Technical Information

Electrochemical Nitrogen Monoxide Gas Sensor

NE-NO

For Industrial Application

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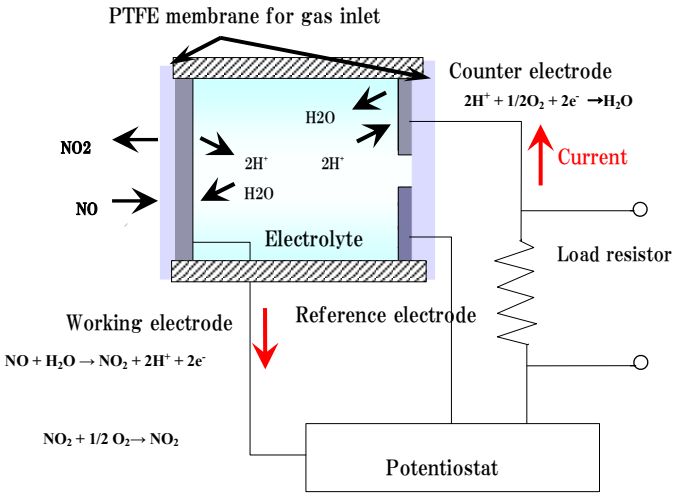
1. General

Nemoto NE series sensors were developed for industrial applications, and NE-NO is a newly developed electrochemical nitrogen monoxide gas sensor. Shape and pin positions are compatible with others, but the stability, repeatability, durability and reliability are superior to others, however the price is competitive with others. Features and applications are as follows.

2. Detection principle

Electrochemical sensor consists of working electrode on which oxidization or reduction takes place, counter electrode on which reduction or oxidization takes place, and reference electrode which can monitor and keep the voltage at constant. Structure of electrochemical sensor is shown in the following figure, nitrogen monoxide gas diffuses through membrane into working electrode, and it is oxidized to nitrogen dioxide at working electrode in case that the designated bias voltage is supplied. Consequently generated proton at working electrode reacts with hydroxide ion, and then, water is generated at this reaction. Water molecule proceeds to working electrode, and increase at counter electrode by generated current of this serial reaction. Total reaction is in the below described. NO gas concentration is proportional to the current that is generated by this serial reaction.



3. Features

- Quick response
- Excellent selectivity
- Good linearity and stability
- High reliability

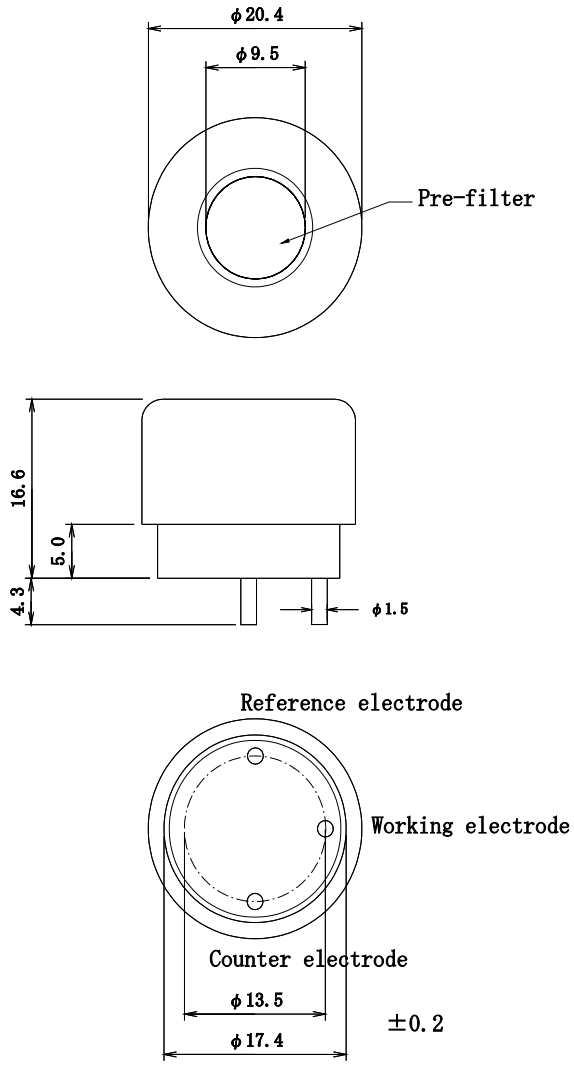
4. Detected gas

Nitrogen monoxide

5. Application

- NO gas densitometer for industrial application
- NO gas alarm for industrial equipment like for car parking area
- Environmental monitoring equipment

