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E SERIES®

End Tidal Carbon Dioxide ($EtCO_2$)

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9650-1212-01 Rev. E

The issue date or revision level for this Operator's Guide is shown on the front cover.

END-TIDAL CARBON DIOXIDE ($EtCO_2$)
General Information

Product Description

E Series® units equipped with software revision 2.00.000 or higher support two End Tidal Carbon Dioxide ($EtCO_2$) monitoring options for the continuous measurement of respiratory carbon dioxide (CO_2) and respiration rate. These options use the same connector on the E Series unit and may be used interchangeably.

The first option uses a unique, mainstream, solid-state, infrared sensor called the CAPNOSTAT® 5 Mainstream CO_2 Sensor. The CAPNOSTAT 5 CO_2 sensor is attached to an airway adapter that connects to an endotracheal (ET) tube or other airway and measures gases flowing through these breathing circuit components. A disposable mouthpiece may be connected to the adapter for monitoring non-intubated patients. A CAPNO$_2$*mask*™ is also available for use with non-intubated patients. This option provides for O_2 delivery while monitoring expired CO_2.

The second option is a sidestream sampling system called the LoFlo™ CO_2 Module. The LoFlo module contains a gas sampling pump, which draws small samples of gas from the patient's airway via a nasal/oral cannula or airway adapter, and passes these gases through a solid state infrared sensor (located away from the patient's airway) that measures CO_2. While the sidestream system is typically used on non-intubated patients, it can also be used for $EtCO_2$ measurement on intubated infant, pediatric and adult patients. The sidestream system should not be used, however, on patients who cannot tolerate the 50ml/min removal of the sample gases from their breathing circuit. The sidestream module uses specially designed cannulas and airway adapters for sampling airway gases and passing them through an integrated sample cell, which connects to the LoFlo module's CO_2 sensor. These cannulas incorporate a filter and sample cell, providing maximum filtration of fluids and contaminants, and protecting the system from aspiration of these fluids.

In both systems, the CO_2 sensor generates infrared light and beams it through the airway adapter or sample cell to a detector on the opposite side. CO_2 from the patient, flowing through the mainstream airway adapter or sample cell, absorbs some of this infrared energy. The E Series unit determines CO_2 concentration in the breathing gases by measuring the amount of light absorbed by gases flowing through the airway or sample cell.

The E Series unit displays $EtCO_2$ (the concentration of carbon dioxide detected at the end of each exhalation) as a numerical value in millimeters of mercury (mmHg), percent (%), or kilopascals (kPa). In addition, the unit can display a capnogram. This capnogram is a valuable clinical tool that can be used to assess patient airway integrity and proper endotracheal (ET) tube placement. The unit calculates respiration rate by measuring the time interval between detected peaks of the CO_2 waveform. The technology differentiates between waveforms caused by breathing and those caused by cardiogenic oscillations and artifact.

How to Use This Manual

This section explains how to set up and use the E Series End Tidal Carbon Dioxide option. Important safety information relating to general use of the E Series End Tidal Carbon Dioxide monitor appears in the "Safety Considerations" section of this manual.

The *E Series Operator's Guide* provides information operators need for the safe and effective use and care of the E Series unit. It is important that persons using this device read and understand all the information contained therein.

Please read both safety considerations and warnings sections thoroughly before operating your E Series unit.

All CAPNOSTAT 5 sensor, LoFlo module, airway adapter and cannula questions with regards to the Declaration of Conformity with European Union Directives should be directed to the authorized representative for Respironics Novametrix LLC:

Respironics Novametrix LLC
Authorized European Contact

Respironics Deutschland
Gewerbestrasse 17
82211 Herrsching
Germany
+49 8152 93060

Safety Considerations

WARNINGS

General

- Carefully read the *E Series Operator's Guide* and these operating instructions before operating the $EtCO_2$ monitoring option.
- Ensure that the E Series $EtCO_2$ option is operated by qualified personnel only.
- Do not use the E Series $EtCO_2$ option as an apnea monitor.
- Do not immerse the E Series unit, patient cables, or sensors in water, solvents, or cleaning solutions.
- If the accuracy of any reading is suspect, first check the patient's vital signs by alternate means and then check the E Series $EtCO_2$ option for proper operation.
- If an alarm condition occurs while the alarms are suspended, the suspended alarm indications will only be visual displays and symbols. No audio alarm indications will occur.
- Elevated oxygen levels, nitrous oxide, or halogenated agents contained in the breathing gases may degrade the accuracy of measurements made with the E Series $EtCO_2$ option. Activate oxygen compensation if O_2 levels in excess of 60% are introduced. Activate N_2O compensation if nitrous oxide is introduced into the airway circuit. The presence of Desflurane beyond 5% may positively bias the carbon dioxide reading by up to 3 mmHg.
- Do NOT use the LoFlo module on patients who cannot tolerate the removal of 50ml/min of breathing gases from the airway.
- Carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.
- Do not touch the bed, patient, or any equipment connected to the patient during defibrillation. A severe shock can result. Do not allow exposed portions of the patient's body to come in contact with metal objects, such as a bed frame, as unwanted pathways for defibrillation current may result.

CAPNOSTAT and Accessories

- Always ensure the integrity of the patient breathing circuit after insertion of the airway adapter by verifying a proper CO_2 waveform (capnogram) on the monitor display.
- Do not use CAPNOSTAT 5 or LoFlo sensors in the presence of flammable anesthetics or other flammable gases.
- Do not attempt to open the sensor. An electrical shock hazard exists internally. Refer servicing to qualified personnel.

CAUTIONS

- CAUTION: Federal (U.S.A.) law restricts this device to sale, or use by or on the order of a licensed medical practitioner.
- Use only ZOLL/Respironics Novametrix CAPNOSTAT 5 sensors and LoFlo modules, airway adapters, nasal and nasal/oral cannula sets with the E Series $EtCO_2$ option.
- The device is protected against interference from radio frequency emissions typical of two-way radios and cellular phones (digital and analog) used in emergency service/public safety activities. Users should assess the device's performance in their typical environment of use for the possibility of radio frequency interference from high-power sources. Radio Frequency Interference (RFI) may be observed as shifts in monitor baseline, trace compression, display brightness changes or transient spikes on the display.
- Do NOT sterilize or immerse the CAPNOSTAT 5 CO_2 sensor or LoFlo module.
- Do NOT reuse or sterilize the disposable airway adapter, airway adapter with mouthpiece, $CAPNO_2$*mask*, nasal or nasal/oral sampling cannula sets, or airway adapters, as system performance will be compromised. These items are intended for single patient use only.
- Do NOT use a damaged sensor or airway adapter.
- Do NOT use the device if it fails to operate properly.
- Do NOT place the mainstream or sidestream airway adapters between the ET tube and the breathing circuit elbow, as this may allow patient secretions to accumulate in the adapter.
- Position airway adapters with windows in a vertical, NOT a horizontal, position. This helps keep patient secretions from pooling on the windows.
- Do NOT insert any object other than the sample cell into the sample cell receptacle on the LoFlo module.
- Remove the LoFlo sample cell from the sample cell receptacle when not in use.
- Clean or replace the airway adapter if excessive secretions are observed.
- ZOLL Medical Corporation recommends that the airway adapter be removed from the circuit whenever aerosolized medication is delivered. The increased viscosity of the medications may contaminate the adapter windows, requiring premature cleaning or replacement of the adapter.
- In order to eliminate the potential build up of CO_2 inside the storage bag, ensure that the LoFlo module exhaust tube vents gases away from the module environment.
- To avoid injury to the patient, remove the nasal/oral cannula from the patient before cutting the oral cannula tip.
- Do NOT apply tension to the sensor cable.
- Periodically inspect the sampling tubing for the absence of kinks.
- Monitor the capnogram for an elevated baseline. If an elevated baseline is observed, verify patient condition first. If the care giver determines that the patient condition is not contributing to the elevated baseline, follow the instructions for zeroing the sensor or module detailed in this manual.
- Do NOT store sensors, modules, airway adapters, or cannula sets at temperatures less than -40° C or greater than 70° C.
- Do not operate CAPNOSTAT sensors at temperatures less than 0° C or greater than 45° C. Do not operate LoFlo modules at temperatures less than 0° C or greater than 40° C.
- Refer servicing to qualified personnel.
- Do not use the LoFlo module on E Series units that have a software version lower than 2.00.000.

