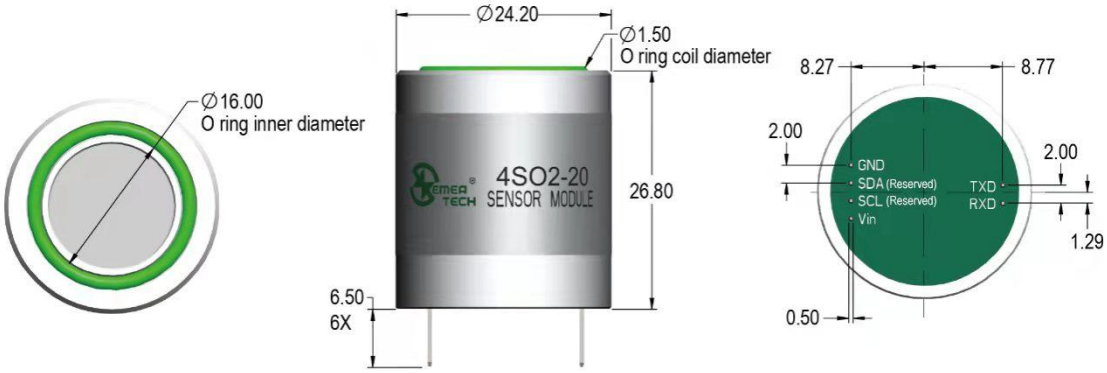
4ECM-SMART SENSOR MODULE

Description

This 4ECM-Smart Sensor Module consists of a data collection and processing PCB assembly, a SemeaTech 4-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 temperature compensation through a built-in MCU to deliver stable and accurate digital output reflecting the actual target gas concentration. Any of SemeaTech 4-series EC sensors can be used to form a 4ECM-Smart Sensor Module that delivers the signal output through UART bus, which provides a good user experience for quickly integrating gas sensors into the existing systems for a variety of gas detection applications. This module has the function of automatic short-circuit pin. For the zero bias sensor, it can be used stably after 30 minutes of power on. For the sensor with bias voltage, it is recommended that the user power on for more than 24 hours before use.



Top view Side view Bottom view

4ECM-Smart Sensor Module Dimensions and Pin Out

Pin Out

Vin	GND	TXD	RXD	SDA	SCL
Power input positive	Power input Negative	Serial Port Sending	Serial port receiving	Reserved	Reserved

Specifications

Product model	4ECM-Smart
Detectable gas types	Toxic and harmful gases such as CO, H2S and NO2

Detection Principle	Electrochemical
Gas concentration range	Refer to EC sensor datasheet
Resolution	Refer to EC sensor datasheet
Measurement error	< ±5%FS
Operating voltage	3.5 ~ 5.5 VDC
Operating current	≤ 2 mA @ +5.0 VDC
Output mode	UART (+3.3V TTL)
Operating temperature	-20°C ~ +50°C
Operating humidity	0% ~ 90%RH non-condensing
Operating pressure	1 ± 0.1 atm
Storage temperature	-20°C ~ +60°C
Dimensions	Φ 24.2 x 26.8 mm
Weight	10 g

Communication Settings

Baud rate	9,600 bps
Data bits	8
Stop bit	1
Check bit	None

Communication Command

This module uses serial port (TXD/RXD) and uses question-and-answer mode for data transmission. All data transmission is in hexadecimal format (HEX). Without special instructions, the response time is less than 100ms (please refer to the specific instructions for special circumstances). System cannot respond to other commands until the current command is answered.

1. Command for terminal Read Module Information

Example: ***AA 0F 01 C5 80 EE***

Byte1--AA: Start byte of a command;

Byte2--0F: Information reading command;

Byte3--01: Module address (default at 0x01);

Byte4--C5: CRC16 (Modbus);

Byte5--80: CRC16 (Modbus);

Byte6--EE: Command end byte;

Note: In this command Byte 2 and Byte 3 will be checked with CRC 16 (Modbus). Perfer to Appendix 1.

