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USER'S MANUAL

NEMOTO INDOOR ODOR SENSOR NAP-11AS

CONTENTS

1. Features and Applications

The semiconductor type gas sensors NAP-11AS have excellent sensitivity to various smells generated in a normal living environment, such as cigarette smoke, cooking odors, putrid smells, organic solvent smells, etc. The table 1. below shows the response characteristics to odors from a variety of common objects.
NAP-11AS is widely used for detection and control units for ventilators, air purifiers, and air pollution detection equipment.

Table 1. NAP-11AS Response characteristics

Sources of smells	Olfaction levels Sensuousness	NAP-11AS response		Remarks
		Sensitivity	Response	
1) Cigarette smoke	Strong	High	Quick	5 pieces
2) Cosmetics	Strong	Very high	Quick	1 puff of cologne
3) Insecticides	Strong	Very high	Quick	Splayed for 10 seconds
4) Fried meat	Med./Strong	High	Medium	100g of pork
5) Fried onions	Strong	High	Quick	3 onions
6) Fried green peppers	Medium	Medium	Slow	5 peppers
7) Coffee	Weak	Low	-	5 cups

** Tested in a room of 30 m^3, air was gently agitated by a fan.

1) Features

* Highly sensitive to low concentrations of gases (100 ppb).
* Very stable in ambient humidity.
* Circuit can be easily designed.

2) Application

* Automatic ventilating fan
* Air purifier (Residential, For automobiles)
* Air conditioners
* Automatic cooking equipment

Please refer to the following lists regarding sensitivities to the main ingredients of cigarette smoke and other unpleasant smells which are generated in normal living environment.

(1) Sensitivity of NAP-11AS to putrid smells

Ingredients		Concentration in test	Gas sensitivity of NAP-11AS (Ra/Rg)	Remarks
Name	Chem. formula			
Methylmelcaptan	CH_3SH	1.0 ppm	13.5	Putrid vegetables
Hydrogen sulphide	H_2S	1.0	8.5	Putrefactive fermentation
Trimethylamine	$(CH_3)_3N$	1.0	11.3	Fish
Scatol	C_9H_9N	1.0	15.5	Excreta
Indor	C_8H_7N	1.0	16.3	Feces

(2) Sensitivity to major ingredients in cigarette smoke

Ingredients		Contained per piece	Gas sensitivity of NAP-11AS (Ra/Rg)	Test conditions
Name	Chem. formula			
A cigarette burnt in a room of $30m^3$			8.0	10 ppm
Carbon monoxide	CO	1 ppm	1.8	
Acetoaldehyde	CH_3CHO	0.5	4.5	
Ammonia	NH_3	0.3	2.5	
Formaldehyde	HCOH	0.2	3.2	
Acetone	$(CH_3)_2CO$	0.07	10.5	
Acetic acid	CH_3COOH	0.07	6.8	
Nicotine	$C_{10}H_{14}N_2$	0.07	18.0	
Toluene	C_5H_5N	0.05	8.3	
Pyridine		0.02	9.3	

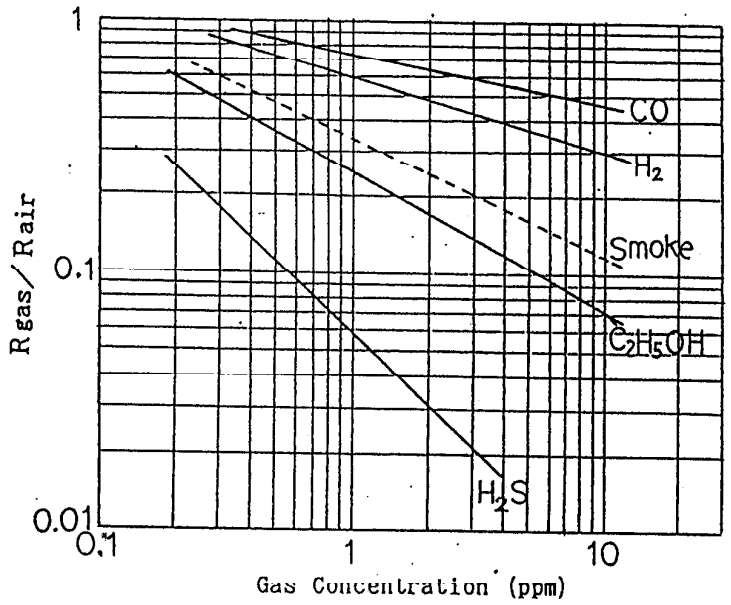
* Ra/Rg = (Resistance value in clean air)/(Resistance value in gas)