$EtCO_2$ Indications for Use

The ZOLL E Series $EtCO_2$ option is indicated for the continuous noninvasive monitoring of end tidal carbon dioxide ($EtCO_2$) and respiration rate in patients requiring ventilator support, transport, or anesthesia. The E Series $EtCO_2$ option with Respironics Novametrix technology supports two methods for continuous measurement of end tidal carbon dioxide ($EtCO_2$) and respiration rate.

The first method uses the CAPNOSTAT 5 Mainstream CO_2 sensor attached to an airway adapter that connects to an endotracheal tube, mask or disposable mouthpiece.

The second method uses the LoFlo CO_2 module to monitor both non-intubated and intubated patients using specially designed sampling cannulas and airway adapters.

The E Series $EtCO_2$ option is designed to monitor adult, pediatric, and neonatal patients.

The following substances can influence CO_2 measurements made with the CAPNOSTAT 5 CO_2 sensor:

- elevated oxygen levels
- nitrous oxide
- halogenated agents

The E Series $EtCO_2$ option allows high oxygen and/or nitrous oxide compensation. Halogenated anesthetic agents alter CO_2 readings, but the E Series unit will monitor CO_2 within specifications when these agents are present at normal clinical levels. The presence of Desflurane in the exhaled breath beyond normal values (5-6%) may positively bias measured carbon dioxide values by up to an additional 2-3 mmHg.

The E Series $EtCO_2$ option is intended for use only with the ZOLL/Respironics Novametrix CAPNOSTAT 5 Mainstream CO_2 Sensor and the LoFlo CO_2 Module, mainstream airway adapters, nasal and nasal/oral sampling cannula sets, and sidestream on-airway adapters.

Mainstream $EtCO_2$ Setup

There are several steps involved with mainstream EtCO2 setup. These steps include:

- Attaching the CAPNOSTAT sensor cable.
- Selecting a mainstream airway adapter.
- Attaching the airway adapter to the CAPNOSTAT sensor.
- Zeroing the CAPNOSTAT sensor/airway adapter.
- Attaching the airway adapter to the airway circuit.
- Applying an airway adapter with mouthpiece.

Attaching the CAPNOSTAT 5 CO_2 Sensor Cable

To attach the CAPNOSTAT 5 CO_2 sensor cable, plug the cable's connector into the yellow CO_2 connector at the back of the E Series unit by matching the key on the cable to the key on the connector (Figure 1).

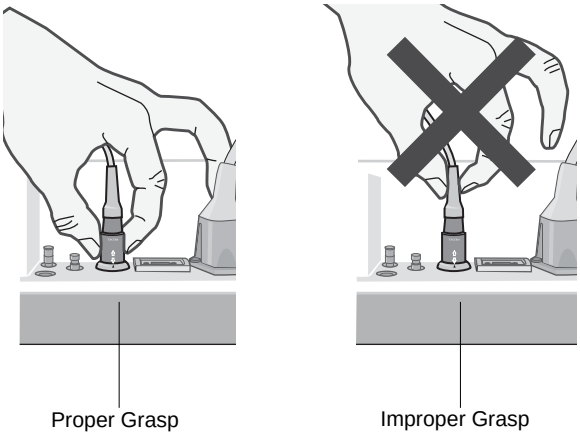


Figure 1

Note To remove the sensor cable from the E Series unit, grasp the collar surrounding the cable's E Series connector and pull up.

Selecting a Mainstream Airway Adapter

Select an airway adapter based on the patient's size, ET tube diameter and monitoring situation. For more information refer to the following table or contact ZOLL Medical Corporation.

Airway Adapter Type	ET Tube Diameter
SPU* Pediatric/Adult	> 4.0 mm
Adult Reusable	> 4.0 mm
SPU* Neonatal/Pediatric	≤ 4.0 mm
Neonatal Reusable	≤ 4.0 mm

*SPU = Single Patient Use

Attaching the Airway Adapter to the CAPNOSTAT 5 CO_2 Sensor

Before attaching the airway adapter to the CAPNOSTAT 5 CO_2 sensor, verify that the airway adapter windows are clean and dry. Clean or replace the adapter if necessary.

CAUTION! The disposable (SPU) Pediatric/Adult and the Neonatal/Pediatric airway adapters are intended for single patient use. Do NOT reuse or sterilize these adapters as system performance will be compromised.

Attach the airway adapter to the CAPNOSTAT sensor, as follows:

1. Align the arrow on the bottom of the airway adapter with the arrow on the bottom of the sensor.

2. Press the sensor and airway adapter together until they click.
3. Turn the Selector switch on the E Series unit to MONITOR (ON for AED units).
4. Wait for the airway adapter and sensor to warm up.

   The unit will display a *WARM UP* message for approximately one minute while the sensor and adapter warm to operating temperature. The message disappears when the sensor is ready to use.

Note Warm up time varies with ambient temperature of the sensor.

5. If the unit displays the *CHECK CO2 ADAPTER* message, follow steps a through c.

   a. Verify proper connection of the adapter to the sensor.

   b. Verify that the airway adapter windows are clean and dry.

   c. If the adapter is properly connected, and the windows are clean and dry, then zero the adapter as described in the next section, "Zeroing the Mainstream CAPNOSTAT 5 CO_2 Sensor/Airway Adapter."

Zeroing the Mainstream CAPNOSTAT 5 CO_2 Sensor/Airway Adapter

Adapter zeroing compensates for the optical differences between airway adapters and should be performed after switching between single patient use and reusable airway adapters, in order to obtain accurate readings.

Zeroing is also recommended the first time a particular CAPNOSTAT 5 CO_2 sensor is connected to the unit.

1. Place the sensor with the adapter installed away from all sources of CO_2 (including the patient's – and your own – exhaled breath and ventilator exhaust valves).
2. Press the **Param.** softkey and select the EtCO2 menu item, then press **Enter**.
3. Press the **Zero** softkey.

   The unit zeroes the adapter and displays the *ZEROING CO2 ADAPTER* message for 15 to 20 seconds.

   The unit displays the message *ZERO DONE* upon completion of the zeroing.

Note Do not attempt zeroing for 20 seconds after removing the adapter from the patient's airway. This time allows any CO_2 remaining in the adapter to dissipate before zeroing. Do not attempt to zero the adapter while it is connected to the patient's airway. Zeroing with CO_2 in the adapter can lead to inaccurate measurement and/or other error conditions. If you attempt zeroing while CO_2 remains in the adapter, the time required to zero the adapter may be increased. If zeroing cannot be completed, the message *ZERO FAILED* will be displayed. If this occurs, clear any occlusion in the adapter, remove any source of CO_2, wait 20 seconds, and try zeroing again.

