

# Maintenance

## Introduction



This chapter describes routine maintenance on the HeartStart MRx monitor/defibrillator.



Most routine maintenance, including periodic operational checks, paper replacement, lithium ion battery maintenance and charge, etc. is performed by the user. Refer to the *Instructions for Use* for detailed information on these maintenance procedures.

Service personnel are responsible for the following routine maintenance:

- Yearly calibration (or every 10,000 cycles) of the Non-invasive Blood Pressure (NBP) module.<sup>1</sup>
- NBP module testing.
- Yearly calibration (or every 4000 hours) of the End-tidal Carbon Dioxide (EtCO<sub>2</sub>) module.<sup>2</sup>
- EtCO<sub>2</sub> module checking.

Click these links to access the maintenance procedures:

Topic	Page
 <a href="#">NBP Module Calibration</a>	14
 <a href="#">NBP Module Tests</a>	17

Topic	Page
 <a href="#">EtCO<sub>2</sub> Module Calibration</a>	18
 <a href="#">EtCO<sub>2</sub> Module Checks</a>	23

## HeartStart MRx Calibration Overview

Consider reviewing the HeartStart MRx *Calibration* instructional video available online at <http://theonlinelearningcenter.com/shtml/mrx/calibration/>.

Perform calibration when prompted by the **CO<sub>2</sub> Calibration Overdue** and **NBP Calibration Overdue** inops. If a calibration is overdue, then the HeartStart MRx Operational Check fails with the code Fail/D (Versions B.05 and above) or Fail/NC (Versions prior to B.05).

Regardless of your configuration settings, millimeters of mercury are the unit of measure for pressure in the HeartStart MRx calibration. Use the conversion formulae in [Table 1](#) if necessary:

**Table 1 Units of Pressure Conversion**

1 unit	=	__ mmHg
1 kPa	=	7.5 mmHg
1 mb	=	.75 mmHg
1 psi	=	51.7 mmHg
1 atm.	=	760 mmHg
1 inHg	=	25.4 mmHg

1. The users may perform NBP calibration themselves if they obtain the *NBP Calibration Kit*, part # 453564063841.

2. The users may perform EtCO<sub>2</sub> calibration themselves if they obtain the *EtCO<sub>2</sub> Calibration Kit*, part # 453564063851.

# NBP Module Calibration

This section describes how to calibrate the HeartStart MRx NBP module.

To calibrate the HeartStart MRx NBP module you need:

- A manometer and cuff assembly or 500 ml expansion chamber. These instructions refer to the cuff assembly, but can be used with the expansion chamber as well.
- A plastic container to wrap the cuff around.

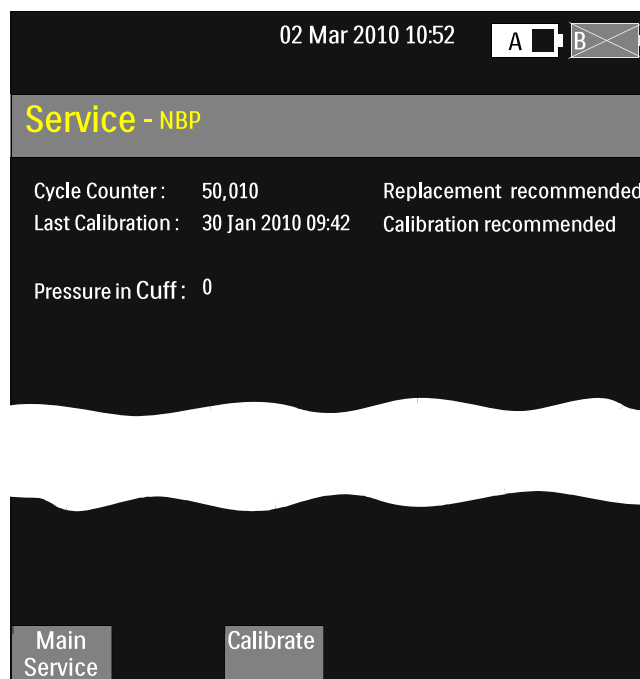
Both the manometer/cuff assembly and plastic container are provided in the NBP *Calibration Kit*, part # 453564063841.

## NBP Calibration Setup

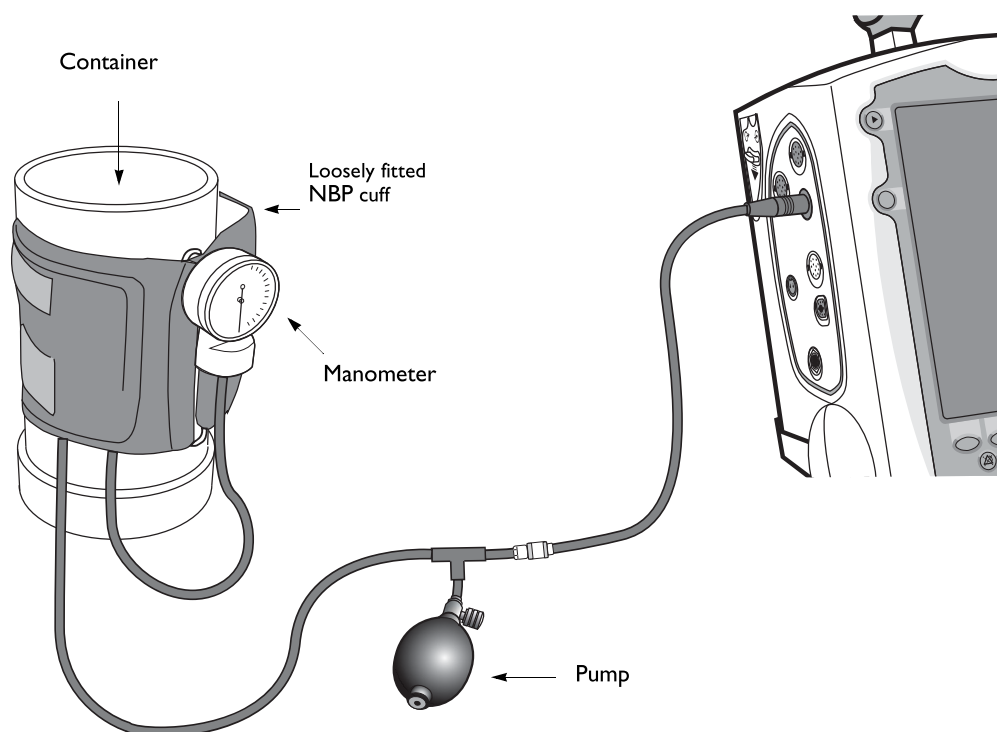
© To prepare for NBP calibration:

