Technical Data ver. 2

Product name: Electrochemical CO sensor
Model number: EC-570

DATA

Rvision history

No.	Date	Contents	By
1st issue	2016.12.22	First issue created	Ohnishi
Amendment	2017.3.28	Explanation added	Ohnishi
2nd edition	2017.6.13	Item added	Ohnishi
Amendment	2017.6.26	Specification change	Ohnishi
Amendment	2017.7.5	Specification change	Ohnishi
Amendment	2018.12.12	Address is updated	Yanagitani

Issued on December 12, 2018
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1. Brief specification

Basic characteristics

	Parameter	Rating	Remark
1	Output current	20±5nA/ppm	CO, 20℃65%RH
2	Base line	±0.2μA	
3	Response	Within 10 sec	
4	Repeatability	±2%	
5	Output at -10℃	13nA/ppm	Temporary
6	Output at 50℃	27nA/ppm	Temporary

Operating/Storage conditions

Parameter	Symbol	Conditions	Remark
Detection concentration range		0 to 5,000 ppm of CO	
Operating temperature and humidity range	T_{op}	-10 to 50C 15 to 90%RH	Without dew condensation
Atmospheric pressure	P	1 atm±10%	
Load resistor	R_L	10ohm±1%	
Bias voltage	V	0mV	Between C-W
Storage temperature range	T_{ST}	0 to 20C	Sensor only stored
Storage period		6 months	Sensor only stored
Mounting direction		Any direction	
Soldering		Edge temperature of soldering iron: Below 350C Soldering time: Below 3 sec per pin Maximum repeated soldering: 2 times after the soldered temperature returns to room temperature.	Hand soldering
Others	Should not be influenced by halogens, organic solvents, etc.		

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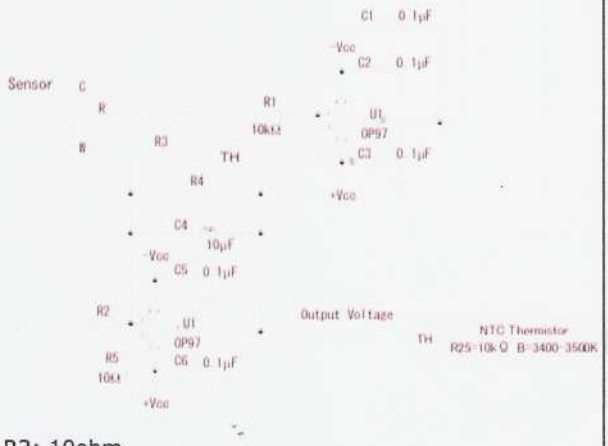
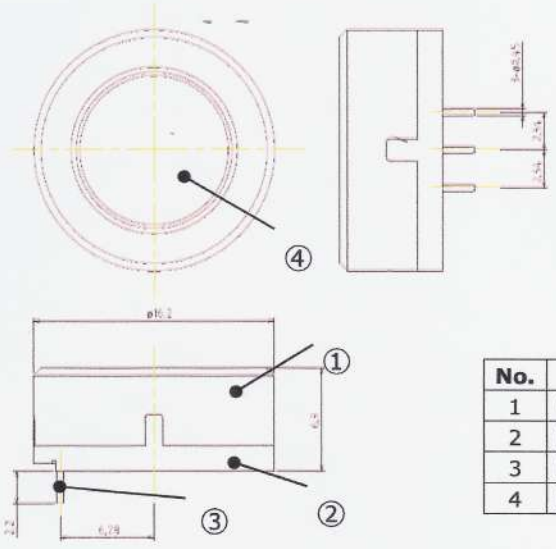
Characteristic measurement conditions

Parameter	Condition	Remark
Temerature and humidity	20±3℃、65±10%RH	
Measurement gas	Clean air	
	Carbon monoxide (purity: more than 99%)	
Circuit	 R2: 10ohm R3: 19.6kohm R4: 14.7kohm TH: NTC thermistor, R25=10kohm, B constant=3400 to 3500K	Pre-heating time: 5 min.

