

# Single-width Airway Module, E-miniC

## Service Manual

Host software version 3

Module hardware version 00



Single-width Airway Module, E-miniC  
English  
3rd edition  
2098086-007  
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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.

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# About this manual

## Intended use of this manual

This manual contains instructions for the planned and corrective maintenance of the acquisition module. This manual must be used together with the monitor's service manual for important safety and installation information.

Use the manual as a guide for maintenance procedures and repairs considered field repairable. Where necessary the manual identifies additional sources of relevant information and technical assistance.

See the monitor's service manual for an overview of the patient monitoring system, information needed for system installation and for planned and corrective maintenance of the monitor.

See the monitor's supplemental information manual for the technical specifications, default settings and compatibility information, including electromagnetic compatibility.

See the monitor's user manual for the instructions necessary to operate the device safely in accordance with its function and intended use.

## Intended audience of this manual

This manual is intended for service representatives and technical personnel who maintain, troubleshoot, or repair this device.

## Manual conventions

This manual uses the following styles to emphasize text or indicate an action. Also note the terminology conventions.

Item	Description
<b>bold</b>	Indicates hardware keys and connectors.
<b><i>bold italic</i></b>	Indicates menu options, software keys and messages.
<i>italic</i>	Indicates terms for emphasis.
>	Indicates menu options to select consecutively.
select	The word select means choosing and confirming.
supplemental information	In this manual, the phrase supplemental information refers to information that appears in the Supplemental Information Manual or supplements provided.
<b>NOTE</b>	Note statements provide application tips or other useful information.

## Illustrations and names

This manual uses illustrations as examples only. Illustrations in this manual may not necessarily reflect all system settings, features, configurations, or displayed data.

Names of persons, institutions, and places and related information are fictitious; any similarity to actual persons, entities, or places is purely coincidental.

## Related documents

- CARESCAPE monitor's service manual
- CARESCAPE monitor's user manual
- CARESCAPE monitor's supplemental information manual
- Cleaning and Disinfecting Supplement
- Supplies and Accessories Supplement

## Product availability

### NOTE

Due to continual product innovation, design and specifications for these products are subject to change without notice.

Some of the products mentioned in this manual may not be available in all countries. Please consult your local representative for the availability.

## Trademarks

GE, GE Monogram, and CARESCAPE are trademarks of General Electric Company.

## Third party trademarks

All third party product and company names are the property of their respective owners.

## 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.
- The equipment is installed, maintained and serviced in accordance with the instructions provided in the related service manuals.

### WARNING

**SAFETY HAZARD.** To avoid risks to personnel and patient, or damage to the equipment, only perform maintenance procedures described in this manual. Unauthorized modifications can lead to safety hazards.



## Module introduction

### E-miniC module introduction

This document provides information for the maintenance and service of the Single-width Airway Module, E-miniC.

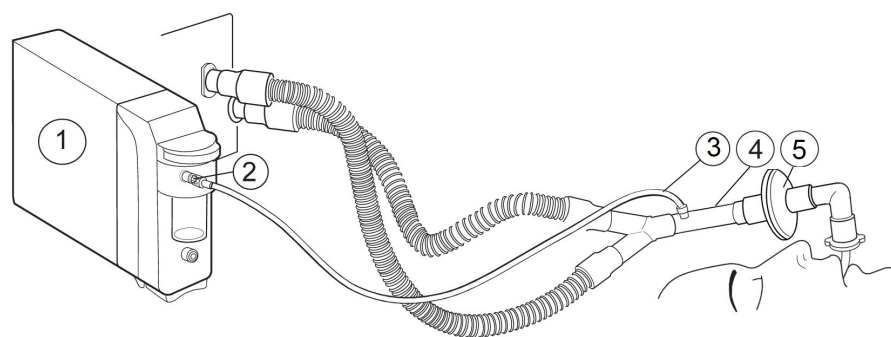
The Single-width Airway Module provides airway and respiratory measurements.

Letter C in the module name stands for CO<sub>2</sub>.

### Module compatibility

For detailed information regarding module, monitor, and accessory compatibility, see the supplemental information provided.

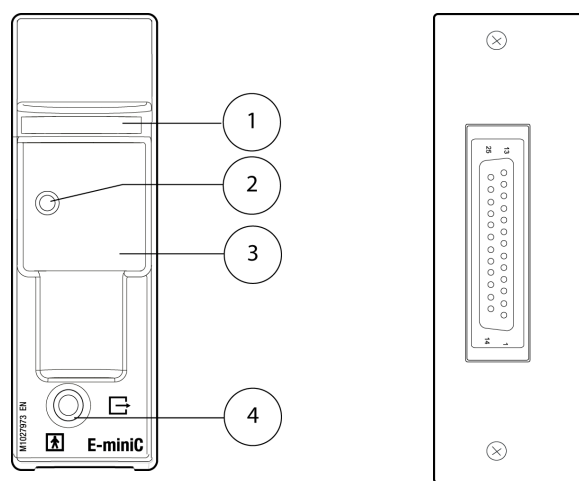
### Airway gases equipment to patient connections with E-miniC, critical care setup



1. E-miniC module
2. Sampling line connector on the water trap
3. Gas sampling line
4. Adapter with sampling line connector
5. Heat and moisture exchanger with filter (HMEF)

### Controls and connectors

Front panel of the E-miniC module and the back of the module:



1. Water trap latch
2. Sampling line connector
3. Mini D-fend water trap
4. Sample gas outlet

There are two types of connectors as indicated in the following figure:



a. Module with Luer exhaust connector: use Luer gas exhaust lines.

b. Module with GE custom exhaust connector: use GE gas exhaust lines.

Connector	Module	Description
D25 connector	E-miniC	Module bus connector

## Measurement principle

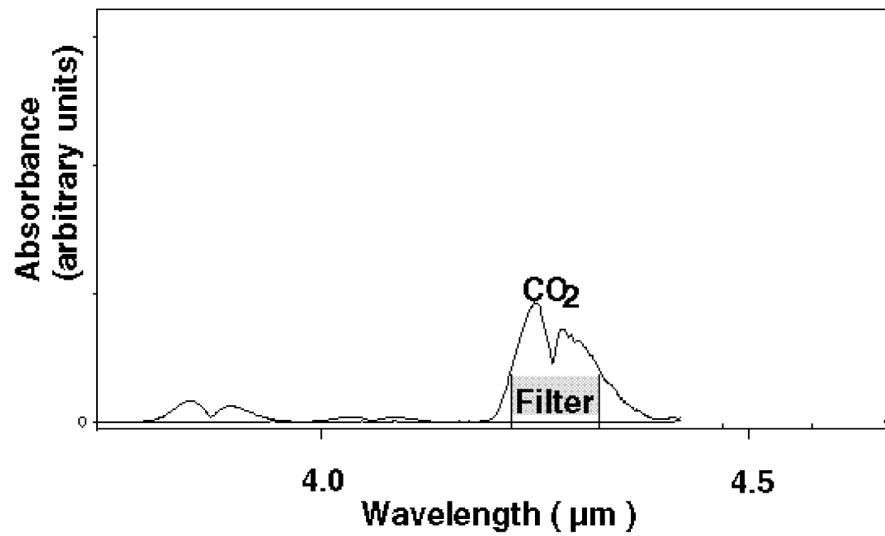
### CO<sub>2</sub> measurement

E-miniC is a side stream gas analyzer, measuring real time concentrations of CO<sub>2</sub>. It is a non-dispersive infrared analyzer that measures absorption of the gas sample by using an optical narrow band filter.

The infrared radiation detector is a thermopile.

Concentration of CO<sub>2</sub> is calculated from absorption measured at 4.2 to 4.3  $\mu\text{m}$ .

