# FiS INFO.

September 1, 2007

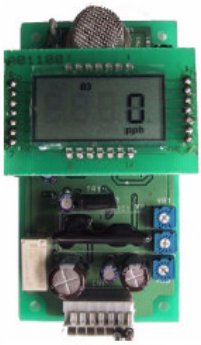
## 1. FiS ozone sensor modules, ozone monitors, ozone detectors (OEM products)

### (1) Ozone sensor related products

FiS ozone sensor related products (sensor modules, monitors, detectors (OEM products) are shown as below.


**1) Ozone Sensor Module**
A051020-SP61-01/02

**2) Ozone Sensor Module**
SDM-O3-05



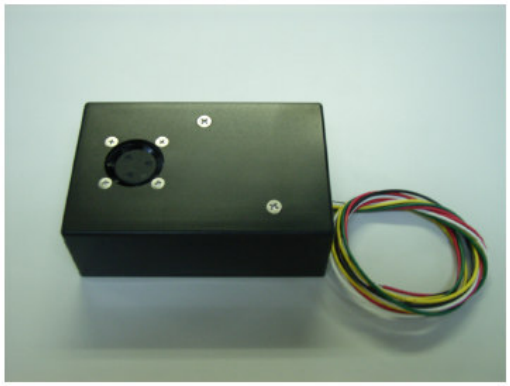
**3) Ozone Sensor Module**
SDM-O3-06

OA-110: Atmospheric Monitoring Type

OA-210:
Device Integration Type

OA-220:
Device Integration Type
Threaded

**4) Ozone Detector**
(OEM for Horiba Ltd.)



**5) Ozone Monitor**
A051020-SP61-01F/02F

**(2) Brief specification list for ozone modules, monitors, and OEM products**

Table 1 shows the brief specifications for the FiS ozone related products.

**Table 1: Brief specifications for the FiS ozone related products**

| | **Sensor modules** | | | | **Monitors Planned release on September 15, 2007** | |
|---|---|---|---|---|---|---|
| **Model No.** | A051020-SP-61-01 | A051020-SP61-02 | SDM-O3-05 | SDM-O3-06 | A051020-SP61-01F | A051020-SP61-02F |
| **Detection range** | 0 to 255 ppb | | | | | |
| **Response time (90%)** | 1 minute | | | | | |
| **Supply voltage** | 5V DC | | 8 to 15V DC | | 5V DC | |
| **Output** | 0 to 1V | 0 to 5V | 0 to 1V<br>4 to 20mA | | 0 to 1V | 0 to 5V |
| **Alarm output level** | 80 ppb<br>MOS | | 80 ppb<br>Relay | | 80 ppb<br>MOS | |
| **Concentration display** | No | | No | Yes<br>LCD | No | |
| **Dimensions** | 51 x 37 x 23 mm | | 105 x 60 x 23 mm | | 64 x 100 x 36 mm | |

## 2. FiS ozone module application example

Table 2 shows some examples where FiS ozone sensor modules are used.
Since the sale started in 2003, many FiS ozone modules have been widely used for ozone detection in the world.

**Table 2: FiS ozone module application examples**

| | **Application fields** | | | |
|---|---|---|---|---|
| | **Hospital, nursing facility** | **Foods** | **Water treatment** | **Air quality** |
| **Purpose** | Deodorization<br>Disinfection<br>Sterilization | Disinfection<br>Sterilization<br>Oxidization | Disinfection<br>Sterilization<br>Oxidization<br>Decolorization | Deodorization |
| **Application examples** | Deodorizing equipment<br>Instrument washing equipment<br>Sterilizing operation room<br>Sterilizing ambulance cars<br>Washing medical instrument | Deodorizing refrigerator rooms | Purifying swimming pool<br>Sewage treatment<br>Leak detection in an ozone water generator | Air purifier<br>Automobiles |
| **Ozone detector in the ozone generators** | The detector is built into an ozone generator. When the ozone concentration reaches a pre-determined level, the detector will stop the generator. Leak detection<br>FiS A051020 series and SDM-O3 series modules are used. | | | |
| **Ozone monitors** | Ozone concentration measurement (0.01 to 0.20 ppm detection)<br>FiS A051020 series are used. | | | |
| **Ozone monitors** | Confirming if ozone concentration is lower than pre-determined level.<br>FiS A051020 series and A051020(F) series are used. | | | |

