

## Chapter 7. Service Procedures

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## 7. SERVICE PROCEDURES

### 7.1 General service information

Field service of the Cardiocap/5 monitor is limited to replacing faulty circuit boards, mechanical parts, or a real-time clock battery. Some boards may be returned to GE Healthcare for exchange.

For service advice from GE Healthcare, please provide the unit serial number, full type designation, and a detailed fault description.

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**CAUTION:** Only trained personnel with the appropriate tools and equipment shall perform the tests and repairs outlined in this chapter. Unauthorized service may void warranty of the unit.

**CAUTION:** Electrostatic discharge through the PC boards may damage the components. Before replacing PC boards, wear a static-control wrist strap. Handle all PC boards by their non-conductive edges and use anti-static containers when transporting them.

**CAUTION:** When reassembling the monitor, make sure all cables and tubing are reconnected properly and are not pinched between other components.

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### 7.2 Monitor software installation

#### “Cold start” instructions

Follow these installation instructions if the monitor has been off for more than 15 minutes:

1. Insert the service software PC card into the data card slot closest to the display.
2. Power on the monitor. Both LEDs illuminate and the screen remains blank for approximately two minutes while loading.
3. When the normal monitoring screen is displayed, remove the card.
4. Perform the factory reset.

#### “Warm start” instructions

Follow these instructions if the monitor has been off for less than 15 minutes:

1. Insert the service software PC card into the data card slot closest to the display.
2. To start the software loading you need to perform the factory reset. Push the ComWheel and select:  
**Install/Service** (16-4-34)  
**Service** (26-23-8)  
**Monitor**  
**Factory Reset**  
Both LEDs illuminate and the screen remains blank for approximately two minutes while loading.
3. When the normal monitoring screen is displayed, remove the PC card.
4. Perform the factory reset.

## 7.3 Replacement procedures

NOTE: Reassembly is essentially the reverse of disassembly. When reassembling the unit, make sure that the cables and tubes, if any, are not pinched between the boards.

### Tools

- Screwdriver (pozidrive)
- Hexagon driver (3.0 mm)
- Pliers
- Cable tie

### 7.3.1 Disassembling the frame assembly

1. Remove the 4 hexagon and 13 pozidrive screws that hold the back cover.
2. To pull the front-cover unit apart from the inner-parts unit, remove the 4 screws that hold the front-cover unit and the inner-parts unit together.
  - Turn the monitor on its side and disconnect the NIBP and gas sampling line tubes.  
NOTE: The foremost NIBP tube is connected to the upper NIBP connector. Notice the correct order of the main stream and sidestream tubes. The Nafion™ tube connects to the outer D-Fend connector.
  - Disconnect all patient connector cables from the front panel.
  - Disconnect 2 cables (blue flat cable and black 4-terminal cable) from the PVX board.
  - Disconnect 3 flat cables and white network cable from the CPU board.
  - Disconnect the power cable from the CPU board by pinching the retainers with a screwdriver.
  - Disconnect the recorder power cable.
3. Lay the front cover unit so that the weight of the unit does not stress the ComWheel. Protect the LCD screen from scratches.

NOTE: When reassembling the frame, be sure the gasket between the front cover and the back-cover frame is placed properly.

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**CAUTION:** When reassembling the monitor, make sure all cables and tubing are connected properly.

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### 7.3.2 Mother board removal

The mother board is removed together with the metal bracket. The Mother board needs to be moved out of the way to get access to the parts located in the inner-parts unit.

To remove the mother board, disconnect the following cables:

1. Disconnect the DC/DC–Mother board (red & black color) cable from the Mother board.
2. Disconnect the Battery–Mother board (red & black color) cable from the Mother board.
3. Disconnect the I/O–Mother board flat cable from the Mother board.
4. Disconnect the I/O–CPU board flat cable from the CPU board.
5. Disconnect the expansion unit–Mother board cable (if N-XNSAT, N-XOSAT, or NMT is installed).
6. Remove the 4 screws that hold the Mother board and the metal bracket to the inner-parts unit. Twist straight the metal clamp that holds the Mother board on the inner-parts unit.
7. Move the Mother board with the metal bracket out of the way.

### 7.3.3 ECG, NIBP, and STP board replacement

The NESTPR unit must be removed before you can replace the ECG, NIBP, or STP boards.

#### NESTPR unit removal

You may separate the display from the frame to gain better access to the NESTPR unit, but it is not necessary. To remove the unit without separating the display:

1. Disconnect the 5 patient-connector cables from the front panel.  
**Important:** For reassembly, note the connection of temperature cable T1 (black wires) and, for monitors with two temperature measurements, temperature cable T2 (yellow wires). T2 is not connected for monitors that have only one temperature measurement.
2. Disconnect the NIBP tubes from the module.  
NOTE: The foremost NIBP tube is connected to the upper NIBP connector.
3. Carefully lift the unit up.

#### ECG board replacement

1. Remove 4 screws from the ECG board and disconnect the flat cable from the STP board.
2. Detach the ECG board.

#### NIBP board replacement

1. To access the NIBP board, remove the ECG board.
2. Remove 4 screws from the corners of the NIBP unit.
3. Disconnect the ribbon cable from the EST board.
4. Disconnect the NIBP tubes from the adapter.  
NOTE: Notice the correct tube connections; lower one to the inner one.
5. Pull the NIBP board carefully out.

#### STP board replacement

1. Detach the ECG board.
2. Disconnect NIBP tubes from the both sides of the plastic strut. Remove the plastic strut carefully from the NESTPR unit's frame.
3. Disconnect the ribbon cable from the STP board
4. Remove 4 screws from the corners of the STP board and detach the STP board.

