January 31, 2005

Users Manual

Ionization Smoke Chamber NIS-02A

Nemoto & Co., Ltd. Sensor Div.
1-15-1, Kamiogi, Suginami-ku, Tokyo 167-0043, Japan
Tel: 81-3-3392-7181 Fax: 81-3-3392-7188
e-mail; intsales @nemoto.co.jp

1. General:
Ionization smoke chamber NIS-02A is a newly developed smoke sensor to detect only smoke generated in the event of fire, cigarette smoke and dust. This sensor is a low radioactivity version of our standard smoke sensor NIS-09C, and is not restricted as a radioisotope described in the international advice. Furthermore, the radioactive source is completely sealed as same as NIS-09C, then it can be handled as an electronic part.
The following are features of NIS-02A.

1) Features;
* The extremely small power consumption enables to operation by battery for several years.
* Simple structure and less expensive than photo-electric type smoke sensors.
* Output is not dependent on colors of smoke.
* Superior durability to photo-electric type smoke sensors.
* Lowest radioactivity less than international restriction on radioisotope.

2) Applications;
* Fire alarms * Air purifiers * Dust counters

3) Maximum ratings;

* Supply voltage	DC 24V	
* Temp. & humidity in operation	Temperature	-20 ~ +70 degree C
	Humidity	Less than 95% RH
* Temp. & humidity in storage	Temperature	-25 ~ +80 degree C
	Humidity	Less than 95% RH

4) Recommended ratings;

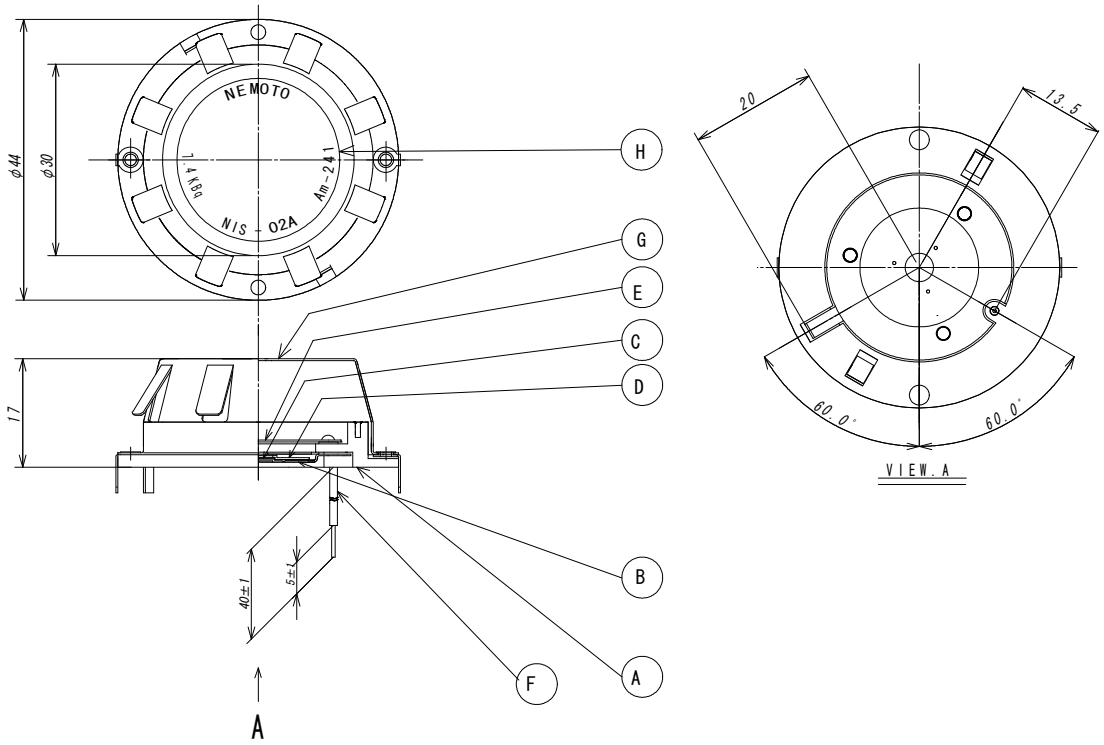
* Supply voltage	DC 9V	
* Current consumption	7 +/- 2 pA (When 9V is supplied)	
* Output in clean air	6.0 +/-0.5 V (25 degree C, 60% RH)	
* Smoke sensitivity	1.1 +/- 0.3 V (2%/foot, according to UL217)	
* Temp. & humidity in operation	Temperature	-10 ~ +60 degree C
	Humidity	Less than 95% RH
* Temp. & humidity in storage	Temperature	-10 ~ +70 degree C
	Humidity	Less than 95% RH

