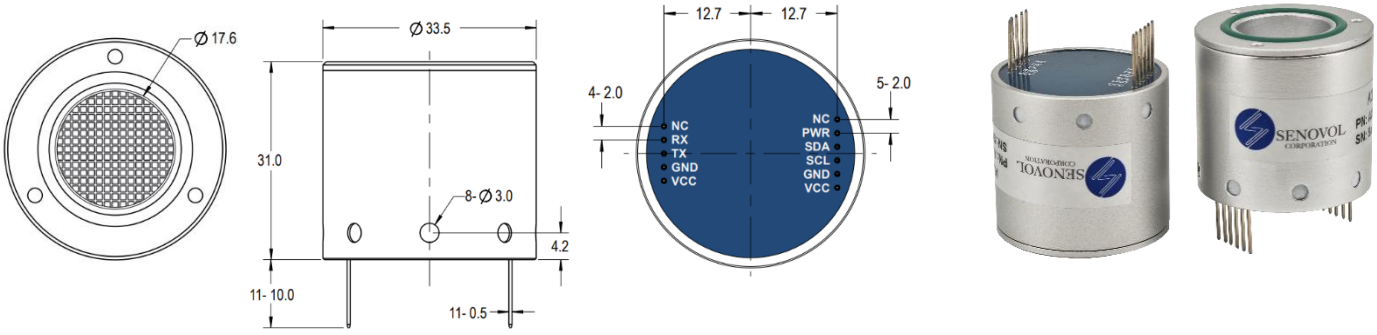
Air Quality Monitoring (AQM) Photoionization Detection (PID)
Digital PID 10.6eV

This Digital PID sensor is part of Senovol's Air Quality Monitoring (AQM) sensor series, utilizing a 10.6eV UV lamp with Senovol's proprietary technology to enhance sensor sensitivity, accuracy, and long-term stability. This design enables the sensor to detect volatile organic compounds (VOCs) with parts per billion (ppb) precision through its lifespan.

The Digital PID shares the same platform with Digital CO, SO2, NO, NO2, O3, H2S, and NH3 sensors. They are all interchangeable using the same digital communication protocol.

Product Dimensions



Top View Side View Bottom View Dimensions in mm

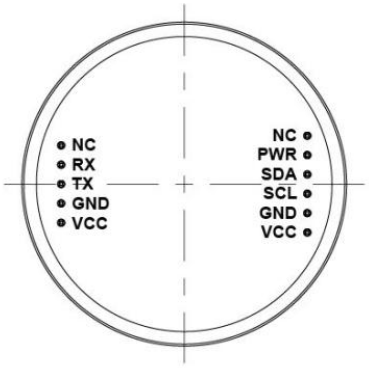
Specifications

Target gas	Volatile Organic Compounds (VOCs)	**Operating temperature**	-20℃ ~ +55℃
Detection range	0 ~ 10000 ppm isobutylene	**Operating humidity**	0% ~ 99% RH Non-condensing
Resolution	0.5 ~ 2000 ppb isobutylene	**Operating pressure**	1 atm ±10%
Response time T90	< 5 seconds	**Expected operating life**	5 yrs for electronics
Output mode	UART (3.3 V TTL) I^2C (3.3 V TTL)	**Storage life**	1 year in original package
Operating voltage	3.2 ~ 5.5 VDC	**Enclosure material**	Aluminum alloy
Operating current	≤ 40 mA @5 V	**Weight**	45 g
Long term output drift	< 10% signal/year	**Warranty for electronics**	2 years
Typical UV lamp life	10,000 hours	**Warranty for UV lamp**	1 year

Pinout

Pin	Function	Description
1	NC	Reserved pins (suspended)
2	RX	Serial port receiving
3	TX	Serial port sending
4	GND	0V - Ground
5	VCC	3.2 ~ 5.5 VDC

6	NC	Reserved pins (suspended)
7	PWR	Module power enable (low level turns off, high level turns on, built-in pull-up resistor). The default pull-up level is high
8	SDA	I2C signal SDA, default high level
9	SCL	I2C signal SCL, default high level
10	GND	0 V - Ground
11	VCC	3.2~5.5 VDC