### 7.3.4 Backplate unit removal

The backplate unit contains the fan, speaker, and I/O board

1. Remove the 3 screws that hold the backplate unit to the AC/DC unit.
2. Push the backplate unit forward and bend the retainers in both sides to loosen the unit.
3. Carefully pull out the backplate unit.
4. Disconnect the CPU-NET board cable from the I/O board.
5. Disconnect the fan power cable from the DC/DC board.
6. To remove the sample gas outlet tube, unfasten the lock washer from the gas outlet connector (X6) and pry the connector out of the cover.

### 7.3.5 Gas unit CPU board, pump, and fan replacement

The airway gas unit must be removed before you can replace the gas unit CPU board, the pump, or the fan.

#### Airway-gas unit removal

1. Move the backplate unit out of the way to access the airway gas unit (see *Backplate unit removal*).
2. Unfasten the 3 screws and washers that hold the locking chock and remove the chock.
3. If installed, disconnect the hook-and-loop strap.
4. Disconnect the 2 tubes from the rear of the airway gas unit.
5. Grip the airway gas unit and pull it out sideways.

#### Gas unit CPU board replacement

1. Remove 4 screws from the corners of the OM board.
2. Disconnect the following cables from the gas unit CPU board:
  - pump cable
  - pneumatics-unit cable
  - fan cable
  - TPX IR-lamp power cable
  - TPX unit ribbon cables (both)

NOTE: Use pliers to disconnect ribbon cables from the gas unit CPU board. Be careful not to bend the ribbon cable connectors.

3. Detach the gas unit CPU board from the OM board.
4. After replacing the gas unit CPU board:
  - Perform the sampling-system leak test.
  - Perform the gas calibration.

#### Pump unit replacement

1. Remove the screw that holds the pump unit to the airway gas unit frame. (The screw is located between the pump and the TPX unit.)
2. Disconnect the pump cable from the gas unit CPU board. Pass the cable under the pneumatic unit by lifting it.
3. Lift the pump unit off the frame.
4. Cut off the cable tie (Panduit) that holds the pump.
5. Unplug the pump hoses.

#### Fan replacement

NOTE: You need to detach the pump unit to access the fan power cable.

1. Detach the fan by carefully bending the fastening springs.
2. Disconnect the fan power cable from the CPU board.

### **7.3.6 AC/DC unit replacement**

1. Remove the 3 screws that hold the AC/DC unit to the backplate unit.
2. Disconnect AC/DC-DC/DC cable from the DC/DC board.
3. Disconnect the ground wire.
4. Lift the AC/DC unit carefully up.

### **7.3.7 DC/DC board replacement**

You may move the AC/DC unit out of the way first to improve access to the DC/DC board.

1. Disconnect the DC/DC-AC/DC board cable from the DC/DC board.
2. Disconnect the DC/DC-Mother board (red & black color) cable from the Mother board.
3. Disconnect the DC/DC-Battery cable from the DC/DC board.
4. Disconnect the Fan power cable from the DC/DC board.
5. Remove the 3 screws from the heat sink from the backside of the inner-part unit.
6. Remove the 6 screws that hold the board to the holder plate from the corners of the DC/DC board.

### **7.3.8 Recorder unit replacement**

1. Press the recorder paper compartment release key on the front panel side.
2. Take the paper roll out.

NOTE: Be careful not to stain the thermal printer head.

3. Loosen the 2 screws in the bottom of the compartment.
4. Grab the recorder compartment and pull firmly.

NOTE: If the recorder unit is stuck in the frame, remove the recorder unit's metal cover from the backside of the front-cover unit and push the recorder out.

### **7.3.9 Inverter board and Backlight board replacement**

1. Disconnect the CPU-Backlight board cable from the Backlight board.
2. Remove the 3 screws that hold the Backlight board to the front-cover unit.
3. Disconnect the Backlight-Inverter board cables (2 pieces) from the Inverter board.
4. Remove the Inverter and Backlight boards together.

#### **Inverter board replacement**

Remember to reassemble all the washers and the O-ring or nylon spacers. Be careful not to drive the screws so tight that you break the Inverter board.

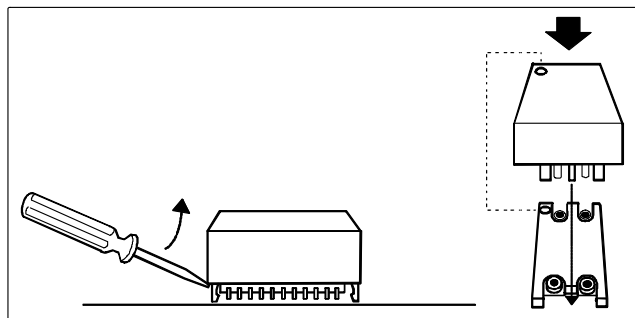
### 7.3.10 CPU battery replacement



**CAUTION:** Discard the lithium battery according to local regulations.

Before replacing the battery, determine the monitor software version. Look on the small sticker on the rear of the monitor. The software version follows the dash after the part number (for example, in 898716-1.0, the monitor software is version 1.0; in 898716-2.4, it is version 2.4). If you cannot determine the software version from the sticker, look at the Service View screen: Press the ComWheel and select **Monitor Setup – Install/Service (16-4-34) – Service (26-23-8)**.

- For version 1.0, you must upgrade to the latest monitor software (see the *Spare Parts* chapter).
  - For version 2.4 or earlier, after replacing the battery you must reconfigure the monitor and, if the N-XNET or N-XDNET option is installed, load the N-XNET or N-XDNET software (see *Spare Parts*).
  - For version 2.5 or later, replace the battery as described below.
1. Turn off the monitor and disconnect the power cord. Remove the cover. Use a screwdriver to carefully detach the battery from the D12 circuit on the CPU board. Align and install the new battery as shown below.