Attaching the Airway Adapter to the Airway Circuit

If you have not yet done so, you must attach the airway adapter to the CAPNOSTAT 5 CO_2 sensor before attaching the airway adapter to the airway circuit. Refer to "Attaching the Airway Adapter to the CAPNOSTAT 5 CO2 Sensor" on page 4 if necessary.

Attach the airway adapter to the airway circuit as follows:

1. Place the CAPNOSTAT 5 CO_2 sensor/airway adapter assembly at the proximal end of the airway circuit between the elbow and the ventilator circuit wye. Do NOT place the airway adapter between the ET tube and the elbow, as this may allow patient secretions to accumulate in the adapter.

   Position the airway adapter with its windows in a vertical, NOT a horizontal, position. This helps keep patient secretions from pooling on the windows. If pooling does occur, the airway adapter may be removed from the circuit, rinsed with water and reinserted into the circuit. To prevent moisture from draining into the airway adapter, do NOT place the airway adapter in a gravity dependent position. See Figure 2.

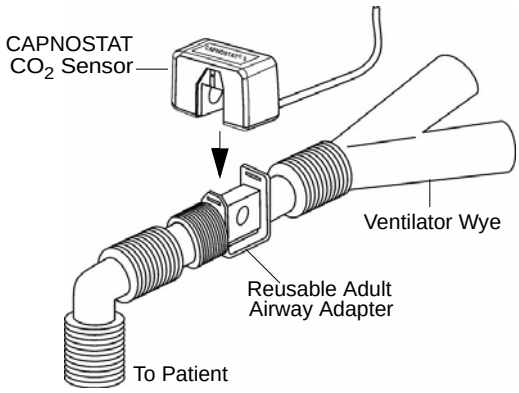


Figure 2

2. Check that connections have been made correctly by verifying the presence of a proper CO_2 waveform on the E Series display.
3. The sensor cable should face away from the patient.

Applying an Airway Adapter with Mouthpiece

The disposable Pediatric/Adult airway adapter with mouthpiece can be used for spot checking CO_2 on non-intubated adult or pediatric patients.

CAUTION! The disposable Pediatric/Adult Airway Adapter with mouthpiece is intended for single patient use. Do NOT reuse or sterilize the adapter, as system performance will be compromised.

1. Remove adapter with mouthpiece from the package. Verify that the adapter and mouthpiece are intact and securely fastened to each other.
2. Attach the airway adapter to the CAPNOSTAT 5 CO_2 sensor, as follows:
   a. Align the arrow on the bottom of the airway adapter with the arrow on the bottom of the CAPNOSTAT sensor.
   b. Press the sensor and airway adapter together until they click (see Figure 3).

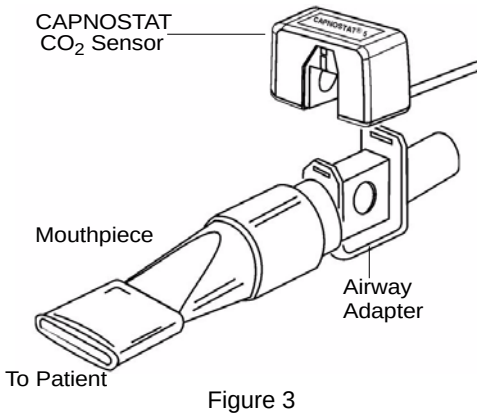


Figure 3

3. If the unit displays the *CHECK CO2 ADAPTER* message, follow steps a through c, else go to step 4.
   a. Verify proper connection of the adapter to the sensor.
   b. Verify that the airway adapter windows are clean and dry.
   c. If the adapter is properly connected, and the windows are clean and dry, then zero the adapter as described in “Zeroing the Mainstream CAPNOSTAT 5 CO2 Sensor/Airway Adapter” on page 5.
4. Ensure the patient seals his or her mouth completely around the mouthpiece and breathes normally.

A nose clip may be needed if the patient is exhaling through the nose. It is important that all, or most, of the exhalation be routed through the airway adapter.

Sidestream $EtCO_2$ Setup

There are several steps involved with sidestream $EtCO_2$ setup. These steps include:

- Attaching the LoFlo Module Cable
- Selecting a Sidestream Airway Adapter Kit or Cannula
- Inserting the Sample Cell
- Zeroing the LoFlo CO_2 Module/Sample Cell
- Applying a Sidestream Airway Adapter Kit
- Applying a Nasal or Nasal/Oral Cannula

Attaching the LoFlo Module Cable

To attach the LoFlo module cable, plug the cable into the yellow CO_2 connector at the back of the E Series unit by matching the key on the cable to the key on the connector.

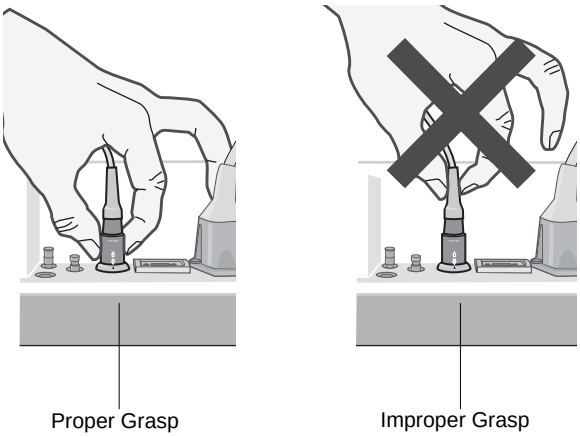


Figure 4

To remove the sensor cable from the E Series unit, grasp the collar surrounding the cable’s E Series connector and pull up.

Selecting a Sidestream Airway Adapter Kit

Select an airway adapter kit based on the patient's size, ET tube diameter, and monitoring situation. Airway adapter kits are disposable and single patient use.

Airway Adapter Kit	ET Tube Diameter
Adult/Pediatric Airway Adapter Kit	> 4.0 mm
Adult/Pediatric Airway Adapter Kit with Nafion® tubing	
Pediatric/Infant Airway Adapter Kit	≤ 4.0 mm
Pediatric/Infant Airway Adapter Kit with Nafion tubing	

Note For monitoring times exceeding 6 hours, Nafion tubing is recommended.

Selecting a Sidestream Cannula

Select a sidestream cannula based on the patient's size and monitoring situation. Nasal and nasal/oral cannulas are disposable and single patient use.

Cannula	Application
Nasal CO_2 Sampling Cannula, Adult	Nasal CO_2 sampling only
Nasal CO_2 Sampling Cannula, Pediatric	
Nasal CO_2 Sampling Cannula, Infant	
Oral/Nasal CO_2 Sampling Cannula, Adult	Oral/Nasal CO_2 sampling only
Oral/Nasal CO_2 Sampling Cannula, Pediatric	
Nasal CO_2 Sampling with O_2 Delivery Cannula, Adult	Nasal CO_2 sampling with oxygen delivery
Nasal CO_2 Sampling with O_2 Delivery Cannula, Pediatric	
Oral/Nasal CO_2 Sampling with O_2 Delivery Cannula, Adult	Oral/Nasal CO_2 sampling with oxygen delivery
Oral/Nasal CO_2 Sampling with O_2 Delivery Cannula, Pediatric	

Inserting the Sample Cell

Follow these steps:

1. Remove the LoFlo sampling cannula or airway adapter kit from the package.
2. Insert the LoFlo sample cell into the LoFlo sample cell receptacle and ensure that it clicks into place.