- 1 Access the Service Mode Main menu as described in “[Accessing Service Mode](#)” on page 8.
- 2 From the Service Mode Main menu, select NBP.
- 3 The NBP Service screen is displayed (see [Figure 9](#)). You may hear a soft, high-pitch tone, this is normal NBP pump operation.

Figure 9 NBP Service Screen



- 4 Check the Cycle Counter.  
If the NBP module has executed more than 50,000 cycles, replacement is recommended.  
*Do not proceed with the calibration. Call for service.*
- 5 Connect the test cuff assembly to the NBP port and wrap the cuff around the container (see [Figure 10](#)).  
Do not overtighten the cuff. It should have space for about 500 mL of air. Leave room for two fingers between the cuff and container before connecting the hook-and-loop fastener.

Figure 10 **NBP Calibration Setup**

## NBP Safety Features

The NBP module is equipped with the Timeout and Overpressure safety features that prevent injury to the patient and damage to the device.

### NBP Timeout

The NBP module times out when the pressure remains greater than 10 mmHg for 3 minutes. Do not keep the cuff pressurized for more than 3 minutes during the calibration.

### NBP Overpressure

The NBP module overpressure occurs when the cuff pressure reaches 300 mmHg. Do not raise the pressure in the cuff to more than 280 mmHg during the calibration.

The safety features cause the valve to open and the pressure to drop.

© To reset the module if a safety feature is triggered during calibration:

- 1 Press the **Main Service** softkey
- 2 Access the NBP Service screen to restart the calibration.

## NBP Calibration Procedure

Complete the calibration process within three minutes to avoid the NBP module timeout.

☉ To calibrate NBP:

- 1 Press the **Calibrate** softkey.  
The message **Apply 0 mmHg. Select Next when ready** is displayed.
- 2 Release all of the pressure in the cuff so that the manometer reads 0 mmHg.
- 3 Press the **Next** softkey.  
The message **Apply 250 mmHg. Select Next when ready** is displayed.
- 4 Increase the pressure so that the manometer reads 250 mmHg.  
Take time to allow the pressure in the unit to equalize and stabilize. One way to do this is to pressurize the cuff to 255 or 260 mmHg and wait for 30 seconds, then gently adjust the pressure with the pump and valve.
- 5 When the pressure is stable at 250 mmHg, press the **Next** softkey again.
- 6 Wait until the message **Calibration complete. Please perform the accuracy and leakage tests to check the results** is displayed.

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**NOTE:** The message instructing you to perform the accuracy and leakage tests is for troubleshooting only (see “[NBP Module Tests](#)” on page 17). These tests are not performed as part of calibration.

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- 7 After several seconds the message clears, and the NBP Service screen is displayed. Release the pressure in the cuff to avoid the safety timeout.
- 8 Run an operational check to update the calibration status. See the “Troubleshooting” chapter of *HeartStart MRx Service Manual* for guidance.

### NBP Calibration Failure

If the error message **Calibration failed. Check that the pressure applied is correct. Please restart calibration** appears at any moment during NBP calibration, then:

- 1 Recheck the manometer and cuff assembly connections.
- 2 Loosen the cuff. If less than ten pump compressions fill the cuff, then it is too tight.
- 3 Press the **Main Service** softkey.
- 4 Select NBP from the Service Main Menu.
- 5 Restart the “[NBP Calibration Procedure](#)” on page 16, making sure that the applied pressures are correct.
- 6 Call for service if you cannot successfully complete the calibration.



# NBP Module Tests

Perform NBP Module Tests only if there is an uncertainty about the module performance.

Each of the procedures assumes the monitor/defibrillator, the manometer, and the cuff assembly are still set up as they were at the end of the previous test.

If all results are as described, the device passes that portion of the test. Return to the Service Mode Main menu by pressing the **Main Service** softkey.

If there is any failure, begin troubleshooting and repairing the device as needed. See “[Troubleshooting](#)” on page 29.

## Accuracy Test

☉ To test the NBP Module accuracy:

- 1 Connect the NBP tubing to the NBP port on the monitor/defibrillator, and connect the test manometer and cuff to the tubing. See [Figure 10 “NBP Calibration Setup”](#) on page 15.
- 2 Pressurize the cuff to approximately 250 mmHg.
- 3 Wait for 30 seconds to allow the pressure in the unit to equalize.
- 4 When the pressure stabilizes, compare the displayed pressure reading to the pressure indicated by the manometer.
- 5 If the difference between the manometer and the displayed pressure is more than 2 mmHg, calibrate the NBP module as described in “[NBP Module Calibration](#)” on page 14 and repeat the test.
- 6 Release the pressure in the cuff before proceeding to the next test to avoid the safety timeout.

