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Technical Information

Electrochemical Ammonia Gas Sensor

NE4-NH3 series

(NE4-NH3, NE4-NH3-1000, NE4-NH3-5000)

For Industrial Application

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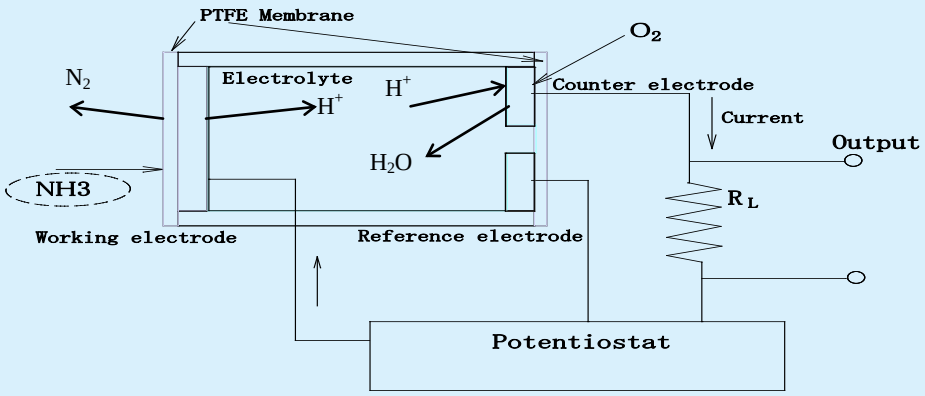
1. General

Nemoto NE4 series sensors were developed for industrial applications, and NE4-NH3, NE4-NH3-1000 and -5000 are available for ammonia gas sensor. Shape and pin positions are compatible with others, however the stability, repeatability, durability and reliability are quite superior to others, additionally the price is competitive with others. Features and applications are as follows.

2. 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 NE4-NH3 is shown in the following figure, ammonia gas diffuses through membrane into working electrode, and decomposes and is partially oxidized, and consequently, nitrogen is generated at working electrode. Subsequently generated proton at this reaction proceeds to counter electrode, and reacts with dissolved oxygen in electrolyte to water. Total reaction is in the below described. Ammonia 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
- Excellent durability against high temperature and humidity

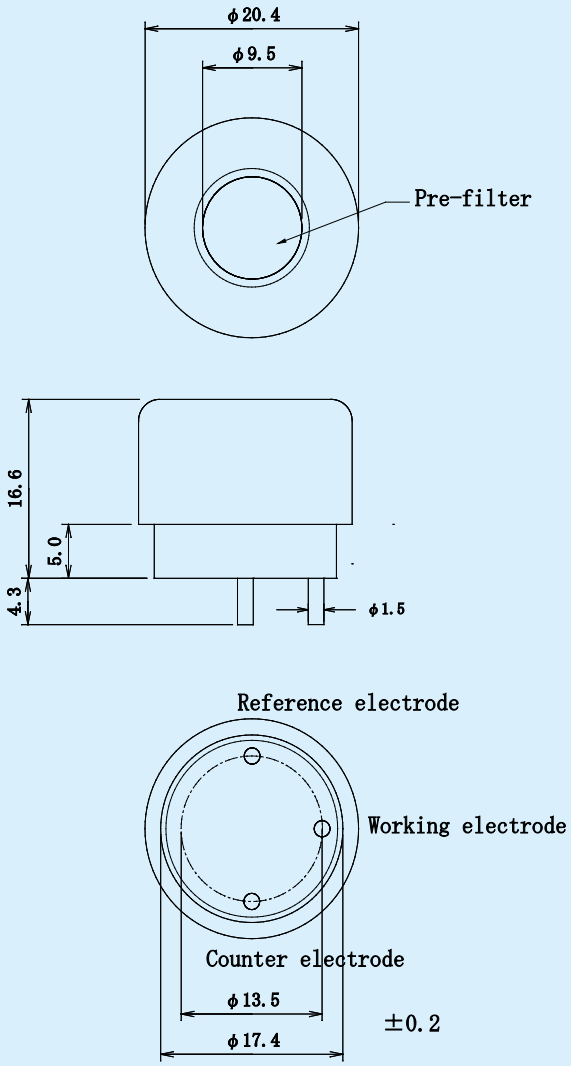
4. Detected gas

Ammonia

5. Application

- NH3 gas densitometer for industrial application
- NH3 gas alarm for industrial equipment
- Handheld type NH3 gas leakage checker

6. Dimensions and appearance



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

Fig.1 Appearance and dimensions of NE4-NH3
(Other NH3 series are the same as the above.)

