



NEMOTO & CO.,LTD

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USER'S MANUAL

HOT-WIRE TYPE GAS SENSOR NAP-100A SERIES (NET10A(R))

(For All Combustible Gases)

1. General

Being designed for light industrial applications, NAP-100A series also available as NET10A(R), rank A, B, C, D, E selected, can be widely used for gas concentration monitoring and gas leakage detection in plants and other industrial premises, and three different types are provided for user's selection. NAP-100AD is housed in a sintered metal cap to have perfect dust proof and high temperature resistance. NAP-100AM is housed in a mesh cap for explosion resistance, and NAP-100AC is housed in a brass cap but to be used with a separate explosion proof housing.

All types show excellent output linearity to gas concentration up to L.E.L. as well as superior reproducibility and durability.

2. Features of NAP-100A

- * Excellent output linearity to gas concentration.
- * Superior reproducibility and stability of output signals
- * Endurable to high temperature (<200°C, NAP-100AD).
- * Distinguished durability to corrosion gases.
- * Low current consumption makes circuit design easy.
- * Excellent long-term stability.

3. Applications

- * Gas leakage detectors in plans and industrial areas.
- * For distinguishing gasoline from diesel oil at gas stand.
- * Gas detectors in gas cylinder refilling facilities.



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4. How to use

NAP-100AD can be directly connected to a circuit of measuring or detecting apparatus with the 4 lead wires (two for power supply and two for signal output), and zero point adjustment is done, then the unit is ready to work. This sensor is hardly affected by wind and does not need an additional temperature compensation circuit for operation under high temperature conditions. Please refer to the recommended circuit included in this manual.

NAP-100AM is smaller sized and easy to handle, and suitable for light industrial gas detectors. This sensor can be assembled in a gas detector with as the same manner as for residential gas detectors.

NAP-100AC is also smaller sized and easy to handle, but being not explosion resistant, this sensor should be housed in an explosion proof cap provided by user.

Please note the following remarks upon usage.

- * Preparatory aging for at least 10 minutes is required before zero point adjustment.
- * Do not drop or give a shock to sensor.
- * Assembling sensor in a detector and zero point adjustment should be done in a clean air condition.
- * Evaluation tests of gas sensitivity and alarm concentration characteristic should be done using the equipment described later in this manual.

5. Specifications

| Model | NAP-100AD | NAP-100AC | NAP-100AM |
|--|-----------------------------------|----------------------------------|-----------------------|
| Objective gases | Combustible gases | | |
| Measuring range | 1 ~ 100 %LEL | | |
| Supply voltage | 2.6 +/- 0.13 V | | |
| Current consumption | 170 ~ 180 mA | | |
| Operational Temp. & Humidity | -30 ~ +250°C, Less than 95 %RH | -30 ~ +50°C, Less than 95 %RH | |
| Temp. & Humidity in storage | -30 ~ +60°C, Less than 95 %RH | | |
| Gas sensitivity (CH ₄ 0.3%) | 22mV or more | 11 mV or more | 24 mV or more |
| 90% response speed | Within 10 seconds | Within 20 seconds | Within 10 seconds |
| Reproducibility to gas concentration within a day | Within +/- 1 mV | Within +/- 0.5 mV | Within +/- 1 mV |
| Gas sensitivity stability | Within +/- 2 mV/month | Within +/- 1 mV/month | Within +/- 2 mV/month |
| Zero point stability | Within +/- 1 mV/month | | |

