Service Manual

HeartStart XL+

861290

Edition 3

PHILIPS

Notice

About This Edition

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The information in this document applies to the HeartStart XL+ defibrillator/monitor software versions indicated below. This information is subject to change without notice.

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This document describes features that may or may not be present on your specific HeartStart XL+ defibrillator/monitor, depending on the installed options.

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WARNING: Radio frequency (RF) interference coming from devices other than the HeartStart XL+ may degrade the performance of the HeartStart XL+. Electromagnetic compatibility with surrounding devices should be assessed prior to using the defibrillator/monitor.

Use of supplies or accessories other than those recommended by Philips may compromise product performance.

Medical Device Directive

The HeartStart XL+ complies with the requirements of the Medical Device Directive 93/42/EEC and carries the CE 0123 mark accordingly.

The HeartStart XL+ defibrillator/monitor is designed and tested for use under the operating conditions and settings stated in the device's Instructions for Use. The expected useful life of the HeartStart XL+ defibrillator/monitor will depend on the actual operating conditions and the degree of adherence to the maintenance schedule described in this manual. Use of the HeartStart XL+ outside of the stated operating conditions may shorten the useful life and void the warranty. Proper maintenance is described in the *HeartStart XL+ Instructions for Use* (IFU) as well as this Service Manual.

Certain accessories, such as cables, lead sets, and batteries, can be subject to wear and abuse. These accessories are not intended to last the life of the defibrillator and should be proactively replaced as stated in the IFU.

According to the American Hospital Association publication, *Estimated Useful Lives of Depreciable Assets, Revised 2008 Edition,* the estimated useful life for defibrillators is 5 years. (Please note: Estimated Useful Life is provided for informational purposes only, and is not a guarantee or warranty of any kind.)

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Chemical Content:

REACH requires Philips Healthcare to provide chemical content information for Substances of Very High Concern (SVHC) if they are present above 0.1% of the product weight. Components of/within electric and electronic equipment may contain phthalates above the threshold (e.g. bis(2-ethyl(hexyl)phthalate), CAS nr.: 117-81-7). The REACH SVHC list is updated on a regular basis. Therefore, please refer to the following Philips REACH website for the most up-to-date information on products containing SVHC above the threshold:
http://www.philips.com/about/sustainability/reach.page

Conventions Used in This Manual

This book contains the following conventions:

WARNING: Warning statements alert you to a potential serious outcome, adverse event or safety hazard. Failure to observe a warning may result in death or serious injury to the user or patient.

CAUTION: Caution statements alert you to where special care is necessary for the safe and effective use of the product. Failure to observe a caution may result in minor or moderate personal injury or damage to the product or other property, loss of data, and possibly in a remote risk of more serious injury and/or cause environmental pollution.

NOTE: Notes contain additional information on usage.

TIP: Tips provide hands-on insight into using or servicing this product.

The "bull's eye" icon indicates a process or a procedure (a set of steps to achieve a certain goal).

The "tools" icon indicates a list of tools or equipment required for a certain task.

Label Text or
Label Text represent keywords.

Online viewing only:

See "Introduction" on page 1 represents hypertext links, which will display as dark blue; click on the link to go to that destination.

Click for quick access

Abbreviations

Name	Abbreviation
Automated Test Summary	ATS
Customer Service Order	CSO
End-tidal CO_2	$EtCO_2$
electrostatic discharge	ESD
HeartStart XL+ defibrillator/monitor	HeartStart XL+; device
Human Interface PCA	HIF PCA
Non-invasive Blood Pressure	NBP
Patient Contact Indicator	PCI
Printed Circuit Assembly	PCA
Pulse Oximetry	SpO_2
support part kit	SPK

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Introduction

This Service Manual provides the information needed to successfully service the 861290 HeartStart XL+ defibrillator/monitor. This manual provides you with information on troubleshooting, repair, and performance verification and safety testing of the defibrillator/monitor. There is also information on the theory of operation, maintenance procedures, and ordering parts and supplies.

NOTE: This manual describes all optional features. If your device does not have some of the optional features listed, then disregard the features, controls, and related information described in the manual.

Who Should Use this Manual

The intended users of this manual are technical personnel who have been trained in the safe and proper servicing of the HeartStart XL+.

How to Obtain Training

To assist in training, the Service Training course is available through Philips Online Learning Center at https://www.theonlinelearningcenter.com/Default.aspx.

Overview

In this chapter, you will find general information that you should know before servicing the HeartStart XL+. Detailed information regarding controls, operation, and capabilities of the device can be found in the *HeartStart XL+ Instructions for Use* that was shipped with the product and provides information on setting up the device and regular maintenance procedures, such as performing operational checks and battery maintenance. We recommend you review the *HeartStart XL+ Instructions for Use* before servicing this device. This Service Manual assumes you are familiar with the controls and basic operations.

This chapter is organized into the following sections:

Features and Capabilities

The HeartStart XL+ is a lightweight, portable, defibrillator/monitor. It provides four clinical modes of operation: Monitor, Manual Defibrillation, AED, and Pacer (optional).

Monitor Mode you can monitor up to three ECG waveforms at a time, acquired through a 3- or 5-lead ECG set or multifunction electrode pads. Optional monitoring of pulse oximetry (SpO_2), end-tidal CO_2 ($EtCO_2$), and non-invasive blood pressure (NBP) are also available. Measurements from these parameters are presented on the display and alarms are available to alert you to changes in the patient's condition. You can also display the Vital Signs Trending Report to view key monitoring parameters and their measurements.

Manual Defibrillation Mode offers simple, 3-step defibrillation. You analyze the patient's ECG and, if appropriate: 1) select an energy setting, 2) charge, and 3) deliver the shock. Defibrillation may be performed using paddles or multifunction electrode pads. Manual Defibrillation Mode also allows you to perform synchronized cardioversion and internal defibrillation.

In **AED Mode**, the HeartStart XL+ analyzes the patient's ECG and determines whether a shock is advised. Voice prompts guide you through the 3-step defibrillation process, providing easy-to-follow instructions and patient information. Voice prompts are reinforced by messages that appear on the display.

The AED Mode incorporates the Philips' SMART Analysis algorithm for ECG analysis and SMART Biphasic waveform for defibrillation.

Optional **Pacer Mode** offers non-invasive transcutaneous pacing therapy. Pace pulses are delivered through multifunction electrode pads using a monophasic waveform in Demand or Fixed modes.

The HeartStart XL+ is powered by a rechargeable lithium-ion battery. Available battery power is easily determined by viewing the battery power indicators located on the device display and the battery itself. An AC power supply may serve as a secondary power source and for continual battery charging.

The HeartStart XL+ performs Automated Tests on a regular basis. The status of the device's critical functions is reported to the Ready For Use (RFU) indicator. The RFU indicator communicates the status of your device, letting you know if it is operating correctly, needs attention, or is unable to deliver therapy. In addition, the manually performed Operational Check ensures that every part of the HeartStart XL+ functions properly.

The HeartStart XL+ automatically stores critical event and trend data in its internal memory. The HeartStart XL+ also enables you to copy data and event information to a USB flash drive for downloading to a compatible data management solution.

The HeartStart XL+ is highly configurable to better meet the needs of diverse users. Be sure to familiarize yourself with the device's configuration before servicing the HeartStart XL+.

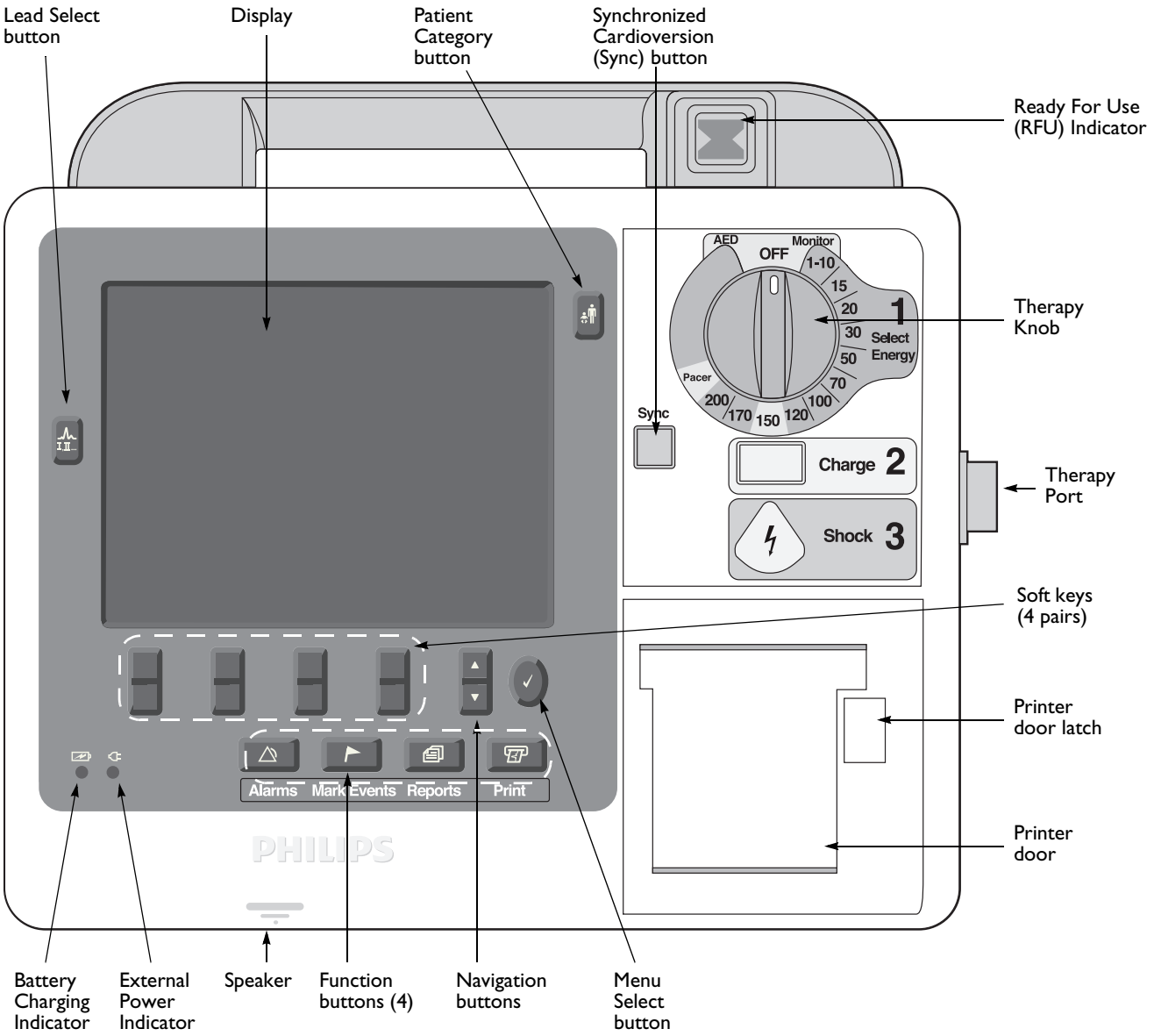
Tour of the Device

This section gives an overview of the outside of the device.

Front of the Device

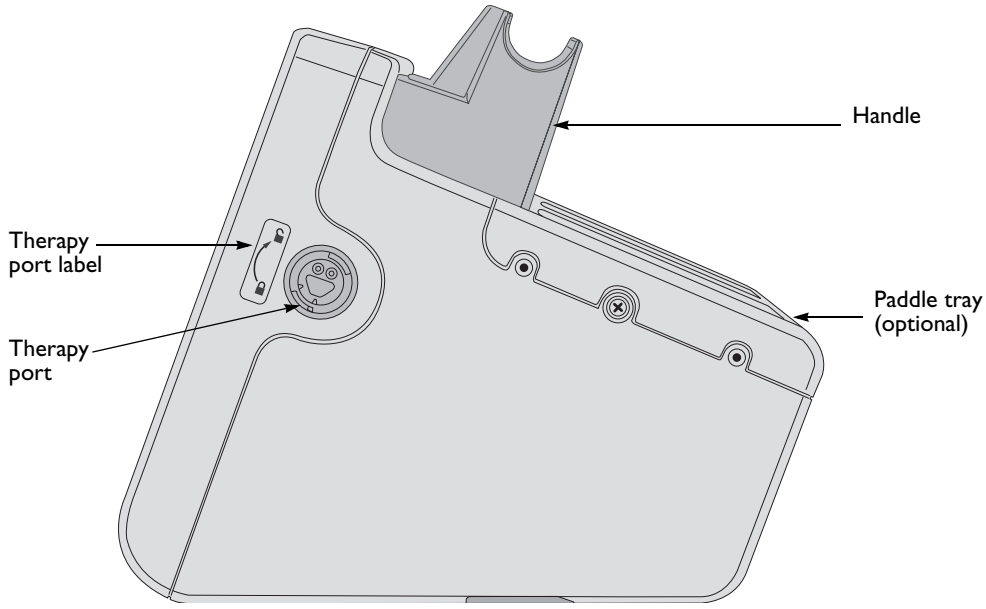
If you have a non-English version of the device, then no **Alarms**, **Mark Event**, **Reports**, or **Print** text labels are present at the functional buttons below the screen. The button functions remain the same regardless of the label presence.

Figure 1 **Front View**



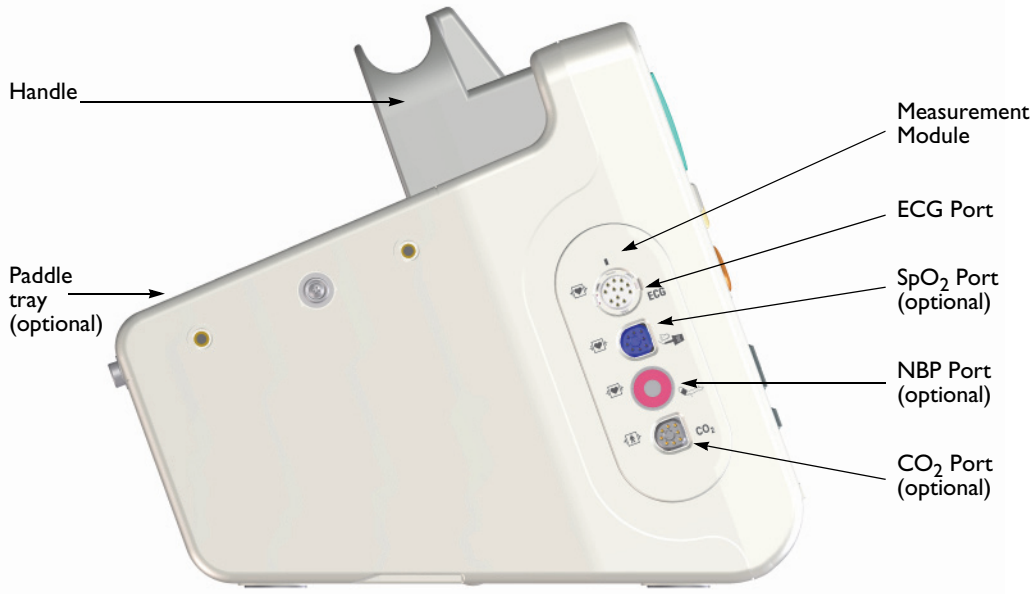
Right (Therapy) Side

Figure 2 **Right Side View**



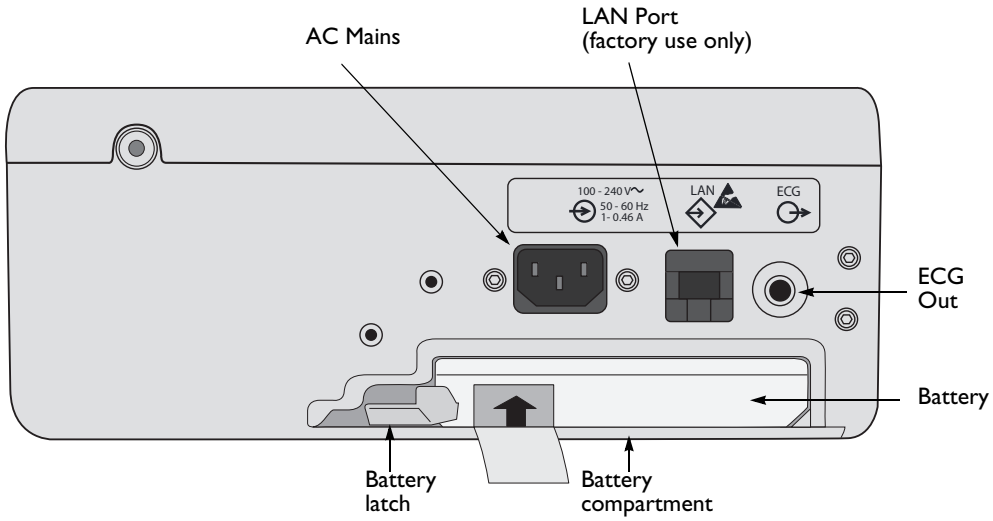
Left (Monitoring) Side

Figure 3 **Left Side View**



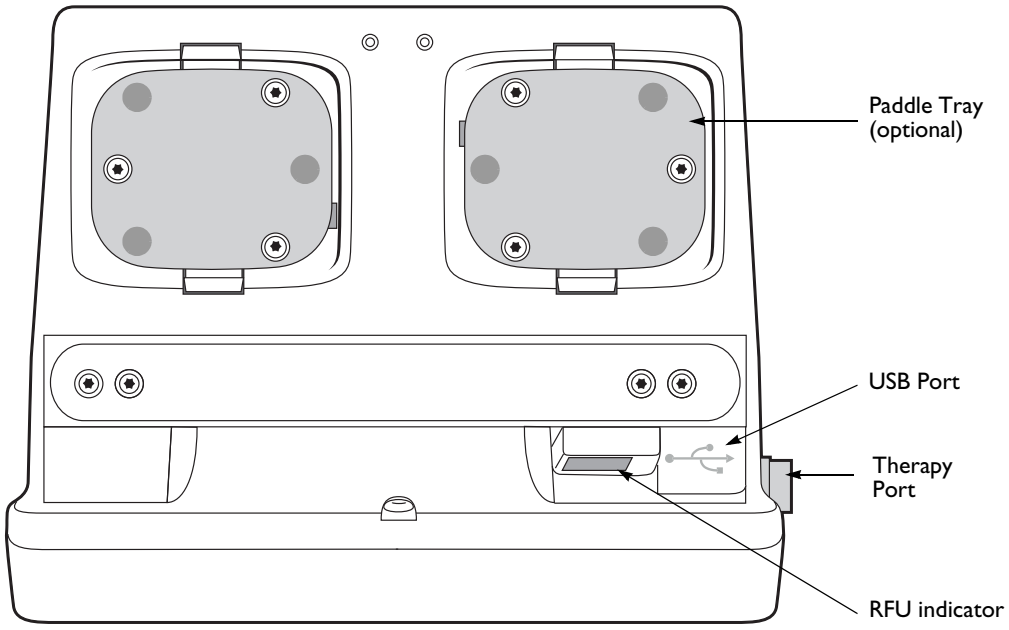
Rear Side

Figure 4 **Rear Side View**



Top Side

Figure 5 **Top Side View**



General Service Information

Keep the following points in mind when servicing this product.

Installation

The HeartStart XL+ does not require installation. The *HeartStart XL+ Instructions for Use* describe the setup required before placing the device into service, as well as configuration options (see "Passwords" below for the configuration password). All setup activities are designed to be performed by personnel trained in the proper operation of the product.

To obtain a copy of the *HeartStart XL+ Instructions for Use* and other HeartStart XL+ documentation in your local language visit: http://www.philips.com/ProductDocs and follow links to **Product Downloads —> Resuscitation / Defibrillation Products —> 861290 – HeartStart XL+ —> Instructions for Use**.

Display Menus

To display a menu, press the Menu Select button. Then use the up or down Navigation buttons to scroll through the available choices until the desired selection is highlighted. To activate the selection, press the Menu Select button. Press **Exit** to close the menu without activating a selection.

Passwords

A password is required in order to access some modes within the defibrillator/monitor. The passwords are:

- Service Mode: 27689
- Configuration Mode: 387466

Upgrades

Upgrades are available to add specific functionality to the device after purchase. Table 1 shows the available upgrades:

Table 1 **HeartStart XL+ Upgrades**

Upgrade #	Upgrade Function	Pre-requisite, if any
861395	SpO_2	
861396	NBP	SpO_2 (861395)
861397	External Pacing	
861402	External Paddles	
861401	Pads Conversion	External Paddles
861497	$EtCO_2$	Hardware Platform (861403)*

* To determine whether you need the Hardware Platform upgrade, print your Device Information (see pg. 10). If your **Main Processor PCA** hardware version is below 8, then perform the upgrade.

Consult your sales representative, dealer, or distributor for the latest details. See also "Ordering Supplies and Accessories" on page 175.

Preventive Maintenance

Preventive maintenance and periodic operational checks are intended to be performed by the user. These topics are respectively covered in the "Maintenance" and "Operational and Shift Checks" chapters of the *Instructions for Use*.

The Maintenance chapter of this manual provides Battery and NBP calibration and testing procedures. Experienced and trained HeartStart XL+ users (e.g. nurses or biomedical and clinical engineers) may perform the NBP calibration using the NBP calibration kit (453564063841). The training material is included in the kit.

CAUTION: Only qualified service personnel should perform the NBP testing procedures.

Repair Philosophy

Defibrillator/Monitor

The repair philosophy of the HeartStart XL+ is subassembly replacement. Examples of subassemblies are the printer, the Processor Printed Circuit Assembly (PCA), Therapy PCA, and selected connectors and other items. Repairs that involve replacing components on a PCA are not supported.

CAUTION: Individual component replacement should not be attempted. Component level repair is inadvisable due to the extensive use of surface mount technology and the high parts-density on the circuit boards. Unauthorized component replacement can impair performance of the HeartStart XL+ and void warranty.

WARNING: Remove all power sources (AC and battery) before opening the device. Failure to do so may allow the device to charge without warning and could result in serious injury or death.

Batteries

The 989803167281 lithium-ion battery is rechargeable. The battery periodically requires calibration. At the end of the battery's useful life, it should be recycled or discarded according to local regulations and replaced. Refer to the *HeartStart XL+ Instructions for Use* for additional information.

For information on ordering replacements, see "Ordering Supplies and Accessories" on page 175.

WARNING: Never crush, penetrate, or attempt to open lithium-ion batteries. Never incinerate lithium-ion batteries. High case temperatures resulting from abuse of the battery could cause physical injury. The electrolyte is highly flammable. Rupture of the battery pack may cause venting and flame.

CAUTION: Due to their high energy density, lithium-ion batteries can deliver significant power. Use care when working with or testing lithium-ion batteries. Do not short-circuit the terminals.

Accessing Service Mode

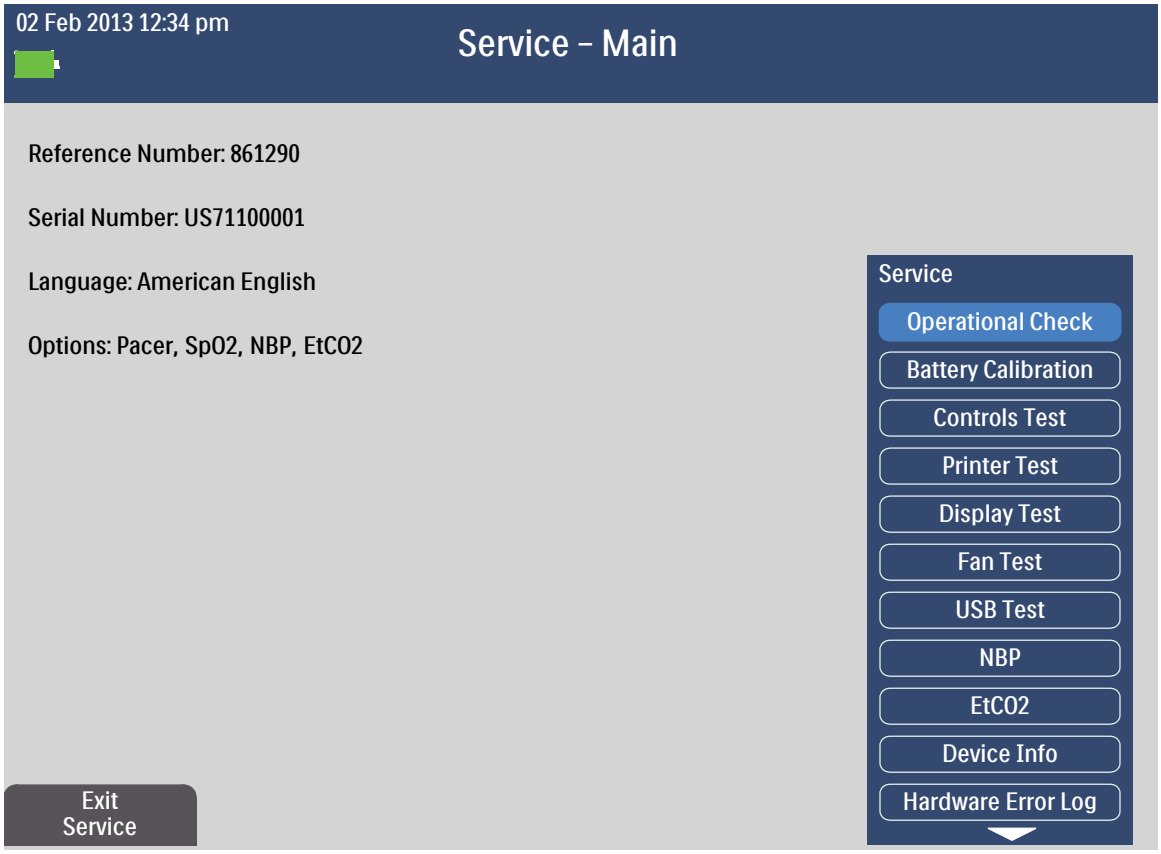
CAUTION: Be sure that the defibrillator/monitor is not connected to a patient when performing any function in Service Mode.

NOTE: Make sure that you insert a sufficiently charged battery (at least two LEDs light up) into the device or connect to AC power when you are performing functions in Service Mode.

To access Service Mode:

1. Turn the Therapy Knob to **Monitor**.
2. Press the Menu Select button to display the Main menu.
3. Navigate to **Other** and press the Menu Select button.
4. From the **Other** menu, select **Service**.
   The message appears: **Leaving clinical mode.**
5. Navigate to **Yes** and press the Menu Select button to confirm the **Exit Clinical Mode?** request.
   You are prompted to enter a password.
6. Enter the password (27689) by scrolling through the list until the desired digit is highlighted.
7. Press the Menu Select button to enter each digit.
8. Select **Done** when you have entered all the digits.
9. Press the Menu Select button to display the Service Mode Main menu, as shown in Figure 6.

Figure 6 **Service Mode Main Menu**



Navigating in Service Mode

Service Mode uses the same navigation controls as normal operating mode:

- To select a menu item, use the Navigation buttons to highlight your choice, then select that choice by pressing the Menu Select button.
- To exit Service Mode and return to clinical mode, press the **Exit Service** soft key.
- To return to the Service Mode Main menu from any service screen press the **Main Service** soft key.

NOTE: The device's default configuration settings are restored when you return to clinical mode after exiting Service Mode.

Service Mode Functions

You can perform a variety of service-related activities from Service Mode, as follows:

- Run an Operational Check (Op Check), see "Operational Check" on page 33 for details.
- Calibrate the battery, see "Battery Calibration" on page 16.
- Print and update the Device Info, see "Device Information" on page 10, "Entering the Serial Number" on page 138, and "Enabling Options" on page 140.
- View, print, and clear the Hardware and Software Error logs, see "Error Log Messages" on page 41.
- Perform maintenance on the NBP module — See "NBP Module Calibration" on page 19.
- Perform $EtCO_2$ maintenance — See "EtCO2 Maintenance" on page 23.
- Run the Controls test, see "Controls Test" on page 162.
- Run the Printer test, see "Printer Test" on page 164.
- Run the Display test, see "Display Test" on page 163.
- Run the Fan test, see "Fan Test" on page 164.
- Run the USB test, see "USB Test" on page 165.
- Install software and change the device's language using the Software Support Tool — See "Software Upgrades" on page 11.
- View information about the device, such as model number, serial number, options enabled on the device, and the device's language — See "Device Information" below. Use the Device Info menu to enter the serial number and to enable options on the device after a SOM PCA repair. See "Entering the Serial Number" on page 138 for more information.

NOTE: You can print detailed information about your HeartStart XL+ defibrillator/monitor software version, circuit boards, and module levels through the Print Device Info option, available in clinical operating mode. See "Device Information" on page 10.

Device Information

You can print detailed information on software versions, board and module levels, and internal memory card capacity from the Print Device Info menu option.

To print the device information:

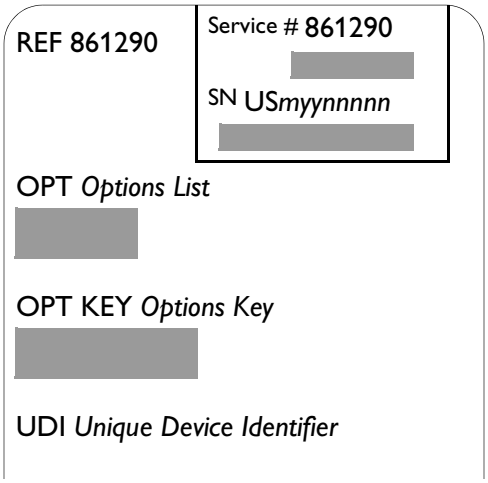
1. Make sure a battery charged to at least 20% is in place, or that external power is connected.
2. Turn the Therapy Knob to Monitor.
3. Press the Menu Select button to access the Main menu.
4. From the Main menu, select Other.
5. From the Other menu, select Print Device Info.
   Detailed information about the device is printed.

NOTE: Run an Operational Check after you have updated software, enabled an option, or performed a repair to update the device information.

Primary Label

TheHeartStart XL+ ships with a primary label shown in Figure 7 affixed to the bottom of the Rear Case.

Figure 7 **Primary Label Fragment**



USmyynnnnn:
m – month of manufacturing code
yy – last two digits of the year of manufacturing
nnnnn – unique number

Options List:
List of options installed on the device

Options Key:
Key for options activation

Other Resources

For additional information on the HeartStart XL+, refer to the following Learning Products:

- *HeartStart XL+ Instructions for Use*
- HeartStart XL+ *Service Web-based Training*
- HeartStart XL+ *Lithium-Ion Battery Characteristics and Care* Application Note

Other documents can be found on the Philips website at: http://www.philips.com/ProductDocs.

2

Maintenance

Introduction

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

Most routine maintenance, including periodic operational checks, paper replacement, cleaning, 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 maintenance:

Software Upgrades

Perform Software upgrades when:

- Installing HeartStart XL+ options upgrade.
- Replacing Processor or Therapy PCA.
- Instructed by Philips Customer Support or a Service Bulletin.

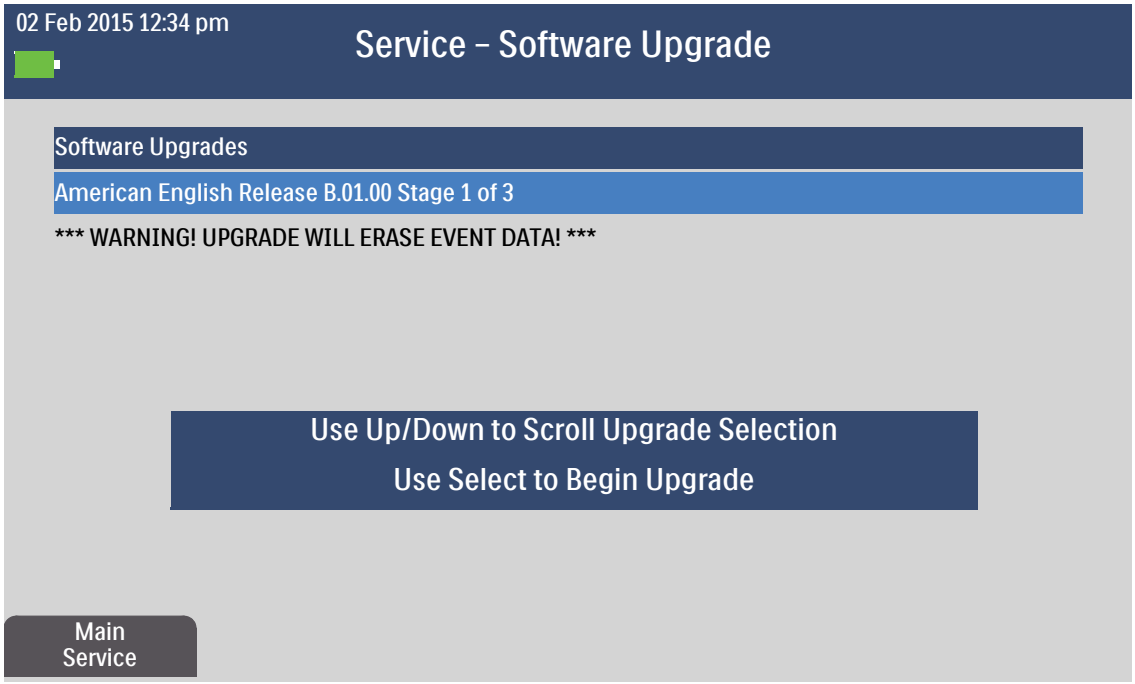
You may download software from the InCenter. Upload the software on a USB 2.0-compatible flash drive, no more than 32 Gb capacity.

NOTE: The RFU indicator may display a red **X** at some point during Software Upgrade. This is normal behavior, as long as an "hourglass" is displayed after the installation.

To install software onto the device or to change the device's language:

1. Be sure that both:
   - **a** AC power is connected, and
   - **b** Charged battery (at least two fuel gauge LEDs light up) is in place.
   - **c** All other cables (Therapy Cable, ECG, and all optional cables and probes) are disconnected.
2. Insert the USB flash drive with the desired software.
3. If there are any event data that you wish to save, save them now.
   The upgrade may erase event data, in this case a screen message will be shown.
4. Access the Service Mode Main menu as described in "Accessing Service Mode" on page 8.
5. From the Service Mode Main menu, select **Software Upgrade**.
6. The screen displays the menu of available software releases and languages on the flash drive.
   See Figure 8 below.

Figure 8 **Software Upgrade, Sample Selection Screen**



7 Use the **Up/Down** buttons to select the desired software release and language.

8 Press the **Select** button to begin the upgrade.
Press the **Main Service** soft key to exit the upgrade screen. Do not attempt to cancel the upgrade after it has started.

CAUTION: **Power interruption during software installation may disable the device and require an extensive repair.** After the upgrade starts, be careful not to remove the USB drive or power source, or turn the Therapy Knob in order to not interrupt the software installation process.

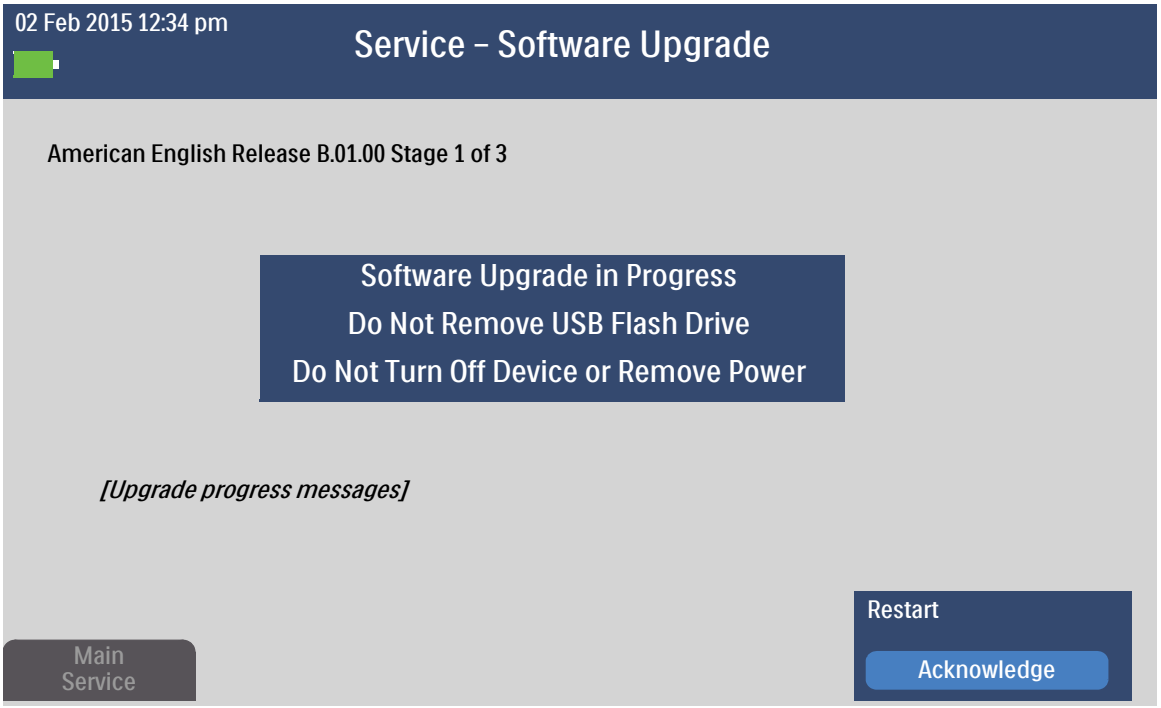
The software is installed on the device. This process takes a few minutes. While the software is being updated, progress messages are displayed and the soft keys are disabled, see Figure 9 on page 13.

NOTE: The screen may change appearance or blank out when the new software is loaded to the Processor PCA, the RFU may display a red **X**, and chirps and alarms may sound—all these are normal behavior. **Do not interfere with the upgrade process!**

9 Depending on the Software Releases currently on your device and the one being installed, the installation may proceed in several stages; in this case you may see the "**Stage *x* of *y***" text.

CAUTION: Remember NOT to remove the USB drive or power source, or turn the Therapy Knob! Disregard any technical alarms that may be displayed in the process.

Figure 9 **Software Upgrade, Sample Progress Screen**

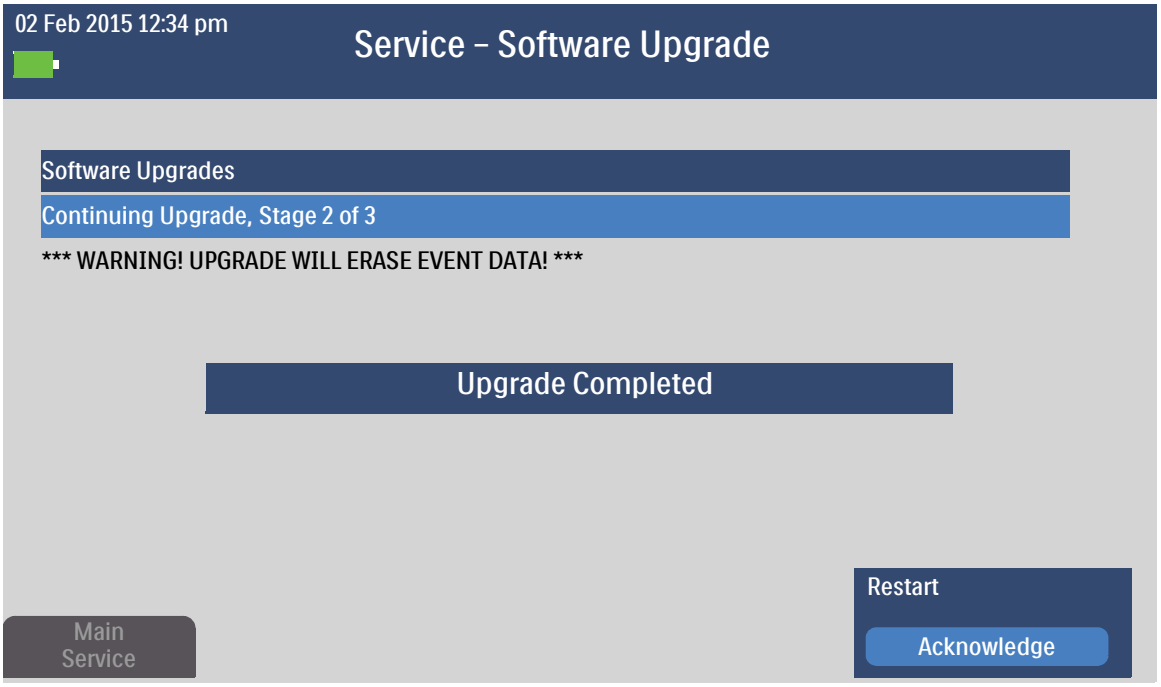


10 In a multi-stage upgrade, the **Upgrade Completed** message may appear. This message indicates a stage completion.

Do not remove the USB drive or power source, or turn the Therapy Knob. Press the Menu Selection key to acknowledge the restart of the upgrade at the next stage, see Figure 10 below.

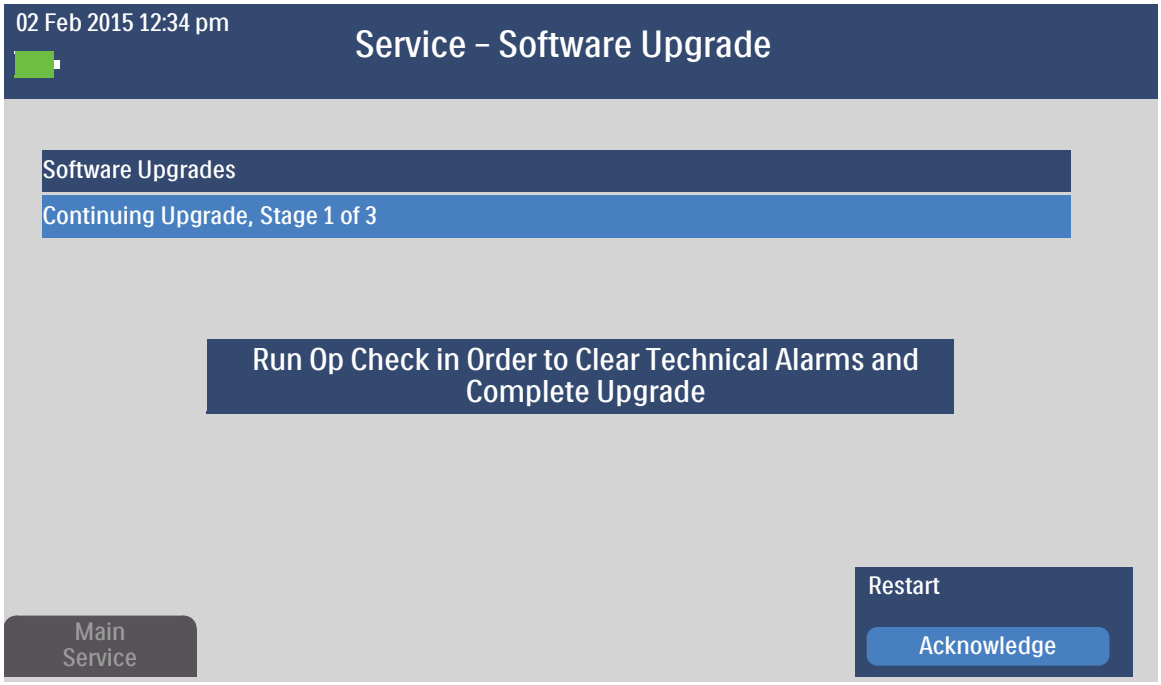
NOTE: If you accidentally removed the USB drive, reinsert it and continue the upgrade.