The following illustrates the absorbance of CO<sub>2</sub>:



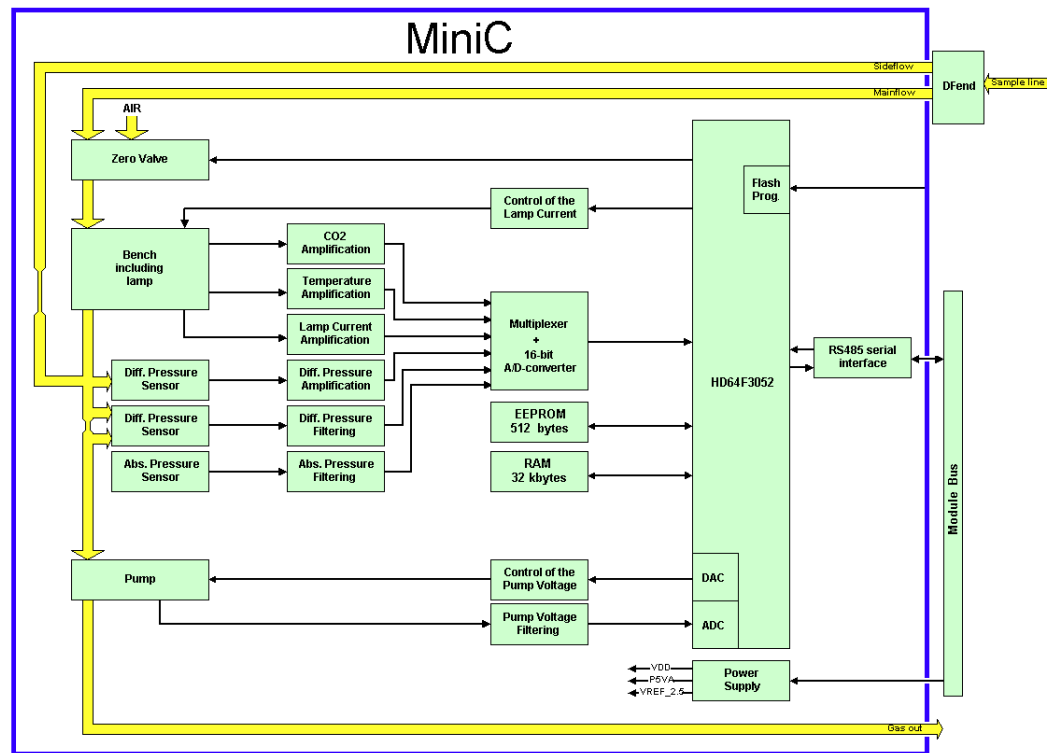
## Main components

### Gas sampling system

The sampling system draws a gas sample to the analyzer at a fixed rate. The gas sampling system samples the measured air to the module and removes water and impurities from it. A sampling line is connected to the water trap. The pump draws gas through the sampling line to the miniC sensor. After the measurement, the gas is exhausted from the sample gas out connector.

The sample flow is nominally 150 ml/min.

The following illustrates the MiniC block diagram:



## Mini D-fend

The sample is drawn through the sampling line. The gas then enters the module through the water trap where it is divided into two flows, a main flow and a side flow. The main flow goes into the analyzer. This flow is separated from the patient side by a hydrophobic filter. The side flow creates a slight subatmospheric pressure within the Mini D-fend water trap which causes fluid removed by the hydrophobic filter to collect in the bottle.

## Zero valve

The main flow passes through a magnetic valve before proceeding to the analyzer. This valve is activated to establish the zero point for the MiniC sensor. When the valve is activated, room air is drawn through a filter into the internal system and the gas sensor.

## Dehumidification tube

A dehumidification tube is used between the water trap and the zero valve to balance the sample gas humidity with that of ambient air. The tube will prevent errors caused by the effect of water vapor on gas partial pressure, when humid gases are measured after calibration with dry gases.

## Gas analyzers

After the zero valve and dehumidification tube, the gas passes through the miniC sensor.

## Sample flow differential pressure transducer

The sample flow differential pressure transducer measures pressure drop across a restrictor and calculates the sample flow from the pressure difference.

## Working pressure transducer

The working pressure transducer measures differential pressure between the tubing and ambient air near the miniC sensor. The following messages are based on the obtained pressure values: **Sample line blocked**, **Check Water Trap**, **Replace Water Trap**, and **Check sample gas out**.

## Absolute pressure transducer

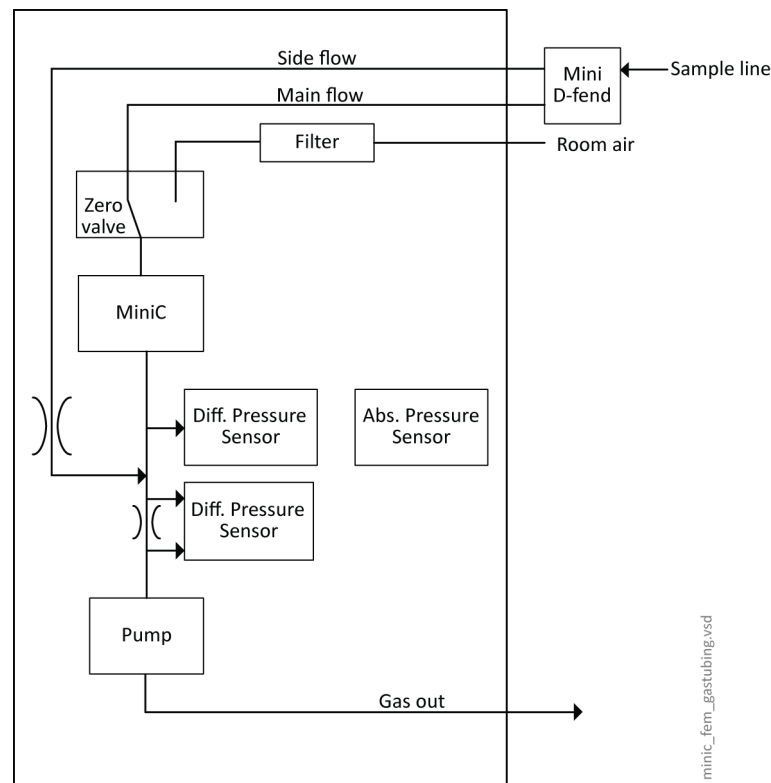
The absolute pressure transducer measures real-time ambient pressure.

## Sampling pump

The gas sampling pump is a membrane pump run by a DC motor. Sample flow is measured with a differential pressure transducer across a known restriction. The motor is automatically controlled to maintain a constant flow even when the Mini D-fend water trap ages and starts to get occluded. It also enables the use of sample tubes with varying lengths and diameters.

**NOTE** In no occasion is the flow reversed towards the patient.

The following illustrates the gas tubing layout:

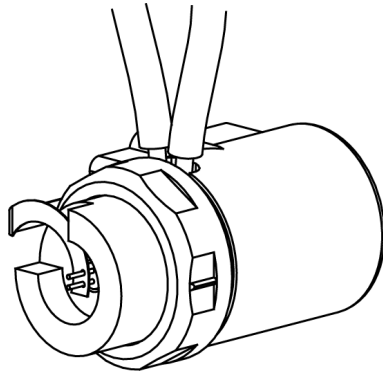


## MiniC sensor

The miniC sensor is a non-dispersive infrared analyzer measuring absorption of the gas sample at 4.2 to 4.3  $\mu\text{m}$  infrared wavelength, which is selected using an optical narrow band filter. The IR lamp is a filament surrounded by thermal isolation. There is a hole in the isolation, passing radiation to a conical measuring chamber with 3 mm length. From the sample chamber, the radiation goes into a thermopile detector with an optical filter in front of it.

The temperature sensor measures the temperature of the miniC sensor and it is used for temperature compensation.

The miniC sensor is connected to the CPU board and they cannot be replaced separately.



## CPU board

The CPU board contains a processor, memories and all the analog signal processing needed. A miniC sensor is attached to the board with a flexible PCB. Also supply voltage and an RS485 serial channel are connected to the CPU board using another flex cable.

Analog signals ( $\text{CO}_2$ , temperature, absolute and differential pressures, and lamp current signals) are fed to a 16-bit A/D converter. The processor controls the A/D converter and calculates the  $\text{CO}_2$  percentage and respiration rate from this data.

The processor controls sample flow by adjusting the pump voltage based on the differential pressure signal. The processor also controls the current of the IR source and keeps it constant.

Calibration data is stored on the EEPROM.

# 3

## Planned and corrective maintenance

### About the maintenance check procedures

This chapter describes the planned and corrective maintenance check procedures for the product. To help ensure the equipment remains in proper operational and functional order and maintains its essential performance and basic safety, follow the corrective and planned maintenance instructions. The tests and the replacement of planned maintenance parts that are related to the essential performance and basic safety are marked with the \*.

The cleaning precautions, cleaning requirements, cleaning procedures, and recommended cleaning solutions are described in the monitor's user manual or supplemental information provided.