5) Structure, dimensions, & weight

* Structure	As per drawing on next page.
* Dimensions	As per drawing on next page.
* Weight	Approx. 13.7g

2. Structure

The following is the structure of NIS－02A



No	Parts	Materials
H	Label (Aluminum sheet)	
G	Cover	SUS304
F	Lead wire	Teflon covered wire
E	Potential electrode	SUS304
D	Inner electrode A	SUS304
C	Radiation source	^{241}Am 7.4KBq
B	Inner plate	SUS304
A	Base mount	PBT resin

Fig. 1　Structure of NIS－02A

Radioisotope mark is not specified on the actual label. The radioisotope (C in the drawing) is Alpha ray emitting ^{241}Am (Americium-241) which radioactivity is as tiny as 7.4 KBq. As the radioactive source is completely sealed by a stainless steel cover (G in the drawing), radioactivity is not leaked to ambient environment. The radioisotope itself is also completely sealed with gold plating for corrosion resistance to organic solvents and acids. In addition the mount base is also solvent resistant, therefore, chambers can be washed with organic solvents when necessary. NIS-02A is a 1 source/2 chamber type and the mount base is made of a poly-

butylene terephthalate (PBT) resin that is resistive to heat and organic solvents. Other parts are made of stainless steel (SUS304) for corrosion resistant to pass tests specified in UL and other standards.

3. Detection principle

This sensor is an ionization type, and its structure is as shown at the right. The air inside the chambers is always excited (ionized) by the alpha ray emitted from the radiation source. When DC 9V is supplied to electrodes, approx 7pA of ionization current is generated and approx. 6.0V of output is obtained. When smoke gets into the chamber, smoke particles are neutralized with ionic pairs, and the ionization current in the upper chamber is decreased. This eventually causes the decrease of Vout in proportion to the smoke density. Smoke is detected by monitoring the decrease in the Vout.

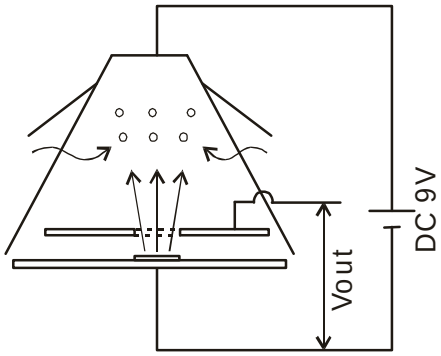


Fig. 2 Detection circuit

4. Basic features

1) Smoke sensitivity characteristic

Fig. 3 shows the sensitivity characteristic to smoke density. The data was obtained using exclusive testing equipment and smoke generated by burning a filter paper. Details of the testing equipment appears later in this brochure.