Dimensions (unit:mm)



Correspondence of terminal symbol and each electrode
R : Reference electrode
W: Sensing electrode
C : Counter electrode

No.	Part	Material
1	Cap	ABS
2	Base	PPE
3	Pin	Brass (Gold plated nickel)
4	Filter	Polyester nonwoven fabric/PTFE

2. Detection principle

Electrochemical sensor EC-570 has three electrodes, sensing, counter and reference electrodes (Fig. 1). Oxidation and reduction occur on the sensing and counter electrodes. Reference electrode monitors the potential at sensing electrode. When the sensor detects CO, the following electrochemical reaction (eq. 1) occurs on the surface of sensing electrode.

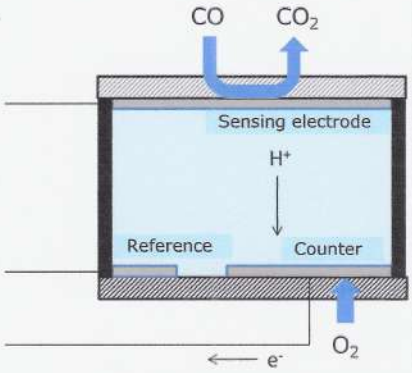


Fig.1 Conceptual diagram

$$CO + H_2O \rightarrow CO_2 + 2H^+ + 2e^- \text{ (eq.1)}$$

If the sensing electrode is connected to the counter electrode through an external circuit, the electron produced on the sensing electrode moves to the counter electrode through the circuit. On the other hand, proton produced on the sensing electrode moves to counter electrode in the electrolyte to combine with atmospheric oxygen. As a result, water will be produced (eq. 2).

$$2H^+ + \frac{1}{2}O_2 + 2e^- \rightarrow H_2O \text{ (eq.2)}$$

As explained above, the chemical reaction energy produced by reduction/oxidation is transferred to electric energy so that electrochemical sensor can detect the gas. The overall reaction is described as below (eq. 3).

$$CO + \frac{1}{2}O_2 \rightarrow CO_2 \text{ (eq.3)}$$

In general, potential difference produced by reduction/oxidation decreases due to polarization near sensing electrode, and inner resistance by proton move during reaction. This decrease becomes large particularly when the sensor detects high concentration gas, which is a major factor to lose sensitivity linearity. A fixed stable constant potential is applied to the sensing electrode. The reference electrode maintains the value of this fixed voltage at the sensing electrode. Then the current flows between sensing and counter electrodes in proportion to the gas concentration. This kind of electrochemical gas sensor having the function to adjust potential difference is called 3 electrode type. This excellent stability allows the sensor to be widely used in various applications including industrial product.

3. CO concentration characteristics

Concentration characteristics to CO is shown in figure 2. Response to each concentration is shown in figure 3. Linear output current to concentration was obtained, and 90% response time in CO concentration from 30 to 5000ppm was within 10 seconds.

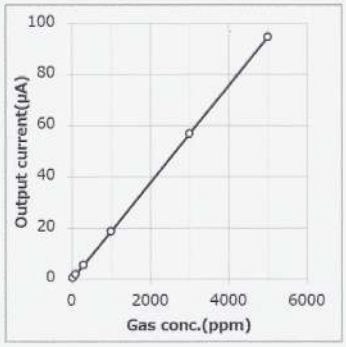


Figure 2. Concentration characteristics to CO

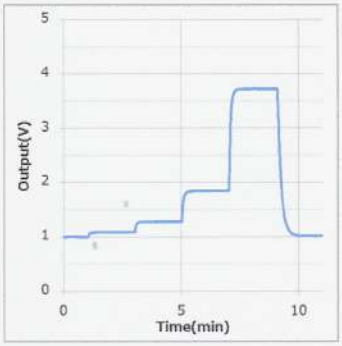


Figure 3. Response to CO (30, 100, 300, 1000ppm)

4. Interference sensitivity characteristics

Concentration characteristics to miscellaneous gases other than CO is shown in figure 4. CO concentration corresponding to output to each gas is shown in table 1. Output to H_2 1000ppm is corresponding to CO concentration 70ppm. The sensor hardly showed sensitivity to the other gases.