For details about cleaning, disinfecting and sterilizing the accessories, see the instructions for use in the accessory package.

Record the results of the planned and the corrective maintenance check procedures to the eCheckforms delivered in the electronic manual media.

#### **WARNING**

**SAFETY HAZARD.** To avoid risks to personnel and patient, or damage to the equipment, only perform maintenance procedures described in this manual. Unauthorized modifications can lead to safety hazards.

#### **CAUTION**

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

### Planned maintenance

#### **WARNING**

**PATIENT SAFETY.** Planned maintenance must be carried out at the specified interval. Failure to implement the maintenance schedule may cause equipment failure and possible health hazards.

Perform the planned maintenance procedure completely every 12 months after installation. Perform the procedure in the following order:

1. Replacement of planned maintenance parts \*
2. Visual inspections
3. Functional check

## Replacement of planned maintenance parts\*

### Required parts

Replace the following parts that wear in use at the following interval.

Description	Pieces	Replacement interval
Dehumidification tube	1	Once a year
Mini D-fend™ O-ring	2	Once a year
Zero valve air filter	1	Once every 3 years

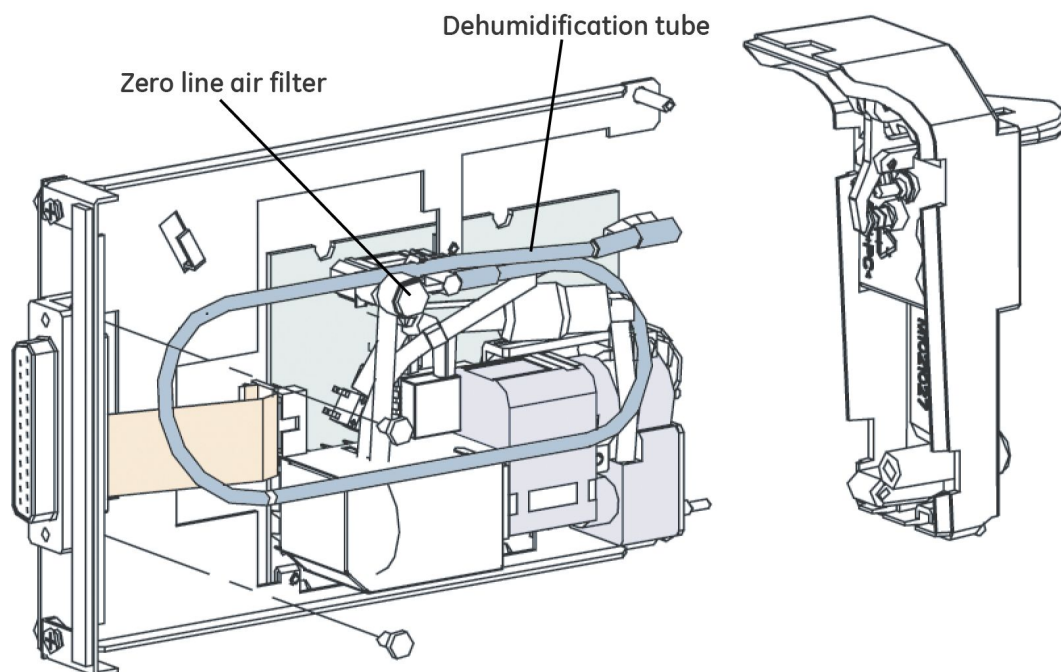
GE recommends that you replace the Mini D-fend water trap and the gas sampling line as part of the planned maintenance procedure.

NOTE: See the supplemental information provided for compatible accessories.

### Replacing planned maintenance parts\*

Replace the specified planned maintenance parts according to the following procedure. For more information, see chapter Disassembly and reassembly and chapter Service parts.

1. Replace the zero valve air filter once every 3 years.
  - a. Use a small flat blade screwdriver to pull the old zero line air filter.
  - b. Attach a new zero line air filter into place.

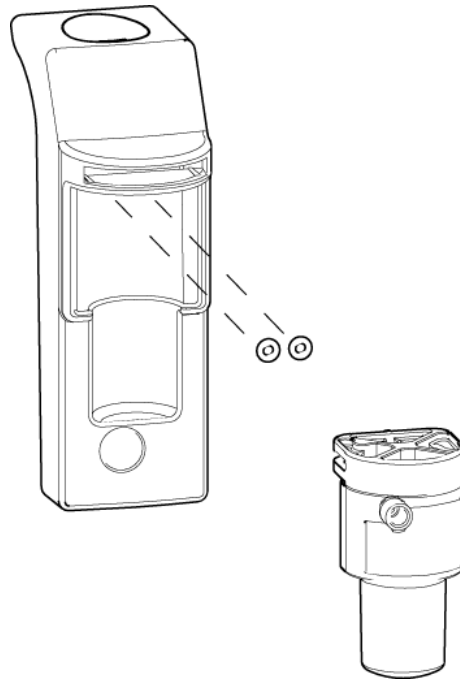




2. Replace the dehumidification tube and check the condition of the internal tubing.
  - a. Replace the 300 mm dehumidification tube in the sample gas line between the Mini D-fend water trap and the zero valve unit.
  - b. Check that the tubing inside the module is not contaminated. Any contamination inside the tubing may indicate that the valve or sensor is contaminated, too. This can increase a risk of faulty operation in valve or sensor. You cannot clean the gas sensor in the field. Therefore, replace the whole E-MiniC assembly with a new one.

NOTE: The dehumidification tubes do not include the silicon fittings they connect to. Use the original silicon fittings unless they are damaged or leaking.

3. Replace the Mini D-fend O-rings.
  - a. Detach the Mini D-fend.
  - b. Detach the old rubber O-rings that are around the metal Mini D-fend connectors e.g. using a small flat blade screwdriver. Pay special attention not to scratch the metal Mini D-fend connectors and thus causing leaking.
  - c. Set the new rubber O-rings into place and attach a new Mini D-fend.



## Corrective maintenance

Perform the following check procedure after any corrective maintenance, before taking the product back into clinical use:

Performed service activity	Required checkout procedure	
	Visual inspection	Functional check
Front cover replacement	All steps	Not applicable.
Mini D-fend O-rings	All steps	Perform the following tests: <ul style="list-style-type: none"> <li>• Check the gas sampling system for possible leakages. *</li> <li>• Check sample flow rate. *</li> </ul>
Module case opened either for troubleshooting purpose or for replacing any of the internal parts.	All steps	All steps

## Performing visual inspection

1. Detach the module from the module slot and check that:
  - a. The front cover is intact.
  - b. All connectors and intact, clean and attached properly.
  - c. The module casing and the latch are clean and intact.
  - d. The metal D-fend connectors and the D-fend O-rings are clean and intact.
  - e. The module and gas sampling tubes are clean and intact.

## Performing functional check

### Required tools

- A barometer.
- A mass flowmeter for measuring air flow, minimum measurement range 100-300 ml/min, accuracy 5% or better in the 100-300 ml/min range.
- P/N: 755534-HEL Calibration Gas Regulator.
- P/N: M1006864 Calibration Gas Regulator (US only).
- P/N: 755580 Calibration gas 5% CO<sub>2</sub> and air, package of 4 cans.
- 3 m / 10 ft gas sampling line.
- A pressure manometer with either an integrated or separate pressure pump.

NOTE: See the supplemental information provided for compatible accessories.

### Making connections for the functional check

Disconnect the module from the monitor, if connected.

### Configuring monitor for CO<sub>2</sub> functional check

1. Configure the CO<sub>2</sub> waveform field to the monitor screen with adequate priority.
2. Select **Gases** > **CO2** > **Setup** and configure:

**FiO2 level:** 21-40%

## Testing E-miniC module features

1. Check the gas sampling system for possible leakages. \*
  - a. Disconnect the module from the monitor.
  - b. Connect a new Mini D-fend water trap to the module.
  - c. Connect a new gas sampling line to the sampling line connector in the water trap.
  - d. Connect the other end of the gas sampling line to a pressure manometer and a pressure pump.
  - e. Block the "Sample Gas Out" connector.
  - f. Pump  $100 \text{ mmHg} \pm 20 \text{ mmHg}$  pressure to the gas sampling system. Let the pressure stabilize for approximately 10 seconds.
  - g. Check that the pressure reading does not drop more than 6 mmHg during 1 minute.