2. Specifications:

1) Heater voltage	;	D.C. 5.0±0.25 V A.C. 5.0±0.25 V r.m.s. (50~60 Hz)
2) Heater current (When 5.0V supplied)	;	D.C. 120~140 mA A.C. 120~140 mA r.m.s. (50~60 Hz)
3) Measuring circuit voltage	;	D.C. Less than 15 V A.C. Less than 15 V r.m.s. (50~60 Hz)
4) Ambient temperature & Humidity during operation	;	Temperature -10~+50oC Humidity Less than 95 %RH
5) Ambient temperature & Humidity during storage	;	Temperature -20~+70oC Humidity Less than 95 %RH

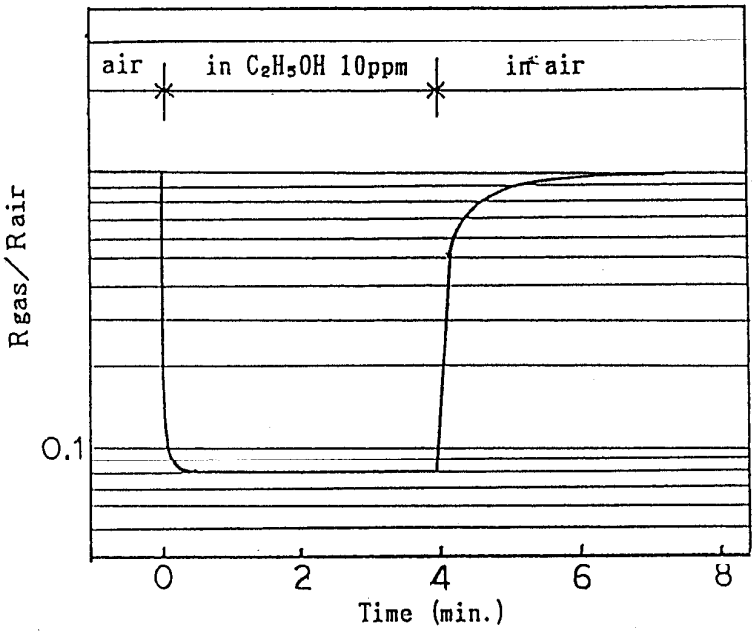
3. Sensitivity characteristics

Shown below are the sensitivity and selectivity characteristics to various gases.



4. Response characteristics

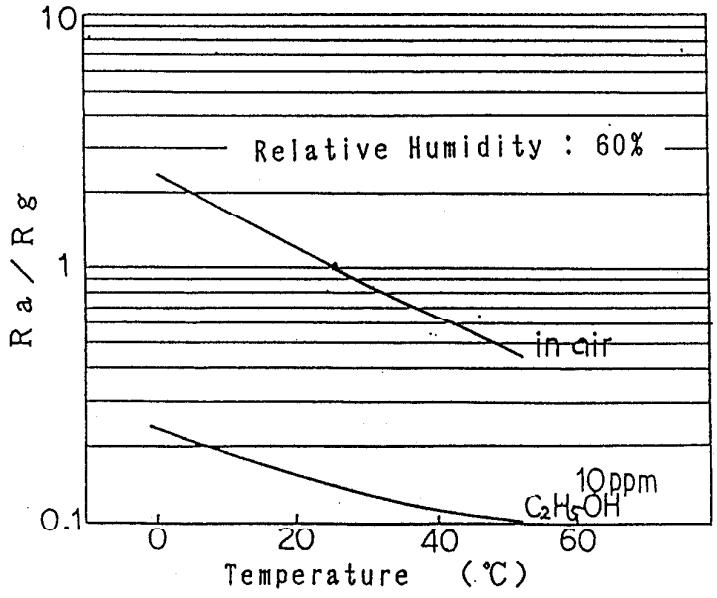
The following is data obtained from a test using alcohol gas. This demonstrates the quick response time of NAP-11AS.



