ENS130

CO Sensor

ENS130 Datasheet

Version: 1.0

Release Date: 2026-02-09

Document Status: Production

The ENS130 CO sensor can very accurately measure CO concentration with calibration.

The ENS130 CO sensor is based on proven fuel cell technology, which offers several key advantages and benefits including very low power consumption, fast response, high accuracy, anti-interference, anti-poisoning and a wide operating temperature range.

With its very reliable performance, high accuracy, and long service lifetime, the ScioSense ENS130 CO sensor can be utilized in many industries and applications for protecting lives.

The ENS130 CO sensor has a compact design which is very suitable for form factor critical applications like portable CO detectors, small residential CO detectors, and multi-sensor fire detectors.

The RoHS-compliant ENS130 meets the requirement of UL2034, UL2075, EN50291 and GB15322.

Key Features & Benefits

- Small form factor
- Electrode and structural design with anti-undershoot
- Low power consumption
- Fast response
- High accuracy
- Anti-interference
- Anti-poisoning
- Wide operating temperature range
- Long service life
- Good stability and repeatability
- Meets UL2034, UL2075, EN50291 and GB15322 requirements
- RoHS Compliance
- UL recognized and FTAM2 certified

Applications

- Energy storage systems
- Smart home CO monitoring
- Fire detection
- Industrial safety
- Residential and commercial CO detectors

Properties

- Sensitivity: 1.5±1nA/ppm
- Detection range: 0~5000ppm
- Linear output current to CO concentration in detection range

Table of Contents

1 Quick Start

The ScioSense ENS130 CO sensor employs electrochemical fuel cell technology. By diffusing a gas sample into a micro fuel cell with chemical reactions, the sensor produces an electrical current. The current output from the sensor is proportional to the concentration of carbon monoxide.

A basic circuit diagram for the ENS130 CO sensor is shown in Figure 1 below: The sensor generates a small current I_{out} which is converted to sensor output voltage V_{out} by an op-amp and a resistor R4. The sensor output voltage V_{out} is proportional to CO gas concentration.

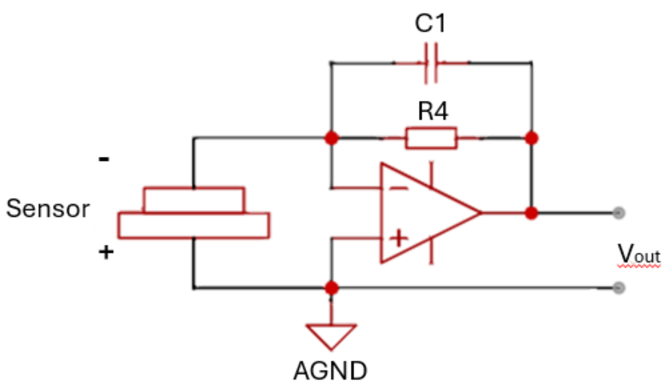

Figure 1: Basic measuring circuit of ENS130.

Product	Detection Gas	Sensitivity	R4	C1	Op-amplifier
ENS130	CO	1.5±1 nA/ppm	1MOhm	10µF	TP5552 or any other amplifier with its V_{os} at the level of µV

Table 1: Parameters of the electrical components used in basic application circuit

2 Product Dimension

Figure 2 shows ENS130 product dimension:

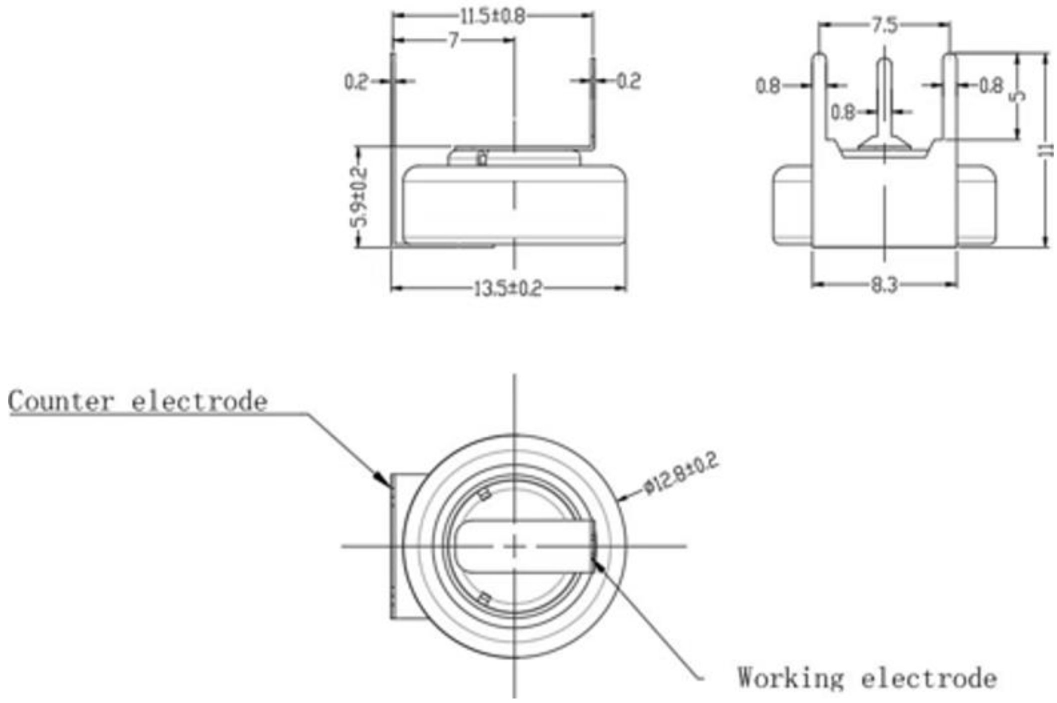

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Figure 2: ENS130 CO sensor product dimension

3 Pin Assignment

Figure 3 shows ENS130 three-pin assignment:

Two-pin counter electrode (+) and one-pin working electrode (-)

Figure 3: ENS130 CO sensor pin assignment

4 Sensor Specification

ENS130 sensor specifications are summarized in the following Table 2.

Characteristic	Parameter		Units	Comments
Performance				
Detection Range	0	5000	ppm	
Overload	10000		ppm	
Sensitivity	1.5±1		nA/ppm	
Response Time(t_{90})	< 60		Second	Sensor exposed to 500ppm CO
Recovery Time(t_{10})	< 60		Second	Sensor exposed to 500ppm CO
Output Linearity	Less than ±5% deviation in the range of 0~5000ppm CO			
Repeatability	Less than ±5% deviation in the range of 0~500ppm CO			
Environmental				
Operating temperature	-40~70		°C	
Operating humidity	10%~90%RH			Non-condensation
Operating Pressure	1±10%		atm	
RoHS	Yes			
Key Specifications				
Lifetime	10 years			
Recommended Storage Temperature	5	30	°C	
Recommended Storage Humidity	30%RH	80%RH		
Weight	3		g	
Vibration	Meet UL Requirement Note: amplitude 0.25mm, frequency 35Hz, duration 4 hours, x-y-z direction			
Handling Drop	Meet UL Requirement Note: height 2.1m, repeat 5 times			
Warranty Period	12 months			

Cross-Sensitivity		
Interference gas	Concentration (ppm)	CO output (ppm)
H_2	1000	< 400
CH_4	1000	< 10
C_2H_5OH	1000	< 10
HMDS	1000	< 20
Toluene	1000	0
Isopropanol	1000	< 10
Freon R22	1000	< 10
Acetone	1000	0
Trichloroethane	1000	0
NH_3	200	0
C_2H_4	200	< 30
Ethyl acetate	200	0
C_2H_2	200	< 300
HCHO	200	< 10

Important Note:

1. The cross-sensitivity table is typical response of a sensor to the interference gas and cannot be used directly for compensation of cross sensitivity.