2. Check the sample flow rate. \*

NOTE: Gas measurement is not available during the first 1 minute after the module is connected due to warm-up. Message Calibrating Gas Sensor is shown in the waveform field. Wait until warm-up is completed before proceeding with the next steps.

NOTE: The ambient temperature and air pressure influence the flow rate measured by the flow meter. A flow meter, which has been calibrated at  $21.1^{\circ}\text{C}$  ( $70^{\circ}\text{F}$ ) and 760 mmHg (1013 mbar), measures the flow rate correctly under the same conditions, i.e. in room temperature at sea level. A flow rate correction as instructed by the manufacturer of the flow meter needs to be performed when measuring flow rate under other conditions, for example in high altitude.

- a. Connect the module with the gas sampling line to the monitor.
- b. Connect the gas sampling line to the sampling line connector in the water trap.
- c. Connect the other end of the gas sampling line to a flowmeter.
- d. Check the sample flow rate reading from the flowmeter. The flow rate should be within the specification limit  $150 \pm 25 \text{ ml/min}$ .

NOTE: You need to readjust if the measured value is not within the specification limits. Adjust the sample gas flow rate according to the instructions in section Sample flow rate adjustment.

NOTE: If the sampling pump is noisy, it indicates possible problems with the motor bearing. In this case GE Healthcare recommends that you replace the noisy sampling pump with a new one.

3. Test the zero valve functionality. \*
  - a. Connect the gas regulator to the calibration gas container.
  - b. Connect the end of the gas sampling line to the regulator on the gas container. Leave the regulator overflow port open to room air.
  - c. Select **Monitor Setup > Main Setup > Parameter Setup > Gases**.
  - d. Select **CO<sub>2</sub> > Setup** and check that **Gas Module (Mod)** has been selected as **Measurement Source**.
  - e. Select **Monitor Setup > Defaults & Service > Service Calibrations**.
  - f. Enter the Username and the Password and press **Enter** to access the **Service / Calibrations** menu.
  - g. Select **Gases**.
  - h. Start feeding calibration gas. Wait until the CO<sub>2</sub> value in the calibration menu rises to approximately 5%.
  - i. Open the zero air valve to room air by selecting **Zero valve : Off** button (zero position).
  - j. Check that the CO<sub>2</sub> value in the calibration menu drops back near to 0%.
  - k. Stop feeding the calibration gas.
  - l. Turn the zero valve back to the normal measurement position by selecting **Zero valve : On** button.
4. Perform the gas calibration according to the instructions in section Gas calibration. \*
5. Use a barometer to check the operation of the absolute pressure sensor. \*
  - a. Check that the ambient pressure value shown in the **Main** menu for calibrations does not differ more than  $\pm 10$  mmHg from the value shown by the barometer.
6. Check the occlusion detection. \*
  - a. Block the tip of the sampling line with your finger.
  - b. Check that the message Sample line blocked appears to the parameter window within 30 seconds.
7. Check the air leak detection. \*
  - a. Detach the Mini D-fend water trap.
  - b. Check that the message Check Water Trap appears to the parameter window within 30 seconds.
8. Gas exhaust blockage \*
  - a. Block the gas exhaust connector with your finger.
  - b. Check that the **Sample gas out** message appears in the parameter window within 30 seconds.

9. Check the airway gases. \*
  - a. Breathe a minimum of 5 times to the tip of the sampling line.
  - b. Check that a normal CO<sub>2</sub> waveform appears to the waveform field and the EtCO<sub>2</sub> and FiCO<sub>2</sub> values are updated to the parameter window.
10. Check the apnea detection.
  - a. Stop breathing to the gas sampling line.
  - b. Check that an Apnea alarm appears to the message field within 30 seconds.

## Completing the functional check

1. Select **Discharge Patient** or **Reset Case** to discard any changes made to the monitor configuration during the functional check.
2. Disconnect the test setup.



# Configuration and calibration

## Configuration

There is no service configuration for this module.

## Calibration and adjustments

### Sample flow rate adjustment

Sample flow rate shall be adjusted:

- if the sample flow rate check failed.

#### Required tools

- A mass flowmeter for measuring air flow, minimum measurement range 100-300ml/min, accuracy 5% or better in the 100-300ml/min range.
- 3 m / 10 ft gas sampling line

**NOTE** See the supplemental information provided for compatible accessories.

**NOTE** Use only accurate, properly maintained, calibrated, and traceable calibration tools for the parameter calibration to ensure measurement accuracy.

**NOTE** If the flowmeter unit is not ml/min, it shall be converted to ml/min according to the instructions of the flow meter manufacturer.

**NOTE** Refer to the flowmeter documentation for user instructions.

#### Making connections

1. Ensure that the module is connected to the monitor.
2. Ensure that you have a new Mini D-fend water trap in use.
3. Connect a new gas sampling line to the sampling line connector in the water trap.
4. Connect the other end of the gas sampling line to the flow meter.

**NOTE** Before checking or adjusting the sample flow, make sure there is no leakage in the sampling system.

## Adjusting sample flow rate

1. Select **Monitor Setup > Main Setup > Parameter Setup > Gases**.
2. Select **CO2 > Setup** and check that **Gas Module (Mod)** has been selected as **Measurement Source**.
3. Select **Monitor Setup > Defaults & Service > Service Calibrations**.
4. Enter the User Name and the Password and press **Enter** to get into the Calibrations menu.
5. Select **Gases**.
6. Select the **Sample Flow Adjustment: Start** button.

Service / Calibrations / Gases

Main | Gases Calibration | Spirometry Calibration

Sample Flow Adjustment **Start**

Sample Flow ml/min 120

Sample Flow Gain 1.091

Confirm

Zero Valve On

measurement position

O2: 20.50 %  
CO2: 0.07 %  
N2O: 0.01 %  
AA: 0.03 %

Fall Time Measurement Start

CO2: 0 ms  
O2: 0 ms  
Del: 0 ms

IDu: 5  
Eri: 10000 h  
Amb: 750 mmHg

Last calibration: 04 Jul 2017 4:37

Previous Menu

7. Adjust the sample flow close to the nominal value 150 ml/min by using the **Sample Flow Gain** up-down spinner controls:
  - a. To decrease the sample flow rate measured by the flow meter by approximately 7.5 ml / min, add gain value by 0.05.
  - b. To increase the sample flow rate measured by the flow meter by approximately 7.5 ml / min, lower the gain value by 0.05.
8. Press **Confirm** to check the effect of the gain adjustment. Wait until the sample flow value shown in the calibration menu returns near to the nominal value 150 ml/min and then check the actual measured flow rate from the flow meter.
9. Repeat steps 7 and 8 until the flow meter shows a  $150 \pm 25$  ml /min flow rate.



10. Select the **Sample Flow Adjustment: Stop** button to save the new gain value to the permanent memory of the module.

**NOTE** Adjust the flow rate according to the reading in the flow meter. The flow rate reading in the calibration menu is measured by the internal electronics and settles always back to the nominal 150 ml /min independent on the real flow rate.

## Gas calibration

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

Gas calibration shall be performed:

- each time planned maintenance is performed.
- each time corrective maintenance is performed.
- each time calibration check (performed by the clinical user) fails.

## Required tools

- P/N: 755534-HEL Calibration Gas Regulator
- P/N: M1006864, Calibration Gas Regulator, US only
- P/N: 755580 Calibration gas 5% CO<sub>2</sub> and balance gas air, package of 4 cans
- 3 m / 10 ft Gas sampling line
- P/N 755587 QUICK CAL calibration gas, 5% CO<sub>2</sub>, balance gas O<sub>2</sub>, package of 4 cans, US only

**NOTE** See the supplemental information provided for compatible accessories.

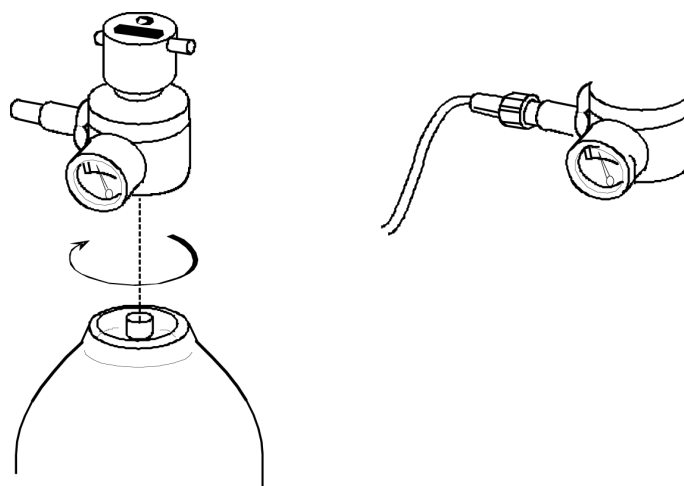
**NOTE** Use only the specified GE Healthcare calibration gas for the gas calibration to ensure measurement accuracy. Do not use any other calibration gases. Check the calibration gas container's labeling to ensure that the calibration gas has not expired.