6. Dimensions and appearance



Case Material	PPO
Cap Color	Light purple
Weight	5 g（approx.）

Fig.1: Appearance and dimensions of NE-NO

7. Ratings

1)	Ambient temperature and humidity in operation	Temperature : -20 - +50 ˚C Humidity : 15 – 90% RH
2)	Recommended ambient and humidity in storage	Temperature : 0 – 20 ˚C Humidity : 15 – 90 %RH
3)	Operating pressure range	0.9 – 1.1 atm
4)	Detection range	0 – 250ppm
5)	Maximum overload	1000ppm
6)	Recommended load resistor	10 ohm
7)	Recommended bias voltage	300mV

8. Specifications

1)	Output signal	400 +/-80nA/ppm of NO
2)	Response time (T90)	Less than 40sec.
3)	Repeatability in the same day	Less than +/- 2%
4)	Zero offset drift	Less than 2%/month
5)	Zero offset temperature dependence (20 ~ +40 ˚C)	Less than 4ppm of NO
6)	Minimum detection range	0.5ppm
7)	Sensitivity reduction in long term	Less than 2%/month
8)	Expected lifetime	24 months
9)	Recommended storage time	Less than 6 months

9. Electrical properties

9-1. Typical Gas Sensitivity

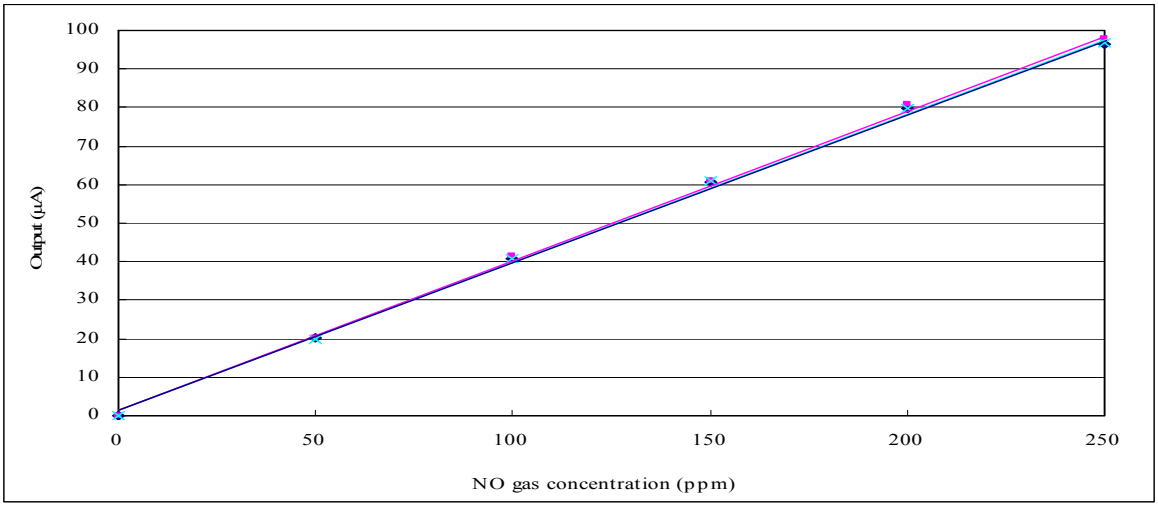


Fig.2: Gas Sensitivity of NE-NO

9-2. Cross Sensitivity

Table1: Cross Sensitivity of NE-NO

Detected gases	Relative sensitivity (Sensitivity to NO is 100.)
Nitrogen monoxide	100
Carbon monoxide	Less than -1
Carbon dioxide	0
Hydrogen	0
Chlorine	0
Sulfur-dioxide	0
Nitrogen dioxide	Less than 10
Hydrogen sulfide	Less than 100
Ammonia	0
Ethyl acetate	-
Chlorine	Less than 100
Ethanol	Less than -7
Toluene	-
Ethylene	-
Ozone	0