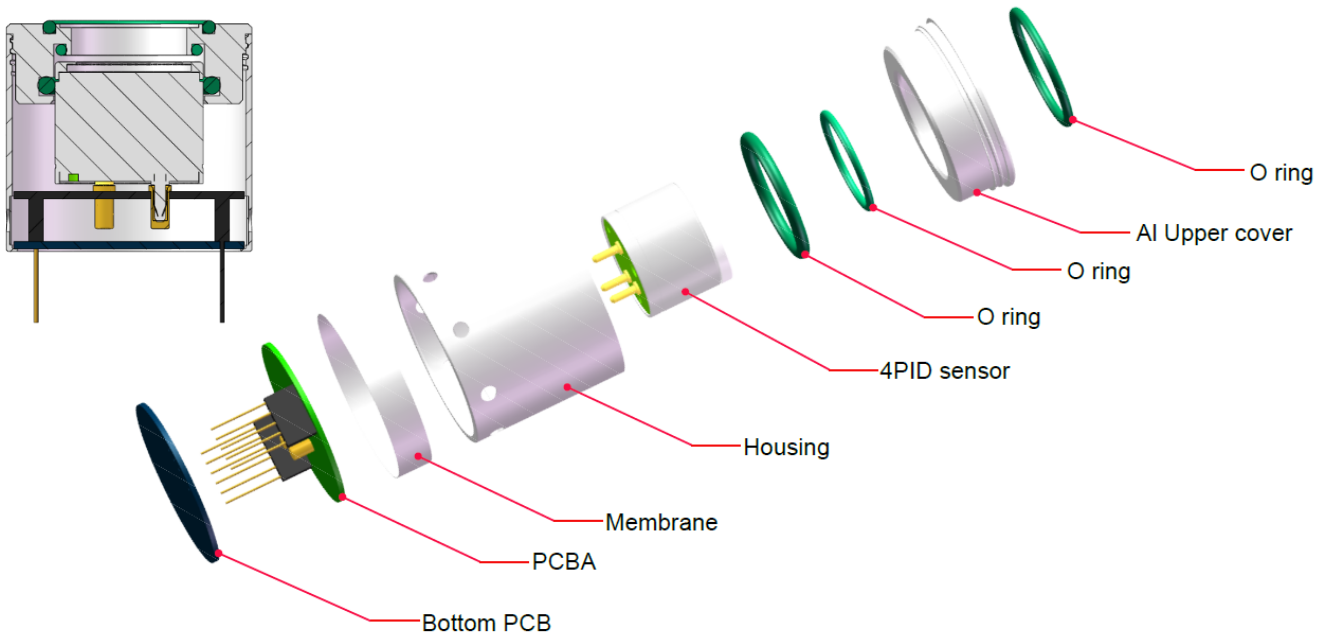


* Note: Two VCCs are connected internally.

Product Selection

Product Name	Part Number	Measurement Range	Photon Energy	Resolution	Sensitivity	Response Time
Digital PID-5	PID-106D-0050	0 ~5 ppm	10.6 eV	0.5 ppb	> 200 mV/ppm	< 5 s
Digital PID-10	PID-106D-0100	0 ~10 ppm	10.6 eV	1 ppb	> 100 mV/ppm	< 5 s
Digital PID-50	PID-106D-0500	0 ~ 50 ppm	10.6 eV	10 ppb	> 20 mV/ppm	< 5 s
Digital PID-100	PID-106D-1000	0 ~100 ppm	10.6 eV	25 ppb	> 10 mV/ppm	< 5 s
Digital PID-200	PID-106D-2000	0 ~ 200 ppm	10.6 eV	50 ppb	> 5 mV/ppm	< 5 s
Digital PID-2000	PID-106D-2001	0 ~ 2,000 ppm	10.6 eV	500 ppb	> 0.5 mV/ppm	< 5 s
Digital PID-5000	PID-106D-5001	0 ~ 5,000 ppm	10.6 eV	1,000 ppb	> 0.2 mV/ppm	< 5 s
Digital PID-10000	PID-106D-1002	0 ~ 10,000 ppm	10.6 eV	2,000 ppb	> 0.1 mV/ppm	< 5 s

Exploded-View Drawing



UART Communication Protocol

1. Settings

Start bit – 1 Data bit – 8 Stop bit – 1 Check bit – None Baud rate –115,200 bps

Without special instructions, the response time is less than 100 ms (please refer to the specific instructions for special circumstances). System cannot respond to other commands until the current command is answered.