Figure 10 **Software Upgrade, Continuation**



11 When the software or language installation process is complete, press the Menu Selection key to acknowledge the restart the device, see Figure 11.
Do not remove the USB flash drive yet.

Figure 11 **Software Upgrade, Completion**



12 Perform the Operational Check to ensure that every programmable chip of the device is updated. See "Operational Check" on page 33.

13 Remove the USB flash drive.

Software Upgrade Errors

If your software upgrade is terminated with the Upgrade Failed: Error *nn* message, then:

1 Do not turn off the device until you have tried steps 2 and 3 below.

2 Try to remove and reinsert the USB drive, upgrade may restart automatically.

3 If upgrade does not restart on USB insertion, press the Menu Select button twice to restart the upgrade.

4 If unsuccessful, then:

- **a** Remove the AC and battery.
- **b** Wait 10 seconds; keep the USB inserted.
- **c** Restore the AC and battery.
  Device starts in the Service Mode.
- **d** Enter the service password if prompted.
- **e** Upgrade should restart automatically.
  If still unsuccessful, then see Table 2 for troubleshooting.

Table 2 **Software Upgrade Errors**

Symptom or Error ID	Possible Causes	Suggested Solutions
1 or 2	• USB drive removed during upgrade • Intermittent USB drive contact	Make sure the USB drive is securely inserted and retry the upgrade.
3 or 4 or the Insert USB Drive prompt when the drive is inserted	Unsupported USB drive	Use a 2.0-compatible, ≤ 32 Gb USB drive,
	• Defective upgrade data • Tampering with the upgrade data	1. Re-download the software. 2. Make sure the upgrade data is not tampered with. 3. Retry the upgrade. 4. If persists, note the attempted upgrade version, and call for service, see "Calling for Service" on page 68.
5	Software upgrade is attempted while the device is active (e.g. prints a report)	1. Remove the battery and AC. 2. Wait 10 sec. 3. Re-insert the battery and AC. 4. Retry the upgrade.
6	The upgrade data is incompatible with the current version of the device software.	Note the attempted upgrade version and call for service, see "Calling for Service" on page 68.
7 - 13 or the Insert USB Drive prompt when the drive is inserted	Defective USB drive	Replace the USB drive.
	Unsupported USB drive	Use a 2.0-compatible, ≤ 32 Gb USB drive.
	• Invalid upgrade data • Tampering with the upgrade data • Device error • Device memory corruption	Re-download the software and retry the upgrade. If persists, then export the Hardware and Software Error Logs, note the attempted upgrade version, and call for service, see "Calling for Service" on page 68.

Battery Maintenance

When you receive a new battery:

- "Wake it up"
- Charge it and start rotating
- Familiarize yourself and the user with the HeartStart XL+ *Lithium-Ion Battery: Characteristics and Care* Application Note (available in various languages).

"Waking Up" a Battery

Your HeartStart XL+ lithium-ion battery is shipped at about one-third of full charge and in a "shutdown" or "sleep" mode to extend battery shelf life. In this mode the power is not delivered, and the fuel gauge lights do not light up, until the battery switches into the working mode.

To transition a new battery into the working mode (wake up a battery):

1. Insert a new battery in a HeartStart XL+ defibrillator/monitor.
2. Plug the device into AC power.
   When the Battery Charging light starts flashing, the battery is in the working mode.
3. Continue charging, or you may start using the battery for therapy if needed.

Once in the working mode, the HeartStart XL+ lithium-ion battery cannot be returned back to the sleep mode.

Battery Calibration

Calibrate the battery when any of these conditions occur:

- the Battery Calibration Required Technical Alarm appears
- Op Check Battery Test results in Calibration Required
- the Replace and Service Battery Op Check message appears
- six months pass after previous calibration.

Calibration of a fully charged Battery may take up to 11 hours to complete.

TIP: To reduce calibration time, charge the Battery before calibration. The Battery charges faster when the HeartStart XL+ is turned off.

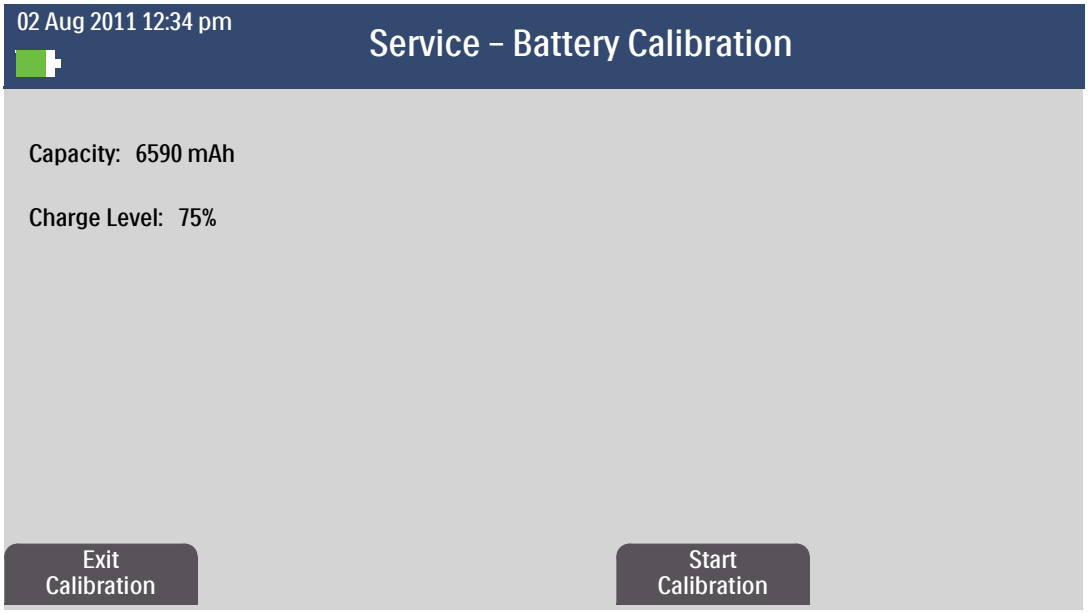
NOTE: Running a calibration cycle at temperatures above 30°C (86°F) or below 10°C (50°F) increases the chance of a calibration failure.

If during Battery calibration your device becomes needed for clinical purposes, use the Exit Calibration and then Exit Service soft keys. Repeat the Battery calibration later. After the initial charge phase, the Battery charge level never falls below 60% during calibration.

To calibrate a Battery:

1. Insert the Battery that needs calibration into the Battery compartment.
2. Connect the AC power.
3. Access Service Mode (see "Accessing Service Mode" on page 8).
4. From the Service Mode Main menu, select Battery Calibration and press the Menu Select button. The Battery Calibration main screen is displayed, see Figure 12:

Figure 12 **Battery Calibration Main Screen**

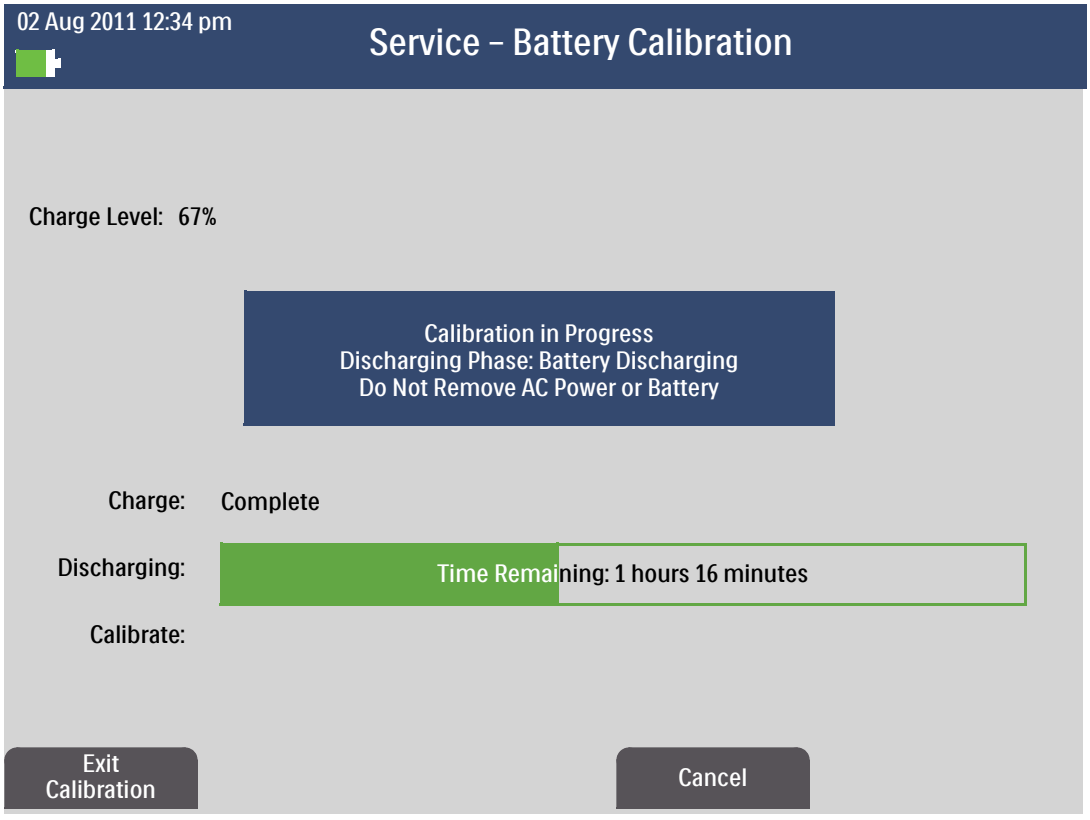


The Battery Capacity value of the most recent calibration is displayed.

5 If a **Battery Calibration Not Required** message appears on the screen, then remove the battery or press the **Exit Calibration** soft key. The Battery is considered calibrated.

6 Press the **Start Calibration** soft key to calibrate the Battery, see Figure 12.
You may leave the device unattended.

Figure 13 **Battery Calibration in Progress**



The Battery Capacity indicator disappears, but the Charge Level is monitored during the entire calibration cycle.

CAUTION: Do not disconnect the AC power during calibration.

The Battery Calibration progresses in three or four phases:

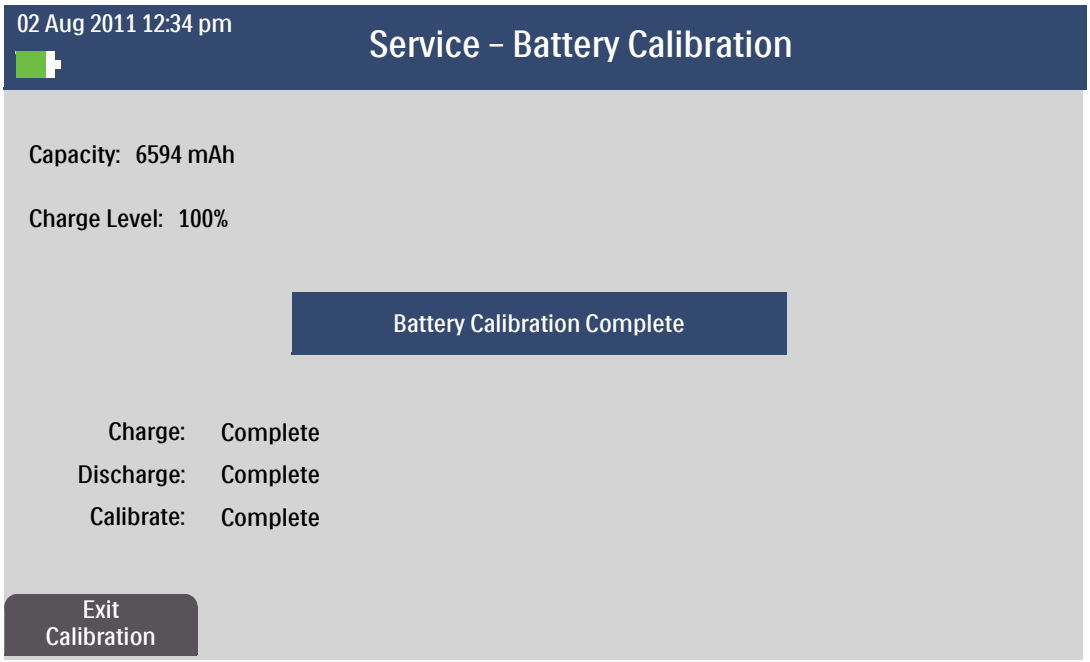
– **Preparation:** This short phase may or may not be present. It takes only a few minutes to complete and presents no progress bar. The Charge Level may drop slightly.

– **Charge**, **Discharge**, and **Calibrate:** Each of these phases may take up to a few hours to complete and consists of the active and test sub-phases indicated by the screen message. The progress bars estimate the remaining time of each phase.

Press the Cancel soft key to interrupt calibration and exit to the Battery Calibration main screen. Press the Exit Calibration soft key to interrupt calibration and exit to the Main Service screen. If you cancel or exit calibration before completion, then your HeartStart XL+ retains previous calibration information.

7 The Battery Calibration is complete when the corresponding message appears on the screen, see Figure 14.

Figure 14 **Battery Calibration Complete**



Replace the Battery if the Calibration Failed message is displayed at any moment during calibration.

NBP Module Calibration

This section describes how to calibrate the HeartStart XL+ NBP module.

Perform calibration when prompted by the **NBP Calibration Overdue** message. If a calibration is overdue, then the HeartStart XL+ Operational Check fails with the code Fail/D.

To calibrate the HeartStart XL+ 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 cylinder to wrap the cuff around. Do not use your arm for NBP calibration.

Everything you may need for the NBP Module calibration is provided in the *NBP Calibration Kit*.

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 15). You may hear a soft, high-pitch tone, this is normal NBP pump operation.
4. Connect the test cuff assembly to the NBP port and wrap the cuff around the container (see Figure 16).

   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 15 **NBP Service Screen**

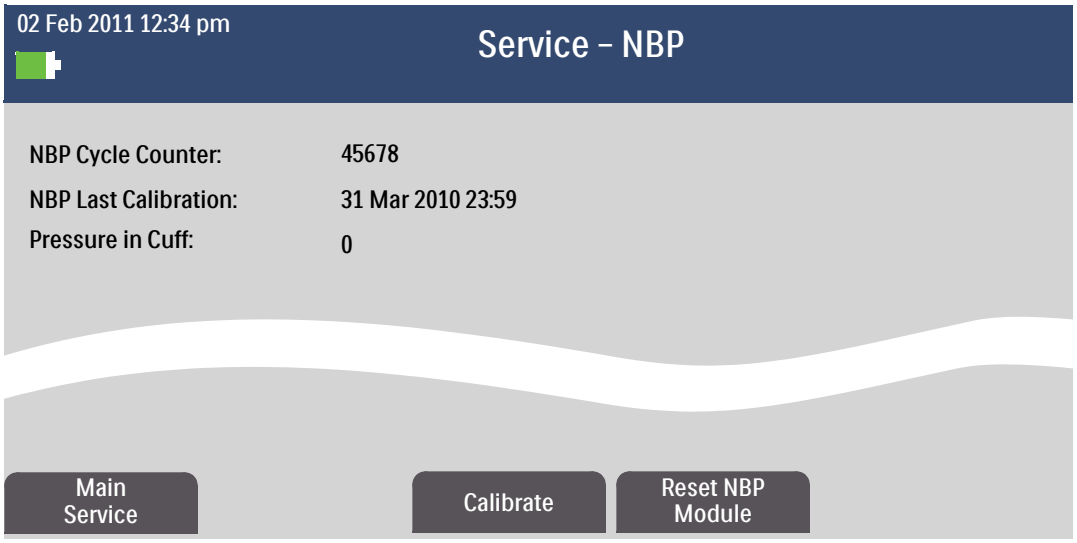
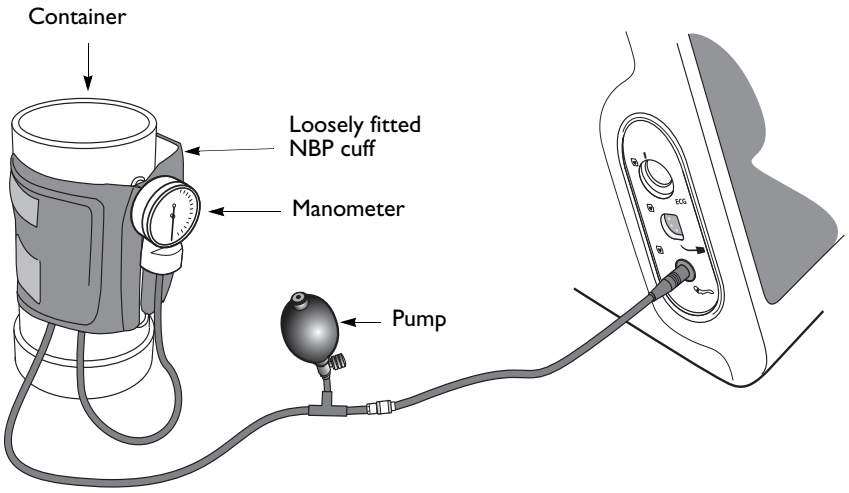


Figure 16 **NBP Calibration Setup**



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 Time-Out

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:

- Press the Reset NBP Module soft key.

NOTE: The reset takes approximately 5 seconds.

NBP Calibration Procedure

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

To calibrate NBP:

1. Press the Calibrate soft key.
   The message Apply 0 mmHg. Select "Next" when ready is displayed (see Figure 17).
2. Release all of the pressure in the cuff so that the manometer reads 0 mmHg.
3. Press the Next soft key.
   The message Apply 250 mmHg. Select "Next" when ready is displayed.

Figure 17 **NBP Calibration Screen**

4 Increase the pressure so that the manometer reads 250 mmHg.

Regardless of your configuration settings, millimeters of mercury are the unit of measure for pressure in the HeartStart XL+ calibration. If your manometer measures pressure in different units, then use the conversion formulae in Table 3:

Table 3 **Units of Pressure Conversion**

1 kPa	=	7.5 mmHg	250 mmHg	=	33.3 kPa
1 mb	=	.75 mmHg	250 mmHg	=	333 mb
1 psi	=	51.7 mmHg	250 mmHg	=	4.83 psi
1 atm.	=	760 mmHg	250 mmHg	=	.329 atm.
1 inHg	=	25.4 mmHg	250 mmHg	=	9.84 inHg

Take time to allow the pressure in the unit to equalize and stabilize. One way to do this is to pressurize the cuff up to about 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** soft key again.

6 Wait until the message **NBP Calibration complete** is displayed.

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 "Operational Check" on page 33.

NBP Calibration Failure

If the error message "NBP Calibration failed: <*reason for the failure*>. 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 soft key.
4. Select NBP from the Service Main Menu.
5. Restart the "NBP Calibration Procedure" on page 20, making sure that the applied pressures are correct.
6. If you cannot successfully complete the calibration, then write down the reason for the failure from the error message and call the Response Center. See "Calling for Service" on page 68.

NBP Module Tests

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

Each of the procedures assumes the device, 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 soft key.

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 defibrillator/monitor, and connect the test manometer and cuff to the tubing. See Figure 16 "NBP Calibration Setup" on page 20.
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 19 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 cuff 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 19 and repeat the test.

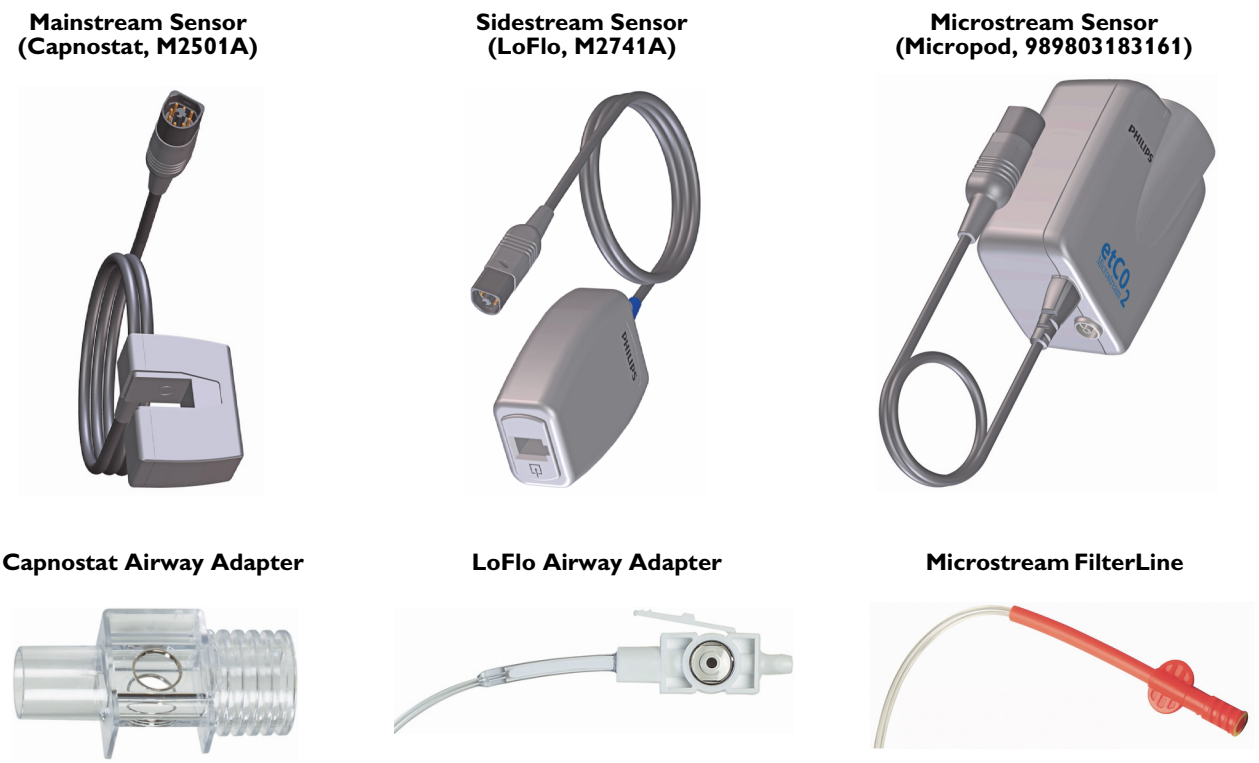
$EtCO_2$ Maintenance

The HeartStart XL+ $EtCO_2$ option allows you to use any of these CO_2 sensor types (see Figure 18):

- Mainstream (Capnostat series, requires a Capnostat airway adapter)
- Sidestream (LoFlo series, requires a LoFlo airway adapter)
- Microstream (CapnoLine series, requires a FilterLine airway adapter)

See "Capnometry Accessories" on page 185 for the complete list.

Figure 18 **CO_2 Sensors and Adapters**



The $EtCO_2$ maintenance procedures depend on the sensor series and consists of:

- Setting Ambient Pressure (for the Mainstream and Sidestream sensors only),
- Flow Rate Check (for the Mainstream and Sidestream sensors only),
- Calibration Check, and
- Calibration (for the Microstream sensors only).

Regardless of your configuration settings, mmHg are the unit of measure for HeartStart XL+ CO_2 service. Refer to Table 3 on page 21 if you need to convert from another measure unit.

You will need the following supplies:

- 5% CO_2 gas cylinders (15210-64010, six cylinders per case)
- Gas flow valve providing a flow rate of 2 liters per minute
- Flowmeter (for Flow Rate Check only)
- Modified airway adapter matching the CO_2 sensor to be checked. If no modified adapter is available, then, depending on your sensor type, you may create one similar to the one shown on Figure 20 on page 27 or Figure 21 on page 27.

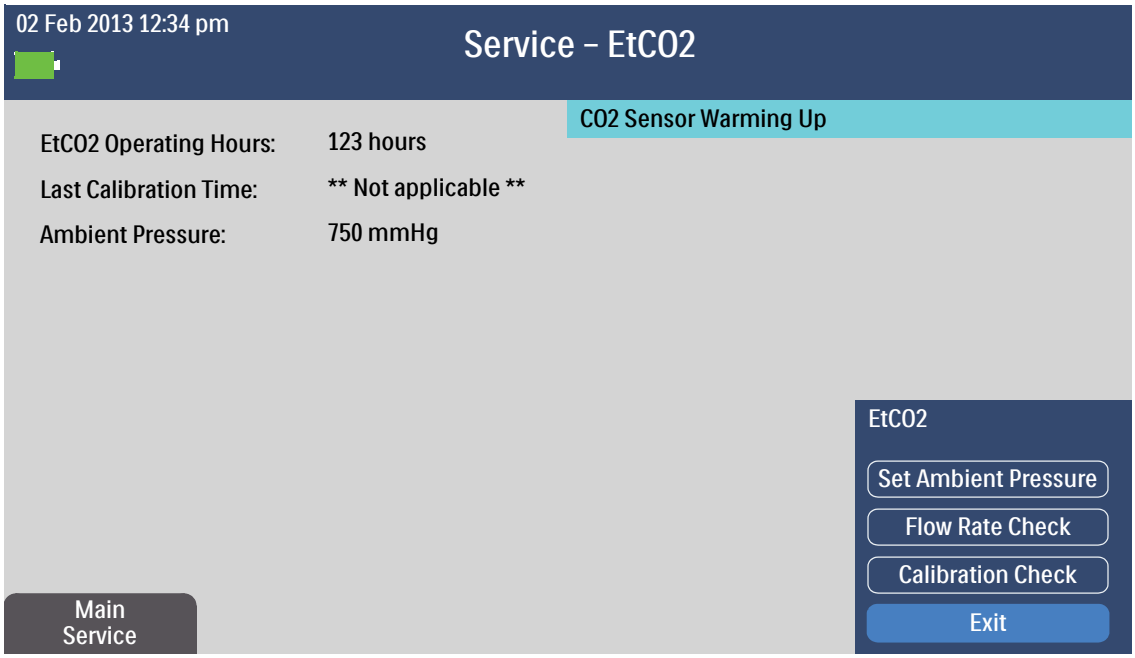
Servicing $EtCO_2$

To service your $EtCO_2$ equipment:

1. Connect your sensor to the device.
2. Connect the modified airway adapter to your sensor.
3. Enter the Service Mode as directed in "Accessing Service Mode" on page 8.
4. Press the Select button.
5. Navigate to the $EtCO_2$ and press the Select button again.

The Service – EtCO2 screen appearance and options depend on the connected sensor model, see Figure 19 on page 24 and Figure 22 on page 28. Calibration Check is available for all sensor models.

Figure 19 **$EtCO_2$ Service Screen (Mainstream and Sidestream sensors)**



Servicing the Mainstream and Sidestream Sensors

Setting Ambient Pressure

Ambient pressure depends on your facility's altitude above the sea level. If your healthcare facility is located in a tall building, then you may consider the floor altitude influence on the ambient pressure. The ambient pressure variations due to the weather and air temperature changes usually are not significant enough and may be ignored.

Verify and, if necessary, adjust the Ambient Pressure setting after your HeartStart XL+ gets moved to a different location, especially to a different altitude.

WARNING: Wrong Ambient Pressure settings may alter the clinical picture.

Set the Ambient Pressure to the prevalent normal atmospheric pressure for your location. If this value is not known, use the approximate values from Table 4 on page 25.

Table 4 **Approximate Ambient Pressure at Different Altitudes**

Altitude above the sea level		Ambient Pressure (mmHg)	Comment, Example
meters	feet		
5000	16400	400	HeartStart XL+ lower pressure limit
4200	13800	450	El Alto, Bolivia
3250	10700	500	La Paz, Bolivia
2700	8850	540	Bogota, Columbia; Quito, Ecuador
2300	7540	570	Addis Ababa, Ethiopia; Mexico City, Mexico
1900	6230	600	
1550	5100	630	Denver, CO; Nairobi, Kenya
1170	3840	660	Calgary, Alberta; Salt Lake City, UT; Yerevan, Armenia
810	2660	690	mean land elevation 90% of the world population live below this altitude.
690	2260	700	Almaty, Kazakhstan; Madrid, Spain; Las Vegas, NV
570	1870	710	Bern, Switzerland; Tbilisi, Georgia
460	1500	720	Munich, Germany; Zurich, Switzerland
340	1100	730	Phoenix, AZ
220	720	740	Delhi, India; Lahore, Pakistan; Vienna, Austria
110	360	750	HeartStart XL+ default value; Chicago, IL; Seoul, Korea
0	0	760	low-rise building on a seashore; Beijing, Berlin, Paris
–100	–330	770	Furnace Creek Airport, Death Valley, USA
–210	–690	780	Tiberias, Israel
–320	–1050	790	
–650	–2100	820	
–950	–3100	850	HeartStart XL+ upper pressure limit

To set the Ambient Pressure:

1. Use Table 4 or 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 facility.

   Some of the weather stations may provide pressure values normalized to the sea level; be sure to use the value for your altitude.
2. Enter the Service Mode and select **EtCO2** to access the $EtCO_2$ maintenance menu.
3. Select **Set the Ambient Pressure**.
4. Use the **Up** and **Down** navigation keys to set the pressure.

Flow Rate Check

Perform the $EtCO_2$ Flow Rate check to validate the values provided by your CO_2 sensors.

To perform the $EtCO_2$ Flow Rate Check:

1. Enter the Service Mode and select **EtCO2** to access the $EtCO_2$ maintenance menu.
2. Select **Flow Rate Check**.
3. Follow the screen instructions to perform the check.

Calibration Check

Perform Calibration Check to validate the values provided by your CO_2 sensors.

To perform a calibration check:

1. Set up the equipment for calibration.
   a. For the Micropod and LoFlo sensors (see Figure 20):
      - Modify the adapter or FilterLine using a T-shaped joint.
        Keep the open end short (about 2" or 5 cm).
      - Connect the modified adapter or FilterLine to the sensor.
      - Connect the tube to the 5% CO_2 gas cylinder.
        Leave the other end of the tube open to the air, do not block.

   b. For the Capnostat sensors (see Figure 21):
      - Modify the adapter by sealing an air tube inside an adapter using a silicone or another airtight plug. The air tube end should not enter the sensor.
      - Connect the modified adapter to another adapter and to the sensor.
      - Connect the tube to the 5% CO_2 gas cylinder.
2. Enter the Service Mode and select **EtCO2** to access the $EtCO_2$ maintenance menu.
3. Press the Main Menu button and select **Calibration Check**.
4. Follow the on-screen instructions. Do not allow excessive gas flow.
5. If the **EtCO2 Calibration Check Failed. Module not ready** message appears, then let the sensor warm up for about 1 minute and restart calibration check.

Figure 20 **CO_2 Calibration Setup, the Micropod and LoFlo Sensors**

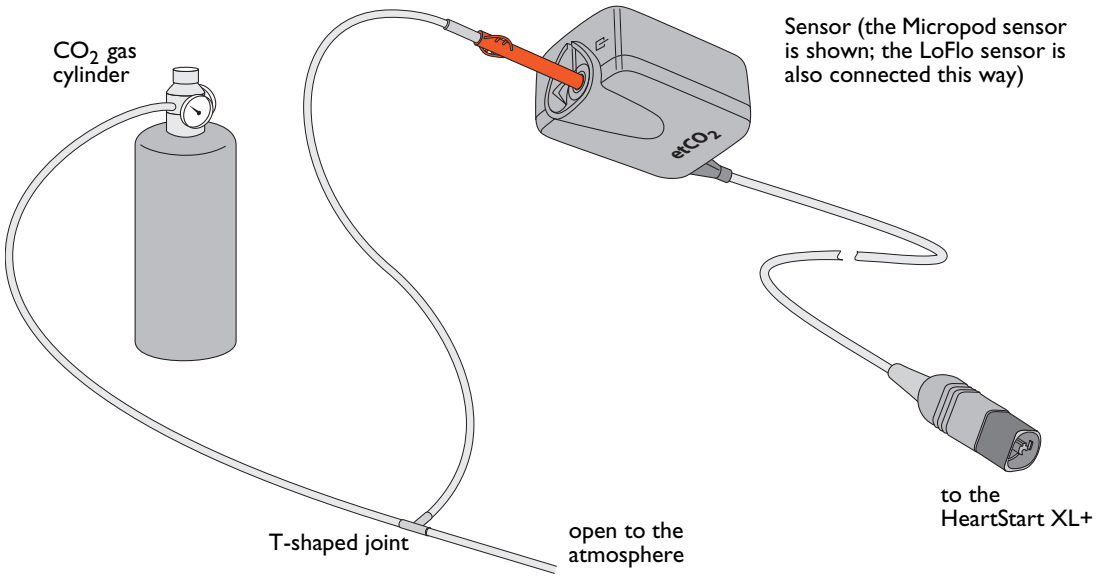
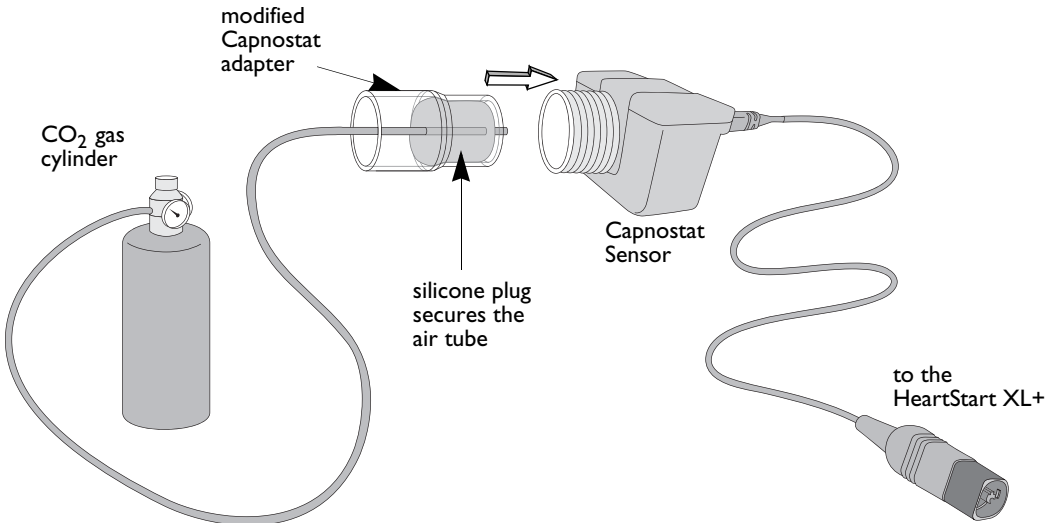


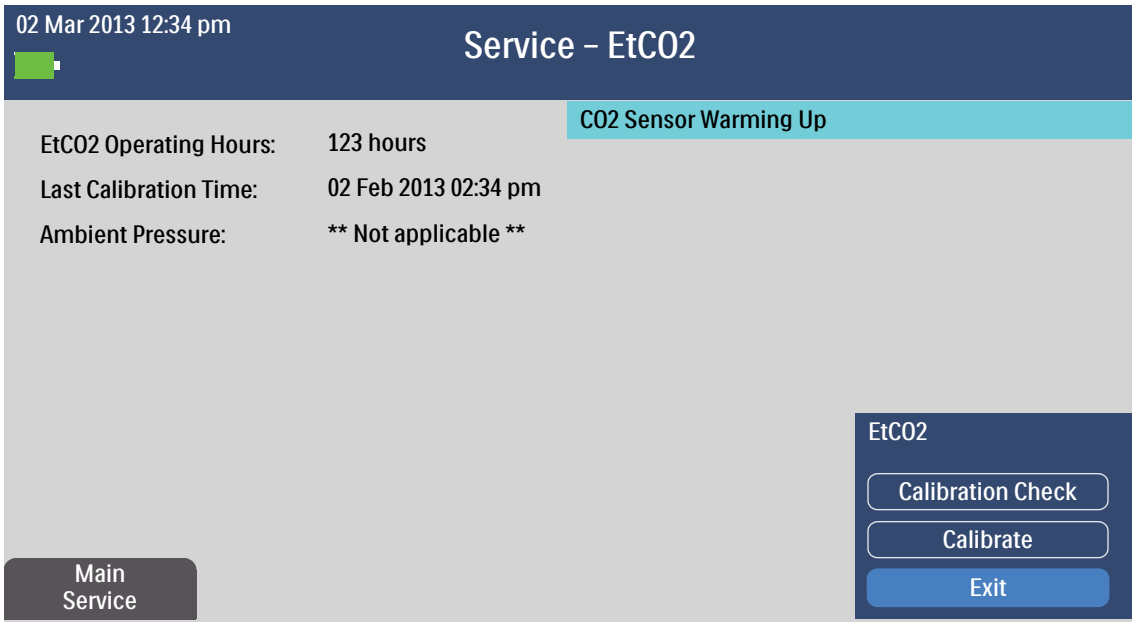
Figure 21 **CO_2 Calibration Setup, the Capnostat Sensor**



Servicing the Microstream Sensors

You may hear a soft, low-pitch tone, this is normal $EtCO_2$ pump operation.

Figure 22 **$EtCO_2$ Service Screen (Microstream sensors)**



Microstream Sensor Calibration and Calibration Check

Perform the Calibration Check as described on page 26.

Calibrate your Microstream sensor when directed by **CO2 Calibration Overdue** Technical Alarm. This alarm is displayed when one of these two events happen (as reported on the **Service – EtCO2** screen):

- 4000 operating hours passed since the last calibration
- a calendar year passed since the last calibration.

TIP: Examine these values and calibrate the sensor if any of them is close to the limit to prevent the **CO2 Calibration Overdue** Technical Alarm.

To calibrate the Microstream sensor:

1. Set up the equipment as shown in Figure 20 on page 27.
2. Enter the Service Mode and select **EtCO2** to access the $EtCO_2$ maintenance menu.
3. Select **Calibrate**.
4. Follow the on-screen instructions.

Disposal of Empty Calibration Gas Cylinders

To dispose of empty calibration gas cylinders:

1. Empty the cylinder completely by opening the valve.
2. When the cylinder is empty, either remove the valve stem from the fill (or regulator) hole, or drill a hole in the cylinder.
3. Write "Empty" on the cylinder and dispose of it appropriately for scrap metal.

WARNING: Ensure that the cylinder is completely empty before trying to remove the valve stem or drill the tank.

3

Troubleshooting

This chapter describes how to troubleshoot the HeartStart XL+ monitor/defibrillator.

Overview

The topics covered in this chapter are:

Troubleshooting Tools and Equipment

You need the following tools and equipment:

- Defibrillator Test Plug (989803171271) or
- 50-ohm Defibrillator Test Load (M3725A)

Obtaining Replacement Parts

See Appendix A “Parts and Accessories” on page 175 for details on replacement parts.

Ready For Use Indicator

The Ready For Use (RFU) indicator, located in the right side of the device handle, reports the status of critical functions of the device as determined by the Automated Tests and Op Check. These Automated Tests run periodically while the device is turned off (but has a power source) and check the following critical functions of the device:

- defibrillation and cardioversion
- pacing
- pads/paddles ECG
- 3-lead/5-lead ECG
- battery

The RFU indicator also reports failures in critical functions detected at run time and during an Op Check and Service Mode tests. Always check the RFU indicator when troubleshooting the device.

Automated test failures of non-critical components (such as the NBP or printer) are not reflected in the RFU indicator, but are reported through Technical Alarm messages when the device is turned on.

The RFU indicator displays the status of the device using the following definitions:

Table 5 **RFU Indicator Status**

RFU Status		Meaning	Required Action
Blinking black hourglass		Shock, pacing, and ECG functions are ready for use and sufficient battery power is available.	None
Blinking red X without a periodic chirp		Low battery is being charged. The device can be used, but run time is limited.	Make a replacement battery available. If a replacement battery is not available, then charge the battery for two hours.
Blinking red X and a periodic chirp		Low battery not charging or no battery.	Charge the battery as soon as possible by connecting HeartStart XL+ to AC power and/or replace the battery with a charged battery. If both the battery and AC power are present, then troubleshoot the battery as described in “Battery Testing and Troubleshooting” on page 47.
Solid red X and a periodic chirp		A critical failure has been detected that may prevent the delivery of a shock, pacing, or ECG acquisition.	Turn the Therapy Knob to **Monitor.** A Technical Alarm describing the failure is displayed. Begin troubleshooting as described in “Troubleshooting Process” on page 43.
Solid red X without a periodic chirp		No power, or device failure (cannot power on).	Insert a charged battery and connect to AC power. If the red X without a chirp persists for more than 10 seconds, then refer to “Troubleshooting Process” on page 43.

NOTE: The RFU indicator may briefly display a solid red “X” when initially turning on the device, switching between clinical and non-clinical operating modes, and at the start of any Automated test.

Automated Tests

The HeartStart XL+ performs many maintenance activities independently, including three tests that run automatically at regularly scheduled intervals *while the device is off* to assess operational performance and alert you if a problem exists. Results of tests associated with critical functionality of the device are reported through the RFU indicator and the Automated Test Summary report. Results are also reported through Technical Alarm messages on the display when the HeartStart XL+ is turned on. Table 6 provides a brief explanation of the tests and lists the frequency with which each test is performed.

Table 6 **Automatic Self-Tests**

Test Type/Frequency	Components and Parameters Tested
Hourly (short)	• power supplies, • charge level of the battery, • internal communication across all critical modules and components • device's internal temperature.
Daily after midnight (medium)	Performs an Hourly Test, plus: • internal clock battery • defibrillation (including low-energy internal discharges) • pacing • ECG • SpO_2, NBP, and $EtCO_2$ (as installed) • USB • Printer • 3- or 5-lead ECG cable (if connected).
Sunday early mornings (long)	Performs a Daily Test, plus a 150-J internal discharge to exercise the entire defibrillation circuitry.

NOTE: Automated tests do not test the therapy cables, paddles, buttons, audio, or the display.

Automated Test Summary

An Automated Test Summary (ATS), showing the results of recent tests, may be viewed or printed as evidence that the HeartStart XL+ is tested regularly.

To view the ATS:

1. Turn the Therapy Knob to Monitor.
2. Press the Menu Select button.
3. Using the Navigation buttons, select Other and press the Menu Select button.
4. Select Operational Check and press the Menu Select button.
5. Using the Navigation buttons, select Auto Test Summary and press the Menu Select button. The message appears: Leaving clinical mode.
6. Navigate to Yes and press the Menu Select button to confirm the Exit Clinical Mode? request.
7. Press the Print soft key to print the report.

The report shows the results of the most recent hourly test, the daily tests that have run since the last weekly test, and the last 53 weekly tests. Test results are reported, as described in Table 7 on page 32.

