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Technical Manual and Characterisation File

NE7-CO-H series

**Electrochemical CO Gas Sensor
For Industrial Applications**



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General

Nemoto NE7 series sensors were newly developed for mainly fixed industrial applications, and there are 2 types in NE7-CO series, NE7-CO-H and NE7-CO-H10000. Both types have a function of hydrogen sensitivity compensation. Shape, dimension, pin positions and basic features are compatible with other 7 series, however the stability, repeatability, durability and reliability are highly superior to competitive sensors, but the price is competitive with the others. Features and applications are as follows.

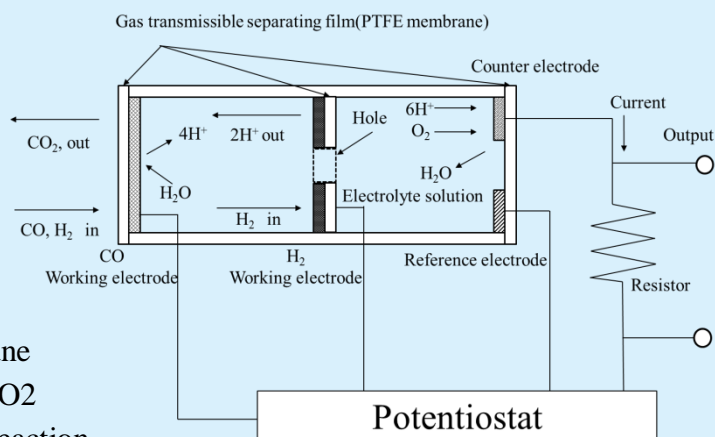
1. Detection principle

Electrochemical sensor consists of working electrode on which oxidization takes place, counter electrode on which reduction takes place, and reference electrode which can monitor and keep the voltage at constant.

Structure of electrochemical sensor is shown

in right figure, CO gas diffuses through membrane into working electrode, and CO is oxidized to CO₂ on working electrode. Generated proton at this reaction proceeds to counter electrode, and reacts with dissolved oxygen in electrolyte to water. Total reaction is in the

above. CO gas concentration is proportional to the current that is generated by serial reaction. This NE7 series has an additional working electrode under the main working electrode for hydrogen sensitivity compensation as shown in the above figure, it is different from the ordinal one.



2. Features

- Quick response and large sensitivity
- Complete selectivity
- Good linearity and stability
- High reliability and long lifetime
- Excellent durability in strict circumstance

3. Detected gas

Carbon monoxide

4. Applications

- CO gas densitometer for industrial application
- CO gas analyzer for gas water heater
- Fixed type CO gas analyzer



