Vapor Concentration Monitor

IR-300 Series
In-line, compact Vapor Concentration Monitor enables MOCVD precursor delivery to be stable, resulting in improved performance and device yield.

Metal-Organic Chemical Vapor Deposition (MOCVD) is widely used in the manufacture of LEDs, optical devices and other components. Liquid and solid precursors are delivered to the reaction chamber by controlling the temperature, pressure and the carrier gas flow rate (bubbling method). Process results can be affected by changes especially in temperature and liquid level. The in-line IR-300 Series measures and reports the precursor concentration in real time.

**Stable deposition process**

- **Benefits of concentration monitoring**
  - Continuous concentration monitoring of precursor
  - Check precursor concentration while adjusting supply conditions
  - Monitor residual quantities of liquid and solid precursors for better utilization

**The IR-300 Series: 6 Features for a Stable Precursor Supply**

- Real-time monitoring
- Multi-display
- Compact & Simple
- Communications function
- Multi Calibration function
- RoHS compliant
Ideal precursor supply through reliable, high-performance vapor concentration monitoring and fluid control backed by a global service support system.

The analysis technology of global analytical equipment manufacturer HORIBA, Ltd. has been combined with the fluid control technology of HORIBA STEC, Co., Ltd. in the creation of the IR-300 Series Vapor Concentration Monitor. This innovative solution for concentration measurement enables new processes, provides an easy to install, compact solution for our customers, and is supported by HORIBA group’s world class global service support network.

Reliable, High-performance Non-dispersive Infrared Absorptiometry (NDIR)

The infrared absorptiometry method employed by the IR-300 Series uses the principle of the absorption by gas molecules of the infrared light emitted from an infrared light source. A sample output from a sample that has absorbed the gas being measured is compared to a reference output with no absorbance, and the result is converted into a gas concentration. The use of this double beam method enables long-term, stable measurement results to be obtained.

The optical system is made up of a light source, gas cell and double beam detectors. The stability of the double beam detector has been proven over a period of more than 40 years.
Real-time monitoring for a stable vapor concentration supply

**Real-time Monitoring**

Response and repeatability that allow tracking of changes in vapor concentration

A high optical intensity, long-life source combined with a high-speed signal processor enables the IR-300 Series to achieve faster, more repeatable responses to changes in precursor concentration (more than two times better than HORIBA prior-generation technologies), in turn enabling new processes with real-time inline concentration measurement.

* For stable monitoring, zero calibration prior to measurement (at least once per day) is recommended.

**Measurement Example of MOCVD Precursor**

**Experiment flow sheet**

- Mass Flow Controller
- MFC
- N₂ 150 SCCM
- Thermal Bath 25 deg.C
- Cell Temp. 60 deg.C
- Bubbler
- IR-300
- Back Pressure Regulator
- Thermo-control System
- Pump
- MOCVD Precursor

**Monitoring of precursor concentration change**

Here is an example in which the concentration of the supplied precursor—which changes due to adjustment of the pressure in the bubbler by the back pressure regulator—was monitored in real time.

**TEGa**

- Concentration vs. Time (min)

**TMAI**

- Concentration vs. Time (min)

**Multi-calibration Curve Function (Optional)**

Allows for the installation of up to 3 discrete chemical/full scale concentration calibration curves.

This option allows the inclusion of 2 additional calibration curves which are customer-enabled using a digital command. This multi-calibration capability reduces Total Cost of Ownership through the reduction of discrete part numbers required and greater flexibility in spares usage, resulting in improved equipment uptime.
Multi-display Function
The multi-display function of the IR-300 Series combines a display and mode LEDs on the top of the unit for onsite checking of concentration monitoring and precursor supply line status. By switching the mode LEDs, the display on the top of the unit can show the following.

Display current set value or status of adjustable parameters "Calibration curve number", "Moving average number", "Concentration correction gain", and "Analog output gain".

* Differs from the measurement location of the sensor connected to the temperature controller for controlling the temperature of gas cells.

Communications Function
Line up includes models for DeviceNet™ and digital/analog communications.

The IR-300 Series supports all standard communications protocols for manufacturing devices, such as the open and global field network DeviceNet™, and digital/analog communications. The IR-300 Series is ideal for applications ranging from high performance MOCVD process tools to lab/benchtop experimentation.

Simple, Compact Design
With a face-to-face size of 124 mm, the unit’s compact design allows mounting orientation free.

The built-in display and controller units eliminate the need for external or remote units, enabling more flexible piping configurations and allowing mounting/design on existing as well as new equipment.