Figure 23 **Automated Test Summary Screen**

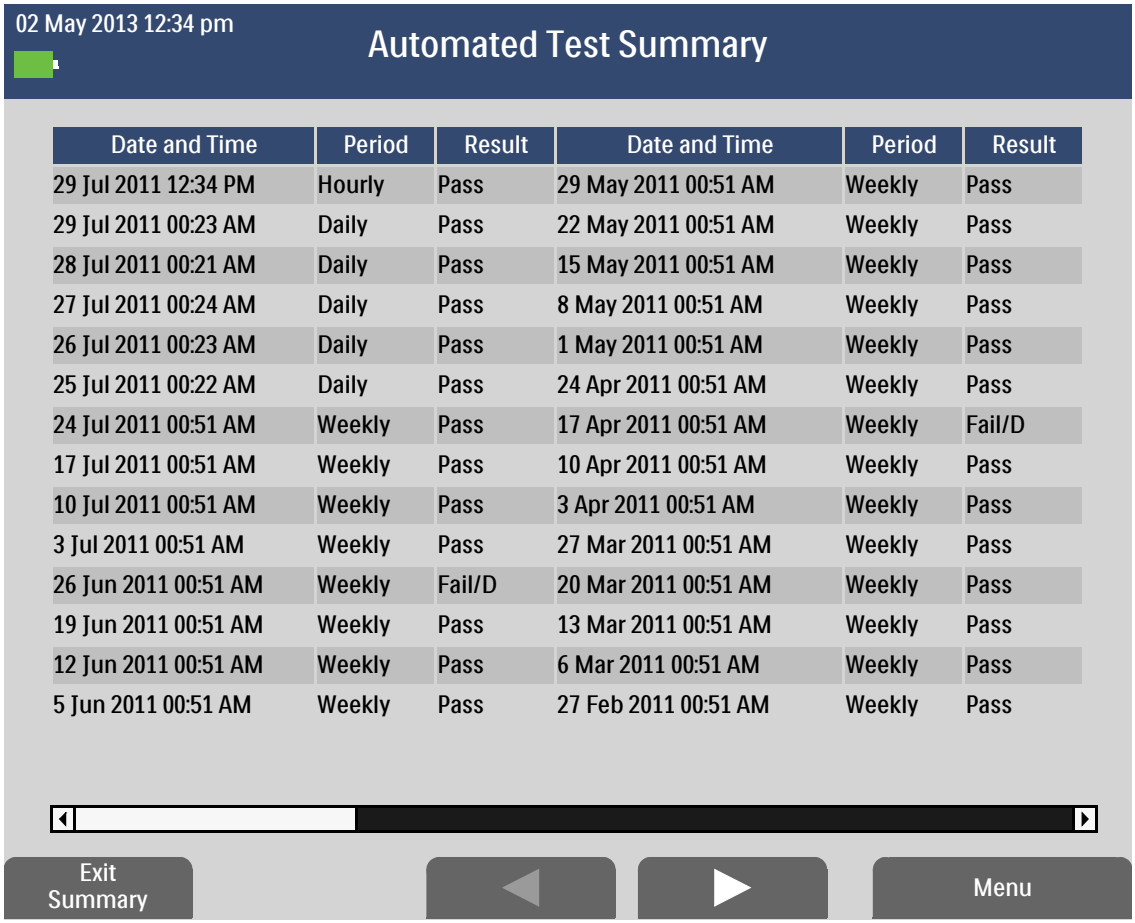


Table 7 **Automated Test Summary Results**

Result	RFU Indicator	Definition	Required Action
Pass	Hourglass	All tests passed	None
Fail/D		A non-critical failure has been detected. Affected component does not affect therapy delivery.	Turn the Therapy Knob to **Monitor.** A Technical Alarm indicating the failed component is displayed. Troubleshoot as described in "Troubleshooting Process" on page 43.
Fail/BW	Blinking red X	Battery low or malfunctioning.	Charge the battery as soon as possible and/or replace the battery with a charged battery.
Fail/CX	Solid red X, chirp	An ECG cable failure has been detected	Replace the ECG cable and run Op Check. Troubleshoot as described in "Troubleshooting Process" on page 43 if persists.
Fail/DX		A critical device failure has been detected.	Turn the Therapy Knob to **Monitor.** A Technical Alarm indicates a problem has occurred. Troubleshoot as described in "Troubleshooting Process" on page 43.

Shift Check and Weekly Shock Test

In addition to the hourly, daily, and weekly Automated Tests, there are three manual tests that help ensure your HeartStart XL+ readiness:

- Shift Check
- Weekly Shock Test, and
- Operational Check

WARNING: Disconnect the ECG leads set from the cable and confirm the HeartStart XL+ is not connected to a patient when performing a Weekly Shock Test or Operational Check.

Shift Check

In order to help ensure that defibrillators are ready for use when needed, the American Heart Association (AHA) recommends that users complete a check list, often referred to as a shift check, at the beginning of each change in personnel. Refer to *HeartStart XL+ Instructions for Use* for details on shift check.

Weekly Shock Test

Verify the ability to deliver defibrillation therapy once a week by performing *one of the following:*

- Operational Check (see below).
- Weekly Shock Test. Refer to *HeartStart XL+ Instructions for Use* for details.

Operational Check

Perform Operational Check (Op Check) at regular intervals to supplement the hourly, daily, and weekly Automated Tests executed by the HeartStart XL+ and to troubleshoot the device. Automated Tests provide adequate assurance that the device is in a functional state of readiness. Op Check supplements the Automated Tests by verifying therapy cables, the ECG cable, paddles, audio, the **Charge, Shock** and **Sync** buttons, and Therapy Knob. Op Check also notifies you if the battery or NBP module need calibration.

To run the Operational Check:

1. Insert a battery displaying at least two green LEDs.
2. Turn the **Therapy Knob** to **Monitor**.
3. Press the **Menu Select** button.
4. Using the Navigation buttons, select **Other** and press the **Menu Select** button.
5. Select Operational Check and press the **Menu Select** button.
6. Select **Run** Op Check and press the **Menu Select** button.
   Exit Clinical Mode? prompt appears.
7. Select **Yes** and press the **Menu Select** button to start the Op Check.
   Select **No** and press the **Menu Select** button to return to the Clinical mode.
8. When a response is required, use the Navigation buttons to select your answer and the Menu Select button to confirm your choice. "Operational Check Tests" on page 35 shows the tests, in the order in which they are performed, explains the prompts that may appear, and describes the actions you should take (if any).

NOTE: If testing paddles, make sure that they are secured in their pockets. If the patient contact indicator (PCI) LEDs light, adjust the paddles in the pockets to improve the electrical contact. If the LEDs continue to light, clean the paddle electrode surfaces.

Operational Check Setup

The HeartStart XL+ performs the readiness check, and when all readiness conditions are satisfied begins to run Op Check tests.

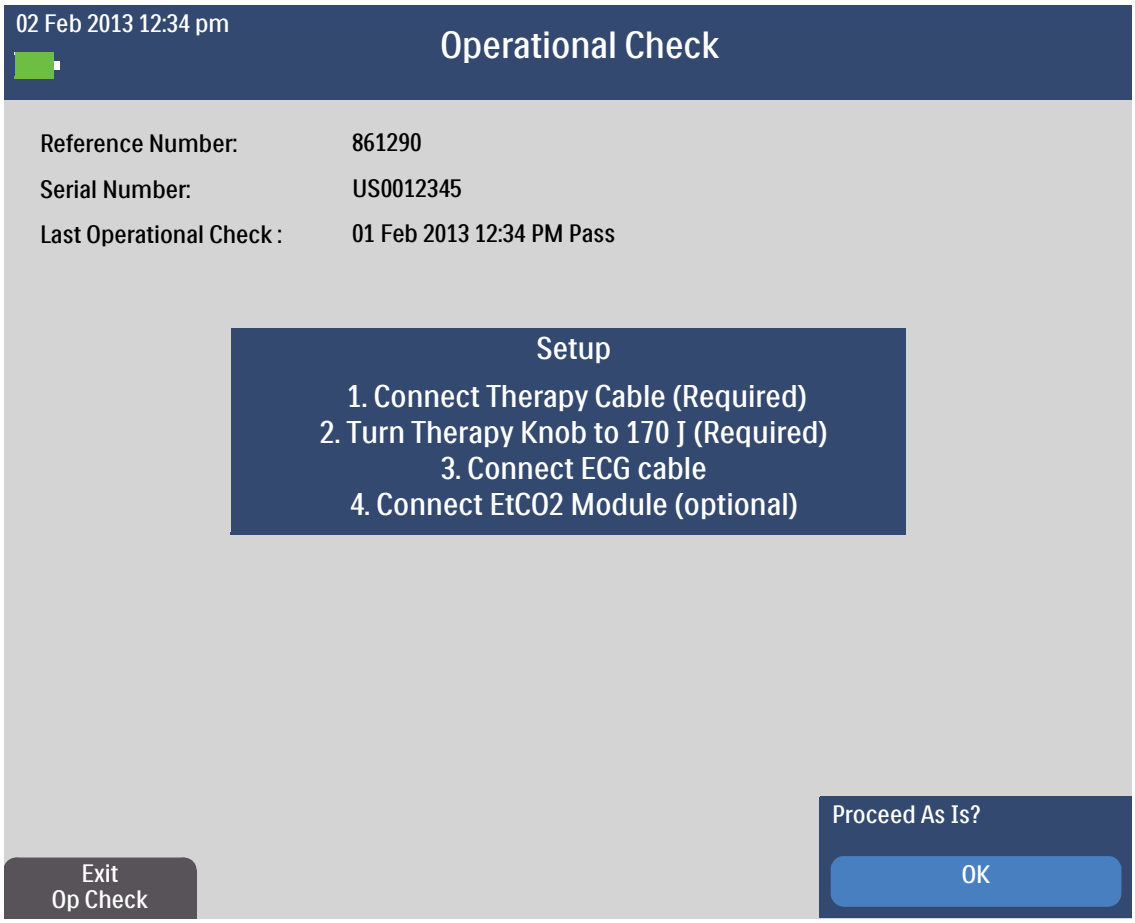
Carefully read the setup instructions on the screen, see Figure 24 for a sample. Once the HeartStart XL+ is set up properly, you can proceed with the Op Check.

You cannot perform the Op Check without a sufficiently charged battery. If there is no battery in the device then the prompt message **Insert Charged Battery or Exit** appears. If the battery charge is low, then the prompt message **Battery Charge Low, Replace Battery** appears.

Options are tested only if present.

NOTE: If you choose to "proceed as is" without performing the required actions, the Op Check will fail. Press the **Menu Select** button to proceed as is.

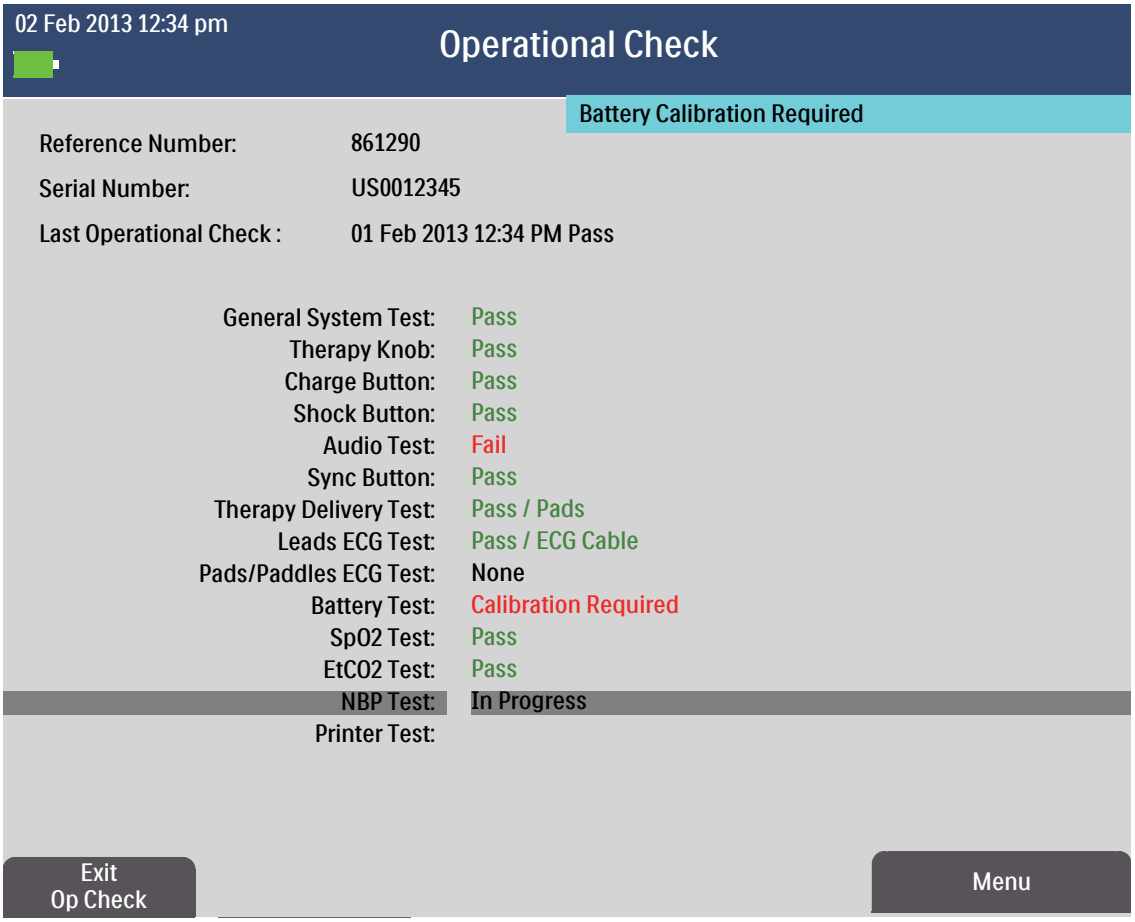
Figure 24 **Operational Check Screen — Setup**



Operational Check Flow

Follow the screen instructions and respond to the prompts. Once you have answered the last prompt (Sync button), you can leave the HeartStart XL+ unattended, and the Op Check will complete.

Figure 25 **Operational Check Screen — in Progress**



WARNING: Be sure to safely discharge paddles tested during the Op Check, as described in "Operational Check Tests" below.

Operational Check Tests

General System Test: Tests the following parameters and features:

- internal case temperature
- internal voltages of the power supplies and the clock battery
- read / write access between PCAs, modules, and programmable components
- executable device software and file system integrity, etc.

Therapy Knob: Tests if the Therapy Knob is reading the correct position.

Charge Button: Tests the Charge button function.

If no cable is attached, the test is skipped.

If the Pads cable is attached, you are prompted to Verify Test Load is Attached and Press the Charge Button. Follow the prompt.

If external paddles are attached, you are prompted to Verify Paddles are in Holders and Press the Charge Button. Follow the prompt.

If the device does not detect a press of the Charge button within 10 seconds, the message If the Charge button does not work, select Charge from the menu below is displayed. If the Charge button is not working, press Charge from the No Button Response menu. The test is marked Fail, and the Op Check fails.

Shock Button: Tests the Shock button (or the Shock buttons on the external paddles) function.

If a pads cable and test load are not attached, or if external paddles are not attached and in the paddle holder, the test is skipped and marked Not Tested.

Once charged, the Shock button(s) flash(es) and you are prompted to Press Shock button or Press Shock buttons on paddles. Follow the prompt.

If the device does not detect a press of the Shock button within 10 seconds, the prompt If the Shock button does not work, select Shock from the menu below is displayed. If the Shock button(s) is (are) not working, press Shock from the No Button Response menu. The test is marked Fail, and the Op Check fails.

NOTE: The device automatically disarms after the time specified in the configuration is reached. The message Defib Disarmed is displayed in this case.

Audio Test: Plays a voice prompt and asks you to reply whether the prompt was heard.

If a shock was delivered during the Shock test, the prompt "Shock Delivered" is annunciated. If a shock was not delivered, then the prompt "No Shock Delivered" is annunciated. When you hear the prompt, use the navigation buttons to select Yes, then press the Menu Select button.

Sync Button: Follow the Press and Release Sync Button prompt.

If the device does not detect a press of the Sync button within 10 seconds, the prompt If the Sync button does not work, select Sync from the menu below is displayed. If the Sync button is not working, press Sync from the No Button Response menu. The test is marked Fail, and the Op Check fails.

TIP: Once you have responded to the Sync Button prompt, you can leave the HeartStart XL+ unattended, and the Op Check will complete.

Therapy Delivery Test: If the Pacing option is installed, this test will test pacing as well. Depending on your configuration and attached cables, the test may display:

- Pass/Pads
- Pass/External Paddles
- Fail/No Cable
- Fail/Pads
- Fail/External Paddles
- Fail/Internal Paddles
- Fail/Battery
- Fail

Leads ECG Test: Depending on your configuration and attached cables, the test may display:

- Pass/ECG Cable
- Pass/No Cable
- Fail/ECG Cable
- Fail/No Cable
- Fail

If a possible reason of the test failure might be a faulty cable connection, then the following prompt is displayed at the end of all remaining tests:

Leads ECG Test Failed With Cable.
Disconnect ECG Cable to Rerun Test Without Cable.

Disconnect the ECG cable or acknowledge the Proceed Without Rerunning Test prompt.

Pads/Paddles ECG Test: Depending on your configuration and attached cables, the test may display:

- Pass/Pads
- Pass/External Paddles
- Pass/No Cable
- Fail/Pads
- Fail/External Paddles
- Fail/Internal Paddles
- Fail/No Cable

Battery Test: The test may display:

- Pass
- Fail
- None (if battery is not inserted)
- Calibration Required
- Low Battery (charge the battery; calibration is not required)

SpO_2 Test: Performed only if the SpO_2 option is installed. The test may display:

- Pass
- Fail

$EtCO_2$ Test: Performed only if the $EtCO_2$ option is installed. Depending on the sensor model, the test may display:

- Pass
- Fail
- No Sensor Detected
- Calibration Overdue
- Replace Sensor

NBP Test: Performed only if the **NBP** option is installed. The test may display:

- Pass
- Fail
- Calibration Overdue

Printer Test: Among other actions, Printer tests determines if the correct font is installed in the printer. If the Printer Font is not installed in the printer, but is available in the device memory, then the Printer Font is installed in the printer, while the message Printer Font Download in Progress is displayed.

Depending on the AutoPrint configuration setting, a successful Printer Test displays either the Check Printed Report or Print Op Check Report to Check Printer prompt.

Operational Check Completion

At completion of the Op Check:

- The message **Operational Check Passed** is displayed if all of the tests pass.
- If any test fails, the message **Operational Check Failed** is displayed along with one or more of the following messages, depending upon the nature of the failed functionality:
  - Service Device
  - Replace Battery
  - Replace Pads Cable
  - Replace Paddles Cable
  - Replace Therapy Cable
  - Replace ECG Cable

Fix the problem and successfully run the Operational Check to clear the failure.

Operational Check Report

At the end of an Op Check, depending on the **AutoPrint** configuration setting, either the Op Check report is printed, or **Print Op Check Report to Check Printer** prompt is displayed.

To export to a USB flash drive or print a copy of the report:

- Select **Export** or **Print** from the Main Menu.

You may export or print any number of copies while in the Op Check mode. After you exit Op Check, the Op Check report is no longer available, but you still may find the result of the Op Check in the Op Check summary (see "Operational Check Summary" on page 39).

Figure 26 shows a sample Op Check report. The first part of the report lists test results. The second part lists checks to be performed by the user.

Figure 26 **Operational Check Report**

```
Operational Check Report                Current Test Results:

                                         General System Test: Pass              Battery Test: Pass
HeartStart XL+ 861290                           Therapy Knob: Pass                 SpO2 Test: Pass
S/N: US00123456                                Charge Button: Pass               EtCO2 Test: Pass
Sw Rev: B.00.00 American English                Shock Button: Pass                  NBP Test: Pass
                                                  Audio Test: Pass              Printer Test: Pass
Current Operational Check :                       Sync Button: Pass
31 May 2013 12:34 Pass                 Therapy Delivery Test: Pass/Pads
                                              Leads ECG Test: Pass/ECG Cable
Last Operational Check :               Pads/Paddles ECG Test: Pass/Pads
29 May 2013 01:23 Pass
```

```
Qty/Check List :                                          Comments:
___ Defibrillator Inspection        ___ NBP Cuff(s) & Tubing
___ ECG Cables/Connectors           ___ USB Connector
___ Paddles/Pads
___ Monitoring Electrodes
___ Charged Battery
___ AC Power Cord
___ Printer Paper
___ SpO2 Sensor
___ EtCO2 Sensor
___ EtCO2 Sampling Line                                   Inspected By:_____________________
```

Operational Check Summary

The Op Check summary lists the results from the last 60 operational checks. Test results are reported as described in Table 8.

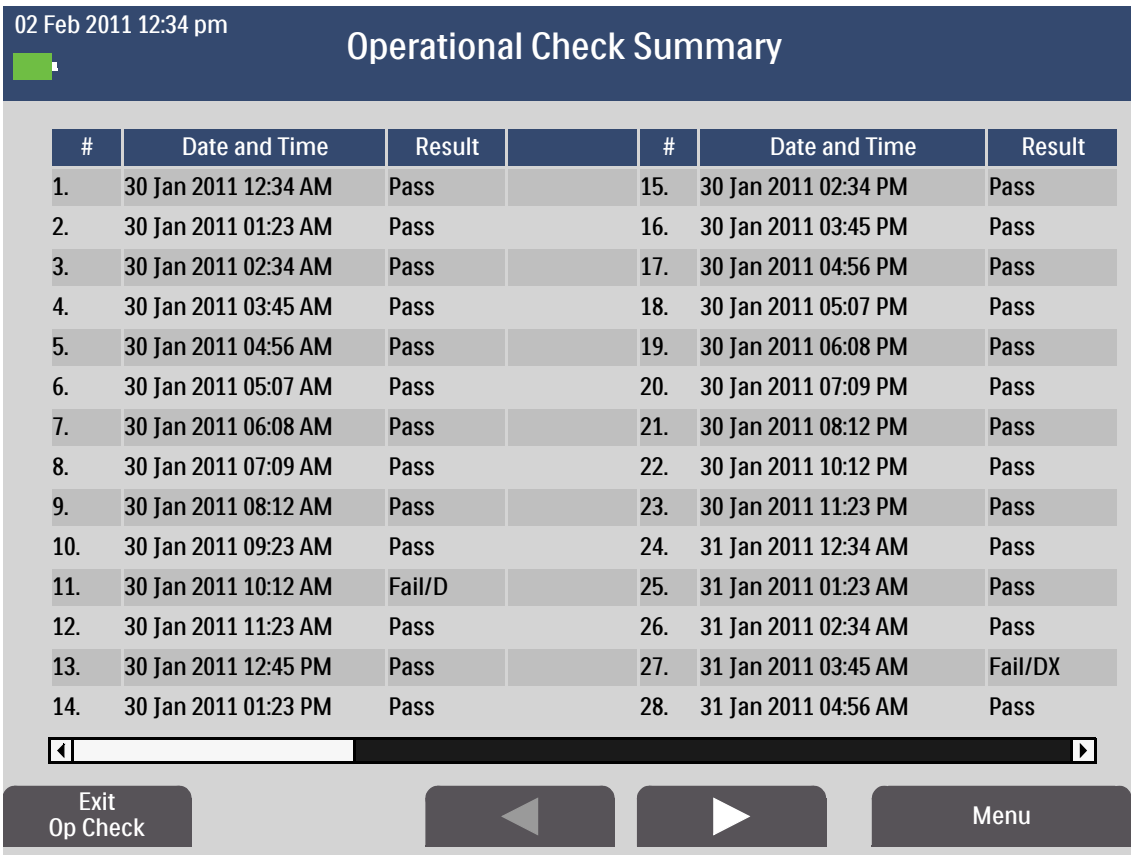
Operational Check Summary Report

To access the Op Check summary report:

1. From the service Main Menu, navigate **Other** > **Operational Check** > **Op Check Summary**.
2. Respond **Yes** to the **Exit Clinical Mode?** prompt.
3. Select **Export** or **Print** from the Main Menu to export to a USB drive or print a copy of the report.

Figure 27 shows a sample Op Check summary:

Figure 27 **Operational Check Screen — Summary**



#	Date and Time	Result	#	Date and Time	Result
1.	30 Jan 2011 12:34 AM	Pass	15.	30 Jan 2011 02:34 PM	Pass
2.	30 Jan 2011 01:23 AM	Pass	16.	30 Jan 2011 03:45 PM	Pass
3.	30 Jan 2011 02:34 AM	Pass	17.	30 Jan 2011 04:56 PM	Pass
4.	30 Jan 2011 03:45 AM	Pass	18.	30 Jan 2011 05:07 PM	Pass
5.	30 Jan 2011 04:56 AM	Pass	19.	30 Jan 2011 06:08 PM	Pass
6.	30 Jan 2011 05:07 AM	Pass	20.	30 Jan 2011 07:09 PM	Pass
7.	30 Jan 2011 06:08 AM	Pass	21.	30 Jan 2011 08:12 PM	Pass
8.	30 Jan 2011 07:09 AM	Pass	22.	30 Jan 2011 10:12 PM	Pass
9.	30 Jan 2011 08:12 AM	Pass	23.	30 Jan 2011 11:23 PM	Pass
10.	30 Jan 2011 09:23 AM	Pass	24.	31 Jan 2011 12:34 AM	Pass
11.	30 Jan 2011 10:12 AM	Fail/D	25.	31 Jan 2011 01:23 AM	Pass
12.	30 Jan 2011 11:23 AM	Pass	26.	31 Jan 2011 02:34 AM	Pass
13.	30 Jan 2011 12:45 PM	Pass	27.	31 Jan 2011 03:45 AM	Fail/DX
14.	30 Jan 2011 01:23 PM	Pass	28.	31 Jan 2011 04:56 AM	Pass

Table 8 **Operational Check Summary Results**

Result	RFU Indicator	Definition	Required Action
Pass	Hourglass	All tests passed	None
Fail/DX	Solid red X, chirp	A critical device failure has been detected. The failure may prevent the delivery of a shock, pacing, or ECG acquisition.	Exit Op Check Summary. A Technical Alarm indicating the problem is displayed. Troubleshoot as described in "Troubleshooting Process" on page 43.
Fail/CX	Solid red X, chirp.	A critical cable failure has been detected.	Exit Op Check Summary. A Technical Alarm indicating the failed cable is displayed. Replace the failed cable.
Fail/BW	Varies *	A battery failure was detected.	Troubleshoot the battery.
Fail/D	Hourglass	A problem has been detected with a component that does not affect therapy delivery.	Exit Op Check Summary. A Technical Alarm indicating the failed component is displayed. Troubleshoot as described in "Troubleshooting Process" on page 43.

* The Automated Tests continually check for a low battery condition and set the RFU Indicator appropriately.

Additional Notes about the Operational Check

Keep in mind the following points about the Operational Check:

- You can run Op Check from the **Other** menu in Clinical Mode or from the Service Mode Main menu – the Op Check is the same in both modes, with the following exceptions:
  - The Op Check in Service Mode runs in English, while in Clinical Mode it runs in the installed language.
  - When you exit the Op Check from Service Mode, you remain in the Service Mode.
- The Op Check runs the Therapy Delivery test on battery power to reflect typical operating conditions for defibrillation. The device automatically disconnects AC power for the time of this test.
- If the HeartStart XL+ is equipped with multifunction defib pads only and does not have a paddle tray, you cannot test paddles during an Op Check.
- Options that are not on the device do not appear on the screen or printed report.
- The message **In Progress** is displayed as each test is run. The test result (Pass or Fail) is displayed at the completion of each test and failures are logged in the Hardware Error Log. If you cancel the Operational Check before it completes, it is not recorded in the Operational Check Summary.

Service Mode Tests

These tests include manual interaction with the display and controls and help you isolate problems with the device. See "Service Mode Tests" on page 161 for more information on Service Mode tests.

Error Log Messages

Error Log menus allow you to review, print, export to USB memory, and clear the log entries.

The Error Logs include entries for all messages logged during normal operating mode (**Clinical**), Configuration mode (**Config**), Data Management mode (**DataMgmt**), boot sequence (**PowerUp**), Automated tests (**AutoTest**), Service Mode tests (**Service**), Operational Checks (**OpCheck**), and Software Upgrades (**SWUpgrade**). The message indicates the error severity and may provide additional information, such as error code and a verbal explanation.

The HeartStart XL+ defibrillator/monitor maintains two error logs: one for software and one for hardware.

Each log can contain up to 50 critical and up to 50 non-critical (up to 100 total) entries. Up to 14 entries may be displayed on a single screen. Each entry includes:

- the date and time of the message
- severity
- device operating mode at the time of the message (**AutoTest**, **Clinical**, **Config**, **DataMgmt**, **OpCheck**, **PowerUp**, **Service**, or **SWUpgrade**)
- numeric error code (software error log only) and optional informational string

When you call the Support Center, you may be asked to check or export the Error Logs.

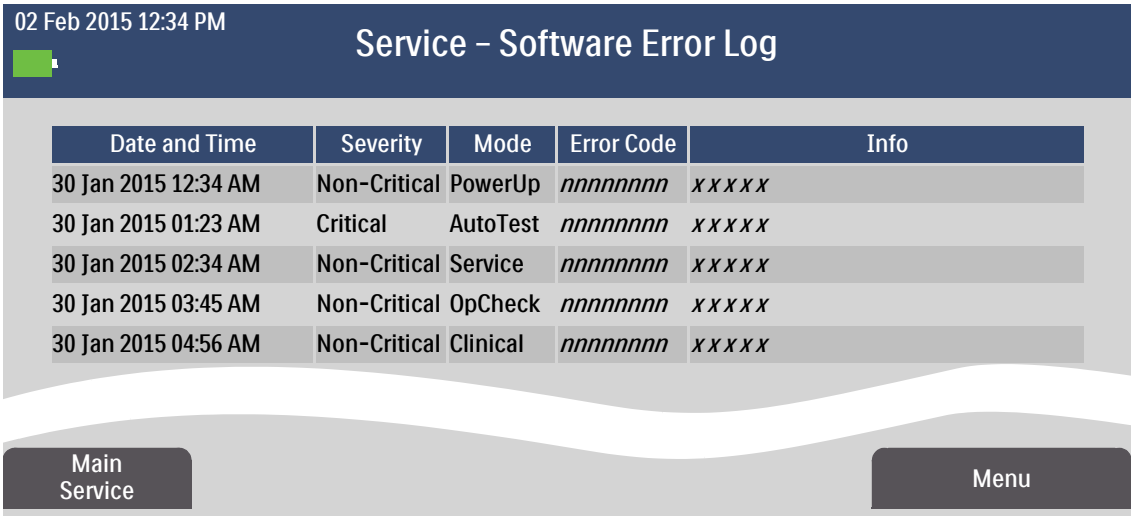
To view the Error Logs:

1. Access the Service mode. See "Accessing Service Mode" on page 8.
2. Select **Hardware Error Log** or **Software Error Log** from the Service Main Menu and press the Menu Select button.
3. Press the Menu Select button again to print, export, or clear the log.

Software Error Log

The Software Error Log is used by the Philips Healthcare software development team. There are no field service actions related to the Software Error Log messages, but the Response Center may ask you to provide the Software Error Log content if you call for help. Figure 28 shows the layout of the Software Error Log.

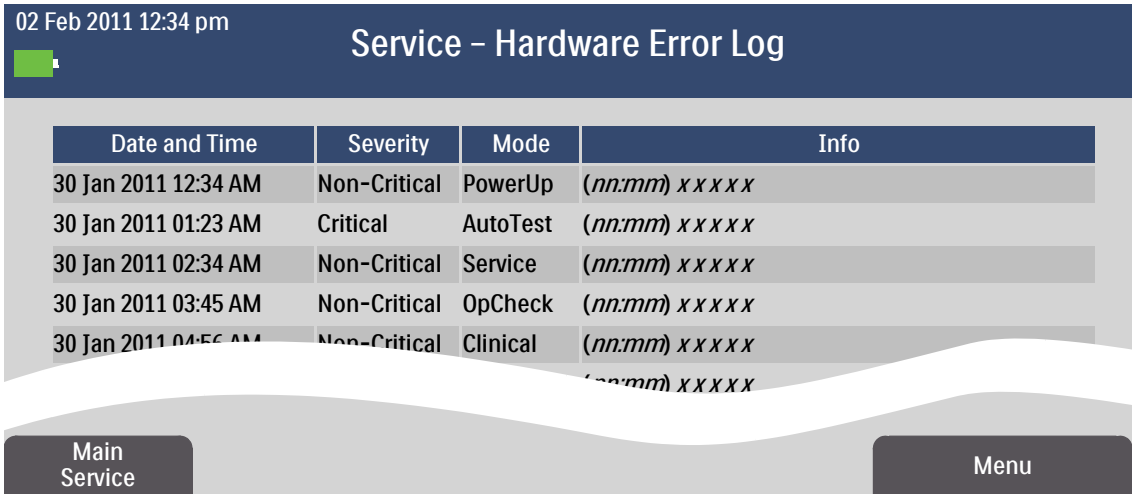
Figure 28 **Software Error Log Screen**



Hardware Error Log

Figure 29 shows the layout of the Hardware Error Log.

Figure 29 **Hardware Error Log Screen**



The Info column of the Hardware Error Log contains unique numeric IDs of the messages. The numeric ID has a format of (***nn:mm***), where ***nn*** is the group code, and ***mm*** is the message number within the group. Some numeric IDs of the Therapy group have a (7:***mm:ll***) format. Some of the Hardware Error Log messages along with their possible causes and suggested solutions are listed in the corresponding subsections of the "Components Troubleshooting" section. Table 9 lists the groups of the Hardware Error Log messages and pointers to the troubleshooting table for that section.

Table 9 **Hardware Error Log Message Groups**

Group ID	Group Name	See Subsection
(1:***mm***)	General System	Table 15 "General Problem Diagnostic with the Hardware Error Log" on page 53
(2:***mm***) (3:***mm***) (4:***mm***)	Therapy Switch Charge Shock	"Controls Problems" on page 62
(5:***mm***)	Audio	"Audio Problems" on page 65
(6:***mm***)	Sync	"Controls Problems" on page 62
(7:***mm***) or (7:***mm:ll***)	Therapy	Table 21 "Defibrillation Diagnostic with the Hardware Error Log" on page 58
(8:***mm***)	reserved	
(9:***mm***) (10:***mm***)	Lead ECG Pads ECG	Table 18 "ECG Diagnostic with the Hardware Error Log" on page 55
(11:***mm***)	Battery	Table 11 "Battery Diagnostic with the Hardware Error Log" on page 49
(12:***mm***)	SpO_2	"SpO2 Monitoring Problems" on page 59
(13:***mm***)	NBP	"NBP Monitoring Problems" on page 61
(14:***mm***)	Printer	Table 29 "Printer Diagnostic with the Hardware Error Log" on page 65
(15:***mm***)	Startup	"Startup Messages" on page 51
(16:***mm***)	CO_2	"CO2 Monitoring Problems" on page 60

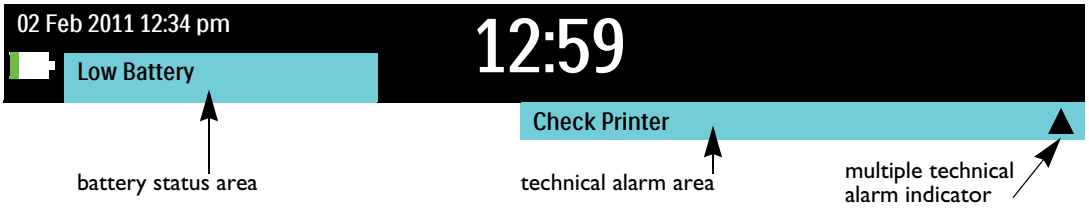
Troubleshooting Process

Use the process described here to isolate problems and repair your HeartStart XL+.

To troubleshoot HeartStart XL+:

1. Decontaminate the device using your local decontamination guidelines.
2. Check the Ready for Use (RFU) indicator. See "Ready For Use Indicator" on page 30.
3. Perform a visual inspection.
   Thoroughly examine the device and its cables and accessories. Refer to "Visual Inspection" on page 160. If no further troubleshooting is needed, proceed to Step 12 to repair the device.
4. Turn the Therapy Knob to **Monitor**.
   Failures and messages appear on the display when you turn on the defibrillator/monitor. Technical Alarms appear on cyan background below the status area, see Figure 30. If multiple Technical Alarms of the same priority are present, then they alternate, and a ▲ symbol appears on in the Technical Alarm text box.

   Figure 30 **Technical Alarm Sample**



5. Run the Operational Check (Op Check).
   The Op Check tests the functionality of all PCAs and modules of the device. E.g., if the device is equipped with the NBP option, the Op Check performs a self-test on the NBP module and reflects the results both on the screen and on the printed report. The Op Check results indicate the problems areas of the device. See "Operational Check" on page 33 for detailed instructions.
6. Check the Hardware error log.
   Save the Hardware and Software error logs content in case you call the Response Center. See "Error Log Messages" on page 41 for more information.
7. Use the Troubleshooting tables to identify the problem.
   Use the "Components Troubleshooting" on page 46 to find information on messages and common troubleshooting issues. If several solutions are offered for your problem, *always* try the solutions in the order they are listed, and apply the next solution only if the previous solutions did not fix the problem. If no further troubleshooting is needed, proceed to Step 12 to repair the device.
8. Interview the user. Gather the external components.
   If possible, talk directly with the user who reported the problem. Identify what they were doing when the problem occurred, and exactly what happened. What was on the display? Were any sounds noticed? Were there operational problems?
   If possible, obtain the cables, paddles, battery, etc., that were in use when the problem occurred and use them in your evaluation. If no further troubleshooting is needed, proceed to Step 12 to repair the device. Otherwise, continue with Step 9.
9. Try to reproduce the problem.
   Use the Troubleshooting tables to identify the symptoms and possible solutions, then proceed to Step 12. If the problem cannot be reproduced, an intermittent condition or operator error is likely.

10 Examine the device's repair history.

Some intermittent problems cannot be reproduced. If the device was returned before for the same problem, replace the most likely subassembly.

11 Run the Service Mode tests, if needed.

Use the tests available in Service Mode to focus in on possible causes. See "Service Mode Tests" on page 40 for more information.

12 Repair any problems found.

Follow the procedures in the "Repair" chapter to replace defective parts or subassemblies. When the repair is complete, continue with Step 13.

13 Verify the device's performance.

Use the procedures described in the "Performance Verification" chapter to verify that the device is operating properly. Be sure the testing you perform is appropriate for the level of repair. The requirements for testing are described in "Required Testing Levels" on page 155.

Troubleshooting Flowcharts

Figure 31 and Figure 32 show the troubleshooting steps for different states of the RFU Indicator.

Figure 31 **RFU Indicator: Hourglass**

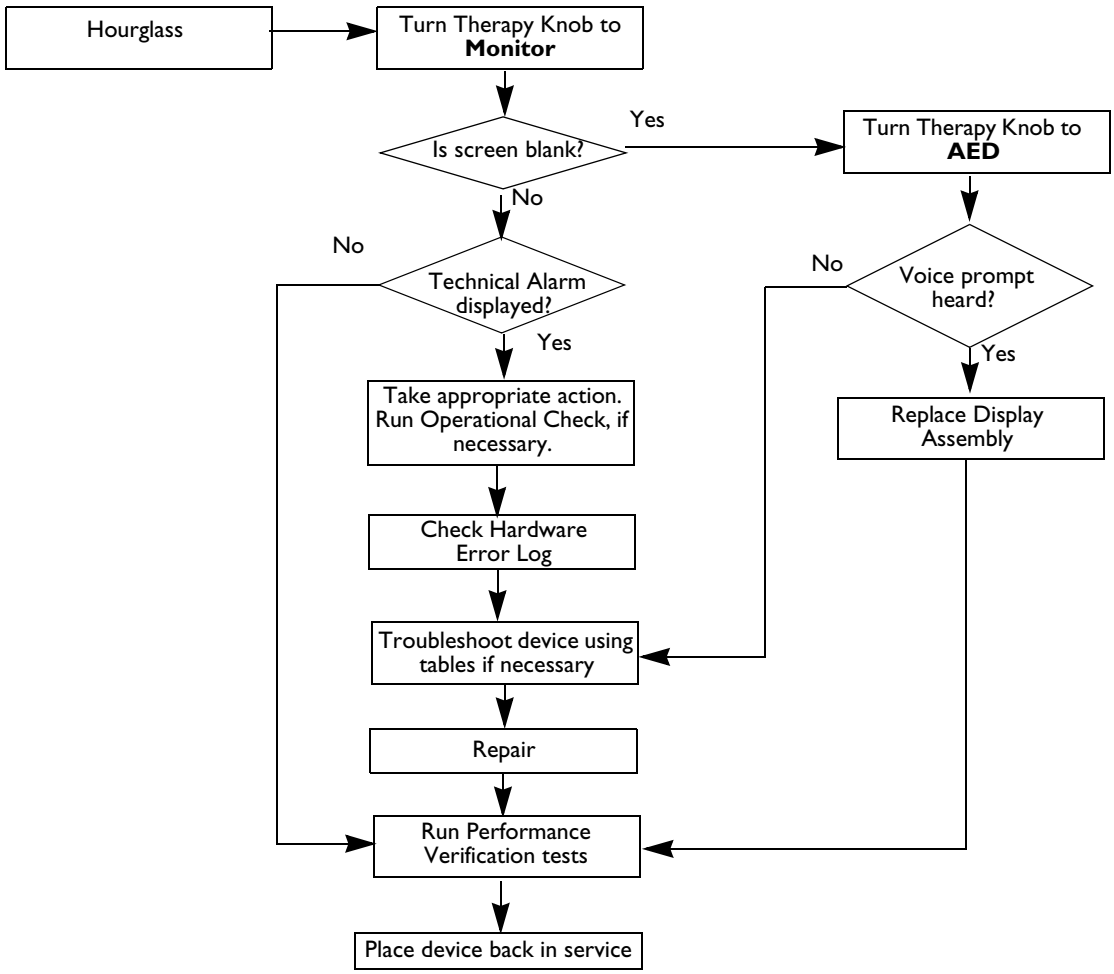
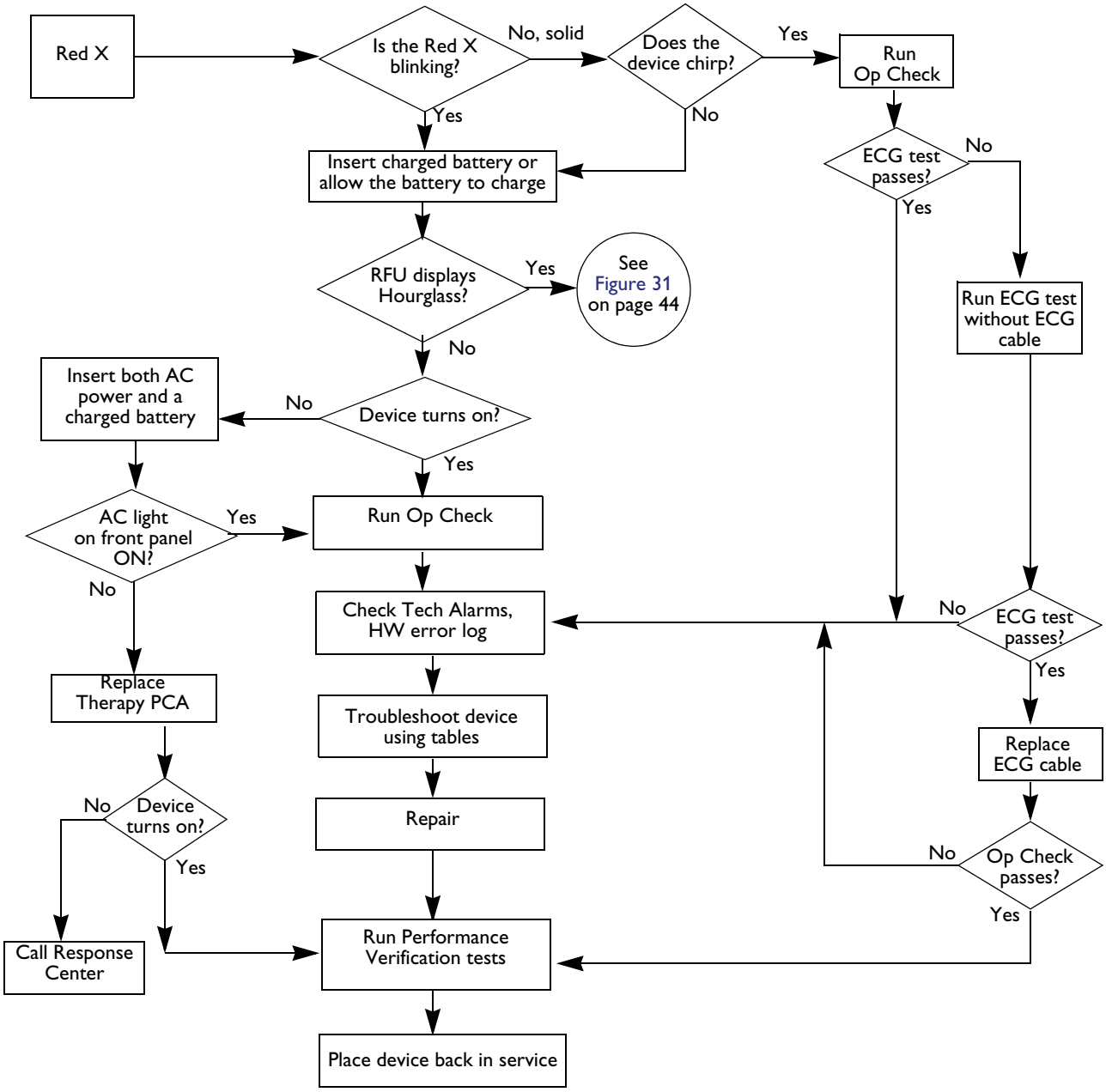


Figure 32 **RFU Indicator: Red X**



Components Troubleshooting

The Troubleshooting tables provide information on messages and common troubleshooting issues.