## Leakage Test

☉ To test the NBP Module for leaks:

- 1 Pressurize the cuff to approximately 250 mmHg.
- 2 Wait for 30 seconds to allow the pressure in the unit to equalize.
- 3 Watch the displayed pressure for 60 seconds.
- 4 Record the pressure drop at the end of 60 seconds.
- 5 If the pressure decreases by more than 6 mmHg, there is a leak. Replace the tubing and cuff assembly and try the leakage test again. If the pressure still decreases by more than 6 mmHg, begin troubleshooting and repairing the device as needed.
- 6 Release the pressure in the cuff before proceeding to the next test to avoid the safety timeout.

## Linearity Test

☉ To test the NBP Module linearity:

- 1 Pressurize the expansion chamber to approximately 150 mmHg.
- 2 When the pressure is stabilized, compare the displayed pressure reading to the pressure indicated by the manometer.
- 3 If the difference between the manometer and the displayed pressure is more than 2 mmHg, calibrate the NBP module as described in “[NBP Module Calibration](#)” on page 14 and repeat the test.

# EtCO<sub>2</sub> Module Calibration

This section describes how to calibrate the HeartStart MRx EtCO<sub>2</sub> (sometimes called CO<sub>2</sub>) module.

## EtCO<sub>2</sub> Calibration Equipment

To calibrate the HeartStart MRx EtCO<sub>2</sub> module you need:

- Gas flow valve
- Modified Filterline set with T-shaped tubing assembly
- 5% calibration gas cylinder (15210-64010, six cans per case)
- Calculator
- Barometer to measure ambient pressure or other means of determining the ambient pressure.

Both the gas flow valve and Modified Filterline are provided in the CO<sub>2</sub> *Calibration Kit*, part # 453564063851. The CO<sub>2</sub> *Calibration Kit*, also contains a flow tube and two air plugs that are used for troubleshooting only (see “EtCO<sub>2</sub> Module Checks” on page 23) and not used in calibration.

## EtCO<sub>2</sub> Calibration Setup

© To prepare for the calibration:


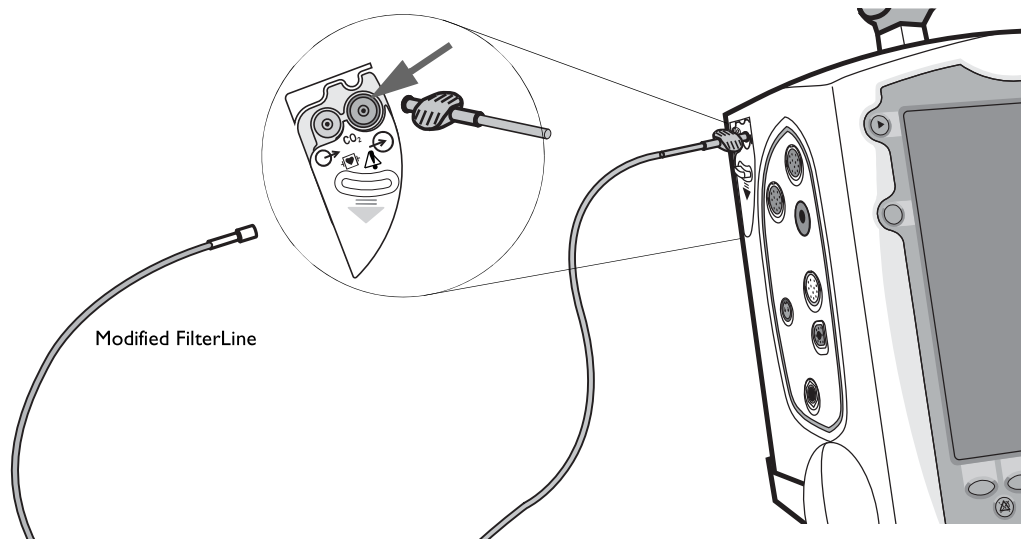
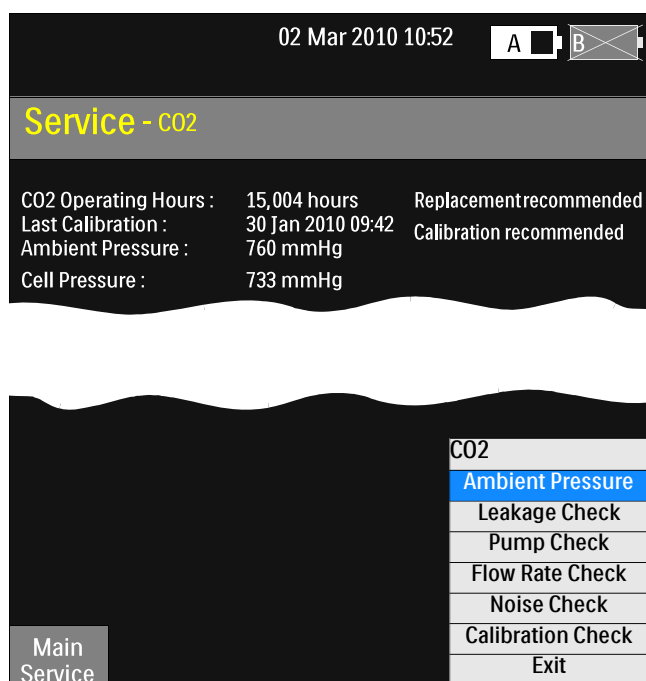
- 1 Access the Service Mode Main menu as described in “Accessing Service Mode” of the *Introduction* chapter of HeartStart MRx *Service Manual*.
- 2 Connect the Modified FilterLine from the kit to the CO<sub>2</sub> inlet marked . See [Figure 11](#).