7. Ratings

1) Ambient temperature and humidity in operation — Temperature : -30 - +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

Model	Detection range
NE4-NH3	0 – 100ppm
NE4-NH3-1000	0 – 1,000ppm
NE4-NH3-5000	0 – 5,000ppm

5) Recommended load resistor 10 ohm

8. Specifications

1) Output signal

NE4-NH3 (Standard type) 40 +/- 12nA/ppm.NH3 at 20 degree C
NE4-NH3-1000 8 +/- 4nA/ppm.NH3 at 20 degree C
NE4-NH3-5000 4 +/- 2nA/ppm.NH3 at 20 degree C

2) Zero offset at 20 degree C

NE4-NH3 (standard type) < +/-10ppm of NH3 equivalent
NE4-NH3-1000 < +/-50ppm of NH3 equivalent
NE4-NH3-5000 < +/-100ppm of NH3 equivalent

3) Response time (T90)

NE4-NH3 < 90sec.
NE4-NH3-1000 < 120sec.
NE4-NH3-5000 < 150sec.

4) Repeatability in the same day < 10% of signal

5) Annual zero offset drift at 20 degree C

NE4-NH3 < +/-10ppm of NH3 equivalent
NE4-NH3-1000 < +/-50ppm of NH3 equivalent
NE4-NH3-5000 < +/-100ppm of NH3 equivalent

6) Zero offset temperature dependence (-30 - +50degree C)

NE4-NH3 < +/-15ppm of NH3 equivalent
NE4-NH3-1000 < +/-75ppm of NH3 equivalent
NE4-NH3-5000 < +/-150ppm of NH3 equivalent