5. Ratings

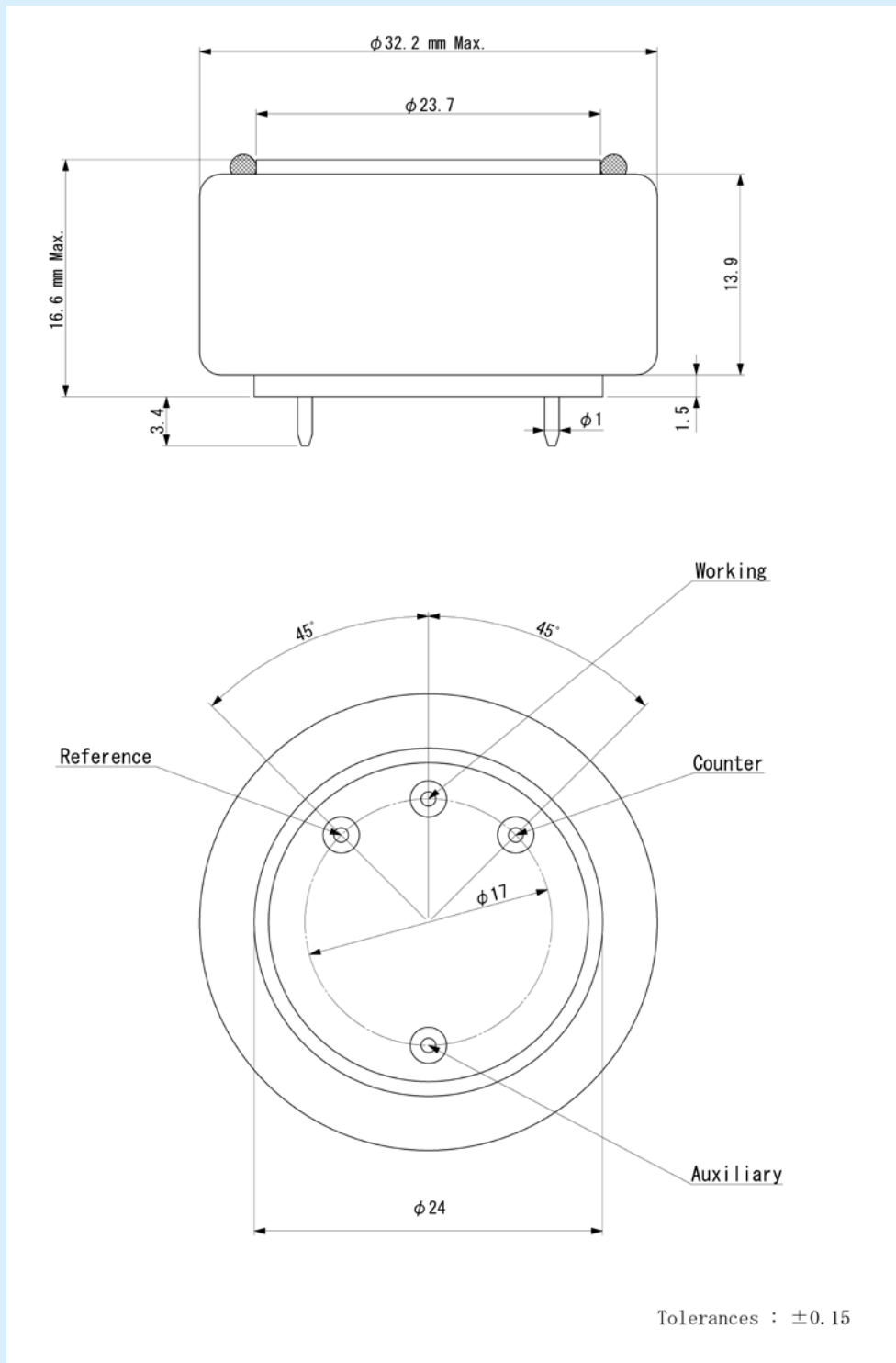
- | | |
|--|---|
| 1) Ambient temperature and humidity in operation | Temperature : -20 - +50 degree C
Humidity : 15 - 90%RH |
| 2) Recommended ambient temperature and humidity in storage | Temperature : 0 - 20 degree C
Humidity : 15 - 90%RH |
| 3) Operating pressure range | 0.9 - 1.1 atm |
| 4) Detection range | 0 - 1,000ppm (NE7-CO-H)
0 - 10,000ppm (NE7-CO-H10000) |
| 5) Maximum overload | 2,000ppm (NE7-CO-H)
20,000ppm (NE7-CO-H10000) |
| 6) Recommended load resistor | 10 ohm |