**NOTE** Ensure that the gas regulator is functioning properly before gas calibration. Refer to the gas regulator's Instructions for Use letter for the annual maintenance instructions.

## Making connections

1. Ensure that the module is connected to the monitor.
2. Ensure that you have a new Mini D-fend water trap in use.
3. Connect the gas regulator to the calibration gas container.
4. Connect a new gas sampling line to the sampling line connector in the water trap.
5. Connect the other end of the gas sampling line to the regulator on the gas container. Leave the regulator overflow port open to room air.

The following illustrates how to connect a gas regulator to the calibration gas container and a sampling line to the gas regulator:



## Calibrating gases

### NOTE

Gas calibration is not available during the first five minutes after the module is connected. The message **Gas calibration is not available during first 5 minutes** is shown in the lower left corner of the gases calibration main menu. For maximum accuracy, let the monitor warm up for 30 minutes before starting calibration.

### NOTE

Gas calibration is not available during a **Sample line blocked**, **Check Water Trap** and **Check sample gas out** alarm condition. The message **Gas calibration is not available due to alarm condition** is shown in the lower left corner of the calibration menu. Resolve the alarm condition before starting calibration.

1. Select **Monitor Setup > Main Setup > Parameter Setup > Gases**.
2. Select **CO2 > Setup** and check that **Gas Module (Mod)** has been selected as **Measurement Source**.
3. Select **Monitor Setup > Defaults & Service > Service Calibrations**.
4. Enter the User Name and the Password and press **Enter** to get into the **Calibrations** menu.
5. Select **Gases**.
6. Select the **Gases Calibration** tab.

Service / Calibrations / Gases

Main **Gases Calibration** Spirometry Calibration

CO2 % 5.36 Adjust

O2 % 20.0 Adjust

Accept

Accept adjusted values

Recalibrate

Last calibration: 04 Jul 2019 7:59am Previous Menu

7. The monitor will start automatic zeroing of the gas sensor. Wait until the message **Zeroing** is replaced by the **Zero OK** message.
8. Wait until the message **Feed gas** appears.
9. Open the regulator and feed the gas. The measured gas concentration is displayed in real-time in the gas calibration menu. Wait until the measured gas concentration is stabilized and the **Adjust** message appears, then close the regulator.
10. Use the up-down spinner controls to adjust the CO<sub>2</sub> and O<sub>2</sub> values displayed in the calibration menu until they match the values on the calibration gas container. Regarding the O<sub>2</sub> compensation:
  - If you use calibration gas, P/N 755580, leave the O<sub>2</sub> level to 20 %.
  - If you use calibration gas, P/N 755587, adjust the O<sub>2</sub> level to 95 %.
11. Confirm by selecting **Accept**.
12. If the calibration is successful, the message **Calibration OK** is displayed for a few seconds. If the calibration fails, the message **Calibration error** appears instead. In this case, start a new calibration by selecting **Recalibrate**.

**NOTE** The message **Zero error** is shown in case the zeroing fails.

**NOTE** The message **Calibration error** is shown, if you do not start feeding gas within one minute after the automatic zeroing is completed, or if the calibration fails due to too large gain adjustment.



# Troubleshooting

## Troubleshooting guidelines

This chapter focuses on troubleshooting technical problems. Refer to the user manual for troubleshooting monitoring problems and clinical configuration issues.

If a problem remains, contact technical support for service. To ensure accurate problem solving, please be prepared to provide the following information:

- Product name and serial number or UDI
- Hardware and software versions
- Detailed problem description
- Error messages, if any
- Configuration information (or settings file)
- Service Logs
- The troubleshooting you have done so far

Perform the specified corrective maintenance check after any corrective maintenance to the product.

## Performing visual inspection

Before any detailed troubleshooting, complete a thorough visual inspection for the module.

1. Remove the module and check that:
  - a. The front cover is intact.
  - b. All the connectors are intact, clean, and attached properly.
  - c. The module casing and the latch are clean and intact.
  - d. The Mini D-fend latch is moving properly.
  - e. The metal Mini D-fend connectors and the D-fend O-rings are clean and intact.

2. If you suspect that there are loose parts or cable connections inside the module, remove the two screws from the back of the module to detach the module box, and check that:
  - a. All the screws are tightened properly.
  - b. All the cables are connected properly.
  - c. The tubes are not pinched, and there are no sharp bends on them.
  - d. All the tubes are connected properly.
  - e. There are no loose objects inside the module.

## Troubleshooting checklist

The following simple troubleshooting hints may help you to localize and isolate a functional problem to the correct unit. Ensure that the monitor is turned on and the module is connected:

- Check if there are any messages shown in the display message field. Find the possible cause and solution from the 'Messages' section later in the chapter.
- Check that the connected modules are compatible with the monitor system. Compatibility information can be found from the CARESCAPE monitor supplemental information manual.
- Check that there are no duplicate modules connected to the monitor. List of identical modules can be found from the CARESCAPE monitor supplemental information manual.
- Connect the accessories to the module. Check that the parameters measured by the module are configured to the display with adequate priority and the parameters are shown to be active (**Monitor Setup > Screen Setup > Upper Parameter Area**).
- Do a visual check to the accessories used with the module. If in doubt, replace the accessories with known good ones.

## Gas sampling system troubleshooting

- Faults which can occur in the sampling system are: leaks or blockages in the tubing, failure of the sampling pump or the magnetic valves, or diminishing of the flow rates because of dirt or other matter accumulating in the internal tubing or failure of pressure sensors.
- Whenever you inspect the sampling system and always after having done any work on the sampling system, check the sampling system for leakages and check the flow rate.
- The Mini D-fend water trap should be replaced when the **Replace Water Trap** message appears.
- If any liquid has entered the IR sensor unit due to water trap filter failure, contact GE Healthcare service.
- If the sampling pump is noisy it indicates possible problems with motor bearing. In this case it is recommended to replace the noisy sampling pump with a new one.
- Check that the tubing inside the module is not contaminated. Any contamination inside the tubing may indicate that the valves or sensors are contaminated, too. This can increase the risk of faulty operation in valves or sensors. You cannot clean the valves or gas sensors in the field. Therefore, if you

noticed any contamination in the module tubing, replace the entire module and send the module to GE Healthcare for factory service.

NOTE: All internal tubes are mechanically fragile. Sharp bends may cause leaks and occlusions.

## MiniC sensor troubleshooting

- The CPU contains factory calibration data for the miniC sensor. Thus, they cannot be replaced separately in the field. In case of failure, replace the complete miniC assembly.

## Viewing device information

To view the hardware, software and configuration information of the monitor, modules and/or connected devices:

1. Ensure that the module is connected to the monitor.
2. Log in to the service interface.
3. Select **Information**.
4. Select an item on the side navigation menu or scroll down the page to view the information.

## Service log files

The monitor collects information about different system events, errors and alarms to log files to help troubleshoot equipment problems. The following service logs may contain related useful information:

- **System Logs** records different system events, messages, clinical alarms, user interactions and internal communication events.
- **EMBC Logs** records module communication events and errors for E-series acquisition modules.

## Viewing log files

1. Log in to the service interface.
2. Select **Diagnostics > View Logs**.
3. Select the log you want to view. The contents of the selected log file are shown on the screen.

## Downloading log files

For security reasons, the contents of the log file(s) will be encrypted with a user-selectable password before the download. Provide the password in a secure way only for the authorized receiver of the log file. Use 7-Zip open-source file archiver (<http://7-zip.org/>) and the password to decrypt the downloaded log file.

1. Log in to the service interface.
2. Select **Diagnostics > Download Logs**.
3. Select the log(s) you want to download.
4. Provide a password to encrypt the contents of the log file. This password is user-selectable.