**Figure 7-1. CPU battery replacement**

2. Reassemble the monitor.
3. Turn on the monitor and enter the Service View screen: Press the ComWheel and select **Monitor Setup – Install/Service (16-4-34) – Service (26-23-8)**.
4. If your monitor software is version 2.5 or later, go to step 7 (perform a factory reset). For version 2.4 or earlier, determine the frame (F-MX or F-MXG) and parameters for your monitor: If your monitor frame is F-MXG (monitor with D-fend), select **Modules – Gas Unit – General** and determine which parameters are available.  
NOTE: **p&V** means the same as **Spirometry** in Module Configurations.
5. Return to the Service View screen, select **Monitor – Configurations**, and choose the **Frame and Set** that correspond to your monitor.
  - There are two F-MX configurations and twelve F-MXG configurations.
  - CO<sub>2</sub> and N<sub>2</sub>O are active at the same time (only CO<sub>2</sub> is shown in the Set configurations). AA and ID are also active at the same time (only AA is shown in the Set configurations).
6. If applicable, load the N-XNET or N-XDNET option.
7. Perform a factory reset (from the Service View menu, select **Monitor – Factory Reset**).
8. Set the time and user configurations. See the *User's Reference Manual*.
9. Turn off the monitor for 5 minutes. Turn it on and check that the time and user configurations are **OK**.



### 7.3.11 CPU board replacement

**Important:** The new CPU board does not contain software or network options. If the network is required, make sure the CPU board supports the network. You must load the software after you replace the board. Refer to the *Spare Parts* chapter.

1. Disconnect the following flat cables from the CPU board:
  - CPU - REC cable
  - CPU - ComWheel cable
  - CPU - Keyboard cable
  - CPU - Display board cable
2. Remove the 6 screws that hold the CPU board to the front-cover unit.
3. Carefully remove the CPU board.

After removing the CPU board, you can access the LCD display, backlights, and keyboard.

### 7.3.12 LCD display, LCD display backlight, and keyboard replacement

#### LCD display removal

1. To remove the CPU board (and access the LCD display), disconnect the following flat cables from the CPU board:
  - CPU - REC cable
  - CPU - ComWheel cable
  - CPU - Keyboard cable
  - CPU - Display board cable

Then, remove the 6 screws that hold the CPU board to the front cover unit and carefully remove the board.

2. Remove the 2 screws that hold the display-adapter board.  
NOTE: These two screws are not used if a foam backing is present.
3. Remove the 4 screws and nylon spacers that hold the LCD to the front-cover unit.
4. Lift the LCD-display unit away.

#### Replacing LCD display backlights

After removing the LCD display, you can replace one or both of the two LCD display backlights.

1. Remove the 2 screws that hold the backlight holder and carefully lift the holder up.
2. Replace the backlight(s).

#### Replacing the keyboard

After removing the LCD display, you can replace the keyboard.

**Important:** For reassembly, note the location of each button before replacing the keyboard.

1. Remove the 6 screws that hold the keyboard to the front-cover unit.  
NOTE: Buttons are loose and may fall as you remove the keyboard.
2. Replace the keyboard and reinstall the buttons in the correct locations.
3. Install the 6 screws that secure the keyboard to the front cover unit.

### 7.3.13 Enhanced pulse oximetry (N-XOSAT) or SpO<sub>2</sub> interface board replacement

1. Disconnect the Mother board cable from the SpO<sub>2</sub> interface board.
2. Remove the 3 screws that secure the assembly cover to the front panel.
3. Remove the 4 screws that secure the SpO<sub>2</sub> interface board to the assembly cover.
4. To remove the pulse oximetry board cover from the SpO<sub>2</sub> interface board, gently bend the tabs to an upright position and lift the cover off.
5. Remove the 4 screws that secure the OSAT pulse oximetry board to the SpO<sub>2</sub> interface board and gently lift to separate the boards.
6. Disconnect the OSAT board cable from the SpO<sub>2</sub> interface board.
7. Disconnect the connector board/cable assembly from the OSAT pulse oximetry board.