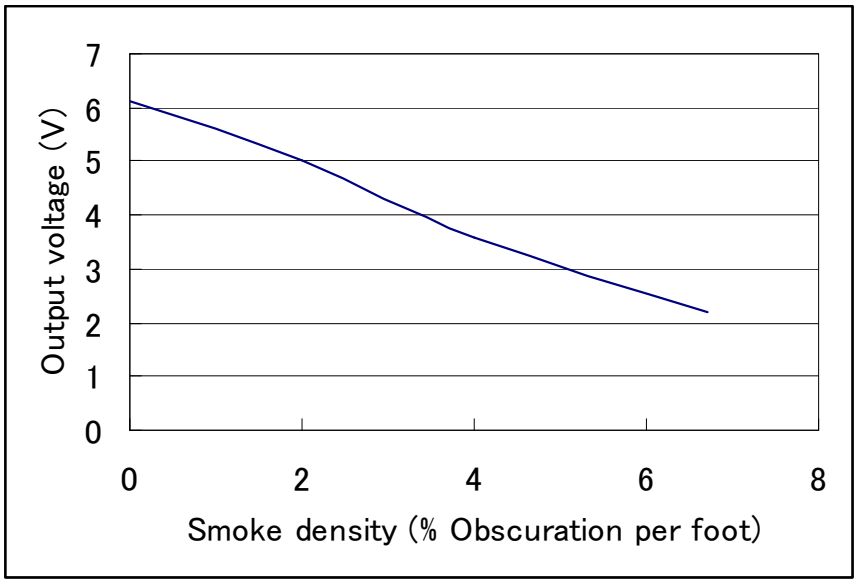


Fig. 3 Smoke sensitivity of NIS-05A

2) Temperature dependency

Fig. 4 shows temperature dependency characteristic of NIS-02A. All pieces retain this output tendency in the temperature range of 0 ~ 50 degree C, and individual differences are negligible. It is possible to compensate the temperature dependency with a thermistor if necessary. However a thermistor is usually not required for fire alarm systems.

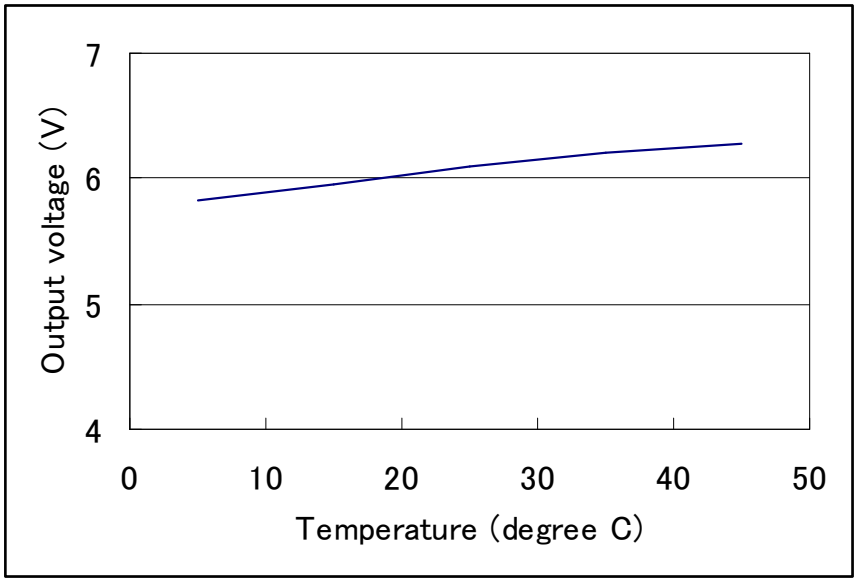


Fig. 4 Temperature dependence of NIS-02A
(Relative humidity : 60%)

3) Humidity dependency

Fig. 5 shows humidity dependence characteristic of NIS-02A at 25 degree C. It may slightly fluctuate in a higher temperature range, but is negligible.

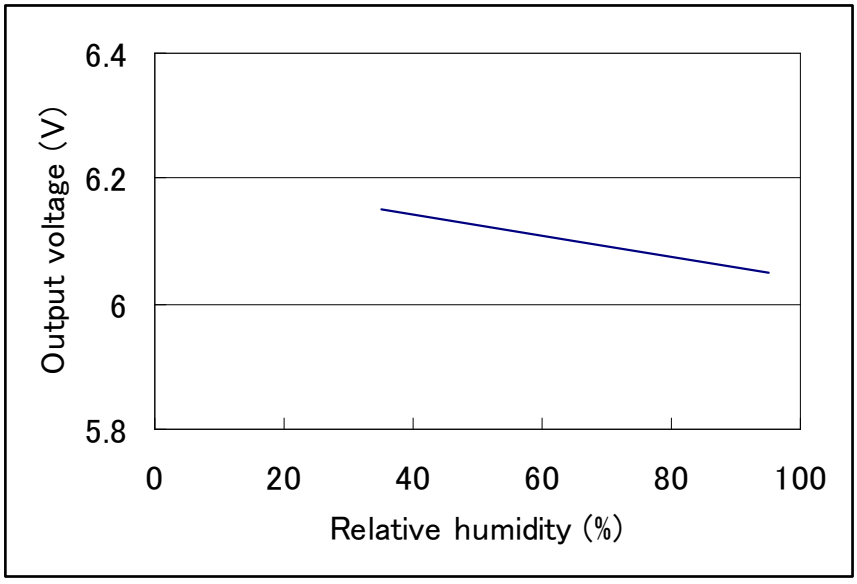


Fig.5 Humidity dependence of NIS-02A
(Temperature : 25 degree C)

4) Wind dependency

Fig. 6 shows wind dependency characteristic of NIS-02A up to 3.5m/sec. of air velocity. As the generated ionic pairs are flown by wind, slight influence cannot be helped. However, it does not create a serious problem in practical applications.