6. Performance characteristics

- | | |
|--|---|
| 1) Output signal | 100 +/- 20nA/ppm.CO at 20 degree C (NE7-CO-H)
15 +/- 4nA/ppm.CO at 20 degree C (NE7-CO-H10000) |
| 2) Zero offset at 20 degree C | Less than 5ppm of CO (NE7-CO-H)
Less than 50ppm of CO (NE7-CO-H10000) |
| 3) Response time (T90) | Less than 35sec. (NE7-CO-H)
Less than 40sec. (NE7-CO-H10000) |
| 4) Repeatability in the same day | Less than 1% of signal (NE7-CO-H)
Less than 2% of signal (NE7-CO-H10000) |
| 5) Resolution | 0.5ppm of CO (NE7-CO-H)
4ppm of CO (NE7-CO-H10000) |
| 6) Zero offset temperature dependence (-20 ~ +50 degree C) | -3 - +15ppm of CO (NE7-CO-H)
-10 - +50ppm of CO (NE7-CO-H10000) |
| 7) Sensitivity reduction in long term | Less than 5% signal loss/year |
| 8) Pressure coefficient | 0.02% signal/mBar |
| 9) Expected lifetime | 5 years in air |
| 10) Recommended storage time | Less than 6 months |
| 11) Bias voltage | Unnecessary |
| 12) Position sensitivity | None |
| 13) Auxiliary electrode | To compensate for H2 cross-interference |
| 14) Inboard filter | To remove hydrogen sulfide |
| 15) Output linearity | Linear |



7. Dimensions and appearance



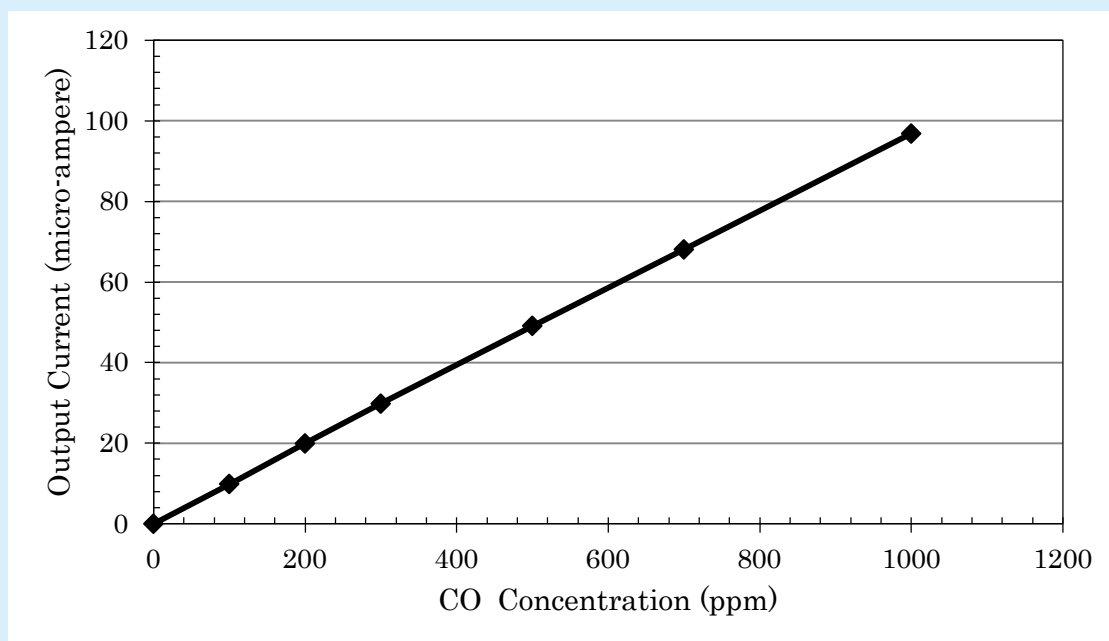
Plastic material	PPO
Weight	11 g (approx.)