5. Temperature & humidity characteristics

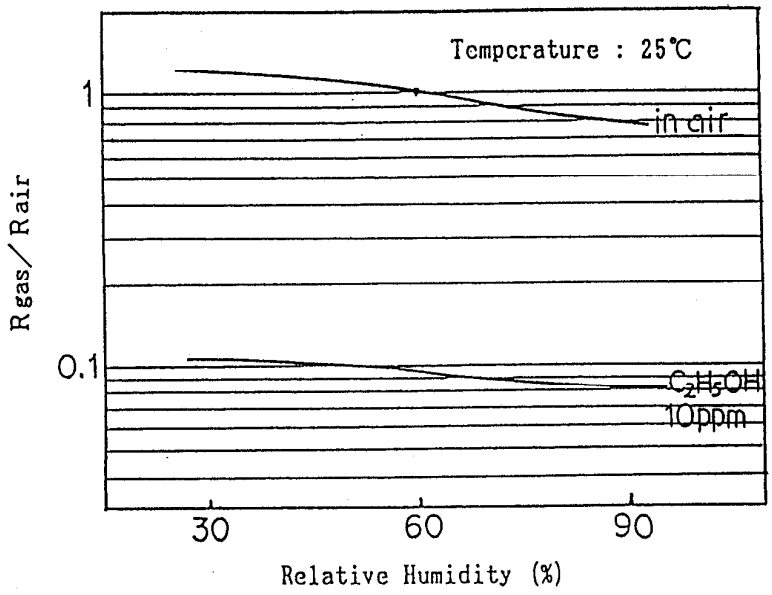
1) Temperature characteristics;

NAP-11AS shows characteristics that are similar to a NTC thermistor in ambient temperatures. The thermistor constant (B constant) is approximately 3,000 as shown in the figure. Therefore, a temperature compensating circuit may be added to your detector depending on your needs regarding accuracy and costs.



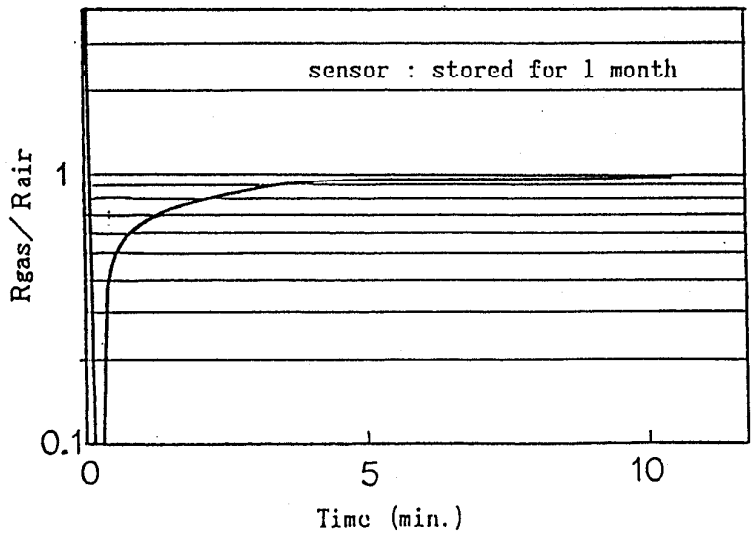
2) Humidity characteristics;

The resistance value and the gas sensitivity of NAP-11AS are very stable within normal humidity range.