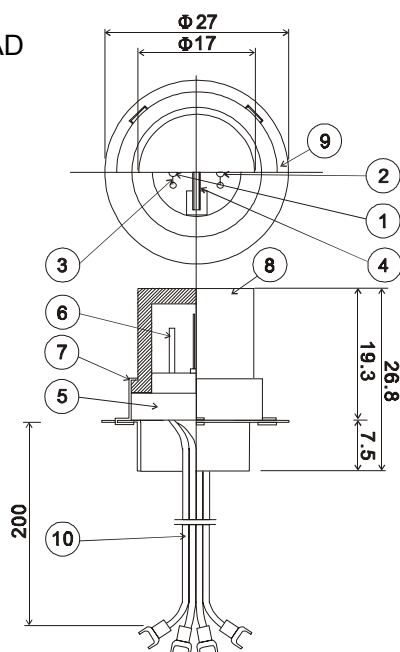


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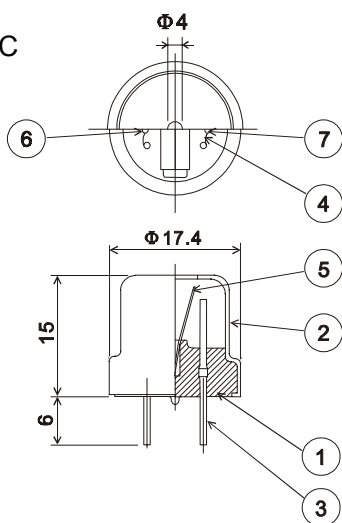
6. Structure

NAP-100AD



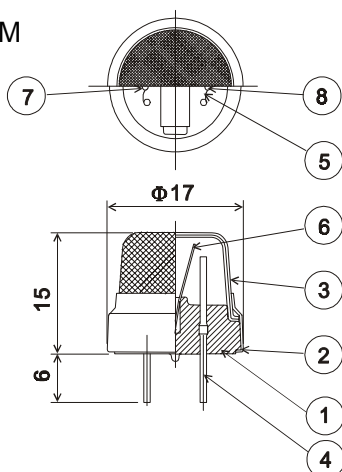
| No. | Part name | Material | Remarks |
|-----|---------------|-------------|--------------|
| 1 | Sensor | | |
| 2 | Compensator | | |
| 3 | Filament coil | PT | 0.03 mm dia. |
| 4 | Partition | SUS 304CSP | t = 0.1 |
| 5 | Mount base | Alumina | |
| 6 | Pins | Pure Ni | 0.8 mm dia. |
| 7 | Strainer | SUS-304 | t = 0.3 |
| 8 | Filter | SUS-316 | |
| 9 | Fixer | SUS-304 | t = 0.5 |
| 10 | Lead wire | UL3266 FRPE | |

NAP-100AC



| No. | Part name | Material | Remarks |
|-----|---------------|------------|--------------|
| 1 | Mount base | PM-EE | |
| 2 | Cap | C2680R-0 | |
| 3 | Pins | Pure Ni | 0.8 mm dia. |
| 4 | Filament coil | PT | 0.03 mm dia. |
| 5 | Partition | SUS 304CSP | t = 0.1 |
| 6 | Sensor | | |
| 7 | Compensator | | |

NAP-100AM



| No. | Part name | Material | Remarks |
|-----|---------------|------------|--------------|
| 1 | Mount base | PM-EE | |
| 2 | Skirt | C2680R-0Ni | |
| 3 | Mesh | SUS-316 | 100 mesh |
| 4 | Pins | Pure Ni | 0.8 mm dia. |
| 5 | Filament coil | PT | 0.03 mm dia. |
| 6 | Partition | SUS 304CSP | t = 0.1 |
| 7 | Sensor | | |
| 8 | Compensator | | |



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7. Relative sensitivity to gases

NAP-100A series sensors are sensitive to all combustible gases but gas sensitivity characteristics are different depending on gases. The following list shows the relative sensitivity to various combustible gases. The figures shown were obtained by our tests using the recommended circuits described later in this manual.