9-3. Zero temperature dependence

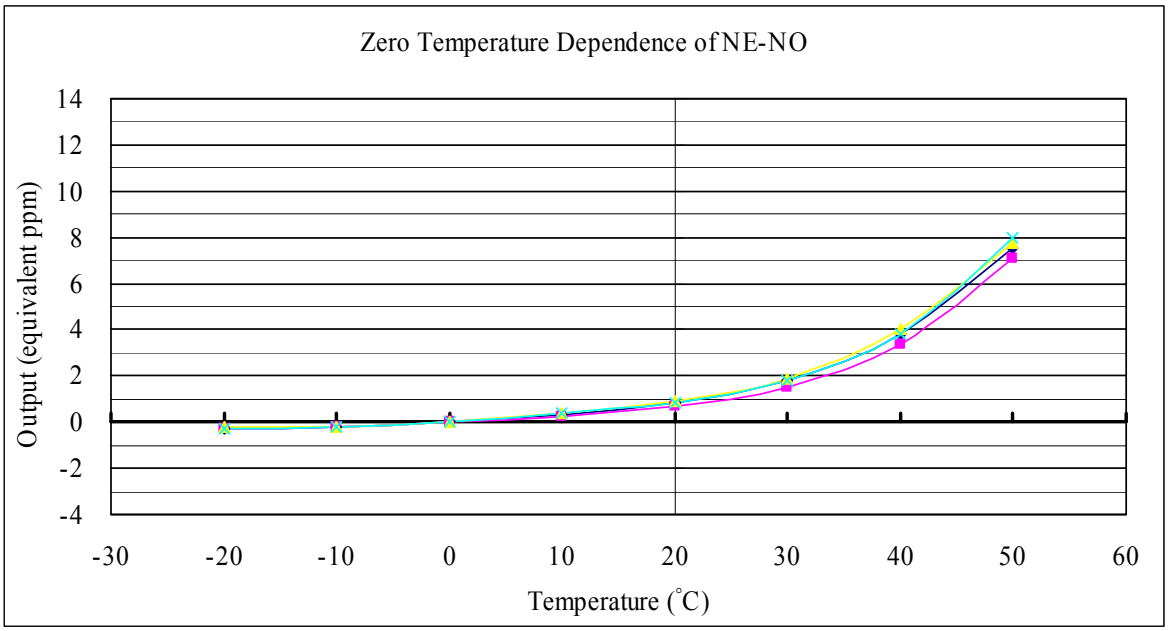


Fig. 3 : Zero temperature dependence of NE-NO

9-4. Temperature dependence

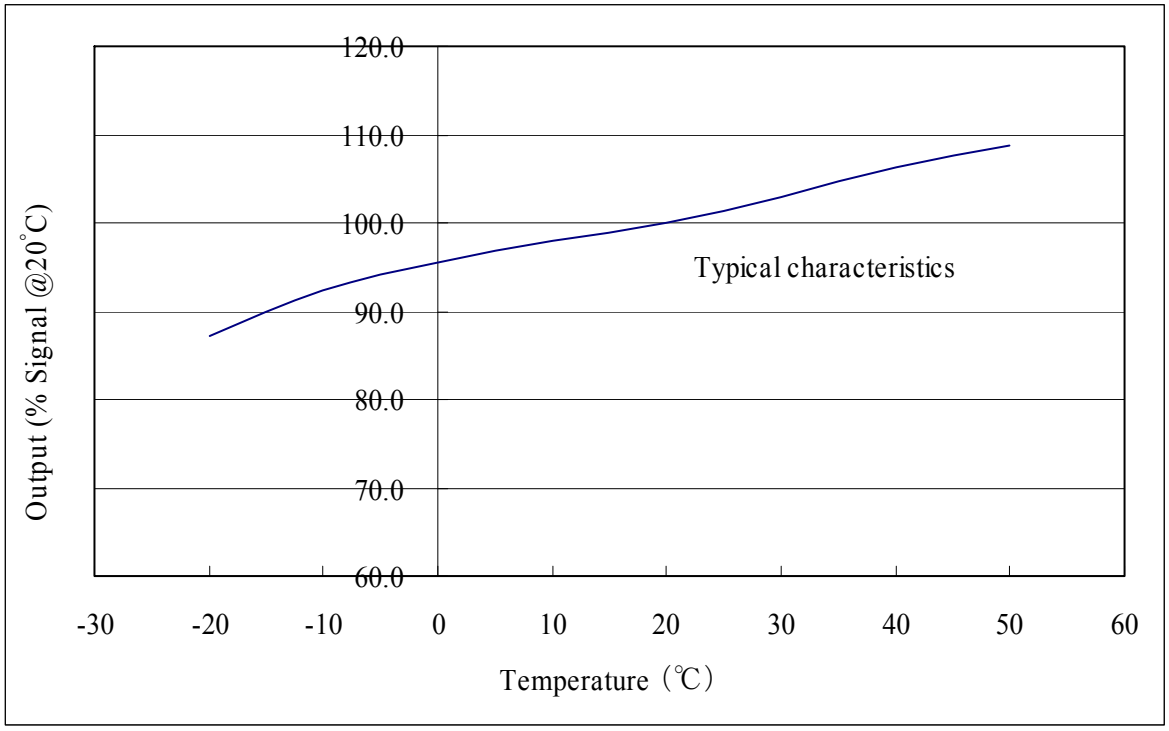


Fig. 4 : Typical temperature coefficient of NE-NO
(100 at 20 ˚C)

9-5. Response and recovery characteristics

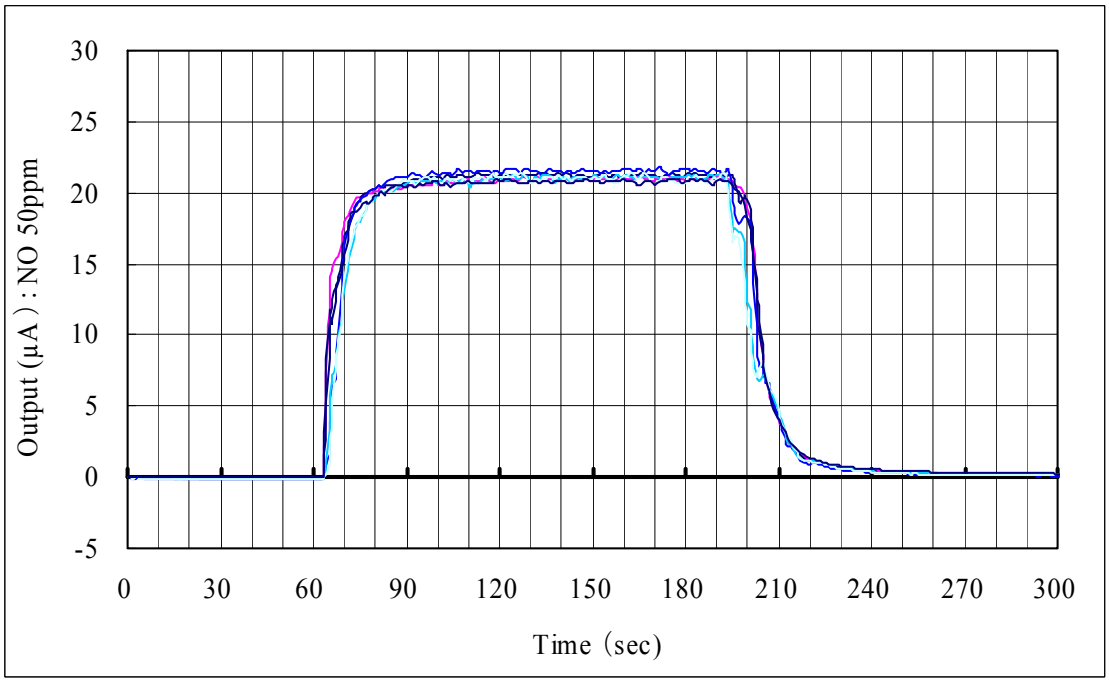


Fig.5: Response and recovery characteristics of NE-NO
(at 20 ˚C)

9-6. Bias voltage dependence

In order to heighten the selectivity, this sensor needs the supply of bias voltage to circuit. As shown in the following figure of supply voltage dependence, around 300mV as bias voltage is recommended in our evaluation circuit.