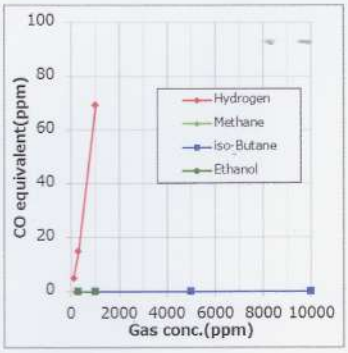


Figure 4. Concentration characteristics to miscellaneous gases

gas	gas concentration(ppm)	CO concentration(ppm)
CO_2	10,000	0
H_2	1,000	69
CH_4	10,000	0
C_4H_{10}	10,000	0
C_2H_6O	1,000	0
SO_2	50	0
H_2S	50	0
NO	10	<1
NO_2	50	0
NH_3	300	0

Table 1. CO concentration corresponding to output to each gas

5. Reproducibility

Reproducibility of output was confirmed by operation to expose the sensor to CO 300ppm and the clean air alternatively every 2 minutes. Results are shown in figure 5 and table 2. Both indicated concentration and difference between maximum and minimum output value stay within 1%.

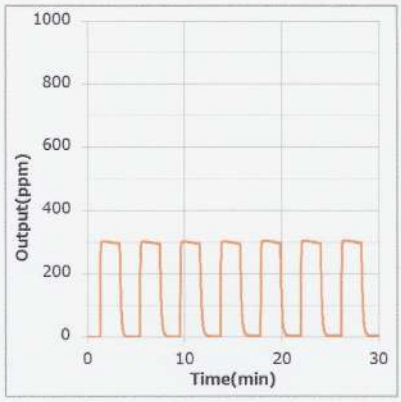


Figure 5. Reproducibility of output

Table 2. Indicated concentration to CO 300ppm

	Indicated concentration(ppm)
1st	297.9
2nd	297.4
3rd	297.0
4th	297.3
5th	299.8
6th	298.8
7th	299.8
average	298.3
Max-Min	2.86

6. Mounting direction dependency

Dependency of attaching direction to output current was confirmed, as results are shown in figure 6. Any fluctuation by attaching direction was not found.

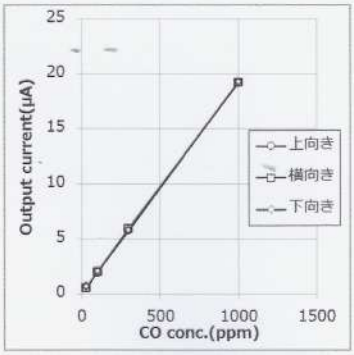


Figure 6. Change of output characteristics by attaching direction

7. Hot-cold shock test

Output fluctuation by hot-cold shock test was confirmed, as results are shown in figure 7 and table 3. Test condition : -20C° (30min) <-> 60C° (30min) 10 cycles
At the time immediately after test, output fluctuation was exceeding 10%, however after 24hour - standing still in the clean air, output fluctuation was staying within 10%.

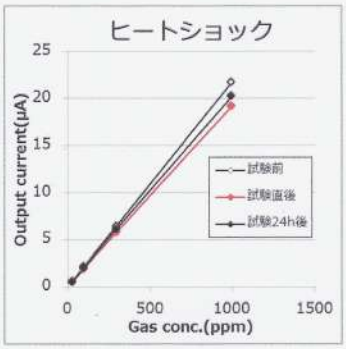


Figure 7. Hot-cold shock test results

Table 3. Output fluctuation

	fluctuation before/after test		
Just after test	-11.8%	-12.8%	-12.1%
After 24hour	-6.7%	-7.5%	-6.6%

8. Temperature dependency

Figure 8 shows baseline shift, figure 9 shows output fluctuation by temperature change. In a temperature range from -20C° to 50C°, any large fluctuation of baseline was not found. However, at around 60C° baseline considerably declined to negative side. +-50% fluctuation of output to CO was found in a temperature range from -20C° to 60C°, however because nearly straight line is shown, it is considered to be possible to correct temperature relatively easily.