Internal structure
The general structure of the product is as shown in the diagram below. It includes a sensor that measures the pressure in the gas cell, and a heater for cell heating. This allows accurate concentration measurement to be performed through correction of concentration in response to pressure changes, and stabilization of gas cell temperature.
**Application Example**  Proposal for control of carrier gas flow rate aimed at stable supply of precursor

In order to keep precursor supply rate fixed, a system can be constructed in which changes in concentration C (vol%) are detected, and the carrier gas flow rate is controlled at an optimum level. System construction is implemented through the control units inside the customer’s equipment.

**DeviceNet™ communication**

<table>
<thead>
<tr>
<th>PLC</th>
<th>Master</th>
<th>DeviceNet™ cable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**DeviceNet™ communication connector**

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drain</td>
</tr>
<tr>
<td>2</td>
<td>V+</td>
</tr>
<tr>
<td>3</td>
<td>V-</td>
</tr>
<tr>
<td>4</td>
<td>CAN_H</td>
</tr>
<tr>
<td>5</td>
<td>CAN_L</td>
</tr>
</tbody>
</table>

Supply voltage: 11 V to 25 V DC Use the ODVA compliant power supply and cable.

**Analog connector (for Concentration Monitor)**

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N.C.</td>
</tr>
<tr>
<td>2</td>
<td>Concentration output 0V to 5V, Minimum load resistance 2K Ohm</td>
</tr>
<tr>
<td>3</td>
<td>Power input +15 V ±5% 250 mA</td>
</tr>
<tr>
<td>4</td>
<td>Power COM/Contact 1/0 COM</td>
</tr>
<tr>
<td>5</td>
<td>Power input -15 V ±5% 250 mA</td>
</tr>
<tr>
<td>6</td>
<td>N.C.</td>
</tr>
<tr>
<td>7</td>
<td>Concentration output COM</td>
</tr>
<tr>
<td>8</td>
<td>Contact output (alarm output)</td>
</tr>
<tr>
<td>9</td>
<td>Zero calibration contact input</td>
</tr>
</tbody>
</table>

Zero calibration is performed on switching ON to ON (Keep on “ON” status for 6 seconds or more until calibration is finished.)

N.C. means no connection.

Do not connect anything.

**DeviceNet™ communication connector**

Connector on gas concentration monitor: Shield type Micro-connector

<table>
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<tr>
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</tr>
<tr>
<td>5</td>
<td>CAN_L</td>
</tr>
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</table>

Supply voltage: 11 V to 25 V DC Use the ODVA compliant power supply and cable.

**Digital connector**

Gas concentration monitor side: RJ45 connector

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Digital signal COM</td>
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<tr>
<td>2</td>
<td>Digital signal COM</td>
</tr>
<tr>
<td>3</td>
<td>N.C.</td>
</tr>
<tr>
<td>4</td>
<td>Serial output(+)</td>
</tr>
<tr>
<td>5</td>
<td>Serial output(+)</td>
</tr>
<tr>
<td>6</td>
<td>N.C.</td>
</tr>
<tr>
<td>7</td>
<td>N.C.</td>
</tr>
<tr>
<td>8</td>
<td>N.C.</td>
</tr>
</tbody>
</table>

N.C. means no connection.

Do not connect anything.

**Analog connector**

Gas concentration monitor side: D-sub 9 pin female (M3 screw type)

<table>
<thead>
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<th>Pin No.</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N.C.</td>
</tr>
<tr>
<td>2</td>
<td>Concentration output 0V to 5V, Minimum load resistance 2K Ohm</td>
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<td>Power COM/Contact 1/0 COM</td>
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<td>Power input -15 V ±5% 250 mA</td>
</tr>
<tr>
<td>6</td>
<td>N.C.</td>
</tr>
<tr>
<td>7</td>
<td>Concentration output COM</td>
</tr>
<tr>
<td>8</td>
<td>Contact output (alarm output)</td>
</tr>
<tr>
<td>9</td>
<td>Zero calibration contact input</td>
</tr>
</tbody>
</table>

Zero calibration is performed on switching ON to ON (Keep on “ON” status for 6 seconds or more until calibration is finished.)

N.C. means no connection.

Do not connect anything.