7) Sensitivity reduction in long term < 2% signal loss/month

8) Expected lifetime 24 months

9) Recommended storage time < 6 months

9. Electrical properties

9-1. Typical Gas Sensitivity

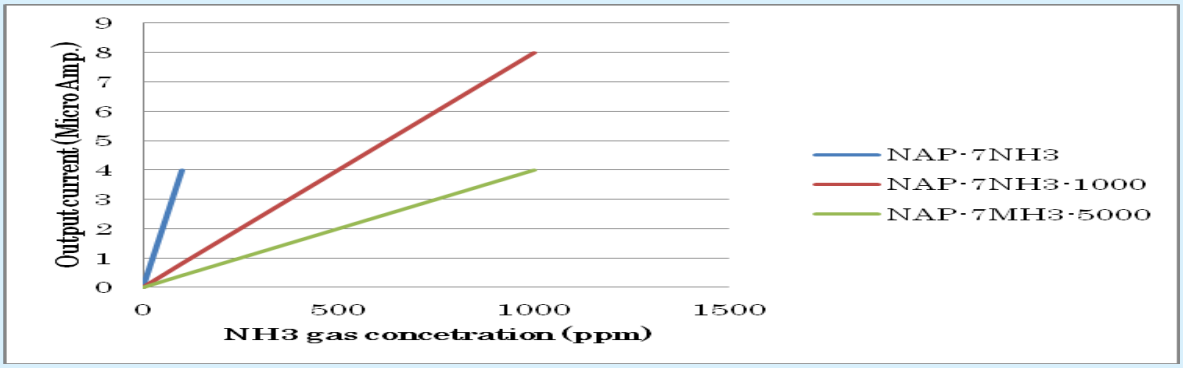


Fig.2 : Gas Sensitivity of NE4-NH3 series

9-2. Cross Sensitivity

Table 1 : Cross Sensitivity of NE4-NH3 series

Detected gases	Relative sensitivity (Sensitivity to NH3 is 100.)		
	NE4-NH3	NE4-NH3-1000	NE4-NH3-5000
Ammonia	100	100	100
Carbon monoxide	0	0	0
Carbon dioxide	0	0	0
Hydrogen	Less than -1	Less than -15	Less than -20
Chlorine	0	0	0
Sulfur-dioxide	Less than 150	Less than 120	Less than 120
Nitric oxide	0	0	0
Methane	0	0	0
Hydrogen sulfide	Less than 300	Less than 150	Less than 150
Nitrogen dioxide	10	0	0
Ethanol	0	0	0
Ethylene	0	0	0

*Exposure time：30min.

9-3. Temperature dependence

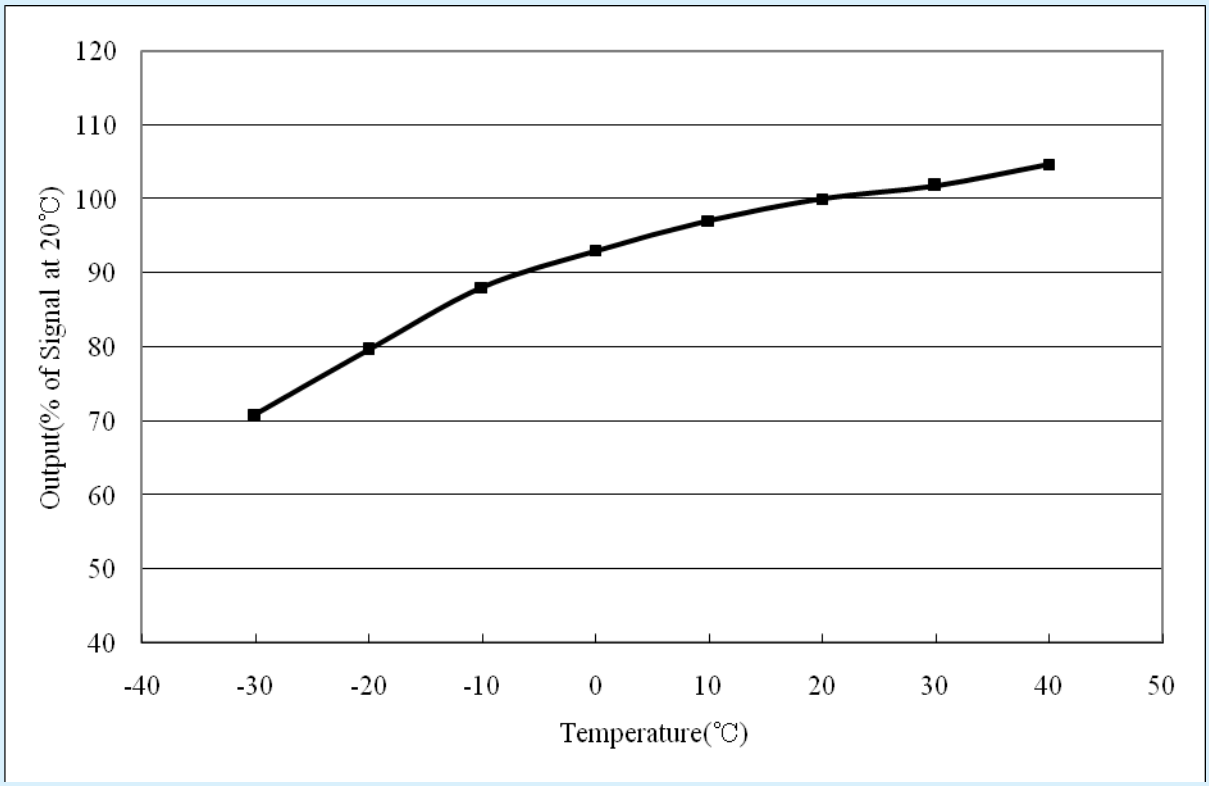


Fig. 3 : Typical temperature coefficient of NE4-NH3
(100 at 20 degree C)

