CARESCAPE respiratory modules
User's Manual

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CARESCAPE respiratory modules
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Due to continuing product innovation, specifications in this manual are subject to change without notice.

For technical documentation purposes, the abbreviation GE is used for the legal entity names, GE Medical Systems *Information Technologies*, Inc. and GE Healthcare Finland Oy.

Contents

About this manual

CARESCAPE respiratory modules' indications for use

The CARESCAPE Respiratory Modules (E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOV, E-sCAiOVX, E-sCAiOE, E-sCAiOVE) are indicated for use with a host device for monitoring respiratory parameters (CO_2, O_2, N_2O, anesthetic agents, anesthetic agent identification, and respiratory rate) and ventilatory parameters (airway pressure, flow and volume) of adult, pediatric, and neonatal patients and gas exchange parameters (VCO_2, VO_2) of adult and pediatric patients.

When monitoring neonatal or other patients that have high respiration rate or low tidal volume these modules shall be used within the limits of respiration rates and tidal volumes to ensure specified measurement accuracy.

These modules are intended for use by qualified medical personnel only.

Intended use of this manual

This manual is to be used with the user documentation of the patient monitor. Pay special attention to all generic safety statements and safety symbols listed in the monitor's user documentation.

Intended audience of this manual

This manual is intended for clinical professionals. Clinical professionals are expected to have a working knowledge of medical procedures, practices and terminology required to provide patient care. Using the device should never replace nor impede the human intervention and required patient care provided by clinical professionals.

Training requirements

No product-specific training is required for the use of these modules.

Manufacturer responsibility

GE is responsible for the effects on safety, reliability, and performance of the equipment only if:

- Assembly operations, extensions, readjustments, modifications, servicing, or repairs are carried out by authorized service personnel.
- The electrical installation of the relevant room complies with the requirements of the appropriate regulations.
- The equipment is used in accordance with the instructions for use.

Related documents

The module may be used with multiple host devices. Always check with the host device's user manual for additional information.

There are two separate technical manuals for the respiratory modules providing information about installing, maintaining, and servicing the modules:

- One for modules E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOV, and E-sCAiOVX used with monitoring host devices
- One for modules E-sCAiO, E-sCAiOV, E-sCAiOVX, E-sCAiOE, and E-sCAiOVE used in the anesthesia systems Avance CS^2 or Aisys CS^2. If the E-sCAiOE or E-sCAiOVE module is used in a patient monitor, also refer to the E-sCAiO, E-sCAiOV, E-sCAiOVX, E-sCAiOE, E-sCAiOVE specific technical manual for instructions on how to perform the module fresh gas branch leak test in connection with preventive maintenance and after servicing the module.

Safety precautions

Safety precautions given in this manual apply to the CARESCAPE respiratory modules. For generic system-level safety statements, refer to the monitor's user documentation. For accessory-specific statements, refer to their own instructions for use.

Safety message signal words

Safety message signal words designate the severity of a potential hazard.

DANGER	Indicates a hazardous situation that, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation that, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a hazardous situation not related to personal injury that, if not avoided, could result in property damage.

Disposal and storage warnings

WARNING

DISPOSAL. At the end of their service life, the products described in this manual, as well as their accessories, must be disposed of in compliance with the guidelines regulating the disposal of each product. If you have any questions concerning disposal of a product, please contact GE or its representatives.

Disposal and storage cautions

General cautions

This symbol is identified by a white background, black triangular band, and a black symbol.

CAUTION

PACKAGING DISPOSAL. Dispose of the packaging material, observing the applicable waste control regulations.

CAUTION STORAGE AND USE. Do not use or store equipment outside the specified temperature, humidity, or altitude ranges.

Module overview

System compatibility

The CARESCAPE respiratory modules E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOV, E-sCAiOVX, E-sCAiOE, and E-sCAiOVE can be used for respiratory monitoring in the following host systems:

- CARESCAPE Monitor B850
- CARESCAPE Monitor B650
- CARESCAPE Monitor B450
- B40 Patient Monitor (2060600-002)
- Aisys CS^2
- Avance CS^2
- S/5 Anesthesia Monitor, software version L-ANE06(A) 24.1 or later
- S/5 Critical Care Monitor, software version L-ICU06(A) 24.1 or later
- S/5 Compact Anesthesia Monitor, software version L-CANE 05(A) 19.6 or later
- S/5 Compact Critical Care Monitor, software version L-CICU 05(A) 19.6 or later

NOTE Low sample gas flow situation is indicated with the message ***Replace D-Fend*** in the L-xxx06(A) software versions 24.1 and L-xxx05(A) software versions 19.6.

NOTE The CARESCAPE respiratory modules cannot be used in the S/5 Extension Frame.

NOTE The Neonatal Intensive Care Unit (NICU) software package of the CARESCAPE modular patient monitors may not support the use of CARESCAPE respiratory modules.

NOTE Displayed data (including but not limited to TV, MV, RR, Raw and N_2O), trends and alarms may vary depending on the host device. Specifications listed represent the capabilities of the modules. Always check the host device's user manual for additional information.

NOTE The following modules are considered identical and cannot be used in the same system at the same time: E-CO, E-sCO, E-COV, E-sCOV, E-COVX, E-sCOVX, E-CAiO, E-sCAiO, E-sCAiOE, E-CAiOV, E-sCAiOV, E-sCAiOVE, E-CAiOVX, E-sCAiOVX, E-miniC, N-CAiO, N-FC, N-FCREC.

CARESCAPE respiratory module parameters

The CARESCAPE respiratory modules use the sidestream method to measure the airway gas concentrations, and optionally Patient Spirometry. The following table shows the parameters measured by different modules. The x indicates that the module measures the parameter referred to in the column heading.

Module	CO_2	N_2O	O_2	Anes-thetic agents	Agent ID	Patient Spirom-etry	Gas exchange	Aisys CS^2 end-tidal control
E-sCO	×	× *	×					
E-sCOV	×	× *	×			×		
E-sCOVX	×	×*	×			×	×	
E-sCAiO	×	×	×	×	×			
E-sCAiOE	×	×	×	×	×			×
E-sCAiOV	×	×	×	×	×	×		
E-sCAiOVX	×	×	×	×	×	×	×	
E-sCAiOVE	×	×	×	×	×	×		×
* N_2O is not displayed by all host devices.								

For more information on the use of the end-tidal control, refer to the Aisys CS^2 user documentation.

About the measurements

The CARESCAPE respiratory modules draw a 120 ml/min flow of sampled gas through the gas sampling line and water trap to the gas sensors. CO_2, N_2O, and anesthetic agent concentrations are measured with an infrared absorption sensor, and the O_2 concentration with a paramagnetic sensor.

The module finds the time instant of the highest CO_2 concentration in each breath. Concentration at that instant is the ET CO_2 reading. Because nitrous oxide and anesthetic agents are measured by the same sensor as CO_2, the ET readings of those gases are obtained directly at the time instant of ET CO_2. For calculating ET readings of oxygen, the module synchronizes the O_2 waveform with the CO_2 waveform. The ET reading of O_2 is then determined as O_2 concentration at the time instant of ET CO_2. If no breaths are detected for a given time (20 s, for example), an apnea situation is triggered. During apnea, the ET values are updated every two seconds to the current concentration of each gas.