| Combustible gases | | L.E.L. (%) | % L.E.L. relative sensitivity | | |
|-------------------|--|---------------|-------------------------------|-----------|-----------|
| | | | NAP-100AD | NAP-100AC | NAP-100AM |
| Methane | CH ₄ | 5.0 | 100 | 100 | 100 |
| Propane | C ₃ H ₈ | 2.2 | 75 | 70 | 80 |
| iso-Butane | C ₄ H ₁₀ | 1.8 | 75 | 65 | 80 |
| n-Pentane | C ₅ H ₁₂ | 1.4 | 80 | 65 | 80 |
| n-Hexane | C ₆ H ₁₄ | 1.2 | 75 | 65 | 75 |
| n-Heptane | C ₇ H ₁₆ | 1.05 | 65 | 55 | 65 |
| iso-Octane | C ₈ H ₁₈ | 0.95 | 60 | 50 | 60 |
| Methanol | CH ₃ OH | 6.7 | 125 | 110 | 130 |
| Ethanol | C ₂ H ₅ OH | 3.3 | 95 | 80 | 95 |
| iso-Propanol | C ₃ H ₇ OH | 2.2 | 80 | 70 | 80 |
| Acetone | (CH ₃) ₂ CO | 2.6 | 85 | 75 | 85 |
| Toluene | C ₆ H ₅ CH ₃ | 1.2 | 65 | 55 | 70 |
| Ethyl acetate | CH ₃ COOC ₂ H ₅ | 2.2 | 70 | 65 | 75 |
| Hydrogen | H ₂ | 4.0 | 110 | 95 | 125 |
| Ammonia | NH ₃ | 15.0 | 150 | 160 | 150 |
| Cyclohexane | C ₆ H ₁₂ | 1.3 | 75 | 65 | 75 |
| Acetylene | C ₂ H ₂ | 2.5 | 40 | 40 | 35 |
| Ethylene | C ₂ H ₄ | 2.7 | 90 | 75 | 95 |

The above table can be used for quick reference as below.

(Example); When 50% LEL ethanol is measured by apparatus calibrated with 0 - 100% methane, the following conversion is made from the table.

$$(95 \times 50) / 100 = 47.5\% \text{ LEL (Methane scale)}$$

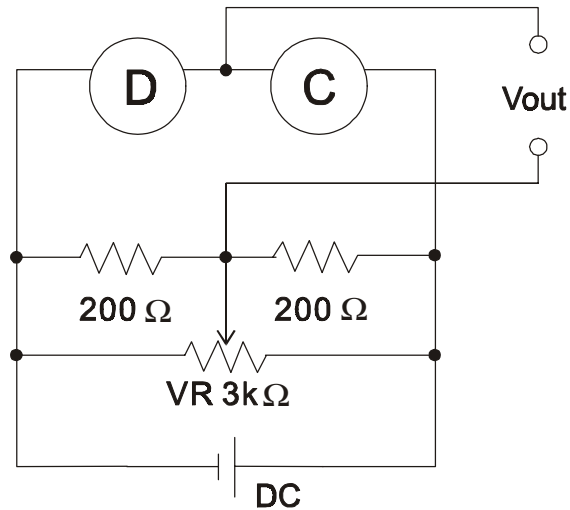


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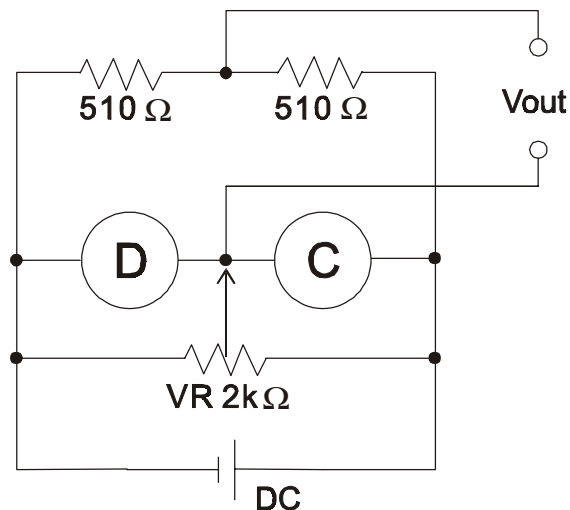
8. Recommended circuits

* Circuit for NAP-100AC and 100AM



For fixed and variable resistors in this circuit = Metal covered resistors are preferable.

