Datasheet ACD10

Infrared CO_2 sensor

- Long-term stability
- Good selectivity
- No obvious oxygen dependence
- Standard digital output
- Quick response
- Fast recovery time
- Strong anti-interference ability

Summary

ACD10 is a sensor detecting the concentration of CO_2 in the air based on the non-dispersed infrared (NDIR) principle. ACD10 consists of precision optical path, high-precision detection circuit and a component to detect the infrared absorption for gas sensing. ACD10 has good selectivity, no obvious oxygen dependence and long life; and ACD10 has digital output, which makes it easy to be used.

Application Scenarios

ACD10 can be used in application scenarios, such as air quality monitoring equipment, fresh air system, air purification equipment, HVAC.

Figure 1. ACD10

1. Principle

ACD10 sensor is developed based on the non-dispersed infrared (NDIR) principle, specifically, the spectral absorption of CO_2. As shown in Figure 2, an ACD10 consists of a light source (IR source), a chamber and an infrared sensor (IR sensor). The infrared sensor is used to measure the intensity of infrared light, which is emitted by the IR source.

The concentration of CO_2 in the chamber is changed depending on the CO_2 concentration out of the chamber by the diffusion of air through the two vents on the chamber. CO_2 absorbs infrared light with a specific wavelength and the absorption amount depends on the concentration of CO_2. With a given intensity of infrared light emitted by IR source, the detected intensity of infrared light by the IR sensor depends on the concentration of CO_2 in the chamber. Thus, ACD10 can detect and calculate the concentration of CO_2 in the chamber with the light intensity detected by IR sensor.

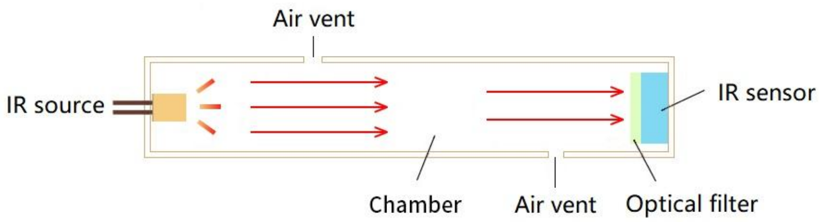


Figure 2. Principle sketch of ACD10

2. Technical characteristics

Table 1. Technical characteristics

No.	Parameter	Description
1	Working voltage	4.75～5.25V
2	Working current	Average current <45mA
3	Typical power	225mW @5V
4	Measurement range	400～5000ppm
5	Accuracy	± (50ppm + 5% reading)
6	Preheating time	120s
7	Operation condition	0℃ ~50℃. 0~95%RH (non-condensation)
8	Storage condition	-20℃ ~60℃. 0~95%RH (non-condensation)
9	Data refresh frequency	2s
10	Life	>5 years
11	Data interface	I^2C/UART

User Guide

1. Calibration

ACD10 can be calibrated automatically and manually. Users can select the calibration approach by sending the corresponding command (see 2.3.2 and 2.4.3 command list) from the host. The sensor is set to be in automatic calibration mode by default.

1.1 Automatic calibration

ACD10 has a built-in automatic calibration algorithm to calibrate the sensor periodically. The sensor will be calibrated first time in 24h after the sensor is powered on. The following calibration will be done every 7 days (168 hours) after the first calibration. To have an accurate calibration, please ensure that the CO_2 concentration of the working environment reaches the outdoor atmospheric level more than 1h before each calibration.

1.2 Manual calibration

Place the sensor in a known CO_2 concentration environment for more than 20minutes, send a manual calibration command via the host (see 2.3.2 and 2.4.3 command list).

2. Interface definition and communication protocol

2.1 Pin assignment

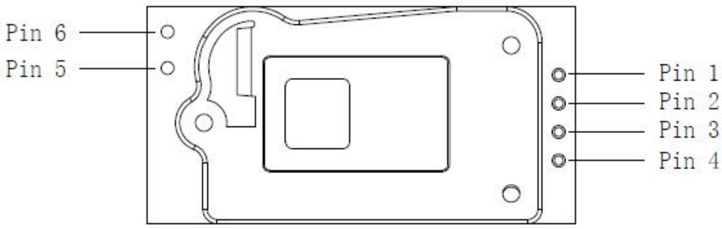


Figure 3. Pins in ACD10

Table 2. Pin Definition

No.	Pin	Name	Function
1	Pin 1	SDA/RX	I^2C data/UART input
2	Pin 2	SCL/TX	I^2C clock/UART output
3	Pin 3	GND	Ground
4	Pin 4	VCC	Power
5	Pin 5	SET	Set communication mode
6	Pin 6	-	Not defined

2.2 Communication interface

ACD10 provides I^2C and UART communication interfaces. The interface input voltage is in the range from 3V to 5V. The output voltage is pulled up to 5V. The default communication interface (Pin 5 suspended, built-in a 4.7 kΩ pull-up resistor) is I^2C, when Pin 5 is suspended and a 4.7 kΩ pull-up resistor is connected; the communication interface is UART, when Pin 5 is connected to low voltage level.