Modular response (Sending Information Data to Terminal)

Example: ***AA 0F 01 0F 00 14 00 05 00 02 00 01 02 C5 99 EE***

Byte1--AA: Start byte of a command;

Byte2--0F: Information reading command;

Byte3--01: Module address (default at 0x01);

Byte4--0F: Sensor type;

Byte5/6--00/14: Modular measurement range (hexadecimal);

Byte7/8--00/05: Calibration of gas concentration (hexadecimal);

Byte9/10--00/02: High Alarm Point (Hexadecimal);

Byte11/12--00/01: Low Alarm Point (Hexadecimal);

Byte13--02: Sensor reading units
(% LEL: 0x00; % VOL: 0x01; PPM: 0x02; PPB: 0X03; N/A: 0x04);

Byte14--C5: CRC16 (Modbus);

Byte15--99: CRC16 (Modbus);

Byte16--EE: Command end byte;

Note: In this command Byte 2 ~ Byte 13 will be checked with CRC 16 (Modbus).
Perfer to Appendix 1.

Addendum: Sensor type code (Decimal)

00 None 01 None 02 CO 03 O2 04 H2 05 CH4 06 None 07 CO2 08 O3 09 H2S 10 SO2 11 NH3
12 None 13 ETO 14 HCL 15 PH3 16 None 17 HCN 18 None 19 HF 20 None 21 NO 22 NO2 23 NOX
24 CLO2 25 None 26 None 27 None 28 None 29 None 30 None 31 THT 32 C2H2 33 C2H4 34 CH2O 35 None
36 None 37 None 38 None 39 C2H3CL 40 None 41 CH3SH

For example: **AA 0F 01 0F 00 14 00 05 00 02 00 01 02 C5 99 EE** (HEX 0F = DEC 15 = PH3 sensor)

2. Commands for gas concentration request

Example: ***AA 01 01 C1 E0 EE***

Byte1--AA: Start byte of a command;

Byte2--01: Command for concentration sending request;

Byte3--01: Module address (default at 0x01);

Byte4--C1: CRC16 (Modbus);

Byte5--E0: CRC16 (Modbus);

Byte6--EE: Command end byte;

Note: In this command Byte2 and Byte3 will be checked with CRC 16 (Modbus).
Perfer to Appendix 1.

response (sending concentration data to the terminal)

Example: ***AA 01 01 80 00 0000 15 CA EE***

Byte1--AA: Start byte of a command;

Byte2--01: Command for concentration sending request;

Byte3--01: Module address (default at 0x01);

Byte4--80: Data symbol bit (0x80: negative; 0x00: positive);

Byte5/6--00/00: Data (ppm) integer part (0-65535);

Byte7--00: Data (ppm) fractional part (0.00-0.99);

Byte8--15: CRC16 (Modbus);

Byte9--CA: CRC16 (Modbus);

Byte10--EE: Command end byte;

Note: In this command Byte 2 ~ Byte 7 will be checked with CRC 16 (Modbus). Perfer to Appendix 1.

3. Command for terminal sending Module Zero-setting

Example: ***AA 02 01 C1 10 EE***

Byte1--AA: Start byte of a command;

Byte2--02: Command for Zero-setting;

Byte3--01: Module address (default at 0x01);

Byte4--C1: CRC16 (Modbus);

Byte5--10: CRC16 (Modbus);

Byte6--EE: Command end byte;

Note: 1) In this command Byte 2 and Byte 3 will be checked with CRC 16 (Modbus); Perfer to Appendix 1.

2) During zero-setting, the LED flickers at a frequency of 1 second per time, lasting for 30 seconds.

Zero-setting success, module sending:

AA 02 01 10 D0 5C EE

Zero-setting failure, module sending:

AA 02 01 20 D0 48 EE

Note: In pure air, when the difference between the baseline voltage collected by the module and the standard baseline voltage is more than 30%, the calibration fails.

Byte1--AA: Start byte of a command;

Byte2--02: Command for Zero-setting;

Byte3--01: Module address (fixed at 0x01);

Byte4--10/20: Signs of success/failure;

Byte5--D0: CRC16 (Modbus);

Byte6--5C/48: CRC16 (Modbus);

Byte7--EE: Command end byte;

Note: In this command Byte 2 ~ Byte 4 will be checked with CRC 16 (Modbus). Perfer to Appendix 1.