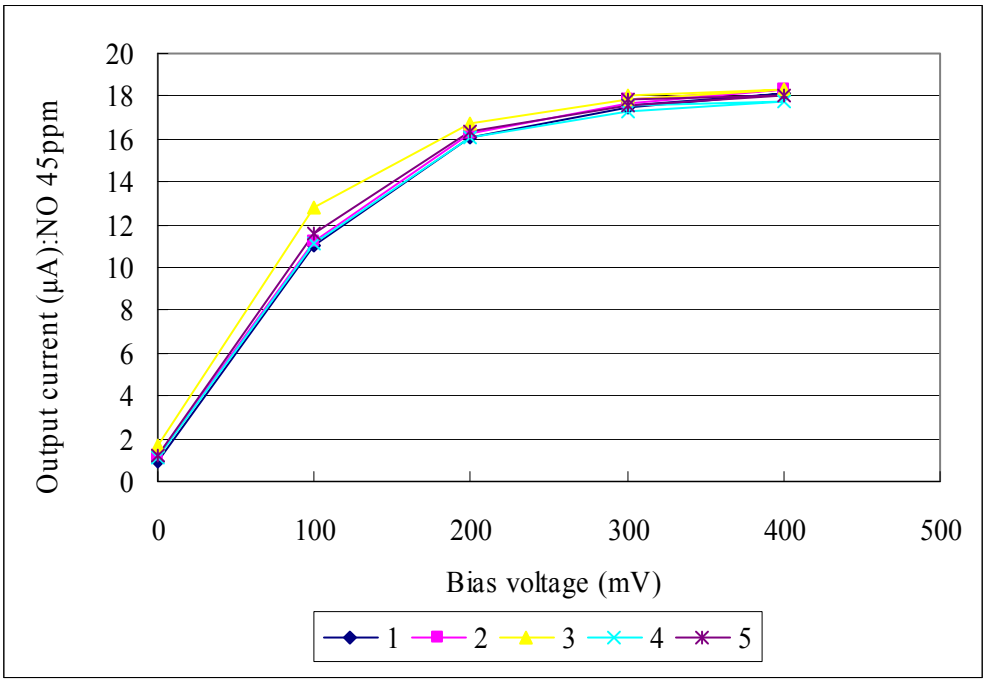


Fig.6: Bias supply voltage dependence

9-7. Long term stability

It is quite stable in normal circumstance.

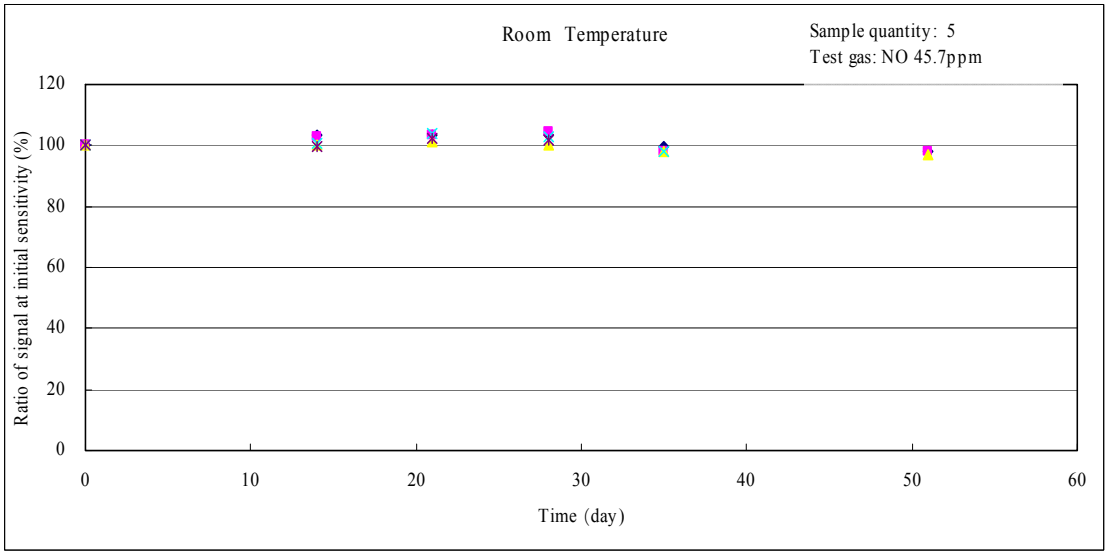


Fig.7: Long term stability in normal circumstance

10. Durability

NE-NO is much durable in strict environment such as high temperature. Features are as follows.