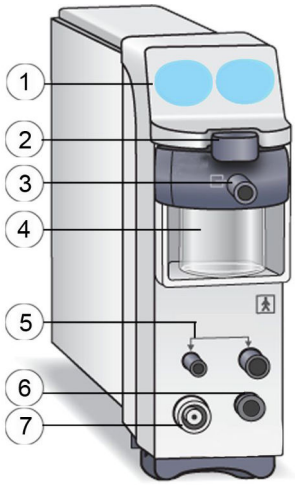
The infrared sensor also identifies the anesthetic agent and mixtures of two anesthetic agents in the sampled gas. The module has a gas exhaust port that can be connected to a scavenging system.

With the E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVX, and E-sCAiOVE modules you can also monitor airway pressures, flow, volumes, compliance and resistance, breath-by-breath. The measurement is taken using the pressure sensors in the module. The sensors are connected to the patient's airway with a double lumen spirometry line that conducts pressures from the D-lite(+)/Pedi-lite(+) spirometry sensor to the module. The respiratory volumes are calculated from the flow data, and the airway compliance and resistance are calculated from both the airway pressure and flow values.

The E-sCOVX and E-sCAiOVX modules also measure gas exchange parameters VCO_2 and VO_2.

For instructions on how to use the airway gases and Patient Spirometry measurements, see the host device's user documentation.

CARESCAPE respiratory module connectors

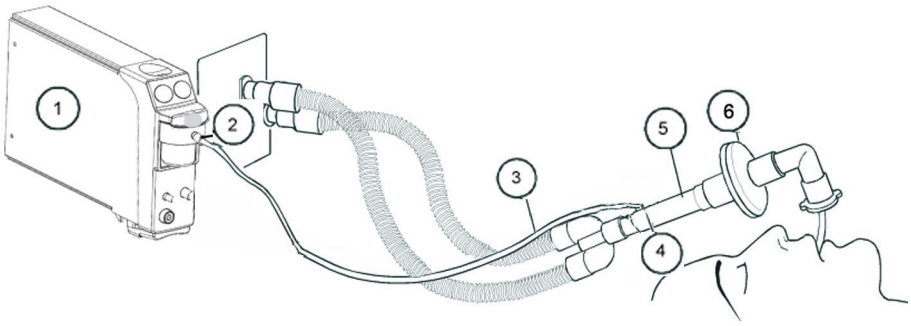


1. Patient Spirometry keys (**Save Loop**, **Change Loop**)
2. Water trap release/locking latch
3. Gas sample, sampling line connector on the water trap
4. Water trap container
5. Connectors for Patient Spirometry tubes
6. Connector for fresh gas used in end-tidal control. For more information on the use of the end-tidal control, please refer to the Aisys CS^2 user documentation.
7. Gas exhaust, connector for the gas exhaust line

NOTE Only qualified service personnel may remove the protecting screw from the fresh gas connector and attach the fresh gas sample tubing.

Airway gases measurement

Airway gases equipment to patient connections with CARESCAPE respiratory modules



1. CARESCAPE respiratory module
2. Gas sample, gas sampling line connector on the water trap
3. Gas sampling line

4. Gas sampling line connector on the airway adapter; place the connector upwards
5. Airway adapter with sampling line connector
6. Heat and moisture exchanger with filter (HMEF) (optional)

Setting up the airway gases measurement

1. Make sure that the water trap container is empty and properly attached.
2. Connect the gas sampling line to the sampling line connector on the water trap.
3. Connect the sample gas outlet to gas scavenging if N_2O or volatile agents are used.
4. Turn on the monitor or connect the module to the monitor. The monitor performs a self-check for the module when the module is connected. Automatic agent identification is activated in those modules that have this feature.
5. Wait until the message ***Calibrating*** or ***Calibrating gas sensor*** disappears before connecting the sampling line to the airway adapter or the airway adapter to the ventilator circuit.
6. Connect the sampling line to the airway adapter or the airway adapter to the ventilator circuit. Position the adapter with the sampling port upwards to minimize the amount of condensed water possibly entering the sampling line.
7. Check that the airway adapter connections are tight and that the adapter is operating properly.

NOTE Check that the sample line is connected to the water trap before connecting the module to the monitor or turning on the monitor.

NOTE To minimize the amount of dust drawn into the gas sampling system, always keep the water trap connected to the module. When gas measurement is not in use, you can disconnect the module from the monitor to eliminate the operating sound of the gas pump.

Airway gases warnings

General warnings

This symbol is identified by a yellow background, black triangular band, and a black symbol.

WARNING Always inspect the airway adapter for a tight connection and proper operation before attaching it to the patient.

WARNING Leaks in the gas sampling circuit (water trap and sampling line) may cause inaccurate readings.

WARNING Remove the airway sampling line from the patient's airway while nebulized medications are being delivered.

WARNING Handle the water trap and its contents as you would any body fluid. Infectious hazard may be present.

WARNING Since sample gas may contain anesthetic agents, make sure that it is not released in the room. Connect exhaust to a scavenging system to prevent exposure to anesthetic agents.

WARNING Strong scavenging suction may cause excessive sample gas flow and inaccurate gas readings.

WARNING Route all tubing away from the patient's throat to avoid strangulation.

WARNING To avoid the spread of infectious disease, do not allow the exhaust to discharge in the direction of the patient or user.

WARNING $EtCO_2$ values may differ from blood gas readings.

WARNING Do not use a CO_2 module at the same time as a multi-gas module.

WARNING When using the CARESCAPE respiratory modules with volume controlled ventilation at low tidal volumes, the specified gas withdrawal rate may significantly reduce the amount of gas delivered to the patient.

WARNING Make sure to compensate for the possible reduction of tidal volume caused by the 120 ml/min gas sample flow.

WARNING A failure in zeroing or calibrating airway gases may cause inaccurate readings.

WARNING Make sure that the module is always in vertical position when used.

WARNING Since calibration gas contains anesthetic agents, always ensure sufficient ventilation of the room during calibration.

WARNING Always ensure the correct size and fit of accessories according to patient type and application, especially when monitoring pediatric and neonatal patients. The size and fit of accessories may impact the measured gas concentration values at low tidal volumes. It is recommended to have the gas sampling port close to the proximal end of the endotracheal tube. Excessive dead space in the circuit, including the accessories, may cause re-breathing of gases. Very low accessory dead space between the breathing circuit Y-piece and the gas sampling site may impact the measured gas concentration due to dilution of the sampled exhaled gas with fresh gas from the ventilator. To confirm accurate correlation with measured gases and blood, check arterial blood gas values to confirm a suitable setup is used.

WARNING EQUIPMENT FAILURE OR INACCURATE READINGS. Planned maintenance should be carried out annually according to the instructions given in the technical manual. Failure to implement the recommended maintenance schedule may cause equipment failure or inaccurate readings.

WARNING PATIENT CROSS-INFECTION. Returning the sampled gas to the patient circuit causes a risk of patient cross-infection.

WARNING PATIENT CROSS-INFECTION. Always use a bacterial breathing system filter proximal to the patient when returning the sampled gas to the patient circuit. If a bacterial breathing system filter is not used, a failure in the D-Fend Pro water trap may cause a risk of patient cross-infection.

WARNING PATIENT CROSS-INFECTION. If the sampled gas is returned to the patient circuit, ensure the protective function of the D-Fend Pro water trap by replacing it at least once a week, or immediately in case of a defective or missing bacterial breathing system filter. Otherwise, there is a risk of patient cross-infection.

Airway gases cautions

CAUTION Never connect the loose end of the gas sampling line to the Patient Spirometry connector as this may break the spirometry unit. The Patient Spirometry connector is meant for the Patient Spirometry tube only.

CAUTION Do not apply pressurized air or gas to any outlet or tubing connected to the monitor. Pressure may destroy sensitive elements.