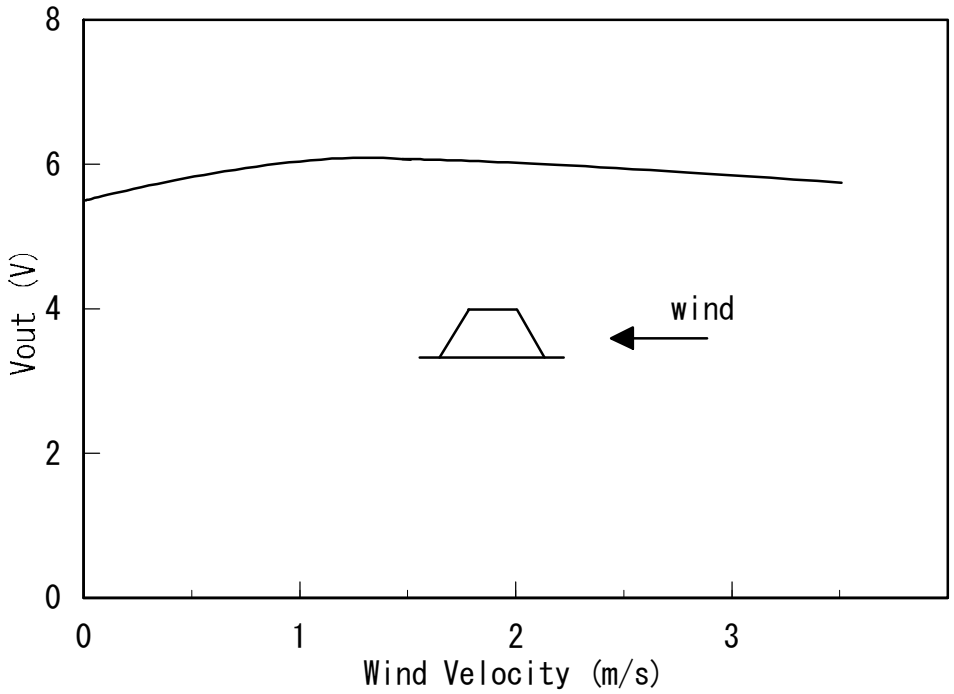


Fig. 6 Wind dependency of NIS-02A

5. Durability

The following durability tests were carried out to confirm that the output and sensitivity characteristics were equivalent* to the ones before tests.

Table 1 Durability tests

	Tests	Test methods
1	Heat resistance	Stored for 72 hrs. at 80 degree C without energizing.
2	Cold resistance	Stored for 72 hrs. at -30 degree C without energizing.
3	High humidity	Stored for 72 hrs. at 40 degree C & 85% RH without energizing.
4	Vibration**	Amplitude 0.25mm, 10 - 35Hz, for 15 min.
5	Drop test	Dropped 3 times on a wooden plate (3cm thick) form a height of 1 meter.

* Appearance tests (deformation, discoloration, cracks etc.) were also carried out.

** There was no sympathetic vibration point.

6. How to use NIS-02A

Because of the tiny power consumption, this sensor can be operated by a battery for several years. However the impedance is very high (about 10^{12}ohm) and an exclusive IC (available on the market) should be required. As NIS-02A may be easily affected by electrical noises from the outside, it is recommended to shield the sensor, especially on connection point of the lead wire and input terminal of the IC. Usually this connection point is supported with a teflon post or connection is made in air with a teflon coated wire not to touch to a PCB. The following is a specimen of circuit for smoke detectors using an exclusive IC. Regarding this IC, Allegro 5348, 5368 and 5367 are also available except MC14466 in the circuit described below.