## 3. Actual examples using FiS sensor modules

The following examples explain the actual usage of FiS ozone sensor modules. (Pictures are cited from ozone generator manufacturer's catalogue)

**[Example 1]**

- Ozone generator installation place: Hospitals (Hospital environmental preparation/ Nosocomial infection)
- Purpose: Sterilization, deodorization, washing
- Ozone sensor installation place: Endoscopy washing equipment

Fig. 2-1 shows the ozone generator installation example (cited from the home page of IHI Shibaura Machinery Co., Ltd.)

Fig. 2-2 shows the endoscopy washing equipment

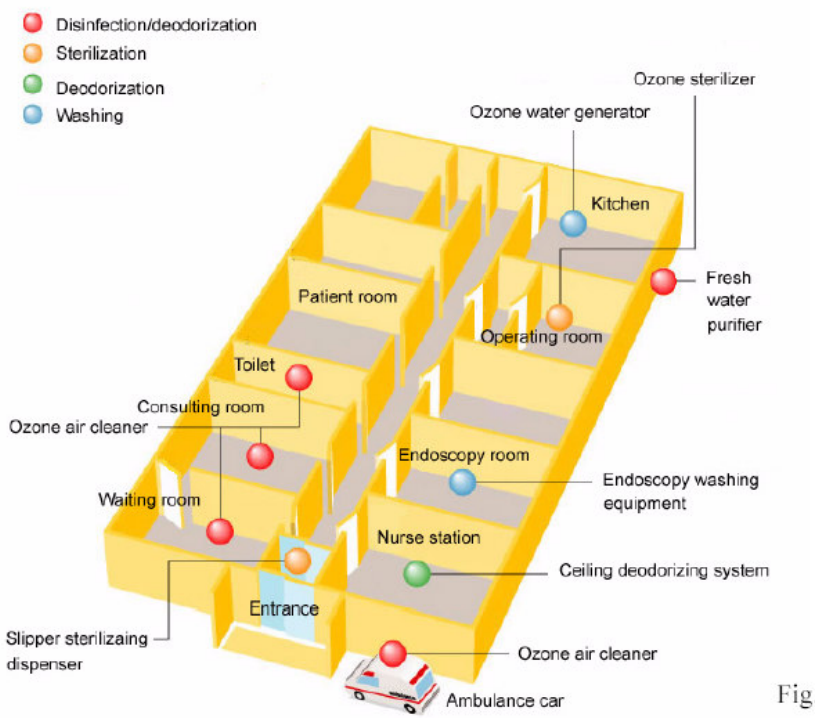



Fig. 2-1


* Specifications
Power supply: 100V AC (50/60Hz)
Power consumption: 50VA
Dimensions: W500 x D500 x H900 mm
Weight: 65kg

Fig. 2-2

**[Example 2]**

- Ozone checker: Installed in the ozone measurement place
- Purpose: Ozone concentration measurement. LCD displayed range: 0 to 0.25ppm

Fig. 3 shows the ozone checker using FiS ozone module.

Fig. 3

**[Example 3]**

- Ozone generator: Sterilizing in ambulance cars
- Purpose: Ozone concentration monitor in an ambulance car after sterilizing and washing by ozone
- Ozone detector installation place: In an ambulance car

Fig. 4 shows the installation example.

Fig. 4

## Appendix

Table 3 shows the ozone sensor applications as per the purpose. The listed applications are difficult to control in ozone concentrations. The world is currently very much concerned about these environmental issues. This is expected to substantially develop the ozone application field. Under these circumstances, ozone sensors will play an important role.