Scavenging

Preventing operating room pollution

When N_2O and volatile anesthetics are used, prevent operating room pollution by connecting the sample gas outlet (gas exhaust) of the module to the scavenging system.

Scavenging through the ventilator reservoir

1. Connect an exhaust line to the sample gas outlet (gas exhaust) on the module's front panel.
2. Attach the other end of the line to the ventilator reservoir. Make sure that the reservoir tube diameter is at least 2 to 3 times larger than the exhaust line.

Scavenging through the anesthesia gas scavenging system

Anesthesia machines are equipped with an anesthesia gas scavenging system (AGSS), and in some machines you can connect the sample gas outlet directly to it. See the anesthesia machine's user documentation to find out where and how the sample gas can be connected.

Connecting directly to the scavenging system

1. Connect the exhaust line to the module's sample gas outlet.
2. Connect the exhaust line only to an open scavenging system where gas is removed at room pressure.

NOTE Do not connect the module directly to a strong vacuum scavenging system.

Returning sampled gas to the patient circuit

Returning sampled gas to the patient circuit causes a risk of patient cross-infection. To prevent patient cross-infection always use a bacterial breathing system filter proximal to the patient. Ensure the protective function of the D-Fend Pro water trap by replacing it at least once a week, or immediately in case of a defective or missing bacterial breathing system filter.

1. Connect the exhaust line to the module's gas outlet.
2. Connect the exhaust line to the patient circuit.

NOTE Refer to the anesthesia machine's documentation to find out where and how the sample gas can be returned.

Airway gases points to note

- Use GE anesthesia sampling lines (PE/PVC) when anesthetic agents are used. If no anesthetic agents are present, you can use GE CO_2 sampling lines (PVC)
- Make sure that you are using the D-fend Pro or D-fend Pro+ water trap.
- Empty the water trap container as soon as it is more than half full. With a sample gas temperature of 37°C, a room temperature of 23°C, and sample gas relative humidity of 100 %RH, the water trap should be emptied every 24 hours (applies when the sample gas flow is within 120 ± 20 ml/min).
- When using an HMEF filter, place it between the patient and airway adapter.
- Place the airway adapter between the HMEF and Y-piece.
- Place the airway adapter in 45° tilt and all ports upwards to prevent condensed water from entering the adapter interior and the tubing
- Always check the tightness of all connections.
- Make sure that the gas sampling line is properly connected to the water trap and the water trap is properly connected to the airway gas module. Gas leaks in these connections may dilute the gas sample from the patient circuit, thus resulting in erroneous gas readings. During normal operation, all sampled gas flows out of the sample gas outlet. Room air is used as reference gas for the oxygen measurement and it is mixed with the sampled gas. The sampled gas is diluted by room air so that the fraction of room air in the exhaust gas is about 20%.

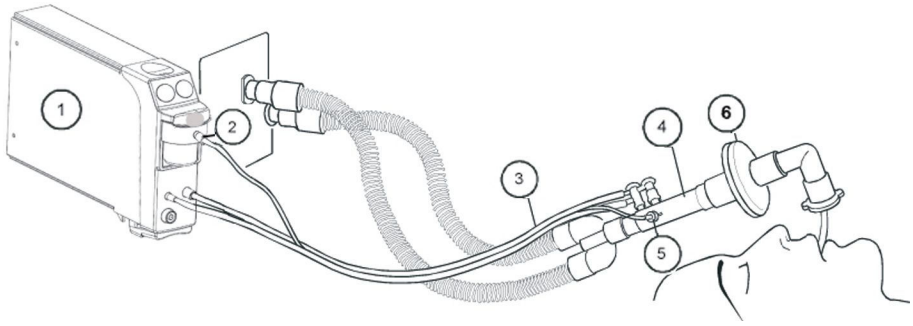
Airway gases troubleshooting

Problem	Solution
Airway gas values seem too low	• Check the sampling line and connectors for leakage. • Check the patient status. • Check the arterial blood gas values.
Airway gas values seem too high	• Check the sampling line for blockage. • Check the patient status. • Check the arterial blood gas values.

Problem	Solution
Module does not work	• Check and clean the filter if necessary. • Check the water trap and water trap connectors. Liquid may have entered the module. Replace the module and have it checked by authorized service personnel.
No airway gas values	• Check that the gas sampling line is connected to the water trap.

Patient Spirometry measurement

Patient Spirometry equipment to patient connection



1. E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVX, or E-sCAiOVE module
2. Gas sample, gas sampling line connector on the water trap
3. Gas sampling and spirometry tubes
4. D-lite/Pedi-lite sensor, or D-lite+/Pedi-lite+ sensor for humid conditions
5. Gas sampling line connector
6. Heat and moisture exchanger with filter (HMEF)

Preparing the Patient Spirometry measurement

1. Take a new Patient Spirometry tube and connect the tube to the D-lite(+)/Pedi-lite(+) sensor by inserting the angle connectors in the sensor connectors. Place all D-lite(+)/Pedi-lite(+) ports upwards with approximately a 45 °C tilt to prevent condensed water from entering the sensor interior and the tubings.
2. Connect the other end of the Patient Spirometry tube to the pressure connectors on the module.
3. Connect a gas sampling line to the Luer connector on the other side of the D-lite(+)/Pedi-lite(+) sensor.
4. Connect the other end of the gas sampling line to the sampling line connector on the module's water trap.
5. Make sure that the connections are tight.
6. Select the correct sensor type.
7. Connect the D-lite(+)/Pedi-lite(+) between the Y-piece and the intubation tube in the breathing circuit.

Patient Spirometry warnings

General warnings

This symbol is identified by a yellow background, black triangular band, and a black symbol.

WARNING The presence of Helium or Xenon in the breathing circuit causes incorrect measurement values.

WARNING Make sure you select the correct sensor type for the patient: D-lite(+) for adult patients, Pedi-lite(+) for pediatric patients. Also check the sensor type selection in the host device.

Patient Spirometry cautions

CAUTION Never connect the loose end of the gas sampling line to the Patient Spirometry connector as this may break the spirometry unit. The Patient Spirometry connector is meant for the Patient Spirometry tube only.

CAUTION Do not apply pressurized air or gas to any outlet or tubing connected to the monitor. Pressure may destroy sensitive elements.

Patient Spirometry points to note

- Place an HME/HMEF/filter between the D-lite(+)/Pedi-lite(+) sensor and the patient.
- Disconnect the HME/HMEF/filter and D-lite(+)/Pedi-lite(+) during nebulization of medications.
- The flow measurement should be calibrated once a year or when there is a permanent difference between inspiratory and expiratory volume. For further information, see the modules technical manual.
- Using a cuffless intubation tube may affect Patient Spirometry readings due to potential leakages around the endotracheal tube.
- When anesthetic agents are used, use a module with anesthetic agent (Ai) identification option.
- The flow and volume measurement of the CARESCAPE respiratory module is compensated for the density of the gas which is important for measurement accuracy with heavy molecules of anesthetic agents like Desflurane. However, using high concentrations of anesthetic agents may still affect flow and tidal volume readings. In this case, the CARESCAPE respiratory module tends to underestimate flow and volume.
- Depending on the type of patient circuit used, the temperature and humidity inside the D-lite flow sensor vary between dry ambient temperature air and 100% humid 37 °C air. As the CARESCAPE respiratory module needs to convert the measured volume/flow to ATPD or BTPS conditions, it needs to assume the temperature and humidity of the gas that flows through the flow sensor. By default the module assumes conditions equivalent to an HME patient circuit. If active humidification is used, the module will therefore overestimate the measured volume/flow by approx. 5%. For some host devices you can select the type of patient circuit used, and in this case the remaining error is minimized.

