ZG09 CO_2 Module

User Manual

Contents

1. General Description

This document describes the user guide of ZG09.
This is a preliminary specification, any update might without notification.

Limited Warranty:
This data sheet contains information specific to products manufactured at the time of its publication. Contents herein do not constitute a warranty.

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2. Features of Design

NDIR (non-dispersive infrared) sensor
The diffusion and sampling method are both available.
Measurement range: 0~10,000ppm
Output interface: UART, RS485, I2C, PWM, DAC

3. Specification

CO_2 Measurement range	0~10,000ppm
Measurement Interval	2 sec
CO_2 Accuracy	±50ppm±3% of reading
CO_2 RMS Noise	<10ppm @ 400ppm, <20ppm @ 1000ppm
CO_2 Repeatability	±20ppm
Resolution	1ppm
Response Time	about 1min for diffusion (90% Rise Time)
Pressure Dependence	0.13% of reading per mm Hg
Warm-Up Time (Cold Start)	30 sec @ 25°C
Power Supply	5.0VDC±0.5 supply
Power Consumption	Max. (0.8 ms shot capture) <190mA, avg. <34mA
IR OFF Avg. Current (mA)	<10mA
Operating Temperature	0~50°C
Storage Temperature	-20~60°C
Operating Humidity	0-95% RH
Storage Humidity	0-95% RH
Dimensions	32.2mm x 20.2mm x 13.7mm

Communication:

UART	3.3V level Modbus RTU protocol
RS485	SCL pin for RS485 R/T control pin shared
I2C	Max. clock 400kHz
PWM	3.3V level at 1kHz
DAC Output	0~1V = 800~1,200ppm