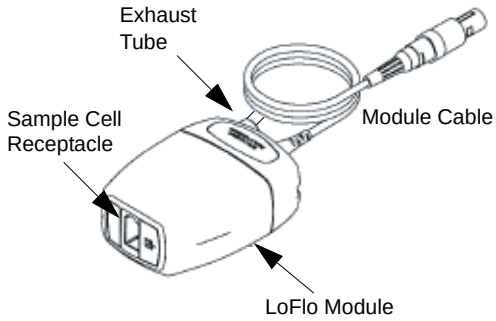


Figure 5

3. Ensure that the LoFlo module exhaust tube vents gases away from the module environment.
4. Turn the selector switch on the E Series to MONITOR (ON for AED units).
5. Wait for the CO_2 module to warm up.

   The unit will display the *WARM UP* message for approximately one minute while the module warms up to operating temperature. The message disappears when the module is ready for use.

Note Warm up time varies with ambient temperature of the module.

Zeroing the LoFlo CO_2 Module/Sample Cell

The module/sample cell zero allows the LoFlo CO_2 module to adjust to the optical characteristics of the sample cell. While zeroing is recommended the first time a particular LoFlo module is connected to the unit, it is only absolutely necessary when the message *ZERO CO2 MODULE* is displayed.

CAUTION! Always ensure that the sample cell is properly connected to the LoFlo module before zeroing.

1. Ensure that the nasal cannula or on-airway adapter is not connected to the patient or close to any source of CO_2 (including the patient's -- and your own -- exhaled breath and ventilator exhaust valves).
2. Press the **Param.** softkey and select the EtCO_2 menu item, then press **Enter**.
3. Press the **Zero** softkey.

   The unit zeroes the module and displays the *ZEROING CO2 MODULE* message for approximately 15-20 seconds.

   The units displays the message *ZERO DONE* upon completion of the zeroing.

Note Do not attempt zeroing for 20 seconds after removing the adapter or cannula from the patient's airway. This time allows any CO_2 remaining in the adapter or cannula to dissipate before zeroing. Do not attempt to zero the module while the adapter or cannula is in the patient's airway. Zeroing with CO_2 in the adapter or cannula can lead to inaccurate measurements and/or other error conditions. If you attempt zeroing while CO_2 remains in the adapter or cannula, the time required to zero the module may be increased. If zeroing cannot be completed, the message "ZERO FAILED" will be displayed. If this occurs, clear any occlusion in the adapter or cannula, remove the source of CO_2, wait 20 seconds, and try zeroing again.

Applying a Sidestream Airway Adapter Kit

The sidestream airway adapter kit is intended for monitoring the EtCO_2 of intubated patients.

Before attaching the airway adapter to the breathing circuit, verify that the adapter is clean, dry, and undamaged. Replace if necessary.

CAUTION! The disposable (SPU) Adult/Pediatric and Pediatric/Infant airway adapter kits are intended for single patient use. Do NOT reuse or sterilize these adapters as system performance will be compromised.

1. Attach the airway adapter kit's sample cell to the sample cell receptacle on the LoFlo module, and ensure that it clicks into place.
2. If the unit displays either of the following messages take the appropriate action.

If you see this message:	Take this action:
CHECK CO2 LINE	Verify that the sample cell is plugged into the module and seated properly. Verify that neither the sample line nor the exhaust tube are blocked, kinked, or pinched. Verify that the airway adapter is not blocked. If the sample line, exhaust tube, or the airway adapter is blocked or otherwise compromised for 15 seconds, this message will appear. The pump will shut off after 2 minutes if the condition that caused the message is not cleared. To restart the pump, correct the blockage, then remove and reinsert the sample cell into the sample cell receptacle. If the problem persists, replace the sample line.
CHECK CO2 MODULE	Check that module cable is plugged in and seated properly. Check that module is not exposed to excessive heat. If problem persists, replace module.

3. Place the airway adapter assembly at the proximal end of the airway circuit between the elbow and the ventilator circuit wye. Do NOT place the airway adapter between the ET tube and the elbow as this may allow patient secretions to accumulate in the adapter.

   If pooling does occur, the airway adapter may be removed from the circuit, rinsed with water and reinserted into the circuit. To prevent moisture from draining into the sample tubing, ensure that the sampling tube exits from the top of the airway adapter, not its bottom or sides. See Figure 6.

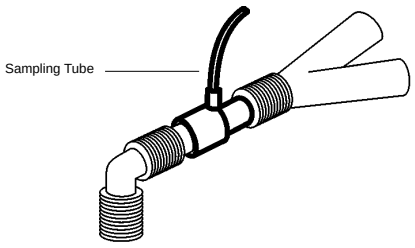


Figure 6

4. Check that connections have been made correctly by verifying the presence of a proper capnogram on the E Series display.

Applying a Nasal or Nasal/Oral Cannula

The nasal and nasal/oral cannulas are intended for monitoring $EtCO_2$ in non-intubated patients.

Oral/nasal sampling cannulas should be used on patients who are prone to mouth breathing, since most (if not all) of the CO_2 is exhaled through the mouth. If a standard nasal CO_2 sampling cannula is used on such patients, the $EtCO_2$ values and capnogram displayed will be substantially lower than the actual CO_2 levels present in the patient's expired breath.

CAUTION! The disposable nasal and nasal/oral cannula sets are intended for single patient use. Do NOT reuse or sterilize the cannula, as system performance will be compromised.

1. Remove the cannula from the package. Verify that the cannula is clean, dry, and undamaged. Replace if necessary.
2. Attach the cannula's sample cell to the sample cell receptacle on the LoFlo module, and ensure that it clicks into place.
3. If the unit displays either of the following messages take the appropriate action.

If you see this message:	Take this action:
CHECK CO2 LINE	Verify that the sample cell is plugged into the module and seated properly. Verify that neither the sample line nor the exhaust tube are blocked, kinked, or pinched. If the sample line, or exhaust tube is blocked or otherwise compromised for 15 seconds, this message will appear. The pump will shut off after 2 minutes if the condition that caused the message is not cleared. To restart the pump, correct the blockage, then remove and reinsert the sample cell into the sample cell receptacle. If the problem persists, replace the sample line.
CHECK CO2 MODULE	Check that module cable is plugged in and seated properly. Check that module is not exposed to excessive heat. If problem persists, replace module.

4. Place the nasal cannula onto the patient as shown in Figure 7.

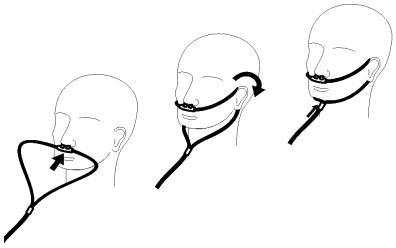


Figure 7

5. Place the oral/nasal cannula onto the patient as shown in Figure 8.

Figure 8

Cleaning the CAPNOSTAT 5 CO_2 Sensor and LoFlo Module

The outside of the sensor or module may be cleaned and disinfected by wiping with 70% isopropyl alcohol, a 10% bleach solution, or mild soap.

After cleaning, wipe with a clean, water-dampened cloth to rinse. Dry before use.