Fig.1 : Appearance and dimensions of NE7-CO-H



8. Electrical properties

9-1. Typical gas sensitivity (NE7-CO-H)



9-2. Cross Sensitivity

Table 1 : Cross Sensitivity of NE7-CO-H series

Detected gases	Gas concentration (ppm)	Cross-sensitivity (CO gas equivalent)
Carbon-monoxide	100	100ppm
Hydrogen*	100	Less than 1ppm
Methane	1,000	0
Iso-butane	1,000	0
Carbon-dioxide	10,000	0
Sulfur-dioxide	5	0
Hydrogen Sulfide	15	Less than 1ppm
Nitric Oxide	35	Less than 7ppm
Nitrogen Dioxide	50	-0.5 - +1ppm
Ethanol	500	0

*: After sensitivity compensation



9-3. Temperature dependence

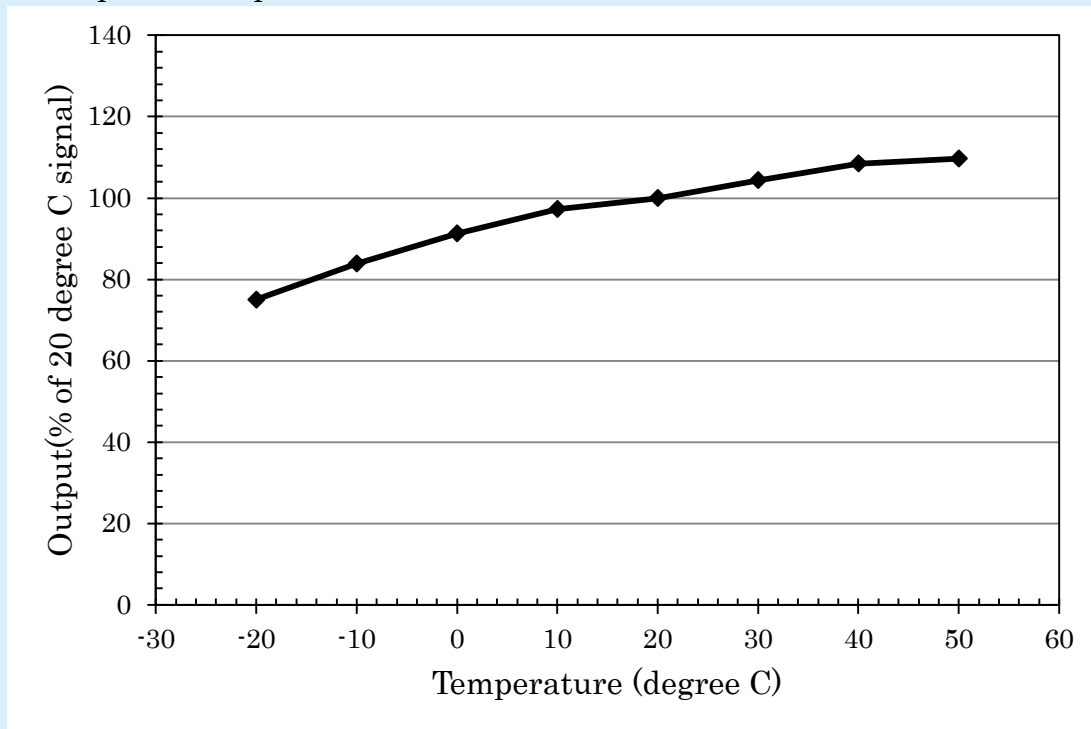


Fig.3 : Typical temperature coefficient of NE7-CO-H
(100 at 20 degree C)