2 The exposure time in this test is 5 min, the sensor's response varies with exposure time.

Table 2: ENS130 specifications

Figure 4 demonstrates the sensor ENS130's sensitivity to CO gas. The Y-axis shows output current I_{out} (nA) with CO concentration range from 0~5000 ppm. The output current is linear to CO concentration, with a deviation of less than ±5%.

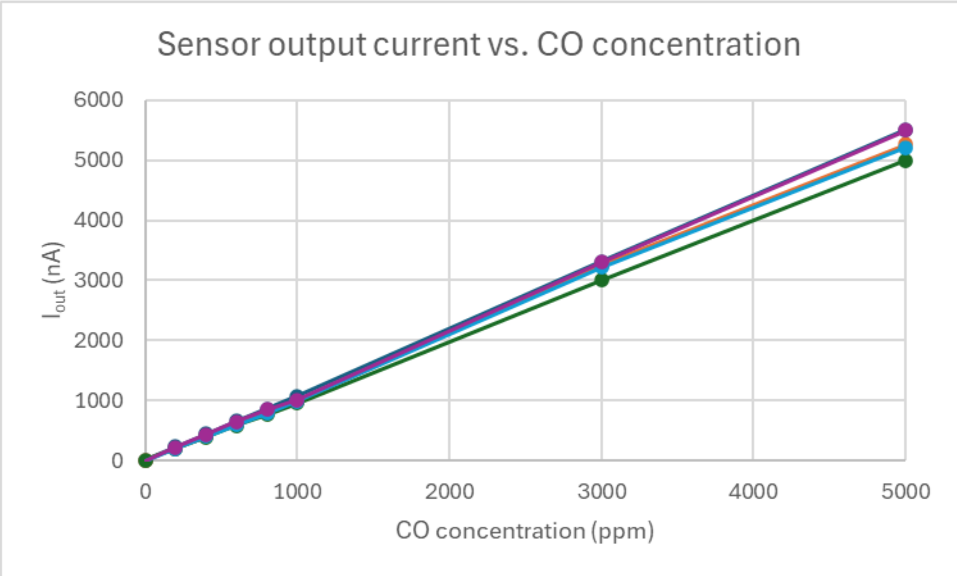
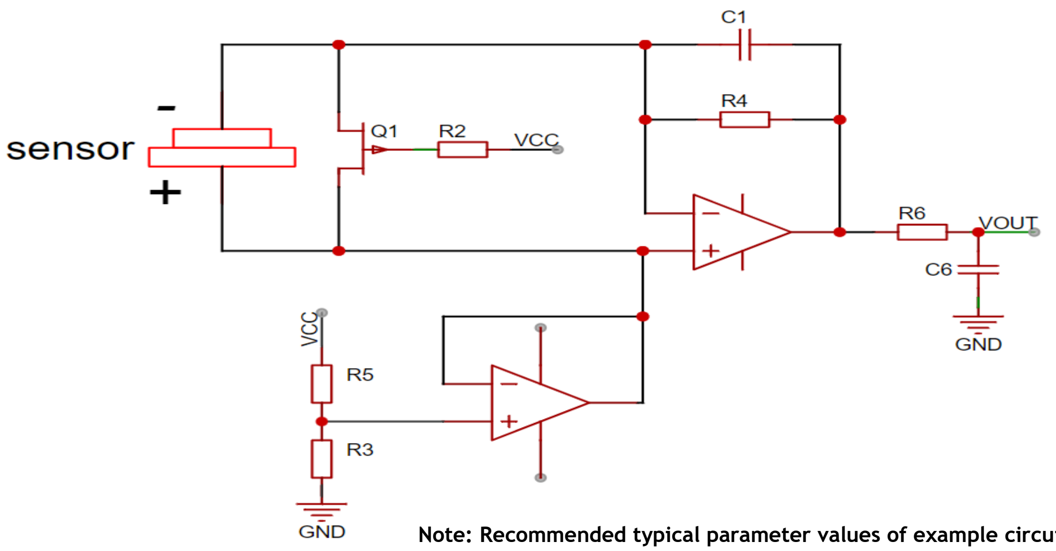