NOTE: Before replacing any components, *always* run an Operational Check and check the Error Logs for messages. Before replacing any parts, check to see if all the cables and flex circuits are properly connected See "Repair Notes" on page 96.
If several solutions are offered for your problem, *always* try the solutions in the order they are listed, and apply the next solution only if the previous solutions did not fix the problem.

This section is organized into the following subsections:

Power and Battery

The HeartStart XL+ lithium-ion battery provides the power necessary to operate your HeartStart XL+ monitor/defibrillator. Proper battery maintenance described in the "Battery Maintenance" section of *HeartStart XL+ Instructions for Use* and HeartStart XL+ *Lithium-Ion Battery Characteristics and Care* Application Note ensures your HeartStart XL+'s readiness and uninterrupted power supply.

Faulty Batteries

CAUTION: A HeartStart XL+ battery that cannot pass calibration is a faulty battery and cannot serve as a reliable power source for the HeartStart XL+'s clinical purposes. A battery that can deliver power may still be faulty. Do not use faulty batteries for any purposes.
If a faulty battery is connected to the device along with AC power source, the faulty battery may not be revealed until the device attempts and fails to draw power from the battery.

Recycle or discard faulty batteries according to local regulations.

Battery Testing and Troubleshooting

A HeartStart XL+ battery is suspect if you do not know when it was last checked.

To test a suspect battery:

1. Check the battery's fuel gauge.
2. If fewer than two battery fuel gauge LEDs are on, then partially recharge the battery:
   a. Insert the suspect battery into the HeartStart XL+.
   b. Connect the HeartStart XL+ to an AC power source.
   c. On the HeartStart XL+, make sure the green AC Power indicator is on and the battery charging indicator is flashing.
   d. Turn off the HeartStart XL+ and charge for 20 minutes.
3. Remove AC power and turn the HeartStart XL+ on.
   If the HeartStart XL+ shuts down immediately or does not turn on, then the battery is faulty.
4. Attempt a shock using the Defibrillator Test Plug (Select the 150 J energy, charge, and shock).
   If the HeartStart XL+ shuts down or restarts, then the battery is faulty.
5. Test the battery fuel gauge.
   If at least one battery fuel gauge LED lights steady, then charge and use the battery as needed; calibrate as soon as possible. Otherwise the battery is faulty.

Sometimes improper wiring inside the HeartStart XL+ box may cause a battery connection problem. If you suspect a battery connection problem, inspect the battery connector in the battery compartment. The pins must be clean and not bent, and the connector should sit comfortably in the opening and "float" slightly when pressed sideways. If the connector is skewed to one side of the opening and does not float, then check for pinched wires inside the Rear Case. See "Opening the Case" on page 87 and "Closing the Case" on page 151.

Table 10 and Figure 33 on page 49 discuss the battery problems that can occur. The messages may appear in the Technical Alarm or Battery Status area of the HeartStart XL+ screen, as shown in Figure 30 on page 43.

Table 10 **Battery Troubleshooting**

Symptom	Possible Causes	Possible Solutions
• Battery power indicator displayed in the Battery Status area shows less than 90% capacity. • Fewer than five battery fuel LEDs are on.	The battery charge is low	• Charge the Battery. • Calibrate the Battery. Replace if calibration does not complete successfully.
Battery does not seem to be charging.	AC power is not present	• Check that the AC Power indicator is lit and the Battery Charging indicator is flashing • Replace the AC Mains Assembly • Replace the Power Supply
	Bad electrical contact	Reinsert the Battery. Push until you hear it click into place.
External Power Indicator is off even though the AC power is connected.	No power in the outlet	Check the AC Power outlet
	AC power supply is disrupted	• Replace the AC Mains Assembly • Replace the Power Supply
• Battery fuel gauge LEDs are on, but the device shuts down when powered by the battery alone. • Battery fuel gauge LEDs are off or blinking even after the battery has been charged for several hours. • The General Status area does not recognize the battery (the icon remains )	Faulty Battery	Replace the Battery
	Faulty Therapy PCA	Try the Battery in another device. If there are no problems with the Battery, then replace the Therapy PCA, otherwise replace the Battery.
Replace Battery message*	The Battery has reached end of life.	Discard or recycle the Battery
Switched to Battery message*	Loss of AC power	Acknowledge
Battery Calibration Required alarm *	Calibration required	Calibrate the Battery
Shutting Down in 1 min or **Shutting Down Now** message* in the Battery Status area	Low Battery	Charge the Battery
Fail/BF Automated Test Summary result		
Battery Communication Failure message	Communication between the device and the battery fails	• Replace the Battery • Replace the Battery PCA • Replace the Therapy PCA
Equipment Disabled: System Failure message	Out-of-range voltage detected	• Replace the Battery • Replace the Power Supply module
Power Equipment Malfunction message		• Replace the Battery • Replace the Power Supply module • Replace the Clock Battery • Replace the Processor PCA
Power Test Failure message	The Battery cannot charge the Capacitor	Replace the Battery

* In your local language

Figure 33 **Power and Battery Troubleshooting Flowchart**

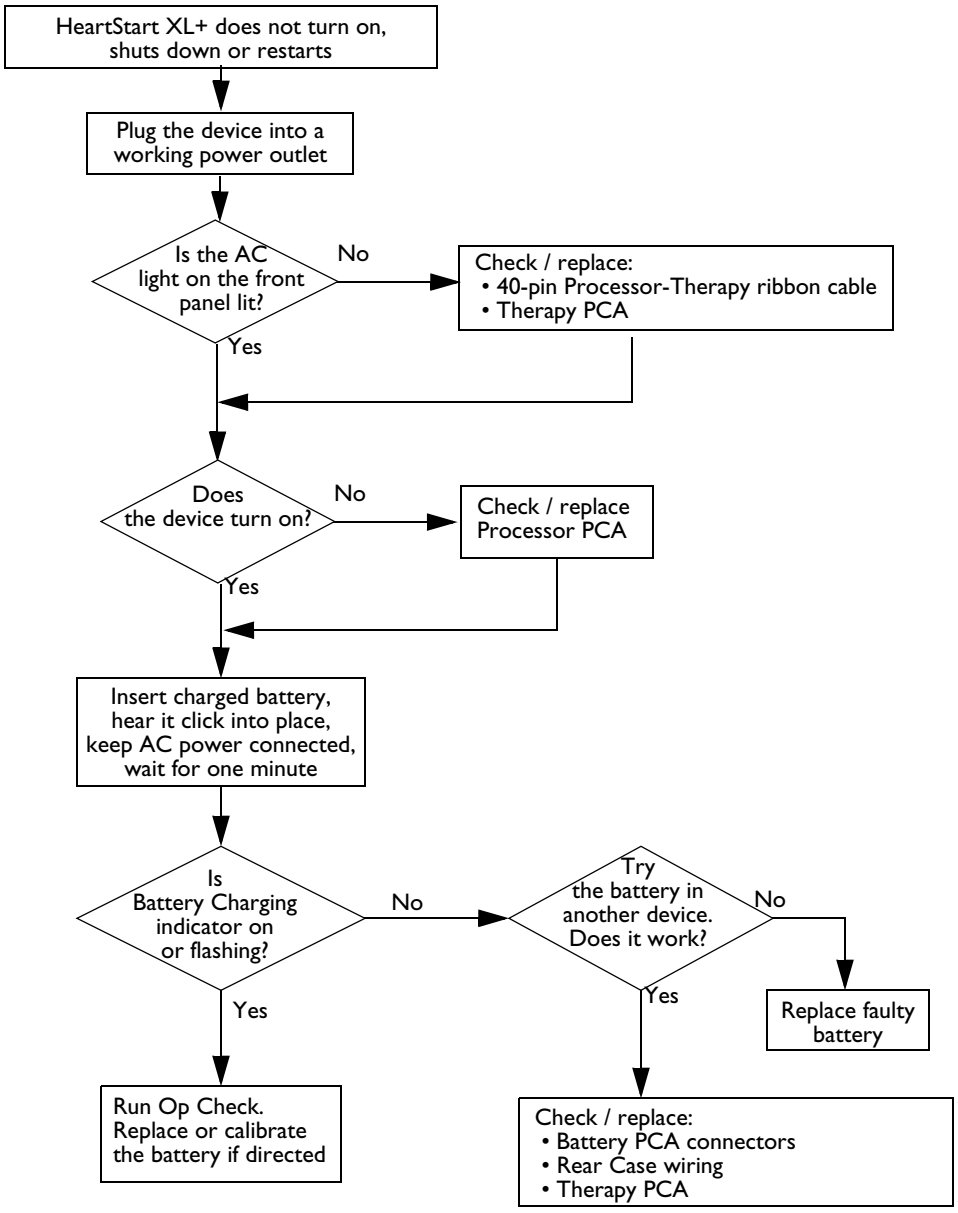


Table 11 **Battery Diagnostic with the Hardware Error Log**

Numeric ID	Info String	Possible Cause	Suggested Actions
(11:1)	RFU Test Timed Out	Test is not completed in time.	Run Op Check
(11:2)	No status received from battery	Battery communication failure	Replace Battery
(11:3)	Battery is not working	Battery low	Charge Battery
(11:4)	Battery is at end of life	Battery is no longer usable	Replace Battery
(11:5)	Battery requires calibration	Battery requires calibration	Calibrate Battery
(11:6)	Battery low	Battery low	Charge Battery
(7:37)	Battery Test Failure	SOM PCA failure during Battery test	Replace Processor PCA

Audio Tones

The HeartStart XL+ emits tones to alert you to its status. The sound pressure range is based on measurements taken 1 meter from the front of the device at its vertical center and horizontally in front of the speaker. The sound pressure measured according to IEC 60601-1-8 ranges between 45 dB at the Very Soft and 85 dB at Very Loud settings.

Table 12 **Audio Tones**

Tone Group	Tone	Description	Indication
Information Tones	Message Tone	Single 0.5 sec 2000 Hz beep	Accompanies a new message on the display.
	"Charging" Tone	Continuous 1333 Hz tone	Generated when the Charge button is pressed and continues until the device is fully charged.
	"Charged" Tone	Continuous 2042 Hz tone	Generated when the selected defibrillation energy is reached and continues until the Shock button is pressed, the Disarm soft key is pressed, or the device disarms automatically.
	Periodic Chirp	Short chirp every 30 seconds	Low battery or RFU failure. Repeated periodically while the condition exists.
	QRS Tone	Short 667 Hz beep	Sounds synchronously with each heart beat.
Alarm Tones	Imminent Shutdown	Continuous tone alternating between 1000 and 2100 Hz.	Device will shut down in one minute.
	High Priority Alarm	A 960 Hz tone repeated every second	Generated while at least one high priority alarm is occurring.
	Medium Priority Alarm	A 480 Hz tone repeated every 2 seconds	Generated while at least one medium priority alarm and no high priority alarm is occurring.
	Low Priority Alarm	A short 480 Hz tone repeated every 2 seconds	Generated while at least one low priority alarm and no high or medium priority alarm is occurring.
Philips' Technical Alarm Tone		Cyan indicator message for low priority Technical Alarm	Repeats every two seconds, lower pitch then yellow alarm tone. Generated while at least one Technical Alarm condition is occurring.
IEC Technical Alarm Tone			Generated while at least one Technical Alarm condition is occurring. Lower pitched tone is repeated twice, followed by a pause.
Voice Prompts		N/A	N/A

Startup Messages

Table 13 lists the messages that can occur at startup or Operational Check.

Table 13 **Startup Messages**

Message	Possible Causes	Suggested Solution
Critical Device Failure Detected. Service Required	Critical failure. The device cannot deliver therapy; service immediately.	• Acknowledge • Run an Op Check • Check the HW Error Log and troubleshoot accordingly
Critical Component Test Failure		
Clinical Mode Not Available due to Equipment Malfunction. Service Required		
AutoTest Failure		
Non-critical Device Failure Detected. Service Required	Non-critical failure. The device can deliver therapy; service at a nearest opportunity.	
Non-Critical Component Test Failure		
• Equipment Disabled: Therapy • Equipment Disabled: System Failure • Power Test Failure	• Hardware failure	
Power Equipment Malfunction	Power Supply or Battery failure	Troubleshoot power and battery, see "Power and Battery" on page 46.
Replace Battery	Battery failure	
Configuration Error. All Settings Reset to Factory Default Values	Attempt to import an invalid Configuration	Reconfigure the device to the user's settings. See the *Instructions for Use* for details.
All Settings Reset To Default Values		
Previous Event Data Record Has Been Closed	An error caused the device to restart	Troubleshoot the device
• Therapy Knob Failure • Therapy Knob Timing Error	Therapy Knob failure during Op Check	• Make sure the Knob was positioned at 170 J and 150 J as directed. • Replace the Therapy Knob • Replace the Therapy Switch
(15:1) RFU Test Deadline Failure - current time *xx* later than deadline time *xx* error log message	RFU Test is not completed in time	Run Op Check
(15:2) RFU Test Deadline Failure - unable to get valid current time error log message	RFU Test failure	• Restart the device (turn off, wait 10 s., turn on) • Replace Processor PCA
(15:3-6) RFU Test Deadline Failure... error log message		• Restart the device (turn off, wait 10 s., turn on) • Replace Processor PCA
(15:7) AutoTest started but failed to complete error log message		• Run Op Check • Replace Processor PCA
System Failure: Service Required tech. alarm	Device option(s) installed improperly.	• Run Op Check to find the failing option(s). • Recheck and re-enter the options key.

General Problems

Table 14 discusses general problems that can occur. Table 15 discusses the Hardware Error Log entries related to the general problems.

Table 14 **General Monitoring Problems**

Symptom	Possible Causes	Suggested Solution
Replace Clock Battery tech. alarm	The clock battery on the Processor PCA failure	Replace clock battery on the Processor PCA.
One or more buttons (**Charge**, **Shock**, **Sync**) do not respond.	Bad connection between buttons and detection circuits	Run Controls Test in Service Mode to confirm. Check connections between HIF PCA and Processor PCA.
	Failure in detection or processing	• Replace Processor PCA. • Replace Processor PCA.
	Failure in keys	Replace HIF PCA.
One or more controls do not respond (e.g., select lead or soft keys).	Bad connection between keys and detection circuits	Run Controls Test in Service Mode to confirm. Check connections between Display Assembly and Processor PCA.
	Failure in keypress detection or processing	• Replace Processor PCA. • Replace Processor PCA.
	Failure in keys	Replace Display Assembly.
Device starts up at the Service Mode password entry screen. The Therapy Knob turns beyond the 200 or Pacer position.	Missing or misplaced stop screw under the Therapy Knob	Make sure the stop-screw is in the left most position (no Pacing) or in the second position from the left (Pacing option installed).
	Broken Therapy Knob	Replace Therapy Knob.
Device Temp High tech. alarm	The internal device temperature is over 65°C (150°F)	If you continue to use the device, it may become inoperable. Let the device cool when possible.
		Run Fan Test, replace fans as needed.
Autotest Failure tech. alarm	A critical failure. Device restarts.	Follow the "Troubleshooting Process" on page 43. If unable to resolve, and the problem persists, save the Op Check Report and Error Logs contents and report to the Support Center, see "Calling for Service" on page 68.
Device Restarted Due to Error tech. alarm		
Device Management Error tech. alarm		
ECG Error tech. alarm		
Equipment Malfunction tech. alarms		
System Failure tech. alarm		
Therapy Controller Error tech. alarm		
User Interface Error tech. alarm		

Table 15 **General Problem Diagnostic with the Hardware Error Log**

Numeric ID	Info String	Possible Cause	Suggested Solutions
(1:1)	RFU Test Timed Out	Test is not completed in time.	• Reinstall software • Replace Processor PCA • Replace Therapy PCA
(1:2)	Invalid ADC Data: xx	Voltage is not reported within specified time	• Reinstall software • Replace Processor PCA
(1:3-9)	nn.n V processor supply out of range, Value = mm.m	Voltage value out of range	Replace Processor PCA
(1:10)	RTC Battery voltage out of range, Value = mm.m	Clock Battery voltage value out of range	• Replace Clock Battery • Replace Processor PCA
(1:11)	Switched supply out of range, Value = mm.m	Switched voltage value out of range	Replace Therapy PCA
(1:12)	Switched supply low on battery power, possible battery failure, Value = mm.m		• Replace Battery • Replace Therapy PCA
(1:13-17)	nn.n V therapy supply out of range, Value = mm.m	Voltage value out of range	Replace Therapy PCA
(1:18)	Serial Number Check Failed	Invalid serial number	Reenter Serial Number
(1:19)	File System Check Failed	File System is corrupted	Replace Processor PCA
(1:20)	Localization Checksum Failure	Invalid localization data	• Reinstall software • Replace Processor PCA
(1:21)	Fan Failure - Fan x	Fan 1 failure	Replace Fan connected to Therapy PCA at J13
		Fan 2 failure	Replace Fan connected to Therapy PCA at J12
(1:22)	Software Image Check Failed	Invalid software	• Reinstall software • Replace Processor PCA
(1:24)	RFU Status Redundancy Failure	RFU status mismatch	Run Op Check
(1:25)	Backlight Fault Check Failed	Backlight failure	• Replace Inverter PCA • Replace Display Assembly
(1:26)	Localization Initialization Failure	Invalid localization data	• Upgrade software • Replace Processor PCA
(1:30-39)	Power MCU or Therapy MCU problems	Software is corrupted	• Reinstall software • Replace Therapy PCA
(1:40, 41)	Watchdog problems		Reinstall software
(1:42-48)	Initialization failures		Replace Processor PCA
(1:49)	Device Options Corrupted		
(1:50-60)	various		• Run Op Check • Reinstall software

Pacing Problems

Table 16 **Pacing Problems**

Symptom	Possible Cause	Suggested Solution
Does not deliver correct current into pacer tester or delivers no current at all	Therapy PCA failure	• Run Op Check • Inspect the Hardware Error Log • Replace Therapy PCA
Equipment Disabled: Therapy message		
Pacing Stopped. Device Error message	Pacer hardware failure	

ECG Monitoring Problems

TIP: When troubleshooting problems with paddles or pads, try replacing the paddles or pads first. When troubleshooting ECG problems, try replacing the ECG cable first.

Table 17 **ECG Monitoring Problems**

Symptom	Possible Causes	Suggested Solution
Flat line – no waveform, no Leads Off, or Pads Off, or Paddles Off message	Short in ECG cable or leads	• Replace ECG cable • Replace Measurement Module Panel
	Short in Therapy Cable	• Replace Therapy Cable • Replace Therapy Port
	Processor PCA failure (if using ECG Leads)	Replace Processor PCA
	Therapy PCA failure (if using Pads)	Replace Therapy PCA
Poor ECG signal quality – (noisy trace, wandering baseline, etc.) from signal acquired from monitoring electrodes.	Poor skin preparation or electrode contact	Ensure that the user is properly connecting electrodes and preparing patient's skin
	Radio frequency interference (RFI) is causing artefact	Relocate or turn off equipment that may be causing RFI
	Defective ECG cable or leads	Replace ECG cable and leads
Equipment Malfunction: ECG message	ECG cable or leads failure	Replace ECG cable and leads
	Internal cables failure	Replace ECG Port
	Processor PCA failure	Replace Processor PCA
Equipment Malfunction: Pads ECG message	Bad connection from Therapy Port to Therapy PCA	Replace Therapy Cable
	Therapy Port failure	Replace Therapy Port
	Therapy PCA failure	Replace Therapy PCA
Leads Off / Pads Off / Paddles Off message even though ECG cable and leads are properly connected. Cannot Analyze ECG message	Poor skin preparation or electrode contact	Ensure that the user is properly connecting electrodes and preparing patient's skin
	Excessive motion artifact	Ensure that the user reduces patient movement
Pads/Paddles Type Undetermined message	Wrong pads or paddles type	Use only Philips-approved pads or paddles
	Pads or paddles failure	Replace pads or paddles

In Table 18 "ECG Diagnostic with the Hardware Error Log", the Numeric IDs of the (9:*nn*) format indicate problems with Leads ECG, and the ones of the (10:*nn*) format indicate problems with Pads ECG.

Table 18 **ECG Diagnostic with the Hardware Error Log**

Numeric ID	Error Log Message	Possible Cause	Suggested Action
(9:1) (10:1)	RFU Test Timed Out	ECG test is not completed in time	Run Op Check
(9:2) (10:2)	Comm Failure: *nn*	Communication failure	Replace Processor PCA
(9:3) (10:3)	DSP File CRC Check Failure - *xxx*		• Reinstall software • Replace Processor PCA
(9:4) (10:4)	Communications Failure: Test Timeout		
(9:5) (10:5)	DSP POST missing at start of test	Self-test result is not received	
(9:6-8, 20) (10:6-8)	Bad number of channels from DSP: *xxx*	Leads / Pads calibration failure	
(9:9) (10:9)	DSP POST failure, test data unavailable	Leads / Pads test failure	
(9:10), (10:10)	Bad IDS revision from DSP. *xxx*		
(9:11)	ECG Leads Calibration Fail	ECG Leads gain failure	Replace Processor PCA
(9:12)	ECG Leads PLL Time Fail	ECG Leads clock failure	
(9:13)	ECG Leads Reference Error	ECG Leads reference error	
(9:14)	ECG Failure - Lead: *n*, Type: Gain, *xxx*	ECG Leads failure	
(9:15)	ECG Failure - Lead: *n*, Type: Noise, *xxx*		
(9:16)	ECG Failure - Lead: *n*, Type: Bias *xxx*	ECG Leads failure	• Replace leads cable • Replace Therapy Port • Replace Processor PCA
(9:21)	Leads Off ECG Common Leakage Current: *nn*	Op Check performed without ECG cable	Run Op Check with ECG cable
(9:22)	ECG Failure - Lead: <*reason*> ECG Common Leakage Current: *nn*		
(9:23)	ECG Failure - Lead: <*reason*>		
(9:24)	ECG Leads Test Rerun Skipped by User		
(10:11)	ECG Pads Calibration Fail	ECG Pads gain failure	Replace Therapy PCA
(10:12)	ECG Pads PLL Time Fail	ECG Pads clock failure	
(10:13)	ECG Pads Reference Error	ECG Pads reference error	
(10:14)	ECG Failure - Pad: n, Type: Gain, *xxx*	ECG Pads failure	
(10:15)	ECG Failure - Pad: n, Type: Noise, *xxx*		
(10:16)	ECG Failure - Pad: n, Type: Bias xxx	ECG Pads failure	• Replace Therapy cable • Replace Therapy Port • Replace Therapy PCA
(10:20)	Pads Common Mode Impedance:	Processor PCA failure	Replace Processor PCA
(10:21)	Pads PCI Impedance Failure: xx		
(10:22)	Cannot run ECG tests with internal paddles	ECG test failure	Run Op Check
(10:23-26)	Pads/Paddles Current Source...		Replace Therapy PCA

Defibrillation Problems

Table 19 **Defibrillation Charging Problems**

Symptom	Possible Cause	Suggested Solution
Charge Button Failure Op Check message	During Op Check, the user pressed the No Button Response menu instead of the Charge button	• Run Op Check and be sure to press the Charge button • Run Controls test to confirm • Check buttons for mechanical operation • Replace HIF PCA
Does not charge in Manual Defib Mode using Charge button on paddles	Paddles not connected properly	Check/restore connection
	Paddles failure	• Confirm paddles problem by connecting Pads and attempting to charge device using Charge button on the HeartStart XL+ • Replace paddles if needed
	Problem with internal connections	Check/restore connections between Therapy port and Therapy PCA, and between Therapy PCA and Processor PCA
	Therapy Port failure	Replace Therapy Port
	Processor PCA failure	Replace Processor PCA
Does not charge in Manual Defib Mode using Charge button on HeartStart XL+	Therapy cable failure	Replace Therapy cable
	Front panel button failure	Run Controls Test in Service Mode to confirm, replace Front Case if needed
	Therapy PCA failure	Replace Therapy PCA
	Processor PCA failure	Replace Processor PCA
Does not charge in AED Mode, but charges in Manual Defib Mode	Shock not advised	Make sure ECG wave is displayed and shock is advised
	Pads ECG front end failure	Replace Therapy PCA
	Processor PCA failure	Replace Processor PCA
Does not charge to energy setting on Therapy switch	Therapy Knob has been replaced and installed incorrectly	• Confirm by rotating Therapy Knob back and forth to check travel and alignment • Run Controls test in Service Mode to test Therapy Knob. Reinstall Therapy Knob, if necessary
	Therapy Switch failure	Replace Therapy Switch
The Capacitor charges too slowly	The device is being operated with AC power (no battery) or the battery power is low	Install a fully charged battery
	Battery not fully charged, or defective	
	Therapy PCA defective	Replace Therapy PCA
Equipment Malfunction: Shock and Pacing message	• Unable to charge to selected energy • Unable to determine energy	• Run Op Check • Check Hardware Error Log • Replace Therapy PCA

Table 20 **Defibrillation Discharging Problems**

Symptom	Possible Cause	Suggested Solution
Shock Button Failure Op Check message	During Op Check the No Button Response menu pressed instead of the Shock button	• Run Op Check and be sure to press the Shock button • Run Controls Test to confirm • Check buttons for mechanical operation
	During Op Check the device disarmed before the user pressed the Shock button	
Does not shock in Manual Defib mode using Shock buttons on paddles	Paddles failure	Confirm paddles problem by connecting Pads and attempting to discharge device using Shock button on the HeartStart XL+. Replace paddles if needed.
	Therapy Port defective	Replace Therapy Port
	Processor PCA failure	Replace Processor PCA
Does not shock in Manual Defib or AED mode using Shock button on HeartStart XL+	Front panel button failure	Run Controls Test to see if the button is operating. Replace HIF PCA if needed.
	HIF PCA failure	Replace HIF PCA
• Does not deliver correct energy into defibrillator analyzer or delivers no energy at all. • Abnormal Shock Dose Delivered message	Therapy PCA failure	Replace Therapy PCA
Charges OK, but aborts the shock when press Shock or paddle buttons	Patient impedance sensed as too high or too low during energy delivery due to: • Pads/paddles losing contact with patient • Pads/paddles failure • Therapy cable failure	• Press the paddles firmly and check the PCI LEDs • Replace paddles, pads, or therapy cable, as needed
	Therapy PCA failure	Replace Therapy PCA
Charges OK, but disarms spontaneously	Device sensed Pads Off or Cable Off due to pads losing contact with patient	• Observe screen messages • Make sure loss of contact is not due to patient movement
	Pads / cable failure	Replace pads or pads cable
	Therapy PCA failure	Replace Therapy PCA
	Processor PCA failure	Replace Processor PCA
Disarm Failure message	Internal Resistors failure	Replace Internal Resistors
	Therapy PCA failure	Replace Therapy PCA
Paddles Power Overload message	An overload is detected in the paddles circuitry	• Replace paddles • Replace Therapy Port • Replace Processor PCA

Table 21 **Defibrillation Diagnostic with the Hardware Error Log**

Numeric ID	Error Log Message	Possible Cause	Suggested Solution
(7:0)	Therapy RFU Test Passed	Test passed after a failure	None, not an error
(7:1)	RFU Test Timed Out	Test is not completed in time	Run Op Check and be sure to press the **Charge** button
(7:2)	Therapy MCU Msg *xxx* Arrived Late		
(7:3)	Therapy MCU Msg *xxx* Checksum Error	Data transmission error	• Reinstall software • Replace Processor PCA
(7:4)	Therapy MCU Failed to Respond to Reset	Therapy PCA failure	• Replace Therapy PCA • Replace Processor PCA
(7:5)	Therapy MCU Msg *xxx* Timed Out	Test is not completed in time	Run Op Check and be sure to press the **Charge** button
(7:6)	Therapy MCU Error during Receiving Data	Data transmission error	• Run Op Check • Replace Therapy PCA
(7:7)	Therapy MCU: Protocol Mismatch (Host=*xxx*, MCU=*xxx*)	Software versions mismatch	Reinstall software
(7:8)	Therapy MCU: Fail to transmit xxx	Software failure	
(7:9)	Therapy MCU: Failed to enter CPLD programming state	Therapy PCA failure	Replace Therapy PCA
(7:10)	Therapy MCU: Flash Programming Failed		
(7:11:xxx)	Therapy MCU: *xxx nn*		• Run Op Check • Replace Therapy PCA
(7:12)	Therapy MCU Flash Upgrade File contained no program data	Corrupted software upgrade file	Reinstall software
(7:13)	Therapy MCU Flash Upgrade File invalid		
(7:14)	Defib Test | not run: *xxx*	Therapy Cable or connection failure	• Run Op Check • Replace Therapy Cable • Replace Therapy Port • Replace Processor PCA • Replace Therapy PCA
(7:15-17)	Therapy MCU: *xxx*	Therapy PCA software upgrade failure	• Reinstall software • Replace Therapy PCA
(7:19)	Patient Safety Relay test failed	Therapy PCA failure	Replace Therapy PCA
(7:20)	Battery brown-out test failed	Battery failure	Replace the Battery
(7:21-24)	Power MCU failed to *xxx*	Therapy PCA failure	Replace Therapy PCA
(7:25)	Therapy MCU: Failed to charge to *nn* J		
(7:26)	Failed to load therapy CPLD program data		
(7:27)	Not Run, Therapy MCU Error		• Run Op Check • Replace Test Plug/Load • Replace Therapy Cable • Replace Therapy Port • Replace Therapy PCA
(7:28:1)	Op Check Shock test aborted	Shock test failed	
(7:28:2)	Therapy MCU: Failed to charge for Op Check	Failure to reach the requested charge level in time	
(7:28:3)	Final Capacitor Voltage after Op Check Shock High	Failure to fully discharge	Replace Therapy PCA
(7:28:4)	Op Check Shock Impedance Out Of Range	Shock test failed	• Run Op Check • Replace Test Plug/Load • Replace Therapy Cable • Replace Therapy Port • Replace Therapy PCA
(7:29:nn)	Therapy ADC Test: *xxx*	Therapy PCA failure	Replace Therapy PCA
(7:30:nn)	LV Inhibit Test: *xxx*		
(7:31:1-23)	HV Inhibit Test: *xxx*		

Table 21 **Defibrillation Diagnostic with the Hardware Error Log *(Continued)***

Numeric ID	Error Log Message	Possible Cause	Suggested Solution
(7:31:24)	HV Inhibit Test: leakage value HIGH	Failure to fully discharge	• Replace Ther. Capacitor • Replace Therapy PCA
(7:31:25)	Final Capacitor Voltage after HV Inhibit RFU High		Replace Therapy PCA
(7:32:nn)	RFU Shock *xxx*	Autotest failed	
(7:34:10)	Pacer RFU: HV Capacitor Energy LOW		Replace Therapy Capacitor
(7:34:nn)	Pacer RFU xxx		Replace Therapy PCA
(7:35)	Defib Sequence Failure	Therapy test failure	• Run Op Check • Re-install Software • Replace Test Plug/Load • Replace Therapy Cable • Replace Therapy Port • Replace Therapy PCA
(7:36)	Proceed Button pressed	"Proceed As Is" soft key pressed during Op Check	Rerun Op Check
(7:37)	Battery Test Failure	SOM PCA failure	Replace Processor PCA
(7:38)	Defib Test Failure		

SpO_2 Monitoring Problems

Table 22 **SpO_2 Monitoring Problems**

Symptom	Possible Causes	Suggested Solution
SpO2 Sensor Malfunction message	SpO_2 sensor or cable failure	• Try another sensor and cable • Replace Measurement Module Panel • Replace SpO_2 PCA
SpO2 Equipment Malfunction message	SpO_2 PCA failure	Replace SpO_2 PCA
SpO2 Interference message	SpO_2 light interference	• Shade the SpO_2 sensor from bright light • Replace the SpO_2 sensor
• No response – no value on screen, no pleth bar. • SpO2 Error message. • The SpO_2 value is obviously wrong. • Noisy/intermittent signal.	Defective SpO_2 sensor or cable	Try another sensor and cable.
	Bad internal connection.	Carefully re-seat the flex circuit between SpO_2 port and SpO_2 PCA. Check that SpO_2 PCA is properly seated on Processor PCA.
	SpO_2 PCA failure	Replace SpO_2 PCA
(12:1) RFU Test Timed Out error log message	Test is not completed in time	Run Op Check
(12:2) SpO2 Communication Failure error log message	SpO_2 communication failure	Replace SpO_2 PCA
(12:3) SpO2 Self Test Failure error log message	SpO_2 self-test failure	
(12:4) SpO2 Malfunction Tech.Alarm reported error log message	SpO_2 PCA failure	

CO_2 Monitoring Problems

Table 23 **CO_2 Monitoring Problems**

Symptom	Possible Causes	Suggested Solution
CO2 Calibration Overdue tech. alarm	Calibration overdue	Perform calibration.
CO2 Check Airway Adapter tech. alarm	• Airway Adapter not installed or dirty • Zero required	• Check the airway adapter and clean or replace as necessary. • Perform an adapter zero. • Replace the sensor if persists.
CO2 Zero Required tech. alarm		
CO2 Out of Range tech. alarm	The calculated value is over the upper limit (99 mmHg).	
CO2 Check Line tech. alarm	Sampling line may be occluded or kinked.	Check the sampling line.
CO2 Communication Failure tech. alarm	Unexpected module behavior	• Unplug sensor from the device for 10 s and reconnect. • Repeat Op Check. • Replace sensor if persists.
CO2 Replace Sensor tech. alarm	Sensor end of useful life	Replace the sensor.
CO2 Sensor Over Temp tech. alarm	The sensor temperature is over 40 °C (104 °F).	• Move sensor away from heat. • Let the sensor cool down. • Replace the sensor if persists.
CO2 Sensor Unplugged tech. alarm	Sensor / sampling line unplugged.	Re-insert sensor / sampling line.
CO2 Tube Unplugged tech. alarm		
CO2 Sensor Warming Up tech. alarm	It may take a few seconds for the sensor to warm up.	Wait until completion.
CO2 Service Required tech. alarm	Hardware Error	• Unplug sensor from the device for 10 s and reconnect. • Replace the sensor if persists.
CO2 Zero In Progress message	The sensor is being zeroed.	Wait until completion.
EtCO2 Error tech. alarm	Unexpected module behavior. Philips asks you to report this unexpected software problem.	1. Disconnect sensor and reboot. 2. Reconnect sensor. 3. Export error logs and report to the Response Center.
(16:2) EtCO2 OpCheck Communications Failure or (16:5) EtCO2 Clinical Communications Failure error log msg	Communications failure. Faulty sensor or connection.	• Check the sensor connection. • Run or rerun Op Check. • Replace the sensor if persists.
(16:3) EtCO2 OpCheck Service Required or (16:4) EtCO2 Clinical Service Required error log message	Service required. Possible sensor's end of useful life.	
(16:6) EtCO2 Power Supply Out of Tolerance error log message	Sensor voltage outside limits	• Replace the sensor. • Replace Proc. PCA if persists.

NBP Monitoring Problems

Table 24 **NBP Monitoring Problems**

Symptom	Possible Causes	Suggested Solution
NBP Calibration Overdue message	The NBP module should be calibrated once a year	Calibrate the NBP module. See "NBP Module Calibration" on page 19.
NBP Measurement Failed message	• Excessive patient movement • Hose or cuff kinked or leak	Ensure the user applies correct procedure
	• Air tube inside the device failure • Defective NBP hardware	• Reconnect the air tube • Replace NBP module
NBP Cuff Overpressure message	External pressure on the cuff during the measurement	Do not touch the cuff during the measurement
NBP Error message	Defective NBP hardware	Replace NBP module if persists
NBP Equipment Malfunction message	NBP Module autotest failure	
NBP Cuff Not Deflated message	NBP cuff blockage	• Check tubes for kinks • Replace NBP cuff
• Measurement cycle does not start. • Pump operates, cuff inflates normally, but does not deflate. • NBP Cuff Not Deflated message	Failure of front panel button	Run Controls test in Service Mode to confirm. Replace Front Case if needed.
	NBP Module failure	Replace NBP Module
	Processor PCA failure	Replace Processor PCA
Reading inaccurate	NBP Module needs calibration	Check accuracy as described in "NBP Module Tests" on page 22. Calibrate if needed.
	NBP Module failure	Replace NBP Module
Liquid inside the tubing	A spill	If the liquid is clean water, and it did not reach the NBP Module, then drain the water and dry the tube. Otherwise replace NBP Module.
(13:1) RFU Test Timed Out error log message	Test is not completed in time	Run Op Check
(13:2) NBP Communication Failure error log message	NBP communication failure	Replace NBP Module
(13:3) Self Test Failure error log message	NBP self-test failure	
(13:4) NBP Equipment Malfunction error log message	NBP Module failure	

Controls Problems

If the controls performance becomes a suspect, run the controls tests as described in "Controls Test" on page 162. Table 25 discusses control problems that can occur.

Table 25 **Controls Problems**

Symptom	Possible Cause	Suggested Solution
Therapy Knob Failure message	During Operational Check, the Therapy Knob was not set to 170 J as directed	• Run an Operational Check setting the Knob to 170 J as directed. • Check the Therapy Knob for mechanical operation. • If the Therapy Knob is not responding, run the Controls Test, if fails replace the Therapy Switch.
One or more of the buttons near the Therapy Knob do not respond correctly	HIF PCA failure	• Run Controls Test to confirm. • Check button pieces for mechanical operation. • Replace HIF PCA.
One or more of the buttons around the display do not respond correctly	Front Case failure	• Run Controls Test to confirm. • Check connections to the Front Case assembly. • Replace the Front Case assembly.
	Processor PCA failure	Replace Processor PCA
The Therapy Switch does not respond correctly	Therapy Knob misaligned	Reseat / replace Therapy Knob
	Therapy Switch failure	Replace Therapy Switch
	Processor PCA failure	Replace Processor PCA
(2:1 / 3:1 / 4:1 / 6:1) Test Time Out error log message	Test is not completed within the specified time	Run Op Check
(2:2) Therapy Knob Test error log message	Control Test failure	• Run Op Check (ensure the Knob is at 170 position) • Replace Therapy PCA • Replace Processor PCA
(2:3) Therapy Knob Energy Selection timing warning error log message	Therapy Switch failure	Replace Therapy Switch
(2:4) Therapy Knob On/Off... error log message		
(3:2) Charge Button Test error log message	Control Test failure	• Run Op Check • Replace HIF PCA
(4:2) Shock Button Test error log message		• Run Op Check • Replace Paddles (if the paddle Shock button fails) • Replace HIF PCA (if the device Shock button fails)
(6:2) Sync Button Test error log message		• Run Op Check • Replace HIF PCA

USB Problems

If necessary, test the USB flash drive as described in "USB Test" on page 165. The USB test is safe for the data on the USB drive.

Table 26 **USB Messages**

Screen Message	Possible Cause	Suggested Solution
Configuration Item Name Setting Not Supported	An imported configuration item is not compatible with the device current software version and is ignored	• Upgrade your HeartStart XL+ software • Ignore the missing item if not applicable
Do Not Remove USB Flash Drive	USB Read or Write operation in progress	Do not touch the USB flash drive or any other controls
Error Reading Configuration Data	A corrupted file or another error prevents reading of the configuration file	• Run the USB Test • Check the USB flash drive content
Insert Compatible USB Device	• No USB device in the drive. • The USB device is not fully inserted. • USB device is not compatible with the HeartStart XL+	Fully insert a standard USB 2.0-compatible flash drive, no more than 32 Gb capacity.
No Configuration Data on USB Flash Drive	Attempt to read configuration data from a USB flash drive, but no configuration data found	• Check the USB flash drive content • Check the product version
No Software Upgrades Available	Attempt to read software upgrades from a USB flash drive, but no software upgrades found	• Check the USB flash drive is inserted • Check the USB flash drive contains a valid software upgrade
USB Error	USB failure	Run the USB Test
USB Flash Drive Error	USB device removed while read or write in progress, or error in data transfer	Repeat the operation
Upgrade Failed, Error *nn*	See "Software Upgrade Errors" on page 14	
USB Flash Drive Full	Not enough memory available on the USB flash drive	Insert a new flash drive or erase data from the flash drive
USB Power Overload	USB power overload is detected	Replace the USB flash drive and restart the device

Display Problems

Run the Display Test (see "Display Test" on page 163) to inspect the screen for defective pixels, random lines or dots, visible permanent patterns, or flickering.