9-4. Response and recovery characteristics

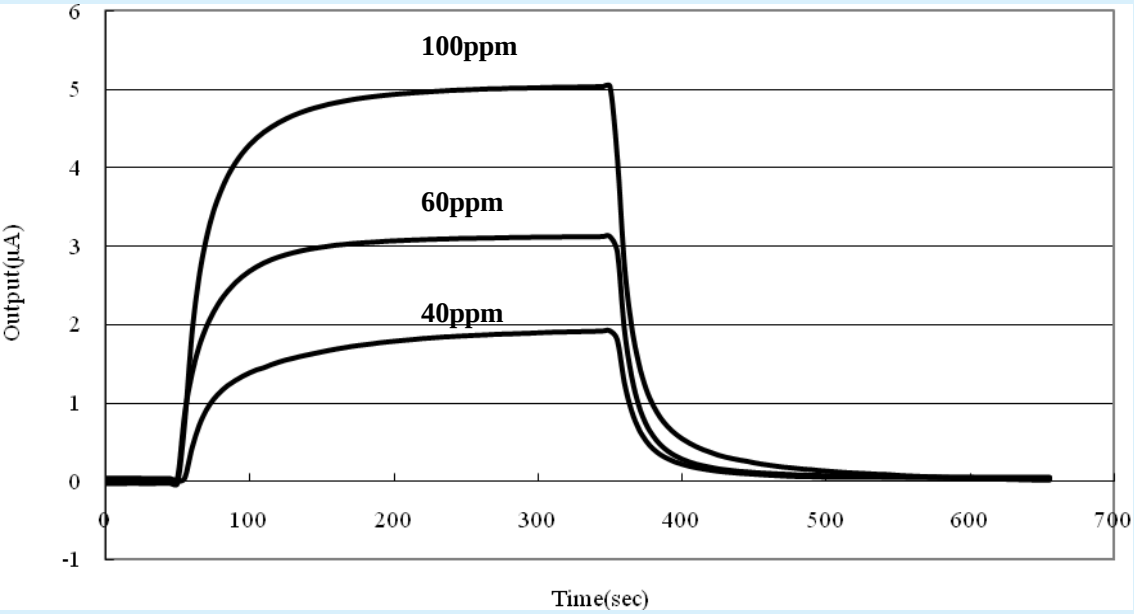


Fig.4 : Response and recovery characteristics
(at 20 degree C)