5. Depending on your access to the service interface:
  - a. If you are using a service PC, you can save the log file to any storage device connected to the service PC.
    - i. Select **Download**.
    - ii. Save the log file according to the instructions provided by the web browser.

The steps to download the log file to a service PC depend on the web browser used. The web browser may also notify you about security issues. Refer to the web browser documentation for details.
  - b. If you are using the local, integrated service interface, you can save the log file to a USB flash drive that is connected to one of the monitor's USB ports:
    - i. Select **Save to USB storage** to save the log file to the USB flash drive.

The log file is saved always to the root directory of the USB flash drive.

**NOTE** Do not disconnect the USB flash drive until downloading is complete.
6. Send the log file and the password in a secure way to GE Service for further investigation.

## Messages related to CO<sub>2</sub>

For information regarding alarm priorities and escalation times, see the supplemental information provided.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- al. area = alarm area
- param. = parameter window
- report = report view
- wavef. = waveform area

Message	Location	Possible causes	Suggested actions
<b>Check Water Trap</b> <i>Check water trap and sample gas out. Press Normal Screen to continue.</i>	al. area wavef.	Water trap is not connected. Air leak inside the internal tubing.	Connect water trap to the module. Check internal tubing for leakages. Replace, if necessary.
<b>Sample line blocked</b> <i>Continuous blockage. Check sample line and water trap.</i>	al. area param. wavef.	Gas sampling line is blocked. Water trap container is full. Water trap is occluded. Internal tubing is blocked.	Check external gas sampling line for blockages. Replace, if needed. Empty the water trap container. Replace the water trap. Check internal tubing for blockages. Replace, if needed.



Message	Location	Possible causes	Suggested actions
<b>Check sample gas out</b> <b>Check water trap and sample gas out.</b> <b>Press Normal Screen to continue.</b>	al. area wavef.	The sample gas outflow is blocked. Internal tubing is blocked. Pump failure.	Check the sample gas out connector in the front panel and the exhaust line for gas return or scavenging for blockages. <ul style="list-style-type: none"> <li>• If the sample gas is returned to the patient circuit, check that there is no occlusion in the tubing.</li> <li>• If the sample gas outlet is connected to a scavenging system, make sure an open system is used where gas is removed in room pressure.</li> </ul> Check the internal tubing for blockages. Replace, if needed. Check sample pump operation by measuring the sample gas flow rate. Replace pump, if needed.
<b>Replace Water Trap</b>	al. area param.	Defective or contaminated Mini D-fend. Occlusion in internal tubing.	Replace Mini D-fend water trap. Check sample and reference flows. Perform a visual check for the internal tubing. Remove the cause for occlusion.
<b>Calibrating</b>	param. calibration menu	CO <sub>2</sub> calibration is in progress.	Wait until calibration is completed successfully.
<b>Zeroing</b>	param. calibration menu wavef.	CO <sub>2</sub> zeroing is in progress.	Wait until zeroing is completed successfully.
<b>Zero error</b>	param. calibration menu	Autozeroing during measurement or in the beginning of gas calibration failed.	Check the zero valve operation. Replace zero valve and filter.
<b>Calibration error</b>	param. calibration menu	Feeding calibration gas was not started within 1 minute after the automatic zeroing was completed. Calibration was failed due to too large gain adjustment. Wrong calibration gas used.	Recalibrate. Use the specified calibration gas.

Message	Location	Possible causes	Suggested actions
<b>Apnea deactivated</b>	param.	Apnea alarm start-up conditions are not reached.	Apnea alarm detection is activated after the 3 breaths are detected.
<b>Sensor INOP</b>	wavef.	Ambient pressure is too high or low. No response from the gas module, high temperature inside the module or EEPROM checksum failure.	Check ambient pressure from the Gas Calibration menu. Replace miniC assembly. Return the module to GE Healthcare for service.
Calibrating gas sensor	wavef.	Gas measurement is not available during the first 1 minute after the module is connected due to warm-up.	Wait until warm-up is completed.
Over Scale	wavef.	Incorrect CO <sub>2</sub> scale. The CO <sub>2</sub> waveform clipped because EtCO <sub>2</sub> value exceeds the upper limit of the current scale.	Change CO <sub>2</sub> waveform scale.
Low gas sample flow	al. area.	Sample flow deviates to less than 80% module specific nominal flow value. Gas sampling line, gas output, water trap, or internal tubing is blocked. Pump failure.	Check sample flow rate. Adjust, if needed. Check or replace gas sampling line, water trap, or internal tubing. Replace pump unit.
Incompatible gas module	al. area.	Incompatible gas module detected by the monitor.	Check the compatibility of the gas module.
Gas measurements removed	al. area.	The module is disconnected.	Reconnect the module.
Identical gas modules	al. area.	The monitor detects CO <sub>2</sub> measurements from two or more modules.	Remove excess modules providing CO <sub>2</sub> measurement.

## Troubleshooting CO<sub>2</sub> measurement

Problem	Possible clinical cause	Possible technical cause	What to do
Too low EtCO <sub>2</sub> value	<ul style="list-style-type: none"> <li>sudden decrease in circulation</li> <li>pulmonary embolism</li> <li>hyperventilation</li> <li>very large dead-space</li> <li>large shunting</li> </ul>	<ul style="list-style-type: none"> <li>leak in sampling system</li> <li>calibration error</li> <li>high by-pass flow from ventilator</li> <li>incorrect humidity compensation</li> </ul>	<ul style="list-style-type: none"> <li>Check all connections.</li> <li>Check calibration.</li> <li>Check the host device's humidity compensation type: <b>Wet</b>(BTPS) / <b>Dry</b>(ATPD).</li> </ul>
Too high EtCO <sub>2</sub>	<ul style="list-style-type: none"> <li>hypoventilation</li> <li>increased metabolism</li> </ul>	<ul style="list-style-type: none"> <li>Water trap contamination</li> <li>calibration error</li> </ul>	<ul style="list-style-type: none"> <li>Change Mini D-fend.</li> <li>Check calibration.</li> </ul>

Problem	Possible clinical cause	Possible technical cause	What to do
		<ul style="list-style-type: none"> <li>incorrect humidity compensation</li> </ul>	<ul style="list-style-type: none"> <li>Check the host device's humidity compensation type: <b>Wet</b>(BTPS) / <b>Dry</b> (ATPD).</li> </ul>
No response to breathing	<ul style="list-style-type: none"> <li>apnea</li> <li>gas sample line disconnected</li> </ul>	<ul style="list-style-type: none"> <li>sampling line or water trap loose or blocked (air leak)</li> <li>sample gas out blocked</li> </ul>	<ul style="list-style-type: none"> <li>Check all connections.</li> <li>Check that the outlet is open.</li> </ul>
EtCO <sub>2</sub> over scale >20% Shown until 32%, specified range 0...20%.	<ul style="list-style-type: none"> <li>abnormally high EtCO<sub>2</sub> (permissive hypercapnia)</li> </ul>	<ul style="list-style-type: none"> <li>CO<sub>2</sub> sensor contaminated</li> <li>Water trap malfunction</li> </ul>	<ul style="list-style-type: none"> <li>Contact your local service representative.</li> <li>Change Mini D-fend.</li> </ul>
EtCO <sub>2</sub> >PaCO <sub>2</sub>	<ul style="list-style-type: none"> <li>unit is mmHg or kPa and EtCO<sub>2</sub> is close to arterial PCO<sub>2</sub></li> </ul>	<ul style="list-style-type: none"> <li><b>Dry gas</b> as default</li> </ul>	<ul style="list-style-type: none"> <li>Change to <b>Wet gas</b> from the <b>Default Setup &gt; Care unit Settings &gt; Parameters</b> menu.</li> </ul>
Abnormally high (or low) response to CO <sub>2</sub> , or sudden occlusion message.		Pressure transducer failure.	Replace the miniC.
Unable to perform gas calibration.		<p>Gas calibration is not available during the first 5 minutes after the module is connected. Message <b>Gas calibration is not available during the first 5 minutes</b> is shown in the calibration menu.</p> <p>Gas calibration is not available during <b>Sample line blocked</b>, <b>Check Water Trap</b>, and <b>Check sample gas out</b> alarm condition. Message <b>Gas calibration is not available due to alarm condition</b> is shown in the calibration menu.</p>	<p>Wait until warm-up is completed.</p> <p>Resolve the alarm condition before starting calibration.</p>



# 6

## Disassembly and reassembly

### Disassembly guidelines

Field repair of the device is limited to replacing field replaceable units (FRUs) and planned maintenance parts.