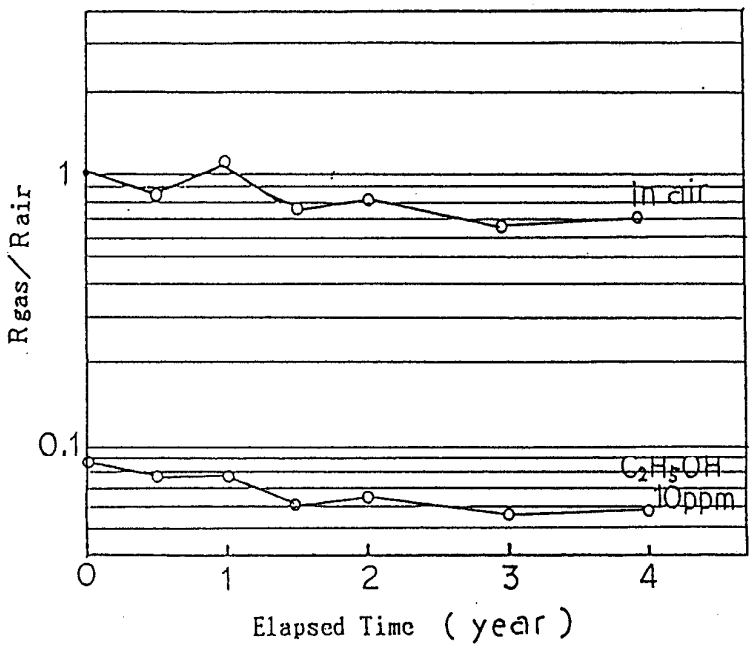
6. Initial stabilization characteristics

As shown below, NAP-11AS stored for a long time without electricity may show a temporary rapid variation in its initial action when it is first powered up, however the characteristics should stabilize quickly, normally 2 to 3 minutes, but the required time for stabilization depends on the storage period. Therefore an additional circuit may be required to compensate for this initial period required for stabilization .



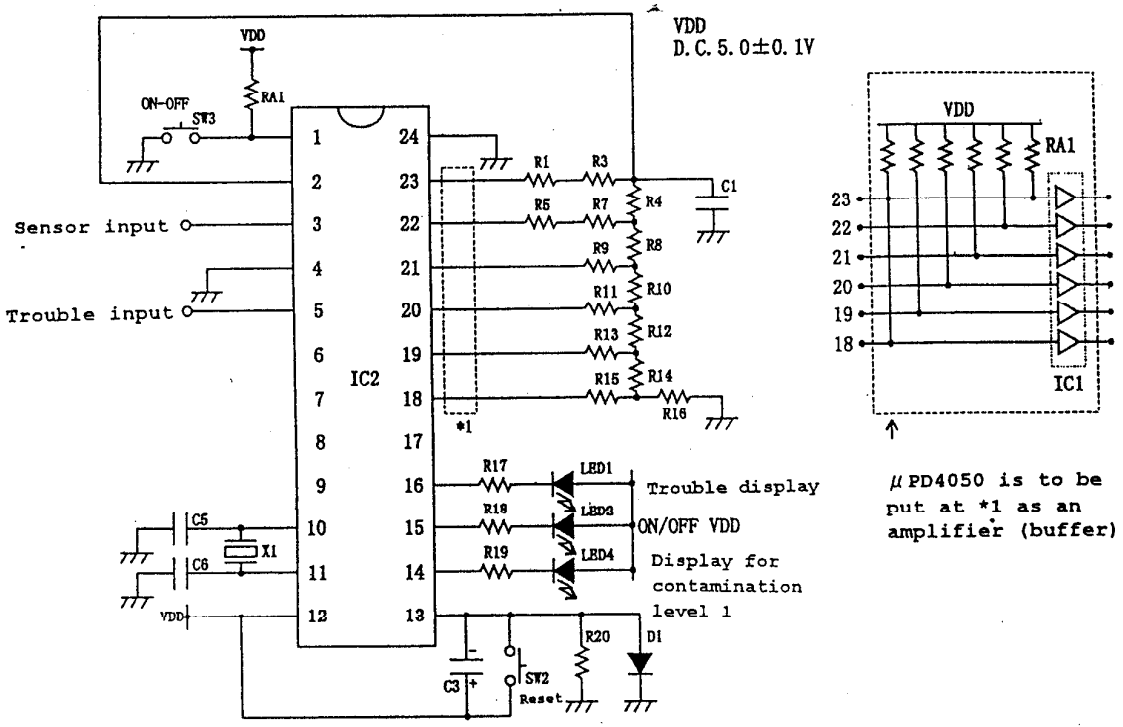
7. Long term stability

The following is long term stability test data of NAP-11AS powered up continuously for a long period in our laboratory. It has been confirmed that NAP-11AS does not show any specific changes in its resistance values and sensitivity to gas throughout the test period of 4 years.