2. Frame Format (The format of each communication frame)

Header	Device Code	Function Code	Starting address	Data Length	Data	Check bit
H	ID	F	A	N	D	CRC16

H – 1Byte, fixed as 0x3A

ID – 1Byte, defaults as 0x10 and can be customized by users

F – 1Byte, for example (0x03)

A – 2Byte, for example (0x0001)

N – 1Byte, in two bytes, for example (0x02: 4 bytes)

D – N * 2Byte, Big Endian for example (MSB LSB) is defined as signed short

CRC16 – 2Byte, using MODBUS_CRC16 checking algorithm (see Appendix 1 for details)

3. Command Description

3.1 Sensor type reading

Request from host device:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x01	0x0000	0x01	0x0000	0x82B0

For example: 3A 10 01 00 00 01 00 00 82 B0

Module response for correct data receiving:

Header	Device Code	Function Code	Data	Check
0x3A	0x10	0x01	D (1byte data)	CRC16

Sensor type code: 2: CO 3: O2 7: CO2 8: O3 9: H2S 10: SO2 11: NH3 21: NO 22: NO2 23: NOX 34: CH2O 42: PID

For example: 3A 10 01 02 8D 68 (HEX 02 = DEC 2, so the sensor is CO sensor)

3.2 Sensor data reading (unit: μg/m^3)

Request from host device:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0000	0x02	0x0000	0x7352

For example: 3A 10 03 00 00 02 00 00 73 52

Module response for correct data receiving:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0000	0x02	D	CRC16

D: Received data, 4Byte, Big Endian

For example: 3A 10 03 00 00 02 00 00 00 5E 25 35

Sensor value (μg/m³): 00 00 00 5E i.e. 94μg/m³

3.3 Sensor data reading (unit: ppb)

Request from host device:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0002	0x02	0x0000	0x72EA

For example: 3A 10 03 00 02 02 00 00 72 EA

Module response for correct data receiving:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0002	0x02	D	CRC16

D: Received data, 4Byte, Big Endian

For example: 3A 10 03 00 02 02 00 00 00 4C A4 DA

Sensor value (ppb): 00 00 00 4C i.e. 76ppb

3.4 Sensor temperature data reading (°C)

Request from host device:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0004	0x01	0x0000	0x8262

For example: 3A 10 03 00 04 01 00 00 82 62

Module response for correct data receiving:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0004	0x01	D	CRC16

D: Received data, 2Byte, Big Endian and divided by 100 to get the temperature value.

For example: 3A 10 03 00 04 01 0A 3D 45 13 (D = 0x0A3D = 2621 to get the temperature of 26.21 °C)

3.5 Sensor humidity data reading (%RH)

Request from host device:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0005	0x01	0x0000	0x839E

For example: 3A 10 03 00 05 01 00 00 83 9E

Module response for correct data receiving:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0005	0x01	D	CRC16

D: Received data, 2Byte, Big Endian and divided by 10,000 to get the percentage humidity value

For example: 3A 10 03 00 05 01 14 89 4D 38 (0x14 89 = 5257 to get the humidity of 52.57%)

3.6 Multiple parameters reading (address 0000-0005)

Request from host device:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0000	0x06	0x0000	0x3293

For example: 3A 10 03 00 00 06 00 00 32 93

Module response for correct data receiving:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x03	0x0000	0x06	D	CRC16

D: Received data, 12Byte

Followed by (MSB first): sensor reading μg/m³ 4Bytes;

Sensor reading ppb 4Bytes; Temperature 2Bytes; Humidity 2Bytes.