- When using active humidification, there might be condensation in the D-lite flow sensor affecting flow and volume readings. In this case, the CARESCAPE respiratory module tends to overestimate flow and volume.

Patient Spirometry troubleshooting

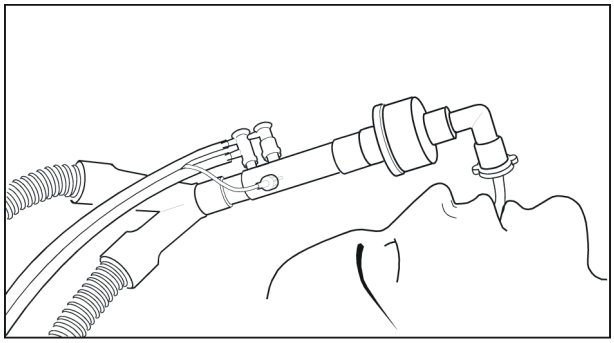
Problem	Solution
Values seem erroneous	• Check the patient status. • Check that you are using the correct sensor type: D-lite(+) for adult patients, Pedi-lite(+) for pediatric patients. • Check the sensor type selection. • Check that the Patient Spirometry tube connectors and their connections are tight and not leaking. • Check the arterial blood gas values. • Check that the sampling line is not kinked.
Values seem unstable	• Remove the D-lite(+)/Pedi-lite(+) and shake drops away. • Check that the connectors on the D-lite(+)/Pedi-lite(+) are intact and that connections are tight.
Strong vibrations in the loop	• Check the patient status. • Check the patient and system for water or secretions.

Gas exchange measurement

Gas exchange equipment to patient connection

The equipment to patient connections for gas exchange are similar to those of Patient Spirometry but there are also some connection-related issues to be noted. Only the modules E-sCAiOVX and E-sCOVX measure gas exchange.

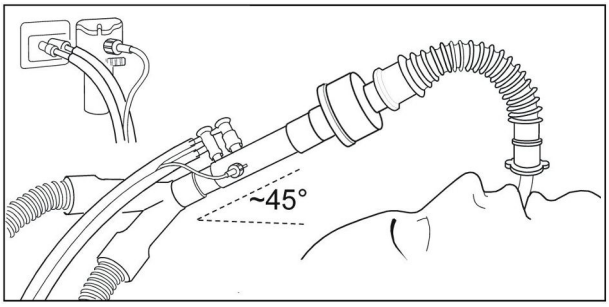
Gas exchange patient connections with HME/HMEF



NOTE Always place the HME/HMEF between the D-lite(+) sensor and the patient.

NOTE By-pass flow together with long expiration flow pause time may disturb the measurement. Consider using shorter expiration time to diminish the effect. In addition, you may use a suitable spacer with a 5 to 10 ml dead space (e.g., a straight T-adapter) between the Y-piece and D-lite(+)/Pedi-lite(+). The by-pass flow effect may exist even in an adult setting, but it is more emphasized when monitoring pediatric patients and using the Pedi-lite(+).

Gas exchange patient connections with flexible tube



NOTE Place all D-lite ports upwards with a 20° to 45° tilt to prevent condensed water from entering the sensor interior and the tubings.

NOTE When monitoring pediatric patients with tidal volumes less than 300 ml, use the Pedi-lite(+) sensor. Remember to select the sensor type accordingly.

Gas exchange warnings

Before using the gas exchange measurement, familiarize yourself with safety precautions related to airway gases and Patient Spirometry measurements as they apply to the gas exchange measurement also.

General warnings

This symbol is identified by a yellow background, black triangular band, and a black symbol.

WARNING The presence of Helium or Xenon in the breathing circuit causes incorrect measurement values.

WARNING Make sure you select the correct sensor type for the patient: D-lite(+) for adult patients, Pedi-lite(+) for pediatric patients. Also check the sensor type selection in the host device.

WARNING If the expiration gas flow during the end phase of the patient's expiration is close to zero for more than two seconds before the next inspiration starts, the ventilator's bypass flow may affect the measurement.

WARNING INACCURATE READINGS. As the gas exchange parameters are calculated from O_2, CO_2, and airway flow data, any conditions affecting the accuracy of these parameters will also affect the accuracy of gas exchange parameters. To avoid the risk of inaccurate gas exchange readings that may result in compromised patient safety, adhere to the given measurement guidelines for O_2, CO_2, and airway flow measurements and check that these measurements are functioning properly.

WARNING INACCURATE READINGS. The following conditions affect the accuracy and performance of the gas exchange measurement:

- A leaking airway.
- The use of a sampling line other than a 2–meter non-nasal sampling line.
- The use of high FiO_2.
- The fluctuation of the delivered FiO_2 level during inspiration.
- The use of N_2O in ventilation.
- High pressure variation from PEEP to Ppeak.
- The use of Helium or Xenon in ventilation.
- High respiration rates.
- The use of high frequency ventilation (HFV).
- The use of bi-level positive airway pressure (BiPAP).
- Irregular airway flow pattern.
- High bias flow, especially when using ventilation settings resulting in periods with no airway flow.
- Irregular CO_2 amplitude.

If these conditions are present, there is a risk of inaccurate readings, which may result in compromised patient safety.

WARNING INACCURATE READINGS. Increased inspiratory dead space in breathing systems without expiratory by-flow through the Y-piece may cause too large VCO_2 and VO_2 readings. To avoid any risk to the patient, always take this into account when interpreting the measurement results with such breathing systems.

Gas exchange cautions

General cautions

This symbol is identified by a white background, black triangular band, and a black symbol.

CAUTION Never connect the loose end of the gas sampling line to the Patient Spirometry connector as this may break the spirometry unit. The Patient Spirometry connector is meant for the Patient Spirometry tube only.

CAUTION Do not apply pressurized air or gas to any outlet or tubing connected to the monitor. Pressure may destroy sensitive elements.

Gas exchange measurement limitations

- This measurement is not available in the NICU software package.
- Only the E-sCAiOVX and E-sCOVX modules measure gas exchange.

NOTE Routine calibration checks are required to ensure the measurement accuracy.

Gas exchange points to note

- Gas exchange measurement is for intubated patients only.
- Use only 2-meter (7-ft) gas sampling lines. Using other lines may cause inaccurate readings.
- FiO_2 delivery from the ventilator side should be stable.
- High PEEP or ventilating pressures may activate a message prompting to check the water trap. In this case, you may consider decreasing the PEEP if possible.
- To ensure measurement accuracy, check the accuracy of airway gas measurement every two months: feed calibration gas mixture to the monitor in the normal operation mode (without entering the calibration menu) and check that the readings on the monitor match those on the calibration gas bottle. If they do not match, calibrate airway gases.
- When anesthetic agents are present, use the E-sCAiOVX module for monitoring airway flow and gas exchange.
- Any acute change in alveolar ventilation will be immediately reflected in CO_2 output, which will not measure the metabolic production of CO_2 until a new steady state has been achieved. The time required for the stabilization varies widely and ranges from 30 to 120 minutes.

Gas exchange troubleshooting

Problem	Solution
Gas exchange values are too low.	• Check the sampling line and connectors for leakage.
Gas exchange values seem unreliable.	• Check the ventilation settings. • Check the inspired oxygen concentration and correct if necessary (max. 85%). • Check that pressure variation from PEEP to Ppeak is not too high. • Check the Patient Spirometry data to ensure that flow measurement is functioning properly.

