

Microstream® Capnography

Capnography is a noninvasive method for monitoring the level of carbon dioxide in exhaled breath (EtCO₂) to assess a patient's ventilatory status.

An inherent property of CO₂ is to absorb infrared radiation at a very specific wavelength. Capnographs contain sensors that produce infrared sources of blackbody radiation at these wavelengths. These sensors enable the calculation of CO₂ levels in a breath sample.

Capnographs produce both waveforms and numeric values of the patient's exhaled breath and are used to identify adverse ventilation events. This helps clinicians diagnose specific medical conditions, leading to important treatment decisions.

Oridion refers to capnography as the “ventilation vital sign” because of the valuable information it provides. Microstream technology enables clinicians to use capnography to its full potential, by working more effectively than other capnography systems, and provides breath sampling lines for the broadest base of patients. Microstream makes capnography a practical and useful tool that clinicians in all environments can depend upon to improve care for their patients.

Conventional Technology

All capnographs – including Microstream – measure CO₂ concentration using either mainstream or sidestream configurations.

Mainstream. In mainstream capnographs, the sensor is located on a special airway adapter so that CO₂ is measured directly in the patient's breathing circuit.

The main drawbacks are:

- ✗ The weight of the sensor on the airway, which is significant with neonates
- ✗ External sensors that are vulnerable to damage
- ✗ The inability to monitor non-intubated patients easily

Sidestream. In sidestream capnographs, a sample of exhaled breath is aspirated from the breathing circuit to a sensor residing inside the monitor. Sidestream configurations are appropriate for both intubated and non-intubated patients. They require external filters to prevent liquids and secretions from reaching the sidestream sampling system.

Drawbacks of sidestream include:

- ✗ Liquid and secretion handling
- ✗ Large breath sample rate; precludes use of low-flow applications (neonates)

Microstream: Molecular Correlation Spectroscopy (MCS™) Technology

Microstream improves on conventional sidestream technology because there is no sensor at the airway. It can work for both intubated and non-intubated patients of all ages.

Microstream uses laser-based molecular correlation spectroscopy (MCS) as the infrared emission source. The Microstream emitter operates at room temperature, and is electronically activated and self-modulating. This eliminates the need for moving parts that are used on some competitive systems and increases the reliability of the Microstream system.

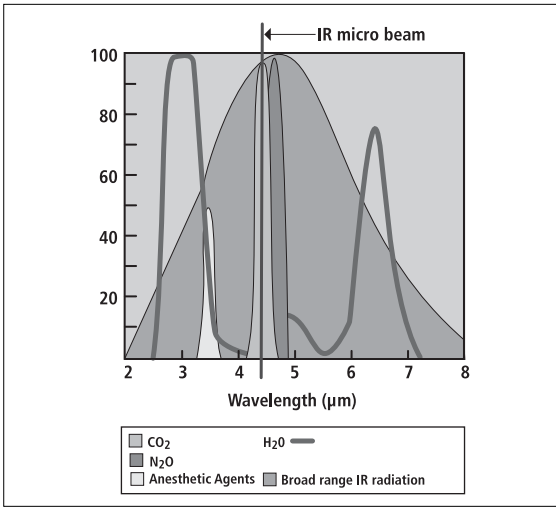


Oridion®

Smart Solutions One Breath at a Time™

Unlike the broad infrared spectrum produced by a blackbody emitter, MCS™ creates an infrared emission precisely matching the absorption spectrum of CO₂. The Microstream® emitter radiates a directed beam of infrared energy with the exact spectral fingerprint of the spectrum that CO₂ molecules absorb. A blackbody emission is typically more than 100 times broader than the region where the CO₂ is actually absorbed. See Figure 1.

Because MCS is highly specific with all gas samples, there is no need to create special algorithms within the monitor to correct for high concentrations of oxygen, nitrous oxide or other anesthetic gases, as required by other capnography technologies.



Microstream: For intubated and non-intubated patients

Because Microstream makes EtCO₂ monitoring feasible for non-intubated patients, it broadens capnography applications beyond their traditional functions. For example, it provides safety monitoring during procedural sedation, in keeping with current ASA and Joint Commission standards¹ that mandate CO₂ monitoring for all anesthetized patients, both intubated and non-intubated.

Minimal Sampling Rate

Figure 1. MCS creates an infrared emission that precisely matches the absorption spectrum of CO₂

Microstream uses a breath sampling rate of 50 ml per minute. A minimal breath sampling rate is important because:

- ✓ It permits the use of capnography for patients of all ages, including neonates. The small tidal volume of neonates cannot be accurately measured with technologies that require larger breath sampling rates.
- ✓ It reduces moisture and humidity entering the sampling line, thus reducing the potential for sampling line obstruction, which is a common problem in conventional sidestream technology.

Small Sample Cell

A small sample cell is imperative when monitoring patients with high respiratory rates. The highly sensitive and CO₂-specific emission source used in Microstream technology permits an extremely short light path. This provides the ability to use a greatly reduced breath sample cell (15 µl).

FilterLine®: Innovations in Breath Sampling Circuit Design

Oridion has developed a unique set of components for the patient sampling circuit. Identified by the trade name, FilterLine, these components include:

- ✓ Normal and high humidity sampling lines for intubated and non-intubated patients
- ✓ Oral/nasal sampling
- ✓ Oxygen delivery

The FilterLine system builds on Microstream technology to solve moisture and occlusion problems that are prevalent in other capnography systems. These unique sampling solutions provide an accurate waveform and respiratory rate. FilterLine sampling line components improve accuracy and response time even at high respiratory rates. These features, along with the small sample cell and low flow rate, give

1 American Society of Anesthesiologists (ASA). Basic Standards for Intraoperative Monitoring; 1999. and Joint Commission 2007.