Figure 11 CO<sub>2</sub> Preparation Setup



- 3 From the Service Mode Main menu, select **CO2**.  
After a few seconds delay, the CO<sub>2</sub> Service screen is displayed, as shown in [Figure 12](#).

Figure 12 CO<sub>2</sub> Service Screen

You may hear a soft, low-pitch tone, this is normal EtCO<sub>2</sub> pump operation. Another indication of the EtCO<sub>2</sub> pump activity is the difference between the Ambient and Cell pressures. Subtract the Cell pressure from the Ambient pressure and consult [Figure 2](#) to interpret the difference.

Table 2 Modified FilterLine Connection Checking and Troubleshooting

Ambient Pressure – Cell Pressure	Possible Cause	Suggested Solution
0	Bad connection	1 Reconnect the Modified FilterLine. 2 Go back to Main Service and reselect EtCO <sub>2</sub> .
	Pump malfunction	Call for service.
9 mmHg or less	Modified FilterLine is broken	Replace the Modified FilterLine.
	Pump malfunction	Call for service.
10 - 30 mmHg	The pump is operating normally, and the sensor is warming up.	
31 mmHg or more	Modified FilterLine is blocked	Check that the Modified FilterLine is not kinked and free of blockages. Replace if necessary.

- 4 Older models of the EtCO<sub>2</sub> sensor must warm up for at least 20 minutes before the calibration.
  - a Check Device Info.
  - b If EtCO<sub>2</sub> Module SW version is 01.xx, then warm up the sensor before calibration. Note the warm-up time. You can use the HeartStart MRx screen clock. Do not start calibration until the EtCO<sub>2</sub> sensor has been warmed up. Continue the preparation.
  - c If EtCO<sub>2</sub> Module SW version is 02.xx or above, then proceed with calibration without waiting for warm-up.



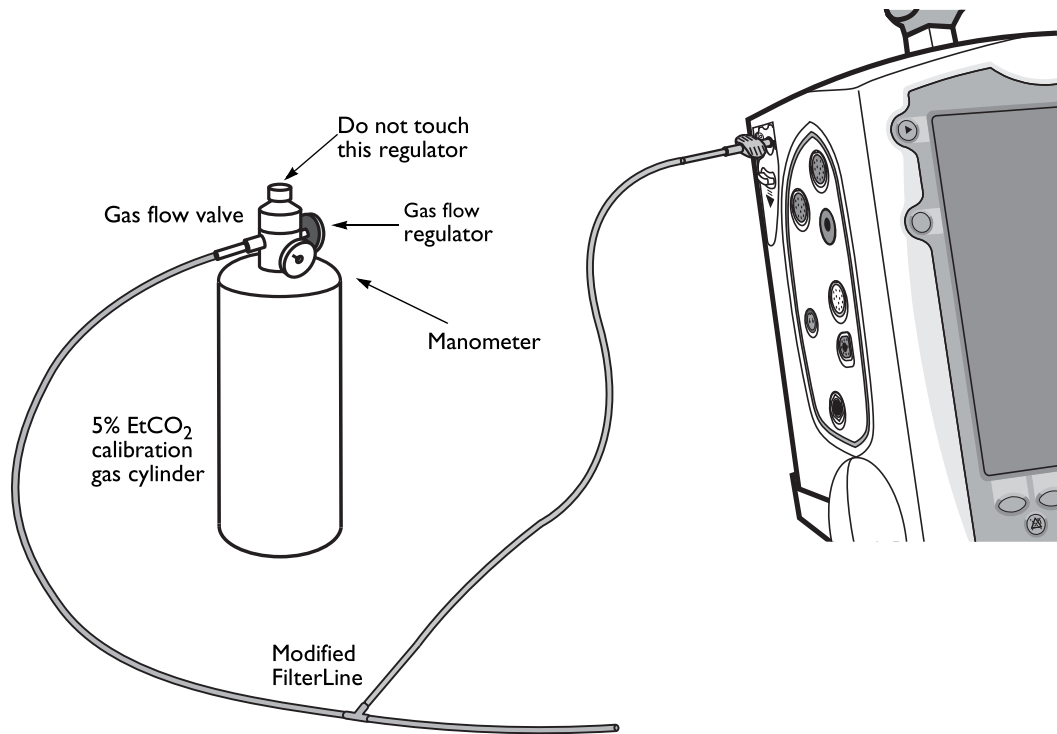
- 5 Check the CO<sub>2</sub> Operating Hours.  
If the CO<sub>2</sub> module has clocked more than 15,000 hours, replacement is recommended.  
*Do not proceed with the calibration. Call for service.*
- 6 Obtain a reliable measurement of local atmospheric pressure by using a barometer or by getting the local atmospheric pressure data from the Internet, local airport, or weather station located at the same altitude as your HeartStart MRx.
- 7 Press the Menu Select button and select Ambient Pressure.
- 8 Using  and  buttons, adjust the HeartStart MRx's Ambient Pressure setting to the measurement obtained in [Step 6](#).
- 9 Press the Menu Select button again to accept the adjusted Ambient Pressure value.
- 10 Calculate the expected CO<sub>2</sub> reading.  
The expected CO<sub>2</sub> reading depends on both the gas concentration you are using (5.0%) and the ambient pressure. Calculate as follows:
  - a  $\text{Cal. Gas Concentration} \times \text{ambient pressure} = \text{Expected CO}_2 \text{ value}$   
For example:  
 $[0.05] \times [760 \text{ mmHg}] = 38 \text{ mmHg}$
  - b Calculate the allowable tolerance, which is  $\pm 5\%$  of the expected reading. Calculate as follows:  
 $[\pm 0.05] \times \text{Expected CO}_2 \text{ value} = \pm \text{tolerance (mmHg)}$   
For example:  
 $[\pm 0.05] \times 38 = \pm 1.9 \text{ (mmHg)}$   
In this example, the displayed reading is expected to be  $38 \pm 1.9 \text{ mmHg}$ .
  - c Round to the nearest whole number because HeartStart MRx does not show fractions. The expected CO<sub>2</sub> reading in our case should be between 36 and 40 mmHg.
  - d Save your calculations. You will compare the numbers with the actual CO<sub>2</sub> sensor reading during the calibration validation.
- 11 Fit the 5% CO<sub>2</sub> gas cylinder with the valve. Screw the valve on tightly.
- 12 Watch the manometer on the valve.  
While the gas pressure does not have to be high for successful calibration, it should be present.
- 13 Connect the soft tubing at one end of the modified Filterline to the gas valve outlet, and leave the other end open to atmosphere. See [Figure 13](#).