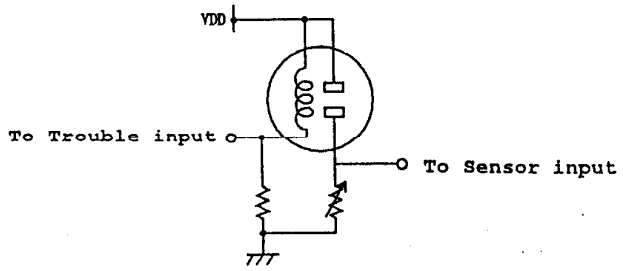


9. Application examples

The following is an example circuit for a detecting unit which has been adopted to an air purifier currently on the market.



Circuit surrounding micron computer



Basic circuit surrounding sensor

** The above circuit is designed with the intent of being able to function as near as possible to the human sense of smell. The designing concepts are as follows.

* The level of the output voltage in a clean air should be occasionally calibrated in accordance with its location or with a change in ambient air quality.

* The sensitivity level can be selected by a user according the users preference.

* Selection of manual or automatic modes, timer function, and trouble alarm function will be incorporated.

*** The normal reading and calibration.

* Initial delay ; Reading is started 1 minute after the unit is switched on.

* Normal reading of output level

; Determined by an average value of 16 readings.
(Once / 20.5 msec.)

* Calibration of a standard output voltage level

; Occasionally calibrated as follows.

1) Calibrated at once if a trend of decreasing output is noticed

2) When a trend of increasing output levels is noticed;

a) When the output level stays below a preset level;
The standard level is re-calibrated every 30 minutes.

b) After the output level exceeds a preset level;
The standard level is calibrated as ;
"Basic level + preset level - 1 basic level"

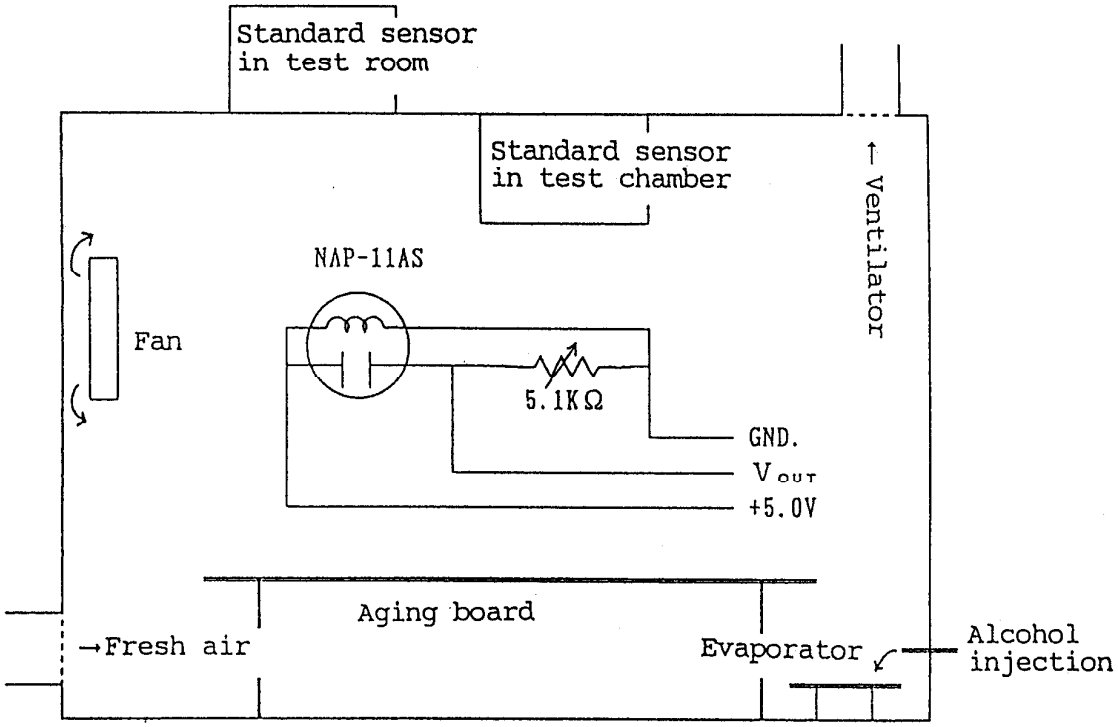
Remarks ; Basic level = 05V of sensor output voltage is divided into 6 levels (0.33V/level).
Preset level= Can be selected among 216 levels.
Normally three sensitivity levels (High, Med., Low) are selected.
Output level for functioning (LED lit)
= Basic level + preset level.