10-1. Durability in high temperature

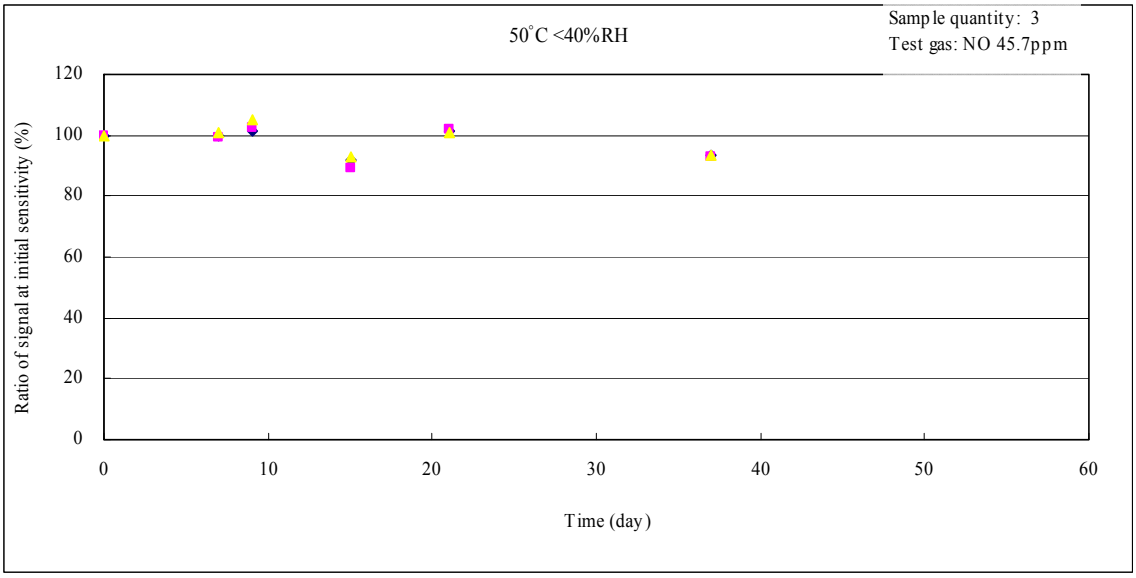


Fig.8: Durability in high temperature (50˚C) with dry circumstance

10-2. Durability in high temperature and normal humidity

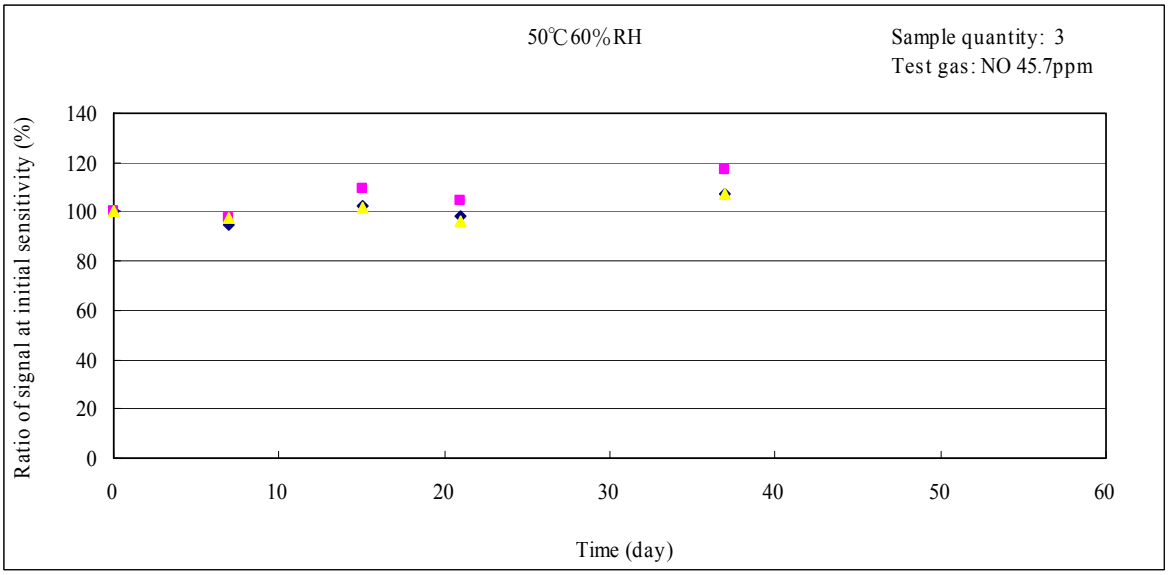


Fig.9: Durability in high temperature (50˚C) and normal humidity (60%RH)

10-3. Low temperature durability

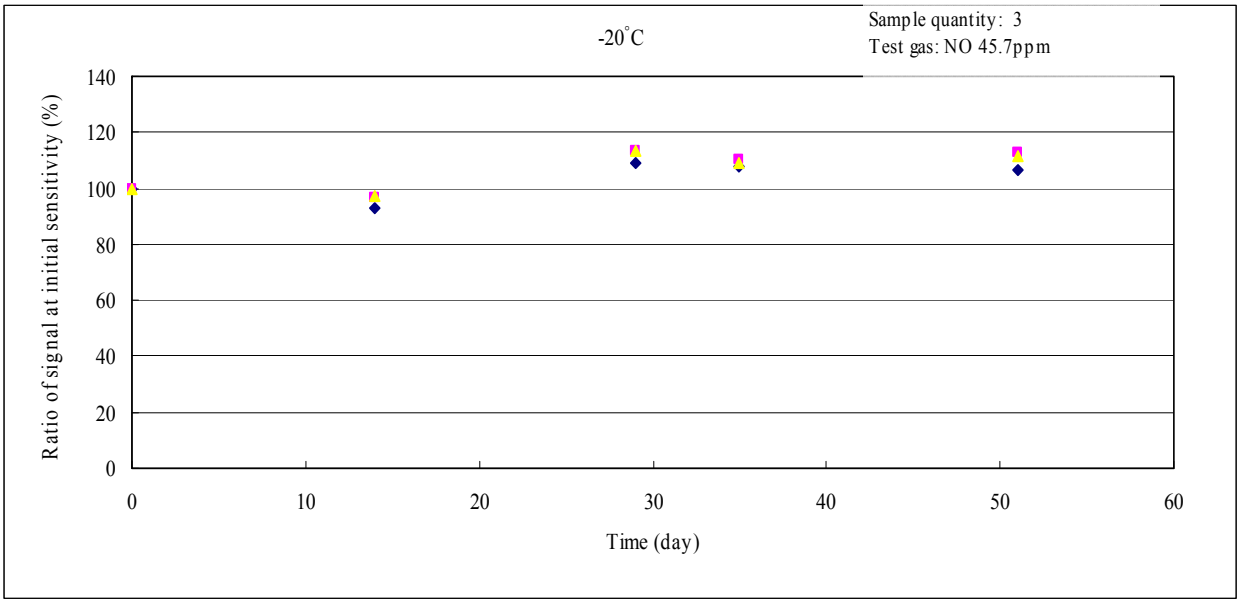


Fig.10: Durability in low temperature (-20˚C)

10-4. Thermal shock test

Test conditions

Sensor is store in -20C for 30min. and in +50C for 30min. respectively, and this cycle was repeated for 10 times.

Table2. Thermal shock test

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air	Sensitivity to 30ppm of NO	Zero offset in air	Sensitivity to 30ppm of NO	
1	0.43	12.2	0.57	12.14	99.5
2	0.45	11.97	0.57	11.92	99.6
3	0.61	12.34	0.72	12.58	101.9
4	0.46	12.36	0.57	12.71	102.9
5	0.48	12.45	0.61	12.79	102.7

10-5. Drop test

Test conditions

Sensor is dropped to concrete floor from the height of 1m with free fall for 5 times.