Table 27 **Display Problems**

Symptom	Possible Cause	Suggested Solution
Display is all dark, no response to controls. In Monitor Mode, press the Sync button. Does it light up?	Yes: Failure of backlight Display failure	• Replace Inverter PCA • Replace Display Assembly • Replace Processor PCA • Replace Processor PCA
	No: Device does not turn on	Troubleshoot the device
Display is all light, no response to controls.	• SOM or Processor PCA failure • Display failure	• Replace Processor PCA • Replace Display Assembly
Display unusually dim.	• Backlight Inverter failure • Backlight bulb failure	• Replace Inverter PCA • Replace Display Assembly
Display Test failure in Service Mode (other than the symptoms above)	• SOM or Processor PCA failure • Processor PCA failure	• Replace Display Assembly • Replace Processor PCA

Printing Problems

Table 28 **Printing Problems**

Symptom	Possible Cause	Suggested Solution
Printer Malfunction message	Printer failure, or there is a problem communicating with the printer	If the message repeats, replace the printer assembly
• Printer Out Of Paper message • Paper does not move	Paper improperly loaded or jammed	Reload paper or clear jam
	Printer is out of paper	Replace paper with fresh dry roll
	Paper is wet	
	Printer failure	Replace printer
Paper moves, but printing is faint or absent	Door improperly latched	Check door latch
	Dirty printhead	Clean printhead according to the procedures in the *Instructions for Use*
	Wrong paper	Use Philips-approved paper
	Paper loaded backwards	Check paper position
	Operating temperature is beyond specified range	• Stop printing and allow the printer to cool • Run Fan Test, replace fans as needed • Relocate the device to continue printing
	Printer failure	Replace printer
Paper moves but print quality poor or some dots missing	Dirty printhead	Clean printhead according to the procedures in the *Instructions for Use*
	Printer failure	Replace printer
• Printer Font Unavailable message • Font does not look right	A special font for your language has not been installed on your device. The printer uses the default font.	• Run an Op Check • Reinstall the correct language software
• Printer Door Open message • Loud buzzing or grinding noise	Door improperly latched	Check door latch
Waveforms or text distorted even though they look OK on display	Moisture damage to the paper roll	Replace paper roll
	Printer failure	Replace printer
Black line running along paper	Dots (printhead elements) stuck on due to printer failure	Replace printer
White line running along paper	Dirt on printhead	Clean printhead
	Dots (printhead elements) stuck off due to printer failure	Replace printer
• Printer Error message • Fails Printer Test in Service Mode (other than symptoms above)	Printer failure	Replace printer
	Processor PCA failure	Replace Processor PCA

Table 29 **Printer Diagnostic with the Hardware Error Log**

# ID	Error Log Message	Possible Cause	Suggested Solution
(14:1)	RFU Test Timed Out	Test is not completed in time	Run Op Check
(14:2)	CMx: Printer Comm Error	Printer communication failure	• Replace printer • Replace Printer PCA • Replace Processor PCA
(14:3)	CEx: Printer Command Error	Invalid printer command	• Reinstall software • Replace printer
(14:4)	FAx: Printer Fault Detected	Printer failure	Replace printer
(14:5)	TE1: Printer Temp exceeds threshold	Printer overheated	• Stop printing to allow the printer to cool • Relocate the device to continue printing • Run Fan Test, replace fans as needed
(14:6)	VL1: Printer Voltage Low	Voltage out of the range	• Replace printer • Replace Processor PCA
(14:7)	VH0: Printer Voltage High		
(14:8-13), (14:22)	Various error log messages	Printer hardware failure	
(14:14-21)		Printer software failure	Reinstall software

Audio Problems

Table 30 **Audio Problems**

Symptom	Possible Cause	Suggested Solution
No audio at all	Speaker failure	• Check speaker connections • Replace Speaker Assembly
	Processor PCA failure	Replace Processor PCA
Audio is distorted	• Audio is too loud • Speaker damage or failure • Processor PCA failure	• Reduce the volume • Replace Speaker Assembly • Replace Processor PCA
Buzzing noise when audio active	• Speaker hardware loose • Speaker failure • Processor PCA failure	• Tighten hardware as needed • Replace Speaker Assembly • Replace Processor PCA
Tones present but no voice prompt (in AED Mode)	Software error or failed localization upgrade	Reload the language
	SOM PCA failure	Replace Processor PCA
Audio Failure technical alarm	Audio failure during Op Check	• Repeat the Op Check. Make sure to acknowledge the audio prompt • Replace Speaker Assembly
(5:1) RFU Test Timed Out error log message	Test is not completed in time	Run Op Check
(5:2) Audio Failure error log message	Speaker failure	• Replace Speaker Assembly
(5:3) Audio Init Error log message	Processor PCA failure	• Replace Processor PCA

NOTES

4

Repair

This chapter describes how to repair the HeartStart XL+ defibrillator/monitor. Details are provided on disassembling the device, removing and replacing subassemblies, and reassembling the device.

These instructions are intended for use only by the service providers who are specifically trained to service the HeartStart XL+ defibrillator/monitor.

Overview

This chapter is organized into the following sections:

Who Should Perform Repairs

Only qualified technical personnel who have been trained in the safe and proper servicing of the HeartStart XL+ should open the defibrillator/monitor case, remove and replace components, or make adjustments. If your medical facility does not have qualified technical personnel, contact the Response Center or your local Philips representative.

WARNING: HeartStart XL+ service should only be performed by qualified service personnel, in accordance with this document, the *HeartStart XL+ Service Manual.*

Repair Philosophy

The repair philosophy of the HeartStart XL+ is subassembly replacement.

Examples of subassemblies are the printer, the Processor PCA, and selected connectors and other items. Repairs that involve replacing individual components on a PCA are not supported.

CAUTION: Individual component replacement should not be attempted. Component level repair is not supported due to the extensive use of surface mount technology and the high parts-density on the circuit boards. Unauthorized component replacement can impair performance of the HeartStart XL+ and void the warranty.

Calling for Service

Download the latest documentation from http://www.philips.com/ProductDocs.

Our InCenter, the eSupport solution for Philips Medical Systems customers is located at http://www.healthcare.philips.com/main/support/InCenter/.

For telephone assistance, call the Response Center nearest to you, or visit our web site at: http://www.healthcare.philips.com/main/support/response_center/ or http://www.healthcare.philips.com/main/about/officelocator/.

Table 31 **Response Center Phone Numbers**

North America	Canada		800-323-2280
	United States of America		800-722-9377
Europe	European International Sales		41 22 354 6464
	Austria		01 60 101 820
	Belgium	French Dutch	02 525 68 80 02 525 68 81
	Finland		09-615 80 400
	France		0810 835 624
	Germany		0180 3333 544
	Italy		800 232100
	Luxembourg		+32 2 525 68 80
	Netherlands		040 27 85600
	Portugal		800 201766
	Spain		900 180612; 902 304050
	Sweden		08-59 85 2530
	Switzerland	German French	0800 80 3000 0800 80 3001
	United Kingdom		0870 532 9741
Asia / Pacific	Australia		1800 251 400
	China:	Beijing Hong Kong Macau	800 810 0038 852 2876 7578 0800 923
	India:		18004256788
	Indonesia		021 794 7542
	Japan		0120 381 557
	Korea in Seoul		080 372 7777 02 3445 9010
	Malaysia		1800 866 188
	New Zealand		0800 251 400
	Philippines		02 845 7875
	Singapore		1800-744-5477
	South Africa		011 471 6000
	Thailand		02 614 3559
	Taiwan		0800 005 616

Key Components

Replacement assemblies marked with an asterisk (*) in the Replacement Parts tables contain one or more Key Components. Key Components require detailed tracking, by recording the key component part number and the key component's date code, its serial number, or both. Record this information on the Customer Service Order (CSO) for both the failed assembly and the replacement assembly.

The Key Components that are part of the replacement assemblies are listed in Table 60"Key Components" on page 189.

Repair Notes

The following sections provide details of how to successfully work with the internal assemblies of the HeartStart XL+ defibrillator/monitor.

Safety Precautions

WARNING: Remove all power sources (AC and battery) before opening the HeartStart XL+. Failure to do so may allow the device to charge without warning and could result in serious injury or death.

CAUTION: Take the necessary precautions against shock or injury before you conduct defibrillator/monitor tests or repairs.

- Only properly trained engineers and technicians should service the device.
- The device can contain deadly voltages even if the device is turned off.
- Make sure the device is disarmed.
  To disarm the defibrillator, press the **Disarm** soft key. If the **Shock** button has not been pressed within the time period specified in the **Time to Auto Disarm** configuration setting, the defibrillator disarms automatically. Additionally, you can disarm the HeartStart XL+ any time by turning the Therapy Knob to the **Off** position.
- Make sure that you disconnect all power before opening the device.
- Make sure you discharge the device before working with it.
- Make sure you work in a static-safe environment. Use a static-control wrist band, in conjunction with an antistatic pad grounded per the manufacturer's instructions.
- Special cleaning technologies are used during the manufacturing of the PCAs. Be careful not to touch the surface areas of the PCAs with bare hands because skin oil can affect product performance. Use anti-static or cotton gloves or rubber finger tips.
- Keep replacement PCAs in antistatic pouches until ready to install.
- Note that the edges of the metal chassis may be sharp. Take care not to cut yourself or shear the wires.

Internal Connections

Whenever troubleshooting indicates a particular PCA may be at fault, it is always good practice to check all the connections to that PCA and retest before replacing the PCA.

Cable and Assembly Placement

How the wires and cables are routed and dressed inside the chassis plays an important role in two areas: in preventing long-term wear and potential pinching problems, and in reducing electromagnetic and radio frequency interference emitted by the defibrillator/monitor.

- When you disassemble any part of the device, pay special attention to how cables and wires are routed.
- When you reassemble the device, be sure to route and dress all cables and wires as they were originally.
- Return all components to their original position within the case.

Device Reassembly

If your repair kit contains new accessories like shields, screws, etc., then install the new accessories and discard the old ones.

Screw Usage

The HeartStart XL+ repair may involve removal and replacement of different screws, some of them may look similar, but not interchangeable. Make sure you replace the same types of screws during reassembly.

Table 32 **Screw Usage**

Screw Designation (Torx Drive)	Usage
M3 x 8 mm (T10)	PCA mounting, Chassis side screws
M3 x 12 mm (T10)	Rear Case to Rear I/O Assembly
M3 x 14 mm (T10) (with patchlock)	with captive standoffs on the Power Supply and Therapy PCAs
M3 x 16 mm (T10)	with the captive standoff on the Processor PCA only
M4 x 10 mm (T15)	mount sheet metal chassis, enclosure, handle, bed rail hook
M4 x 12 Flat Head (T20)	Paddle electrodes
Plastite Screw 6-19 x 3/8" (T15)	HIF PCA, Display casting, Battery Cover
Plastite Screw 6-19 x 3/8" (T15) Cheese Head	Therapy Knob stop. **NOTE:** Not used in service, only in upgrades.

If you do not reassemble the device correctly, it may no longer be properly sealed. This could result in dust and moisture damage to the device. To ensure the adequate seal:

- Place all gaskets in their proper locations.
- Correctly assemble all parts that mate with gaskets (make sure the gaskets are not wrinkled, pinched, or torn).
- Replace all screws.
- If installing several screws at a time, always install all the screws lightly, and then tighten in a criss-cross pattern.
- Make sure that screws are not cross-threaded and firmly tightened.
- Unless instructed otherwise, torque:
  - the M3 (T10) screws to 6 inch-lb (0.7 N m),
  - the M4 (T15 and T20) screws to 10 inch-lb. (1.1 N m).

Disposal

Prior to disposal, remove the external and internal batteries. Then dispose of the device in accordance with your country's regulations for equipment containing electronic parts.

WARNING: To avoid contaminating or infecting personnel, the environment, or other equipment, make sure you disinfect and decontaminate the defibrillator/monitor appropriately prior to disposal.
Properly dispose or recycle depleted batteries according to local regulations. Do not puncture, disassemble, or incinerate batteries. Be careful not to short the battery terminals because this could result in a fire hazard. Disposal of the device with the battery inserted presents a potential shock hazard.

Repair Tools and Equipment

The following tools are needed to perform the procedures in this chapter:

- Torx T10, T15, and T-20 drivers (or Torx driver kit). T15 driver shaft should be less than 0.4-inches (10 mm) in diameter to reach down to recessed handle screws.

TIP: You need the T-20 driver only for the Paddle Tray and Plates replacement.

- Slip-joint pliers or adjustable open-end wrench.
- open-jaw 1 1/8" (29-mm) or adjustable wrench for the Therapy Port replacement.
- Straight-tip needle-nose pliers or tweezers.
- Bent-tip needle-nose pliers whose jaws are covered with a soft material (e.g. plastic tubing or tape).
- Utility knife.
- Wire cutter.
- Four pins of no more than 1/8" (3 mm) in diameter to support the Rear Chassis in removal and replacement procedures. T15 and smaller screwdrivers may be used.
- Software Support tool for upgrades and Processor PCA repairs (see Table 39"Software Support Tool" on page 176 for part numbers).
- Defibrillator Discharge Tool (M2475-69573).
- Gloves and ESD protection for PCA handling.

External Assemblies

This section describes how to remove and replace assemblies that are external to the case. You *do not* need to open the case for any of these procedures.

CAUTION: There are electrical components in the Handle Assembly. Wear ESD protection and follow electrical safety precautions during the Handle and RFU-and-USB assemblies replacement.

NOTE: See the *HeartStart XL+ Instructions for Use* for information on attaching the carrying case and accessory pouches.

This section is organized into the following topics:

Battery Compartment Cover and Latch

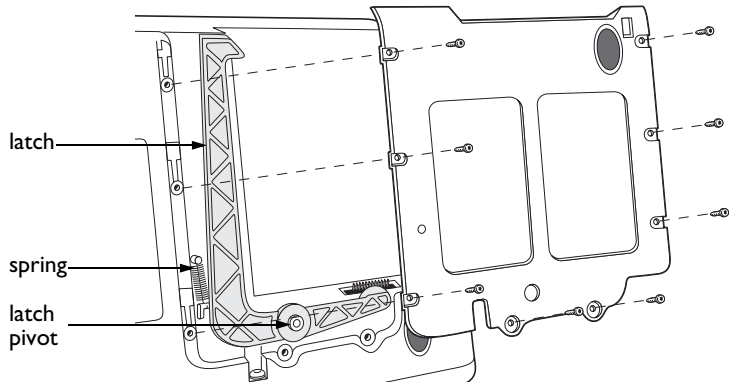
Preparation

1. Turn the device off and remove the battery and the AC power.
2. Position the device.
   Lay the device on a work surface with the display facing down and the bottom facing you.

Removal

1. Loosen and remove the eight self-threading T15 screws. See Figure 34.

Figure 34 **Battery Compartment**



2. Remove the compartment cover.
3. Remove the latch and the spring.

Replacement

1. Install the new latch and the spring.
   Do not reuse old parts. Position the latch as shown in Figure 34.
2. Replace the compartment cover.
3. Install the eight plastite T15 screws and torque to 10 inch-lb. (1.1 N m).

To Complete the Replacement:

1. Visually inspect the device to ensure that you installed the latch and cover correctly.
2. Insert, remove, and install a battery to verify the latch performance.
3. Turn on the device to make sure the battery connects properly.

It is not necessary to run any Performance Verification and Safety testing.

Bedrail / Roll Stand Mount

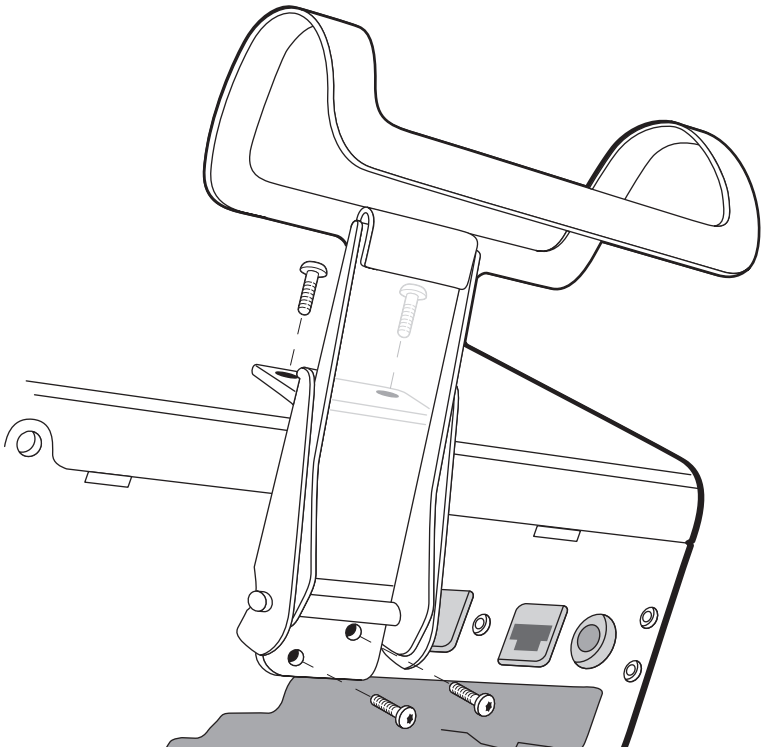
Preparation

1. Turn the device off and remove the battery and the AC power.
2. Position rear of the device facing you.

Removal

1. Loosen and remove the four T15 screws.
2. Remove the bedrail / roll stand mount.

Figure 35 **Bedrail / Roll Stand Mount**



Replacement

1. Fold the bedrail / roll stand mount extension.
2. Secure the bedrail / roll stand mount to the back of the device using four M4x10 (T15) screws:
   a. Install the top two screws first.
   b. Install the bottom two screws.
   c. Torque the screws to 10 inch-lb. (1.1 N m)

To Complete the Replacement:

- Visually inspect the device to ensure that you installed the bedrail / roll stand mount correctly. It is not necessary to run any Performance Verification or safety testing.

Labels

There are four groups of labels for the HeartStart XL+:

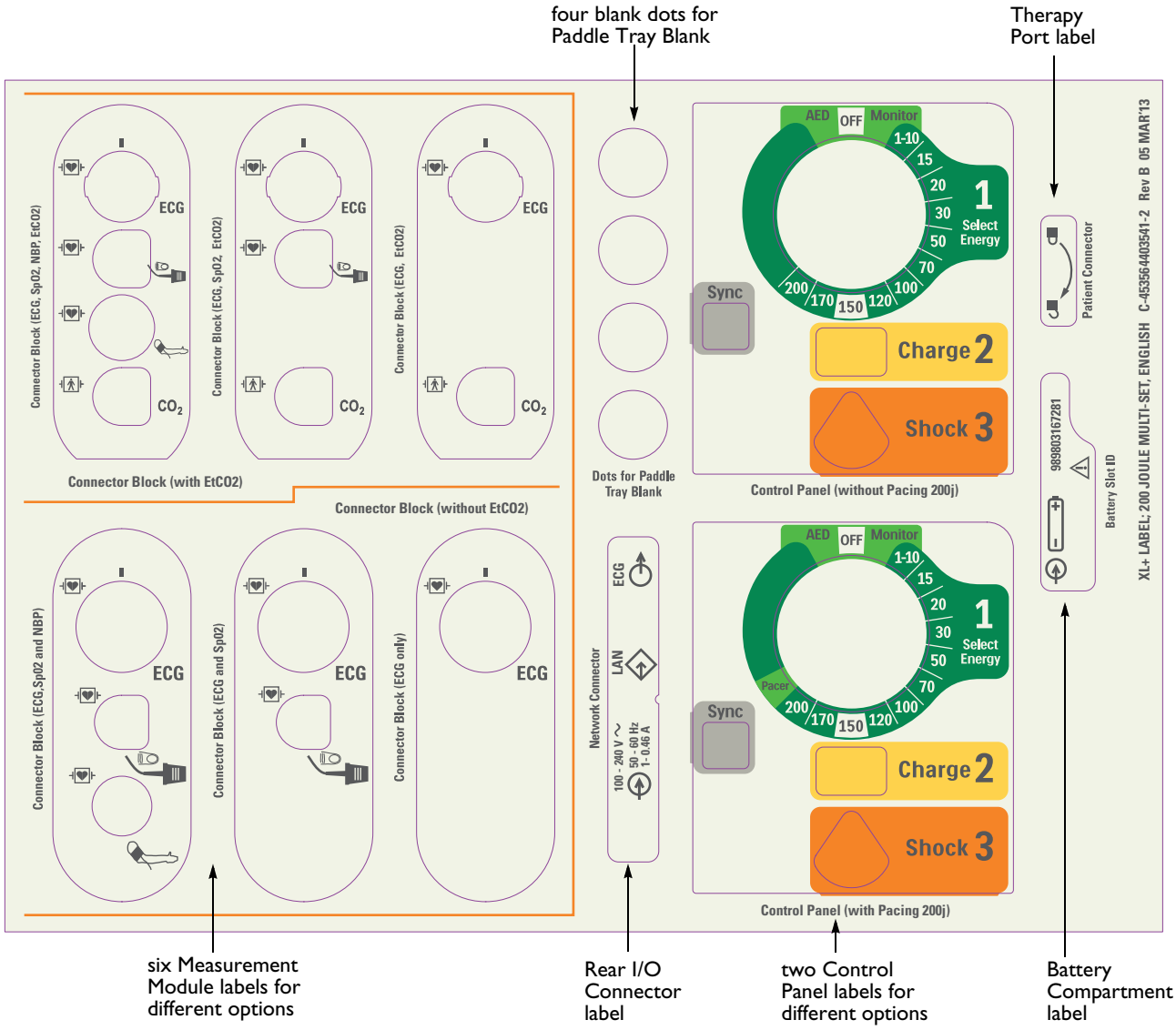
- the Instruction label set
- the Branding (Nameplate) label
- the Primary label, and
- the Option Key labels (optional)

Instruction Label Sets

Each Instruction Label set includes labels for devices with and without pacing. It also includes three different Measurement Module labels for different option sets. Make sure to order the correct localized set (see "Instruction Label Sets" on page 180) and place the correct labels on the device.

Be sure to apply the correct Measurement Module (marked Connector Block) and Control Panel labels matching your device options.

Figure 36 **Instruction Labels**



There is one instruction label set for each language (see "Instruction Label Sets" on page 180 for part numbers). This set includes die-cut labels for:

- Battery Compartment label
- six Measurement Module label (marked Connector Block) for different options
- two Control Panel labels
- Rear I/O Connector label (marked Network Connector) for different options
- Therapy Port label (marked Patient Connector)
- four blank dots to cover screw holes on the blank paddle tray.

Branding Label

The branding label is affixed to the top of the device above the left side of the Display.

Primary Label

Primary label is not included in the label kit and shipped with the device. It lists the Serial Number and the Options Key, and is affixed to the bottom of the device. See "Primary Label" on page 10.

Contact your local Response Center (see "Calling for Service" on page 68) if you replace the Rear Case for the primary label replacement. Be prepared to provide the information from the old primary label.

Option Key Label

Option Key labels are shipped with upgrade kits and are affixed to the bottom of the device. Contact your local Response Center (see "Calling for Service" on page 68) if you replace the Battery Compartment Cover for the Option Key labels replacement. Be prepared to provide the information from the old Option Key labels.

Removing and Replacing Labels

Preparation

- Turn the device off and remove the battery and the AC power.

Removal

1. Start at one corner.
   Using a sharp tool such as a utility knife, pick up one corner of the old label.
2. Peel up the label.
   Peel the label up by pulling slowly and evenly on the loosened corner.

Replacement

1. Clean the surface:
   a. Remove any adhesive residue by rubbing the dry surface with your finger and "rolling up" the adhesive residue.
      Solvents are ineffective, as is scraping with a tool.
   b. Clean the surface with isopropyl alcohol. Allow it to dry.
2. Peel the new label off the backing.
   Avoid touching the label adhesive, as this may prevent the label from bonding properly.

3 Apply the label:
   a For the Control Panel label, align around the Buttons and Switch first.
   b Align one edge of the label with the recess on the case, then roll the label slowly into position.
   c Press firmly all over the label, especially the edges, to ensure it adheres to the case.

To Complete the Replacement:

- Visually inspect the device to ensure that you applied the labels correctly.

It is not necessary to run any Performance Verification and Safety testing.

Handle Assembly

Preparation

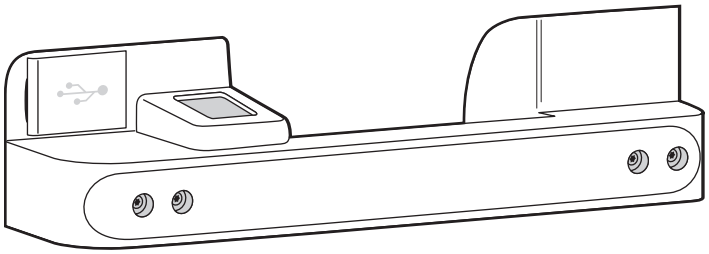
1 Turn the device off and remove the battery and the AC power.

2 Position the device on the work surface with the rear side facing you.

Removal

1 Completely loosen but do not remove the four T15 screws in the handle. See Figure 37.

Figure 37 **Handle Screws**

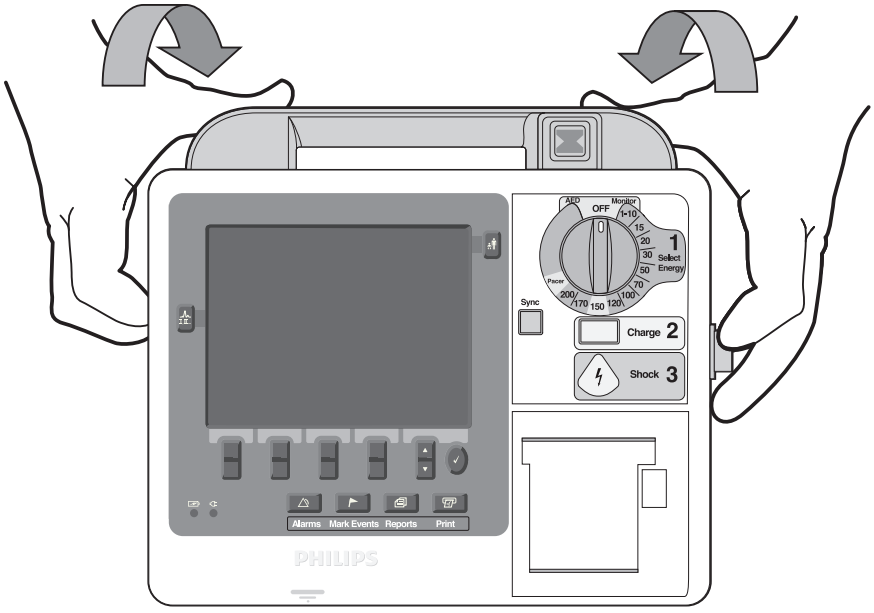


2 Position the device so there is at least a foot (30 cm) of free working surface between you and the rear side.

3 Grasp the device from both sides and position your thumbs in the handle over the screw holes. See Figure 38.

4 Roll the device toward yourself.

Figure 38 **Handle Removal**

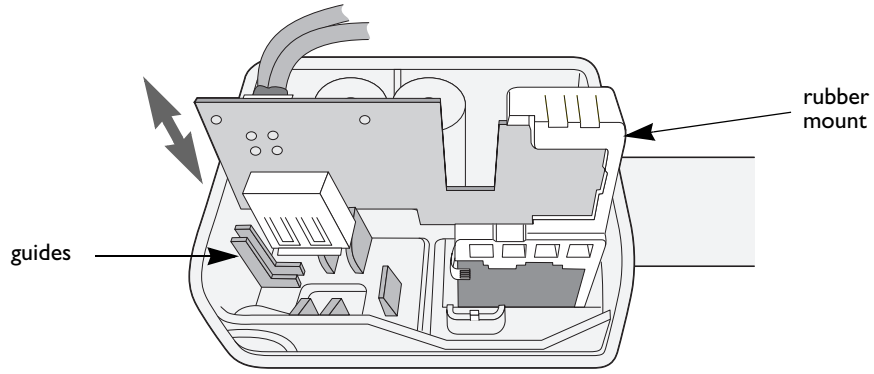


5 While holding the handle in place, slide your thumbs to let the screws fall out.

6 Once the screws are all out and accounted for, position the device on the work surface with the rear side facing you.

7 Carefully lift the handle and remove the RFU-and-USB Assembly from the handle. Grasp the rubber mount, wiggle and pull. Do not disconnect from the Front Case. See Figure 39.

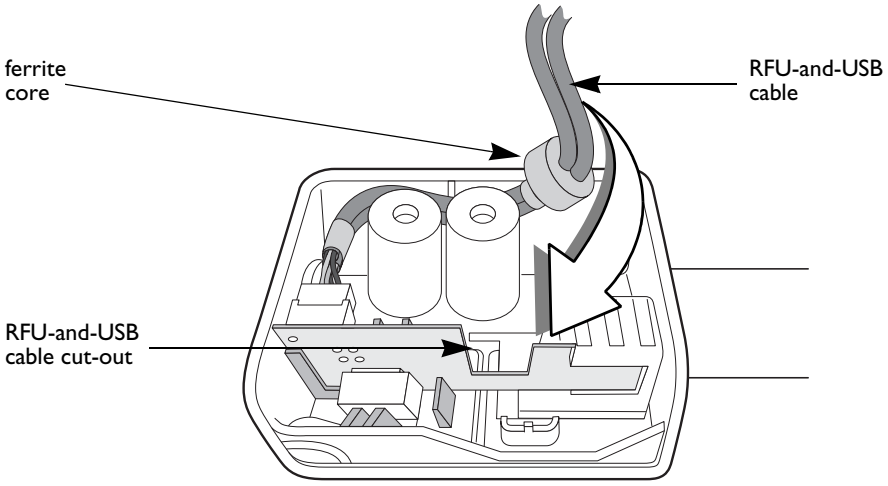
Figure 39 **Handle Replacement**



Replacement

1. Position the device on the work surface with the rear side facing you.
2. Use the guides inside the handle to insert the RFU-and-USB Assembly into the new Handle. See Figure 39.
3. Make sure that both the mount and PCA are fully seated and flush with the Handle's bottom.
4. Wrap the RFU-and-USB cable around the plastic standoffs and guide through the cut-out. Slightly wiggle the ferrite core to make sure it fully fits into the handle. See Figure 40.

Figure 40 **RFU-and-USB Cable Inside the Handle**



5. Align the Handle against the Front Case.
   Make sure not to pinch wires between the Handle and the Front Case.
6. Replace the four M4x10 (T15) screws in the handle. Tighten the screws to 10 inch-lb. (1.1 N m).

To Complete the Replacement:

1. Visually inspect the device to ensure that you installed the handle assembly correctly.
2. Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

RFU-and-USB PCA

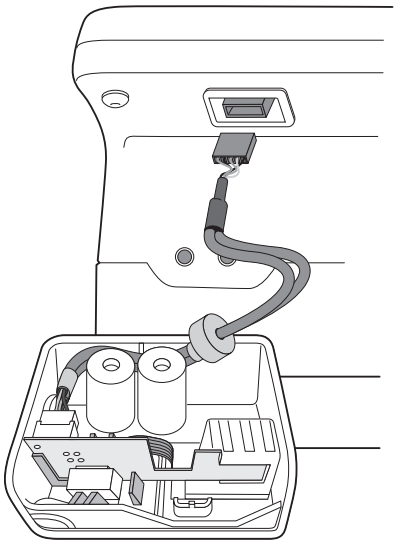
Preparation

1. Turn the device off and remove the battery and the AC power.
2. Position the device on the work surface with the rear side facing you.

Removal

1. Follow the Handle removal steps up to Step 6. See "Handle Assembly" on page 78.
2. Disconnect the 10-pin RFU-and-USB cable connector.

Figure 41 **RFU-and-USB Connector**



3. Remove the RFU-and-USB Assembly from the handle.
   Grasp the rubber mount, wiggle and pull. See Figure 39 on page 79.

Replacement

1. Position the device on the work surface with the rear side facing you.
2. Use the guides inside the handle to insert the new RFU-and-USB assembly into the handle. See Figure 39 on page 79.
3. Connect the 10-pin RFU-and-USB cable connector. See Figure 41.
   Ensure the connector is fully seated.
4. Wrap the RFU-and-USB cable around the plastic standoffs and guide it through the cut-out. See Figure 40 on page 79.
5. Replace the four M4x10 (T15) screws in the handle. Tighten the screws to 10 inch-lb. (1.1 N m).

To Complete the Replacement:

1. Visually inspect the device to ensure that you installed the handle assembly correctly.
2. Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Paddle Tray and Plates

There is a 50-ohm load resistor pre-assembled inside the tray, which is used to test the paddles.

You need a T20 Torx screwdriver for this repair.

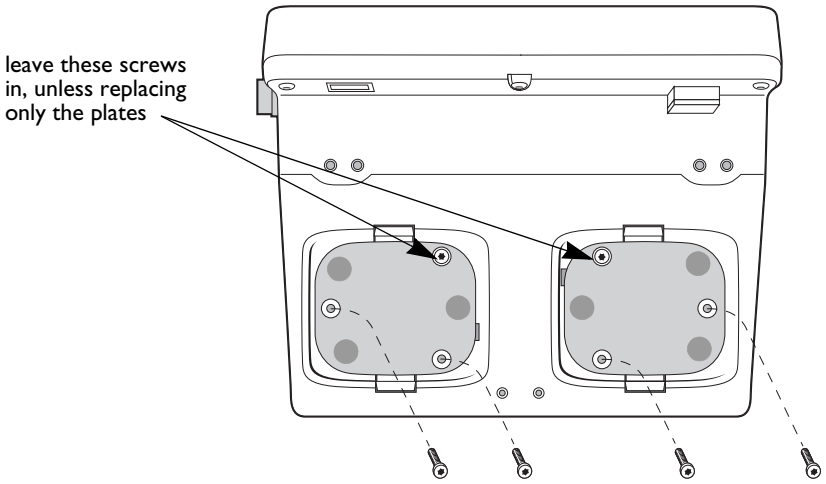
Preparation

1. Turn the device off and remove the battery and the AC power.
2. Remove the Handle Assembly, see "Handle Assembly" on page 78.

Removal

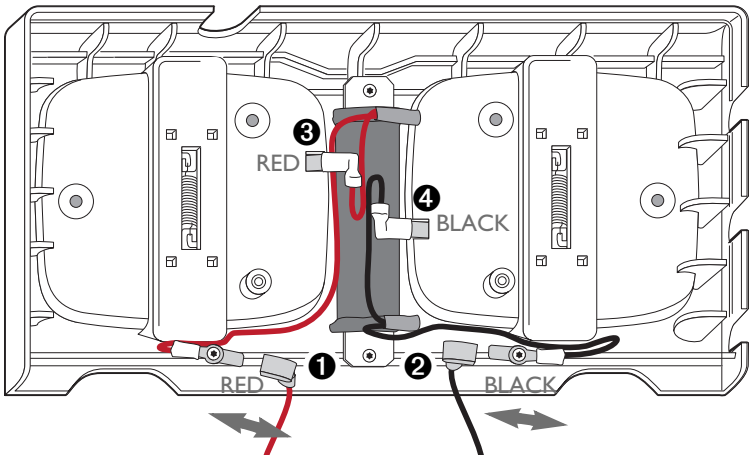
1. Remove the paddles from the tray.
   Disconnect the paddles from the Therapy port. Snap both paddles out of the paddle tray and lay them aside.
2. Remove the four rear T20 screws from the tray plates. See Figure 42.

Figure 42 **Removing the Paddle Tray**



3. Gently lift the paddle tray to gain access to the wires underneath.
4. Pull the spade connectors straight off of the tabs. See Figure 43, ❶, ❷.

Figure 43 **Installing the Tray Plates**



Replacement

1. If you are replacing the plates only, then install the tray plates into the tray.
   a. Position the paddle tray up side down and front facing you. See Figure 43.
   b. Holding the tray plate at an angle, place the plates into the left and right pockets, inserting the tabs through the holes ❸, ❹.
   c. Connect the spade connector from the *red* wire to the marked RED tab ❸ being careful not to bend the tab.
   d. Connect the spade connector from the *black* wire to the marked BLACK tab ❹.
   e. Ensure the connectors are fully seated.
   f. Replace the two uppermost flat-head M4x12 (T20) screws to attach the new plates to the paddle tray. Tighten the screws to 10 inch-lb. (1.1 N m).
2. Connect the paddle tray to the device. See Figure 43.
   a. Connect the spade connector from the red wire to the tab with the red wire on the resistor (❶).
   b. Connect the spade connector from the black wire to the tab with the black wire on the resistor (❷).
   c. Ensure the connectors are fully seated.
3. Place the paddle tray into position on the device.
   Line up the screw holes in the paddle tray and tray plates with the threaded inserts on the device. Be careful not to pinch the wires under the tray.
4. Replace the four remaining flat-head M4x12 (T20) screws.
   Tighten the screws to 10 inch-lb. (1.1 N m).
5. Replace the Handle Assembly, see "Handle Assembly" on page 78.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Paddle Tray, Blank

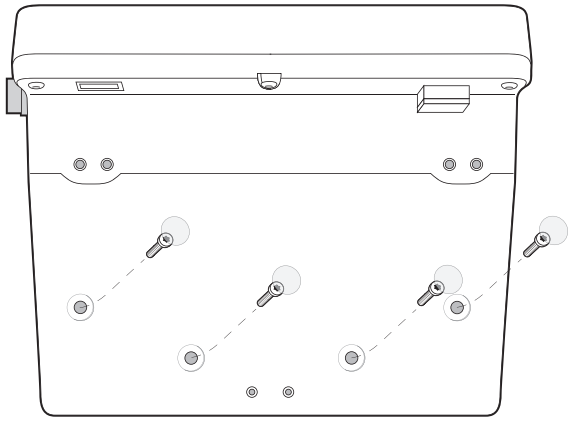
Preparation

1. Turn the device off and remove the battery and the AC power.
2. Remove the Handle Assembly, see "Handle Assembly" on page 78.

Removal

1. Remove the old Paddle Tray:
   a. If you are replacing a Blank Paddle Tray, then remove and discard the four round screw cover stickers from the tray:
      – Puncture the stickers with tweezers or needle-nose pliers and lift. See Figure 44.
      – Remove the four T15 screws from the blank paddle tray.
   b. If you are replacing a Paddle Tray and Plates, then follow the removal instructions of "Paddle Tray and Plates" on page 81.

Figure 44 **Removing the Blank Paddle Tray**



2. Lift the Paddle Tray.

Replacement

1. Inspect the paddle tray wires.
   If the wires became loose, then group the wires together and secure with the cable tie wrap. Cut off any excess tie wrap.
2. Place the blank paddle tray into position on the device.
   Line up the screw holes in the paddle tray with the threaded inserts on the device. Be careful not to pinch the wires under the tray.
3. Replace the four M4x10 (T15) screws. Tighten the screws to 10 inch-lb. (1.1 N m).
4. Apply four blank dot stickers to cover the screw holes, see "Labels" on page 75.
5. Replace the Handle Assembly, see "Handle Assembly" on page 78.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Paddle Tray Load Resistor

The 50-ohm load resistor comes pre-assembled in the paddle tray. However, if it fails, you can replace it using the following procedures.

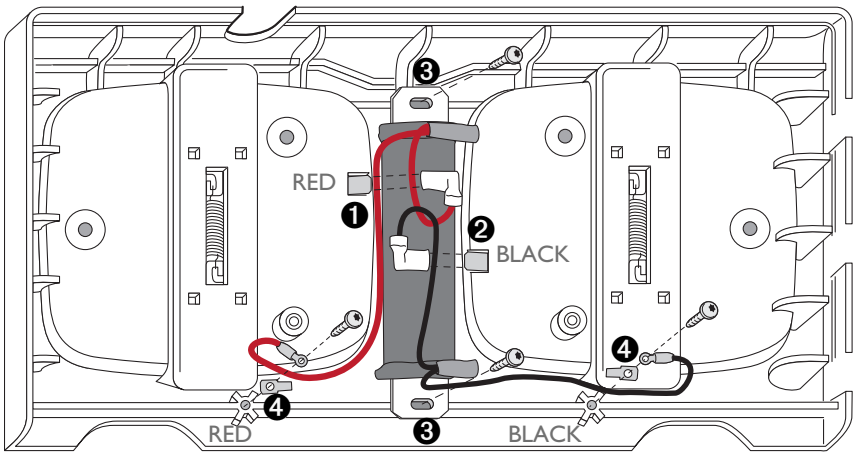
Preparation

1. Turn the device off and remove the battery and the AC power.
2. Remove the Handle Assembly, see "Handle Assembly" on page 78.
3. Remove the paddle tray. See "Paddle Tray and Plates" on page 81.
   Do not remove the plates.

Removal

1. Disconnect the spade connectors from the paddle plate tabs (❶, ❷).
2. Remove the four T15 screws (❸, ❹). Put aside the two spade connectors.
3. Lift the 50-ohm load resistor and the wires out of the paddle tray.

Figure 45 **Replacing the Load Resistor**



Replacement

1. Place the load resistor into the paddle tray. Position the wires and connectors as shown in Figure 45. Secure with two T15 plastite screws (❸).
2. Place two other T15 plastite screws through the spade connectors and ring terminals, and secure to the paddle tray on both sides (❹). Tighten the four screws to 10 inch-lb. (1.1 N m).
3. Connect the spade connector from the *red* wire to the *left* plate tab (❶) being careful not to bend the tab. The tab is marked RED.
4. Connect the spade connector from the *black* wire to the *right* plate tab marked BLACK (❷).
5. Ensure the connectors are fully seated.
6. Route the wires as shown in Figure 43 on page 81.
7. Replace the paddle tray, see "Paddle Tray and Plates" on page 81.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Printer Assembly

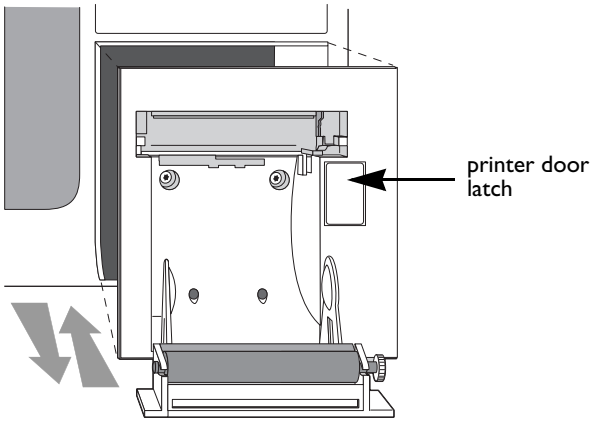
Preparation

- Turn the device off and remove the battery and the AC power.

Removal

1. Push in the printer door latch and open the printer door.
2. Remove the paper roll.
3. Loosen the two captive T10 screws at the back of the printer, see Figure 46.
4. Remove the printer by grasping the inside and pulling it straight out of the printer well.

Figure 46 **Printer Assembly**



Replacement

1. Slide the printer straight into the printer well.
   The Printer connector is of a "blind mate" type and should align with the Printer PCA connector.
2. Gently push in the Printer until it is fully seated.
3. Open the Printer door and tighten the two T10 captive screws to 6 inch-lb (0.7 N m).
4. Replace the paper (grid side up) and close the door.

To Complete the Replacement:

1. Perform Performance Verification and Safety testing as described in the "Performance Verification" chapter.
2. Perform the "Printer Test" on page 164.