1) The following is a recommended circuit using NIS－02A

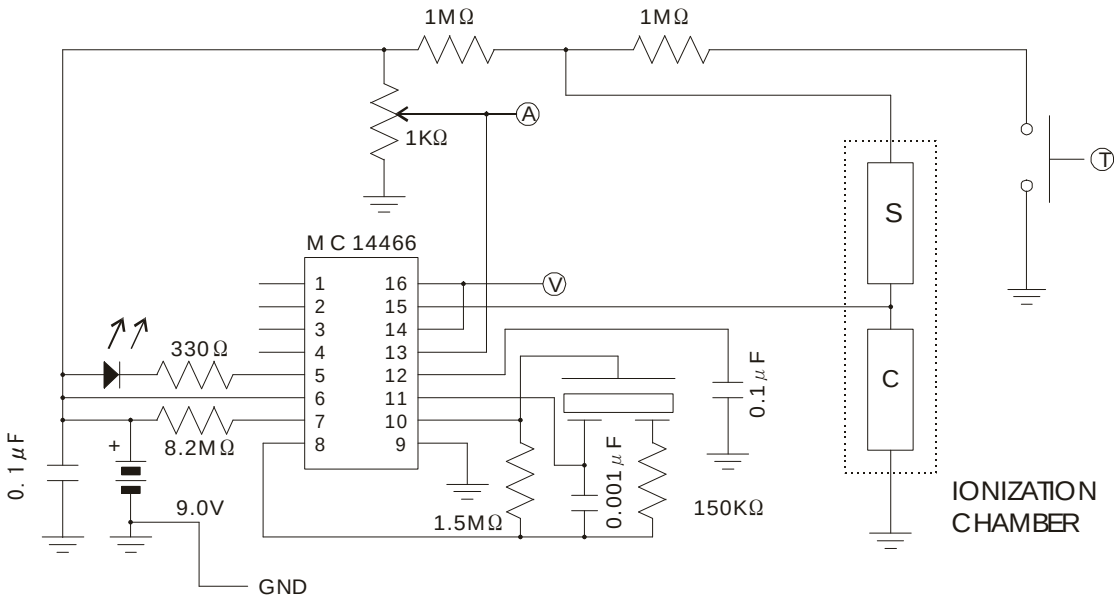


Fig. 7　Recommended circuit using NIS-02A

2) Application methods

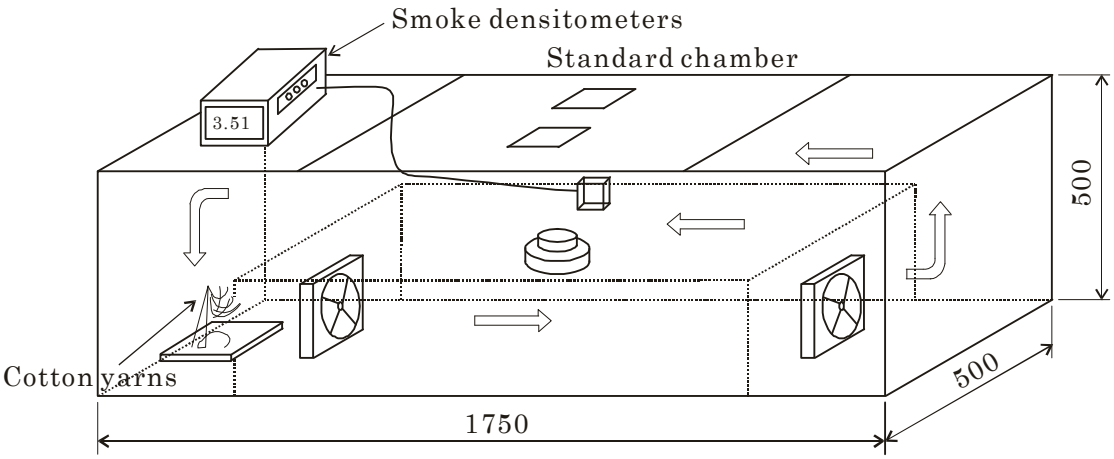
DC 9V is applied to INPUT and GND terminals. As this sensor does not have a heater, monitoring can be done just after energized. A tester or a recorder is to be connected to GND and V terminals to obtain output signal.　The "T" in the drawing is a button to check a battery life, "S" is the upper chamber (to let smoke in) of the sensor, and "C" is the lower chamber of the sensor.　The alarm level can be calibrated by the V/R monitoring the voltage between GND and A terminals. Detailed description is written in the following page of this brochure.