Table3. Drop test

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air	Sensitivity to 30ppm of NO	Zero offset in air	Sensitivity to 30ppm of NO	
1	0.36	11.98	0.42	12.18	98.4
2	0.39	11.67	0.45	11.96	97.6
3	0.57	12.05	0.61	12.32	97.8
4	0.63	12.92	0.46	12.35	104.6
5	0.82	12.31	0.49	12.45	98.8

11. Recommended circuit diagram

Recommended circuit diagram for evaluation of NE-NO 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 also employed, resistance value of 10Kohm at 25 ˚C and around 3500 as B constant is recommended. Ishizuka thermistor is not designated, and another one is also available.

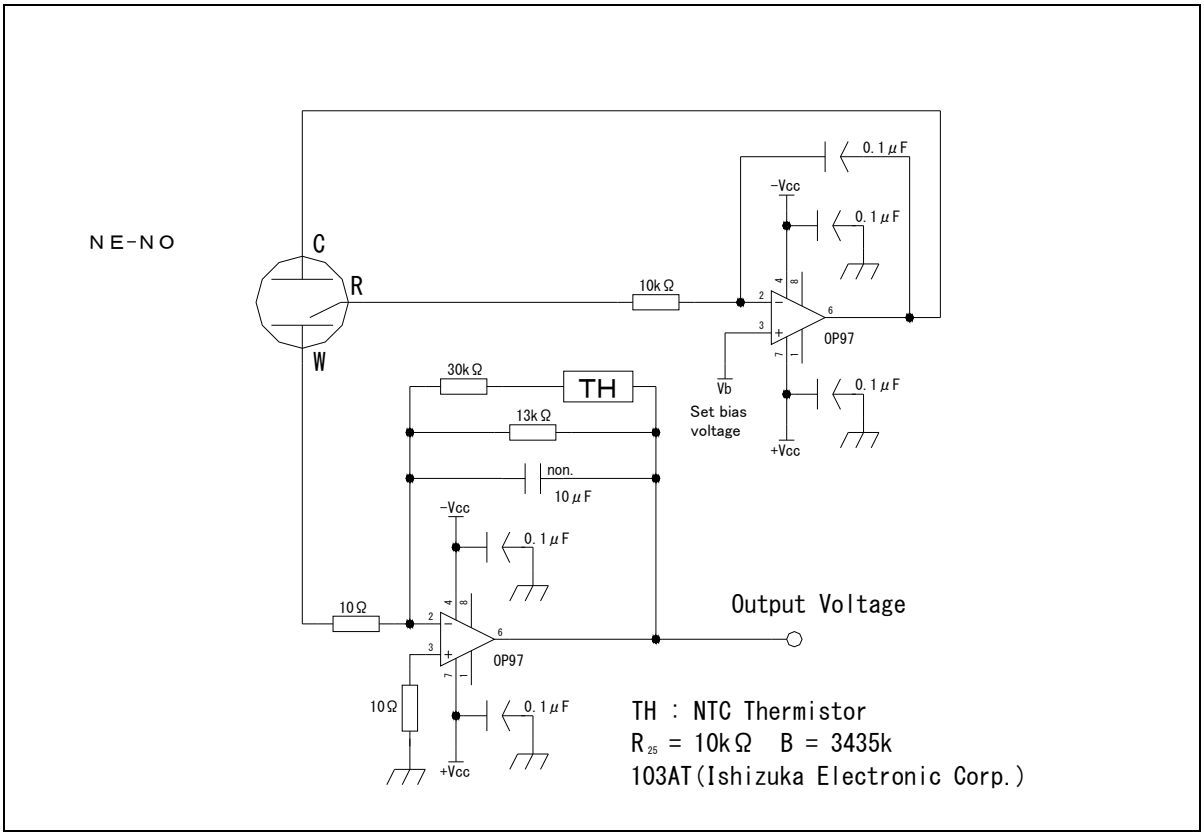


Fig. 11: Measuring circuit diagram for evaluation

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 2% per month is to be taken into account at designing of gas alarm as recommendation. In case that precise detection is required, periodical calibration.
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 ˚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.
- Do not use contact grease when sensor is connected to the sockets.

- 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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