Figure 4: Sensor sensitivity characteristics

5 Interface Circuit Design

5.1 Circuit Diagram

The ENS130 CO sensor based on the proven fuel cell technology generates a current signal which is proportional to the concentration of CO. To use the sensor for CO detection, the output current is usually converted to voltage for measurement. Figure 5 is an example circuit. In this circuit the output voltage (V_{out}) is measured to get the exact CO concentration. The circuit is powered by 3.3V and V_{out} without sensor connected should be 0.148V(V_{ref}). With the sensor connected, V_{out} increases with the CO concentration. CO concentration can be calculated from V_{out} as detailed in section 5.2.



Note: Recommended typical parameter values of example circuit

1. V_{CC}: 3.3V
2. V_{out} : output voltage in V; V_{ref} : offset voltage of the circuit in V
3. Define typical value of V_{ref} as 0.148V
   with R_3:47kΩ,0.1% and R_5:1MΩ,0.1% then V_{ref}=0.148V
4. R_2:1MΩ,1%
5. R_4:1MΩ,1%
6. C_1: 10uF
7. Op-amlifier TP5552 from 3peak is recommended
8. R_6:1kΩ,1%; C_6:100nF,10%.
9. Q1: p-channel JFET for preventing polarization of the sensor to shorten the settling time

Figure 5: Example circuit diagram

5.2 CO Concentration Calculation

CO concentration C_{ppm} can be calculated according to the following equation：

$$C_{ppm}= ((V_{out}-V_{ref}) *10^9/R_4-I_0)/S_1$$

R_4 : op-amp's feedback resistor in Ohm

I_0: output in fresh air in nA

S_1 : sensitivity after temperature compensation in nA/ppm

6 Calibration and Compensation

Sensor calibration and compensation are crucial for ensuring the accuracy of CO measurements.

6.1 Calibration

It is strongly recommended to implement sensor calibration for accurate CO detection. There are two methods for sensor calibration.

Method 1: Calibration with certain concentration CO gas

The calibration procedure can be executed as below:

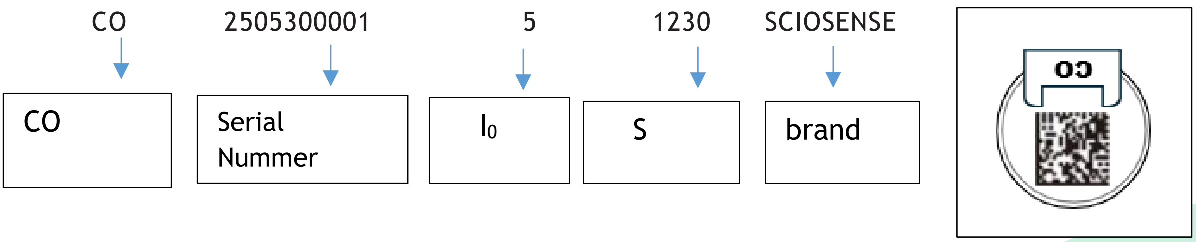
- Subject the ENS130 sensor in the calibration system.
- Record the output current of the ENS130 sensor in fresh air, I_0 (nA). The time needed to get a stable output I_0 depends on anti-polarization.
- Inject CO gas with a certain concentration C_1 in ppm. Note that the test gas must be diluted in air or synthetic air, not in nitrogen. The sensor's detection principle relies on oxygen being present, so operating it in nitrogen will lead to permanent damage and invalid measurements.
- After sensor output stabilization, measure sensor output I_1 in nA.
- Calculate the sensitivity of the sensor in nA/ppm using the formular below
  $S=(I_1-I_0)/C_1$

  Important Note: Temperature must be 25°C during calibration

Method 2: Calibration with sensor marking i.e. two-dimensional barcode

Every sensor is calibrated in the factory before shipment and the information is stored in the sensor barcode. Using the factory calibration is less accurate than calibrating the final product with CO gas as described in Method 1.

Information on the sensor barcode



Group 1 : CO : target gas.

