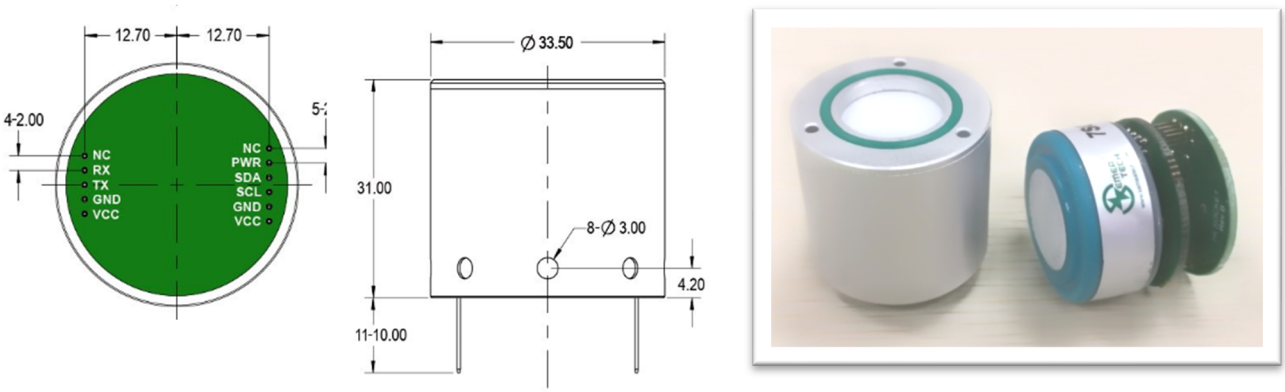
7 SMART SENSOR MODULE

Description

This 7 Smart Sensor Module consists of a data collection and processing PCB assembly, a SemeaTech 7-Series electrochemical (EC) sensor, and a metal enclosure. The PCB assembly in the module collects the data from the gas sensor output and then processes it with amplification, sampling, filtration, and compensation through a built-in MCU to deliver stable and accurate digital output reflecting the actual target gas concentration. Any of SemeaTech 7-series EC sensors and 4-electrode EC sensors can be used to form a 7 Smart Sensor Module to detect the target gas with the digital output. This module provides the convenience and friendly user experience for users to quickly integrate gas sensors into their existing systems for a variety of gas detection applications.

- Unified electrical interface, mechanical dimensions and communication protocol;
- Working with all SemeaTech 7-series EC sensors and 4-electrode EC sensors;
- Built-in temperature and humidity sensors for better environmental independence;
- Multiple output interfaces, including USART, and I^2C;
- Built-in power switch controllable through programming;
- Programmable I^2C address for user friendly interfaces.

Product Dimensions



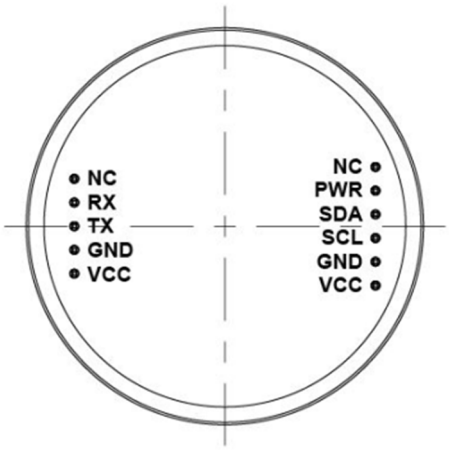
Specifications

Design for	SemeaTech 7-Series EC Sensors	**Installation**	11 pins, plug-in
Detection principle	ElectroChemical	**Operating temperature**	-20℃ ~ +55℃
Detection range	Refer to sensor data sheet	**Operating humidity**	0%~90% RH Non-condensing
Detection resolution	Refer to sensor data sheet	**Operating pressure**	1 atm ±10%
Measurement error	Refer to sensor data sheet	**Enclosure material**	Aluminum alloy
Operating voltage	3.2 ~ 5.5 VDC	**Dimensions**	Φ33.5x31 mm
Operating current	≤ 5mA @5V	**Weight**	30 g
Output mode	USART (3.3V TTL) I^2C (3.3V TTL)	**Expected operating life**	PCBA: 5 years Sensor: Refer to sensor data sheet

Pin Definitions

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
8	SDA	I2C signal SDA
9	SCL	I2C signal SCL
10	GND	0V-Ground
11	VCC	3.2~5.5 VDC

*Note: Two VCC signals are connected internally.