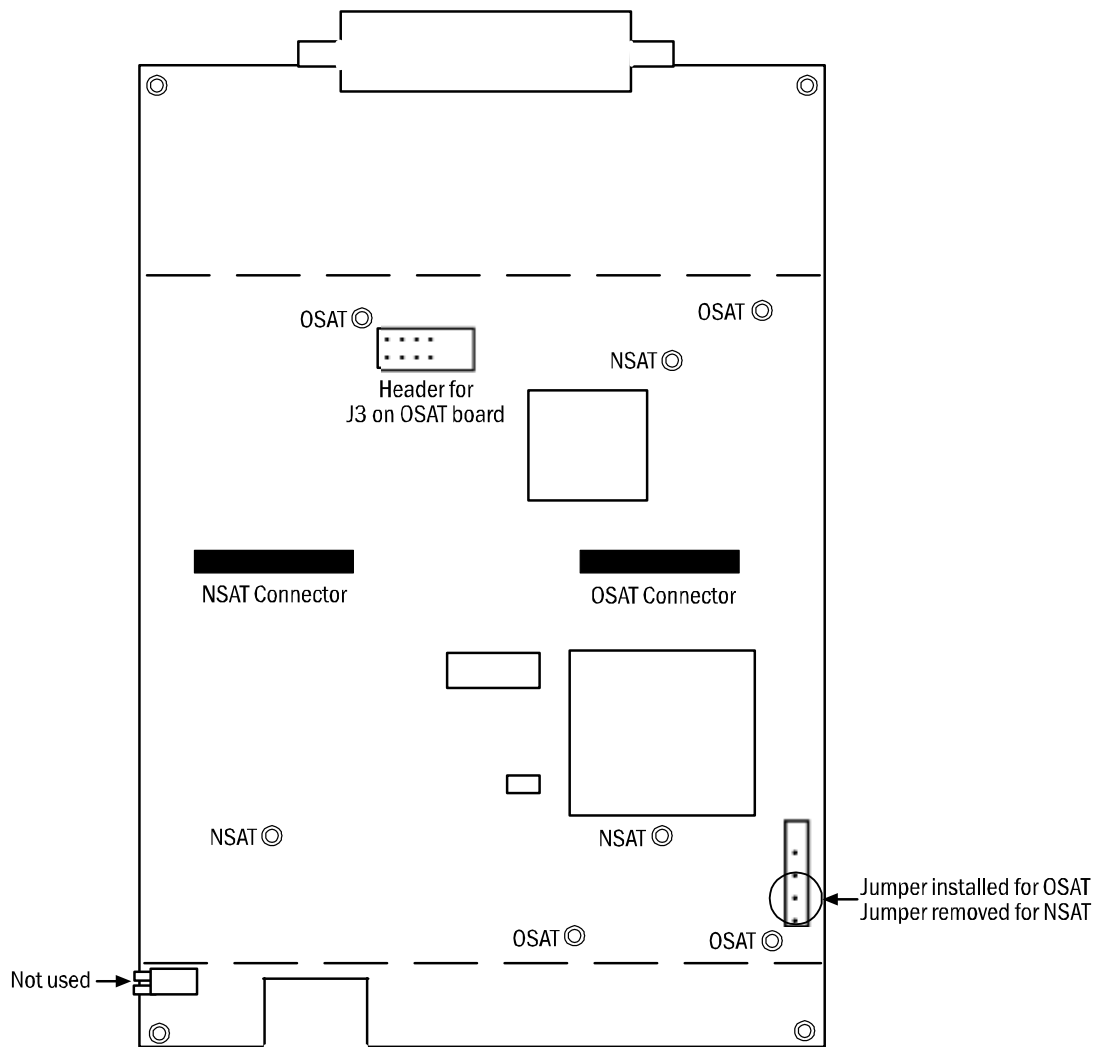


Figure 7-2. SpO<sub>2</sub> interface board

**Installation notes** (refer to figure 7-2):

- When installing the SpO<sub>2</sub> interface board, be sure the jumper for OSAT is installed. Transfer each standoff bushing from the old board to the new board at the four locations designated "OSAT" in figure 7-2.
- When installing the OSAT board, connect the connector board/cable assembly to the OSAT board and connect the OSAT board cable to the OSAT connector on the SpO<sub>2</sub> interface board. Then, align the connector J3 pins on the OSAT board with the matching header on the SpO<sub>2</sub> interface board. Gently press down to connect the two boards.

**7.3.14 Nellcor pulse oximetry (N-XNSAT) or SpO<sub>2</sub> interface board replacement**

1. Disconnect the Mother board cable from the SpO<sub>2</sub> interface board.
2. Remove the 3 screws that secure the assembly cover to the front panel.
3. Remove the 4 screws that secure the SpO<sub>2</sub> interface board to the assembly cover.
4. To remove the pulse oximetry board cover from the SpO<sub>2</sub> interface board, gently bend the tabs to an upright position and lift the cover off.
5. Remove the 3 screws that secure the NSAT pulse oximetry board to the SpO<sub>2</sub> interface board and gently lift to separate the boards.
6. Disconnect the NSAT board cable from the SpO<sub>2</sub> interface board.
7. Disconnect the connector board/cable assembly from the NSAT pulse oximetry board.

**Installation notes** (refer to figure 7-2):

- When installing the SpO<sub>2</sub> interface board, be sure the jumper on the SpO<sub>2</sub> interface board is not installed. Transfer each standoff bushing from the old board to the new board at the three locations designated "NSAT" in figure 7-2.
- When installing the NSAT board, verify that a jumper is installed on J6 (and a jumper is not installed on J5). If a jumper is installed on J5, remove it before installing the board. Then, connect the connector board/cable assembly to the NSAT board and connect the NSAT board cable to the NSAT connector on the SpO<sub>2</sub> interface board.

**7.3.15 NMT board or NMT cable assembly replacement**

1. Disconnect the Mother board cable from the NMT board (at the top of the NMT assembly located inside the front panel).
2. Remove 3 screws that secure the NMT assembly to the front panel.
3. Remove the 4 screws that secure the NMT board to the assembly cover and remove the board.
4. Disconnect the NMT input board/connector cable from X2 and X3 on the NMT board.  
NOTE: Replace the old NMT board or NMT cable assembly with the new one in the steps that follow.
5. Connect the NMT input board/connector cable to the NMT board:
  - Connect the 10-pin connector to X2.
  - Connect the 3-pin stimulus connector to X3.
6. Position the NMT board in the assembly cover and install the 4 screws that secure it to the cover.
7. Position the NMT assembly over the front panel and install the 3 screws that secure it to the front panel. Be sure the NMT shield is correctly positioned under the NMT board against the front panel.
8. Connect the Mother board cable to the NMT board.

## 7.4 Adjustments and calibration

You use service menus to perform procedures in this section. Once you have entered the Service View menu, you can enter and exit the specific service menus at which you make the adjustments.