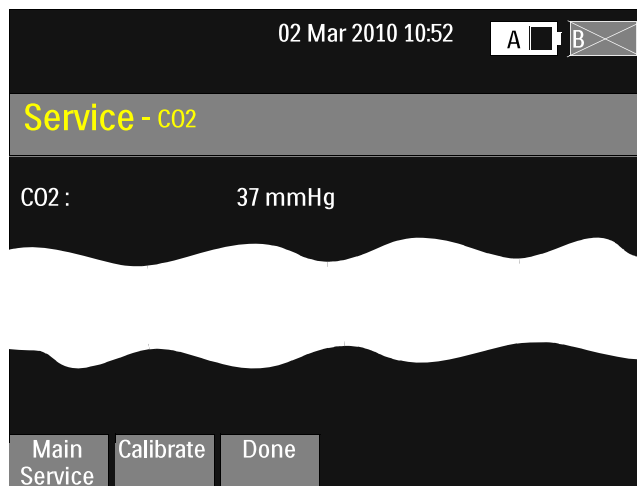
Figure 13 CO<sub>2</sub> Calibration Setup

## EtCO<sub>2</sub> Calibration Procedure

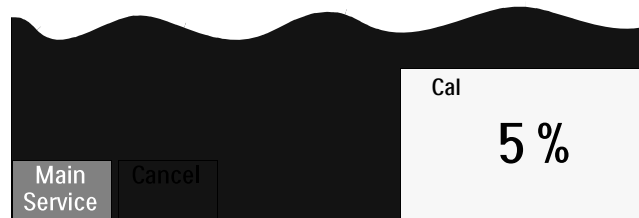
If you warm up the sensor as determined in [Step 4](#) of “EtCO<sub>2</sub> Calibration Setup”, then make sure the EtCO<sub>2</sub> sensor has been warmed up for at least 20 minutes before starting the calibration steps.

© To calibrate the EtCO<sub>2</sub> module:

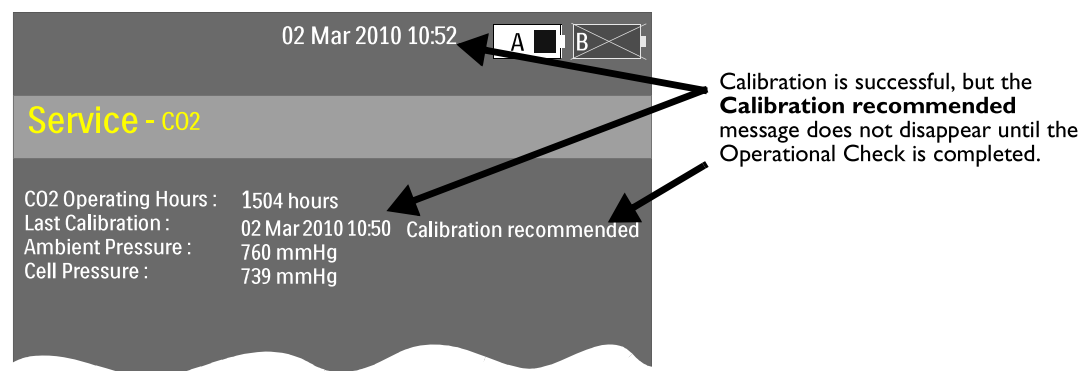
- 1 From the **CO<sub>2</sub>** Service menu, select **Calibration Check**.  
The CO<sub>2</sub> Calibration screen is displayed.
- 2 Wait a few seconds until the softkeys become active. See [Figure 14](#).

Figure 14 CO<sub>2</sub> Calibration Screen

- 3 Fully open the gas flow valve.  
Turn the regulator on the side of the valve counterclockwise. Do not touch the regulator on the top of the valve.
- 4 Allow the CO<sub>2</sub> value to stabilize.
- 5 Press the **Calibrate** softkey.
- 6 Use the Menu Select button to confirm that you are using the 5% CO<sub>2</sub> gas mix. See Figure 15.  
You can calibrate the CO<sub>2</sub> module with 4% or 6% CO<sub>2</sub> gas mix, but Philips recommends and provides instructions for the 5% calibration gas.

Figure 15 CO<sub>2</sub> Calibration Gas Selection

- 7 Do not turn off gas or touch any buttons or tubing until completion.  
The **CO2 calibration in progress** message indicates that the calibration has started.  
The **Calibration complete** message indicates that the calibration is successful.
- 8 Turn off the gas.
- 9 Validate the calibration by checking the displayed CO<sub>2</sub> value against the expected value calculated in the section [Step 10](#) on page 20 of the “EtCO<sub>2</sub> Calibration Setup” section.  
The displayed value should match the expected value within the calculated allowable tolerance.
- 10 Press the **Done** softkey.  
Note that even though the calibration is successful (the time of last calibration is updated), the calibration status does not get updated until the operational check is completed. See Figure 16.