Therapy Knob

Preparation

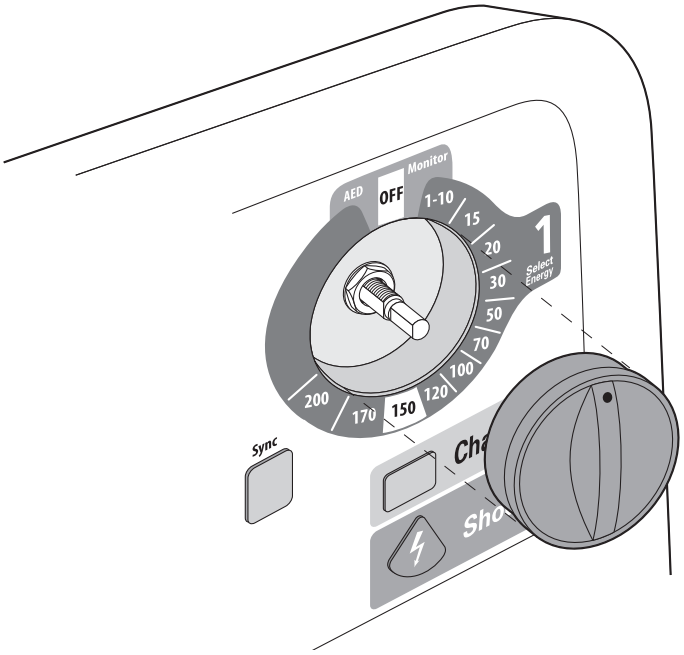
1. Turn the device off.
   If the Knob is broken or lost, use pliers to turn the device off. The shaft should be positioned as shown in Figure 47. If the Shutting Down in ... seconds message is displayed, then the Therapy Switch is in the Off position.
2. Disconnect all external power and remove the battery.

Removal and Replacement

1. Pull the Knob off its shaft.
   Grasp the Knob and pull straight out from the front of the device. Use pliers if necessary, however be careful not to damage the Knob if you are going to reuse it.

NOTE: Do not remove the screw under the Knob.

Figure 47 **Therapy Knob Replacement**



2. Align the flat side of the copper clip inside the Knob with the flat surface on the shaft and press the Knob into place.
   Make sure the Knob is pressed fully into place and its rim is almost flush with the front panel.
3. Make sure the Knob rotates freely and that it points to the correct markings on the front panel.
4. Make sure the Knob does not rotate beyond the last marking on the label.

To Complete the Replacement:

1. Perform Performance Verification and Safety testing as described in the "Performance Verification" chapter.
2. Perform the "Controls Test" on page 162.

Internal Assemblies — Introduction

This section is organized into the following topics:

WARNING: Remove all power sources (AC, battery) before opening the device. Failure to do so may allow the device to charge without warning and could result in serious injury or death.

Opening the Case

To open the sealed case safely, perform the following steps, in the order listed.

Each step is described in more detail in following sections.

1. Separate the case (see "Separating the Case" below).
2. Discharge the Therapy Capacitor (see "Discharging the Therapy Capacitor" on page 89).

Separating the Case

Separate the Front and Rear Cases from each other by performing the following steps.

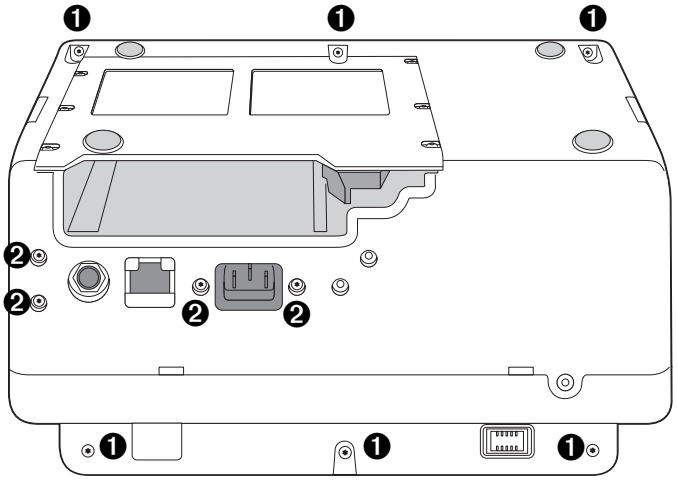
WARNING: Dangerous voltages may be present on components and connections exposed during device disassembly. Use extreme caution while the device is separated.

CAUTION: Be sure to work in a static-free environment. Use an electrostatic wrist band. The work surface and area surrounding it must be static-free. Use an antistatic pad which is grounded per the manufacturer's instructions.

To separate the Front and Rear Case from each other:

1. Remove accessory pouches, if present.
2. Remove the Bedrail / Roll Stand Mount, if present. See "Bedrail / Roll Stand Mount" on page 74.
3. Remove the Handle Assembly, see "Handle Assembly" on page 78.
4. Lay the device on a padded work surface with the display facing down and the top of the device toward you.
5. Remove the case screws, see Figure 48.
   a. Remove the six T15 screws in the perimeter of the case (❶).
   b. Remove the four T10 screws in the back of the case near the Rear I/O assembly (❷).

Figure 48 **Case Screws**

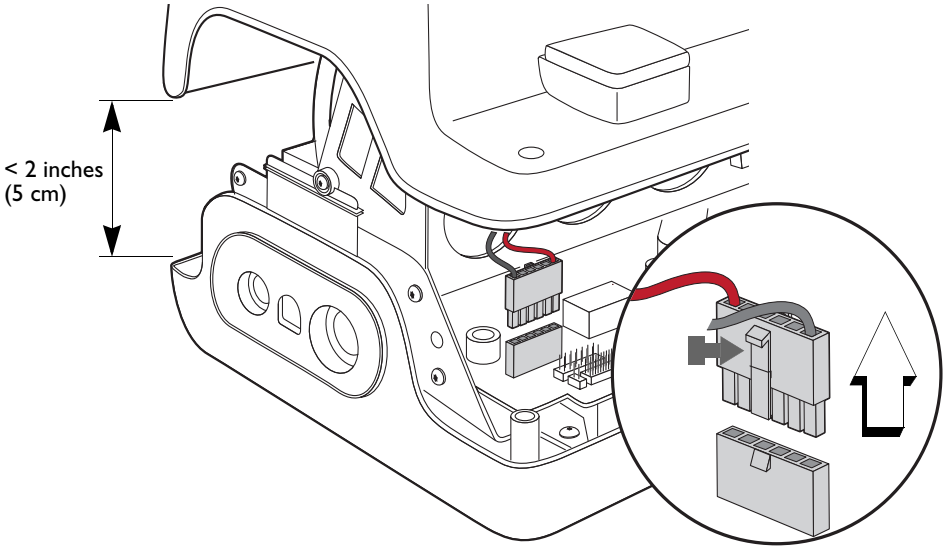


6 Carefully lift the Rear Case cover no more than 2 inches (5 cm).

7 Put your right hand fingers through the AC mains and LAN openings and hold the Rear Case cover while pressing the latch behind the paddle connector with your left hand to separate, see Figure 49.

CAUTION: Be careful not to bend or damage the pins in front of the paddle connector.

Figure 49 **Separating the Case**



8 Lift the Rear Case straight up.

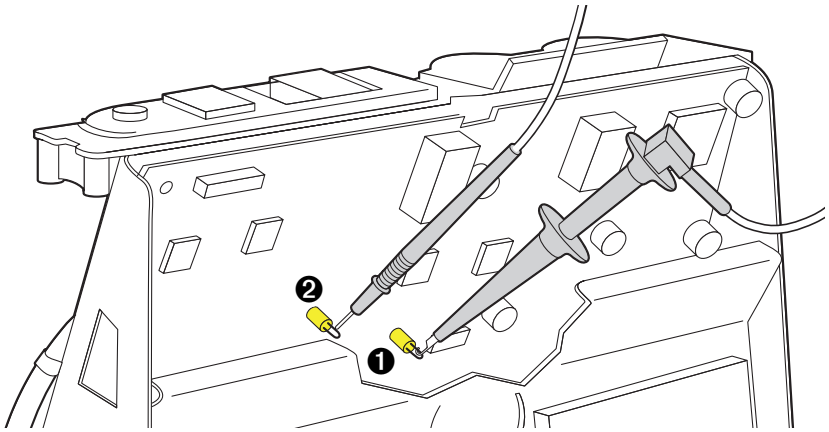
Discharging the Therapy Capacitor

WARNING: Use extreme caution in the following steps. Dangerous voltages may be present on components and connections. Do not touch any components or connections until you are sure the Therapy Capacitor is discharged.

To discharge the Therapy Capacitor:

1. Find two wire loops positioned on yellow standoffs on the Therapy PCA. See Figure 50, ❶, ❷.
2. Using the Defibrillator Discharge Tool, clip the hooked end onto the wire loop ❶.
3. Touch the pointed end of the discharge tool to the wire loop ❷ and hold in place for at least 10 seconds.
4. Once you made a 10-second contact, the Therapy Capacitor is now discharged.

Figure 50 **Using the Discharge Tool**

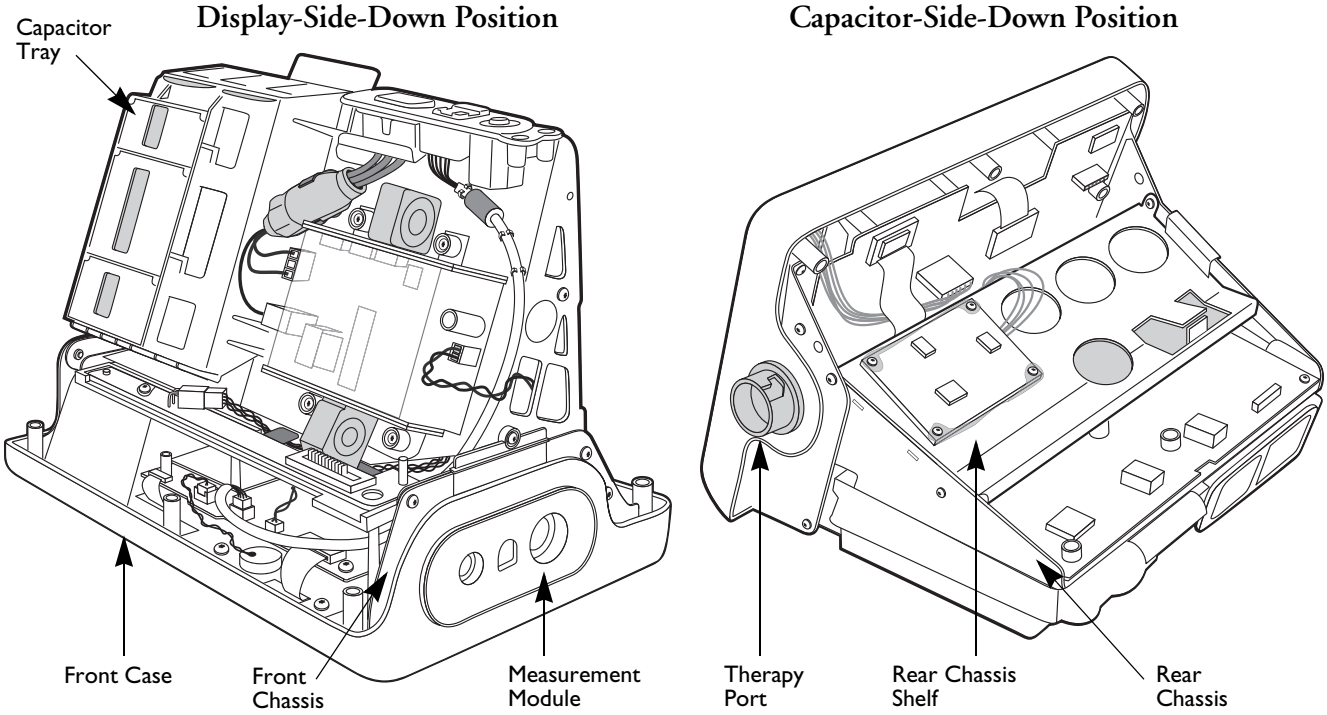


Overview of the Internal Assemblies

The Internal Assemblies are organized in the following groups (see Figure 51):

- Assemblies mounted on the Rear Chassis and Rear Chassis Shelf
- Assemblies mounted on the Front Chassis
- Assemblies mounted directly on the HeartStart XL+ Front Case.

Figure 51 **Internal Assemblies Overview**



The Rear Chassis may tilt or pivot up or down to provide access to some Front Chassis assemblies without the removal of the Rear Chassis.

Positioning of the Box

Most of the repairs are performed while the HeartStart XL+ lays with the display side down. Some repairs are performed while the HeartStart XL+ lays on its bottom or the Capacitor Assembly. See Figure 51.

CAUTION: Never position an open HeartStart XL+ box on its top (shelf) side.
When the Rear Chassis is tilted or not fully secured to the Front Chassis, then the only allowed position is the “display side down”.

Tilting Rear Chassis

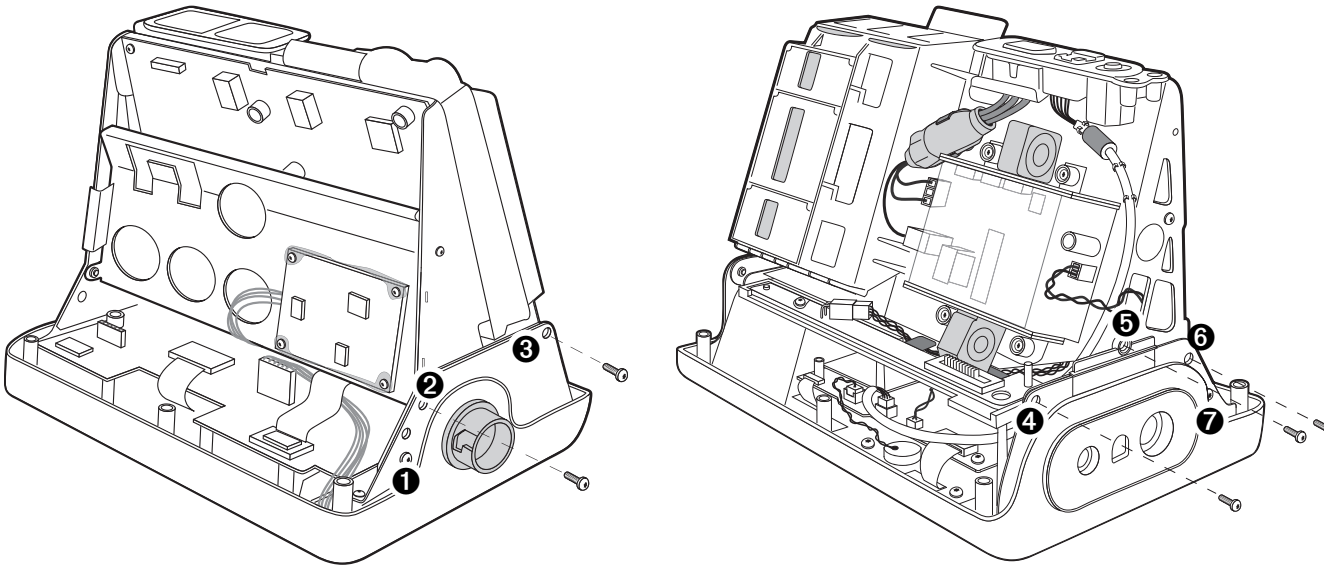
Some repair procedures require you to tilt the Rear Chassis. Other repair procedures may require you to pivot the Rear Chassis upward or downward or remove it altogether; these procedures are discussed in corresponding sections.

CAUTION: Tilting or pivoting of the Rear Chassis involves a scissor-like movement between the Rear and Front Chassis. Take care not to injure your fingers or shear the wires.

To tilt the Rear Chassis:

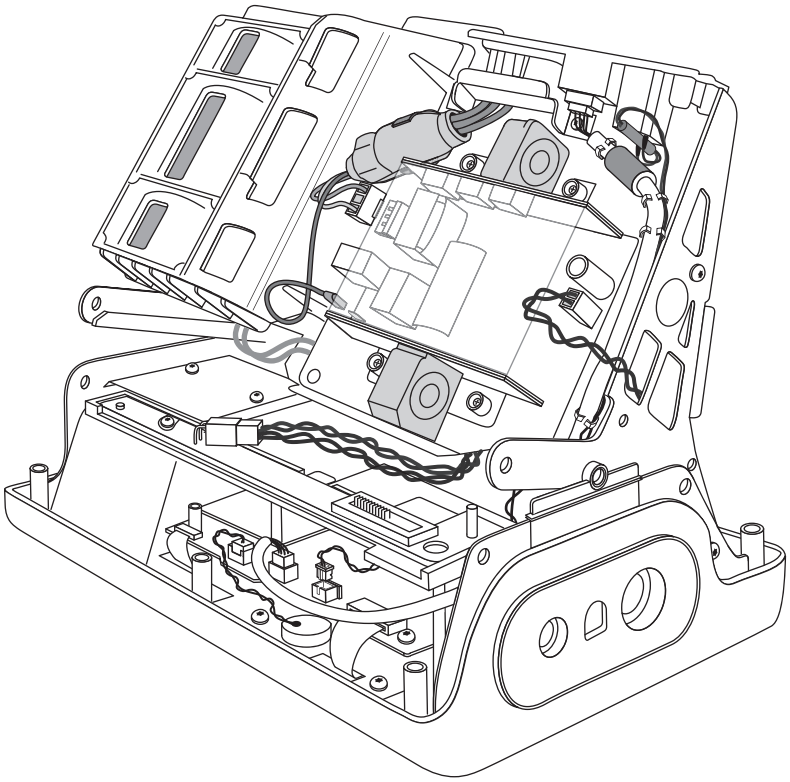
1. Open the HeartStart XL+ Case. See "Opening the Case" on page 87.
2. Position the box display side down.
3. Remove the T10 screws ❷, ❸, ❹, ❺, and ❻, see Figure 52.

Figure 52 **Rear Chassis Screws**



4. Loosen slightly but not remove the screws ❶ and ❼.
5. Tilt the Rear Chassis up around the axis formed by the screws ❶ and ❼.
   Do not stress wires and connectors by turning too far.
6. While in the tilted position, tighten the screws ❶ and ❼ to prevent the Rear Chassis from accidental movements.

Figure 53 **Rear Chassis Tilted**



To bring the Rear Chassis into the upright position:

1. Loosen but not remove the screws ❶ and ❼.
   Hold the Capacitor Tray to prevent the Rear Chassis from falling.
2. Straighten up the Rear Chassis to align with screw holes ❷, ❸, ❹, ❺, and ❻, see Figure 52.
   If your device has the NBP Module, then make sure the NBP air tube passes under the cut-out in the right lower corner of the Rear Chassis and not pinched, see Figure 55 on page 94.
3. Make sure no wires are pinched between the lower Fan and the Battery PCA support pad.
4. Install and tighten the M3x8 (T10) screws ❷, ❸, ❹, ❺, and ❻ to 6 inch-lb (0.7 N m).
5. Tighten the screws ❶ and ❼ to 6 inch-lb (0.7 N m).

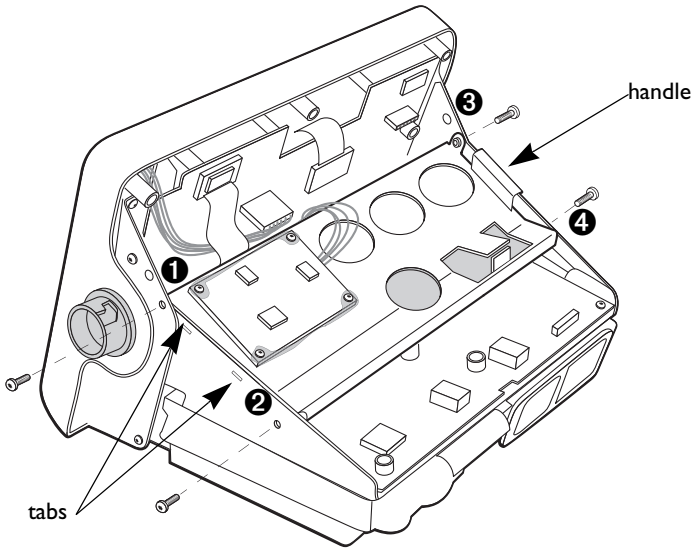
Rear Chassis Shelf

Some repair procedures require you to remove the Rear Chassis Shelf.

To remove the Rear Chassis Shelf:

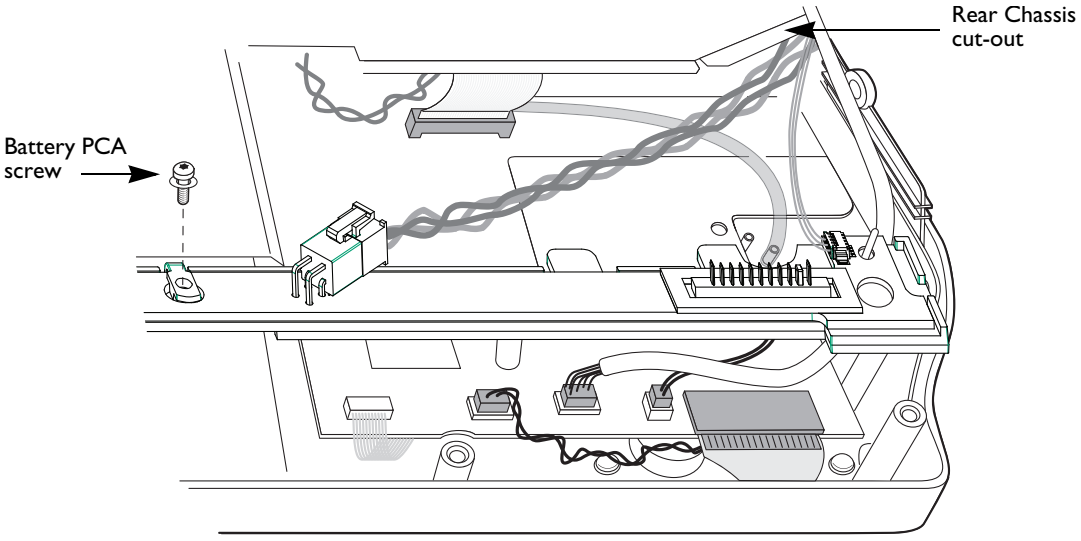
1. Open the HeartStart XL+ Case. See "Opening the Case" on page 87.
2. Position the box display side down, shelf side toward you.
3. Remove the T10 screws ❶, ❷, ❸, and ❹, see Figure 54.

Figure 54 **Rear Chassis Shelf**



4. If your device has the NBP Module, then disconnect the NBP air tube:
   a. Tilt the Rear Chassis, see "Tilting Rear Chassis" on page 91.
   b. Remove the Battery PCA screw and move the Battery PCA out of the way for better access to the NBP air tube. Do not disconnect any cables from the Battery PCA, see Figure 55.
   c. Carefully disconnect the NBP air tube from the NBP Port.
   d. Position the Battery PCA on the pegs and replace the screw, see Figure 55.
   e. Bring the Rear Chassis into the upright position, see "Tilting Rear Chassis" on page 91.

Figure 55 **NBP Air Tube Route and Connection**

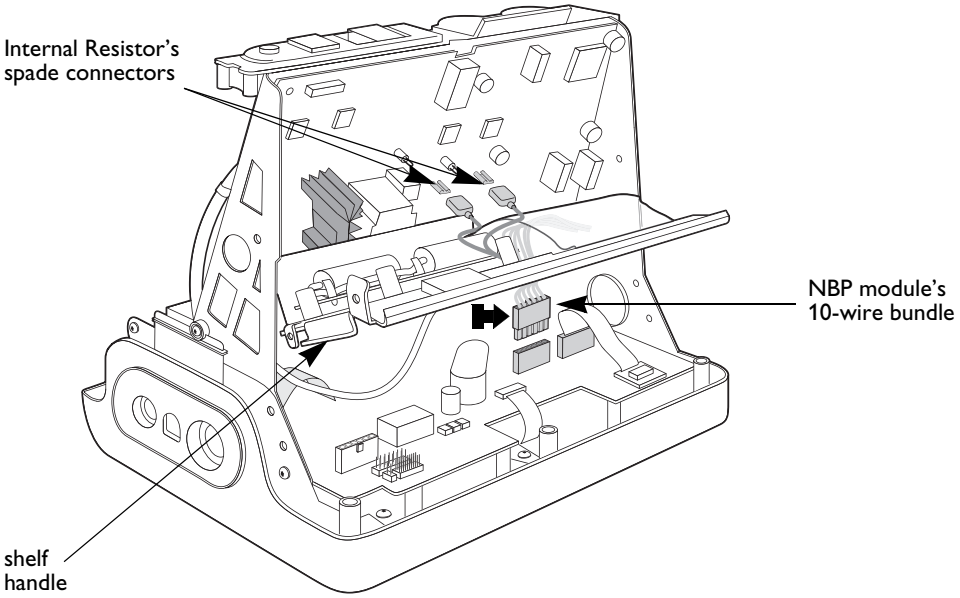


5 Pull the Shelf handle toward yourself, see Figure 56.
Support the shelf to prevent it from falling down.

6 Detach two Internal Resistor spade connectors from the Therapy PCA.
Pull straight from the Therapy PCA. Use pliers if necessary.

7 If your device has the NBP Module, then disconnect the NBP module's 10-wire bundle from the Processor PCA.
Press the latch behind the connector.

Figure 56 **Rear Chassis Shelf Connectors**



To install the Rear Chassis Shelf:

1. Position the box display side down, shelf side toward you.
2. Position the Rear Chassis Shelf:
   a. Reconnect the two Internal Resistor spade connectors in any order to the Therapy PCA positions J18 and J19, see Figure 56.
   b. If your device has the NBP Module, then:
      - Pass the NBP air tube through the Rear Chassis cut-out above the SpO_2 plastic shield, see Figure 55 on page 94.
      - Reconnect the NBP module's 10-wire bundle to the Processor PCA, see Figure 56.
   c. Align the tabs on the right side of the shelf with the slots in the Rear Chassis frame, see Figure 54 on page 93.
3. Gently push the shelf handle into the Rear Chassis to align the screw holes ❶, ❷, ❸, and ❹.
4. If your device has the NBP Module, then reconnect the NBP air tube:
   a. Turn the device around, the Capacitor side toward you.
   b. Tilt the Rear Chassis, see "Tilting Rear Chassis" on page 91
   c. Remove the Battery PCA screw and move the Battery PCA out of the way for better access to the NBP air tube. Do not disconnect any cables from the Battery PCA, see Figure 55.
   d. Reconnect the NBP air tube to the central airway nipple of the NBP Port, see Figure 55. Make sure the tube slides all the way down the airway nipple.

TIP: You may wet the end of the air tube so it slides on the NBP Port easier.

NOTE: If you have the $EtCO_2$ option installed, then thread the air tube between the SpO_2 PCA and ECG Connector. Depending on the available tools, you may have to remove the Measurement Module to do this, see "Measurement Module with the CO2 Port" on page 128.

   e. Position the Battery PCA on the pegs and replace the screw, see Figure 55 and Figure 75 on page 116.
   f. Ensure the connectors are fully seated.
5. If tilted, bring the Rear Chassis into the upright position, see "Tilting Rear Chassis" on page 91.
6. Install the M3x8 (T10) screws ❶, ❷, ❸ and ❹, and tighten to 6 inch-lb (0.7 N m), see Figure 54.

Tubing Gasket Replacement

The Tubing Gasket protects the internal assemblies of the HeartStart XL+ from moisture and dust. There are two Tubing Gaskets inside the HeartStart XL+:

- on the perimeter of the Front Case
- on the perimeter of the Measurement Module.

Inspect the Tubing Gasket whenever you open the box or the Measurement Module. Replace the Tubing Gasket if dirty, cracked, frayed, pinched, or there is a gap between the ends of the tubing.

To remove and replace the Tubing Gasket:

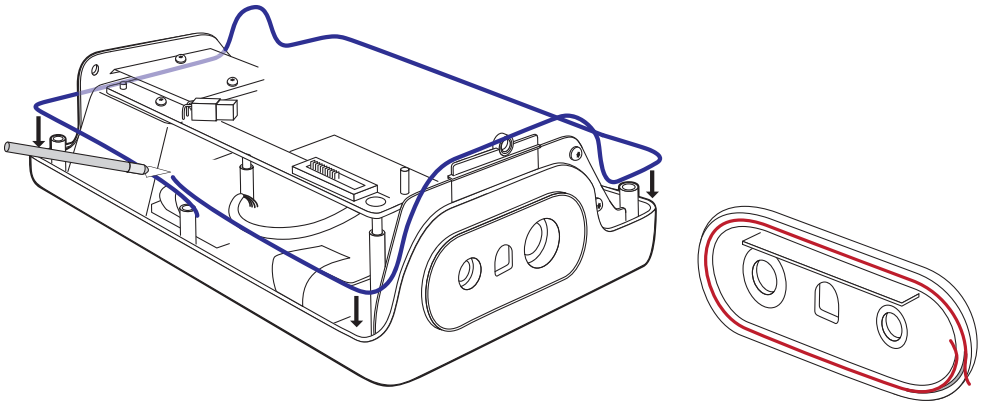
1. Use tweezers to remove the old gasket.
2. Clean the groove.
3. Prepare the tubing:
   - For the Front Case, prepare approximately 3' 10" (115 cm) of the gray tubing.
   - For the Measurement Module, prepare approximately 11" (28 cm) of the dark-red tubing.

   Do not stretch the tubing while measuring.
4. For the Front Case, start between the Printer and the Speaker (so that the Gasket ends meet at the bottom of the device) and freely lower the gasket into the groove and press lightly.

   For the Measurement Module, start opposite to the ECG Connector (so that the Gasket ends meet at the bottom of the Measurement Module).

   Leave the ends out. Do not stretch the tubing.

Figure 57 **Tubing gasket Replacement**



5. Cut where the ends meet so that there is no gap or overlap.
6. Tuck the ends into the groove.
7. Slightly spread or stretch the gasket to remove any residual overlap or cover a gap.

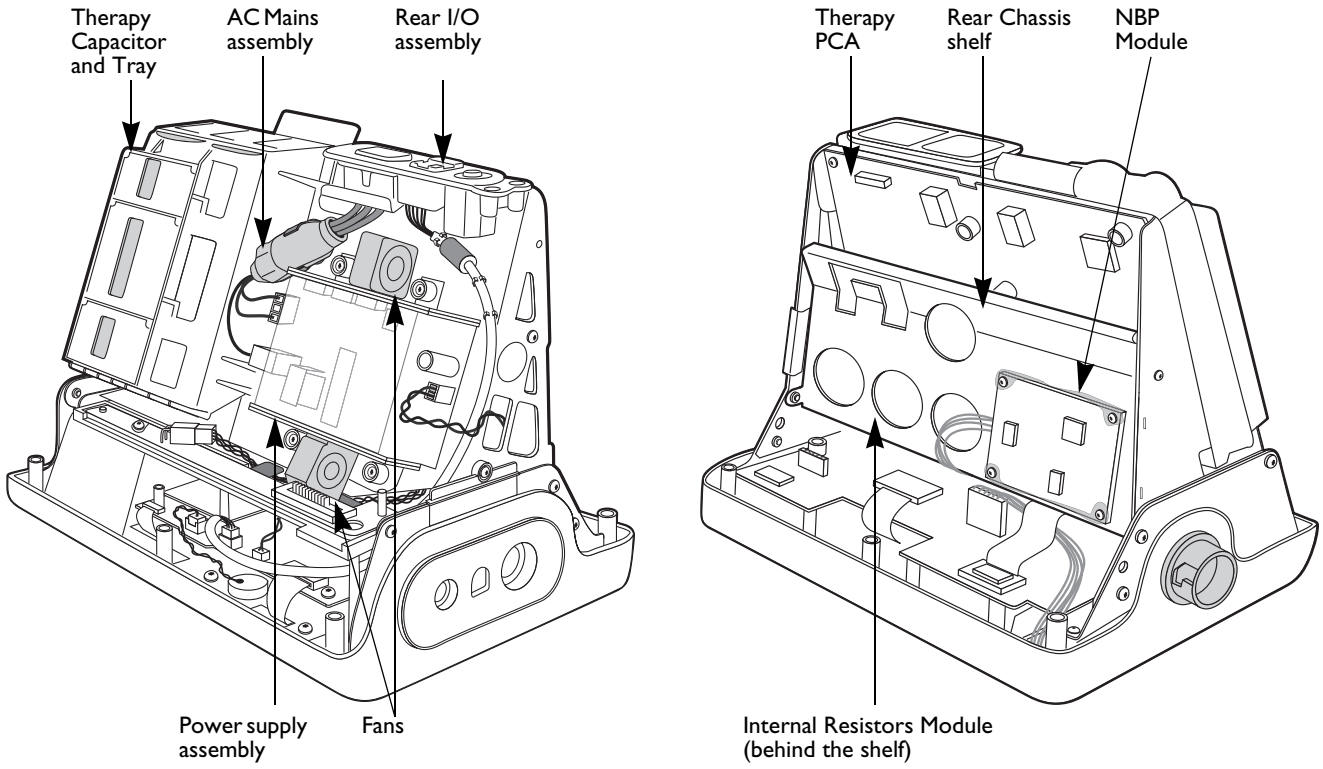
Internal Assemblies — Rear Chassis

This section is organized into the following topics:

Rear Chassis Overview

See Figure 58 for the major repair units of the Rear Chassis.

Figure 58 **Rear Chassis Overview**



NBP Module

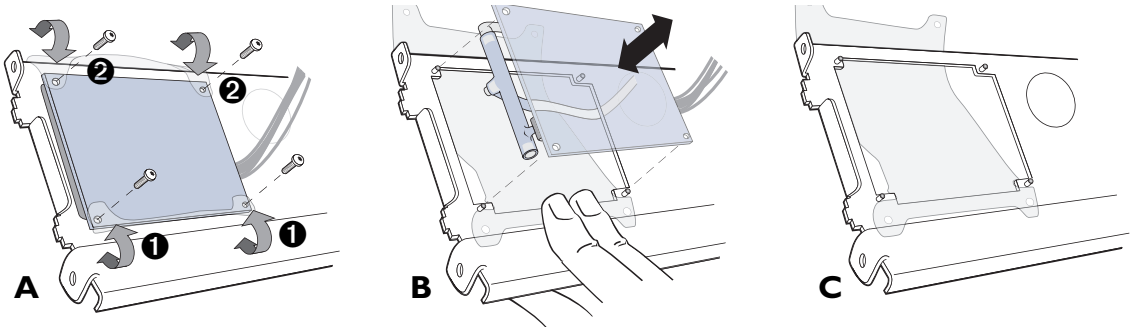
Preparation

1. Open the Case. See "Opening the Case" on page 87.
2. Position the HeartStart XL+ display side down and shelf side toward you.
3. Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.

Removal

1. Remove the four T10 screws, see Figure 59, A.

Figure 59 **NBP Module**



2. Remove the NBP Module, see Figure 59, B.
3. Remove the plastic shield.

Replacement

1. Position the Rear Chassis Shelf so that the shelf handle is up, and the NBP Module opening is to your left, see Figure 59, C.
2. Install the NBP plastic shield into the Rear Chassis Shelf, so that the notches in the shield fit around the metal corners.
3. Lift the shelf while holding the plastic shield in place. Slide the NBP Module into the NBP opening so that:
   a. the air tube is between the shelf and the plastic shield.
   b. the 10-wire bundle is above the shelf
   c. the NBP Module's plastic tubes are under the shelf, see Figure 59, B.
4. Align the plastic shield screw holes with the NBP Module mounting screw holes and the shelf standoffs, see Figure 59, A, ❶.
5. Secure the plastic shield with two M3x8 (T10) screws.
6. Wrap the plastic shield around the NBP Module and install the two other M3x8 (T10) screws, see Figure 59, A, ❷. Tighten the four screws to 6 inch-lb (0.7 N m).
7. Install the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
8. Bring the Rear Chassis into the upright position. See "Tilting Rear Chassis" on page 91. Make sure not to pinch the air tube.
9. Close the Case. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Internal Resistors Module

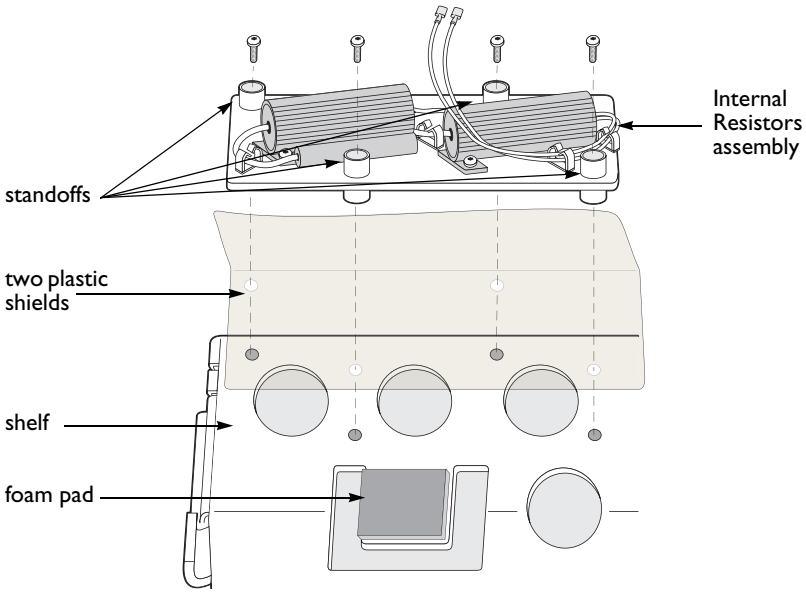
Preparation

1. Open the Case. See "Opening the Case" on page 87.
2. Position the HeartStart XL+ bottom side down, rear side toward you.
3. Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.

Removal

1. Remove the four T10 screws from the plastic standoffs, see Figure 60.
   Do not remove the standoffs. Do not detach the resistors from the aluminum mount.

Figure 60 **Internal Resistors**



2. Remove the Internal Resistors Module and the two plastic shields.

Replacement

1. Install the Internal Resistors Module and the two plastic shields, see Figure 60.
   Position the Internal Resistors Module so that the connectors are toward the foam pad, and the shield flap is toward the edge.
2. Install the four M3x8 (T10) screws in the plastic standoffs.
3. Tighten the screws to 6 inch-lb (0.7 N m).
4. Install the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
5. Close the Case. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Rear I/O Assembly

Preparation

1 Open the Case. See "Opening the Case" on page 87.

2 Tilt the Rear Chassis, see "Tilting Rear Chassis" on page 91.

3 Position the open HeartStart XL+ display side down, Capacitor to your left.

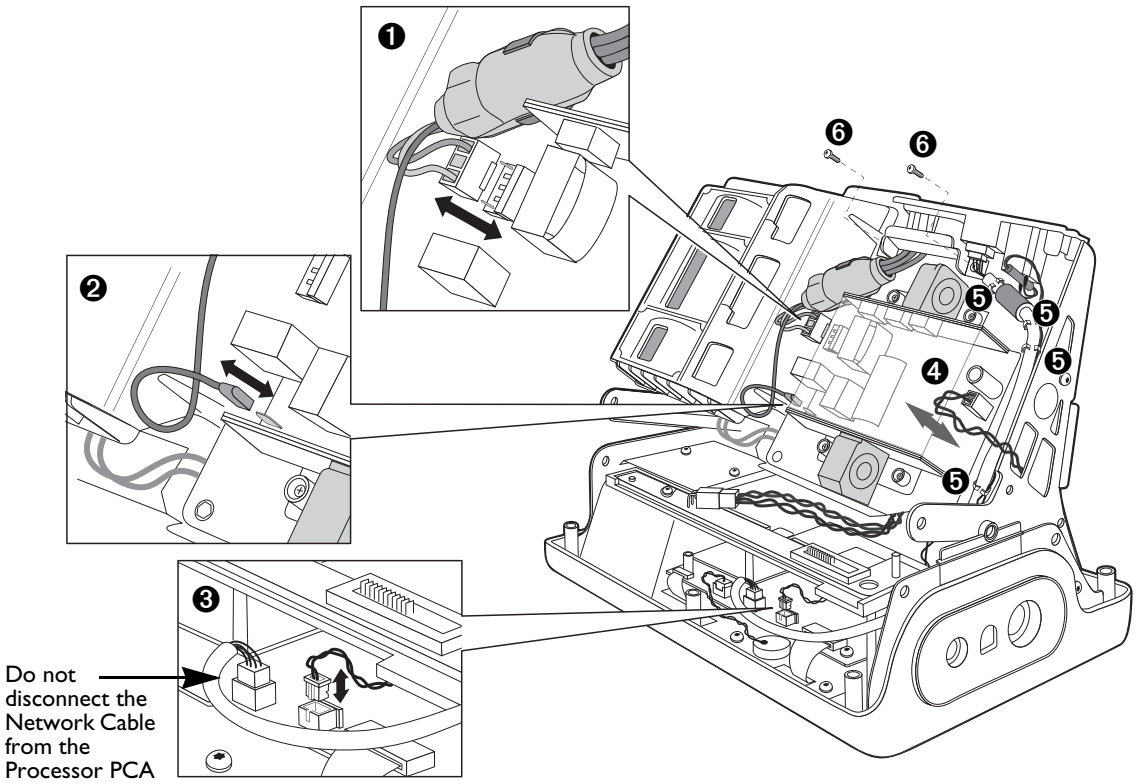
Removal

1 Disconnect the Power and ECG Out cables, see Figure 61:

- **a** Disconnect the AC power 2-wire bundle from the Power Supply (❶).
- **b** Disconnect the AC ground spade connector from the Power Supply (❷). Use pliers if necessary.
- **c** Disconnect the ECG Out 2-wire bundle from the Processor PCA (❸).
- **d** Disconnect the Therapy PCA power 2-wire bundle from the Power Supply (❹).

Do not disconnect the Network cable.

Figure 61 **Rear I/O Assembly**



2 Release the Network cable and ECG Out 2-wire bundle from the four saddle clamps (❺).

3 Remove the two T10 screws from the Rear I/O Assembly bracket (❻).

4 Remove the AC ferrite core from the AC ferrite clamp.

5 Disconnect the Network cable from the Rear I/O Assembly.

Replacement:

1. Connect the Network cable to the Rear I/O Assembly.
2. Install the AC ferrite core into the AC ferrite clamp.
   Make sure the bulge on the AC ferrite faces you and out of the clamp.
3. Install, but do not tighten the two M3x8 (T10) screws to position the Rear I/O Assembly (❻).
4. Install the wires into the saddle clamps (❺):
   a. Make sure no Fan wires escaped from the saddle clamps.
   The Lower Fan wires must be in the lower saddle clamp, and the Upper Fan wires must be in the three upper saddle clamps.
   b. Install the ECG Out 2-wire bundle into the three lower saddle clamps.
   c. Install the Network cable into all four saddle clamps.

   Route the ECG Out 2-wire bundle and the Network cable under the Battery Connection PCA and between the two tall standoffs to the right.
5. Connect Power and ECG Out:
   a. Reconnect the AC ground spade connector to the Power Supply (❶).
   b. Reconnect the AC power 2-wire bundle to the Power Supply (❷).
   c. Reconnect the ECG Out 2-wire bundle to the Processor PCA (❸).
   d. Reconnect the Therapy PCA power 2-wire bundle to the Power Supply (❹).
6. Ensure the connectors are fully seated.
7. Bring the Rear Chassis into the upright position, see "Tilting Rear Chassis" on page 91.
8. Tighten the two M3x8 (T10) screws to 6 inch-lb (0.7 N m) to secure the Rear I/O Assembly (❻).
9. Close the Case. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Fans

This procedure replaces both Fans.