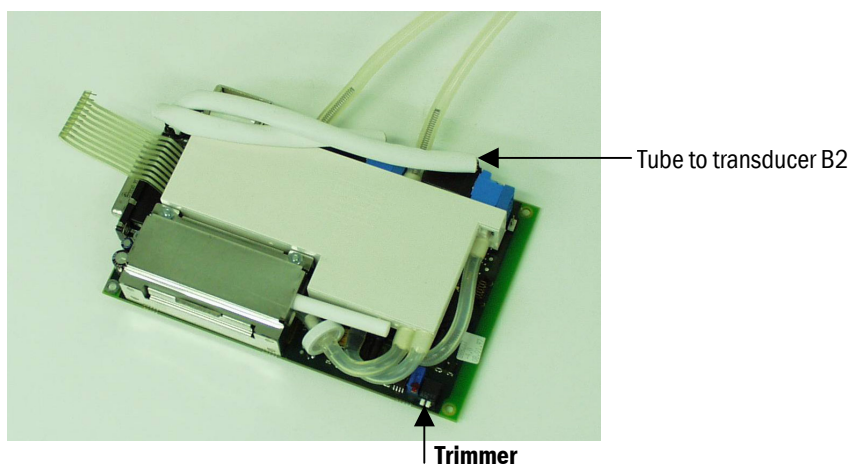
To enter the Service View menu, from which you access all other service menus:

1. Press the ComWheel and select **Monitor Setup**.
2. Select **Install/Service** and enter the password (16-4-34).
3. Select **Service** and enter the password (26-23-8)  
The Service View menu is displayed.

NOTE: Refer to the *Service Menus* chapter for illustrations and detailed explanations of the service menus and screens.

### 7.4.1 Pressure safety-level detection "OFFSET"

The pressure safety-level adjustment trimmer is located on the NIBP board beside the calibration protection gear wheel. To access the pressure safety-level adjustment trimmer, you must detach the NIBP board from the NESTPR unit frame.



**Figure 7-3. NIBP board**

#### Tools

- Troubleshooting extension cable (884298)
1. Connect the NIBP board to the NESTPR connector on the mother board using the troubleshooting extension cable.
  2. Switch on the monitor.
  3. To enter the NIBP Pneumatics menu from the Service View menu, select:  
**Modules**  
**NIBP**  
**Pneumatics**
  4. Apply 13 mmHg/1.7 kPa (11 to 15 mmHg/1.5 to 2.0 kPa) pressure to pressure transducer B2 with a precision manometer and adjust the trimmer to change the AD5 value on the screen from negative to positive.

## 7.4.2 NIBP calibration check

NIBP pressure measurement electronics are calibrated at the factory. The processor maintains zeroing pressure automatically. If the zero point of the pressure transducer drifts more than specified, an error message is given and the NIBP board should be recalibrated or replaced.

### Checking the primary pressure channel calibration

1. To check the primary pressure channel calibration, press the **NIBP** key and select **NIBP Setup** to open the NIBP Setup menu.
2. If an NIBP hose is connected, disconnect it to expose atmospheric pressure to the pressure transducers.
3. Select **Calibration Check**.  
Autozeroing is performed at start. The primary pressure is displayed. The zero-offset value should be zero.
4. Reconnect the NIBP hose and pressurize to 200 mmHg (26.7 kPa).

### Using a manometer to check NIBP calibration

1. To enter the NIBP Calibration service menu from the Service View menu, select: **Modules – NIBP – Calibrations**.
2. Set **Calibration Check** to **ON**.
3. Connect an external precision manometer to the NIBP connector.
4. Manually pump the following pressures to the NIBP tubing and check the difference between the manometer and monitor pressure display for pressure channels B1 and B2:

Pressure	Maximum Error	Example
0 mmHg (0 kPa)	$\pm 9$ mmHg (= zero offset)	- 2
100 mmHg (13.3 kPa)	100 + zero offset $\pm 2$ mmHg	98 $\pm 2$
200 mmHg (26.7 kPa)	200 + zero offset $\pm 3$ mmHg	198 $\pm 2$

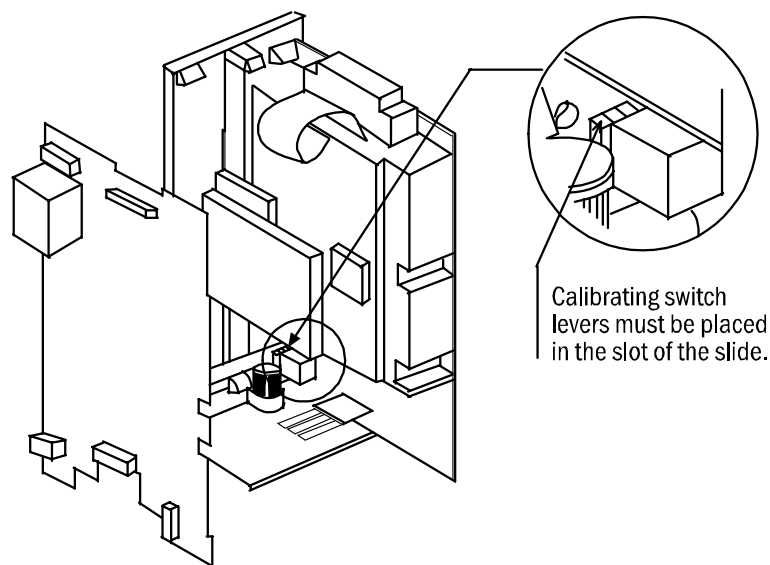
If the error for pressure channel B1 is larger than specified above, recalibrate.

The error for pressure channel B2 may be twice as large because it does not affect blood pressure measurement accuracy. When the B2 error is larger than specified above, however, recalibration is recommended to ensure the best possible operation.

### 7.4.3 NIBP calibration

A hole in the middle of the monitor bottom plate provides access to a gear wheel for the Temperature and NIBP calibration protection switches. Turning the gear wheel moves a slide that operates the switches.

CAUTION: Turning the gear wheel more than 1/4 turn can damage the calibration switch.