Figure 16 Successful CO<sub>2</sub> Calibration

- 11 Run an operational check to update the calibration status. See the “Troubleshooting” chapter of *HeartStart MRx Service Manual* for guidance.

## EtCO<sub>2</sub> Calibration Failure

If the error message **Calibration failed. Please restart calibration** appears at any moment during CO<sub>2</sub> calibration, then:

- 1 Recheck the Modified FilterLine, gas cylinder, and valve connections.
- 2 Recheck gas presence in the gas cylinder. While the gas pressure does not have to be high for successful calibration, it should be present.
- 3 If the warm-up process is necessary, and the CO<sub>2</sub> module is off, then restart the warm-up process and wait for 20 minutes.  
See the section “EtCO<sub>2</sub> Calibration Setup” on page 18.
- 4 Restart the calibration as described in “EtCO<sub>2</sub> Calibration Procedure” on page 21.
- 5 If you cannot successfully complete the calibration, call for service.

## EtCO<sub>2</sub> Module Checks

Perform the EtCO<sub>2</sub> Module checks only if there is an uncertainty about the module performance.

In addition to the equipment listed in “EtCO<sub>2</sub> Calibration Equipment” on page 18, for EtCO<sub>2</sub> Module checks you will need:

- Electronic flowmeter, part # 453564178121.
- A flow tube and two air plugs. The flow tube and air plugs are provided in the CO<sub>2</sub> Calibration Kit, part # 453564063851.


Each of the procedures assumes that the HeartStart MRx, flowmeter, and tubing are still set up as they were at the end of the previous test.

If all results are as described, the device passes that portion of the test. Return to the Service Mode Main menu by pressing the **Main Service** softkey.

If there is any failure, then troubleshoot and repair the device as needed. See the “Troubleshooting” chapter of *HeartStart MRx Service Manual*.

## EtCO<sub>2</sub> Module Check Setup

© To prepare for EtCO<sub>2</sub> checks:

- 1 Access the Service Mode Main menu as described in “Accessing Service Mode” on page 8.
- 2 Connect the FilterLine to the HeartStart MRx CO<sub>2</sub> inlet marked . See Figure 11 “CO<sub>2</sub> Preparation Setup” on page 18.
- 3 From the Service Mode Main menu, select **C02**.  
After a few seconds delay, the CO<sub>2</sub> Service screen is displayed, as shown in Figure 12 “CO<sub>2</sub> Service Screen” on page 19.
- 4 Follow the steps of “EtCO<sub>2</sub> Calibration Setup” on page 18. The CO<sub>2</sub> Service screen is displayed, as shown in Figure 12 “CO<sub>2</sub> Service Screen” on page 19.

**TIP:** To check the EtCO<sub>2</sub> module, you do not need to wait for the module warm up, except for the Calibration Check.

## EtCO<sub>2</sub> Status Display Check

- 1 Check the EtCO<sub>2</sub> Operating Hours.  
Replace the CO<sub>2</sub> module after 15,000 hours of operating time. If the number of hours is more than 15,000, then the message **Replacement Recommended** is displayed. See the *Repair* chapter of HeartStart MRx *Service Manual* for instructions on replacing the CO<sub>2</sub> module.
- 2 Check calibration status.  
Check the date of the last calibration (see [Figure 12](#) on page 19). The CO<sub>2</sub> module should be calibrated every year or after 4000 hours. If more than one year has passed, or the module has operated more than 4000 hours since the last calibration, the message **Calibration Recommended** is displayed. If this message appears, then perform a calibration as described in [“EtCO<sub>2</sub> Module Calibration”](#) on page 18 regardless of the passed CO<sub>2</sub> tests.
- 3 Check the ambient and cell pressure (see [“Ambient Pressure Check”](#) below).

## Ambient Pressure Check

This option enables you to adjust the ambient pressure setting of the HeartStart MRx.

Obtain a reliable measurement of local barometric pressure (reference value). This is typically available from a local airport, weather station, or the Internet. Be sure the reading is taken at the same altitude as the HeartStart MRx is at now. Check that the HeartStart MRx's internal setting of ambient atmospheric pressure (barometric pressure) is within  $\pm 12$  mmHg of the reference value. If the ambient pressure is *not* within  $\pm 12$  mmHg of the reference value, adjust it through the Ambient Pressure menu, otherwise proceed with the [“Leakage Check”](#) below.

- ⊙ To adjust Ambient Pressure:
- 1 Select **Ambient Pressure** from the CO<sub>2</sub> Service menu.
  - 2 Use the Navigation buttons to enter the barometric pressure reference value.
  - 3 Press the Menu Select button to set the adjusted pressure value in the HeartStart MRx's memory.

## Leakage Check

The leakage check consists of two parts:

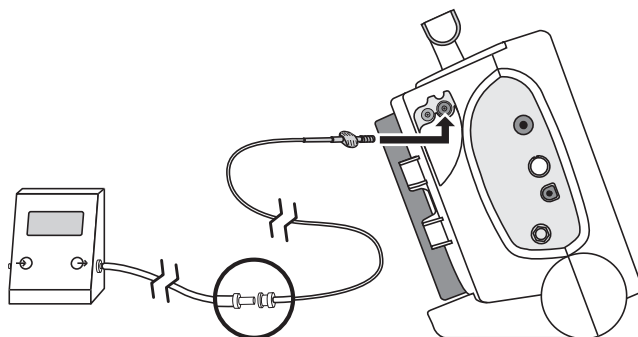
- 1 Check of the internal tubing between the pump outlet and the HeartStart MRx's CO<sub>2</sub> Outlet port (device outlet). This test is done by pressurizing the outlet line between the pump and the outlet port.
- 2 Check of the internal tubing between the pump inlet and the FilterLine inlet. This test is done by pulling a vacuum on the inlet line between the inlet fitting and the pump.