*** The detailed information is available upon request regarding the IC used in the above circuit.

10. Evaluation of NAP-11AS

Before evaluation, age for more than 1 day. An insufficient initial aging time may cause inaccurate evaluation results.

1) Testing equipment: The following is an outline of test system.



Remarks:

a) Test chamber; Metal or glass which does not generate or absorb gases is desirable as test chamber material. The volume of the chamber should be larger than 1 liter / sensor.

b) Air supply; Clean, fresh air from outdoors should be supplied to the test chamber. Filtration by a charcoal filter or other appropriate filters is required if it is possible that the air supply contains organic solvents, flammable gases, bad or unpleasant smells.

c) Air agitation; The air inside the chamber should be agitated, but not so as to directly blow on the sensor. Air flow should be less than 0.5m / sec.

d) Power supply: Sensors can be operated using either D.C. or A.C., but for optimal measurement accuracy, use of a D. C. voltage stabilizer is recommended.

e) Voltmeter; A voltmeter with approximately 20 MOhm impedance is sufficient for measuring sensor output voltage.

f) Ventilation; Before proceeding to a subsequent test, the air inside the chamber should be ventilated using a ventilator which has a capacity of more than 10 times of the volume of the chamber per minute.
While monitoring that the output voltage of the standard sensor placed in the chamber drops below the standard level, confirm complete air turnover in the chamber.

(2) Adjustment of gas concentration

Gas concentration in the test chamber is usually adjusted by a volumetric method, but in case of liquid ethyl alcohol which is injected into the chamber, the injected quantity should be determined according to the following formula.
(When 10 ppm of Ethyl alcohol gas concentration is required.)

$$V(\mu 1) = V1 \cdot 10^{-5} \cdot \frac{46}{22.4 x 0.789} = 2.603 x 10^{-5} x V1$$

V1 = Volume of a test chamber (Millie liter)

(3) Conditioning of a test room

As NAP-11AS is very sensitive to air pollution, the air inside a test or measuring room should be always be preceded by a complete air change. The temperature and the humidity should also be controlled by an air conditioner etc.. The recommended conditions are 25±2°C, and 60±5%RH.

(4) Measurement

a) Preparatory aging; Before measurement of gas sensitivity, an ageing for more than 1 day with the specified voltage should be given to test samples. The appropriate aging time depends on the length of a storage period, but a longer aging time would be preferable.

b) Measurement;

* Test samples on the testing board are put into the test chamber.
* The samples are supplied with the specified voltage, and the door of the chamber closed after confirming the inside air has been replaced with fresh clean air.
* Va (Output voltage in clean air) is measured 1 minute later.
* Using a syringe, reagent grade ethanol is injected onto an evaporator in the test chamber.
* In order to obtain even dispersion, wait until the ethanol has completely evaporated in the chamber. (More than 60 seconds; Heat the surface of the evaporator to around 70~80°C)
* Vg (Output voltage in gas) is measured.
* After measurement the test chamber should be completely ventilated while monitoring the output voltage of the standard sensor. The door of the test chamber should not be opened until the ventilation is complete.

11. Comparison with other similar sensors

The following data compares other sensors with similar uses to NAP-11AS.