9-5. Long term stability

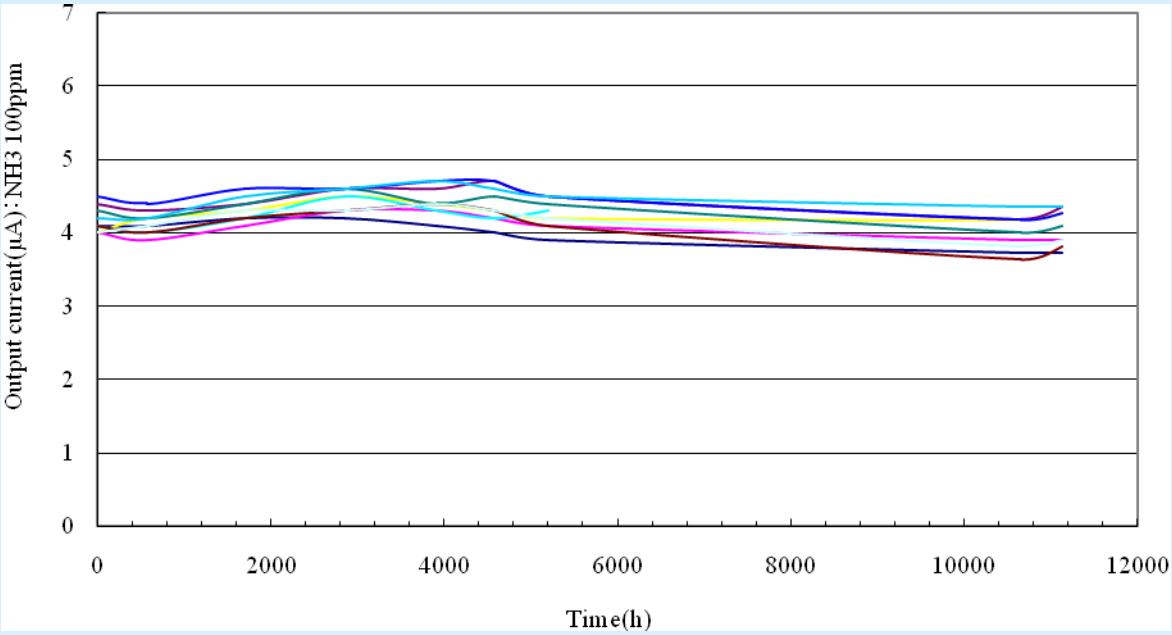


Fig. 5 : Long term stability of NE4-NH3 in normal circumstance

10. Durability

NE4-NH3 series are exceedingly resistant in severe circumstance in comparison with others.

10-1. Effect of humidity variation

Sensor in operation is alternatively exposed in between dry condition and wet condition for 10min. each (every 20min. after 60min.). When the circumstance is suddenly changed, output current correspondent to 5ppm of ammonia is observed.