USART Communication Protocol

1. Settings

Start bit – 1 Data bit – 8 Stop bit – 1 Check bit – None Baud rate –115200 bps

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

Module response for correct data receiving

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

D: Sensor code

0：Not define 2：CO 3：O2 4：H2 5：CH4 6：C3H8 7：CO2 8：O3 9：H2S
10：SO2 11：NH3 12：CL2 13：ETO 14：HCL 15：PH3 16：HBR 17：HCN
18：ASH3 19：HF 20：BR2 21：NO 22：NO2 23：NOX 24：CLO2 25：SIH4
26：CS2 27：F2 28：B2H6 29：GEH4 30：N2 31：THT 32：C2H2 33：C2H4
34：CH2O 35：LPG 36：HC 37：C6H6 38：H2O2 39：CH3SH 40：C2H3CL
For example：3A 10 01 0D CD 6C i.e. D=0x0D=13 It is ETO sensor

3.2 Sensor data reading (unit: ug/m3)

Request from host device

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

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 (ug / m^3): 00 00 00 5E i.e. 94ug / m^3

3.3 Sensor data reading (ppb)

Request from host device

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

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 (ºC)

Request from host device

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

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: (D = 0x0A3D = 2621 to get the temperature of 26.21 ºC)

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	0x3292

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 10000 to get the percentage humidity value
For example: (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

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
For example: 3A 10 03 00 00 06 00 00 00 8F 00 00 00 50 0A 70 16 11 35 96
Sensor value (ug/ m^3): 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: 3A1008000AF9

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

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：Make sure the module in the zero gas environment at least 5 minute before calibration

3.9 Gas Calibration

Request from host device

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

D: 2Byte gas concentration data, Big Endian, Unit: ppm, the value should be lower than 255ppm
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 start the command

I²C Communication Protocol

1. I²C Interface

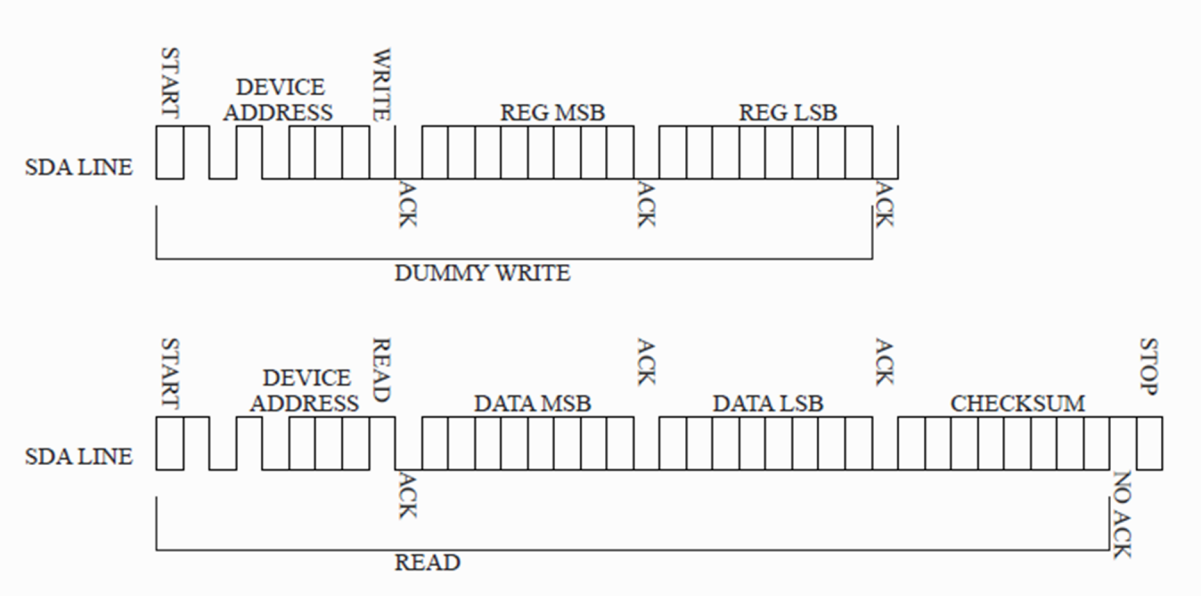
Parameter	Definition	State	Min	Max	Unit
f_{ck}	I2C clock frequency	Slave Mode		100	kHz
t_{su}	Data input setup time	Slave Mode	6.5		ns
t_h	Data input Holding Time	Slave Mode	15.5		ns

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

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	0x01
Temperature	0x00	0x02
Humidity	0x00	0x03

Data examples:

DATA	MSB	LSB	CHECKSUM	Actual value	Remarks
Sensor value (ug/m³)	0x0000	0x0005	0xFA	5ug/m³	Same with USART Data Conversion Method
Sensor value (ppb)	0x0000	0x0005	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!

1) This product does not have any intrinsic safety certification or explosion proof certification. Please do NOT use this product in any hazardous locations.
2) 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.
3) 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^=*ptr++;
                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)

}
```

Appendix 2: CHECKSUM Accumulation and Verification

```
unsigned char  CheckSum(unsigned char *buf, unsigned char len)    //return CheckSum value
{
    uint8_t i, ret = 0;

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