2.3 I^2C Communication protocol

According to the standard I^2C protocol for communication, the maximum communication rate of 100kHz, when I^2C communication interface is used.

2.3.1 CRC calibration mode

Table 3. CRC Calibration Parameter

No.	Item	Value
1	Name	CRC-8
2	Multinomial	0x31 ($x^8+ x^5+ x^4+1$)
3	Initial value	0xFF
4	Example	CRC (0x0000) =0x81

2.3.2 Command

Table 4. I^2C communication command

No.	Function	Command
1	Read CO_2 concentration	0x0300
2	Set / read calibration mode	0x5306
3	Set / read manual calibration value	0x5204
4	Factory reset /Read factory set	0x5202
5	Read firmware version	0xd100
6	Read sensor code	0xd201

1) To read the CO_2 concentration, instructions including downlink command and uplink data as shown in Tables 5 and 6 can be used.

Table 5. Downlink instruction

Startbit	Address	Command high byte	Command low byte	Stopbit
Start	0x54	0x03	0x00	Stop

Table 6. Uplink data

Start bit	Address	Concentration (the highest byte)	Concentration (sub-high byte)	CRC (first 2 bytes)	Concentration (sub-low byte)	Concentration (the lowest byte)	CRC (first 2 bytes)	Temperature (high byte)	Temperature (low byte)	CRC (first 2 bytes)	Stopbit
Start	0x55	PPM3	PPM2	CRC1	PPM1	PPM0	CRC2	TEMP 1	TEMP 2	CRC3	Stop

2) To set the calibration mode to the manual or automatic mode, instructions as shown in Table 7 can be used.

Table 7. Instruction to set calibration mode setting

Startbit	Address	Command high byte	Command low byte	Data high byte	Data low byte	CRC first 2 bytes	Stopbit
Start	0x54	0x53	0x06	0x00	0x00	0x81	Stop

Note: ACD is set to be manual calibration mode when low byte is 0, and to be automatic calibration mode when low byte is 1.

Instructions to read calibration mode are shown in Table 8 and 9, which includes downlink instructions and uplink data. The response data is used to check whether the set calibration mode command writes correctly. When the response data in Table 9 is the same as the written data in Table 7, the set calibration mode command is written correctly. The instructions in Table 8 and Table 9 need not be used in pairs with the instructions shown in Table 7. Table 8 and 9 must be used at least 5ms after the instructions in Table 7 was sent.

Table 8. Downlink instruction

Startbit	Address	Command high byte	Command low byte	Stopbit
Start	0x54	0x53	0x06	Stop

Table 9. Uplink data

Startbit	Address	Data high byte	Data low byte	CRC (first 2 bytes)	Stopbit
Start	0x55	0x00	0x00	0x81	Stop

Note: ACD is set to be manual calibration mode when low byte is 0, and to be automatic calibration mode when low byte is 1.

3) To set manual calibration mode (single point calibration), instructions as shown in Table 10 can be used to set the reference point to be a customized value.

Table 10. Manual calibrate instruction

Startbit	Address	Command high byte	Command low byte	Data high byte	Data low byte	CRC (first 2 bytes)	Stopbit
Start	0x54	0x52	0x04	0x01	0xC2	0x50	Stop

Note: Data is the calibrated value in ppm, such as 450ppm.

Instructions to read the manual calibrated value are shown in Table 11 and 12, which includes downlink instructions and uplink data. The response data is used to check whether the manual calibrated value is written is correctly. When the response data in Table 12 is the same as the written data in Table 10, the manual calibrated value is written correctly. The instructions in Table 11 and 12 must be used in pairs with the manual calibration instruction shown in Table 10, and other instructions cannot be inserted in the pair. Table 11 and 12 must be used as least 5ms after the instructions in Table 10 was sent.