4. Command for terminal sending Module Calibration

Example: AA 03 01 C0 80 EE

Byte1--AA: Start byte of a command;

Byte2--03: Command for Calibration;

Byte3--01: Module address (default at 0x01);

Byte4--C0: CRC16 (Modbus);

Byte5--80: CRC16 (Modbus);

Byte6--EE: Command end byte;

Note: 1) In this command Byte 2 and Byte 3 will be checked with CRC 16 (Modbus); Perfer to Appendix 1.

2) During calibration, the LED flickers at a frequency of 1 second per time, lasting for 120 seconds.

Calibration success, module sending:

AA 03 01 10 81 9C EE

Calibration failure, module sending:

AA 03 01 20 81 88 EE

Note: In the calibration gas with corresponding concentration, when the difference between the voltage collected by the module and the corresponding calibration voltage is more than 70%, the calibration fails.

Byte1--AA: Start byte of a command;

Byte2--03: Command for Calibration;

Byte3--01: Module address (default at 0x01);

Byte4--10/20: Signs of success/failure;

Byte5--81/81: CRC16 (Modbus);

Byte6--9C/88: CRC16 (Modbus);

Byte7--EE: Command end byte;

Note: 1) In this command Byte 2 ~ Byte 4 will be checked with CRC 16 (Modbus). Perfer to Appendix 1.

2) In order to ensure the accuracy of measurement, we recommend that the user calibrate every 3 to 6 months.

5. Command for Module Address Modification

Example: ***AA 04 02 82 B1 EE***

Byte1--AA: Start byte of a command;

Byte2--04: Command for Address Modification;

Byte3--02: Module new address;

Byte4--82: CRC16 (Modbus);

Byte5--B1: CRC16 (Modbus);

Byte6--EE: Command end byte;

Note: 1) In this command Byte 2 and Byte 3 will be checked with CRC 16 (Modbus); Perfer to Appendix 1.

2) Apply to serial communication between host and multiple modules.

Address Modification success, module sending:

AA 04 02 10 30 AD EE

Byte1--AA: Start byte of a command;

Byte2--04: Command for Address Modification;

Byte3--02: Module new address;

Byte4--10: Signs of success/failure;

Byte5--30: CRC16 (Modbus);

Byte6--AD: CRC16 (Modbus);

Byte7--EE: Command end byte;

Note: In this command Byte 2 ~ Byte 4 will be checked with CRC 16 (Modbus). Perfer to Appendix 1.

6. Command for Adjustment of Calibration Gas Concentration

Example: ***AA 05 01 01 F4 51 3F EE***

Byte1--AA: Start byte of a command;

Byte2--05: Command for concentration adjustment;

Byte3--01: Module address;

Byte4/5--01/F4: Concentration to be modified (hexadecimal, 0x1F4);

Byte6--51: CRC16 (Modbus);

Byte7--3F: CRC16 (Modbus);

Byte8--EE: Command end byte;

Note: In this command Byte 2 ~ Byte 5 will be checked with CRC 16 (Modbus). Perfer to Appendix 1.

Adjustment success, module sending:

AA 05 01 10 01 F4 E8 2E EE

Adjustment failure, module sending:

AA 05 01 20 01 F4 E8 21 EE

Byte1--AA: Start byte of a command;

Byte2--05: Command for concentration adjustment;

Byte3--01: Module address;

Byte4--10/20: Signs of success/failure;

Byte5/6--01/F4: Concentration to be modified (hexadecimal, 0x1F4);

Byte7--E8/E8: CRC16 (Modbus);

Byte8--2E/21: CRC16 (Modbus);

Byte9--EE: Command end byte;

Note: In this command Byte 2 ~ Byte 6 will be checked with CRC 16 (Modbus). Perfer to Appendix 1.

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^=*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 05 01 01 F4 get the wcrc value 51 3F through the above program. In this way, we get the calibration command: AA 05 01 01 F4 51 3F EE.