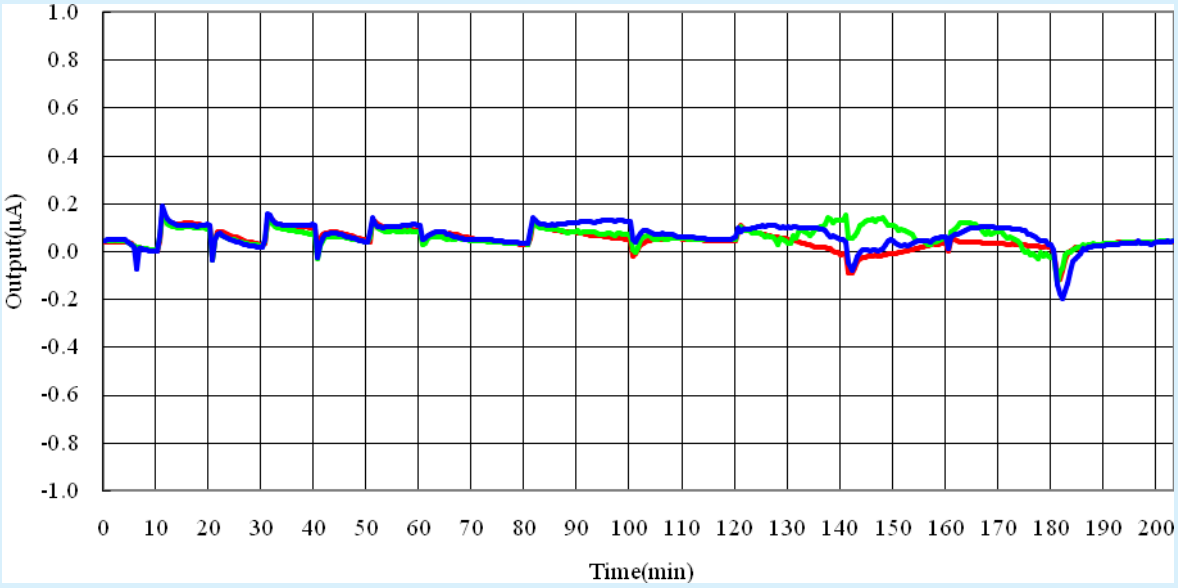


Fig.6 : Zero offset variation dependent on humidity variation

10-2. Durability in high temperature

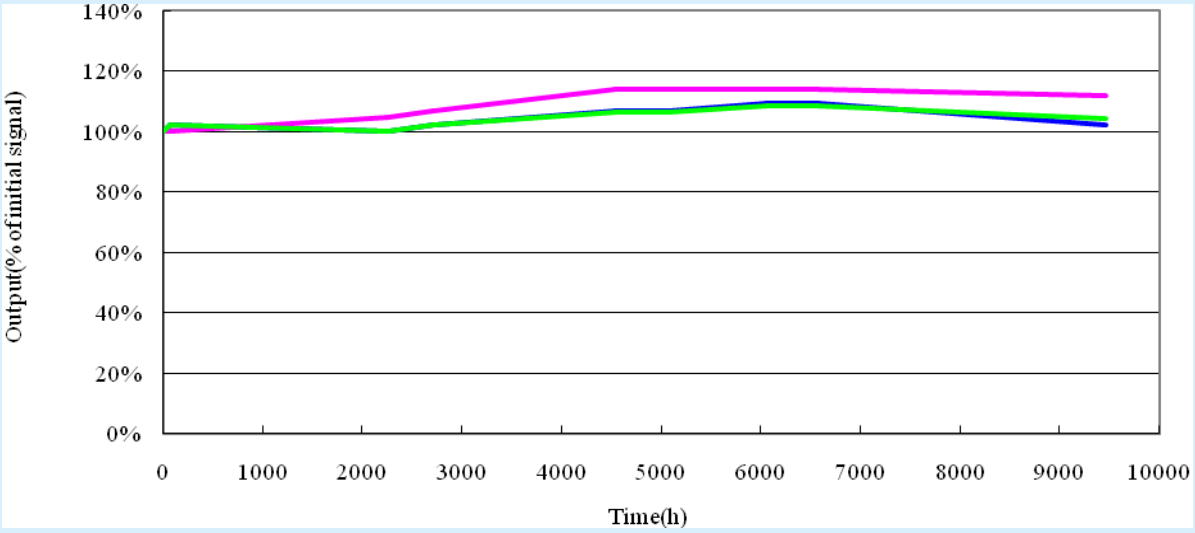


Fig. 7 : Durability in high temperature (50 degree C) with dry circumstance

10-3. Durability in high temperature and high humidity

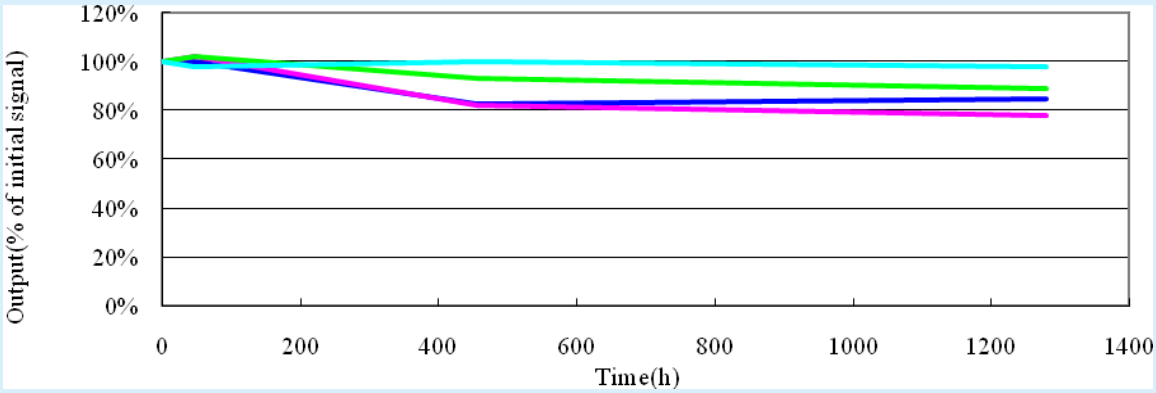


Fig. 8 : Durability in high temperature (50 degree C) and high humidity (90%RH)