Group 2 : 2505300001 : ten-digit serial number of the sensor.

Group 3 : 5 : This number, which could be positive or negative, is related to sensor output current (nA) in 0 ppm CO condition. The number from the barcode should be divided by 10 to get I_0. In this case, for example, I_0 is 5/10=0.5nA.

Group 4 : 1230 : This three to four-digit number is related to sensor sensitivity S (nA/ppm). The number stored in the barcode should be divided by 1000 to get the S. In this case, for example: S =1230/1000=1.23nA/ppm

Group 5: The brand information is SCIOSENSE

6.2 Temperature Compensation

Figure 6 and Table 3 show how the temperature influences sensor output current when the humidity is kept constant at 50%RH.

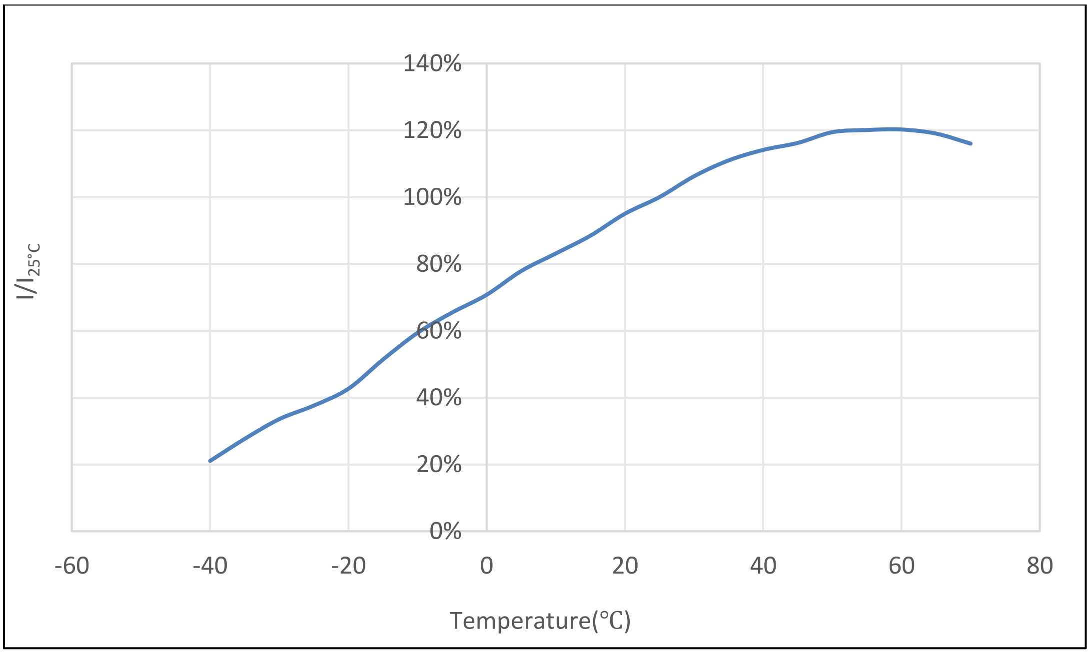


Figure 6: Temperature influence test

Column $I/I_{25^\circ C}$ shows the change in output current relative to the output current at 25°C ($I_{25^\circ C}$) when applying 500 ppm CO. Temperature dependency varies from sensor to sensor and the values listed in Table 3 are an average of 1000 sensors. If the application requires accurate temperature compensation, the temperature dependency may need to be measured individually for every device.

Temperature influence with 50%RH			
T(°C)	$I/I_{25°C}$	T(°C)	$I/I_{25°C}$
-40	21%	20	95%
-35	28%	25	100%
-30	34%	30	106%
-25	38%	35	111%
-20	43%	40	114%
-15	51%	45	116%
-10	59%	50	119%
-5	65%	55	120%
0	71%	60	120%
5	78%	65	119%
10	83%	70	116%
15	88%		

Table 3: Temperature compensation coefficient

Important Note:

1. The compensation coefficient is the average data of 1000 sensors, and the exact coefficient varies slightly from sensor to sensor. If precise compensation is necessary, please test the influence factor separately.