**Digital Communication**

[Example using PE-D10 monitor unit and HC-100AE thermo-control unit]
### Connector examples

*Please refer to the Reference Manual for details of communication protocol and commands.*

- **DeviceNet™ communication**

*Please refer to the Reference Manual for details of communication protocol and commands.*

50/60 Hz

**200 to 240 V AC**

**MFC**

**PC**

**(PLC etc. inside equipment)**

**Process gas control unit**

**Bath**

**IR-314M**

**PLC**

**IR-312M**

**DeviceNet™ cable**

*Changes to set value*

**[Example using PE-D10 monitor unit and HC-100AE thermo-control unit]**

**50/60 Hz**

**200 to 240 V AC**

**HC-100AE**

**Converter**

**SC-EBR cable**

**PLC bus line**

**HC-100AE**

**Heater cable**

**thermocouple**

**(IR-K31)**

**Vapor concentration monitor**

**Concentration value**

#### Example calculation of precursor supply rate

- **200 to 240 V AC**

**50/60 Hz**

**200 to 240 V AC**

**HC-100AE**

**(PE-20 series)**

**Power supply**

**+/-15 V DC**

**Alarm contact output signal**

~

**Concentration output signal:** 0

**50/60 Hz**

**200 to 240 V AC**

**HC-100AE**

**Power**

**Molecostandard**

100 to 240 V AC

**100-C**

**MOCVD**

**Analog connector (for Concentration Monitor)**

**DeviceNet™ communication connector**

**Connector on gas concentration monitor : Shield type Micro-connector**

Do not connect anything.

**D-sub 9 pin female (M3 screw type)**

**Gas concentration monitor side:**

**power supply and cable.**

Supply voltage: 11 V to 25 V DC

Use the ODVA compliant

Do not connect anything.

**N.C. means no connection.**

Molar volume (22.4L)

#### Pin No.

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Male(pin)</th>
<th>+24 V</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
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</tbody>
</table>

*The specification is guaranteed under the standard conditions of HORIBA STEC.*

*This is recommended operating condition.*

*Required specification of temperature controller

**PID operation by auto tuning**

Control cycle : 1 second or less

*Optional wetted Material : Body : SUS-316L, Gas cell optical window : Sapphire, Ni, Al

It is necessary to change # of moving average of firmware settings by digital communication.

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### Specifications

#### Type/Specification Selection Chart: Please make selections from specification columns ④, ⑤, ⑦, ⑨, and ⑫ below.

<table>
<thead>
<tr>
<th>IR-3</th>
<th>1</th>
<th>4</th>
<th>M</th>
<th>-</th>
<th>Target chemical 1/ full-scale concentration</th>
<th>Target chemical 2/ full-scale concentration</th>
<th>Target chemical 3/ full-scale concentration</th>
<th>T</th>
<th>1</th>
<th>3</th>
<th>200</th>
<th>K</th>
<th>60</th>
<th>4CPL</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>Gas cell specification</td>
<td>1</td>
<td>5 mm optical path length cell</td>
<td>2</td>
<td>50 mm optical path length cell</td>
<td></td>
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<tr>
<td>②</td>
<td>Communication type</td>
<td>2</td>
<td>Analog/RS-485/F-net Protocol</td>
<td>4</td>
<td>DeviceNet™</td>
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<tr>
<td>④</td>
<td>Target chemical/full scale concentration</td>
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<tr>
<td>⑤</td>
<td>Connector location</td>
<td>Top-side of the monitor</td>
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<tr>
<td>⑥</td>
<td>Calibration curve number</td>
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<tr>
<td>⑦</td>
<td>DeviceNet™ output range</td>
<td>Blank</td>
<td>Other than DeviceNet™ model</td>
<td>1</td>
<td>Concentration output full scale &quot;100%FS.5&quot;</td>
<td></td>
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<td></td>
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<td>3</td>
<td>Concentration output full scale &quot;133%FS.5&quot; (standard)</td>
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<td></td>
<td></td>
<td>5</td>
<td>Concentration output full scale &quot;133.2%FS.5&quot;</td>
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<tr>
<td>⑧</td>
<td>Heater power requirement</td>
<td>200-240 V AC</td>
<td></td>
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<tr>
<td>⑨</td>
<td>Temperature sensor</td>
<td>K type thermocouple</td>
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<tr>
<td>⑩</td>
<td>Heater set temperature</td>
<td>60°C (Standard)</td>
<td></td>
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<td></td>
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<tr>
<td>⑪</td>
<td>AMB</td>
<td>Non-heated (Option)*</td>
<td></td>
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</tr>
<tr>
<td>⑫</td>
<td>Fitting</td>
<td>1/4VCR male or equivalent, Fitting to fitting = 124 mm</td>
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<tr>
<td>⑬</td>
<td>Cell window blazing</td>
<td>Blank</td>
<td>Ag blazing (standard)</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>A</td>
<td>Kovar with Ni coating (option)</td>
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</tbody>
</table>

*Please choose AMB.*

*Please select the desired target chemical and full-scale concentration (① for standard, ② for option).

This determines the gas cell specification (IR-31 or IR-32) in ④.

*Please contact us regarding target chemicals/full scale concentrations not listed above.