9-4. Response and recovery characteristics

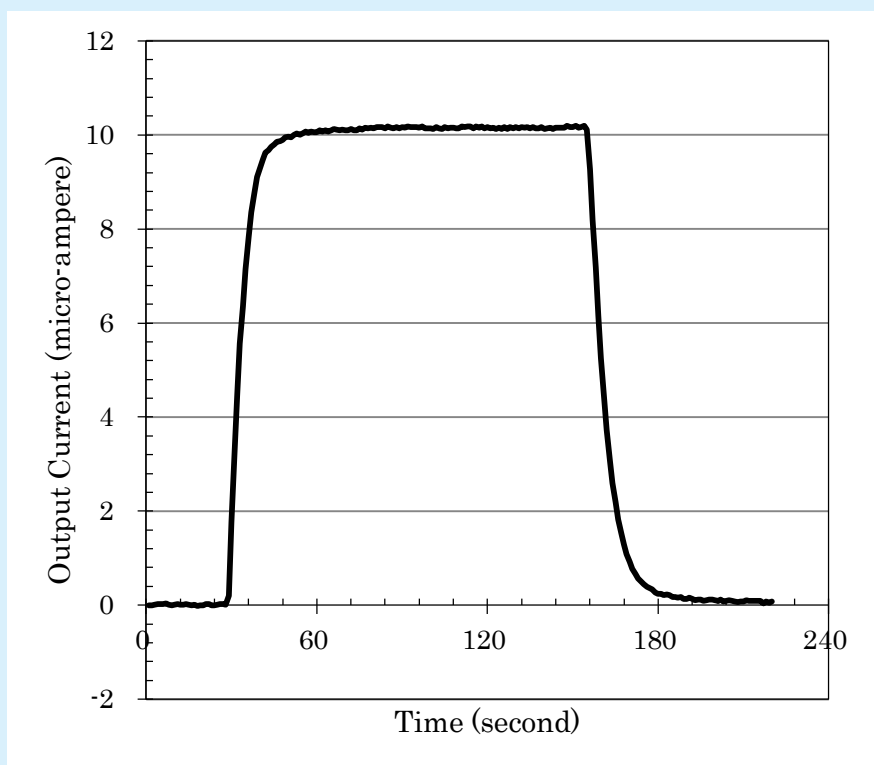


Fig.4 : Response and recovery characteristics (at 20 degree C)



9. Recovery characteristics after exposure in high concentration of CO gas

Comparison of recovery time in clean air after exposure in 1% of CO gas for 5 min. with competitive sensor.

CO gas equivalent	NE7-CO-H	Competitive sensor
100ppm	35sec.	109sec.
50ppm	52sec.	157sec.
10ppm	179sec.	413sec.

10. Recommended circuit diagram

Recommended circuit diagram for evaluation of NE7-CO series is shown in figure 5. In this circuit diagram, OP97 as operational amplifier is employed, however the other low price one is to be applicable for actual use. And, thermistor is employed, resistance value of 10Kohm at 25 degree C and around 3500 as B constant is recommended. Ishizuka thermistor is not pointed, and another one is also available.