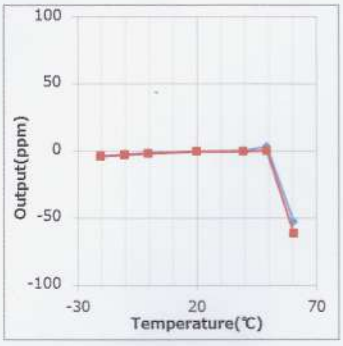


Figure 8. Baseline shift

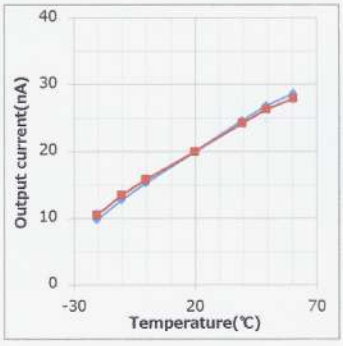


Figure 9. Output fluctuation

9. Aging change

On the condition that initial output value was set to an alarm concentration, aging change of alarm concentration was confirmed, as results are shown in figure 10 and 11. Fluctuation range was within 10% in either case of CO concentration 100, 300 and 1000ppm.

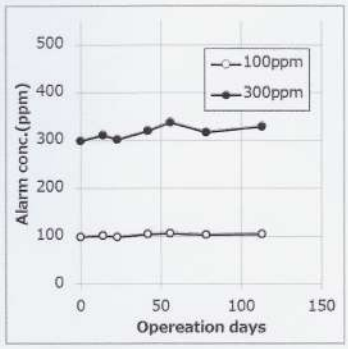


Figure 10. Aging change of alarm concentration (100, 300ppm)

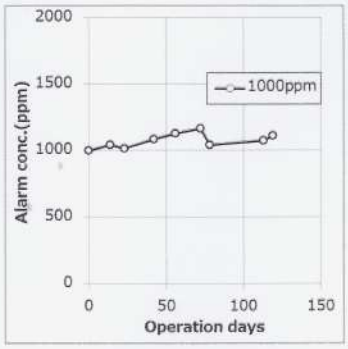


Figure 11. Aging change of alarm concentration (1000ppm)

10. Effect by Vibration

Effect to output due to vibration by part feeder was confirmed, as results are shown in figure 12. Because differences of output value between rest time and vibration time stay within 1 ppm, it is considered that vibration can not cause any large output fluctuation.