**Figure 7-4. Calibration switch**

1. Detach the NIBP hoses from the front panel connector to enable proper zeroing.
2. To enter the NIBP Calibration service menu from the Service View menu, select **Modules – NIBP – Calibrations**.
3. If **Protection** is **OFF** and **Calibration** is highlighted, go to step 7. Otherwise, continue with step 4.
4. Place the monitor on its left side. Insert a medium-sized, flat-head screwdriver into the hole that accesses the gear wheel for the calibration protection switches (see Figure 7-4).
5. Turn the gear wheel approximately 1/4 turn counterclockwise until **Protection** is highlighted on the screen. Select **Protection OFF** and push the ComWheel.
6. Turn the gear wheel approximately 1/4 turn clockwise until **Calibration** is highlighted. The "Calibration not protected" message appears in the NIBP digit field.
7. With **Calibration** highlighted, push the ComWheel to start the calibration. The "Zeroing" message will appear. After successful zeroing, the pressure adjustment bar will appear.
8. Connect an external mercury manometer with pump to the NIBP connector through both tubes of the hose (transducers B1 and B2 must be calibrated simultaneously). Pump up to about 200 mmHg (26.7 kPa) pressure, according to the manometer, to the NIBP tubing. Calibration is possible in the range of 150 to 300 mmHg (20.0 to 40.0 kPa).
9. Verify that both pressure values on the screen match the manometer reading. If not, adjust by turning the ComWheel. When the values are equal, push the ComWheel to confirm the calibration. When the calibration data has been saved, the "Calibrated" message will appear.  
 NOTE: When calibrating NIBP, always change the displayed pressure value slightly, even in cases where the value would be correct (that is, use the ComWheel to change the value one step higher and then back, one step lower, for example). The "Calibrated" message should be displayed. This process ensures that the calibration procedure is correctly registered and stored.
10. Place the monitor on its left side. Insert a medium-sized, flat-head screwdriver into the hole that accesses the gear wheel for the calibration protection switches (see Figure 7-4).

11. Turn the gear wheel approximately 1/4 turn counterclockwise until **Protection** is highlighted. Choose **Protection ON** and push the ComWheel. Turn the gear wheel approximately 1/4 turn clockwise until **Calibration** and **Protection** become faint.
12. Perform the *NIBP calibration check* (earlier in this chapter) to verify the new calibration.

#### 7.4.4 Temperature calibration

Always calibrate the temperature:

- When measured test values deviate more than  $\pm 0.1$  °C.
- After replacing the STP board.

##### Tools

- Temperature calibration test plugs, 25 °C and 45 °C (884515)

1. To enter the STP Calibrations service menu from the Service View menu, select **Modules – ESTP : STP – Calibrations**
2. Place the monitor on its left side. Insert a medium-sized, flat-head screwdriver into the hole that accesses the gear wheel for the calibration protection switches (see Figure 7-4).

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**CAUTION:** Turning the gear wheel more than 1/4 turn can damage the calibration switch.

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3. Turn the gear wheel approximately 1/4 turn counterclockwise until **Protection** is highlighted on the screen. Select **Protection OFF** and push the ComWheel.
4. Turn the gear wheel approximately 1/4 turn clockwise to highlight **Calibrate T1** and choose **Calibrate T1** (or highlight **Calibrate T2** and choose **Calibrate T2**).
5. Insert a calibration plug (25 °C) into the appropriate connector (T1 or T2). Push the ComWheel.
6. Remove the plug and insert a calibration plug (45 °C) into the same connector. Push the ComWheel.
7. To reset the protection, turn the gear wheel approximately 1/4 turn counterclockwise until **Protection** is highlighted. Select **Protection ON** and push the ComWheel. Turn the gear wheel approximately 1/4 turn clockwise until **Calibration** and **Protection** become faint.

#### 7.4.5 Invasive pressure calibration

Calibrate invasive pressure when the pressure transducer (probe) is replaced with a different type of transducer and when the STP board is replaced.

1. To enter the ESTP : STP Calibrations service menu from the Service View menu, select **Modules – ESTP : STP – Calibrations**
2. Connect a pressure transducer to the P1/P2 connector.
3. Choose **Calibrate P1** or **Calibrate P2**.
4. Expose the transducer to ambient pressure.
5. Push the ComWheel to start zeroing.
6. Connect a pressure manometer with a pump to the transducer dome. Pump a pressure of 100 mmHg to 300 mmHg (13.3 to 40.0 kPa) to the transducer. The recommended pressure is 200 mmHg (26.7 kPa).
7. Turn the ComWheel to adjust the pressure on the display to match the pressure reading on the manometer, then push the ComWheel. A tolerance of  $\pm 1$  mmHg is allowed.

The “Calibrated” message will be displayed.

### 7.4.6 General checks for gas system components

These faults can occur in the sampling system:

- Leaks or blockages in the tubing.
- Sampling pump or magnetic valves failure.
- Diminished flow rates because of dirt accumulation in the internal tubing.

The following checks should help in localizing the fault. Whenever you suspect the sampling system and always after you work on the sampling system, check and (if necessary) adjust the flow rate.

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**CAUTION:** The special internal sample tube is mechanically fragile. Sharp bends will cause leaks.

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#### Oxygen measuring (OM) unit

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**CAUTION:** Because of the complex and sensitive construction of the oxygen measuring unit, no repairs should be attempted inside the unit. If a fault is found in the measuring unit, the entire airway gas measurement unit should be replaced. Send the faulty unit to GE Healthcare for repair.

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In cases of no response to O<sub>2</sub> or strong drift, check the tubing for loose connections, blockages, and leaks.

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**CAUTION:** To avoid permanent damage to the pressure transducer, never apply overpressure to the oxygen measuring unit.