*Notes:*

1. *Table 3 is cited from the document issued by "The committee of high concentration ozone application", METI (Ministry of Economy, Trade and Industry), Japan.*
2. *Tables 4, 5, and 6 are cited from the Interim Evaluation Report of "Development of Energy Saving Wastewater Treatment Technology" issued by the Technology Evaluation Committee of NEDO (New Energy and Industrial Technology Development Organization) in September 2003.*

### 1. Application fields of ozone

**Table 3: Ozone application fields**

| | Application | Purpose | Concentration |
|---|---|---|---|
| **Deodorization** | Air-purifier<br>Deodorizing equipment<br>Refrigerator, freezer | Indoor deodorization<br>Large scale construction, Trash can<br>Deodorization | 0.05 to 0.1 ppm<br>0.05 to 1 ppm<br>0.05 to 0.5 ppm |
| **Disinfection, sterilization** | Nursing/caring facilities<br>Medical facilities<br>Medical equipment<br>Purifying swimming pools<br>Food and food factories | <br>Preventing nosocomial infection<br>Sterilization, Disinfecting<br>Replacing chlorine, transparency<br>Disinfection, Sterilization, Floating virus | <br>0.1 to 3ppm<br>Gaseous phase, Liquid phase<br>Liquid phase<br>Gaseous phase, Liquid phase |
| **Decolorization** | Water purification<br>Factory drainage<br>Treatment of human wastes<br>Pulp bleaching | Removing musty smell, declaring<br>Drainage standard<br>Drainage standard<br>Decoloring | Liquid phase<br>Liquid phase<br>Liquid phase<br>Liquid phase |
| **Oxidizing treatment** | Drainage and sewage treatment<br>Resin surface treatment<br>Cyanide drainage treatment<br>Semiconductor washing<br>CVD equipment | Decreasing COD<br>Improving wettability<br>To be harmless<br>Oxide film treatment<br>Oxidizing treatment | Liquid phase<br>Gaseous phase<br>Gaseous phase<br>Gaseous phase<br>Gaseous phase |

### 2. Ozone concentration measurement

Since high concentration ozone is harmful to the human body, it is necessary to detect and monitor its concentration. The following four points are important to secure the safety level.

(1) Controlling environmental ozone concentration in the facilities.
(2) Controlling the ozone amount exposed to workers.
(3) Controlling the concentration of ozone released from the facilities.
(4) Monitoring the place where ozone leakage could occur.

Table 4 shows the summary of ozone detection methods used in the environmental air. An ozone measurement device with high accuracy and a low price is almost not available. The semiconductor (thin-film) type ozone sensor is mainly used in the world.

**Table 4: Ozone measurement method**

| | **Principle and features** |
|---|---|
| **Semiconductor sensor (thin-film)** | When oxidizing gas such as ozone adsorbes on the surface of semiconductor thin-film sensor, its electric resistance changes. The degree of change depends on the ozone concentration. |
| **Ultraviolet light absorption** | Ozone is introduced in the specimen cell and the specified wave length (254 nm) of ultraviolet light is radiated to that cell. Ozone concentration is measured by the UV absorbance (process leakage monitoring). |
| **Spectrophotometric method** | When ozone is absorbed into the potassium iodide solution, the iodine is isolated by the interaction between ozone and the potassium iodide. The absorbance in the solution is measured for determining ozone concentration. |
| **Coulometric method** | When the voltage is applied between the platinum electrodes in the potassium iodide solution, hydrogen films are generated. Radiating ozone removes the film, then causes the re-polarization. This re-polarization generates the current which is proportional to ozone concentration. |
| **Chemiluminescence** | Chemiluminescence occurs when ethylene, carbon monoxide, hydrogen sulfide, etc. reacts with ozone. The amount of this chemiluminescence is proportional to the reacted ozone concentration. |
| **Detection tube** | Indico dye changes in color when reacting with ozone. This dye is deposited on the particle substances. These particles are packed into a glass tube. (The color change length determines ozone concentration.) |
| **Gas-phase titration (GPT)** | A pre-determined concentration of nitrogen oxide reacts with ozone. Then non-reacted amount of nitrogen oxide is measured to determine the reacted amount. This amount relates to ozone concentration. |
| **CT method** | Atraquinone derivative dyes change in color. The color change depends on the product of ozone concentration and contact time. This change is visually confirmed. |

**3. Ozone safety**

Acute toxicity of ozone exposure in the environment in the respiratory symptoms are coughing, pain below the sternum at deep breath, breathlessness, dryness of the throat, wheezing, difficulty in breathing. Non-respiratory symptoms are headache, nausea, and fatigue. Serious influence are somnolency, exhaustion, dizziness, lowered concentration, cyanosis, and pulmonary edema. Table 5 shows the ozone influence on the human body.