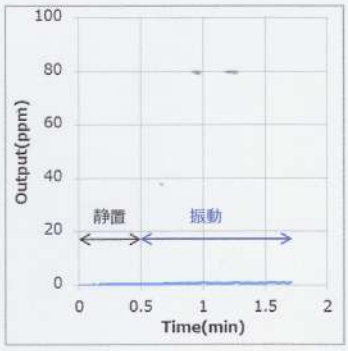


Figure 12. Fluctuation output by vibration

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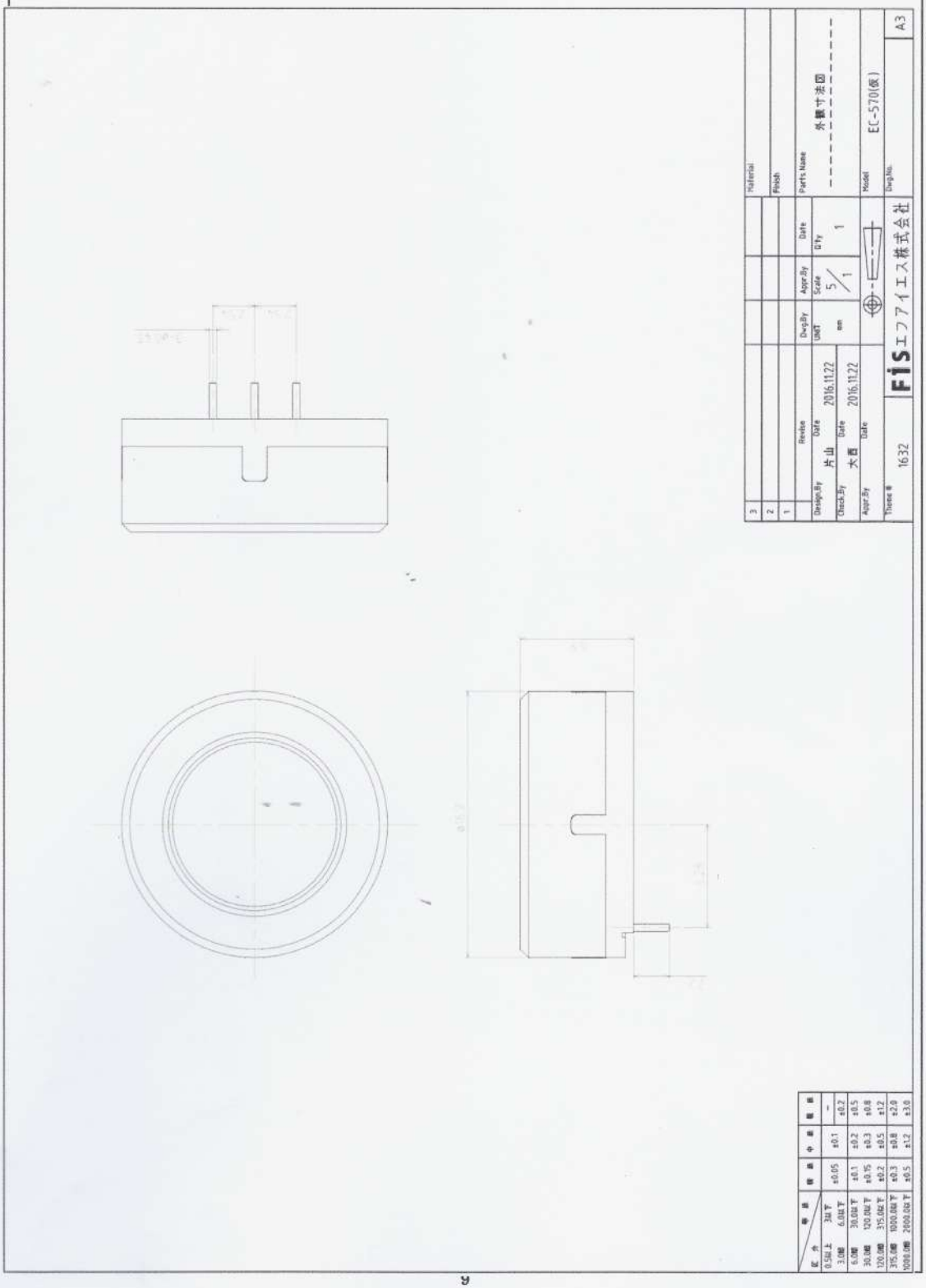

寸法 \ 等級	3以下	6以下	30以下	120以下	315以下	1000以下	2000以下	等級	中級	粗級	極粗級
0.5以上 3.0以								±0.1	±0.05	±0.2	—
3.0以 6.0以	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±0.2	±0.1	±0.5	±0.8
6.0以 30.0以	±0.1	±0.15	±0.3	±0.4	±0.6	±1.0	±1.5	±0.3	±0.15	±0.8	±1.2
30.0以 120.0以	±0.2	±0.2	±0.4	±0.5	±0.8	±1.2	±2.0	±0.5	±0.2	±1.2	±2.0
120.0以 315.0以	±0.3	±0.3	±0.5	±0.8	±1.2	±2.0	±3.0	±0.8	±0.3	±2.0	±3.0
315.0以 1000.0以	±0.5	±0.5	±0.8	±1.2	±2.0	±3.0	±5.0	±1.2	±0.5	±3.0	±5.0
1000.0以 2000.0以	±0.8	±0.8	±1.2	±2.0	±3.0	±5.0	±8.0	±2.0	±0.8	±5.0	±8.0