Problem	Solution
	• If the expiration gas flow during the end phase of the patient's expiration is close to zero for more than two seconds before the next inspiration starts, the ventilator's bypass flow may affect the measurement. You can reduce this effect by adding a suitable spacer with a 5 to 10 ml dead space (e.g., a straight T-adapter) between the Y-piece and the D-lite or the Pedi-lite adapter.
Module does not work.	• Check and clean the filter if necessary. • Check the water trap. If it was too full, liquid may have entered the module. Replace the module and have it checked by authorized service personnel.
No gas exchange values.	• Check that the gas sampling line is not connected to the sample gas out connector.
VO_2 values are non-physiologic.	• Verify that the oxygram curve is stable. • Change the sampling line. • Check the D-lite placement.
Are gas exchange values accurate with 100% oxygen?	No, gas exchange measurements are not possible when the FiO_2 > 85%. This is also indicated on screen by the replacement of numbers by ---. Please also note that full measurement accuracy is obtained when FiO_2 is less than 65%. Between 65% and 85% FiO_2, the accuracy is reduced to +/-15%
Can the gas exchange modules be used with active humidification?	Yes, they can. Use the D-lite+/Pedi-lite+ flow sensor for humid conditions. If HME is used, both the D-lite/Pedi-lite and D-lite+/Pedi-lite+ can be used.
Can the gas exchange modules be used with pediatric patients?	Yes, for those pediatric patients whose respiration rate is below 35 breaths/minute. When monitoring pediatric patients, use the Pedi-lite sensor and select the sensor accordingly from the monitor menu.
How can I ensure that the VCO_2 and VO_2 values are correct?	Always make sure that you are using correct accessories and that the measurement setup and patient connections are correct.
Why does the RQ value rise above 1.0?	The physiological range of RQ is usually between 0.7 and 1.0. If the value is out of this range, check the measurement setup.
Why does the RQ value sometimes show unphysiological values such as RQ < 0.6?	Usually this is due to a non-steady state: the ventilator settings have been changed, FiO_2 has changed, the ventilation is irregular.

Cleaning and care

For detailed maintenance instructions, refer to the respiratory modules' technical documentation.

WARNING EQUIPMENT FAILURE OR INACCURATE READINGS. Planned maintenance should be carried out annually according to the instructions given in the technical manual. Failure to implement the recommended maintenance schedule may cause equipment failure or inaccurate readings.

For detailed cleaning instructions, refer to the host device's user documentation.

CAUTION Do not apply pressurized air or gas to any outlet or tubing connected to the monitor. Pressure may destroy sensitive elements.

D-fend Pro(+) water trap

- Change the water trap every two months (D-fend Pro) or every 24 hours (D-fend Pro+), or whenever a message prompts you to do so.
- If the sampled gas is returned to the patient circuit, ensure the protective function of the D-Fend Pro water trap by replacing it at least once a week, or immediately in case of a defective or missing bacterial breathing system filter.
- Remove the water trap by pressing the release latch and pulling the water trap out.
- Attach the water trap by pushing it firmly to its place, so that the locking latch makes a clicking sound.
- Empty the container whenever half full and for each new patient. In normal conditions, the container fills up in 24 hours.
- The water trap cartridge is disposable. Do not wash or reuse the cartridge.
- Also read the water trap instructions for use in the accessory package.

Reusable D-lite and Pedi-lite sensor cleaning instructions

Reusable D-lite and Pedi-lite sensors can be washed, disinfected, or steam autoclaved. Make sure that the sensor is dry and the connectors are not damaged. A tight connection is essential for correct measurement.

Also read the sensor instructions for use in the accessory package.

Calibration warnings

General warnings

This symbol is identified by a yellow background, black triangular band, and a black symbol.

WARNING A failure in zeroing or calibrating airway gases may cause inaccurate readings.

WARNING Since calibration gas contains anesthetic agents, always ensure sufficient ventilation of the room during calibration.

Airway gas calibration

Follow the recommended calibration intervals (every six months in normal use and every two months in continuous use) to ensure that the measurement accuracy remains within specifications.

- E-sCAiO, E-sCAiOV, E-sCAiOVX, E-sCAiOE, E-sCAiOVE: Use calibration gas 755583-HEL.
- E-sCO, E-sCOV, E-sCOVX: Use calibration gas 755581-HEL.
- All modules: Use regulator 755534-HEL.

NOTE Calibration gas bottles with anesthetic agents must be disposed of in compliance with the guidelines regulating the disposal of products containing anesthetic agents.

For detailed instructions, see the monitor's user documentation.

Patient Spirometry calibration

Perform flow calibration if the difference between the inspiratory and expiratory volumes is permanent. For instructions, see the modules technical manual.

System compatibility

The CARESCAPE respiratory modules E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOV, E-sCAiOVX, E-sCAiOE, and E-sCAiOVE can be used for respiratory monitoring in the following host systems:

- CARESCAPE Monitor B850
- CARESCAPE Monitor B650
- CARESCAPE Monitor B450
- B40 Patient Monitor (2060600-002)
- Aisys CS^2
- Avance CS^2
- S/5 Anesthesia Monitor, software version L-ANE06(A) 24.1 or later
- S/5 Critical Care Monitor, software version L-ICU06(A) 24.1 or later
- S/5 Compact Anesthesia Monitor, software version L-CANE 05(A) 19.6 or later
- S/5 Compact Critical Care Monitor, software version L-CICU 05(A) 19.6 or later

NOTE Low sample gas flow situation is indicated with the message ***Replace D-Fend*** in the L-xxx06(A) software versions 24.1 and L-xxx05(A) software versions 19.6.

NOTE The CARESCAPE respiratory modules cannot be used in the S/5 Extension Frame.

NOTE The Neonatal Intensive Care Unit (NICU) software package of the CARESCAPE modular patient monitors may not support the use of CARESCAPE respiratory modules.

NOTE Displayed data (including but not limited to TV, MV, RR, Raw and N_2O), trends and alarms may vary depending on the host device. Specifications listed represent the capabilities of the modules. Always check the host device's user manual for additional information.

NOTE The following modules are considered identical and cannot be used in the same system at the same time: E-CO, E-sCO, E-COV, E-sCOV, E-COVX, E-sCOVX, E-CAiO, E-sCAiO, E-sCAiOE, E-CAiOV, E-sCAiOV, E-sCAiOVE, E-CAiOVX, E-sCAiOVX, E-miniC, N-CAiO, N-FC, N-FCREC.

Supplies and accessories

General warnings

This symbol is identified by a yellow background, black triangular band, and a black symbol.

WARNING Single-use products are not designed to be reused. Reuse may cause a risk of cross-contamination, affect the measurement accuracy and/or system performance, and cause a malfunction as a result of the product being physically damaged due to cleaning, disinfection, re-sterilization and/or reuse.

WARNING Use only approved accessories, including mounts, and defibrillator-proof cables and invasive pressure transducers. For a list of approved accessories, see the supplemental information manual. Other cables, transducers and accessories may cause a safety hazard, damage the equipment or system, result in increased emissions or decreased immunity of the equipment or system or interfere with the measurement.

Always ensure the correct size and fit of accessories according to patient type and application, especially when monitoring pediatric and neonatal patients.

The listed GE accessories may be used to perform the full respiratory gas monitoring, Patient Spirometry and gas exchange measurements.

NOTE Certain accessories are not available in all markets.

NOTE For information regarding materials used in accessories, see the instructions for use for the specific accessory.