<b>WARNING</b>	ERRONEOUS READINGS. To prevent erroneous readings, always perform gas sampling system leak test after the module cover is reassembled.
<b>WARNING</b>	ERRONEOUS READINGS. To prevent erroneous readings, always perform gas calibration after any planned or corrective maintenance.
<b>NOTE</b>	Only qualified service personnel should perform field replacement procedures.
<b>NOTE</b>	Perform the specified corrective maintenance check after any corrective maintenance to the product.

### Serviceable parts

- MiniC assembly, including the following components (CPU board, miniC sensor, pump unit, tubing unit and zero valve and pressure transducers).
- Tubing unit.
- Pump unit.
- Zero valve.
- Air filter.
- Mini D-fend O-rings.
- Dehumidification tube.
- Mini D-fend.
- Mechanical parts listed in the service parts chapter.

### Service limitations

The following parts are not serviceable:

- MiniC sensor and CPU board cannot be replaced separately.

NOTE: The CPU contains factory calibration data for the miniC sensor. In case of failure, replace the complete MiniC assembly. Attempts to repair or calibrate the

unit elsewhere will adversely affect operation of the unit. The information provided in this document is for reference only.

## ESD precautions

All external connectors of the device are designed with protection from ESD damage. However, if the device requires service, exposed components and assemblies inside are susceptible to ESD damage. This includes human hands, non-ESD protected work stations or improperly grounded test equipment. The following guidelines may not guarantee a 100% static-free workstation, but can greatly reduce the potential for failure of any electronic assemblies being serviced:

- Discharge any static charge you may have built up before handling semiconductors or assemblies containing semiconductors.
- Wear a grounded, antistatic wristband or heel strap at all times while handling or repairing assemblies containing semiconductors.
- Use properly grounded test equipment.
- Use a static-free work surface while handling or working on assemblies containing semiconductors.
- Do not remove semiconductors or assemblies containing semiconductors from antistatic containers until absolutely necessary.
- Do not slide semiconductors or electrical/electronic assemblies across any surface.
- Do not touch semiconductor leads unless absolutely necessary.
- Store the semiconductors and electronic assemblies only in antistatic bags or boxes.
- Handle all PCB assemblies by their edges.
- Do not flex or twist a circuit board.

## Protection from dust

### WARNING

EQUIPMENT DAMAGE AND ERRONEOUS READINGS. Module must be handled with care to prevent dust from entering the gas sampling system.

The gas sampling system must be protected from dust entering the tubes, valves and other components. In order to achieve this goal, the following measures must be taken:

- Always connect the mini D-fend water trap to the module.
- Have a clean and dust-free working environment during all service procedures.
- Minimize the times with any open connections in the gas sampling system.
- Always close the open tube connections of the sampling system when not working on the module.
- Remove the protective caps on the gas pump only immediately before assembling it to the module.
- The clothing of the service person must be such that the dust risk has been taken into account.

## Before disassembly

- Note the positions of any wires or cables. Mark them if necessary to ensure that they are re-assembled correctly.

- Save and set aside all hardware for reassembly.

## Required tools

- Flat blade screwdriver
- Pozidrive screwdriver
- Antistatic wristband

## Disassembly procedures

For reference, see the exploded view in Service parts chapter.

### Detaching the module casing

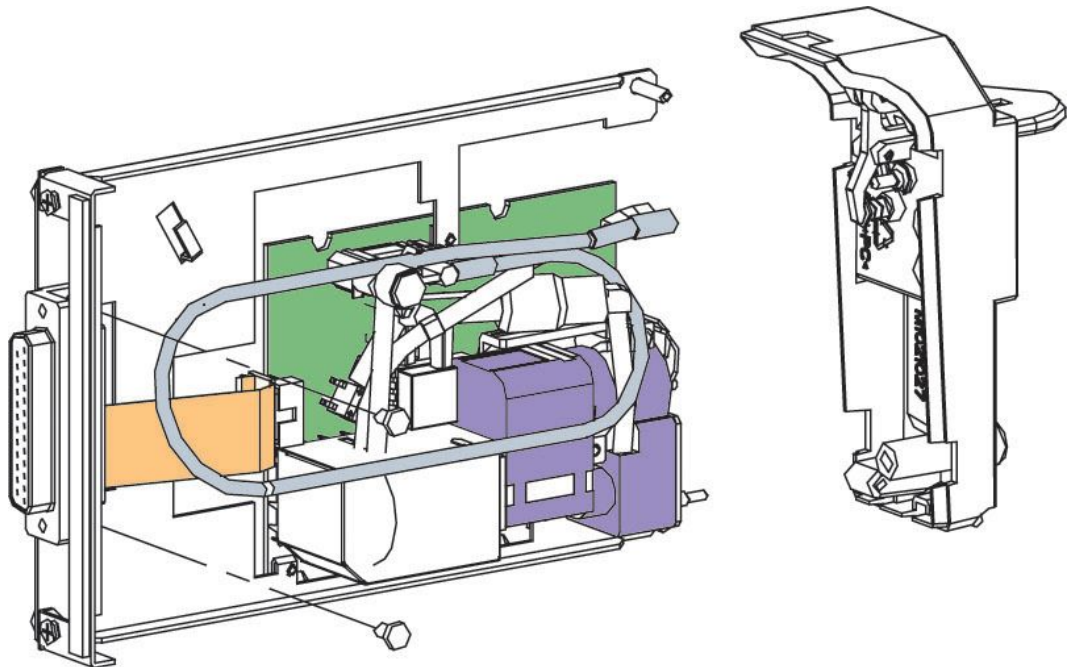
To disassemble the airway module (see the exploded view of the module in chapter Service parts):

1. Remove the two screws from the back of the module.
2. While pressing the release latch, pull the module casing slowly backwards and remove it from the main body.

### Detaching the pump unit

1. Detach the front cover of the module by releasing the snaps that hold the front cover to the front chassis unit by using a small flat blade screwdriver. There are 2 snaps on both sides of the module and 1 snap on the top.
2. Remove the module casing.
3. Unplug the two tubes from the back of the front chassis.
4. Detach the front chassis from the metal frame by removing the two screws.
5. Unplug the hose of the pump.
6. Disconnect the pump's cable from the CPU board.

7. Remove the two screws that connect the pump unit to the board.



## Detaching the MiniC assembly

1. Detach the front cover of the module by releasing the snaps that hold the front cover to the front chassis unit by using a small flat blade screwdriver. There are 2 snaps on both sides of the module and 1 snap on the top.
2. Remove the module casing.
3. Unplug the two tubes from the back of the front chassis.
4. Detach the front chassis from the metal frame by removing the two screws.
5. Detach the MiniC assembly from the metal frame by removing the three screws.
6. Disconnect the flex board from MiniC assembly.

## Reassembling the module

1. Reassemble in reverse order. Make sure that:
  - a. All screws are tightened properly.
  - b. All cables are connected properly.
  - c. Tubes are not pinched and there are no sharp ends on them.
  - d. All tubes are connected properly.
  - e. There are no loose objects inside the module.