Cleaning Reusable Airway Adapters

Reusable airway adapters may be cleaned by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant such as 70% isopropyl alcohol, a 10% bleach solution, Cidex® or System 1® (refer to the disinfectant manufacturer's instructions for use). Adapters should then be rinsed with sterile water and dried.

Reusable airway adapters may also be pasteurized or autoclaved. Autoclave at 121° C (250° F) for 20 minutes, unwrapped.

Before reusing the adapter, ensure the windows are dry and residue-free, and that the adapter has not been damaged during handling or by the cleaning process.

How $EtCO_2$ is Displayed

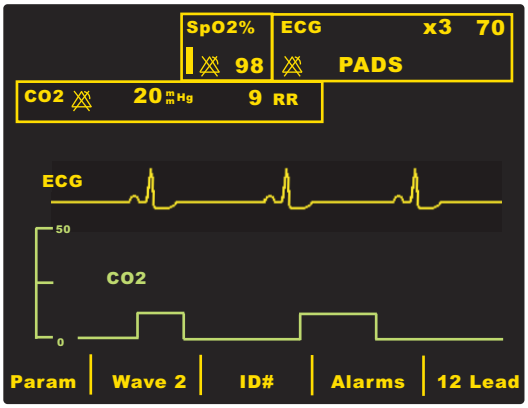
The E Series unit displays the numeric $EtCO_2$ value in units of mmHg, unless configured for percent or kPa. Refer to the *E Series Configuration Guide* (Part No. 9650-1201-01) for instructions on how to configure alternate units of measure. The unit also displays the number of breaths per minute, labeled "RR" for respiration rate. In addition, a capnogram may be displayed using the **Wave 2** softkey.

Displaying the Capnogram Waveform

The E Series unit can display one or two waveforms in Monitor, Defib, or Manual (AED) mode, as long as the defibrillator is not charging or ECG analysis is not in progress. The unit displays only one waveform in Pacer mode.

Note If you don't see the CO_2 display box on the monitor, check the sensor cable connection to the E Series unit. The CO_2 box is not displayed if the sensor is not connected to the unit. Once the box is displayed, after power-on, it remains displayed even if the sensor is disconnected from the unit.

With $EtCO_2$ monitoring, the unit can display a capnogram below the ECG trace for a visual indicator of the moment-by-moment CO_2 values. The unit displays the capnogram at half the speed of the ECG display, and provides 8 seconds of data.



The unit temporarily removes the second waveform from the display when the user presses the **CHARGE**, **ANALYZE**, or **ENERGY SELECT** buttons, or the **Sync On/Off** softkey. The unit restores the second waveform to the display 4 seconds after:

- a shock is delivered
- an analysis is completed, unless the defibrillator is charging
- the last **Energy Select** button press
- Sync mode is turned off

To cycle the display from the capnogram, to the plethysmograph waveform (if SpO_2 is installed), to no second waveform displayed, press the **Wave 2** softkey.

Use the **Zoom** softkey from the $EtCO_2$ submenu to adjust the waveform display size. Numbers shown on the left side of the capnogram display indicate the scaling.

Physiological Monitoring

The physiological monitoring menu includes the following softkeys: **Param**, **Wave 2**, **ID#**, **Alarms**, and **12 Lead**.

Param Softkey

When you press the **Param** softkey, the following softkeys are displayed: **Select**, **Enter**, and **Return**.

Press the:

- **Select** softkey to scroll among the different available physiological parameters.
- **Enter** softkey to select the parameter that is highlighted.
- **Return** softkey to return to the physiological monitoring menu.

Selecting the EtCO2 parameter causes the following softkeys to appear: **Zero, Disable EtCO2** (or **Enable EtCO2**)**, Zoom, MORE**, and **Return**.

Pressing the:

- **Disable EtCO2** softkey puts the sensor into the power saving sleep mode.
- **Enable EtCO2** takes the sensor out of sleep mode and turns the heater on for normal operation.
- **MORE** softkey causes the following softkeys to appear: **Average, Comp., RR Filter Disable,** (or **RR Filter Enable**), **MORE**, and **Return**.
- **Return** softkey returns you to the physiological monitoring menu.

See the next sections for a description of the Zero and Zoom softkey functions.

Pressing the MORE softkey causes the previous selections to appear. Pressing the Return softkey returns the user to the physiological monitoring menu. Refer to the sections "Average Softkey," "Comp. Softkey," and "RR Filter Enable/Disable" for descriptions of those softkey functions.

Zero Softkey

Adapter zeroing should be performed whenever you change between reusable and disposable adapters. Module zeroing may be necessary if the unit displays the message *ZERO CO2 MODULE*. Adapter zeroing may also be necessary if the unit displays *CHECK CO2 ADAPTER.*

Note Do not attempt zeroing for 20 seconds after removing the adapter or cannula from the patient's airway. This time allows any CO_2 remaining in the adapter or cannula to dissipate before zeroing. Do not attempt to zero while the adapter or cannula is in the patient's airway. Zeroing with CO_2 in the adapter or cannula can lead to inaccurate measurements and/or other error conditions. If you attempt zeroing while CO_2 remains in the adapter or cannula, the time required to zero may be increased. If zeroing cannot be completed, the message *ZERO FAILED* will be displayed. If this occurs, clear any occlusion in the adapter or cannula, remove any source of CO_2, wait 20 seconds, and try zeroing again.

Pressing the **Zero** softkey initiates adapter or module zeroing.

The unit displays the *ZEROING CO2 ADAPTER* or *ZEROING CO2 MODULE* message during the zeroing process, which is typically finished in 15 - 20 seconds.

The unit displays the *ZERO DONE* message when the zeroing process is complete.

The unit displays the *ZERO FAILED* message if the zeroing process did not complete successfully. If this occurs, clear any occlusion in the adapter or sample line, remove any source of CO_2, and try zeroing again.

Pressing **Return** returns the user to the $EtCO_2$ submenu.

Zoom Softkey

Select the full scale range for the displayed capnogram by pressing the **Zoom** softkey to scroll among the different zoom levels. Zoom levels change with each press of the **Zoom** softkey. They are as follows:

- 0-12.5 mmHg
- 0-25 mmHg
- 0-50 mmHg
- 0-75 mmHg
- 0-100 mmHg
- 0-150 mmHg

If the unit is using kPa or %, the scales are 0-1.7, 0-3.3, 0-6.6, 0-10, 0-13.3, and 0-20.0. (Refer to the *E Series Configuration Guide* for instructions on how to configure alternate units of measure.)

Average Softkey

The E Series unit provides 3 different time periods over which $EtCO_2$ values are averaged: 1 breath, 10 seconds (default), and 20 seconds.

The user can select the averaging period by pressing the **Average** softkey. When the **Average** softkey is pressed, the unit displays the **Average**, **Enter**, and **Return** softkeys.

Pressing the **Average** softkey scrolls the highlighted area among the different averaging periods.

Pressing the **Enter** softkey allows the user to select the highlighted averaging period. Pressing the **Return** softkey returns the user to the $EtCO_2$ submenu.

Comp. Softkey

The E Series unit can compensate for elevated levels of oxygen and/or the presence of nitrous oxide. Oxygen compensation should be activated when oxygen levels in excess of 60% are present in the airway circuit. Nitrous oxide compensation should be activated when nitrous oxide is present in the airway circuit. If the concentration of oxygen in the breathing circuit exceeds 60% and nitrous oxide is in use, both O_2 and N_2O should be activated.