Gas accessories

Part Number	Gas Accessory Description	Approved for use with
M1182629	D-fend Pro Water Trap for anesthesia, reusable. Recommended use: anesthesia, recommended time to replace: 2 months or when occluded.	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1200227	D-fend Pro+ Water Trap for critical care, single use. Recommended use: ICU or other humid conditions, recommended time to replace: 24 hours or when occluded.	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
73385-HEL	Straight T-adapter, 22mm/15mm, dead space: 7.5 ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE

Part Number	Gas Accessory Description	Approved for use with
733856	Straight T-adapter, 22mm/15mm, dead space: 7.5 ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1145066	Straight T-adapter UK Version	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
73386-HEL	Elbow Adapter, 22mm/15mm, dead space: 10 ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
733866	Elbow Adapter, 22mm/15mm, dead space: 10 ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1145067	Airway Elbow Adapter, Disposable, UK Version	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8001540	Low Dead Space Adapter for ET tubes with ID 2.5 mm, dead space: 0.1 ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8001541	Low Dead Space Adapter for ET tubes with ID 3.0 mm, dead space: 0.15ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8001542	Low Dead Space Adapter for ET tubes with ID 3.5 mm, dead space: 0.2ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8001543	Low Dead Space Adapter for ET tubes with ID 4.0 mm, dead space: 1 ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8000062	Low Dead Space Adapter for ET tubes with ID 4.5 mm, dead space: 1 ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8000063	Low Dead Space Adapter for ET tubes with ID 5.0 mm, dead space: 1 ml	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
73318-HEL	Disposable Anesthesia Gas Sampling Line, Male/Male Luer-Lok, 2 m/7 ft., material: PVC/PE, inner Ø 1.2 mm, outer Ø 2.8 mm	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE

Part Number	Gas Accessory Description	Approved for use with
733188	Disposable Anesthesia Gas Sampling Line, Male/Male Luer-Lok, 2 m/7 ft., material: PVC/PE, inner Ø 1.2 mm, outer Ø 2.8 mm	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1145069	Disposable Anesthesia Gas Sampling line, 2m/7ft, UK Version	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
73319-HEL	Disposable Anesthesia Gas Sampling Line, Male/Male Luer-Lok, 3 m/10 ft., material: PVC/PE, inner Ø 1.2 mm, outer Ø 2.8 mm	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
733199	Disposable Anesthesia Gas Sampling Line, Male/Male Luer-Lok, 3 m/10 ft., material: PVC/PE, inner Ø 1.2 mm, outer ØO 2.8 mm	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1145070	Disposable Anesthesia Gas Sampling Line, 3m/10ft, UK Version	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
73306	Disposable Anesthesia Gas Sampling Line, Male/Male Luer-Lok, 6 m/20 ft., material: PVC/PE, inner Ø 1.2 mm, outer Ø 2.8 mm	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1145071	Disposable Anesthesia Gas Sampling Line, 6m/20ft, UK Version	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
733170	Disposable Anesthesia Gas Sampling Line with elbow connector Male/Male elbow Luer-Lok, 3 m/10 ft., material: PVC/PE, inner Ø 1.2 mm, outer Ø 2.8 mm	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1145072	Disposable Anesthesia Gas Sampling Line with elbow connector Male/Male elbow Luer-Lok, 3m/10ft, UK Version	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8004383	Disposable Anesthesia Gas Sampling Line with elbow connector Male/Male elbow Luer-Lok, 2 m/7 ft., material: PVC/PE, inner Ø 1.2 mm, outer Ø 2.8 mm	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1145073	Disposable Anesthesia Gas Sampling Line, with elbow connector Male/Male elbow Luer-Lok, 2 m/7 ft, UK Version	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
733162-HEL	Disposable CO2 Sampling Line, Male/Male Luer-Lok, 2 m/7 ft., material: PVC, inner Ø 1.2 mm, outer Ø 2.8 mm	E-sCO, E-sCOV, E-sCOVX
M1145075	Disposable CO2 Sampling Line, Male/Male Luer-Lok, 2 m/7 ft., UK Version	E-sCO, E-sCOV, E-sCOVX

Part Number	Gas Accessory Description	Approved for use with
733163	Disposable CO2 Sampling Line, Male/Male Luer-Lok, 3 m/10 ft., material: PVC, inner Ø 1.2 mm, outer Ø 2.8 mm	E-sCO, E-sCOV, E-sCOVX
M1145076	Disposable CO2 Sampling Line, Male/Male Luer-Lok, 3 m/10 ft., UK Version	E-sCO, E-sCOV, E-sCOVX
878033	Nasal Sampling Line, pediatric, 2 m/7 ft., material: PVC	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
878034	Nasal Sampling Line, adult, 2 m/7 ft., material: PVC	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
878035	Nasal Sampling Line, large adult, 2 m/7 ft., material: PVC	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1031274	Exhaust Line for gas return or scavenging, 2 m/7 ft., disposable	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8004462	Exhaust Line with Coulter fitting, 1 m/41 in., disposable	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
8004463	Exhaust Line with Coulter fitting, 18 cm/7 in., disposable	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
755534-HEL	D-gate Calibration Gas Regulator for Quick Cal calibration gas aerosol cans	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
M1006864	Calibration Gas Regulator for Quick Cal calibration gas, aerosol cans	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
755581-HEL	Quick Cal Calibration Gas, aerosol can, contains 5.0% CO_2, 40.0% N_2O, 55.0% O_2, balance O_2, accuracy: ±0.5% relative	E-sCO, E-sCOV, E-sCOVX
755587	Quick Cal Calibration Gas, aerosol can, contains: 5.0% CO_2 ±0.03% abs, balance O_2	E-sCO, E-sCOV, E-sCOVX
755583-HEL	Quick Cal Calibration Gas, aerosol can, contains 2.0% Desflurane, 5.0% CO_2, 33.0% N_2O, 55.0% O_2, balance N_2, accuracy: ±2.0% relative	E-sCAiO, E-sCAiOE, E-sCAiOV, , E-sCAiOVX, E-sCAiOVE
2070599–001	Adult O_2 Nasal Cannula with CO_2 sampling, 2 m (7 ft)	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE

Part Number	Gas Accessory Description	Approved for use with
2070600–001	Pediatric O_2 Nasal Cannula with CO_2 sampling, 2 m (7 ft)	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
4797 (Salter Labs part number)	Salter Labs Adult oral/nasal CO_2 sampling cannula with O_2 line, 2 m (7 ft)	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
4793 (Salter Labs part number)	Salter Labs Pediatric oral/nasal CO_2 sampling cannula with O_2 line, 2 m (7 ft)	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
4000 (Salter Labs part number)	Salter Labs Adult nasal CO_2 sampling cannula, 2 m (7 ft)	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE
4100 (Salter Labs part number)	Salter Labs Pediatric nasal CO_2 sampling cannula, 2 m (7 ft)	E-sCO, E-sCOV, E-sCOVX, E-sCAiO, E-sCAiOE, E-sCAiOV, E-sCAiOVX, E-sCAiOVE