Pin assignment of ZG09

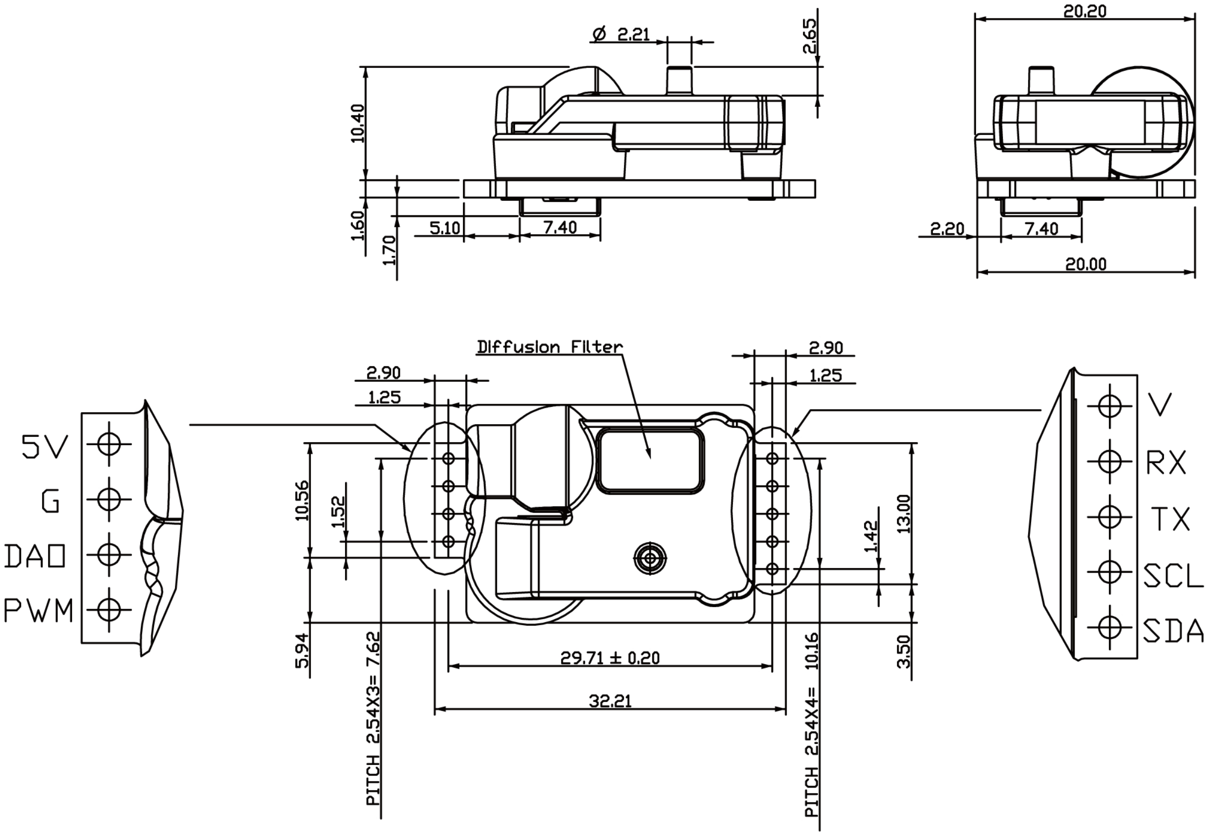

Figure 1. Module External Drawing
Note: The dimensions in this drawing are for reference only.

Pin Configuration:

Pin	Function
PWM	CO_2 ppm PWM output
DAO	DAC output
G	Ground
5V	Power input +5V
SDA	I2C Data pin
SCL	I2C Clock pin (default) or RS485 R/T control pin
TX	UART TX
RX	UART RX
V	3.3V output

4. UART

UART default:
BPS: 19200
Data Bit: 8
Parity bit: None
Stop bit: 1

Protocol:
The protocol for ZG09 UART is Modbus RTU, commends are for sending and receiving:
Send

ID (1 Byte)	Function Code (1 Byte)	Start (2 Bytes)	Length (2 Bytes)	CRC (2 Bytes)
FEH	03H	0000H (Note 1)	0003H	XXXX

Receive

ID (1 Byte)	Function Code (1 Byte)	Length (1 Byte)	data (N Bytes)	CRC (2 Bytes)
FEH	03H	06H (Note 2)	6 * 8 bit (Note 3)	XXXX

Note 1: Start = Start address for getting data. i.e. CO_2 value = 0x0B
Note 2: The length of Data
Note 3: Data length for Receiving = Length for Sending x 2

ID
The user can define the ID code of the device. The factory default is 0x01, 0xFA and 0xFE reserved for broadcast commands.

Function Code
0x03 Read
0x06 Write

Start

Start	Read / Write	Description
00(0x00) : SlaveID	R/W	ID: The factory default is 0x01. 250 (0xFA) and 254 (0xFE) are reserved for broadcast and cannot be adjusted.
01(0x01) : BPS	R/W	Baud rate setting (settings will be applied after reset or repower) 0x00 : 9600 0x01 : 19200 (default) 0x02 : 38400 0x03 : 57600
02(0x02) : Uart Parity Set	R/W	Uart Parity setting (settings will be applied after reset or repower) 0x00:n82 0x01:n81 (default) 0x02:e81 0x03:o81
11(0x0B) : CO_2 Value	R	CO_2 concentration reading in units of ppm.

Example for getting CO_2 data:
Send the command, FA03 000B 0001 E043, to 250(0xFA) with the broadcast method.
The sensor is addressed as “Any address” (0xFE or 0xFA).

ID (1 Byte)	Function Code (1 Byte)	Start (2 Bytes)	Length (2 Bytes)	CRC (2 Bytes)	Note
(1) FAH	03H	000BH	0001H	E043H	
(2) FEH	04H	0003H	0001H	D5C5H	

Commend for data returning 0103 0201 F8B8 56

ID (1 Byte)	Function Code (1 Byte)	Length (1 Byte)	data (N Bytes)	CRC (2 Bytes)	Note
(1) FAH	03H	02H	01ACH	5C7DH	428ppm
(2) FEH	04H	02H	0197H	ED1AH	407ppm

Data length for Receiving =Length for Sending x 2
CO_2 value is 0x01ACH = 428ppm, 0x0197=407ppm

CRC Code

```
unsigned int Crc16(unsigned char * data, unsigned char length)
{
    int     j;
    unsigned int reg_crc=0xFFFF;
    while(length--)
    {
            reg_crc     ^= *data++;
            for(j=0;j<8;j++)
            {
                    if(reg_crc & 0x01) /* LSB(b0)=1   */
                            reg_crc=reg_crc    >>1    ^ 0xA001;
                    else
                            reg_crc=reg_crc    >>1;
            }
    }
    return reg_crc;
}
```