Microstream® a distinct advantage in accurately monitoring patients with small respiratory volumes.

The FilterLine® system provides the following solutions for non-intubated patients:

- ✓ Accurately monitors patients alternating between oral or nasal breathing
- ✓ Provides continuous O₂ delivery without diluting the breath sample

Sampling Line Design

Filter. The FilterLine sampling circuit incorporates the sampling line and hydrophobic filter in one component. The filter’s hollow longitudinal structure and its linear orientation provide laminar gas flow within the sampling line. A hydrophobic filter material has a pore size of 0.2 micron. The filter allows the patient sample to pass through the hollow structure while preventing liquids from entering the monitor.

Positioning Flexibility. The FilterLine sampling circuit with its built-in filter can function in any orientation. This important positioning feature enables monitoring during patient motion or transport and eliminates the need to maintain a water trap. Conventional sidestream technology requires a separate water trap that the clinician must attach in an upright position for it to operate properly.

Narrow Microbore Tubing for Fast Response. FilterLine sampling circuits are made with microbore tubing that have a diameter of 1.0 mm. The small diameter of the sampling line coupled with a laminar low flow rate increase response time.

Nafion® Combats Humidity. Some FilterLine sampling circuits contain Nafion, which compensates for humidity by allowing water vapor to escape. This feature was incorporated for high-humidity applications such as long-term mechanical ventilation or continuous long term usage.

Intubated Airway Adapter

The Microstream airway adapter was engineered with unique features that:

- ✓ Prevent the sampling line from being occluded
- ✓ Improve response time
- ✓ Allow flexibility in positioning the breathing circuit.

The lightweight design also reduces the risk of endotracheal tube kinking and accidental extubation.

Two Port Design to prevent occlusion and allows flexible positioning. The Microstream airway adapter has two ports with narrow hydrophobic openings facing in opposite directions. This design reduces the possibility of the sampling line being occluded by water or patient secretions. A conventional airway adapter has only one sample channel that can easily become obstructed or allow liquids to penetrate the sample line.

See Figure 2

As compared to competitive designs where the ports are positioned on the side, the FilterLine airway adapter sampling ports are positioned in the center of the airway adapter. This allows for flexible positioning of the airway adapter.

Narrow Channels for Fast Response. As with the microbore tubing in the FilterLine® circuits, the airway adapter channel ports have a very small diameter. This feature together with the airway adapter ports that are designed in close proximity to the ventilation path enhances response time.

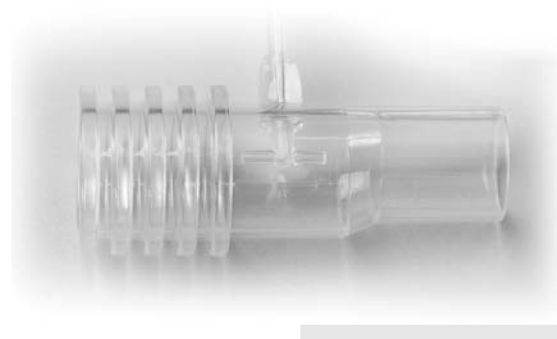


Figure 2. Microstream airway adapter two port design lessens the chance of occlusions.

Non-Intubated Smart Technology

As seen in Figure 3, the Smart CapnoLine® Plus samples CO₂ from either the nares or the mouth. An option for Oxygen delivery (up to 5 liters/min) is available.

The Smart CapnoLine Plus products feature a unique oral and nasal adaptation that delivers oxygen with reliability and efficacy. Its special design provides greater sampling accuracy in the presence of low tidal volumes.

Uni-junction™. The Smart CapnoLine Plus is a balanced system, with the Uni-junction valve enabling CO₂ sampling from a patient breathing from either the mouth or the nose. If the patient is breathing through the nostrils, the Uni-junction registers positive pressure that pushes the breath towards the mouth. If the patient is breathing through the mouth, the funnel functions as an amplifier, collecting the breath and pushing it upwards.

In both cases, the positive pressure from either the nose or mouth is sufficient to prevent ambient air from being sampled.

Microstream®: Capnography for All Patients in All Environments

Through technological innovation, Oridion has overcome the drawbacks of conventional capnography that have prevented its widespread use. Microstream technology and FilterLine components offer clinicians many advantages:

- ✓ Highly accurate EtCO₂ readings and crisp waveforms
- ✓ Effective with both intubated and non-intubated patients as well as oral or nasal breathers
- ✓ No dilution with supplementary O₂
- ✓ Capability to monitor patients with high respiration rates (above 100 bpm) and low tidal volumes
- ✓ Moisture handling minimizes complications caused by clogged sample lines
- ✓ Flexibility to monitor all patient populations in most environments
- ✓ No cross sensitivity with other gases
- ✓ Rugged construction has no moving parts or external sensors

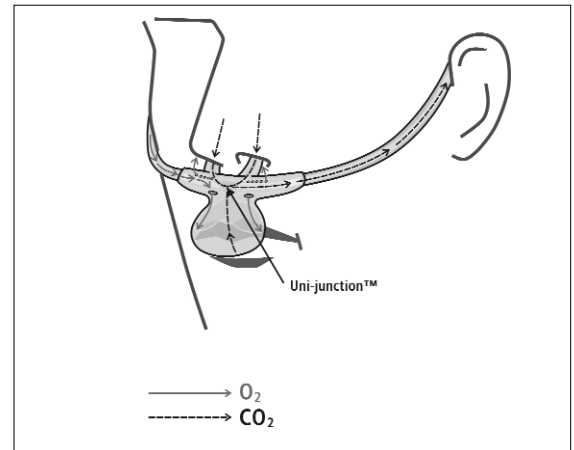


Figure 3. The Uni-junction enables sampling from either the mouth or the nose

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