*Gas cell specification:

<table>
<thead>
<tr>
<th>Target chemical/full scale concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>T MGa</td>
</tr>
<tr>
<td>IPA</td>
</tr>
</tbody>
</table>

*DeviceNet™: 50/60 Hz

**200 to 240 V AC**

**MFC**

**PC**

**(PLC etc. inside equipment)**

**Process gas control unit**

**Bath**

**IR-314M**

**PLC**

**IR-312M**

**DeviceNet™ cable**

*Changes to set value*

**[Example using PE-D10 monitor unit and HC-100AE thermo-control unit]**

**50/60 Hz**

**200 to 240 V AC**

**HC-100AE**

**Converter**

**SC-EBR cable**

**PLC bus line**

**HC-100AE**

**Heater cable**

**thermocouple**

**(IR-K31)**

**Vapor concentration monitor**

**Concentration value**

#### Example calculation of precursor supply rate

- **200 to 240 V AC**

**50/60 Hz**

**200 to 240 V AC**

**HC-100AE**

**Power**

**Molecostandard**

100 to 240 V AC

**100-C**

**MOCVD**

**Analog connector (for Concentration Monitor)**

**DeviceNet™ communication connector**

**Connector on gas concentration monitor : Shield type Micro-connector**

Do not connect anything.

**D-sub 9 pin female (M3 screw type)**

**Gas concentration monitor side:**

**power supply and cable.**

Supply voltage: 11 V to 25 V DC

Use the ODVA compliant

Do not connect anything.

**N.C. means no connection.**

Molar volume (22.4L)

#### Pin No.

<table>
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<tr>
<th>Pin No.</th>
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</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
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</tbody>
</table>

*The specification is guaranteed under the standard conditions of HORIBA STEC.*

*Ambient temperature: 23 ± 2°C / Gas cell temperature: 60°C / Measurement flow rate: 1000 SCCM / Calibration gas: CH₄ balanced in N₂ at 105 KPa (A).

*Accuracy is based on concentration of the calibration gas. *2 Gas replacement time (Td: time delay) is not included in the response. The typical Td in our inspection equipment is approx. 1.0 second. *3 The response without moving average is approx. 1.5 seconds.

*It is necessary to change # of moving average of firmware settings by digital communication.*

---

### Type/Specification Selection Chart: Please make selections from specification columns ④, ⑤, ⑦, ⑨, and ⑫ below.

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</tr>
<tr>
<td>⑤</td>
<td>Connector location</td>
<td>Top-side of the monitor</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>⑥</td>
<td>Calibration curve number</td>
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<td>⑦</td>
<td>DeviceNet™ output range</td>
<td>Blank</td>
<td>Other than DeviceNet™ model</td>
<td>1</td>
<td>Concentration output full scale &quot;100%FS.5&quot;</td>
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<td>3</td>
<td>Concentration output full scale &quot;133%FS.5&quot; (standard)</td>
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<td>5</td>
<td>Concentration output full scale &quot;133.2%FS.5&quot;</td>
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<tr>
<td>⑧</td>
<td>Heater power requirement</td>
<td>200-240 V AC</td>
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<tr>
<td>⑨</td>
<td>Temperature sensor</td>
<td>K type thermocouple</td>
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<tr>
<td>⑩</td>
<td>Heater set temperature</td>
<td>60°C (Standard)</td>
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<td>⑪</td>
<td>AMB</td>
<td>Non-heated (Option)*</td>
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<tr>
<td>⑫</td>
<td>Fitting</td>
<td>1/4VCR male or equivalent, Fitting to fitting = 124 mm</td>
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<td>⑬</td>
<td>Cell window blazing</td>
<td>Blank</td>
<td>Ag blazing (standard)</td>
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<td>A</td>
<td>Kovar with Ni coating (option)</td>
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</table>

*Please contact us regarding target chemicals/full scale concentrations not listed above.*

*This is recommended operating condition.*

*Required specification of temperature controller

**PID operation by auto tuning**

Control cycle : 1 second or less

*Optional wetted Material : Body : SUS-316L, Gas cell optical window : Sapphire, Ni, Al

It is necessary to change # of moving average of firmware settings by digital communication.
Please read the operation manual before using this product to ensure safe and proper handling of the product.

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DeviceNet is the trademark of Open Device Net Vendors Association Inc.

Applying to the EU RoHS Directive: This product is compliant with the restriction of the designated 6 hazardous substances(*)

(*) lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE)

Using lead-free soldering: Lead-free soldering is used for mounting components of printed circuit boards.

Many countries consider the reinforcement of regulations concerning the risk caused by lead to human body and the environment.

Please read the operation manual before using this product to ensure safe and proper handling of the product.