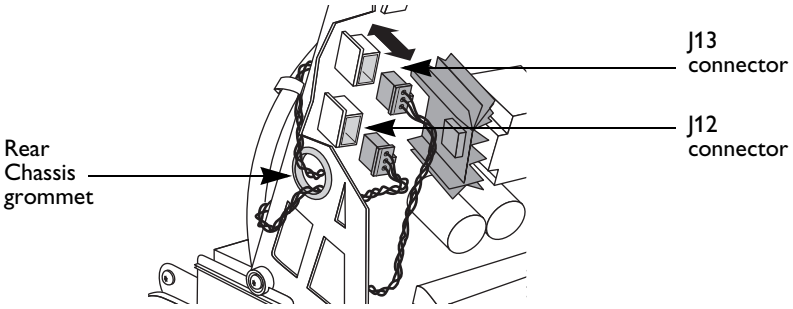
Preparation

1. Open the Case. See "Opening the Case" on page 87.
2. Position the open HeartStart XL+ display side down, Capacitor to your left.
3. Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.

Removal

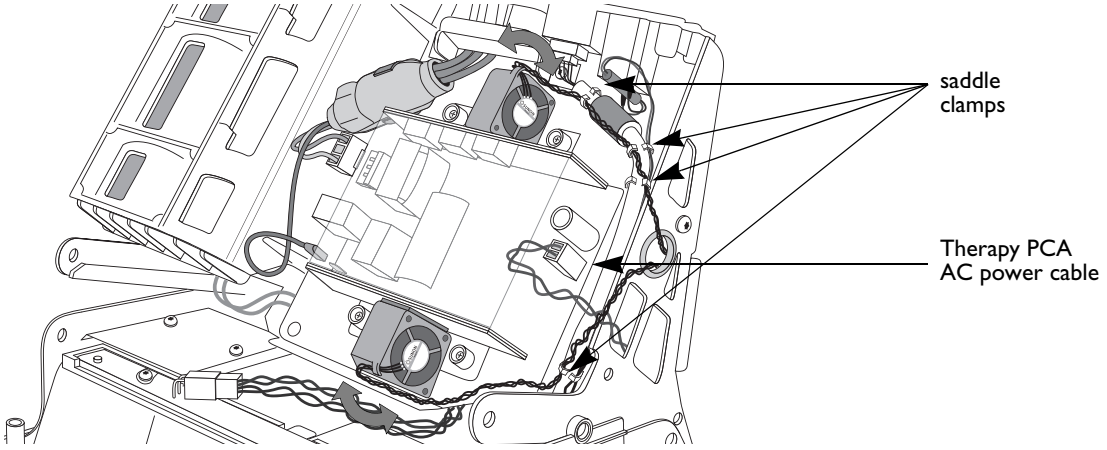
1. Disconnect both braided Fan cables from the Therapy PCA J12 and J13 connectors, see Figure 62.

Figure 62 **Fan Connectors**



2. Remove both Fan wires from the Rear Chassis grommet.
3. Disconnect the Therapy PCA AC power 2-wire bundle from the Power Supply (see Figure 63).
4. Release the Network cable, ECG Out 2-wire bundle, and both Fan braided wires from four saddle clamps (see Figure 63).

Figure 63 **Fan Wires**



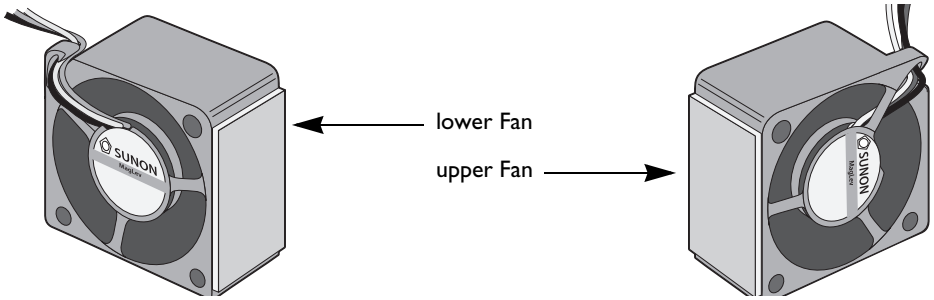
5. Remove the upper Fan:
   a. While holding the Capacitor Tray with your left hand, slowly rock the Fan side to side to loosen the adhesion, being careful not to damage the sheet metal.
   b. When the Fan is loose, lift it off of the adhesive.
6. Tilt the Rear Chassis. See "Tilting Rear Chassis" on page 91.
7. Repeat Step 5 to remove the lower Fan.

8 Peel the adhesive off of the sheet metal. Make sure that all of the adhesive is removed.

Replacement:

1 Clean the Fans and Power Supply aluminum plates. Do not touch the surfaces once you have cleaned them.
   a Wipe Fan sides with 70% isopropyl alcohol wipes and let them dry.
   Use Figure 64 to determine the adhesive side of the Fan.
   b Wipe the upper and lower Power Supply aluminum plates with 70% isopropyl alcohol wipes and let them dry. Make sure alcohol does not drip into the device.

Figure 64 **Fan Adhesive Pads**



2 Reinstall the lower Fan first:
   a Remove one side of the adhesive backing and secure it to the side of the lower Fan, as shown in Figure 64 (lower Fan).
   b Position the lower Fan, so that:
      – the label on the Fan's hub is facing away from the Capacitor Tray,
      – adhesive pad is facing the Power Supply, and
      – the braided bundle of Fan wires is facing you and away from the Power Supply.
      – the Fan is flush with the Power Supply insulator sheet.
   c Peel off the adhesives backing and install the Fan on the Power Supply sheet metal.
   Press and hold the Fan in place for 10 to 20 seconds to secure it to the metal.
3 Secure the Rear Chassis in the upright Position, see "Tilting Rear Chassis" on page 91.
4 Repeat all sub-steps of Step 2 to reinstall the upper Fan.
5 Install the wires into the saddle clamps (see Figure 63):
   a Install the lower Fan braided wire bundle into the lower saddle clamp.
   b Install the upper Fan braided wire bundle into in three upper saddle clamps.
   c Install the ECG Out 2-wire bundle into the three lower saddle clamps.
   Route the ECG Out 2-wire bundle under the Battery Connection PCA and its wires.
   d Install the Network cable into all four saddle clamps.
6 Thread both Fan braided wires through the Rear Chassis grommet.
7 Connect the Fan braided wires to the Therapy PCA in any order, see Figure 62 on page 102.
8 Ensure the connectors are fully seated.
9 Install the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
10 Close the device. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Power Supply Assembly

NOTE: Philips recommends replacing Fans during this repair. Purchase the 453564206371 kit and follow the instructions below.

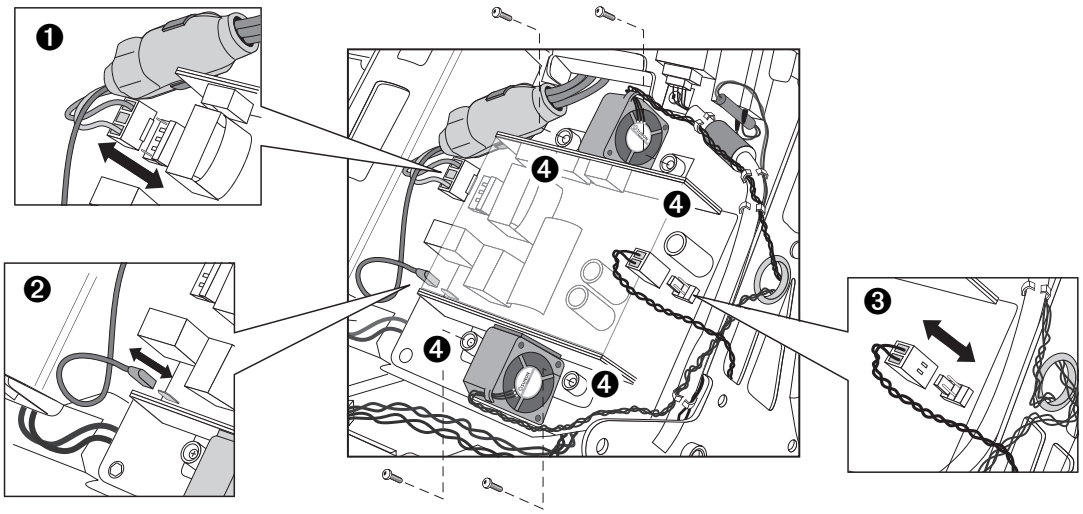
Preparation

1. Open the Case. See "Opening the Case" on page 87.
2. Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.

Removal

1. Disconnect both braided Fan bundles from the Therapy PCA, see Figure 62 on page 102.
2. Remove both braided Fan bundles from the Rear Chassis grommet.
3. Release the Network cable, ECG Out 2-wire bundle, and both Fan braided wires from four saddle clamps (see Figure 61 on page 100).
4. Disconnect Power Supply Assembly (see Figure 65):
   a. Disconnect the AC power 2-wire bundle from the Power Supply (❶).
   b. Disconnect the AC ground spade connector from the Power Supply (❷). Use pliers if necessary.
   c. Disconnect the Power Output Connector (❸).

Figure 65 **Power Supply**



5. Remove the four T10 screws from the Power Supply Assembly (❹).
6. Remove the Power Supply Assembly.
   Reuse the two plastic shields.

Replacement:

1. Align the two plastic shields with the screw holes.
2. Install the Power Supply Assembly.
   a. Position the ground spade connector to your left (see Figure 65, ❷).
   b. Secure to the Rear Chassis with the four M3x8 (T10) screws (❹).
   c. Tighten the screws to 6 inch-lb (0.7 N m).
3. Connect Power Supply Assembly (see Figure 65):
   a. Connect the AC power 2-wire bundle from the Power Supply (❶).
   b. Connect the AC ground spade connector from the Power Supply (❷).
   c. Connect the Power Output Connector (❸).
4. Ensure the connectors are fully seated.
5. Install the Fans, see "Fans" on page 102.
6. Secure the Rear Chassis in the normal Position, see "Tilting Rear Chassis" on page 91.
7. Close the device. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Therapy Capacitor and Therapy Capacitor Tray

Preparation

1 Open the Case. See "Opening the Case" on page 87.

2 Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.

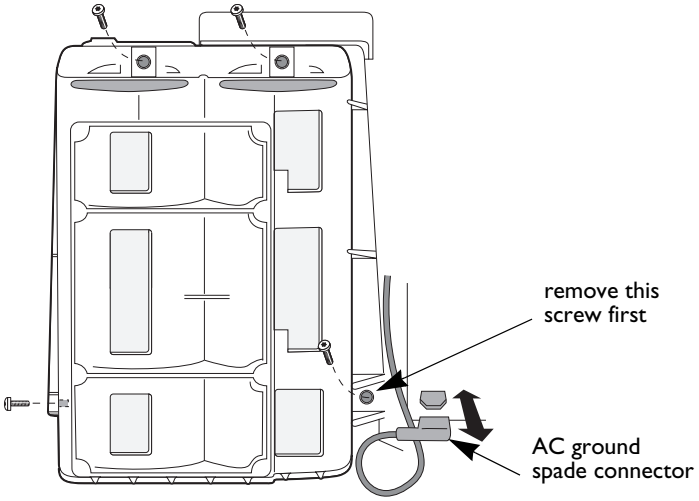
3 Position the open HeartStart XL+ display side down, Capacitor to your left.

Removal

1 Remove the bottom-right T10 screw (next to the Power Supply) from the Therapy Capacitor Tray first, see Figure 66.

CAUTION: Be careful not to drop the screw. Use tweezers; disconnect the AC ground spade connector if needed. If dropped, the screw may damage the Processor and SOM PCAs below.

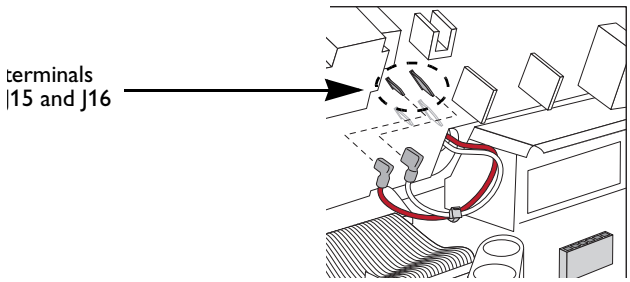
Figure 66 **Therapy Capacitor Tray**



2 Position the open HeartStart XL+ display side down, top side toward you.

3 Disconnect the Therapy Capacitor spade connectors from the Therapy PCA J15 and J16 terminals, see Figure 67.

Figure 67 **Therapy Capacitor Connectors**



4 Tilt the Rear Chassis. See "Tilting Rear Chassis" on page 91.

5 Carefully pass the spade connector bundle under the Rear Chassis.

CAUTION: Make sure not to scratch any PCA surfaces.

6 Remove the remaining three T10 screws from the Therapy Capacitor Tray.

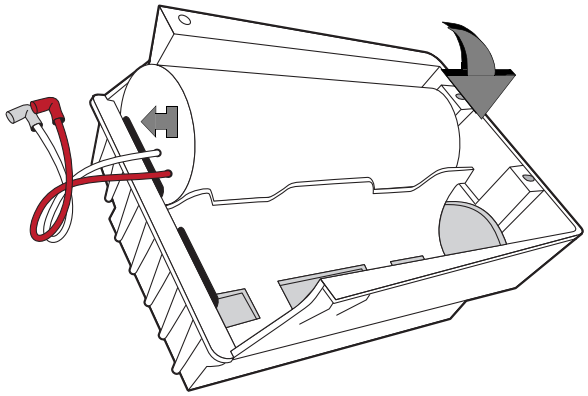
7 Remove the Therapy Capacitor with the Tray.

8 Push the Capacitor out of the Tray.

Replacement:

1 Install the Capacitor into the Tray.
   - **a** Position the Tray as shown in Figure 68.
   - **b** Position the Capacitor over the Tray compartment on the Power Supply side, with the red wire to the center of the compartment.
     Leave the other compartment empty.
   - **c** Install the wire end of the Capacitor first. Then press on the Capacitor to slip the other side into the Tray, see Figure 68.

Figure 68 **Therapy Capacitor Positioning**



2 Attach the Therapy Capacitor Tray to the Rear Chassis with four M3x8 (T10) screws.
   - **a** Start the top two screws first, do not tighten.
   - **b** Take care not to drop the bottom right screw while installing.
     Do not lay the device on the Therapy PCA side.
   - **c** Install the remaining screws and tighten all four screws to 6 inch-lb (0.7 N m).

3 Carefully pass the spade connector bundle under the Rear Chassis to the Therapy PCA side between the Printer PCA shield and Therapy PCA shield.

4 Reconnect two Therapy Capacitor spade connectors to the Therapy PCA, see Figure 67.
   There are two narrow spade connectors for the red wire and two wide spade connectors for the white wire. Use the upper pair of the connectors (J15 and J16).

5 Secure the Rear Chassis in the normal Position, see "Tilting Rear Chassis" on page 91.

6 Reconnect the AC ground spade connector if disconnected.

7 Ensure the connectors are fully seated.

8 Replace the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.

9 Close the device. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Pivoting Rear Chassis Downward

Pivot the Rear Chassis downward to access assemblies on the top of the Rear and Front Cases.

Preparation

1. Open the Case. See "Opening the Case" on page 87.
2. Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
3. Position the open HeartStart XL+ display side down, Therapy PCA facing you.

Removal

1. Disconnect cable connectors ①, ②, ⑤ only from the Therapy PCA, see Figure 69 and Table 33.

Figure 69 **Therapy PCA Connections**

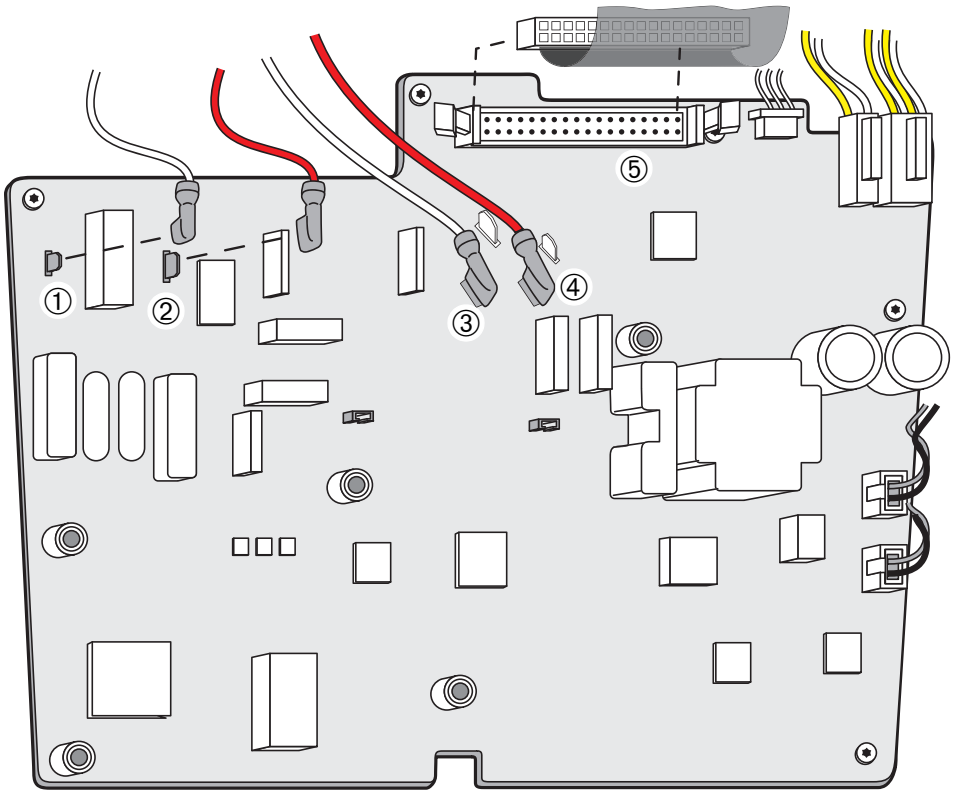


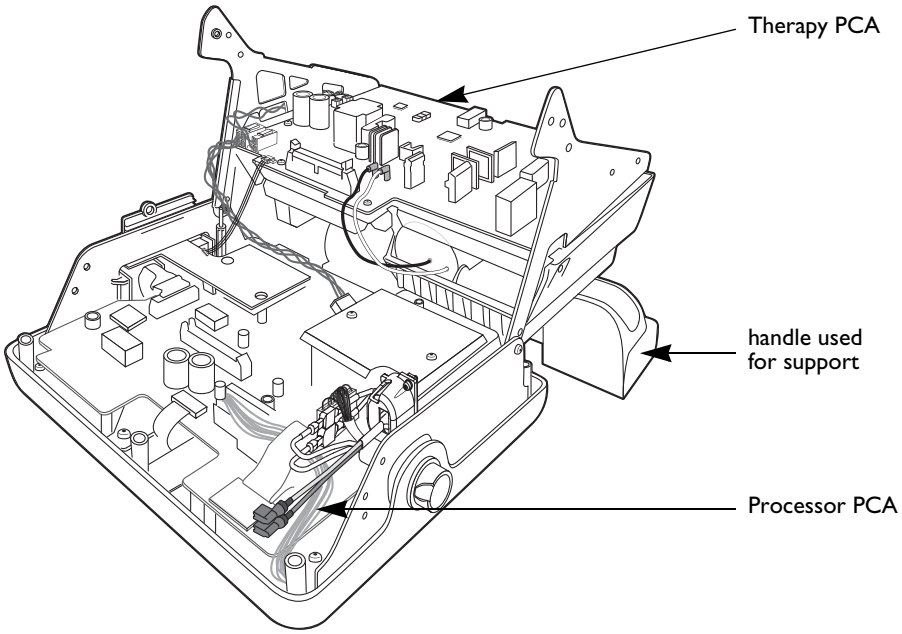
Table 33 **Therapy PCA – Rear Chassis Connections**

Ref. #	PCA Mark	Description	Connects To	Disconnect By
①	J10, Apex	narrow spade connector, white wire	Therapy Port extension	Pull, wiggle, use pliers if needed
②	J8, Sternum	wide spade connector, red wire		
③	J16, White	wide spade connector, white wire	Therapy Capacitor	Do not disconnect yet
④	J15, Red	narrow spade connector, red wire		
⑤	J4	ribbon cable	Processor PCA	Release latches at edges of connector, pull

2 Pivot the Rear Chassis downward:
   a Remove the T10 screws ❶, ❺, and ❼, see Figure 52 on page 91.
   b Loosen but not remove the screws ❸ and ❹.
   c Pivot the Rear Chassis around the axis formed by the screws ❸ and ❹.

TIP: Place the device Handle under the Capacitor Tray for support, see Figure 70.

Figure 70 **Rear Chassis Pivoted Downward**



To bring the Rear Chassis into the upright position:

1 Disconnect the ribbon cable ⑤ from the Processor PCA and connect to the Therapy PCA.
2 Secure the Rear Chassis in the upright position.
Install and secure the M3x8 (T10) screws ❶ – ❼, see Figure 52 on page 91. Tighten to 6 inch-lb (0.7 N m).
3 Reconnect the ribbon cable ⑤ to the Processor PCA.
4 Reconnect the spade connectors ①, ②, see Figure 69 and Table 33.
5 Ensure the connectors are fully seated.
6 Replace the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.

Therapy PCA

Removing the Therapy PCA involves disconnecting many cables and removing many screws. Take your time and be methodical.

CAUTION: Never touch the Therapy PCA surface with your fingers.
Keep the replacement Therapy PCA in the antistatic pouch until ready to install.

Preparation

1. Open the Case. See "Opening the Case" on page 87.
2. Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
3. Position the open HeartStart XL+ display side down, Therapy PCA facing you.
4. Pivot the Rear Chassis downward. See "Pivoting Rear Chassis Downward" on page 108.

Removal

1. Disconnect all remaining Therapy PCA cables, ⑥ – ⑩, see Table 34 and Figure 71.
   You have already disconnected cables ①, ②, ⑤ when pivoted the Rear Chassis downward.
   a. Disconnect cables ③, ④, ⑥ – ⑩.

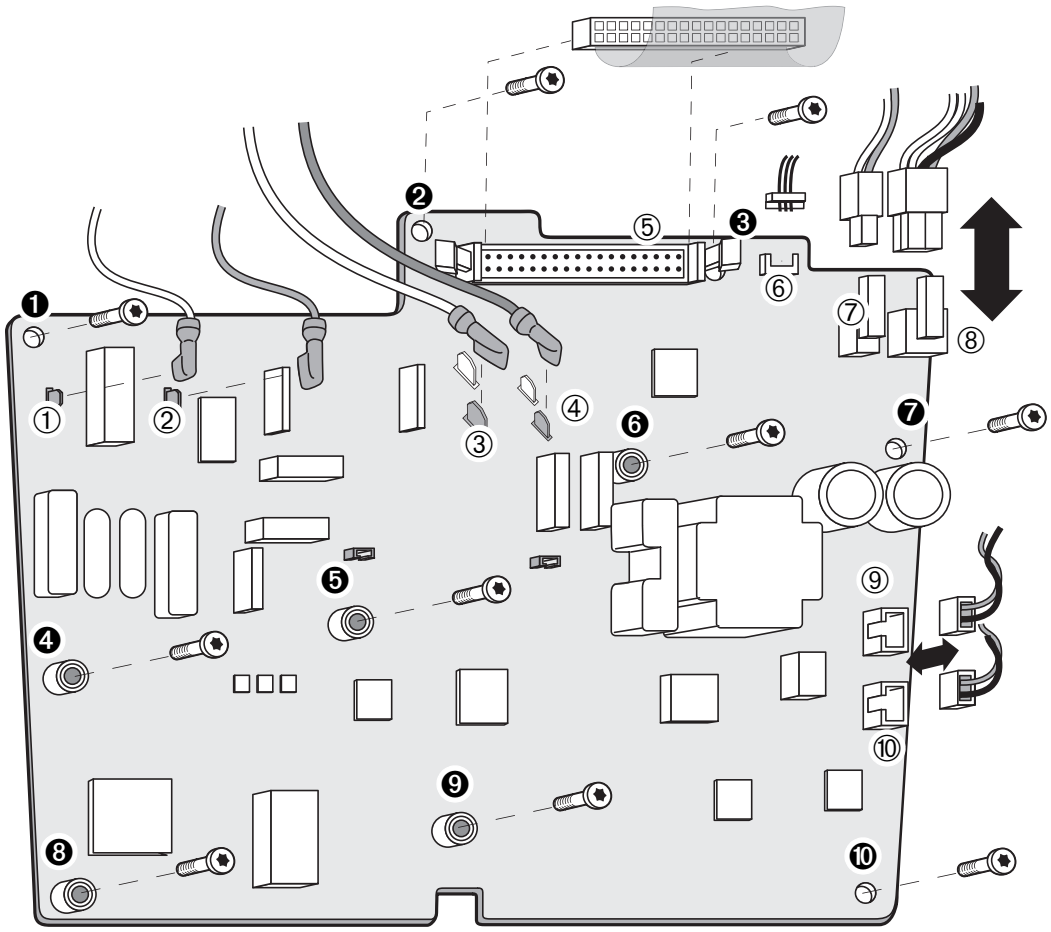
TIP: Use your fingernails to disconnect the battery data cable ⑥. Do not use any tools to avoid crushing the fragile connector ⑥.

   b. Remove both Fan wires (⑨, ⑩) from the Rear Chassis grommet.
   c. Remove the Therapy PCA AC Power supply wire ⑦ from the Rear Chassis opening.

Table 34 **Therapy PCA Connections**

Ref. #	PCA Mark	Description	Connects To	Disconnect By
①	J10, Apex	narrow spade connector, white wire	Therapy Port extension	Pull, wiggle, use pliers if needed
②	J8, Sternum	wide spade connector, red wire		
③	J16, White	wide spade connector, white wire	Therapy Capacitor	
④	J15, Red	narrow spade connector, red wire		
⑤	J4	ribbon cable	Processor PCA	Release latches at the connector sides, pull
⑥	J5	3-wire bundle	Battery PCA	Gently pull, wiggle
⑦	J1	2-wire bundle	Power supply	Push on latch to release, pull, wiggle
⑧	J2	4-wire bundle	Battery PCA	
⑨	J12	3-wire bundle	Fans	Pull, wiggle
⑩	J13	3-wire bundle		

Figure 71 **Therapy PCA Connectors and Screws**



2 Remove the ten T10 screws, see Figure 71, ❶ – ❿, from the Therapy PCA.

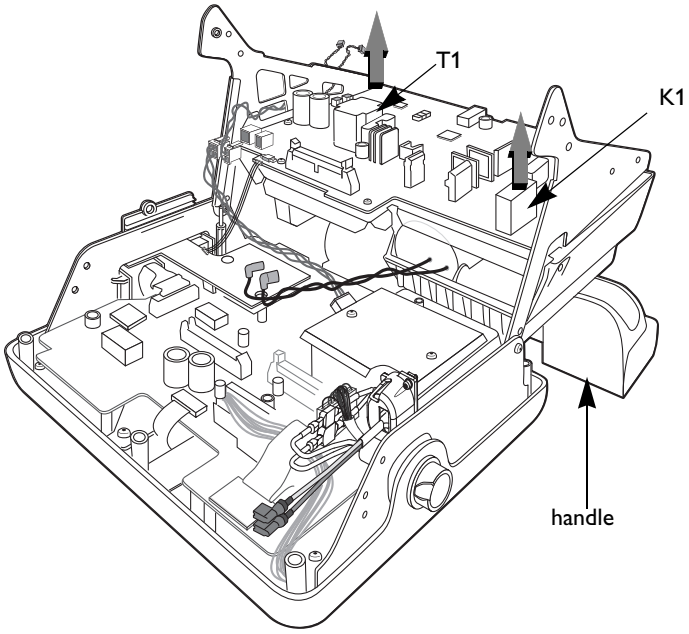
3 Move all the wires aside.

4 Carefully but firmly grasp the Therapy PCA at positions K1 and T1 (see Figure 72) and lift the Therapy PCA straight up.

NOTE: The Therapy PCA is shaped as a trapezoid and must be lifted straight up. Do not attempt to slide the Therapy PCA from the Rear Chassis sideways, because it may get wedged and damaged.
There are two plastic shields under the Therapy PCA. Make sure you reuse both of them in the replacement procedure.

5 Leave the two plastic shields in place.

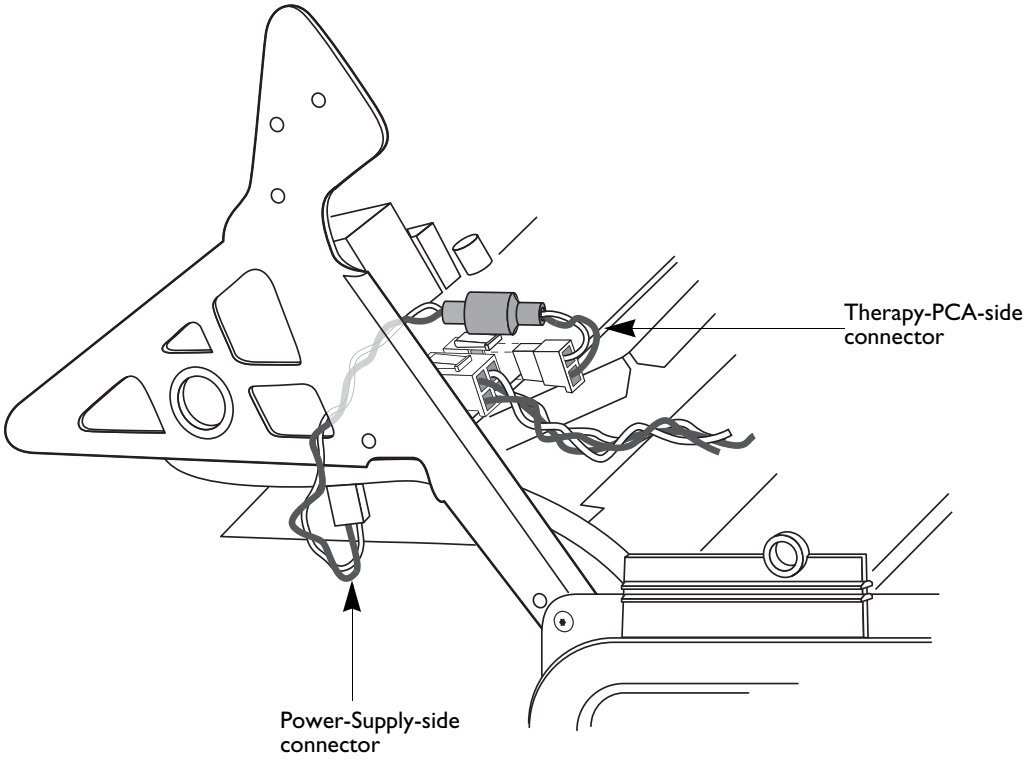
Figure 72 **Therapy PCA Removal**



Replacement:

1. Position the Therapy PCA in the Rear Chassis:
   - **a** Move all the wires aside.
   - **b** Align both plastic shields with the screw holes.
   - **c** Carefully but firmly grasp the positions K1 and T1 of the new Therapy PCA (see Figure 72) and lower the Therapy PCA onto the Rear Chassis.
2. Secure the Therapy PCA with the ten T10 screws, see Figure 71, ❶ – ❿, to .
   Note that the screws in positions ❹, ❺, ❻, ❽, and ❾ (standoff positions) are M3 x 14 mm, and the remaining screws are M3 x 8 mm. See "Screw Usage" on page 70.
   - **a** Manually start the screws ❶ – ❿.
   - **b** Tighten the screws ❶ – ❿ to 6 inch-lb (0.7 N m). Use a criss-cross sequence, e.g. ❶-❿-❷-❾-❸-❽-❼-❹-❻-❺.
3. Thread both Fan wires (⑨, ⑩) through the Rear Chassis grommet.
4. Thread the Therapy PCA Power Supply cable connector ⑦ through the side opening of the Rear Chassis as shown in Figure 73, and reconnect.
5. Reconnect cable connectors ③, ④, ⑥ and ⑧ – ⑩, see Table 34 on page 110 and Figure 71 on page 111.
   The Fan wires (⑨, ⑩) can be connected to J12 and J13 in any order.
6. Ensure the connectors are fully seated.

Figure 73 **Therapy PCA Power Supply Connection**



7 Bring the Rear Chassis into the upright position. See "Pivoting Rear Chassis Downward" on page 108.

8 Close the device. See "Closing the Case" on page 151.

To Complete the Replacement:

1 Upgrade the software to ensure the Therapy PCA firmware is compatible with the software installed on the SOM and Processor PCAs. See "Software Upgrades" on page 11.

2 Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

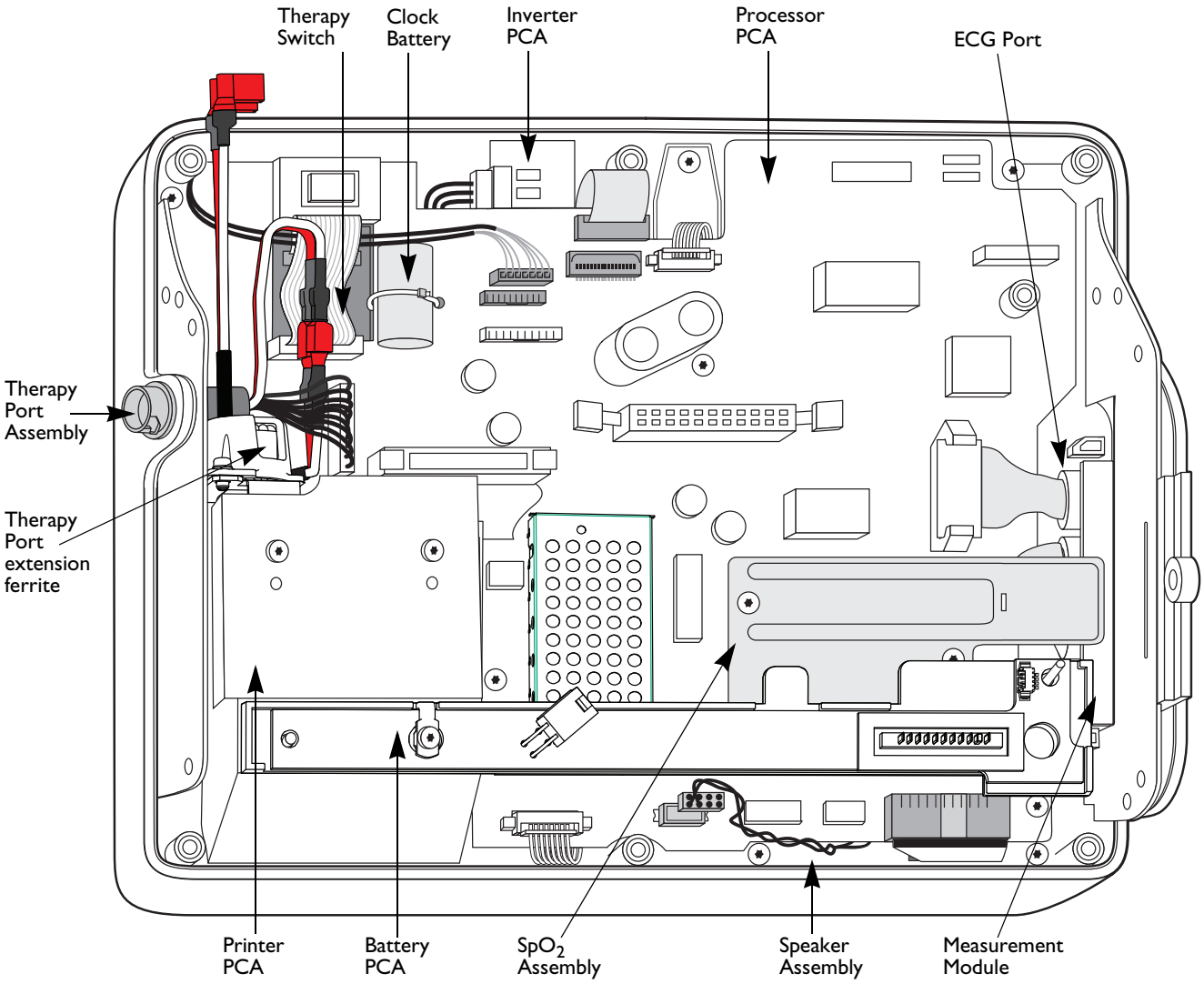
Internal Assemblies — Front Chassis

This section is organized into the following topics:

Front Chassis Overview

See Figure 74 for the major repair units of the Front Chassis. The Display Assembly, Human Interface (HIF) PCA, and Therapy Buttons are not visible behind the Processor PCA. The SpO_2 Port is not visible behind the SpO_2 Assembly shield.

Figure 74 **Front Chassis Overview**



Battery PCA

Battery PCA is accessible with the Rear Chassis tilted on top of the Front Chassis.

Preparation

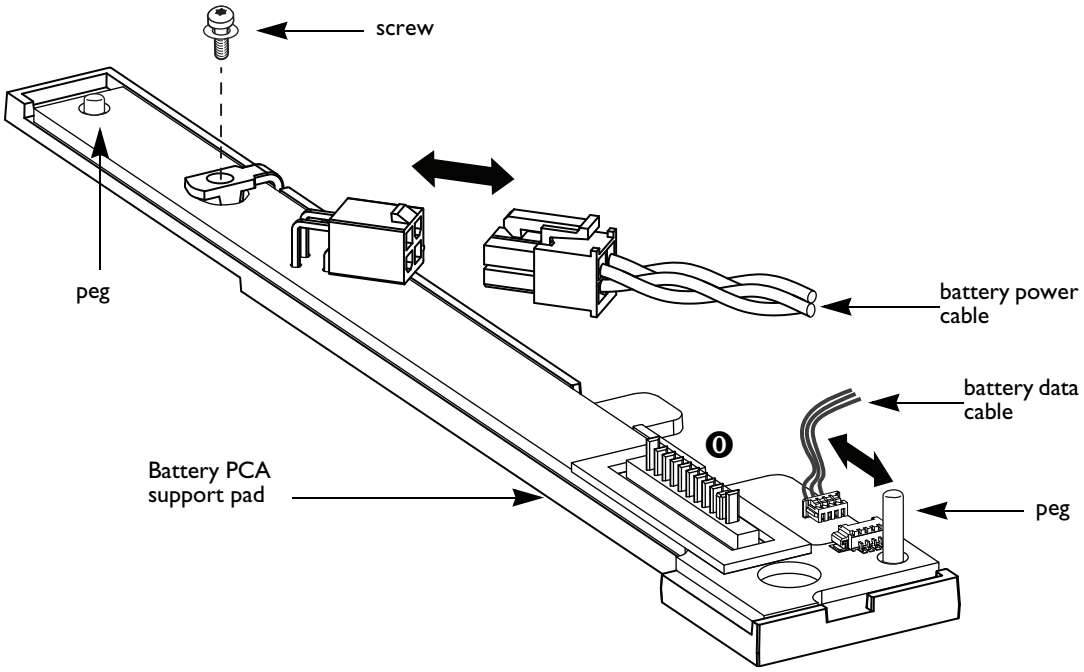
1. Open and separate the Case. See "Opening the Case" on page 87.
2. Tilt the Rear Chassis. See "Tilting Rear Chassis" on page 91.
3. Position the device on the work surface with the display facing down and the printer to your left.

Removal

1. Disconnect the battery power and battery data cables, see Figure 75.

TIP: Use your fingernails to disconnect battery data cable.
Do not use any tools to avoid crushing the connector.

Figure 75 **Battery PCA Connections and Screws**



2. Remove the M3x8 (T10) screw.

Replacement

NOTE: The Battery PCA is designed to "float" and is loosely secured on the Front Chassis to ensure effortless Battery connection. Do not try to tighten the Battery PCA.
The replacement Battery PCA comes as an assembly with the Battery PCA support pad. Do not separate the PCA from the support pad. If they become accidentally separated, assemble them taking extra care not to break off the support bracket.

1. Position the Battery PCA support pad with the Battery PCA on the two pegs, see Figure 75.
2. Thread the Network and ECG Out cables between the two tall standoffs to the right and under the Battery PCA.
3. Replace and tighten the M3x8 (T10) screw to 6 inch-lb (0.7 N m).
The Battery PCA intentionally remains loosely secured.

4 Reconnect the battery power and battery data connectors.
Make sure no wires are threaded in the area marked ⓿ to avoid pinching between the lower Fan and Battery PCA support pad.

5 Ensure the connectors are fully seated.

6 Bring the Rear Chassis into the upright position. See "Tilting Rear Chassis" on page 91.

7 Reassemble and close the device. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Clock Battery

The rechargeable lithium Clock Battery resides on the Processor PCA, next to the Therapy Knob connector. A cable tie wrap and a package of ProGold wipes are included in the replacement kit. Make sure you clean the contact clips and the new battery terminals with a ProGold wipe and replace the cable tie wrap that holds the battery in place.

Preparation

1. Open and separate the case. See "Opening the Case" on page 87.
2. Pivot the Rear Chassis downward. See "Pivoting Rear Chassis Downward" on page 108.
3. Position the device with the display facing down and the Measurement Module to your left.

Removal and Cleaning

1. Remove the battery from the Processor PCA.
   a. Use a pair of fine-nose wire cutters to cut and remove the cable tie wrap that holds the battery in place.
   b. Remove the battery from the holder.
   c. Follow local rules and regulations regarding battery disposal.
2. Thoroughly clean the contact clips and new battery terminals with the wipes included in the kit.

Replacement

1. Insert the new battery into the holder.

CAUTION: Make sure that you install the new battery with the correct orientation. Follow the polarity markings on the battery holder (under the battery).

2. Bend the cable tie wrap to thread it through a small hole to the left of the battery and out of the square opening to the right.
3. Secure the battery with the cable tie wrap.
   Do not overtighten; use your hands, not pliers.
4. Cut off the excess tie wrap.
5. Bring the Rear Chassis into the upright position. See "Pivoting Rear Chassis Downward" on page 108.
6. Close the case. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Therapy Port

Therapy Port nut socket, part # 453564556231 is the preferred tool for this repair.

