3 Maintenance and checkout

To help ensure the equipment remains in proper operational and functional order, adhere to a good maintenance schedule.

Corrective maintenance

Service personnel shall perform the following checkout procedure after any corrective maintenance, before taking the module back into clinical use:

Performed service activity	Required checkout procedure	
	Visual inspections (section 3.2)	**Functional check (section 3.3)**
Front cover replaced	All steps	Not applicable
Mini D-fend O-rings	All steps	Check "Gas Sampling System Leak Test" and "Sample Flow Rate Check"
Module casing opened either for troubleshooting purpose or for replacing any of the internal parts.	All steps	All steps

Planned maintenance

Service personnel shall perform the following checkout procedure completely every 12 months after installation:

1. 3.1. Replacement of planned maintenance parts
2. 3.2. Visual inspections
3. 3.3. Functional checkout

3.1 Replacement of planned maintenance parts

3.1.1 Required parts

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

Part number	Description	Pieces	Replacement interval
733382-HEL	Nafion Tube	1	Once a year
656565	Mini D-fend™ O-ring	2	Once a year
M1011471	Zero valve air filter	1	Once every 3 years

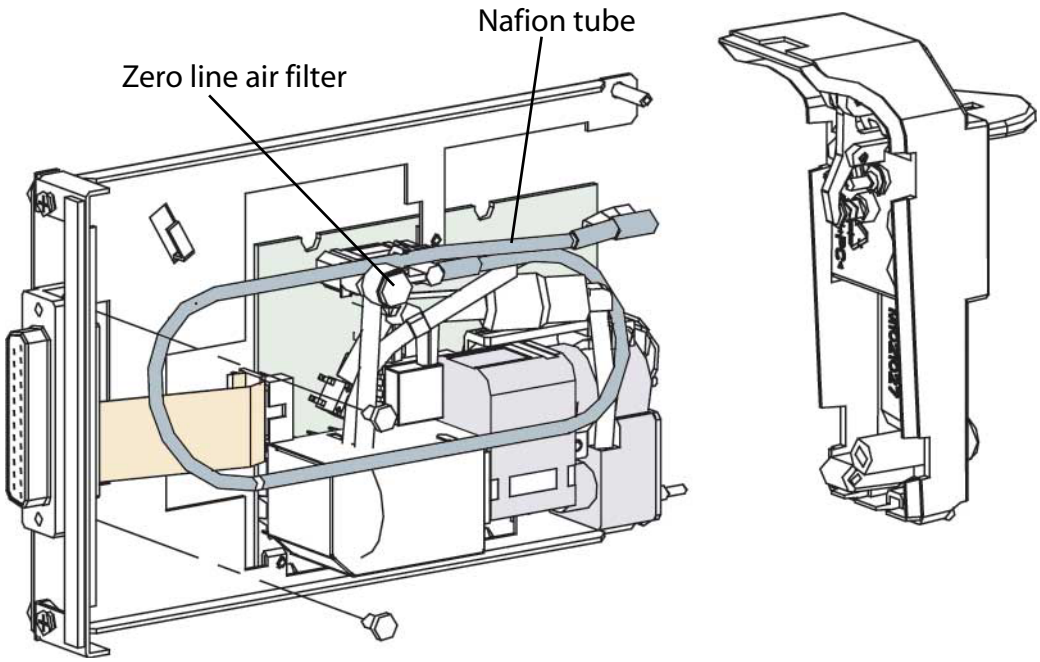
It is also recommended to replace the Mini D-fend water trap and the gas sampling line as part of the planned maintenance procedure.

NOTE: See the supplemental information manual for compatible accessories.

3.1.2 Replacement procedures

Replace the specified planned maintenance parts according to the following procedure. Refer to chapter 6. Disassembly and reassembly and to chapter 7. Service parts for additional information.

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.

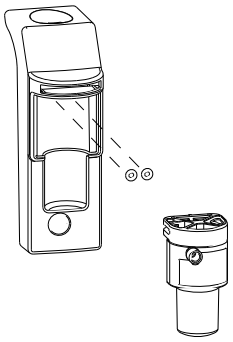


2. Replace the special tube (Nafion) and check the condition of the internal tubing.
   a. Replace the 300 mm nafion tube in the sample gas in line between the Mini D-fend water trap and the zero valve unit.
   b. Check that the tubing inside the module is not contaminated. Any contamination inside the tubing may indicate that the valve or sensor is contaminated, too. This can increase a risk of faulty operation in valve or sensor. The gas sensor is not possible to clean in the field. Therefore, replace the whole miniCO2 assembly with a new one.