When the **Comp** softkey is pressed, the unit displays the **Comp.**, **Enter**, and **Return** softkeys.

Pressing the **Comp.** softkey scrolls the highlight among the different types of compensation available.

The O2&N2O selection turns oxygen and nitrous oxide compensation on. The unit displays two asterisks (*) on the left side of the CO2 field to indicate compensation for both oxygen and nitrous oxide. The left asterisk indicates oxygen compensation is active and the right asterisk indicates nitrous oxide compensation is active.

The O2 selection turns oxygen compensation on and displays an asterisk in the far left of the CO2 field. The N2O selection turns nitrous oxide compensation on and displays an asterisk to the right of the O2 asterisk. The None selection turns all compensations off and eliminates the asterisks from the display.

After selecting the appropriate compensation press **Enter** to activate the selected function. Pressing the **Return** softkey returns the user to the $EtCO_2$ submenu.

RR Filter Enable/Disable

The respiration rate filter makes respiration rate counting more accurate in the presence of artifact, and is only valid when the LoFlo module is in use. Pressing the:

- **RR Filter Enable** softkey turns the respiration rate filter on.
- **RR Filter Disable** softkey turns the respiration rate filter off.

Note that when the RR filter is in use, the E Series adapts more slowly to sudden changes in respiratory rate.

Alarms

The E Series $EtCO_2$ option provides user programmable "out-of-range" alarms for both $EtCO_2$ and respiration rate.

The $EtCO_2$ and respiration rate alarms share the same State field, therefore you cannot enable or disable them separately. Enabling the $EtCO_2$ alarms enables both $EtCO_2$ and respiration rate alarm functions; disabling $EtCO_2$ or respiration rate alarms disables both functions. See the *E Series Operator's Guide* for details on enabling, disabling, and suspending alarm functions on the E Series unit.

When the $EtCO_2$ and respiration rate alarm states are set to AUTO, the unit automatically sets the lower and upper limits for $EtCO_2$ and respiration rate.

For $EtCO_2$, the unit sets the upper and lower alarm limits to +/- 25% of the patient's currently measured CO_2 value. If the $EtCO_2$ value is greater than 40 mmHg (equivalent to 5.3 kPa or 5.3% at a barometric pressure of 760 mmHg), then 10 mmHg (1.3 for kPa or %) is added and subtracted from the current reading to set the upper and lower limits. The auto alarm limits are set only if valid measurements are present for the vital sign.

For the automatic respiration rate alarm limits, the unit sets the upper and lower limits for respiration by adding and subtracting the values shown in the following table to/from the patient's current breath rate.

Respiration Limits (Auto)		
Respiration Rate Average	**High Limit**	**Low Limit**
1-15 breaths/min.	+7 breaths/min.	-50% value
16-40 breaths/min.	+10 breaths/min.	-7 breaths/min.
> 40 breaths/min.	+15 breaths/min.	-10 breaths/min.

See "Default Settings" on page 14 for low and high alarm limit default values and ranges.

Recorder Operation

If $EtCO_2$ measurements have been taken, press the RECORDER button to print a stripchart that includes the following values across the top part of the paper:

- Date and time
- ECG lead and size
- Heart rate
- $EtCO_2$ value
- Respiration rate

The recorder runs continuously until the button is pressed again. If selected, the capnogram is also printed at a fixed scale of 40 mmHg/cm, under the ECG trace. All waveforms printed by the recorder are delayed by six seconds relative to their occurrence.

Automated External Defibrillator (AED) Operation

E Series AED units equipped with the $EtCO_2$ option operate in a slightly different way than Manual Advisory models equipped with $EtCO_2$.

Semi-Automatic Operation

The $EtCO_2$ monitoring parameters can be changed by pressing the **Param** softkey, as outlined in "Physiological Monitoring" on page 10. The capnogram waveform cannot be displayed in semi-automatic mode.

Although $EtCO_2$ alarm functions are operational in semi-automatic mode, heart rate alarm functions are disabled. Background ECG analysis functions continue to operate as described in the "AED" section of the *E Series Operator's Guide*.

The **ALARM SUSPEND** button can be used to activate, deactivate, or audibly disable the $EtCO_2$ alarms (as described in the *E Series Operator's Guide*). The alarm limit settings cannot, however, be changed in semi-automatic mode; only the default alarm limits are available. See the *E Series Configuration Guide* for information on setting alarm limit defaults.

Manual Mode Operation

When the AED unit is in manual mode, the unit can display the capnogram waveform as described in "Displaying the Capnogram Waveform" on page 10.

Both heart rate and $EtCO_2$ alarms are operational. The alarm limits can be changed by pressing the **Alarms** softkey. The $EtCO_2$ monitoring parameters can be changed by pressing the **Param** softkey, as outlined in "Physiological Monitoring" on page 10.

Check Out Procedures

The following procedures verify that the $EtCO_2$ option is functioning properly.

Mainstream $EtCO_2$ (CAPNOSTAT 5 CO_2 Sensor)

1. Connect the CAPNOSTAT 5 CO_2 sensor cable to the yellow $EtCO_2$ connector at the back of the E Series unit.
2. Connect an airway adapter to the CAPNOSTAT 5 CO_2 sensor.
3. Turn the selector switch to **MONITOR** mode (**ON** for AED units and select **Manual Mode**).
4. Wait for the CO_2 sensor to warm up. The message *WARM UP* is displayed for approximately one minute.
5. Perform a zero procedure if necessary (see “Zeroing the Mainstream CAPNOSTAT 5 CO2 Sensor/Airway Adapter” on page 5).
6. Breath normally into the adapter.
7. Verify that the unit displays appropriate readings in the $EtCO_2$ display area of the monitor.
8. Verify the capnogram is displayed by pressing the **Wave2** softkey.
9. With alarms enabled, verify that the patient alarms are functional by adjusting the high and low limits until the unit:
   - Emits a continuous audio tone.
   - Highlights the alarming parameter’s value and flashes the alarm symbol on the display.

Sidestream $EtCO_2$ (LoFlo Module)

Use an Adult/Pediatric Airway Adapter kit when performing this procedure.

1. Connect the LoFlo module cable to the $EtCO_2$ connector at the back of the E Series unit.
2. Insert the sample cell into the LoFlo module sample cell receptacle.
3. Turn the selector switch to **MONITOR** mode (**ON** for AED units and select **Manual Mode**), and wait approximately one minute while the module warms to operating temperature (unit displays *WARM UP* message).
4. Perform a zero procedure if necessary (see “Zeroing the LoFlo CO2 Module/Sample Cell” on page 7).
5. Breath normally into the adapter.
6. Verify that the unit displays $EtCO_2$ readings in the $EtCO_2$ display area of the monitor.
7. Verify the capnogram is displayed by pressing the **Wave 2** softkey.
8. With alarms enabled, verify that the patient alarms are functional by adjusting the high and low limits until the unit:
   - Emits a continuous audio tone.
   - Highlights the alarming parameter’s value and flashes the alarm symbol on the display.

Default Settings

When the unit is turned on, the following default $EtCO_2$ settings are automatically selected and remain in operation until changed.