* Circuit for NAP-100AD & ADP



For fixed and variable resistors in this circuit = Metal covered resistors are preferable.
Especially the resistor of $510\ \Omega$ should be of high quality with a tolerance $\pm 1\%$ or less.

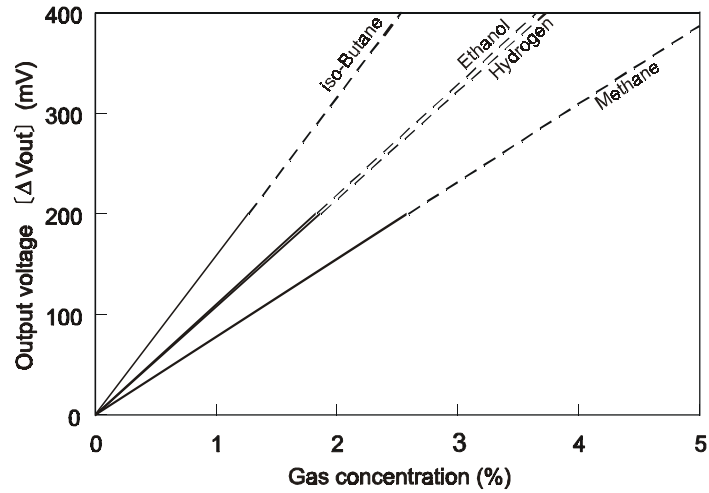


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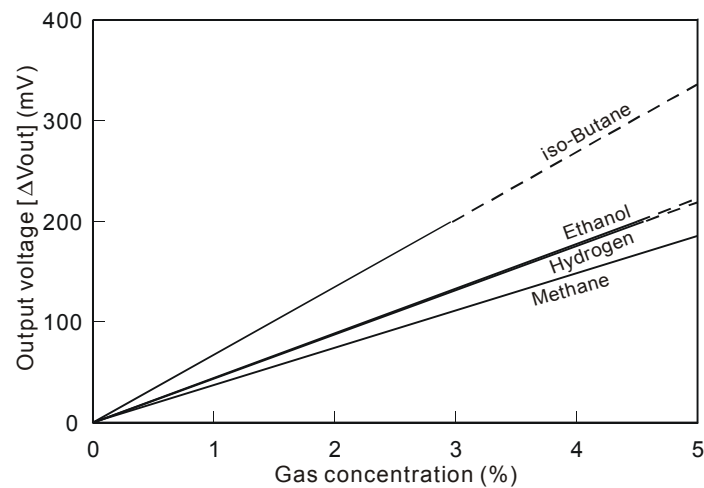
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9. Typical gas sensitivity characteristics