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If the O<sub>2</sub> signal is noisy, check the measurement unit suspension.

#### TPX measuring unit

If liquid enters the TPX measuring unit due to the failure of the water trap filter, contact GE Healthcare Technical Services.

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**CAUTION:** The TPX measuring unit can only be calibrated and repaired at the factory. In case of failure, the entire airway gas unit should be replaced and sent to GE Healthcare for repair.

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#### PVX measuring unit

The PVX unit can be replaced in case of failure.

NOTE: Never apply overpressure or negative pressure of more than 300 cmH<sub>2</sub>O to the flow and volume tubing. Also never apply differential pressure of more than 25 mmHg on one PVX connection at a time.

#### Gas unit CPU board

Due to the complexity of the large-scale integrated circuitry, few faults in the CPU digital electronics can be located without special equipment. Check only that socketed ICs are properly installed.



### 7.4.7 Gas sampling system leak test

1. To enter the Gases service menu from the Service View menu, select **Modules – Gas Unit – Gases**
2. Prevent the monitor from performing the normal occlusion functions, such as controlling the valves, by turning the pump OFF, then ON again from the menu.
3. Open the rear cover and block the reference gas connector.
4. Connect a flow cassette with high-flow resistance (50/1.1) to the end of the sampling line.
5. Check the Amb-Work value that is displayed. When the value exceeds 170 mmHg, connect the other port of the flow cassette to the sample-gas-out connector and switch the pump off.
6. Wait until pressure inside the sampling system stabilizes, then check the Amb-Work value. The value, or pressure inside the sampling system, should not drop more than 6 mmHg in one minute.
7. If the pressure drops more, first ensure the connections you have made and then repeat the test.

### 7.4.8 Flow rate checks and adjustments

NOTE: Let the monitor run for 15 minutes before measuring flow rates.

A flowmeter with a low flow resistance and that is capable of measuring low flow rates is required for measuring flow rates. A sampling line of normal length must be connected to the monitor, as its length has a considerable affect on the flow.

**If any flow rates are not correct, replace the D-fend water trap. Then, recheck the incorrect flows.**

#### Flow rate checks

You check and adjust the sampling flow rate from the Gases service menu.

1. To enter the Gases service menu from the Service View menu, select **Modules – Gas Unit – Gases**
2. Wait until the **Sample Flow** value shown in the Gases service menu is near 200 ml/minute.
3. Connect a flowmeter to the 3-meter sampling line (use a 2-meter line for the N-XCAiO and N-XV options). Check that the sample flow reading on the flowmeter is within 180-220 ml/minute.
4. Connect the flowmeter to the reference gas connector on the front panel to check the reference flow of the oxygen measuring unit. Check that the reference flow reading on the flowmeter is within 31 to 45 ml/minute.

#### Flow rate adjustment

NOTE: Before adjusting the sampling flow, make sure there are no leaks in the sampling system.

##### To adjust the sampling flow rate:

1. In the Gases service menu, select Sample gain adj.
2. Turn the ComWheel counterclockwise to increase the sampling flow (clockwise to decrease). A 0.050 change in the Gain value changes the flow by approximately 10 ml/minute.
3. After you change the gain, wait until the Sample Flow value on the screen is near the original. Then, check that the sample flow (flowmeter reading) is within 180-220 ml/minute.
4. In the service menu, set the Zero valve to ON. The Sample Flow value should not change more than 20 ml/minute (30 ml/minute if the absorber is connected).
5. After adjusting the sample flow rate, connect the flowmeter to the reference gas tube. Check that the reference flow of the oxygen measuring unit (flowmeter reading) is within 31 to 45 ml/minute. This flow rate is not adjustable.

### 7.4.9 Spirometry leakage test and calibration

1. To enter the Spirometry service menu from the Service View menu, select **Modules – Gas Unit – Spirometry**.
2. Connect a spirometry tube to the monitor front panel connector. Connect a D-lite sensor to the tube.

#### Spirometry leakage test

3. Block the D-lite sampling line port with, for example, a luer stopper.
4. Grasp the D-lite and tightly occlude both ends, using your fingers or both hands to create pressure inside the D-lite.
5. Check that the **Aw Pressure** value on the Service Data screen is near 5 cmH<sub>2</sub>O.
  - For a heavy leak, no pressure will be generated.
  - For a small leak, a pressure difference is measured, interpreted as flow, and displayed on the screen. The pressure waveform (**Aw Pressure** value) decreases slowly. The flow waveform (**Flow** value) goes above or below the zero line, depending on which connector is leaking.
6. If a leak is present, check all connectors and try again.
7. Unblock the D-lite sampling line port.

#### Flow calibration

The PVX measuring unit is calibrated at the factory and due to the unit's design calibration is not regularly needed. The calibration data is saved into the board's EEPROM. In case calibration is needed, it is recommended to perform the calibration both with adult values using the D-lite, and with pediatric values using Pedi-lite.

1. Connect a spirometry tube with a D-lite sensor to the compact airway module. To improve the accuracy, the endotracheal tube and all accessories which normally are in use should be attached also during the calibration.
2. Enter the Gas Unit service menu: **Monitor Setup - Install Service - Service - Modules**. Enter the Spirometry menu.
3. After the flow is zeroed ('Zero OK' message displayed) attach a preferably spirometry tester to the flow sensor (D-lite or Pedi-lite). Select the sensor type.
4. Perform the calibration according to the tester instructions. Observe the values of inspired and expired tidal volumes.
5. Adjust the reading to match the calibration volume (about 1000 ml for the D-lite and 300 ml for the Pedi-lite). Adjust Exp Flow Gain and Insp Flow Gain values in proportion to the difference between measured values and the spirometry tester reading.