Parameter	Default Setting	Range
Averaging Mode	10 seconds	1 breath 10 seconds 20 seconds
High $EtCO_2$ Alarm Limit	55 mmHg 7.2% 7.3 kPa	5 - 100 mmHg, OFF 0.6 - 13.1%, OFF 0.6 -13.3 kPa, OFF
Low $EtCO_2$ Alarm Limit	25 mmHg 3.2% 3.3 kPa	0 - 95 mmHg, OFF 0 - 12.5%, OFF 0 -12.6 kPa, OFF
High Respiration Rate Alarm Limit	120 respirations per minute	5 - 150 respirations per minute, OFF
Low Respiration Rate Alarm Limit	5 respirations per minute	0 - 100 respirations per minute, OFF

Note The power-on default settings for the capnogram waveform scale and CO_2 compensation are set in System Configuration, as are the power-on default settings for alarm limits. See the *E Series Configuration Guide* for more information.

$EtCO_2$ Accessories

The following table lists the accessories available for the E Series mainstream $EtCO_2$ monitoring option.

Table 1: CAPNOSTAT 5 Mainstream CO_2 Accessories

Accessory	REF	Application
CAPNOSTAT 5 CO_2 Sensor and Cable	8000-0312-01	
SPU* Pediatric/Adult Airway Adapter	8000-0260-01	Single patient use, for ET tube sizes > 4.0 mm
SPU* Neonatal/Pediatric Airway Adapter	8000-0261-01	Single patient use, for ET tube sizes ≤ 4.0 mm
Reusable Adult Airway Adapter	8000-0262-01	Reusable, for ET tube sizes > 4.0 mm
Reusable Neonatal/Pediatric Airway Adapter	8000-0263-01	Reusable, for ET tube sizes ≤ 4.0 mm
SPU* Pediatric/Adult Airway Adapter with Mouthpiece	8000-0265-01	Single patient use, for non-intubated patients
$CAPNO_2$*mask*, Large Adult	8000-0761	SPU, for non-intubated large adults
$CAPNO_2$*mask*, Standard Adult	8000-0760	SPU, for non-intubated adults
$CAPNO_2$*mask*, Pediatric	8000-0762	SPU, for non-intubated adults pediatric patients

* SPU = Single Patient Use

Table 2: LoFlo Sidestream CO_2 Accessories

Accessory	REF	Application
LoFlo Module and Cable	8000-0367	
Nasal CO_2 Sampling Cannula, Adult	8000-0351	SPU, Nasal CO_2 sampling only (adult)
Nasal CO_2 Sampling Cannula, Pediatric	8000-0352	SPU, Nasal CO_2 sampling only (pediatric)
Nasal CO_2 Sampling Cannula, Infant	8000-0353	SPU, Nasal CO_2 sampling only (neonate)
Oral/Nasal CO_2 Sampling Cannula, Adult	8000-0354	SPU, Oral/Nasal CO_2 sampling only (adult)
Oral/ Nasal CO_2 Sampling Cannula, Pediatric	8000-0355	SPU, Oral/Nasal CO_2 sampling only (pediatric)
Nasal CO_2 Sampling with O_2 Delivery Cannula, Adult	8000-0356	SPU, Nasal CO_2 sampling with O_2 delivery (adult)
Nasal CO_2 Sampling with O_2 Delivery Cannula, Pediatric	8000-0357	SPU, Nasal CO_2 sampling with O_2 delivery (pediatric)
Oral/Nasal CO_2 Sampling with O_2 Delivery Cannula, Adult	8000-0358	SPU, Oral/Nasal CO_2 sampling with O_2 delivery (adult)
Oral/Nasal CO_2 Sampling with O_2 Delivery Cannula, Pediatric	8000-0359	SPU, Oral/Nasal CO_2 sampling with O_2 delivery (pediatric)
Adult/Pediatric Airway Adapter Kit	8000-0362	SPU, for ET tube sizes > 4.0 mm
Adult/Pediatric Airway Adapter Kit with Nafion tubing	8000-0363	SPU, for ET tube sizes > 4.0 mm
Pediatric/Infant Airway Adapter Kit	8000-0361	SPU, for ET tube sizes ≤ 4.0 mm
Pediatric/Infant Airway Adapter Kit with Nafion tubing	8000-0364	SPU, for ET tube sizes ≤ 4.0 mm

* SPU = Single Patient Use

Note Components of this product and its associated $EtCO_2$ accessories that make patient contact are free of latex.

Note: The CAPNOSTAT 5 CO_2 sensor and its accessories are covered by the following US patents:

- 4,859,858
- 4,859,859
- 4,914,720
- 5,146,092
- 5,153,436
- 5,369,277
- 5,616,923
- 5,793,044

Other patents pending.

Messages and Troubleshooting

The following three tables list the messages that may appear on the E Series unit, possible causes, and the action(s) to take if the message indicates a problem. You should become thoroughly familiar with this information before monitoring patients.

COMMON MESSAGES		
Message/Symptom	**Possible Cause(s)**	**Recommended Action(s)**
----- (dashed lines in $EtCO_2$ field)	After a defibrillation discharge, the numeric value displays as "----" for approximately 10 seconds. When the respiration rate is zero, the numeric CO_2 value will display "---". When the respiration rate is greater than zero, the actual CO_2 numeric value will be displayed. Cable not plugged in. Cable defective.	None, normal operation. Check/replace sensor or module.
----- (dashed lines at top of capnograph waveform)	The scale value setting is incorrect. CO_2 higher than scale limits was detected.	Adjust to higher scale setting using the Zoom key.
CAL BARO PRESSURE	Barometric pressure reading is out of range.	Calibrate the barometric pressure as described in the *E Series Service Manual*.
CO2 COMM ERROR	There is no communication from the $EtCO_2$ module or sensor.	Turn E Series unit off, then on again to reset. Try another $EtCO_2$ sensor. If the problem persists, return sensor and/or unit for service.
CO2 DEVICE NOT READY	The zero operation cannot be initiated because: • The sensor or module is still warming up. • No sensor or module is attached to the unit. • The sample cell is not plugged into the module. • Zeroing was attempted within 20 seconds of a detected breath.	 Wait for sensor or module to warm up. Attach sensor or module to the unit. Plug sample cell into sample cell receptacle on module.
CO2 OUT OF RANGE (dashed lines for CO_2)	The calculated CO_2 value is greater than 150 mmHg.	If error persists, perform a mainstream airway adapter or module zero, as described in "Zeroing the Mainstream CAPNOSTAT 5 CO2 Sensor/Airway Adapter" on page 5 and "Zeroing the LoFlo CO2 Module/Sample Cell" on page 7.
CO2 UNIT ERROR	The $EtCO_2$ sensor or module has detected a hardware error.	Check that the sensor is properly plugged in. Reinsert the sensor. Turn E Series unit off, then on again to reset. Perform a mainstream airway adapter or module zero, as described in "Zeroing the Mainstream CAPNOSTAT 5 CO2 Sensor/Airway Adapter" on page 5, and "Zeroing the LoFlo CO2 Module/Sample Cell" on page 7. If the problem persists, contact Technical Support.
WARM UP	The mainstream sensor or LoFlo module is warming up. This may take up to 5 minutes.	Wait for sensor or module to warm up. If the message persists more than 5 minutes, replace the sensor.

COMMON MESSAGES (Continued)		
Message/Symptom	**Possible Cause(s)**	**Recommended Action(s)**
ZERO DONE	The sensor/adapter zero, or the LoFlo module zero is finished.	No action required.
ZERO FAILED	The zero operation did not complete successfully.	Clear the occlusion, remove any source of CO_2, and try zeroing again. If problem persists, contact Technical Support.