NOTE: The nafion tube do not include the silicon fittings they connect to. Use the original silicon fittings unless they are not 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.



3.2 Visual inspections

Detach the module from the module slot and check that:

- the front cover panel is intact
- all connectors are intact and attached properly
- the module box and latch are intact
- the metal D-fend connectors and the D-fend O-rings are clean and intact
- the module and the applied parts are clean

The cleaning precautions, cleaning requirements, cleaning procedures, and recommended cleaning solutions for the monitor are described in the patient monitor's user's manual. For details about cleaning, disinfecting and sterilizing the accessories, see the instructions for use in the accessory package.

NOTE: Mark this task as complete on the checkout form.

3.3 Functional checkout

Turn the monitor on. Wait until the normal monitoring screen appears.

3.3.1 Test setup

Required tools

– A barometer
– A mass flowmeter for measuring air flow, minimum measurement range 100-300ml/min, accuracy 5% or better in the 100-300ml/min range.
– P/N: 755534-HEL Calibration Gas Regulator
– P/N M1006864 Calibration Gas Regulator, (US only)
– P/N: 755580 Calibration gas 5% CO2 and air, package of 4 cans
– P/N 755587 QUICK CAL calibration gas, (US only)
– 3 m / 10 ft gas sampling line
– A pressure manometer with either an integrated or a separate pressure pump

NOTE: See the supplemental information manual for compatible accessories.

Connections

Disconnect the module from the monitor, if connected.

Monitor configuration

1. Configure the CO2 waveform field to the monitor screen with adequate priority.
2. Select ***CO2 Setup*** tab in ***Gases*** menu and configure:
   FiO2 level: 21-40%

3.3.2 Procedure

1. Gas sampling system leak test

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 mmHg ± 20 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.

NOTE: The gas module shall be disconnected from the monitor during the leak test.

2. Sample flow check

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.

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 shall be within the specification limit 150 ± 25 ml/min.

NOTE: Readjustment is needed, if the measured value is not within the specification limits. Adjust the sample gas flow rate according to the instructions in section 4.1.2. Sample flow rate adjustment.

NOTE: 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.

3. Zero valve operation

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.
a. Select **Monitor Setup > *Service Calibrations***.

b. Enter the User Name and the Password and press ***Enter*** to get into the Calibrations menu.
c. Select ***Gases***.
d. Start feeding calibration gas. Wait until the CO_2 value in the calibration menu rises to approximately 5%.

Open the zero valve to room air by selecting ***Zero valve Off*** (zero position).

e. Check that the CO_2 value in the calibration menu drops back near to 0%.
f. Stop feeding the calibration gas.
g. Turn the zero valve back to the normal measurement position by selecting ***Zero valve On***.

4. Gas calibration

Perform gas calibration according to the instructions in section 4.2. Gas calibration.

5. Ambient pressure

Use a barometer to check the operation of the absolute pressure sensor.

a. Check that the ambient pressure value shown in the Gas Calibrations menu does not differ more than ± 10 mmHg from the value shown by the barometer.

6. Occlusion detection
   a. Block the tip of the sampling line by your finger.
   b. Check that message 'Sample line blocked' appears to the parameter window within 30 seconds.

7. Air leak detection
   a. Detach the Mini D-fend water trap.
   b. Check that message 'Check Water Trap' appears to the parameter window within 30 seconds.

8. Airway gases
   a. Breathe a minimum of 5 times to the tip of the sampling line.
   b. Check that a normal CO_2 waveform appears to the waveform field and the $EtCO_2$ and $FiCO_2$ values are updated to the parameter window.

9. Apnea detection
   a. Stop breathing to the gas sampling line.
   b. Check that an 'Apnea' alarm appears to the message field within 30 seconds.

Mark each task as complete on the checkout form.

3.3.3 Test completion

- Select ***Discharge patient*** or ***Reset case*** to discard any changes made to the monitor configuration during checkout.
- Complete on the “Maintenance check form” on page 10-33.

4 Calibration and adjustments

4.1 Sample flow rate adjustment

Sample flow rate shall be adjusted:

- if the sample flow rate check in section "3.3.2" failed.

4.1.1 Calibration setup

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 manual for compatible accessories

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

NOTE: Refer to the flowmeter documentation for user instructions.