These procedures are described below.

### Outlet Leakage

- ⊙ To perform the CO<sub>2</sub> outlet leakage check:
- 1 Set up the flowmeter and the HeartStart MRx as shown in [Figure 17](#).
    - a Connect the FilterLine to the monitor/defibrillator CO<sub>2</sub> Inlet port.
    - b Connect the flow tube from the flowmeter outlet to the FilterLine.



Figure 17 **CO<sub>2</sub> Outlet Leakage Check Setup**

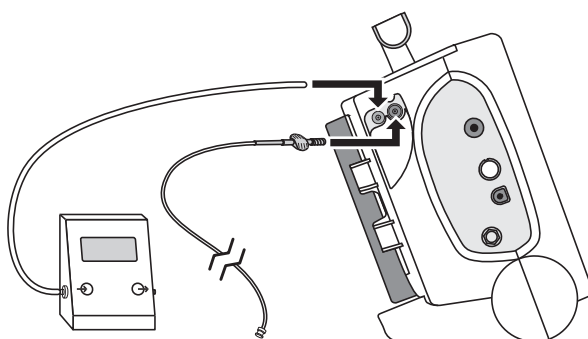
- 2 From the CO<sub>2</sub> Service menu, select **Leakage Check**.
- 3 Follow the instructions on the screen to perform Part 1 of the Leakage check.  
The reading on the flowmeter should decrease to between 0 and 4 ml/min.
- 4 If this reading is correct, then press the **Proceed** softkey to proceed to the second part of the leakage test (see the “[Inlet Leakage](#)” below).

If this reading is incorrect (> 4 ml/min. flow), then it indicates a leak in the line between the pump outlet and the CO<sub>2</sub> Outlet port. Troubleshoot and repair the device as needed. See “[Troubleshooting](#)” on page 29.

### Inlet Leakage

☉ To perform the CO<sub>2</sub> inlet leakage check:

- 1 Set up the flowmeter and the HeartStart MRx as shown in [Figure 18](#).
  - a Leave the FilterLine connected to the monitor/defibrillator CO<sub>2</sub> Inlet port.
  - b Disconnect the FilterLine from the flowmeter outlet.
  - c Connect the flow tube from the flowmeter inlet to the monitor/defibrillator CO<sub>2</sub> Outlet port.

Figure 18 **CO<sub>2</sub> Inlet Leakage Check Setup**

- 2 Follow the instructions on the screen to perform Part 2 of the Leakage check.
- 3 Press the **Done** softkey.

If this reading is incorrect (> 4 ml/min. flow), then it indicates a leak in the line between the FilterLine inlet and the pump inlet. Troubleshoot and repair the device as needed. See “[Troubleshooting](#)” on page 29.

## Pump Check

This test checks the ‘strength’ of the pump by occluding the inlet and measuring how deep a vacuum the pump can pull.

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**NOTE:** The tests must be conducted in the order they are described here. For example, if you perform the Pump Check, and there is a leak that you have not found because you did not perform the Leakage Check, it may appear that the device has a faulty pump, when in fact it has a loose tubing connection.

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⊙ To check the pump:

- 1 From the CO<sub>2</sub> Service menu, select **Pump Check**.
- 2 Follow the instructions on the screen to perform the pump check.  
The difference between the cell and ambient pressures displayed should be more than 120 mmHg.
- 3 Press the **Done** softkey.

If the pressure reading is correct (difference >120 mmHg), then the device passed the pump test.

If the pressure difference < 120 mmHg, then the pump is defective (regardless of the number of hours it has run) and the CO<sub>2</sub> module must be replaced. See the “CO<sub>2</sub> Module” on page 149

## Flow Rate Check

Be sure there are no kinks, pinches, or obstructions in any of the tubing — this can create a restriction that would diminish the flow rate and cause a false failure of this test.

⊙ To check the flow rate:

- 1 Disconnect the flow tube from the flowmeter inlet.
- 2 From the **CO2** Service menu, select **Flow Rate Check**.
- 3 Connect the FilterLine to the flowmeter outlet.
- 4 Follow the instructions on the screen to perform the Flow Rate check.
- 5 If the flow rate is within the tolerance limit ( $50 \pm 7.5$  ml/min), the test passes.  
If the flow rate is *not* within the tolerance limit, proceed to “EtCO<sub>2</sub> Module Calibration” on page 18 to calibrate the flow rate.
- 6 Use the Navigation buttons to increase and decrease the flow until it is as close as possible to 50 ml per minute as indicated on the flowmeter gauge.
- 7 When you are satisfied that the flow is set as close as possible to 50 ml, press the **Store Flow** softkey to confirm the setting. If the adjusted flow is not stored within 60 seconds of the adjustment, the old flow setting is restored.