MAINSTREAM MESSAGES		
Message/Symptom	**Possible Cause(s)**	**Recommended Action(s)**
CHECK CO2 ADAPTER	This is usually caused when the airway adapter is removed from the CAPNOSTAT 5 CO_2 sensor, or when there is an optical blockage on the windows of the airway adapter. It may also be caused by not having performed an adapter zero after changing the adapter type (single patient use vs. reusable).	Clean the airway adapter and reattach it. If the problem persists or the adapter type was changed, perform a mainstream airway adapter zero as described in “Zeroing the Mainstream CAPNOSTAT 5 CO2 Sensor/ Airway Adapter” on page 5.
CHECK CO2 SENSOR	The CAPNOSTAT 5 CO_2 sensor cable is not properly plugged in or is over temperature.	Check that the sensor cable is plugged in and properly seated in the connector. Check that the sensor is not exposed to excessive heat. If the problem persists, replace the sensor.
CO2 IN ADAPTER: WAIT	There is CO_2 in the airway adapter when attempting to zero. Zeroing was attempted within 20 seconds of previous zero operation.	Remove airway adapter from CO_2 source including the patient’s, and your own exhaled breaths, and ventilator exhaust valves. Wait up to 20 seconds before retrying a mainstream airway adapter zero, as described in “Zeroing the Mainstream CAPNOSTAT 5 CO2 Sensor/Airway Adapter” on page 5.
ZERO CO2 ADAPTER	Negative CO_2 detected. May be caused by a sensor that was zeroed with CO_2 in the airway, or by an optical blockage of the airway adapter.	Check the airway adapter and clean if necessary. Perform a mainstream airway adapter zero as described in “Zeroing the Mainstream CAPNOSTAT 5 CO2 Sensor/ Airway Adapter” on page 5.
ZEROING CO2 ADAPTER	Adapter zeroing is in progress.	Wait for the adapter zeroing to finish.

SIDESTREAM MESSAGES		
Message/Symptom	**Possible Cause(s)**	**Recommended Action(s)**
CHECK CO2 LINE	Sample line blockage or damage. Sample line is kinked or pinched. Exhaust tube is blocked.	Verify that the sample line is plugged into the module and seated properly. Verify that neither the sample line nor the exhaust tube are blocked, kinked, or pinched. Verify that the airway adapter is not blocked. If the sample line, exhaust tube, or the airway adapter is blocked or otherwise compromised for 15 seconds, this message will appear. The pump will shut off after 2 minutes if the condition that caused the message is not cleared. To restart the pump, correct the blockage, then remove and reinsert the sample cell into the sample cell receptacle. If the problem persists, replace the sample line.
CHECK CO2 MODULE	Module not properly plugged in. Module over temperature.	Check that module cable is plugged in and seated properly in the connector. Check that module is not exposed to excessive heat. If problem persists, replace module.
CO2 IN LINE: WAIT	CO_2 in cannula/adapter when attempting to zero. Sample line disconnected while zero in progress.	Wait up to 20 seconds before retrying module zero. Remove adapter or cannula tip from CO_2 source including the patient's - and your own - exhaled breaths, and ventilator exhaust valves.
ZERO CO2 MODULE	Negative CO_2 detected. May be caused by a module that was zeroed with CO_2 in the sample line.	Perform module zero as described in "Zeroing the LoFlo CO2 Module/Sample Cell" on page 7.
ZEROING CO2 MODULE	Module zeroing in progress.	Wait for module zeroing to finish.

Specifications

This section summarizes the specifications of the E Series End Tidal Carbon Dioxide ($EtCO_2$) option.

	CAPNOSTAT 5® CO_2 Sensor	**LoFlo™**
Transducer Type	Mainstream	Sidestream
Principle of Operation	Non-Dispersive Infrared (NDIR) single beam optics, dual wavelength, no moving parts.	
Warm Up Time	Full specifications within 2 minutes at an ambient temperature of 25º C. Capnogram in 15 seconds.	
$EtCO_2$ Measurement Range	0 - 150 mmHg 0 - 20% 0 - 20 kPa	
$EtCO_2$ Accuracy (at 760 mmHg, ambient temperature of 25°C)	0 - 40 mmHg, ±2 mmHg 41 - 70 mmHg, ±5% of actual 71 - 100 mmHg, ±8% of actual 101 - 150 mmHg, ±10% of reading (At respiration rates > 80 breaths per minute, all ranges are ±12% of actual.)	
$EtCO_2$ Resolution	0.1 mmHg 0 - 69 mmHg 0.25 mmHg 70 - 150 mmHg	
$EtCO_2$ Stability	Short-Term Drift: Drift over four hours ≤ 0.8 mmHg. Long-Term Drift: Accuracy specification will be maintained over a 120 hour period after zeroing.	
$EtCO_2$ Noise	RMS noise of the sensor ≤ 0.25 mmHg at 7.5% CO_2.	RMS noise of the sensor ≤ 0.25 mmHg at 5% CO_2.
$EtCO_2$ Rise Time (10-90%)	< 60 ms (Adult/pediatric adapters) < 60 ms (Infant/pediatric adapters)	< 3 seconds (includes transport and rise time)
Respiration Rate Range	2 - 150 breaths per minute	
Respiration Rate Accuracy	±1 breath per minute	
Sample Flow Rate	N/A	50 ml/min ±10 ml/min
Compensations	Barometric pressure 400 - 850 mmHg (automatic). Operator selectable O_2/N_2O compensation.	
$EtCO_2$ Alarm Limits	User selectable, High 5 - 100 mmHg, Low 0 - 95 mmHg, OFF.	
Respiration Rate (RR) Alarm Limits	User selectable, High 5 - 150 respirations per minute, Low 0 - 100 respirations per minute, OFF.	
Halogenated Agents	Specification allows for halogenated anesthetic agents that may be present at normal clinical levels. The presence of Desflurane in the exhaled breath beyond normal values (5-6%) may positively bias carbon dioxide values by up to an additional 2-3 mmHg.	
Airway Adapter Deadspace	Adult < 5 cc Infant < 1.0 cc	Adult < 7.3 cc Maximum Pediatric/Infant < 1.0 cc
Environmental (sensor or module)	Operating Temperature: 0º C to 45º C (0º C to 40º C for LoFlo Module) Storage and Shipping Temperature: -40º C to 70º C The E Series unit may not perform to specifications when stored at the upper or lower extreme limits of storage temperature and immediately put into use.	
Electromagnetic Immunity	AAMI DF-80:2003, IEC 60601-1-2, 10 V/m	

	CAPNOSTAT 5® CO_2 Sensor	**LoFlo™**
Software Hazards	Minimized by compliance with EN1441	
Operating Time $EtCO_2$ and SpO_2 Options	For a new fully charged PD4410 battery pack at 20º C (68° F): • 35 defibrillator discharges at maximum energy (200 J), or • 1.5 hours minimum of continuous ECG monitoring, or • 1.0 hour of continuous ECG monitoring/ pacing at 60 mA, 70 beats per minute.	For a new, fully charged lithium ion battery pack at 20°C (68°F): • 90 defibrillator discharges at maximum energy (200 J), or • 3.0 hours minimum of continuous ECG monitoring, or • 2.5 hours of continuous ECG monitoring/pacing at 60 mA, 70 beats per minute.