Comparison in specifications & characteristics

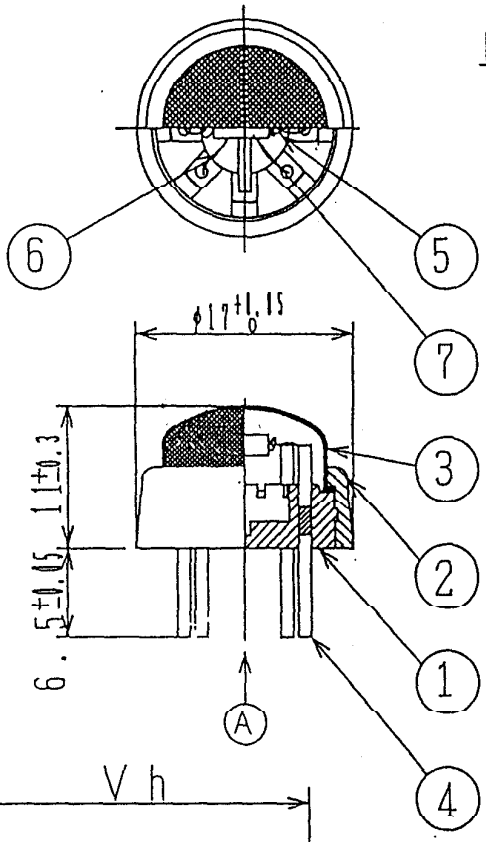
Gas sensors	A	B	NAP-11AS
1. Type	SnO_2 Semiconductor	SnO_2 Semiconductor	In_2O_3 Semiconductor
2. Ratings	Heater 1.0V Circuit 100V Wattage 0.6 W	Heater 5.0V Circuit ~24V Wattage 0.8 W	Heater 5.0V Circuit ~15V Wattage 0.8 W
3. Gas sensitivity (Ra/Rg)			
Cigarette smoke	2.0	1.7	8.0
Carbon monoxide	1.8	1.4	1.8
Hydrogen	2.5	2.2	2.8
Ethylalcohol	3.5	2.5	9.5
Acetic acid	2.6	1.7	6.8
Nicotine	4.3	3.5	18.0
4. Response	○	○	○
5. Temperature			B = 3,000
6. Humidity	△	△	○

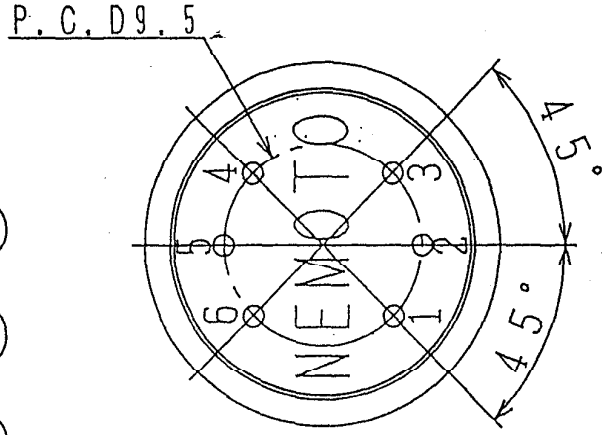
* Gas sensitivity test conditions :

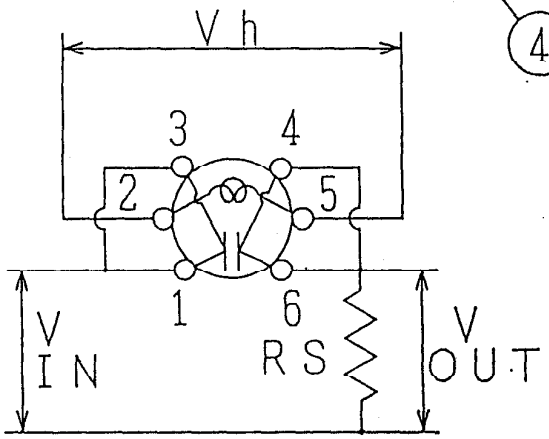
Cigarette smoke; Cigarette was burned at a rate of 30 mg/m^3.
Other gases ; Tested in 10 ppm concentration.

9. Drawings :

規格部品仕様書図面







Vh : D.C. 5V
V IN : D.C. 5V

Measuring circuit

No.	Parts	Materials	Remarks
1	Mount	Nylon 66	with 20% of glass
2	Cap	Nylon 66	with 20% of glass
3	Mesh	SUS316	Double layered #100 mesh
4	Pin	Pure nickel	Φ 1.0 mm
5	Coil	Fe-Cr alloy	Φ 0.06 mm
6	Lead wire	Pt alloy	Φ 0.08 mm
7	Semiconductor element		

APPROVED	CHECKED	DESIGNED	DRAWN	MATERIAL	Q.TY	SCALE
						2/1

THIRD ANGLE PROJECTION

TITLE: NAP-11AS

DATE: APR. 28. 1993

DRG.NO.: G-01-04-103

NEMOTO & CO., LTD