For example: 3A 10 03 00 00 06 00 00 00 8F 00 00 00 50 0A 70 16 11 35 96

Sensor value (μg/m³): 00 00 00 8F;

Sensor value (ppb): 00 00 00 50;

Temperature: 0A 70; Humidity: 16 11

3.7 Check error response

Header	Device Code	Function Code	Data	Check
0x3A	0x10	0x08	0x00	CRC16

For example: 3A 10 08 00 0A F9

3.8 Zero Calibration

Request from host device:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x07	0x0000	0x01	0x0000	0x82D6

For example: 3A 10 07 00 00 01 00 00 82 D6

Module response for correct data receiving:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x07	0x0000	0x01	D	CRC16

D: 2Byte data

For example: 3A 10 07 00 00 01 04 7A 01 F5

Caution: *Please place the module in the pure air environment stabilizing for at least 5 minutes then send the Zero calibration command.*

3.9 Span Calibration

Request from host device:

Header	Device Code	Function Code	Starting address	Data Length	Data	Check
0x3A	0x10	0x09	0x0000	0x01	0x0000	0x82D6

D: 2Byte gas concentration data, Big Endian, Unit: ppm,

For example: 3A 10 09 00 00 01 00 0A 03 FF i.e.: D=0x000A 10ppm gas is used for calibration.

Module response for correct data receiving:

Header	Device Code	Function Code	Data	Check
0x3A	0x10	0x09	0x00 (Success) 0x01 (Processing) 0x02 (Fail)	CRC16

For example: 3A 10 09 01 CA A9 (Calibration processing)

Caution: *The calibration process for environmental detection is about 300 seconds, and for industry usage is about 60 seconds, please wait for the module to respond before starting the command.*

I²C Communication Protocol

1. I²C Interface

Parameter	Definition	State	Min	Max	Unit
f_{ck}	I2C clock frequency	Slave Mode		100	kHz
t_{su}	Data input setup time	Slave Mode	6.5		ns
t_h	Data input Holding Time	Slave Mode	15.5		ns

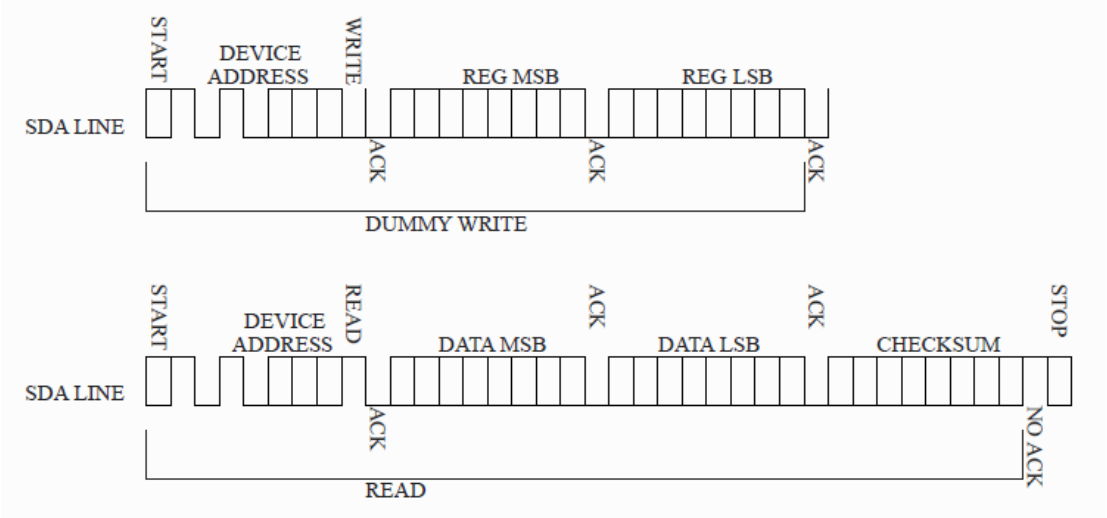
2. Slave Device Address

Slave device addresses can be customized by software tools,
Default setting

CO	0	0	0	0	0	0	1	R/W
O3	0	0	0	0	1	0	0	R/W
SO2	0	0	0	0	1	0	1	R/W
NO2	0	0	0	1	0	1	1	R/W

I²C Sensor Type Address: CO: 0x02 O3: 0x08 H2S: 0x06 SO2; 0x0A NH3: 0x10 NO: 0x1E NO2: 0x16 CH2O:0x22 PID; 0x42

3. I²C Communication Protocol



CHECKSUM is cumulative and retrieve check. See Appendix 2 for details.