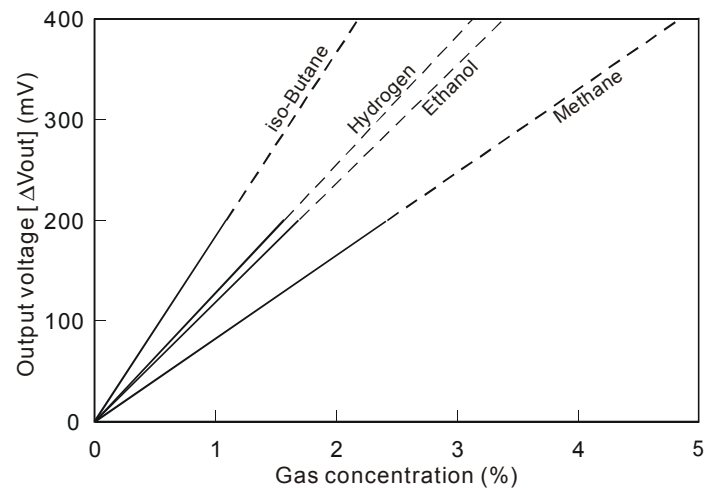
NAP-100AD



NAP-100AC

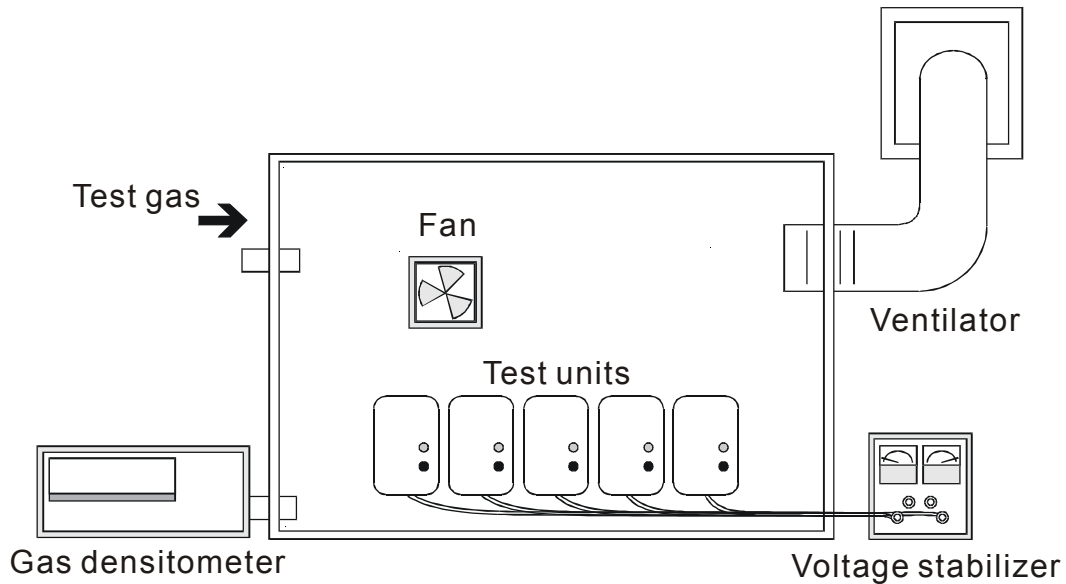


NAP-100AM



10. Evaluation method on NAP-100A series sensors

(1) The following is an outline of a test system.



Remarks:

a) Test chamber ;

- * Metal, glass or acrylic plate which does not generate or absorb gases is desirable as test chamber material.
- * The volume of the chamber should be larger than 100 liters.

b) Atmosphere ;

- * Tests are to be carried out in a clean air condition. Organic solvents, combustible gases, and dusts may cause an inaccurate test result.

c) Gas densitometer ;

- * An optical or infrared gas densitometer is recommended for measuring gas concentration.

d) Air agitation ;

- * The air inside the chamber should be agitated, but not so as to directly blow on the sensors. Air flow nearby the test samples should be less than 0.5m/sec.



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e) Power supply ;

- * The most adequate power source for the test units is to be provided, but for optimal measurement accuracy, use of a voltage stabilizer is recommended.

f) Ventilation ;

- * Before proceeding with a subsequent test, the air inside the test chamber should be ventilated using a ventilator which has a capacity of more than 10 times the volume of the chamber per minute.

(2) Adjustment of gas concentration

Gas concentration in a test chamber is usually adjusted by a volumetric method. For instance, in order to get 1,500ppm of iso-butane gas concentration, the quantity of iso-butane gas to be injected using a syringe will be calculated according to the following formula.

$$V_{(ml)} = V_i \times 1500 \times 10^{-6} \times \frac{273 + T_r}{273 + T_c}$$

V_i ; Inside volume of a chamber (ml)

T_r ; Room temperature ($^{\circ}\text{C}$)

T_c ; Temperature inside a chamber ($^{\circ}\text{C}$)

(3) Measurement

a) Preparatory aging;

- * Before measurement, test samples should be supplied with the specified voltage at least for more than 5 minutes.

b) Measurement;

- * After preparatory aging a test gas is gradually injected into the test chamber. In case of the volumetric method, an adequate injection speed would be around 10ppm/Second.
After a test is completed, the air inside the chamber should be thoroughly ventilated.