### 7.4.10 Gas calibration

#### Calibration gas regulator flow check

Interval: every 12 months

Regulator flow specification:

REF 755533 & 755534: 260 – 410 ml/min at 1-10 bar cylinder pressure

REF 755530: 260 – 410ml/min at 5-7psi cylinder pressure

Tools needed: calibration gas can, regulator, piece of silicon hose and a flow meter. The manufacturer recommends the use of TSI 4140 Flow Meter.

Insert the calibration gas regulator on the gas cylinder. Connect a silicon hose between the regulator and the flow meter. Block the regulator overflow port and open the regulator. Check the flow rate from the flow meter and verify that the flow is within the specification.

### Gas calibration

Perform a gas calibration every 6 months or whenever there are indications of errors in the gas readings. The time of the last calibration is shown near the bottom of the Gas Calibration menu.

Gas calibration is not available during the first five minutes of monitoring and during a gas sampling warning.

#### NOTE:

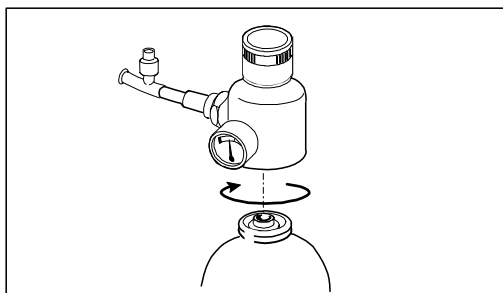
- During gas calibration, % units are always used for CO<sub>2</sub> regardless of selected measuring units.
- Anesthetic agent is always calibrated with Desflurane.

### Calibration equipment and use

- Use *only* Datex-Ohmeda calibration gas to calibrate the gas measurement. Otherwise, the calibration will not succeed.
- The calibration gas container may be used until the pressure indicator reaches the red zone.
- If separate gas containers are used, each gas must be calibrated separately.
- If you use an older brass regulator, the feeding pressure should be adjusted between 5 and 7 psi. The use of an old regulator with the new aerosol containers requires an adapter available from GE Healthcare. For ordering details, see the Datex-Ohmeda *Supplies and Accessories Catalog*.

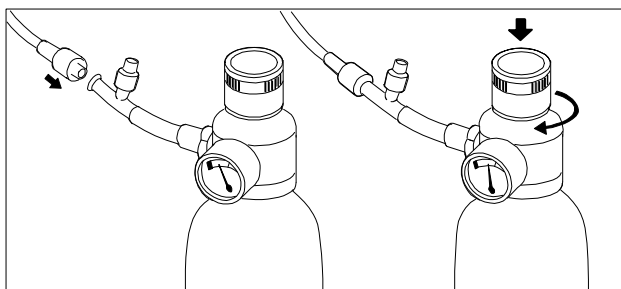
NOTE: The calibration procedure for Critical Care and Anesthesia monitors is the same except that users of Critical Care monitors select **Ventilation** (not **Airway Gas**) from the Parameters menu.

1. Power on the monitor. For maximum accuracy, let the monitor warm up for 30 minutes.
2. Attach the regulator to the gas container.



**Figure 7-5. Attaching the regulator**

3. Attach a new sampling line to the water trap. Connect the loose end of the sampling line to the regulator on the gas container.



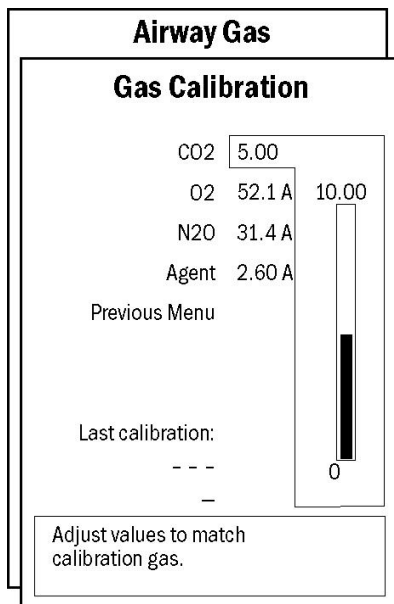
**Figure 7-6. Connecting a sampling line and feeding gas**

4. To enter the Gas Calibration menu, press the ComWheel and select **Parameters – Airway Gas**.  
The **Gas Calibration** menu item remains gray (inactive) until the ‘Calibrating gas sensor’ message is no longer displayed.
5. Select **Gas Calibration**.
6. Wait until the ‘Zero ok’ and then ‘Feed gas’ messages appear on the screen after each gas.  
If the ‘Zero error’ message is displayed, press the **Normal Screen** key and repeat the calibration procedure. If the problem persists, the unit may require service.
7. Open the regulator and feed the calibration gas until ‘Adjust’ appears, then close the valve.  
NOTE: When the monitor is in automatic agent ID mode and it detects a calibration gas and no anesthetic agent (when using the Datex-Ohmeda Quick Cal calibration gas, for example), the ‘Cal gas found’ message is displayed. If the identification sensor fails, the ‘Agent id inop’ message is displayed.
8. Check that the displayed gas values match the values on the calibration gas container.

### Calibration adjustments

Calibration adjustments may be required if the gas values displayed during calibration do not match the values on the calibration gas container.

If adjustments are required:



1. Select **Gas Calibration** in the Airway Gas menu.
2. Turn the ComWheel to highlight the first gas to be adjusted and press the ComWheel.
3. Turn the ComWheel until the displayed value matches the desired value. Press the ComWheel to confirm the adjustment.
4. Repeat steps 2 and 3 for each gas.

### Autozeroing intervals

Autozeroing intervals after startup are as follows: every 5 minutes for the first 15 minutes, then every 15 minutes for the next 45 minutes, and every hour thereafter. Autozeroing may also occur after agent selection.