Patient Spirometry and gas exchange accessories

Part Number	Patient Spirometry and Gas Exchange Accessory Description	Approved for use with
733950	D-lite Sensor, 22mm M/15mm F-15mm M, material: yellow polystyrene, dead space: 9.5 ml, resistance: 0.5 cm H_2O at 30 l/min; patient range: TV 150 - 2000 ml	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
M1145077	D-lite Sensor, 22mm M/15mm F-15mm M, material: yellow polystyrene, UK Version	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
896952	D-lite+ Sensor, for humid conditions, 22mm M/15mm F-15mm M, material: clear polystyrene, dead space: 9.5 ml, resistance: 0.5 cm H_2O at 30 l/min; patient range: TV 150 - 2000 ml	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
8001948	Pedi-lite+ Sensor for humid conditions, 22mm M/ 15mm F - 15mm M, material: clear polystyrene, dead space 2.5 ml, resistance: 1.0 cm H_2O at 10 l/min; patient range: TV 15 - 300 ml	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
733910-HEL	D-lite Sensor, 22mm M/15mm F-15mm M, material: transparent yellow polyphenylsulfone, dead space: 9.5 ml, resistance: 0.5 cm H_2O at 30 l/min; patient range: TV 150 - 2000 ml	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
73393	Pedi-lite Sensor, 22mm M/15mm F-15mm M, material: transparent yellow polyphenylsulfone, dead space: 2.5 ml, resistance: 1.0 cm H_2O at 10 l/min; patient range: TV 15 - 300 ml	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX

Part Number	Patient Spirometry and Gas Exchange Accessory Description	Approved for use with
890031	Spirometry Tube, yellow, 2 m/7 ft.	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
M1145087	Spirometry Tube, yellow, 2 m/7 ft., UK Version	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
884101	Spirometry Tube, yellow, 3 m/10 ft.	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
M1145088	Spirometry Tube, yellow, 3 m/10 ft., UK Version	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
889560	Patient Spirometry Kit, adult, includes: • 1 disposable 3 m/10 ft. anesthesia sampling line (73319-HEL) • 1 disposable yellow, D-lite sensor (733950) • 1 disposable 3 m/10 ft. spirometry tube, yellow (884101)	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
M1145081	Patient Spirometry Kit, Adult, UK Version	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
8002718	Patient Spirometry Kit, pediatric, includes: • 1 disposable 2m/7 ft. anesthesia sampling line (73318) • 1 disposable Pedi-lite+ flow sensor (8001948) • 1 disposable 2 m/7 ft. spirometry tube (890031)	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
M1032634	Patient Spirometry Kit, pediatric, includes: • 1 disposable 3 m/10 ft. anesthesia sampling line (73319-HEL) • 1 disposable Pedi-lite+ flow sensor (8001948) • 1 disposable 3 m/10 ft. spirometry tube (884101)	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
894255	Patient Spirometry Kit for ICU, includes: • 1 disposable 2 m/7 ft. CO_2 sampling line (733162) • 1 disposable 2 m/7 ft. spirometry tube (890031) • 1 single-use D-lite sensor (733950) • 1 HMEF 1000 (557070100)	E-sCOV, E-sCOVX
8004381	Patient Spirometry Kit for humid conditions, includes: • 1 disposable 2m/7ft. anesthesia gas sampling line with elbow connector (8004383) • 1 disposable D-lite+ sensor (896952) • 1 disposable 2m/7ft. spirometry tube (890031)	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX

Part Number	Patient Spirometry and Gas Exchange Accessory Description	Approved for use with
8004382	Patient Spirometry Kit for humid conditions, includes: • 1 disposable 3m/10ft., anesthesia gas sampling line with elbow connector (733170) • 1 disposable D-lite+ sensor (896952) • 1 disposable 3m/10ft. spirometry tube (884101)	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
884202	Spirometry Tester, measurement range: tidal volumes 0-300/1200 ml, pressures 0-29 cm H_2O	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
891191-HEL	Spirometry Tube, yellow, 6m/20ft	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX
M1145089	Spirometry Tube, yellow, 6m/20ft, UK Version	E-sCOV, E-sCOVX, E-sCAiOV, E-sCAiOVE, E-sCAiOVX

Technical specifications

Physical characteristics

Size (H x W x D)	112 x 37 x 205 mm (4.4 x 1.5 x 8.7 in)
Weight	0.7 kg (1.5 lb)
Power consumption	3.9 W

Operating characteristics

Warm-up time	CO_2, O_2 and N_2O measurements: 1 minute Anesthetic agent measurement and identification: 5 minutes
Gas sampling rate	120 ml/min ±20 ml/min

The electronic sampling rate of the gas sensor signals is 25 Hz, equaling a new data point on the gas waveform traces every 40 ms.

Automatic compensation for ambient pressure

Operating conditions

Ambient temperature	+10°C to +40°C
Ambient pressure	660 mbar to 1060 mbar
Ambient humidity	0%RH to 98%RH, non-condensing

Storage conditions

Ambient temperature	-25°C to +60°C
Ambient pressure	500 mbar to 1060 mbar
Ambient humidity	10%RH to 90%RH, non-condensing

Airway gases specifications

General characteristics

Specifications are valid at the following normal operating conditions:

Ambient temperature	+18°C to +28°C, within ±5°C of calibration
Ambient pressure	660 mbar to 1060 mbar, ±67 mbar of calibration
Ambient humidity	20%RH to 80%RH, non-condensing, ±20%RH of calibration
Sampling line length	2 and 3 meters
Respiration rate	4 to 70 breaths/minute (Halothane 4 to 50 breaths/minute)
Airway pressure	-20 mbar to +100 mbar
Module operating time	>20 minutes continuously

The displayed ranges of parameter values depend on the host device. For more information, refer to the host device's user documentation.

Respiration rate

Breath detection	1 vol% change in CO_2 level
Measurement range	4 to 100 breaths/min
Accuracy	At 4 to 20 breaths/min: ±1 breath/min At 20 to 100 breaths/min: ±5%

RR value is updated breath-by-breath.

Respiration rate verification method

The rated respiration rate range and the corresponding end-tidal gas reading accuracy were tested with reference gases of known concentrations. The test gases were fed to the gas sampling system of the module through an electrically actuated valve with very low internal volume. Depending on its actuation status, the valve directed either room air or a test gas to the gas sampling line. The desired respiration rates were set by the electrical actuating times of the valve.

The measurement accuracy of the end-tidal gas readings was tested using 3–meter gas sampling lines connected to the gas sample port of the D-fend Pro water trap. The gas sampled to the sampling line was switched from room air to the test gases using electrically actuated valve with low internal dead space to generate step changes in the gas concentrations. The electrical actuating signal of the valve was generated using a highly accurate signal generator to accurately control the simulated respiration rate.

Expiration time and end-tidal readings

The length of expiration time has impact on the accuracy of the gas-specific end-tidal readings. The longer the expiration time, the better the module achieves the correct end-tidal reading. With I:E 2:1, the gas specific end-tidal values are within specifications up to respiration rate 45 1/min except with halothane (32 1/min with halothane). With other I:E values, the end-tidal readings are within specifications.

Carbon dioxide

Measurement range	0 vol% to 15 vol% 0 kPa to 15 kPa 0 mmHg to 113 mmHg
Accuracy	±(0.2 vol% +2% of reading)
Gas cross effects by O_2, N_2O, and anesthetic agents	<0.2 vol%
Total system response time	< 3.3 s
Rise time	< 260 ms
CO_2 drift	< 0.1 vol%

$EtCO_2$ and $FiCO_2$ values are updated breath-by-breath.

Oxygen

Measurement range	0 vol% to 100 vol%
Accuracy	±(1 vol% +2% of reading)
Gas cross effects by anesthetic agents	<1 vol%
Gas cross effects by N_2O	<2 vol%
Total system response time	< 3.3 s
Rise time	< 260 ms
O_2 drift	< 0.3 vol%

$EtCO_2$ and $FiCO_2$ values are updated breath-by-breath.