Table 11. Downlink instruction

Startbit	Address	Command high byte	Command low byte	Stopbit
Start	0x54	0x52	0x04	Stop

Table 12. Uplink data

Startbit	Address	Data high byte	Data low byte	CRC (first 2 bytes)	Stopbit
Start	0x55	0x01	0xC2	0x50	Stop

Note: Data is the calibrated value in ppm, such as 450ppm.

4) To restore the factory setting, instructions as shown in Table 13 can be used.

Table 13. Instruction to restore the factory setting

Startbit	Address	Command high byte	Command low byte	data	Stopbit
Start	0x54	0x52	0x02	0x00	Stop

Instructions as shown in Table 14 and 15 can be used to check if restoring of factory setting is done, instructions. Instructions includes downlink instructions and uplink response. When the response data in Table 15 is 1, the restoring of factory settings is successful. After the restoring of factory setting instruction in Table 13 is done successfully, the uplink response data can be read.

Table 14. Downlink instruction

Startbit	Address	Command high byte	Command low byte	Stopbit
Start	0x54	0x52	0x02	Stop

Table 15. Uplink data

Startbit	Address	Data high byte	Data low byte	CRC (first 2 bytes)	Stopbit
Start	0x55	0x00	0x 01	0xB0	Stop

Note: Data is the factory value result, recovery is 1 and recovery is 0.

5) To read firmware version, instructions as shown in Table 16 and 17 can be used.

Table 16. Downlink instruction

Startbit	Address	Command high byte	Command low byte	Stopbit
Start	0x54	0xd1	0x00	Stop

Table 17. Uplink data

Startbit	Address	Version high bit…low bit	Stopbit
Start	0x55	10 ASCII codes	Stop

6) To read the sensor code, instructions as shown in Table 18 and 19 can be used.

Table 18. Downlink instruction

Startbit	Address	Command high byte	Command low byte	Stopbit
Start	0x54	0xd2	0x01	Stop

Table 19. Uplink data

Startbit	Address	Sensor code high bit…low bit	Stopbit
Start	0x55	10 ASCII codes	Stop

2.3.3 Actual code routines

Continuous reading instruction in I^2C mode:
Downlink command: 0x54 0x03 0x00 CRC (0x54 is the result of one bit shift to the left side of 0x2A)
Uplink data: PPM3 PPM2 CRC PPM1 PPM0 CRC TEM1 TEM0 CRC (CRC exists after every two bytes)

Concentration

```
PPMCO2 = (uint)((((uint )PPM 3)<<24) | (((uint )PPM2)<<16) |
         (((uint )PPM1)<<8) | ((uint )PPM0));
```

Temperature:

```
Temperature = TEM1 * 256 + TEM0;
```

The CRC checksum algorithm:

```
unsigned char Calc_CRC8(unsigned char *data, unsigned char Num)
{
    unsigned char bit, byte, crc =0xFF;

    for (byte=0; byte<Num; byte++)
    {
        crc ^=(data[byte]);
        for (bit=8;bit >0;--bit)
        {
            if(crc&0x80) crc = (crc <<1)^0x31;
                else crc = (crc <<1);
        }
    }
    return crc;
}
```

2.4 UART communication protocol

ACD10 supports UART communication, and the communication baud rate is 1200. The communication data include 1 data byte, no parity, 1 stop bit. The protocol data are hexadecimals.

2.4.1 Protocol format

Table 20. UART protocol format

Frame header	Fixed code	Length	Command code	Data 1	……	Data n	Checksum
FE	A6	XX	XX	XX	……	XX	XX

Table 21. UART protocol format description

No.	Item	Description
1	Length	Data Length
2	Command	Command word
3	Data	Data to read or write, with a variable length
4	Check Sum	Data cumulative sum = Fixed code + Length + Command + Data

2.4.2 Command

Table 22. UART command

No.	Function	Value
1	Read CO_2 concentration	0x01
2	Manual Calibration	0x03
3	Set calibration mode	0x04
4	Factory reset	0x05
5	Read firmware version	0x1E
6	Read the sensor code	0x1F

1）To read CO_2 concentration, instructions as shown in Table 23 can be used.

Table 23. UART instruction to read the concentration

Transmit data	Receive data	Description

FE A6 00 01 A7	FE A6 04 01 D1~D4 CS	CO_2 Concentration value =D1×256+D2. D3, D4 are reserved

2）To set manual calibration (single-point calibration) mode, instructions as shown in Table 24 can be used to set the reference point to be a customized value.