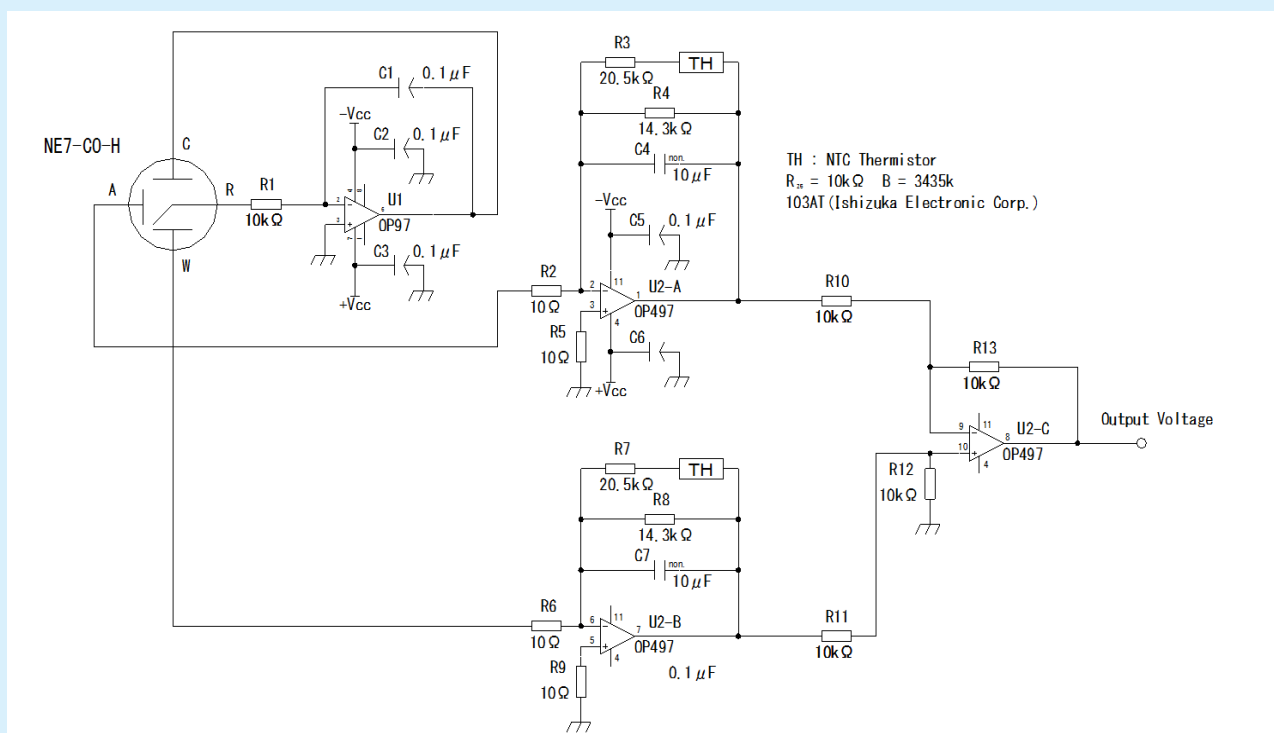


Fig. 5 : Provisional measuring circuit diagram for evaluation

12. Notice on handling

12-1. Seasonal variation of sensitivity

Highly hygroscopic electrolyte is normally employed for electrochemical sensor, and then the sensitivity varies according to change of temperature and humidity, i.e. sensitivity is little lower in low humidity than in high humidity. Since it is because of amount of electrolyte, this seasonal variation of sensitivity should be taken into account in case that precise measurement is necessary. However, this variation is reversible phenomenon.



12-2. Design of gas alarm or gas densitometer

- a. Calibration of gas alarm or gas densitometer is to be carried out in clean air after the output was stabilized.
- b. Gas sensitivity reduction ratio of 5% per year is to be taken into account at designing of gas alarm as recommendation. In case that precise detection is required, periodical calibration once or twice a year is recommended.
- c. In case that water drop or oil is on the pre-filter, accurate measurement may not be available because of low diffusion of detected gas to sensor. If such accident may be conceived, design of prevention from such one is to be considered.
- d. Warranty time is 2 years in case of being used in normal circumstance.

12-3. Storage of sensor

It is recommended that electrochemical sensor should be stored in normal temperature and humidity, possibly 0-20 degree C, of clean air.

Recommended storage time after delivery is less than 6 months. If the storage time is extended, the warranty term is to be shortened. It is because the lifetime of electrochemical sensor is not dependent on being electrified or not like semi-conductive type or catalytic type, and then this matter is to be correctly comprehensive in order to keep quality.

12-4. General notice

- Use only within specified conditions.
- Sensor characteristics must be measured in clean air.
- Electrode pins must be correctly connected. Wrong connection does not allow correct functions.
- Do not apply voltage directly to electrode pins.
- Do not bend pins.
- Do not put excess vibration or shocks.
- If sensor housing is damaged or scratched, do not use.
- Do not blow organic solvents, paints, chemical agents, oils, or high concentration gases directly onto sensors.
- Do not solder pins of sensor directly. Use exclusive sockets.
- Do not disassemble or change any parts.
- In case that sensor is stored by detachment from circuit board, it is recommended that working electrode pin should be short-circuited with reference electrode pin in order to shorten the initial stabilization time.
- If sensor is used under irregular atmosphere, contact us.

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