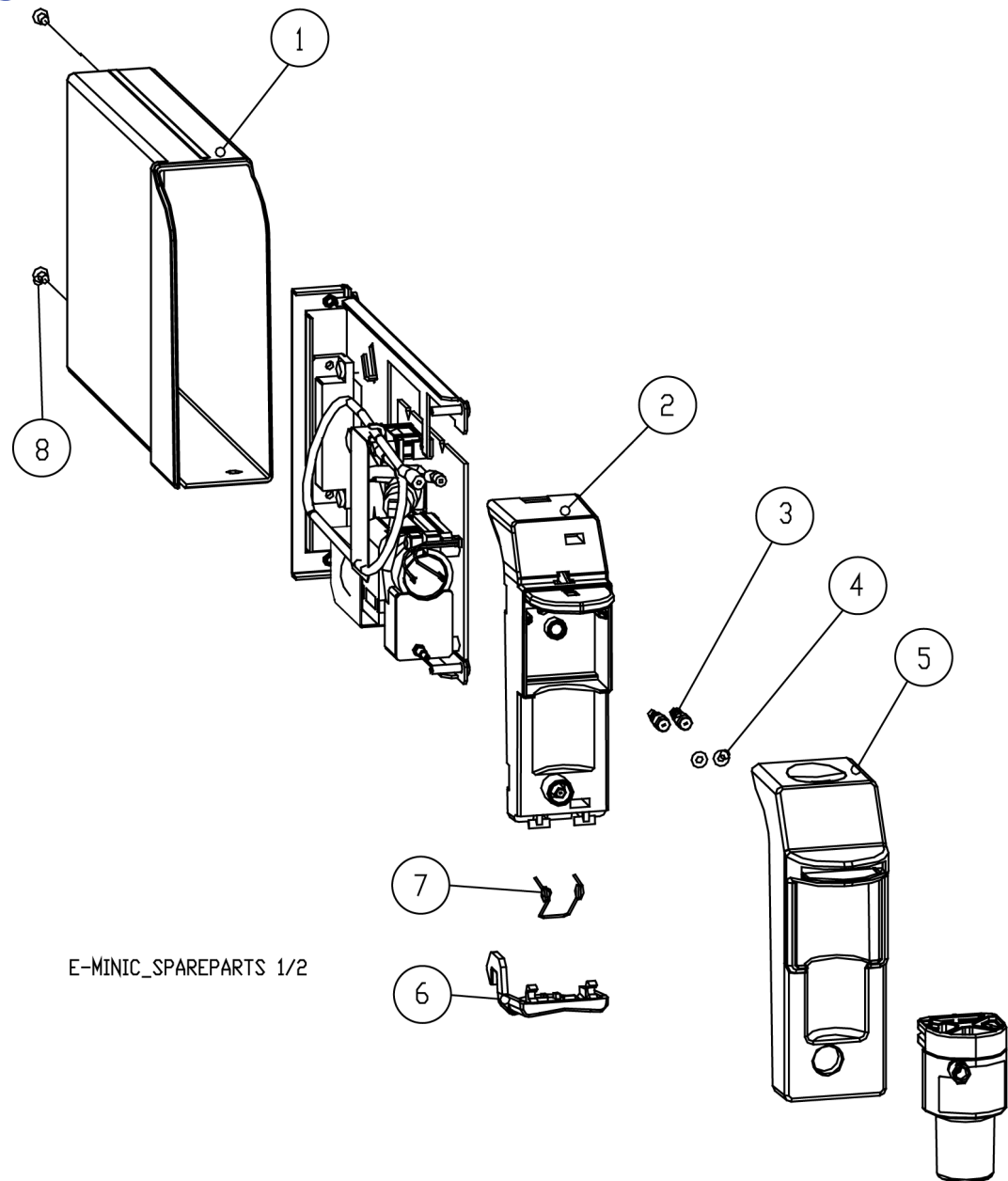
# 7

## Service parts

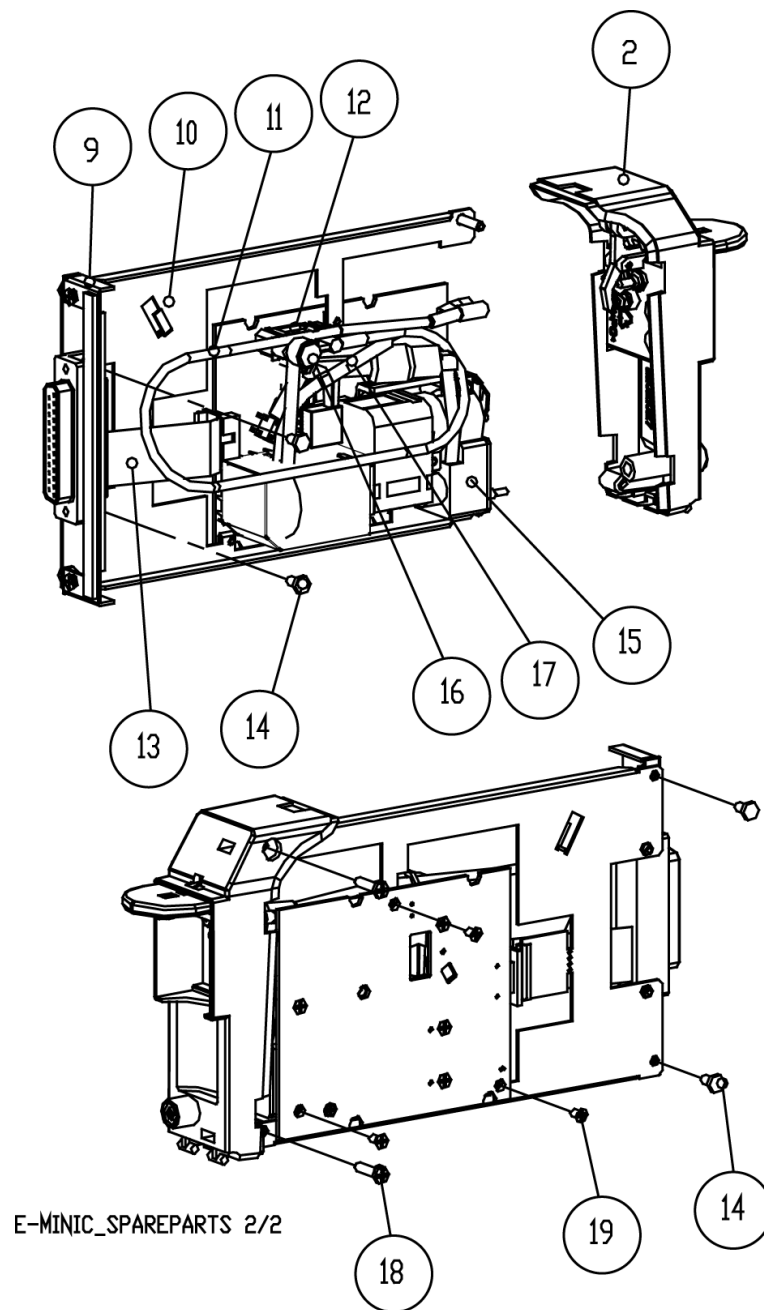
### Ordering parts

To order parts, contact your local GE representative. Contact information is available at [www.gehealthcare.com](http://www.gehealthcare.com). Make sure you have all necessary information at hand.

## Exploded view of Single-width Airway Module, E-miniC



E-MINIC\_SPAREPARTS 1/2



## Gas exhaust connectors

There are two types of connectors as indicated in the following figure:



a. Luer exhaust connector

b. GE custom exhaust connector

## List of FRUs for E-miniC

Part number	Description
M1026943	Front Cover, E-miniC (#5)
M1026941	Front Cover, USA, E-miniC (#5)
M1027134	Front Chassis Unit, E-miniC (#2) NOTE: Excludes the latch (#6) and torsion spring (#7) NOTE: Use this FRU with the module with Luer gas exhaust connector (a).
5697238	Front Chassis Unit, E-miniC (#2) (SUB) NOTE: Excludes the latch (#6) and torsion spring (#7) NOTE: Use this FRU with the module with GE custom gas exhaust connector (b).
2083166-001	Pump Unit, E-MiniC (#15)
2099523-001	E-MiniC assembly, including the following components: <ul style="list-style-type: none"> <li>• CPU board</li> <li>• Mini CO2 sensor with EMI cover</li> <li>• Pump unit (#15)</li> <li>• Tubing unit (#17)</li> <li>• Dehumidification tube (#11)</li> <li>• Magnetic valve, zero valve (#12)</li> <li>• Pressure transducer</li> <li>• Air filter (#16)</li> <li>• 3 mounting screws (#19)</li> </ul>
M1013717	Tubing unit (#17)

Part number	Description
M1206392	FRU, E-Modules Hardware kit: <ul style="list-style-type: none"> <li>• 2 mounting screws for metal frame (#14)</li> <li>• 2 mounting screws for front chassis unit (#18)</li> <li>• 2 mounting screws for module casing (#8)</li> <li>• Latch (#6)</li> <li>• Torsion spring (#7)</li> <li>• Membrane keypad (not used in this module)</li> </ul>
879184	Metal frame (#9)
M1024360	Frame, E-miniC (#10)
2107756-001	Module Connection Flex, E-miniC (#13)
8002173	Connector for D-fend, miniC (#3)
656565	O-RING, 2.5x1.6 (#4)





## Single-width Airway Module, E-miniC



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