10-3. Low temperature durability

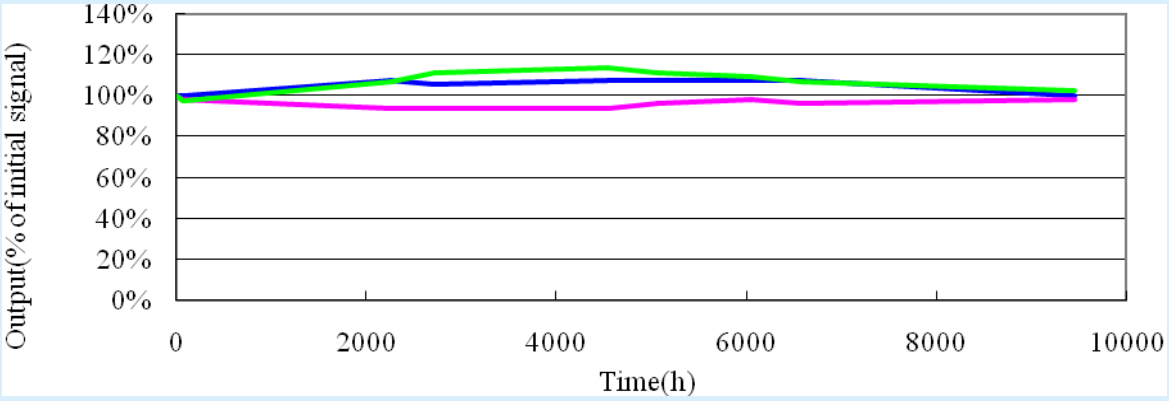


Fig.9 : Durability in low temperature (-20 degree C)

10-4. Thermal shock test

Test conditions

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

Table 2. Thermal shock test

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	
1	0.01	4.32	-0.01	4.50	104.2
2	0.02	4.25	-0.01	4.12	96.9
3	0.08	4.77	0.02	4.63	97.1
4	0.12	4.70	0.01	4.69	99.8
5	0.05	4.28	0.02	4.10	95.8

10-5. Drop test

Test conditions

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

Table 3. Drop test

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	
1	0.07	4.53	0.04	4.60	101.5
2	-0.01	4.75	0.01	4.90	103.2
3	-0.02	4.75	0.02	4.71	99.2

10-6. Exposure in noise gas

A. Exposure in SO2 gas

Test conditions

Sensor is exposed in 50ppm of sulfur dioxide for 2hrs. at normal temperature and humidity.

Table 4. Exposure in SO2

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air at 20 degree C	Sensitivity to 100ppm of H2S	Zero offset in air at 20 degree C	Sensitivity to 100ppm of H2S	
1	-0.05	4.69	0.01	5.01	106.8
2	0.01	4.43	-0.03	4.56	102.9
3	-0.05	4.09	0.01	3.88	94.8
4	0.05	3.97	0.06	3.72	93.7
5	0.02	4.32	0.03	4.35	100.7

B. Exposure in hydrogen sulfide gas

Test conditions

Sensor is exposed in 50ppm of hydrogen sulfide for 2hrs. at normal temperature and humidity.

Table 5. Exposure in hydrogen sulfide

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	
1	-0.02	4.24	-0.05	4.68	110.4
2	-0.02	3.82	0.01	4.43	116.1
3	0.02	4.22	-0.05	4.94	116.4
4	0.00	4.32	0.02	4.67	108.2
5	0.00	4.10	0.03	4.55	111.0

C. Exposure in NO2 gas

Test conditions

Sensor is exposed in 50ppm of nitrogen dioxide for 2hrs. in normal temperature and humidity.

Table 6. Exposure in NO2

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	
1	0.01	5.18	0.00	5.08	98.0
2	-0.03	4.53	-0.01	4.59	101.1
3	0.02	3.89	0.02	4.00	102.7
4	0.06	3.77	0.04	3.87	102.7
5	0.03	4.37	0.02	4.28	98.0

D. Exposure in hydrogen gas

Test conditions

Sensor is exposed in 500ppm of hydrogen for 10hrs. at normal temperature and humidity.