CRC Code (Lookup Table)

```
unsigned int Crc(unsigned char *ucTx, unsigned int Len)
{
if    (Len && ucTx)
        {
        unsigned char *ucPtr=ucTx;
        unsigned char ucCRCHi = 0xff;
        unsigned char ucCRCLo = 0xff;
        unsigned uIndex;
        while(Len--)
            {
            uIndex = ucCRCHi ^ *ucPtr++;
            ucCRCHi = ucCRCLo ^ ucCRCHigh[uIndex];
            ucCRCLo = ucCRCLow[uIndex];
            }
        return (unsigned int)(ucCRCLo << 8) | (unsigned int)ucCRCHi;
        }
    else
        return 0;
}

unsigned char ucCRCHigh[] =
{
    0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,
    0x40,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x00,0xc1,0x81,0x40,0x01,0xc0,
    0x80,0x41,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x00,0xc1,0x81,0x40,0x01,
    0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x01,0xc0,0x80,0x41,
    0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x00,0xc1,0x81,
    0x40,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x01,0xc0,
    0x80,0x41,0x00,0xc1,0x81,0x40,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x01,
```

```
    0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,
    0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,
    0x40,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x01,0xc0,
    0x80,0x41,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x00,0xc1,0x81,0x40,0x01,
    0xc0,0x80,0x41,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,
    0x00,0xc1,0x81,0x40,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,
    0x40,0x01,0xc0,0x80,0x41,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x01,0xc0,
    0x80,0x41,0x00,0xc1,0x81,0x40,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x01,
    0xc0,0x80,0x41,0x00,0xc1,0x81,0x40,0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,
    0x00,0xc1,0x81,0x40,0x01,0xc0,0x80,0x41,0x01,0xc0,0x80,0x41,0x00,0xc1,0x81,
    0x40
};

unsigned char ucCRCLow[] =
{
    0x00,0xc0,0xc1,0x01,0xc3,0x03,0x02,0xc2,0xc6,0x06,0x07,0xc7,0x05,0xc5,0xc4,
    0x04,0xcc,0x0c,0x0d,0xcd,0x0f,0xcf,0xce,0x0e,0x0a,0xca,0xcb,0x0b,0xc9,0x09,
    0x08,0xc8,0xd8,0x18,0x19,0xd9,0x1b,0xdb,0xda,0x1a,0x1e,0xde,0xdf,0x1f,0xdd,
    0x1d,0x1c,0xdc,0x14,0xd4,0xd5,0x15,0xd7,0x17,0x16,0xd6,0xd2,0x12,0x13,0xd3,
    0x11,0xd1,0xd0,0x10,0xf0,0x30,0x31,0xf1,0x33,0xf3,0xf2,0x32,0x36,0xf6,0xf7,
    0x37,0xf5,0x35,0x34,0xf4,0x3c,0xfc,0xfd,0x3d,0xff,0x3f,0x3e,0xfe,0xfa,0x3a,
    0x3b,0xfb,0x39,0xf9,0xf8,0x38,0x28,0xe8,0xe9,0x29,0xeb,0x2b,0x2a,0xea,0xee,
    0x2e,0x2f,0xef,0x2d,0xed,0xec,0x2c,0xe4,0x24,0x25,0xe5,0x27,0xe7,0xe6,0x26,
    0x22,0xe2,0xe3,0x23,0xe1,0x21,0x20,0xe0,0xa0,0x60,0x61,0xa1,0x63,0xa3,0xa2,
    0x62,0x66,0xa6,0xa7,0x67,0xa5,0x65,0x64,0xa4,0x6c,0xac,0xad,0x6d,0xaf,0x6f,
    0x6e,0xae,0xaa,0x6a,0x6b,0xab,0x69,0xa9,0xa8,0x68,0x78,0xb8,0xb9,0x79,0xbb,
    0x7b,0x7a,0xba,0xbe,0x7e,0x7f,0xbf,0x7d,0xbd,0xbc,0x7c,0xb4,0x74,0x75,0xb5,
    0x77,0xb7,0xb6,0x76,0x72,0xb2,0xb3,0x73,0xb1,0x71,0x70,0xb0,0x50,0x90,0x91,
    0x51,0x93,0x53,0x52,0x92,0x96,0x56,0x57,0x97,0x55,0x95,0x94,0x54,0x9c,0x5c,
    0x5d,0x9d,0x5f,0x9f,0x9e,0x5e,0x5a,0x9a,0x9b,0x5b,0x99,0x59,0x58,0x98,0x88,
    0x48,0x49,0x89,0x4b,0x8b,0x8a,0x4a,0x4e,0x8e,0x8f,0x4f,0x8d,0x4d,0x4c,0x8c,
    0x44,0x84,0x85,0x45,0x87,0x47,0x46,0x86,0x82,0x42,0x43,0x83,0x41,0x81,0x80,
    0x40
};
```