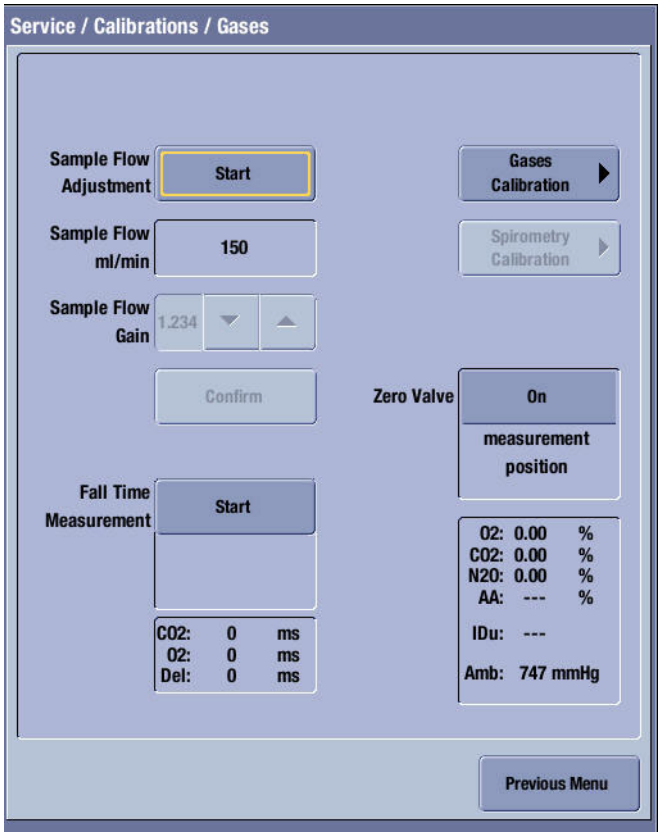
Connections

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

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

4.1.2 Sample flow rate adjustment

1. Select **Monitor Setup > *Service Calibrations***.
2. Enter the User Name and the Password and press ***Enter*** to get into the 'Calibrations' menu.
3. Select ***Gases***.
4. Select ***Start Sample Flow Adjustment***.



5. Adjust the sample flow close to the nominal value 150 ml/min by using the ***Sample Flow Gain*** up-down spinner controls:
   - To decrease the sample flow rate measured by the flow meter by approximately 7,5 ml / min, add gain value by 0.05.
   - To increase the sample flow rate measured by the flow meter by approximately 7,5 ml / min, lower the gain value by 0.05.
6. 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.
7. Repeat steps 5 and 6 until the flow meter shows a 150 ± 25 ml /min flow rate.
8. Select ***Stop Sample Flow Adjustment*** 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.

4.2 Gas calibration

Gas calibration shall be performed:

- each time planned maintenance is performed
- corrective maintenance is performed.

NOTE: Gas Calibration is a normal user action. Refer to the patient monitor's user's manual for the recommendation for gas calibration interval in clinical use.

4.2.1 Calibration setup

Required tools

– P/N: 755534-HEL Calibration Gas Regulator
– P/N M1006864 Calibration Gas Regulator, (US only)
– P/N: 755580 Calibration gas 5% CO2 and air, package of 4 cans
– 3 m / 10 ft Gas sampling line
– P/N 755587 QUICK CAL calibration gas, (US only)
–

NOTE: See the supplemental information manual 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 labelling 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.

Connections

- Ensure that the module is connected to the monitor.
- Ensure that you have a new Mini D-fend water trap in use.
- Connect the gas regulator to the calibration gas container.
- Connect a new gas sampling line to the sampling line connector in the water trap.
- 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.