4. Data Analysis

The REG parameters are shown below, which is the data address in the module.

REG	MSB	LSB
Sensor value（ug/m³）	0x00	0x00
Sensor value（ppb）	0x00	0x02
Temperature (°C)	0x00	0x04
Humidity (%RH)	0x00	0x05

Data examples:

DATA	MSB	LSB	CHECKSUM	Actual value	Remarks
Sensor value （ug/m³）	0x00	0x05	0xFA	5ug/m³	Same with USART Data Conversion Method
Sensor value （ppb）	0x00	0x05	0xFA	5ppb	
Temperature	0x0A	0x3D	0xB8	26.21℃	
Humidity	0x14	0x89	0x62	52.57%	

Caution: *To receive 5Byte data when reading sensor value, and to receive 3Byte data when reading temperature and humidity*

Warning!

- This product does not have any intrinsic safety certification or explosion proof certification. Please do NOT use this product in any hazardous locations.
- This product does not have reverse power protection and Electrostatic Discharge (ESD) protection. Please carefully verify the electrical polarity and make the ESD protection before each use or installation.
- Please use a stable DC power supply for this gas sensor module. It is highly recommended to use a power supply with the output voltage fluctuation less than 1%.

Appendix 1: MODBUS CRC16 algorithm

```
unsigned short modbus_CRC16(unsigned  char *ptr, unsigned char len)
{
unsigned short wcrc=0XFFFF; / /
int  i=0, j=0;
for (i=0; i<len; i++)
        {
                wcrc^=*prt++;
                for ( j=0; j<8; j++)
                    {
                        if (wcrc&0X0001)
                          {
                             wcrc=wcrc>>1^0XA001;
                          }
                        else
                          {
                             wcrc>>=1;
                          }
                    }
         }
return wcrc<<8| wcrc>>8;   //little endian (LSB fist)

}
```

In CRC calculation, only 8 data bits, start bit and stop bit are used. If there are parity bit, including this bit, they are not involved in CRC calculation. The CRC calculation method:

1. Load a 16 bit register with the value of 0 xffff, which is CRC register.
2. The XOR of the first 8-bit binary data (the first byte of communication information frame) and the 16 bit CRC register is still stored in the CRC register.
3. Move the contents of CRC register one bit to the right, fill the highest bit with 0, and detect whether the moved out bit is 0 or 1.
4. If the move out bit is zero, repeat the third step (move one bit to the right again); If the shift out bit is 1, the CRC register XORs with 0xa001.

5. Repeat steps 3 and 4 until the right shift is 8 times, so that the entire 8-bit data is processed.
6. Repeat steps 2 and 5 to process the next byte of the communication information frame
7. After all the bytes of the communication information frame are calculated according to the above steps, the high and low bytes of the 16 bit CRC register are exchanged
8. Finally, the content of CRC register is CRC check code.
9. For example, a command 3A 10 09 00 00 01 00 32 get the wcrc value of 02 2D through the above program. In this way, we get the calibration command: 3A 10 09 00 00 01 00 32 02 2D.

Appendix 2: CHECKSUM Accumulation and Verification

```
unsigned char CheckSum(unsigned  char *buf, unsigned char len)  //return CheckSum value
{
      unit8_t  i, ret = 0;

     for (i=0; i<len; i++)
          {
                ret +=*(buf++);
           }
                ret = ~ret;
                return ret;
}
```

The check sum method:
Sender: accumulate the data to get a sum, and reverse the sum to get our check value. Then send the data with the check value to the receiver.
For example:
Sender: to send 0xA8 and 0x50, we use the unsigned char (8 bits) to save the accumulated sum, i.e. 0xf8 (0b11111000), and get the check sum of 0x07 (0b00000111). Then send these three data out.