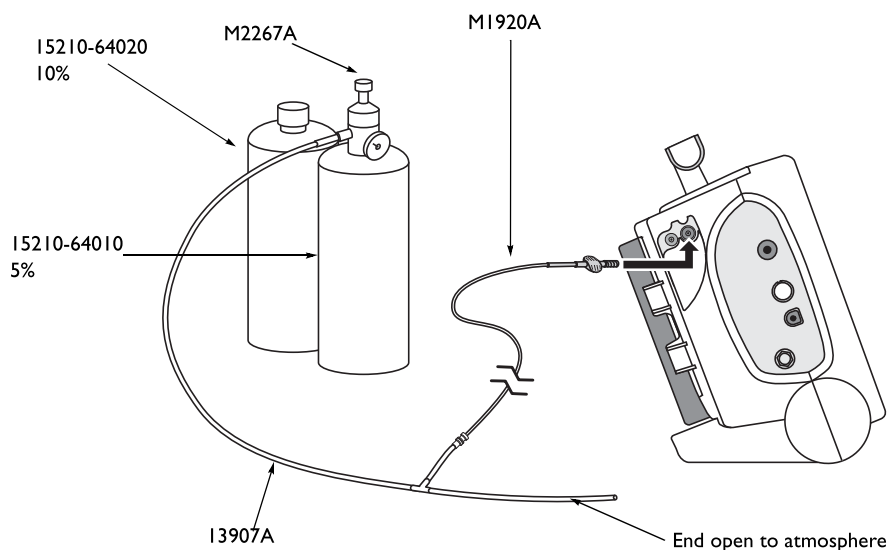
If the flow cannot be adjusted within tolerance, the CO<sub>2</sub> module must be replaced. See “CO<sub>2</sub> Module” on page 149

## Noise Check

This test looks for noise on the CO<sub>2</sub> signal due to deterioration of the infrared source.

⊙ To check the flow rate:

- 1 From the **CO2** Service menu, select **Noise Check**.
- 2 Set up the calibration gas as shown in [Figure 19](#).
  - a Connect the 5% calibration gas to the CO<sub>2</sub> Inlet port.
  - b Turn on the gas.

Figure 19 CO<sub>2</sub> Noise and Calibration Check Setup

- 3 Follow the instructions on the screen to perform the Noise check.
- 4 Wait until the displayed CO<sub>2</sub> value is stable. Check the noise index reading.
- 5 If the noise index exceeds 3 mmHg, the CO<sub>2</sub> module must be replaced. See “CO<sub>2</sub> Module” on page 149.

## Calibration Check

This test checks the accuracy of the CO<sub>2</sub> measurement without actually calibrating the CO<sub>2</sub> module. The calibration check can be performed using either 5% or 10% calibration gas or both.

- 1 See the “EtCO<sub>2</sub> Calibration Setup” on page 18 to set up the module.
- 2 From the **CO2** Service menu, select **Calibration Check**.  
The CO<sub>2</sub> Calibration screen is displayed,

### Calibration Check with 5% Gas

- 1 Set up the calibration gas as shown in Figure 19.
  - a Connect the 5% calibration gas to the CO<sub>2</sub> Inlet port.
  - b Turn on the gas.
- 2 Wait until the displayed CO<sub>2</sub> value is stable.
- 3 Calculate the expected CO<sub>2</sub> reading, which depends on both the gas concentration you are using (5.0%) and the ambient pressure.

Calculate as follows:

$$[\text{concentration of cal gas}] \times [\text{ambient pressure}] = \text{expected CO}_2 \text{ value}$$

For example:

$$[0.05] \times [736 \text{ mmHg}] = 36.8 \text{ mmHg}$$

- 4 Calculate the allowable tolerance, which is  $\pm 5\%$  of the expected reading.

Calculate as follows:

$$[\pm 0.05] \times [\text{expected CO}_2 \text{ value}] = \pm [\text{tolerance}] \text{ mmHg}$$

For example:

$$[\pm 0.05] \times [36.8 \text{ mmHg}] = \pm 1.8 \text{ mmHg}$$

In this example, the reading displayed with 5% cal gas must be 36.8 mmHg  $\pm$  1.8 mmHg, or between 35.0 mmHg and 38.6 mmHg.

- 5 Compare the displayed CO<sub>2</sub> value to the allowable range of values.

If the displayed value falls within the allowable range, proceed to the “[Calibration Check with 10% Gas](#)” section below.

If the displayed value does not fall within the allowable range, the CO<sub>2</sub> measurement module needs to be calibrated. Perform “[EtCO<sub>2</sub> Module Calibration](#)” on page 18.

### Calibration Check with 10% Gas

- 1 Disconnect the 5% gas (and regulator, if needed) and connect the 10% gas.
- 2 Turn on the gas.
- 3 Wait until the displayed CO<sub>2</sub> value is stable.
- 4 Calculate the expected CO<sub>2</sub> reading, which depends on both the gas concentration you are using (10.0%) and the ambient pressure.

Calculate as follows:

$$[\text{concentration of cal gas}] \times [\text{ambient pressure}] = \text{expected CO}_2 \text{ value}$$

For example:

$$[0.10] \times [736 \text{ mmHg}] = 73.6 \text{ mmHg}$$

- 5 Calculate the allowable tolerance, which is  $\pm$ 7% of the expected reading.

Calculate as follows:

$$[\pm 0.07] \times [\text{expected CO}_2 \text{ value}] = \pm [\text{tolerance}] \text{ mmHg}$$

For example:

$$[\pm 0.07] \times [73.6 \text{ mmHg}] = \pm 5.2 \text{ mmHg}$$

In this example, the reading displayed with 10% cal gas must be 73.6 mmHg  $\pm$  5.2 mmHg, or between 68.4 mmHg and 78.8 mmHg.

- 6 Compare the displayed CO<sub>2</sub> value to the allowable range of values.

If the displayed value falls within the allowable range, then the device has passed its accuracy test.

If the displayed value does not fall within the allowable range, then the CO<sub>2</sub> measurement module needs to be calibrated. Perform “[EtCO<sub>2</sub> Module Calibration](#)” on page 18.

- 7 Return to the **C02** Service screen by pressing the **Done** softkey.