7. Evaluation on NIS-02A

A sample unit to be evaluated is made according to the recommended circuit shown on the previous page.

1) Testing equipment

The following is the testing equipment we use in our labs.



Volume; approx. 430 litters

Fig. 8 Testing equipment

Remarks:

a) Test chamber

The test chamber is to be made of wood or metal. In case of a metallic chamber, inside walls are to be painted black (to prevent reflection) so that a photoelectric type smoke densitometer can be used. In order to obtain even dispersion of smoke in the chamber, a fan for agitation and honeycomb layers are to be provided inside the chamber. It is recommended to use a chamber of the above size. For further information, please refer to UL-217 standard.

b) Agitation of smoke

In order to get even dispersion of smoke in the chamber, two fans are to be equipped as shown above and air velocity is to be controlled about 0.2m/sec. Higher air velocity may cause inaccurate output signals because of the wind dependency of the sensor. Too lower air velocity may cause uneven dispersion of smoke that may result inaccurate measurement.

c) Ventilation of smoke

Special ventilation system is usually not required to let smoke out of chamber after tests.

d) Kind of smoke
Generally cotton yarns are burnt to generate gray smoke that is specified in UL-217.

2) Adjustment of smoke concentration
Smoke concentration is adjusted by the time of burning cotton yarns, but actual concentration is to be measured by a photoelectric type smoke densitometer. UL-217 specified also black smoke obtained by burning gasoline, but it may be too dangerous to conduct experiments with black smoke in your labs. An experiment with black smoke is usually not carried out in private labs.

3) Calibration of alarm point
The following explanation is for calibration of smoke detectors for fire alarm systems. Output range of NIS-02A in clean air is 6.0+/- 0.5V, but the smoke sensitivity is within 1.1 +/- 0.3V/2%/foot. Therefore it is recommended to set an alarm point at 1.1V lower than the output in air. Calibration is made by adjusting the V/R, but the alarm point set as above is equivalent to the smoke concentration of 2%/foot. This unit of smoke concentration represents the dimming out ratio of light when measured using a photoelectric densitometer. The above alarm level means that 2% of light is absorbed (dimmed out) by smoke particles when measured at a distance of 1 foot (30cm). In most of the smoke detectors, the alarm point is set at around 2%/foot.

4) Measurement
a) Smoke densitometer
* Photoelectric type smoke densitometers available on the market have units in %/m, but different results would be obtained depending on color and particle size of smoke. This type of densitometers does not need a warning up period.
* Particle counters available on the market count particle of smoke and the provided unit is particles/m^3. This type of equipment is not used for experiments because the light dimming out ratio cannot be obtained.

b) Measurement
* A sample unit to be measured is set in the test chamber.
* Fans are operated, and DC 9V is supplied to the test sample. Voltage is supplied by either batteries or voltage stabilizer.
* Monitoring the output voltage, burning cotton yarns are put into the test chamber.
* Smoke concentration is monitored and the cotton yarns are taken out of the test chamber when it reaches at 2%/foot.

c) Ventilation
* After a test is completed, the door of the test chamber is opened and smoke is naturally ventilated by fans.

d) Judgment

* It is confirmed that the output in clean air is within 6.0 +/- 0.5V, and output variation in smoke of 2%/foot (delta V) is within 1.1V +/- 0.3V.

5) Remarks

a) Keep away from moisture to prevent dew condensation.

b) During storage, take measures of anti-static-electricity.

c) Do not frequently touch the teflon-shield lead wire of the sensor.

d) Do not block the smoke inlet opening of the sensor upon calibration.

e) Use an electrometer with impedance of more than 10^{14}ohm and the recommended circuit with an exclusive IC. Measurement cannot be done by a regular tester.

f) Upon mounting the sensor onto a PCB, pay attention not to let soldering flux get into the sensor. Washing is necessary when it happens.

g) Use silicone resin for protecting the connected point of IC with the lead wire of the sensor. Humidity would affect to the connected point to cause malfunctions.

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