Table 7. Exposure in hydrogen

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	Zero offset in air at 20 degree C	Sensitivity to 100ppm of H2S	
1	0.01	4.95	0.02	4.53	91.5
2	0.06	4.47	0.01	4.01	89.8
3	0.01	5.19	0.03	4.74	91.6
4	0.05	4.32	0.03	4.08	94.5
5	0.03	4.07	0.02	3.91	95.9

E. Exposure in HMDS gas

Test conditions

Sensor is exposed in 200ppm of HMDS (Hexa-methyl di-siloxane) for 2hrs. at normal temperature and humidity.

Table 8. Exposure in HMDS

No.	Before test (micro A)		After test (micro A)		Sensitivity variation ratio (%)
	Zero offset in air at 20 degree C	Sensitivity to 100ppm of NH3	Zero offset in air at 20 degree C	Sensitivity to 100ppm of H2S	
1	-0.07	4.49	-0.05	4.32	96.2
2	-0.03	4.21	0.01	4.27	101.4
3	-0.05	4.54	-0.04	4.34	95.6
4	-0.07	4.99	-0.06	5.00	100.2
5	-0.04	5.15	-0.04	5.21	101.2

11. Recommended circuit diagram

Recommended circuit diagram for evaluation of NE4-NH3 is shown in figure 10. 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.

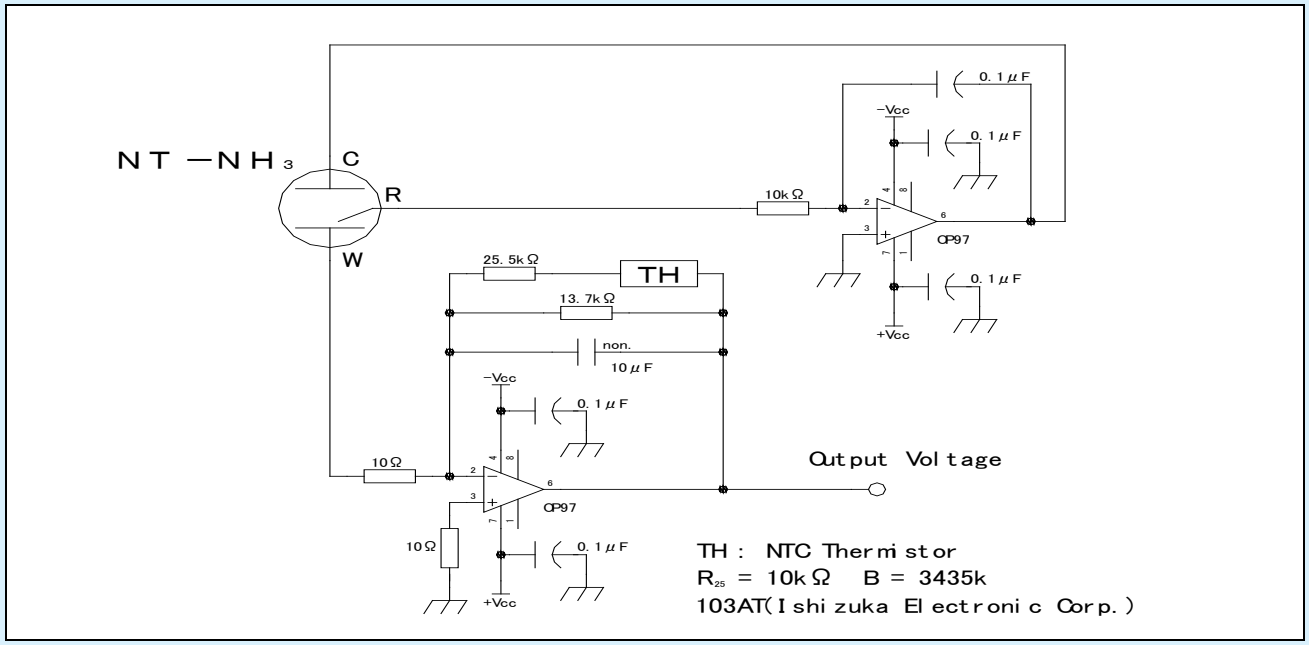


Fig. 10 : Measuring circuit diagram for evaluation

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 high humidity than in low humidity in case of NE4-NH3. 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 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 1 year 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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