Table 24. UART instructions to set manual calibration (single-point calibration)

Transmit data	Receive data	Description
FE A6 02 03 D1 D2 CS	FE A6 00 03 A9	Single-point calibrated concentration value =D1×256 + D2

3）To set calibration mode, instructions as shown in Table 25 can be used.

Table 25. UART instructions to calibration mode (manual or automatic)

Transmit data	Receive data	Description
FE A6 02 04 00 D1 CS	FE A6 00 04 CS	For D1=0, set to manual (single point) calibration mode and for D1=1

4）To restore the factory setting, instructions as shown in Table 26 can be used.

Table 26. UART instructions to restore the factory setting

Transmit data	Receive data	Description
FE A6 00 05 AB	FE A6 00 05 AB	

5）To read the firmware version, instructions as shown in Table 27 can be used.

Table 27. UART instructions to read the firmware version

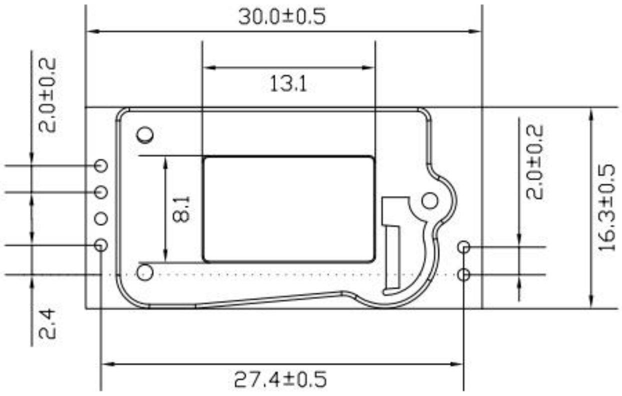
Transmit data	Receive data	Description
FE A6 00 1E C4	FE A6 0B 1E D1~D11 CS	D1~D10 is the ASCII code of the version number. D11 is reserved

6）To read the sensor code, instructions as shown in Table 28 can be used.

Table 28. UART instructions to read the sensor code

Transmit data	Receive data	Description
FE A6 00 1F C5	FE A6 0A 1F D1~D10 CS	The D1~D10 is the ASCII code of the sensor code

3. Dimension



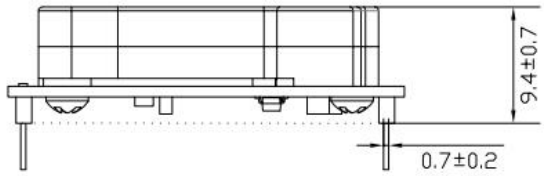


Figure 4. ACD10 Dimension (unit: mm, tolerances unmarked: ±0.5mm)

4. Caution

(1) To prevent irreversible damage, users should not disassemble ACD10.

(2) For manual calibration, ACD10 must be placed in an environment with stable and given CO_2 concentration longer than 20 minutes.

(3) In manual calibration mode, the recommended calibration period is less than 6 months.

(4) ACD should be mounted on an equipment with the size of air inlet and outlet larger than the opening size of ACD 10 (the 13.1mm×8.1mm window shown in Figure 4).

(5) ACD10 should be used in a place far away from the heat source, and a direct sunlight or other thermal radiation on ACD10 should be avoid.

(6) Do not use the sensor in an environment with high dust density for a long time.

(7) Flow welding must not be used for ACD10. The welding temperature shall be below 350℃ and the welding time should be less than 3s.

(8) To install sensors with welded sockets is suggested for easy maintenance in future.

(9) ACD10 has been calibrated. Do not take the third-party instrument or data as standard for comparison. If the user wants the measurement data to be consistent with the third-party instrument, ACD10 can be calibrated referring the data from third-party instrument.

(10) PCB in ACD10 has been treated to be moisture-proof with coating of silicone potting or acrylic conformal coating with a thickness more than 0.15mm. Please protect the coating during use.

Warning

Do not apply this product to safety protection devices or emergency stop equipment, and any other applications that may cause personal injury due to the product's failure. Do not use this product unless there is a special purpose or use authorization. Refer to the product data sheet and application guide before installing, handling, using, or maintaining the product. Failure to follow this recommendation may result in death and serious personal injury.

The Company will not bear all compensation for personal injury and death arising therefrom, and will exempt the company's managers and employees, affiliated agents, distributors, and other claims that may arise therefrom, including various costs, claims, lawyers' fees, etc.

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Description of Warranty Period of Main Components

Accessories Category	Shelf Life
ACD10 IR CO_2 Sensor	12 Months

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