5. RS485 Communication

Schematic

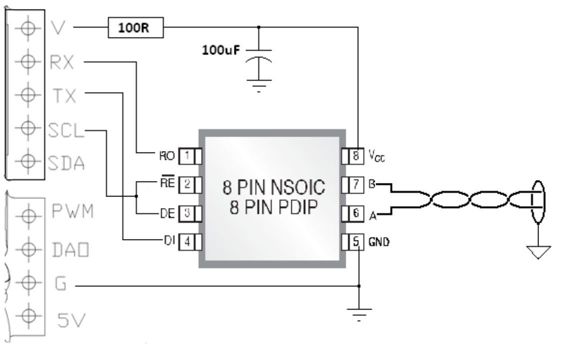

Figure 2

Connect with the Chip SP3072 for RS-485/RS422 for long distance monitoring. Shield wire is required for long distance. The chip SP3072 can be powered by 3V power from ZG09 as Figure 2. Keep the lead as short as possible. Please refer Item 4. UART for Modbus Protocol.

6. I2C Communication

The speed of I2C is 100KHz to 400KHz.

7. PWM Output

Adjustable CO_2 measurement range PWM VCC (3.0~3.3V) level at 1 kHz output 0~10,000ppm. Schematic is as Figure 3. AL1=0~10,000ppm, AL2=0~10,000ppm. The AL1<AL2 setting is for HVAC. AL1>AL2 setting is for agriculture, If the gas concentration for agriculture is 0-10,000ppm, then the AL1=0ppm, AL2=10,000ppm.

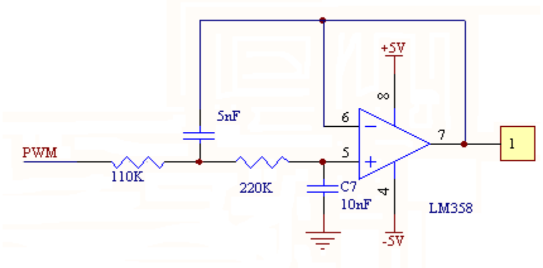

Figure 3

Application	AL1 0~10,000ppm	AL2 0~10,000ppm	Remark
CO_2 monitoring	0ppm (0V)	10,000ppm (VCC)	
HVAC	800ppm default (<800ppm=0V)	1200ppm default (>1200ppm=VCC)	Note 1
Agriculture	Adjustable	Adjustable	Note 2

Note 1: For HVAC, the ventilation will be activated when the CO_2 concentration is higher than AL2 1200ppm (adjustable). The ventilation will be inactivated when the CO_2 lower than 800ppm(adjustable).
Note 2: For planting, the alarm setting is AL1>AL2. The CO_2 generator will be activated when the CO_2concentration is lower than AL2 400ppm (adjustable). The CO_2 generator will be inactivated when the CO_2 concentration is higher than AL2 1200ppm (adjustable). The difference between AL1 and AL2 has to be 100ppm at least.

8. DAV Output

DAV output can be controlled by user. For high precise CO_2 monitoring is not recommended. Output 0~1V = default 800~1,200ppm (210 steps). The range can be controlled by AL1 and AL2. Users can use comparator to control the relay. AL2>AL1 is for HVAC. AL1>AL2 is for agriculture. When AL1 is 800ppm and the CO_2 reading is also 800ppm, DAV output is 0V. AL1=0 and AL2=10,000ppm is for full range output.

9. Reliability

9.1 Long term stability

16 samples were on long-term test (25°C, 70% RH, 500 hours) and the average results are shown in Figure 4.
The Y axis is the CO_2 concentration and the X axis is the time.