Nitrous oxide

Measurement range	0 vol% to 100 vol%
Accuracy at ($0 < N_2O < 85$ vol%)	±(2 vol% +2% of reading)
Gas cross effects by anesthetic agents	<2 vol%
Total system response time	< 3.4 s
Rise time	< 320 ms
O_2 drift	< 0.3 vol%

$EtCO_2$ and $FiCO_2$ values are updated breath-by-breath.

Anesthetic agents

Measurement range	Sevoflurane: 0 vol% to 8 vol% Desflurane: 0 vol% to 20 vol% Isoflurane, enflurane, halothane: 0 vol% to 6 vol%
Accuracy	±(0.15 vol% +5% of reading)
Gas cross effects by N_2O	0.15 vol%
Total system response time	< 3.5 s (< 3.8 s for Halothane)

Anesthetic agents

Rise time	< 420 ms (< 800 ms for Halothane)
Hal drift	< 0.1 vol%
Enf drift	< 0.1 vol%
Iso drift	< 0.1 vol%
Sev drift	< 0.1 vol%
Des drift	< 0.3 vol%

EtAA and FiAA values are updated breath-by-breath.

The module automatically identifies the anesthetic agent present in the sampled gas and measures the concentration of the identified agent.

Identification threshold	0.15 vol%
Identification time	< 20 s

The module automatically identifies mixtures of two anesthetic agents present in the sampled gas and measures the concentrations of the two identified agents.

Identification threshold for the 2nd agent

At 1 MAC of the 1st agent	0.2 vol% +10% of the concentration of the 1st agent

Non-disturbing gases

A gas is considered non-disturbing if its effects to the measured gas are as follows:

CO_2	< 0.2 vol%
O_2, N_2O	< 2 vol%
Anesthetic agents	< 0.15 vol%

The following gases are non-disturbing when tested according to ISO 21647(2004B):ethanol, acetone, isopropanol, methane, nitrogen, carbon monoxide, nitric oxide, freon R134A (for CO_2, O_2 and N_2O), water vapor.

The effects caused by N_2O to the measurement of CO_2, O_2 and anesthetic agents are automatically compensated for.

The effects caused by anesthetic agents to the measurement of CO_2 and N_2O are automatically compensated for.

Effects of interfering gases

Helium (50 vol%)	Decreases CO_2 readings by less than 0.5 vol% at 5 vol% of CO_2 Decreases O_2 readings by less than 2 vol% at 50 vol% of O_2
Xenon (80 vol%)	Decreases CO_2 readings by less than 0.5 vol% at 5 vol% of CO_2 Decreases O_2 readings by less than 1.5 vol% at 14 vol% of O_2

Patient Spirometry specifications

General characteristics

Specifications are valid at the following operating conditions:

The module has been operating continuously for 10 minutes.

Airway adapter, adult	D-lite
Airway adapter, pediatric	Pedi-lite
Respiration rate	Adults: 4 to 35 breaths/min Pediatric patients: 4 to 70 breaths/min
I:E ratio	1:4.5 to 2:1
Airway humidity	10 %RH to 100 %RH
Ambient temperature	+10°C to +40°C
Ambient pressure	660 mbar to 1060 mbar
Ambient humidity	10 %RH to 98 %RH (non-condensing)

The displayed ranges of parameter values depend on the host device. For more information, refer to the host device's user documentation.

Airway pressure

Measurement range	-20 cmH_2O to +100 cmH_2O
Accuracy	±1 cmH_2O
Time resolution	10 ms

Values calculated from the measured airway pressure data:

- Peak pressure (Ppeak)
- Plateau pressure (Pplat)
- Mean pressure (Pmean)
- Positive end expiratory pressure (PEEPtot or PEEPi and PEEPe)
- Static positive end expiratory pressure (static PEEPe and static PEEPi)

Airway gas flow

Measurement range	Adults: -100 l/min to +100 l/min Pediatric patients: -25 l/min to +25 l/min
Time resolution	10 ms

Flow measurement has automatic compensation for airway pressure and effects caused by variation in the concentrations of the gas components measured by the module.

Tidal volume

The module calculates the volume by integrating the measured gas flow over time. Tidal volumes (TVinsp and TVexp) are obtained as the change of volume during inspiration and expiration.

Measurement range	With D-lite: 150 ml to 2000 ml With Pedi-lite: 5 ml to 300 ml
Accuracy	With D-lite: ±6% or 30 ml (whichever is greater)
• Accuracy verified at ATPD conditions.	With Pedi-lite: ±6% or 4 ml (whichever is greater)

Minute volume

The module calculates the inspired and expired minute volumes as the sum of inspired (MVinsp) and expired (MVexp) gas volume during one minute.

Measurement range	With D-lite: 2 l to 20 l With Pedi-lite: 0.1 l to 5 l

Compliance

The module calculates both the compliance (Compl) and static compliance (static Compl). Compliance is calculated by dividing the expired gas volume (TVexp) by the change in the airway pressure (Pplat - PEEPtot). Static compliance is calculated by dividing TVexp by the difference of static Pplat and static PEEPtot.

Measurement range	Adults: 4 ml/cmH_2O to 100 ml/cmH_2O Pediatric patients: 1 ml/cmH_2O to 100 ml/cmH_2O

Airway resistance

The module calculates the airway resistance (Raw) by solving the lung model equation P(t) = Raw * F(t) + V(t) / Compl + PEEPtot

where: P(t), F(t) and V(t) are the time dependent waveforms of pressure, flow, and volume, respectively

Measurement range	0 cmH_2O/l/s to 200 cmH_2O/l/s

Inspiration to expiration ratio

The module measures ratio of the inspiratory and expiratory time (I:E). The inspiratory time is the time from the start of inspiration to the start of expiration. The end inspiratory pause, if one exists, is included in the inspiration. Accordingly, expiratory time is the time from the start of expiration to the start of the next inspiration.

Gas exchange specifications

General characteristics

Not valid with N_2O, Xenon, or Helium.

Specifications are valid at the following operating conditions:

The module has been operating continuously for >20 minutes.

Ambient temperature	+18°C to +28°C, within ±5°C of gas calibration
Ambient pressure	660 mbar to 1060 mbar, ±67 mbar of gas calibration

General characteristics

Ambient humidity	20 %RH to80 %RH (non-condensing), ±20 %RH of gas calibration
Sampling line length	2 meters
Airway adapter, adult	D-lite
Airway adapter, pediatric	Pedi-lite
Respiration rate	Adults: 4 to 35 breaths/min Pediatric patients: 8 to 35 breaths/min
Tidal volume	Adults: 150 to 1500 ml Pediatric patients: 50 to 300 ml
Minute volume	Adults: 4 to 14 liters Pediatric patients: 1 to 5 liters
I:E ratio	1:4.5 to 2:1
Airway humidity	10 %RH to 100 %RH
Airway compliance	Adults: 30 to 60 ml/cmH_2O Pediatric patients. 10 to 40 ml/cmH_2O
Airway resistance	Adults: 5 to 20 cmH_2O/l/s Pediatric patients: 10 to 40 cmH_2O/l/s
Airway PEEP	0 to 30 cmH_2O
FiO_2	≤ 85%

The displayed ranges of parameter values depend on the host device. For more information, refer to the host device's user documentation.

VCO_2 and VO_2 measurement range	20 to 999 ml/min
VCO_2 and VO_2 resolution	1 ml/min
VCO_2 and VO_2 accuracy (verified in room air conditions using dry gas.)	FiO_2 <65%: ±10% or 10 ml, whichever is greater FiO_2 <85%: ±15% or 15 ml, whichever is greater
VCO_2 and VO_2 measurement	Not valid with O_2+N_2O mixtures

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