, until the sensor receives new command or re-powering on.
2. Data format, the master device receives DF_0 first, and then receives CS at last. [DF_0] …… [DF_9] is ASCII.

3. Communication Diagram

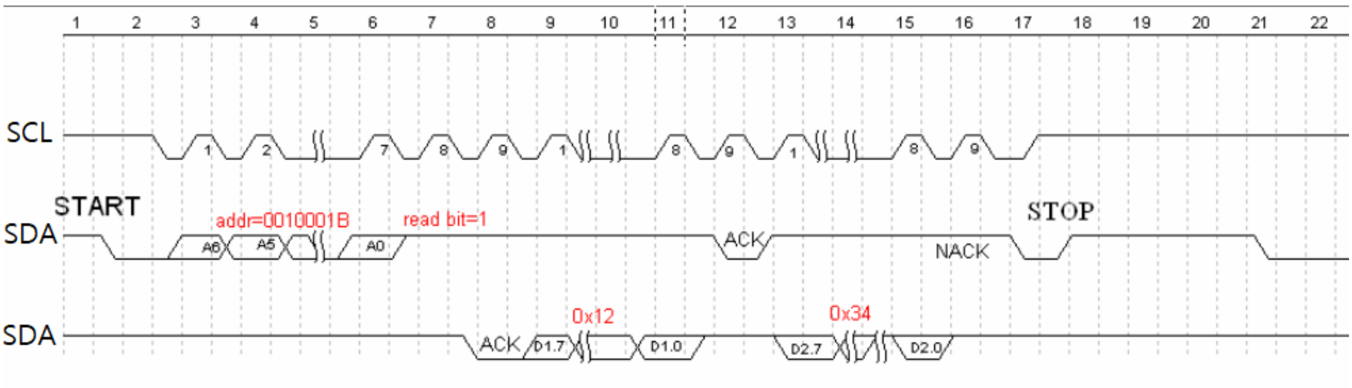
Diagram 1: The master device read two bytes continuously from the slave device.
The slave machine address: 0x31 = 0110001 (the machine address is 7 bit) + read/write bit（1bit）
The slave data address: 0x01 = 00000001
Step 1: The master device sends the address of the slave device+ write bit: 0110001+0 → 01100010 (0x62); at this time, the master device is in sending status.
Step 2: The master device sends the slave data address: 0x01



Picture 6: The timing diagram send from the master device

Step 3: The master device send the slave machine address+ read bit : 0110001+1 → 01100011 (0x63); at this time, the master device is in receiving status.

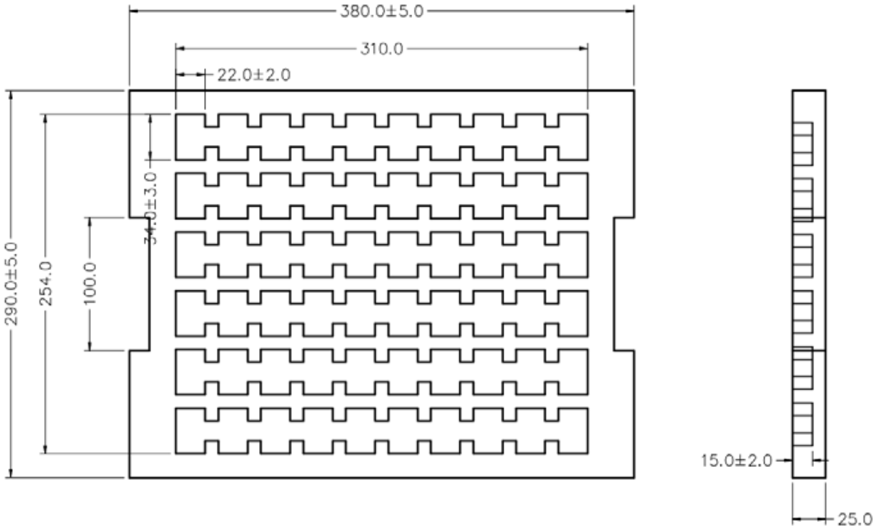
Step 4: The master device sends the answer bit after receiving a one-bit data and the slave continuously sends the next data. If the master device sends the no-answer bit after receiving a one-bit data, then the communication will stop.



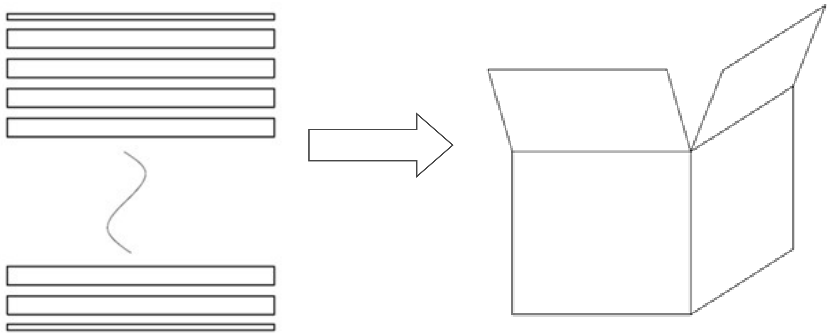
Picture 7: The master device receives the data from the slave device

Packing Information

Tray Size



Tray Qty 18



Carton

CO2METER.COM
CO2 MEASUREMENT SPECIALISTS

After-Sales Services and Consultancy

CO2Meter.com
131 Business Center Drive
Ormond Beach, FL 32174
E-mail: Sales@CO2Meter.com Support: Support@CO2Meter.com
Phone: 877-678-4259 Website: www.co2mter.com