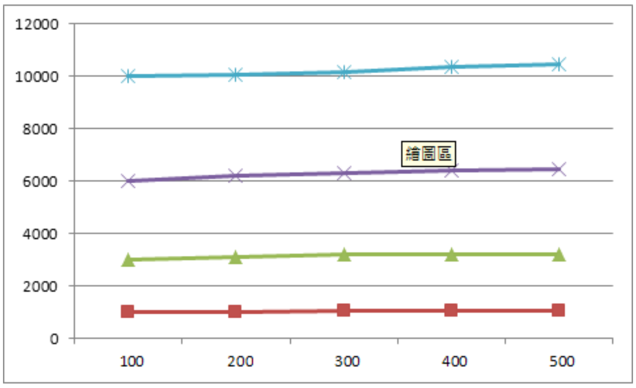

Figure 4

9.2 Temperature cycle test

16 samples were on long-term test (-20°C, +65, +60°C, 85% RH, 400 hours) and the average results are shown in Figure 5. The Y axis is the CO_2 concentration and the X axis is the time.

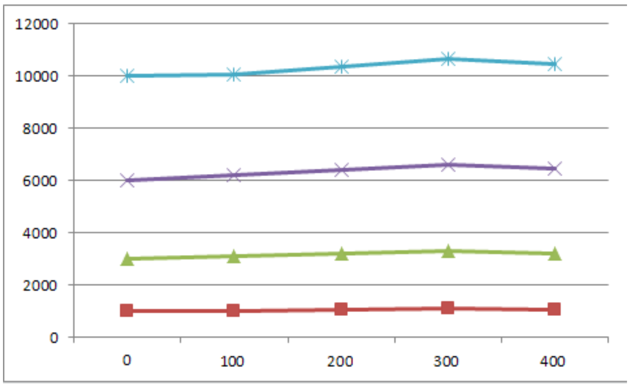

Figure 5

9.3 High/Low temperature test

The performance of CO_2, at -20°C~60°C and 5V±0.25V, is displayed on Figure 6. The performance is consistent in 4.75~5.25V. The accuracy will be affected when the voltage drops to 4.5V.

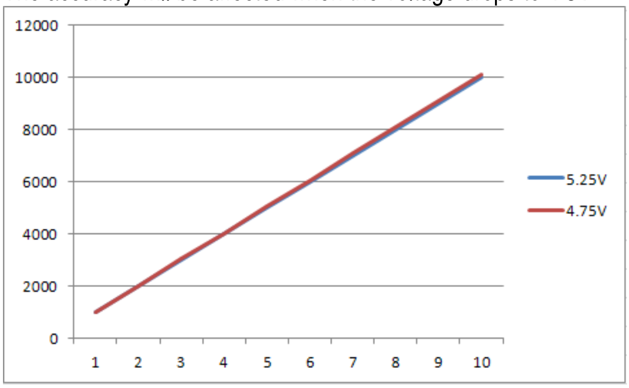

Figure 6

10. Response Time

It shows how much time is needed for CO_2 monitor to reach the 90% response to step change. Test methods 1: putting the monitor in the environment at 1,000ppm in 10 minutes, then move it to the environment at 400ppm.
Test method 2: putting the monitor in the environment at 400ppm in 10 minutes, then move it to the environment at 1,000ppm.

Test Method	Time
400ppm~1,000ppm	~60sec (90% response to step change)
1,000ppm~400ppm	~120sec (90% response to step change)

11. CO_2 RMS Noise

Measure for 3 hours in conditions: CO_2 concentration of 1000ppm and 25°C±2°C.
The stability and variation are less than ±20ppm.

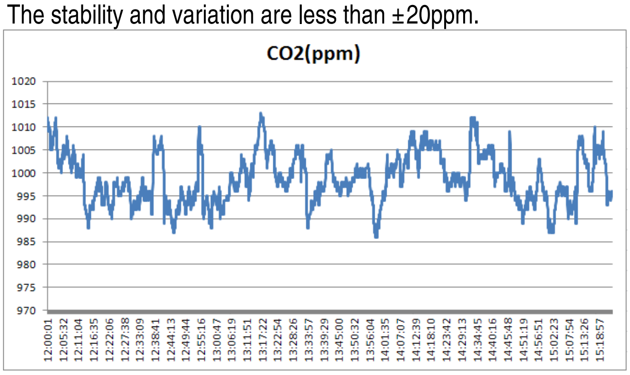

Figure 7