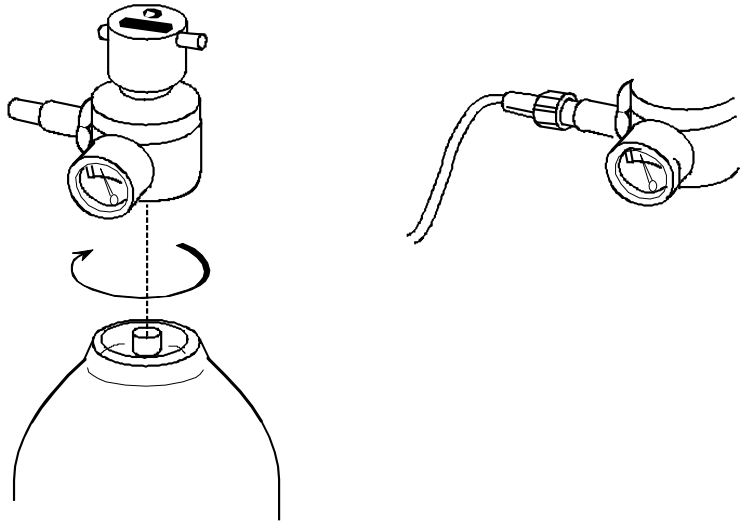


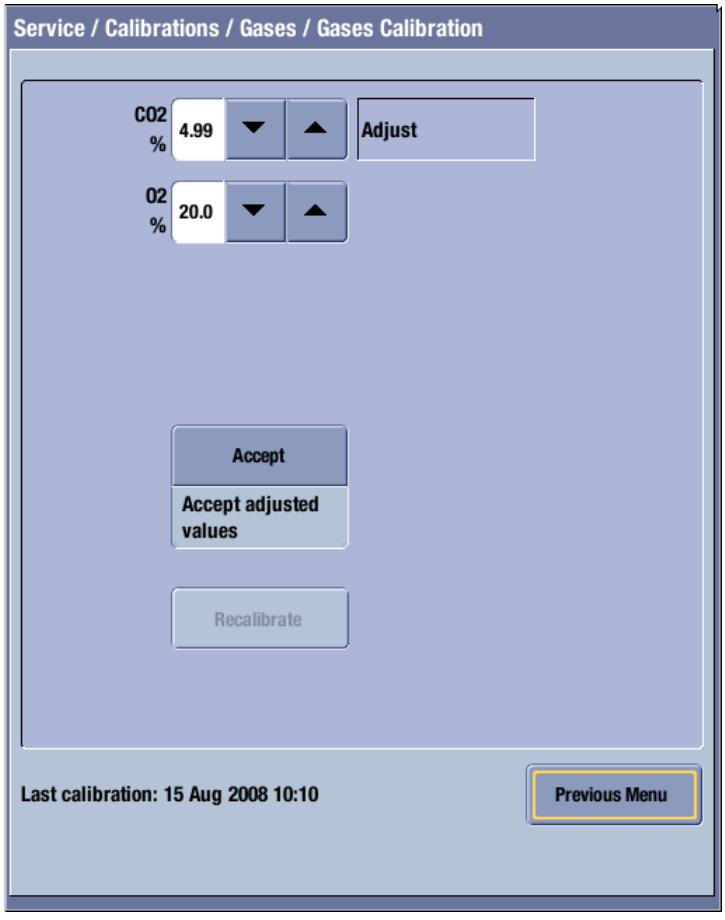
Figure 7 Connecting a gas regulator to the calibration gas container and connecting a sampling line to the gas regulator.

4.2.2 Procedure

1. Select the CO_2 Setup tab in the Gases menu and set the FiO_2 level to '21-40%'.
2. Select **Monitor Setup** > ***Service Calibrations***.
3. Enter the User Name and the Password and press ***Enter*** to get into the 'Calibrations' menu.
4. Select ***Gases***.
5. Select ***Gases Calibration***.

NOTE: Gas calibration is not available during the first 5 minutes after the module is connected. A message 'Gas calibration is not available during first 5 minutes' is shown in the lower left corner of the calibration menu. For maximum accuracy, let the monitor to warm up for 30 minutes before starting calibration.

NOTE: Gas calibration is not available during a 'Sample line blocked', 'Check Dfend' and 'Check sample gas out" alarm condition. 'Gas calibration is not available during gas sampling warning' message is shown in the lower left corner of the calibration menu. Resolve the alarm condition before starting calibration.



6. The monitor will start automatic zeroing of the gas sensor. Wait until the message 'Zeroing' is replaced by 'Zero Ok' message.
7. Open the regulator after a message 'Feed gas' is shown. The measured gas concentration is shown in real-time in the gas calibration menu. Wait until the measured gas concentration is stabilized and 'Adjust' message is shown. Close the regulator.

8. Use the CO_2 up-down spinner controls in the calibration menu to adjust the CO_2 reading shown in the calibration menu to match with the CO_2 reading in the labelling of the calibration gas container. Select Accept to accept the adjusted value when the two CO_2 readings match each other.
9. Wait until message 'Ok' is shown.

NOTE: Message 'Zero Error' is shown in case the zeroing fails.

NOTE: Message 'Calibration Error' is shown, if you do not start feeding gas within 1 minute after the automatic zeroing is completed, or if the calibration fails due to too large gain adjustment.

NOTE: If zeroing or calibration failed, select 'Recalibrate' button to restart the calibration procedure from the beginning.