   I: the current output in 500ppm CO at different temperatures with constant humidity 50%RH.

   $I_{25°C}$: the current output in 500ppm CO at 25℃ with constant humidity 50%RH.

6.3 Compensation of Long-term Drift

The sensitivity of electrochemical sensors tends to decrease slightly over time due to loss of active points of catalysts in real detection circumstance. It is recommended that compensation for the sensitivity loss at a pace of 3% per year should be made to achieve a more accurate result.

7 Storage Conditions and Influence

Prior to usage, the sensors should be stored in ScioSense's original package under conditions: temperature around 5~30℃ and humidity should be around 30~80%RH. Condensation should be avoided.

Open-circuit sensors (working electrode and counter electrode not connected) build up an electrical charge over time (polarization). Sensors are shipped in an open circuit condition and stabilization, once connected to a read-out circuit, would typically take one or two hours to settle down, which depends on if it has anti-polarization circuit. Stabilization time of one hour (typical) is recommended for sensors soldered on PCBAs which include an anti-polarization circuit. For PCBAs without anti-polarization circuit, it would be recommended to take more than 2 hours for sensor stabilization. It is thus recommended to include anti-polarization features in the circuit design (see section 5.1) to reduce this stabilization time.

Note that exposure to solvents/vapor, corrosive gases, dust, oil, water or alkaline compounds such as ammonia can damage the sensor, both in storage and in operation.

8 Soldering Information

Please pay attention to the following points for soldering :

- Flux should be sufficiently dried before sensors are soldered onto a PCB to avoid any contamination of the sensor by flux vapor.
- A certain period is needed for the sensor to settle down after soldering onto the PCBA because of the polarization caused by the shipment under open circuit.
- Make sure that there is more than 1.5mm gap between the sensor and the PCBA to ensure that target gas can reach the sensor freely as shown in Figure 7.

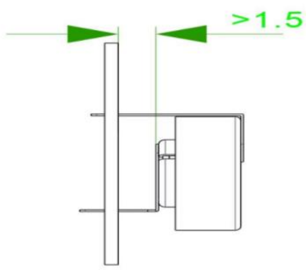


Figure 7: Soldering example

- Recommended conditions for manual soldering: temperature of soldering copper head: 360°C

and time should be less than 5 sec.

9 RoHS Compliance and ScioSense Green Statement

RoHS: The term RoHS compliant means that Sciosense B.V. products fully comply with current RoHS directives. Our semiconductor products do not contain any chemicals for all 6 substance categories, including the requirement that lead does not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, RoHS compliant products are suitable for use in specified lead-free processes.

ScioSense Green (RoHS compliant and no Sb/Br): ScioSense Green defines that in addition to RoHS compliance, our products are free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material).

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11 Document Status

Document Status	Product Status	Definition
Product Preview	Pre-Development	Information in this datasheet is based on product ideas in the planning phase of development. All specifications are design goals without any warranty and are subject to change without notice.
Preliminary Datasheet	Pre-Production	Information in this datasheet is based on products in the design, validation or qualification phase of development. The performance and parameters shown in this document are preliminary without any warranty and are subject to change without notice.
Datasheet	**Production**	**Information in this datasheet is based on products in ramp-up to full production or full production which conform to specifications in accordance with the terms of ScioSense B.V. standard warranty as given in the General Terms of Trade.**
Datasheet (Discontinued)	Discontinued	Information in this datasheet is based on products which conform to specifications in accordance with the terms of ScioSense B.V. standard warranty as given in the General Terms of Trade, but these products have been superseded and should not be used for new designs.

Table 4: Document status

12 Revision Information

Revision	Date	Comment	Page
0.7	2025-05-26	Initial Preliminary Version	All
0.9	2025-07-29	Preliminary Version	All
1.0	2026-02-09	Production Version	All

Note(s) and/or Footnote(s):

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.

Table 5: Revision history

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