**Table 5: Ozone influence on the human body**

| Ozone concentration (ppm) | Influence |
|---|---|
| 0.01 | Threshold of odor sensitive persons |
| 0.01 to 0.015 | Threshold of ordinary persons |
| 0.06 | Chronic lung disease patients are not influenced in inhalation. |
| 0.1 | Indisposed to ordinary person. Irritating the nose and throat (Occupational allowable level in Japan) |
| 0.1 to 0.3 | Increasing spasm of coughing for asthmatics |
| 0.2 to 0.5 | Three to six exposure decreases eyesight. |
| 0.23 | Increasing chronic bronchitis for long-time exposed workers |
| 0.4 | Increasing respiratory tract resistance |
| 0.5 | Clearly irritating upper respiratory tract |
| 0.6 to 0.8 | Chest pain, cough, increasing respiratory tract resistance, difficulty in breathing, lowering the ability of lung gas-exchange |
| 0.50 to 1.0 | Respiratory problem, decreasing oxygen consumption |
| 0.8 to 1.7 | Irritating upper respiratory tract |
| 1.0 to 2.0 | Cough, fatigue, heavy head, dryness of upper respiratory tract, two hour exposure decreases hour lung capacity by 20%, chest pain, losing mental capability |
| 5 to 10 | Difficulty in breathing, lung congestion, pulmonary edema, increasing pulse, body pain, paralysis, lethargic sleep |
| 50 | Life crisis by one hour exposure |
| more than 1000 | Dying within several minutes |
| 6300 | Sterilizing virus in air |

**4. Allowable level of ozone exposure and occupational safety level in the world**

Table 6 shows the occupational safety level of ozone concentration in the world. (This data is collected in Japan. Please check the latest information in each country.)

In Japan The Committee for Recommendation of Occupational Exposure Limits in the Japan Society for Occupational Health decided the limits in 1985. The limit is 0.1ppm, 0.20mg/m3 in a workers environment. This is the reference value to the mean exposure concentration at or below which adverse health effects caused by the ozone do not appear in most workers working for 8 hours a day, 40 hours a week under a moderate workload.

**Table 6: Occupational exposure limits for ozone**

| | Standard (year) | Limit |
|---|---|---|
| **U.S.A.** | ACGIH TLV-TWA (8hr) (1996) | 0.20mg/m$^3$ 0.1 ppm (light work) |
| | ACGIH TLV-TWA (8hr) (1997) | 0.16mg/m$^3$ 0.08 ppm (moderate work) |
| | ACGIH TLV-TWA (8hr) (1997) | 0.10mg/m$^3$ 0.05 ppm (heavy work) |
| | ACGIH TLV-STEEL | 0.40mg/m$^3$ 0.2 ppm |
| | MSHA air:TWA (1996) | 0.20mg/m$^3$ 0.1 ppm |
| | NIOSH: REL air: CL (1992) | 0.1 ppm |
| | OSHA PEL 8hr: TWA (1996) | 0.20mg/m$^3$ 0.1 ppm |
| **Austria** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| | STEL (1993) | 0.60mg/m$^3$ 0.3 ppm |
| **Belgium** | STEL (1993) | 0.20mg/m$^3$ 0.1 ppm |
| **Denmark** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| **Egypt** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| **Finland** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| | STEL (1993) | 0.60mg/m$^3$ 0.3 ppm |
| **France** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| | STEL (1993) | 0.40mg/m$^3$ 0.2 ppm |
| **Germany** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| **Hungary** | TWA (1993) | 0.20mg/m$^3$ |
| | STEL (1993) | 0.40mg/m$^3$ |
| **Japan** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| **Holland** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| **Poland** | TWA (1993) | 0.10mg/m$^3$ |
| **Russia** | TWA (1993) | 0.1 ppm |
| | STEL (1993) | 0.10mg/m$^3$ |
| **Sweden** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| | STEL (1993) | 0.60mg/m$^3$ 0.3 ppm |
| **Switzerland** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| | STEL (1993) | 0.40mg/m$^3$ 0.2 ppm |
| **Turkey** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| **U.K.** | TWA (1993) | 0.20mg/m$^3$ 0.1 ppm |
| | STEL (1993) | 0.3 ppm |