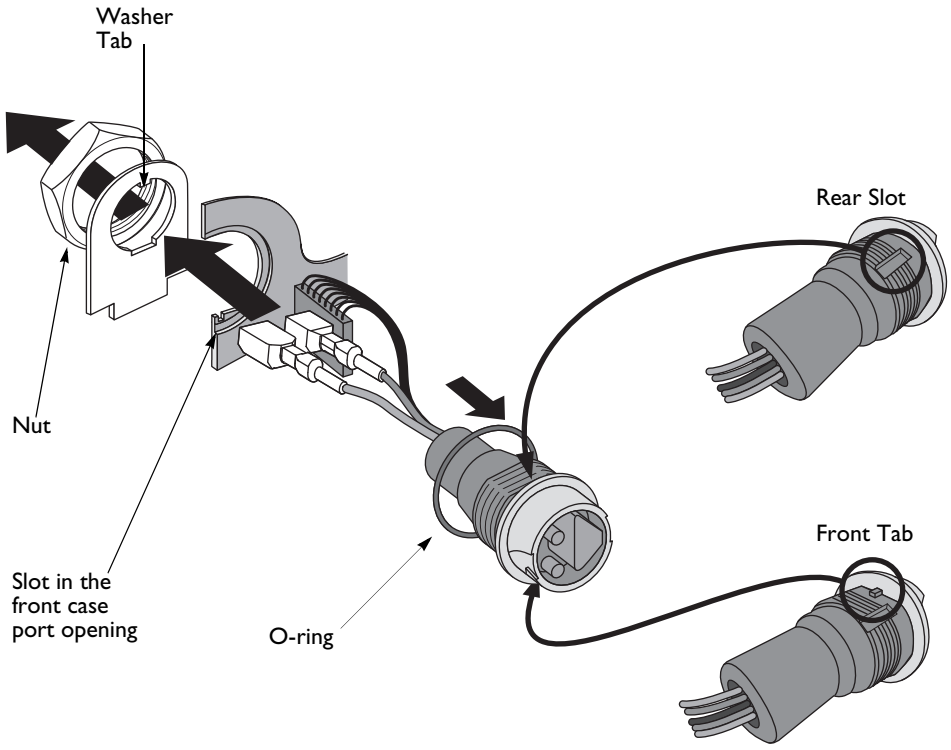
Preparation

1. Position the device with the display facing down and the Measurement Module to your left.
2. Pivot the Rear Chassis downward. See "Pivoting Rear Chassis Downward" on page 108.

Removal

1. Disconnect the Therapy Port 9-wire bundle from the Processor PCA, see Table 35 on page 135, ①.
2. Unscrew the large nut.
   If available, use the Therapy Port nut socket to unscrew the large nut on the back of the Therapy Port. Use an open-jaw adjustable wrench if the socket is not available.
   Do not use pliers with sharp teeth because if they slip, they can create small metal shavings trapped inside the box that may affect performance of your HeartStart XL+.
3. Remove the hardware.
   Remove the nut and washer from the Therapy port. Guide the wires and connectors through the nut and washer. Turn the 9-pin connector so it passes through sideways.
4. Remove the Therapy Port.
   Slide the Therapy Port out of its hole in the Front Case. Guide the wires and connectors through the hole.

Figure 76 **Therapy Port**



Replacement

1. Replace the Therapy port. See Figure 76.
   - **a** Install the washer into the guides inside the Front Case wall next to the Therapy Port opening.
   - **b** Install the O-ring onto the Therapy port.
   - **c** Slide the Therapy port into its hole in the case. Guide the wires and connectors through the hole and the washer. Turn the 9-wire connector sideways so it passes through first.
   - **d** Guide the wires and connectors the same way through the nut.
   - **e** Reconnect the Therapy Port 9-wire bundle to the Processor PCA, see Table 35 on page 135, ①.
   - **f** Ensure the connector is fully seated.
   - **g** Hold the O-ring while engaging the Front Tab into the slot of the Therapy Port opening. Make sure:
     - The O-ring is not visible on either side of the case
     - The washer tab is engaged with the Rear Slot of the Therapy port.
     - The washer is engaged with the ribs on the Front Case wall.
2. Replace the nut.
   - **a** Manually start the nut to avoid cross-threading the metal nut on the plastic connector.
   - **b** Tighten the nut against the metal plate with the Therapy Port nut socket at 20 inch-lb. (2.3 N m).
     If the Therapy Port nut socket is not available, then do not use pliers with sharp teeth because if they slip, they can create small metal shavings trapped inside the box that may affect performance of your HeartStart XL+.
3. Bring the Rear Chassis into the upright position. See "Pivoting Rear Chassis Downward" on page 108.
4. Close the case.
   See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Therapy Switch

Preparation

1. Remove the Therapy Knob. See “Therapy Knob” on page 86.
2. Loosen and remove the 9/16-inch nut and washer, see Figure 77.
3. Open and separate the case. See “Opening the Case” on page 87.
4. Position the device with the display facing down and the Measurement Module to your left.
5. Pivot the Rear Chassis downward. See “Pivoting Rear Chassis Downward” on page 108.

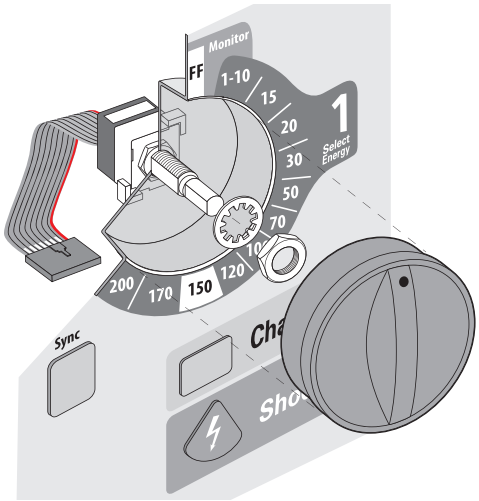
Removal

1. Unplug the ribbon cable from the Processor PCA.
2. Remove the Therapy switch.

Replacement

1. Position the switch, as shown in Figure 77.
   Position the red stripe on the ribbon cable on the edge closest to the Therapy Port.

   Figure 77 **Therapy Switch**



2. Connect the ribbon cable to the Processor PCA without twisting or kinking the cable. Ensure the connector is fully seated.
3. Replace the washer and nut. Tighten the nut to 12 inch-lb. (1.4 N m).
4. Replace the Therapy Knob. See “Therapy Knob” on page 86.
5. Bring the Rear Chassis to normal position. See “Pivoting Rear Chassis Downward” on page 108.
6. Close the case. See “Closing the Case” on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the “Performance Verification” chapter.

Pivoting Rear Chassis Upward

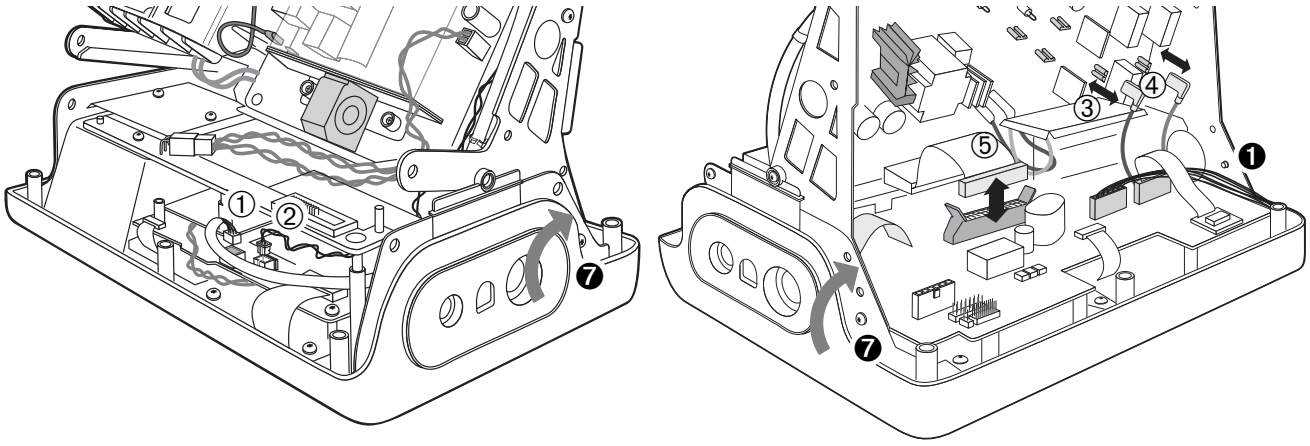
Pivot the Rear Chassis upward to access these Front Case assemblies:

- Printer PCA
- Measurement Module and the Ports and the ECG, SpO_2, and NBP Ports
- SpO2 PCA

To pivot the Rear Chassis upward:

1. Open the HeartStart XL+ Case. See "Opening the Case" on page 87.
2. Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
3. Tilt the Rear Chassis. See "Tilting Rear Chassis" on page 91.
4. Disconnect the cables between the Rear and Front Chassis:
   a. Detach the Battery PCA screw, but leave the Battery Power (4-wire) and Battery Data (3-wire) bundles connected, see "Battery PCA" on page 116.
   b. Disconnect the Network Cable from the Processor PCA, see Figure 78, ①.
   c. Disconnect the ECG Out 2-wire bundle from the Processor PCA, see Figure 78, ②.
   d. Turn the HeartStart XL+ around and disconnect the Therapy Port spade connectors, see Figure 78, ③ and ④.
   e. Disconnect the Therapy PCA ribbon cable from the Processor PCA, see Figure 78, ⑤.

Figure 78 **Rear Chassis Connectors and Screws**

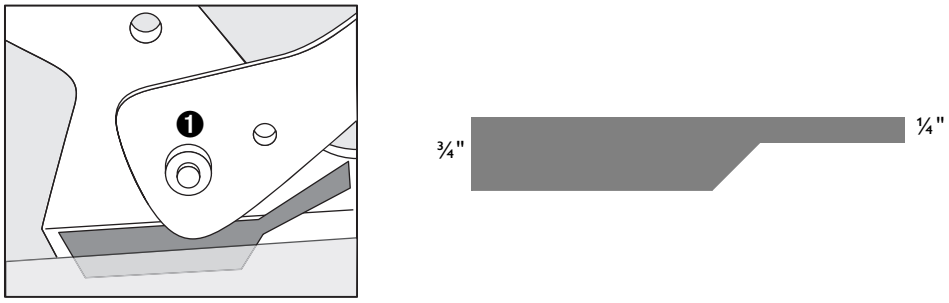


5. Position two plastic strips on the Front Chassis under the screws ❶ and ❼ as shown in Figure 78 and Figure 79.
   The plastic strips protect the chassis from grinding against each other. The grinding can create small metal shavings trapped inside the box that may affect performance of your HeartStart XL+.

TIP: Strips of a discarded plastic shield or dielectric tape offer good protection.

6. Holding the Rear Chassis by the Capacitor Tray, pivot the Rear Chassis until its feet push against the plastic strips, see Figure 79.
   Make sure no cables get entangled in the SpO_2 PCA or SpO_2 shield.

Figure 79 **Rear Chassis Feet Protection**



7 Remove the Battery PCA, see "Battery PCA" on page 116.

To bring the Rear Chassis into the upright position:

1 Install the Battery PCA screw, see "Battery PCA" on page 116.
Do not attach the Battery PCA connectors.

2 Bring the Rear Chassis to the tilted position and tighten the screws ❶ and ❼, see "Tilting Rear Chassis" on page 91.

3 Remove the plastic pieces from under the Rear Chassis feet.

4 Reconnect the cables between the Rear and Front Chassis:
   - **a** Reconnect the Battery PCA 4-wire and 3-wire bundles, see Figure 75 on page 116.
   - **b** Reconnect the Network Cable to the Processor PCA, see Figure 78 on page 122, ①.
   Thread below the Battery PCA 3-wire bundle.
   - **c** Reconnect the ECG Out 2-wire bundle to the Processor PCA, see Figure 78, ②.
   - **d** Turn the device around and reconnect the Therapy PCA ribbon cable to the Processor PCA, see Figure 78, ⑤.
   - **e** Reconnect the Therapy Port spade connectors, see Figure 78, ③ and ④.
   - **f** Ensure the connectors are fully seated.

5 Replace the Rear Chassis Shelf, see "Rear Chassis Shelf" on page 93.

Printer PCA

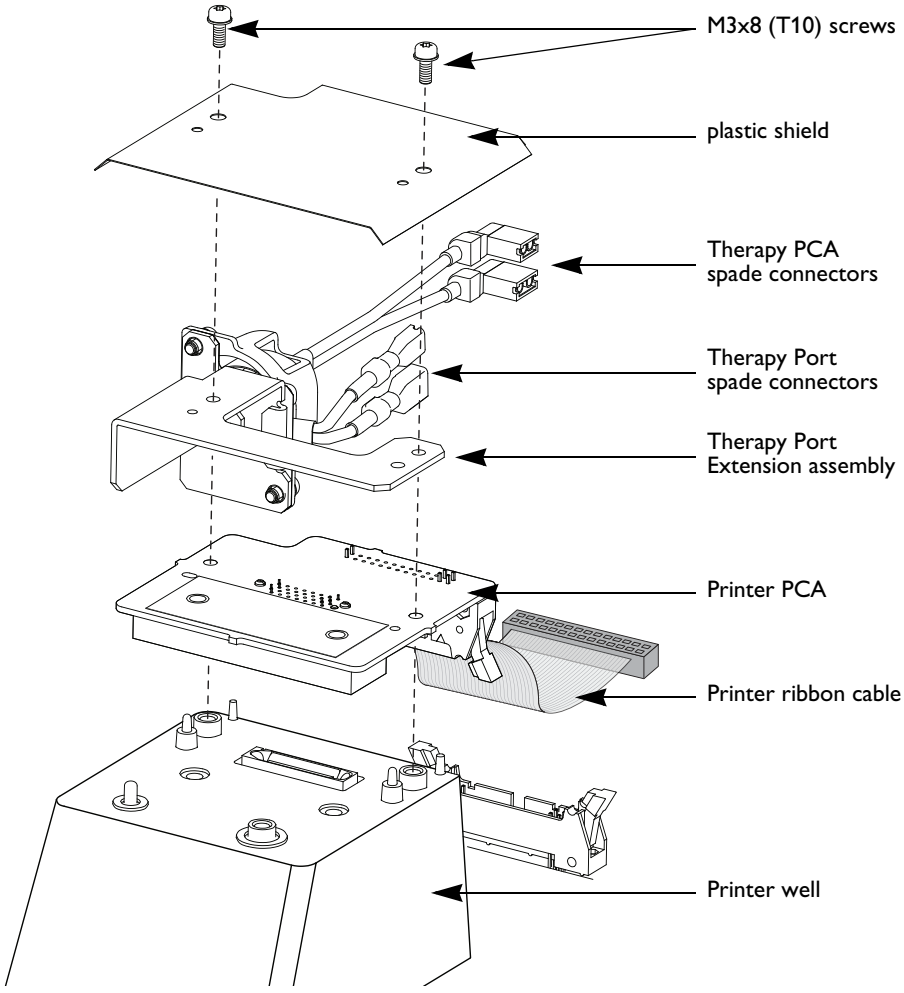
Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Pivot the Rear Chassis upward. See "Pivoting Rear Chassis Upward" on page 122.
3. Position the device with the display facing down and the printer compartment to your left.

Removal

1. Remove the Therapy Port Extension assembly, see Figure 80:
   a. Disconnect the Therapy Port Extension assembly spade connectors from the Therapy Port and from the Therapy PCA.
   b. Loosen and remove the two T10 screws.
   c. Lift up the plastic shield.
   d. Lift up the Therapy Port Extension assembly.
2. Disconnect the Printer ribbon cable from the Processor PCA.
3. Lift the Printer PCA with the ribbon cable.
4. Disconnect the Printer ribbon cable from the Printer PCA.

Figure 80 **Printer PCA**



Replacement

1. Connect the new Printer PCA to the Processor PCA with the Printer ribbon cable. Ensure the connector is fully seated.
2. Install the Printer PCA on the plastic pegs.
3. Install the Therapy Port Extension assembly on the plastic pegs.
4. Install the plastic shield on the plastic pegs, folds on top and both sides facing the Processor PCA, see Figure 80.
5. Install the two M3x8 (T10) screws, tighten to 6 inch-lb (0.7 N m).
6. Reconnect the Therapy Port Extension assembly spade connectors to the Therapy Port (straight connectors) and to the Therapy PCA (angle connectors).
7. Bring the Rear Chassis into the upright position. See "Pivoting Rear Chassis Upward" on page 122.
8. Reassemble and close the device. See "Closing the Case" on page 151.
9. Reinstall the Printer Assembly. See "Printer Assembly" on page 85.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

SpO_2 PCA

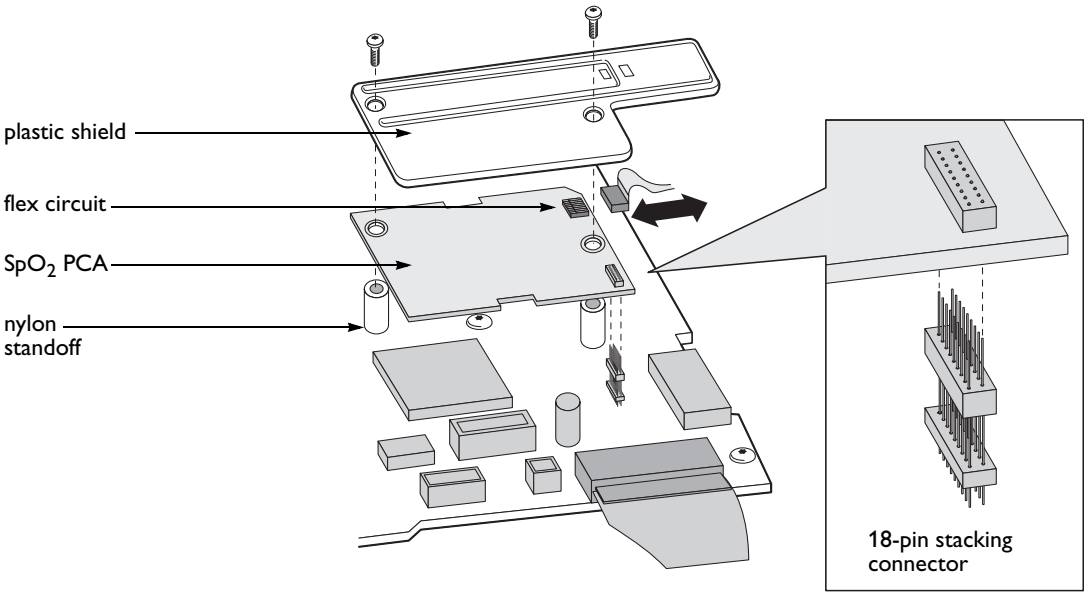
Preparation

1. Open and separate the case. See "Opening the Case" on page 87.
2. Position the device with the display facing down and the printer compartment to your left.
3. Pivot the Rear Chassis upward. See "Pivoting Rear Chassis Upward" on page 122.

Removal

1. Remove the plastic shield, see Figure 81.
   a. Loosen and remove the two T10 screws.
   If the left screw comes out with the nylon standoff underneath, then remove the screw from the standoff and manually install the standoff back into the Processor PCA. Make sure to not cross-thread the standoff and torque to no more than 1 inch-lb.
   b. Lift up the plastic shield.

Figure 81 **SpO_2 PCA Removal**



2. Disconnect the SpO_2 flex circuit from the SpO_2 PCA.
   Grasp the connector and pull sideways. Wiggle slightly.
3. Lift the SpO_2 PCA.
   As you lift the SpO_2 PCA, it will disconnect from the Processor PCA. The 18-pin stacking connector may lift up with the SpO_2 PCA or it may stay connected to the Processor PCA. In either case, keep the connector, because you will need it for the replacement procedure.

Replacement

1. Secure the 18-pin stacking connector to the Processor PCA.
   a. If the stacking connector is sitting on the Processor PCA, leave it in place, but make sure it is firmly engaged in the socket.
   b. If the stacking connector is sitting on the SpO_2 PCA, remove it and insert the short plug into the J1004 socket on the Processor PCA. Make sure that all pins are properly aligned and the stacking connector is firmly engaged in the socket.
   c. If the stacking connector is disconnected, then insert the short plug into the J1004 socket on the Processor PCA. Make sure that all pins are properly aligned and the stacking connector is firmly engaged in the socket.
2. Place the SpO_2 PCA in position.
   a. Line up the screw holes on the SpO_2 PCA with the standoffs on the Processor PCA.
   b. Line up all 18 holes on the SpO_2 PCA with the 18-pin stacking connector on the Processor PCA. Push gently to ensure that the pins on the stacking connector are fully engaged.

TIP: Observe the tips of all the 18 pins of the stacking connector show up above the PCA socket.

3. Connect the SpO_2 flex circuit to the SpO_2 PCA. Make sure it slides all of the way in.
4. Place the plastic shield over the SpO_2 PCA and install the two M3x8 (T10) screws.

CAUTION: The left screw is secured in a nylon standoff. Make sure to not cross-thread the standoff and manually torque to no more than 3 inch-lb. (0.3 N m).
Tighten the other screw to 6 inch-lb (0.7 N m).

5. Bring the Rear Chassis into the upright position. See "Pivoting Rear Chassis Upward" on page 122.
6. Close the case. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Measurement Module and the Ports

The Measurement Module assembly consists of the measurement ports: ECG Port, SpO_2 Port (optional), NBP Port (optional), and CO_2 Port (optional). Depending on the installed options, the Measurement Module face plate may look different, and the removal and replacement procedures are different.

Preparation

- Open and separate the case. See "Opening the Case" on page 87.

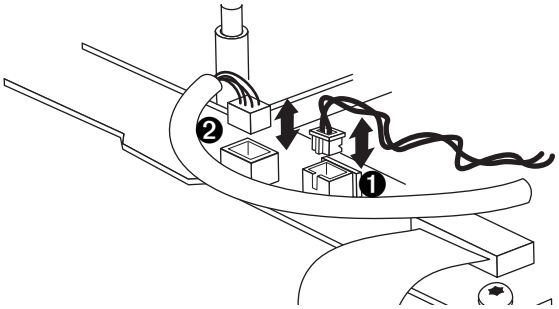
Measurement Module with the CO_2 Port

If your HeartStart XL+ does not have the $EtCO_2$ option installed, then refer to "Measurement Module without the CO2 Port" on page 132.

Removal

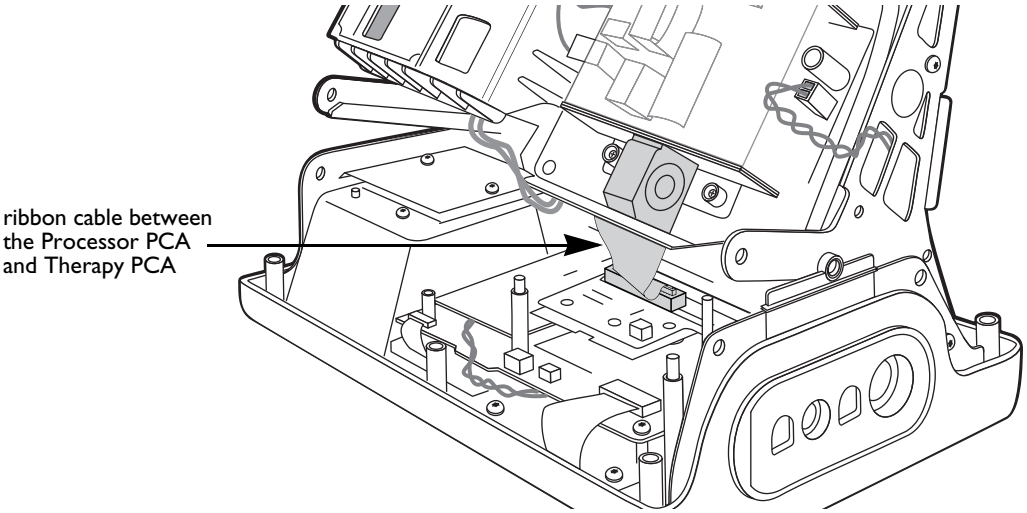
1. Remove the Battery PCA. See "Battery PCA" on page 116.
2. Position the device with the display facing down, and the printer compartment to your left.
3. Disconnect the ECG Out bundle, see ❶, Figure 82.

Figure 82 **Disconnecting Wires (for the CO_2 Port Access)**



4. Disconnect the Network cable, see ❷, Figure 82.
5. Tilt the Rear Chassis as far as possible without stressing the ribbon cable between the Processor PCA and Therapy PCA, see Figure 83.

Figure 83 **Measurement Module Access (for the CO_2 Port)**

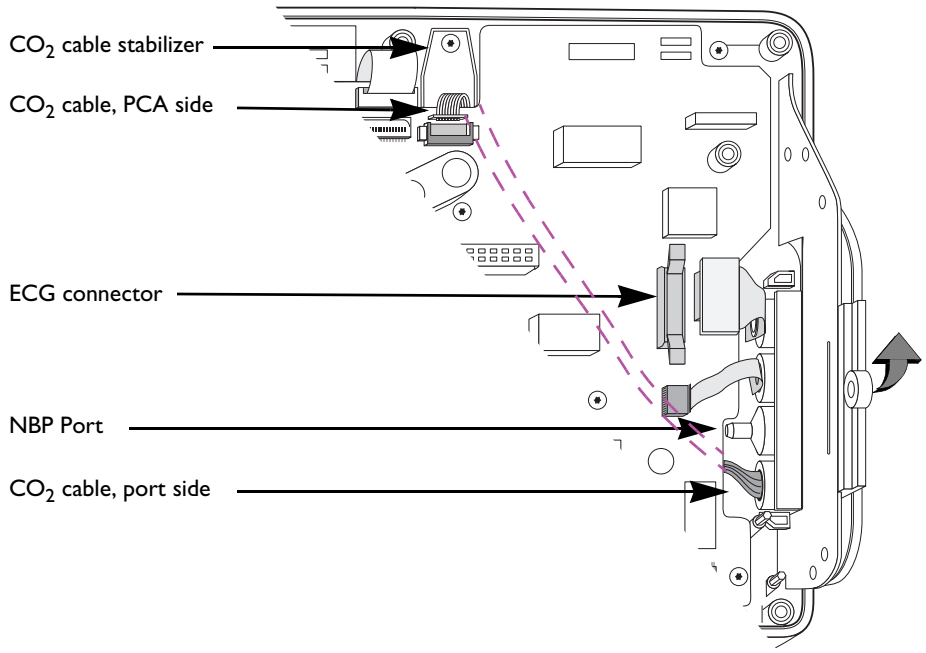


6 If present, disconnect the NBP airtube from the NBP Port.

7 If present, remove the SpO_2 PCA, but do not move the Rear Chassis. Follow the instructions for "SpO2 PCA" on page 126 starting from the "Removal" section.

8 Open the ECG Port connector and disconnect the ECG Port from the Processor PCA, see Figure 84 (Rear Chassis not shown for clarity).

Figure 84 **Measurement Module CO_2 Connections**



9 Disconnect the CO_2 cable from the Processor PCA, see Figure 84.

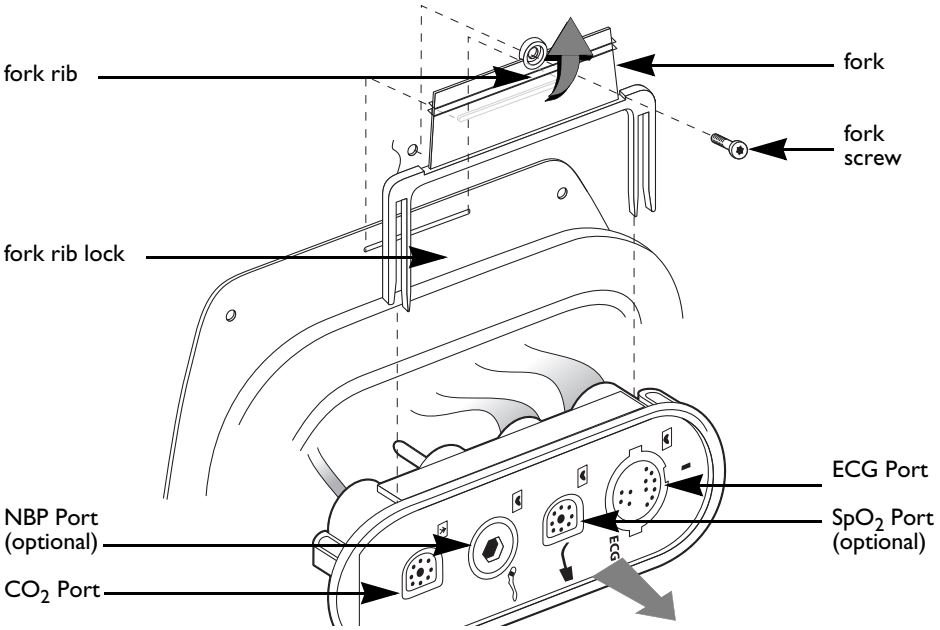
10 Remove the CO_2 cable core stabilizer screw and the stabilizer, see Figure 84.

11 Remove the Measurement Module fork screw, see Figure 85.

12 Gently pull the Measurement Module fork away from the Rear Chassis to free the rib from the lock and lift up, see Figure 85 on page 130.

13 Gently sliding the CO_2 cable under the Processor PCA, remove the Measurement Module assembly from the Front Case.

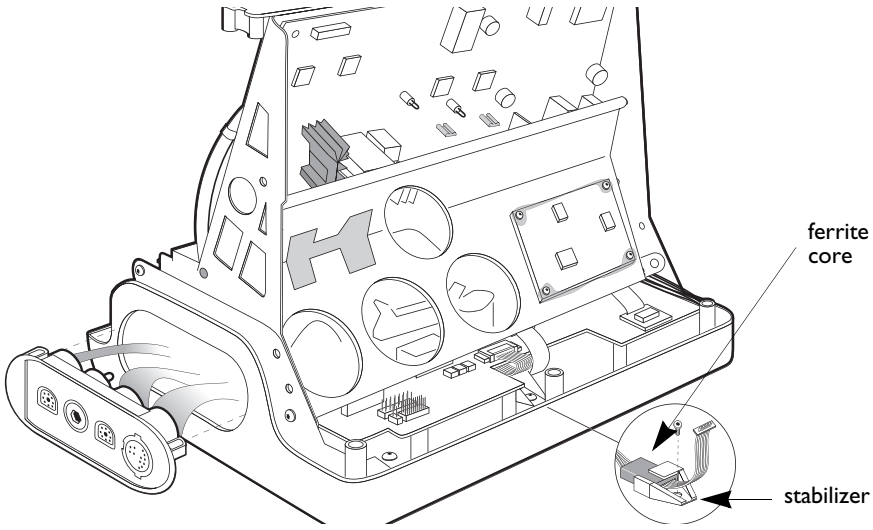
Figure 85 **Measurement Module Assembly (with CO_2) Removal**



Replacement

1. Inspect the tubing gasket on the perimeter of the face plate, see Figure 89 on page 133.
   If the gasket is soiled, cracked, frayed, pinched, damaged in any other way, or developed a gap between the tubing ends, then replace the gasket. See "Tubing Gasket Replacement" on page 96.
2. Position the Measurement Module so that the CO_2 Port is facing left, and the metal contacts of the CO_2 cable connector face down toward the work surface.
3. Gently slide the CO_2 cable under the Processor PCA, guiding it toward the Processor PCA CO_2 connector (see Figure 84 on page 129) and positioning the Measurement Module in the Front Case opening.
4. Install the Measurement Module:
   a. Guide the Measurement Module with your right hand into the Front Case, and the flex circuits in the Front Case opening, see Figure 86.

Figure 86 **Positioning the CO_2 Cable**



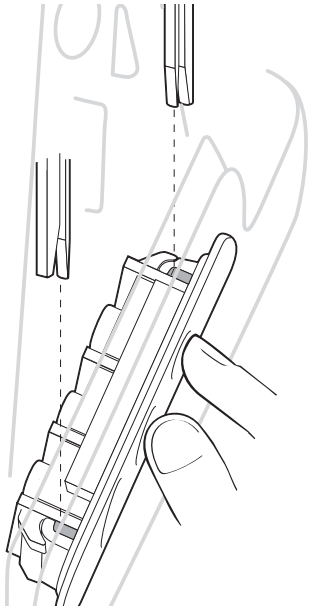
b Position the fork in your left hand, so that the rib faces the slot in the Front Chassis, and the longer prong is closer to you.

c Starting with the longer prong of the fork, install the fork between the Front Chassis and Front Case so that it locks the Measurement Module, see Figure 87.

d Engage the fork rib with the slot in the Front Chassis and secure with the M3x8 (T10) screw, see Figure 85 on page 130.

e Tighten the screw to 6 inch-lb (0.7 N m).

Figure 87 **Measurement Module Installation**



5 Turn the device around on the working surface.

6 Position the CO_2 cable core in the stabilizer and secure with the M4x10 (T15) screw, see Figure 86, inset.

7 Tighten the screw to 10 inch-lb. (1.1 N m).

8 Bend the CO_2 cable upward and connect to the Processor PCA CO_2 connector.

9 Reconnect the ECG Port to the Processor PCA.

10 If present, reconnect the SpO_2 Port to the SpO_2 PCA, see "SpO2 PCA" on page 126.

11 Ensure the connectors are fully seated.

12 If present, reconnect the NBP air tube to the NBP Port.
Thread the tube between the SpO_2 PCA (if present) and ECG Connector.

13 Reassemble and close the device. See "Closing the Case" on page 151.

To complete the replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Measurement Module without the CO_2 Port

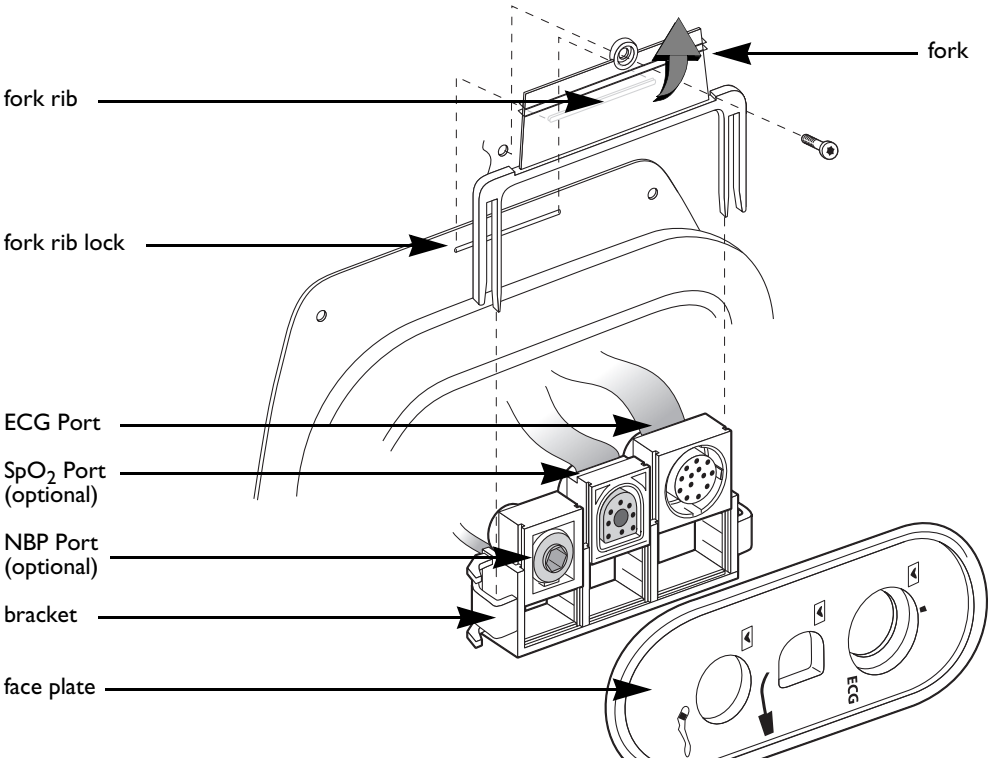
If your HeartStart XL+ has the $EtCO_2$ option installed, then refer to "Measurement Module with the CO2 Port" on page 128.

For Measurement Module without the CO_2 port, all replacement procedures involve the Measurement Module disassembly.

Removal

1. Pivot the Rear Chassis upward. See "Pivoting Rear Chassis Upward" on page 122.
2. Position the device with the display facing down and the printer compartment to your left.
3. If present, remove the SpO_2 PCA, see "SpO2 PCA" on page 126.

Figure 88 **Measurement Module Assembly**

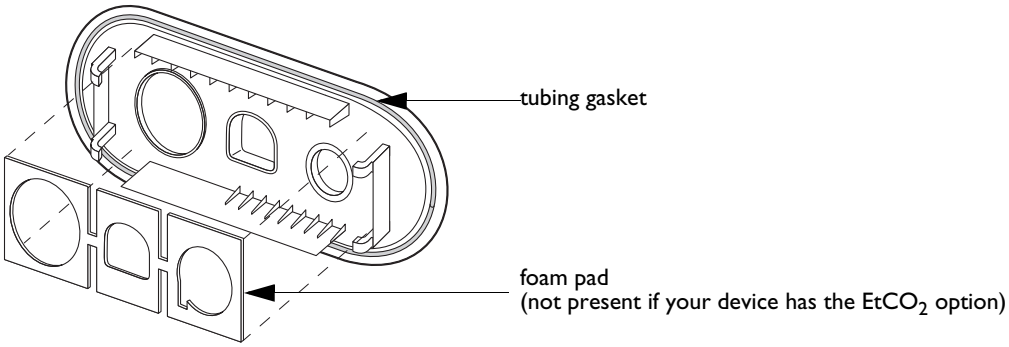


4. Open the ECG Port connector and disconnect the ECG Port from the Processor PCA. See ⑤, Figure 91 on page 136.
5. Gently pull the Measurement Module fork away from the Rear Chassis to free the rib from the lock and lift up, see Figure 85 on page 130.
6. Remove the Measurement Module assembly with the measurement ports from the Front Case.

Replacement

1 Slide the measurement port or ports into the bracket.
Make sure:
- the ports are positioned in the order shown in Figure 85.
- the flex circuits and NBP Port airway pegs are facing upward,
- the ports slide along the railings in the bracket.

Figure 89 **Measurement Module Face Plate**



2 Inspect the tubing gasket on the perimeter of the face plate, see Figure 89.
If the gasket is soiled, cracked, frayed, pinched, damaged in any other way, or developed a gap between the tubing ends, then replace the gasket. See "Tubing Gasket Replacement" on page 96.

3 Install the foam pad into the face plate, see Figure 89.

4 Position the Measurement Module's face plate to match the ports and slide it onto the bracket.

5 Make sure the foam pad is inside the face plate and not visible from the outside.
If necessary, go back to Step 3.

6 Lightly press the Measurement Module assembly with your right hand into the Front Case.
Guide the flex circuits in the Front Case opening.

7 Position the fork in your left hand so that the rib faces the slot in the Front Chassis, and the longer prong is closer to you.

8 Install the fork between the Front Chassis and Front Case so that it locks the Measurement Module assembly together, see Figure 87 on page 131.
Start with guiding the longer prong of the fork.

9 Engage the fork rib with the slot in the Front Chassis, see Figure 85 on page 130.

10 Secure the Measurement Module fork with the M3x8 (T10) screw.

11 Tighten the screw to 6 inch-lb (0.7 N m).

12 Reconnect the ECG Port to the Processor PCA.

13 If present, reconnect the SpO_2 Port to the SpO_2 PCA, see "SpO2 PCA" on page 126.

14 Ensure the connectors are fully seated.

15 Reassemble and close the device. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

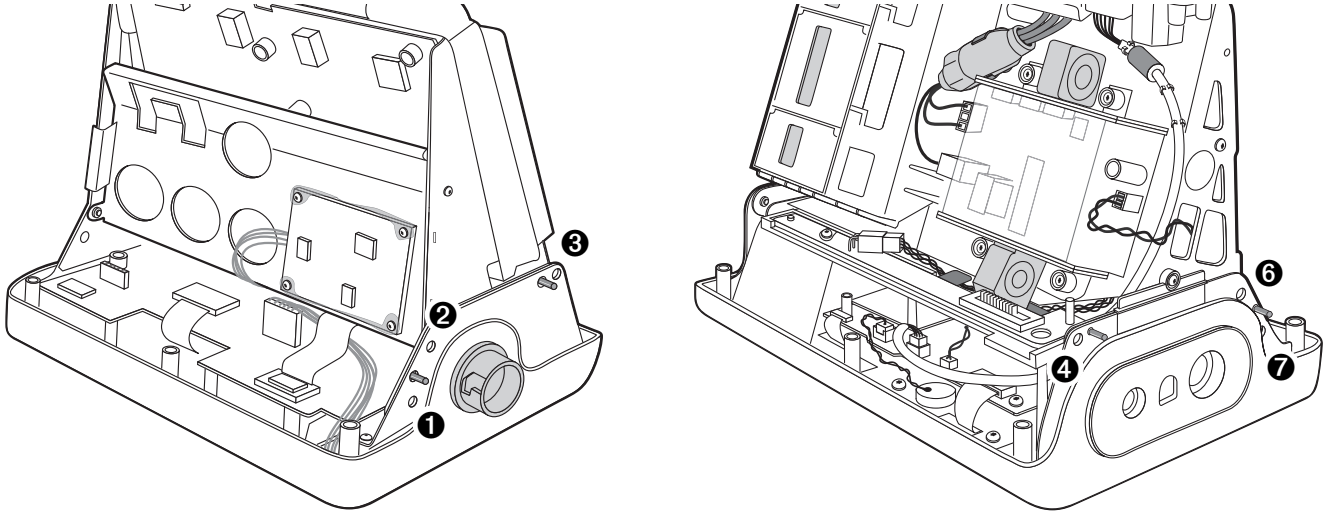
Front Chassis and Case Access

Remove the Rear Chassis completely to access Front Chassis and Front Case assemblies.

To remove the Rear Chassis:

1. Open the device. See "Opening the Case" on page 87.
2. Disconnect the Rear Chassis:
   a. Follow the Pivoting Rear Chassis Upward instructions on page 122 up to Step 4.
   b. Return the Rear Chassis into the upright position and carefully insert four pins in the openings between the screw holes ❶ and ❷, ❻ and ❼, next to screw ❸, and next to screw ❹.
   c. Remove the two remaining screws ❶ and ❼.

Figure 90 **Rear Chassis Removal**



3. Support the Rear Chassis by the metal frame while removing the pins and put the Rear Chassis aside.

To install the Rear Chassis:

1. Install the Battery PCA screw, see "Battery PCA" on page 116.
   Do not attach the Battery PCA connectors.
2. Align the Rear Chassis with the Front Chassis and insert four pins in the openings between the screw holes ❶ and ❷, ❻ and ❼, next to screw ❸, and next to screw ❹.
3. Insert M3x8 (T10) screws in the screw holes ❶ and ❼.
4. Remove the pins and bring the Rear Chassis to the tilted position, see Figure 53 on page 92.
5. Reconnect the cables between the Rear and Front Chassis:
   a. Reconnect the Battery PCA 4-wire and 3-wire bundles, see Figure 75.
   b. Reconnect the Network Cable to the Processor PCA, see Figure 78, ①.
   c. Reconnect the ECG Out 2-wire bundle to the Processor PCA, see Figure 78, ②.
   d. Turn the HeartStart XL+ around and connect the Therapy Port spade connectors, see Figure 69, ① and ②.
   e. Reconnect the ribbon cable to the Processor PCA, see Figure 69, ⑤.
6. If your device has the NBP module, then reconnect the NBP air tube to the NBP Connector, see "Measurement Module and the Ports" on page 128.
7. Bring the Rear Chassis into the upright position. See "Tilting Rear Chassis" on page 91.

Processor PCA

The Processor PCA contains the SOM PCA that stores the device software and configuration data. When you install a new Processor PCA, you must also:

- Enter the device's serial number and enable options using the Service Mode menus.
- Install the most recent software in the appropriate language using the Software Support tool. See Table 39 on page 176 for part numbers.
- Give the user the *README* document that contains instructions for downloading the most recent *HeartStart XL+ Instructions for Use* from the Philips' Documentation and Download web site (http://www.philips.com/ProductDocs).

CAUTION: Never touch the Processor PCA surface with your fingers, always use gloves.
Keep the new Processor PCA in an antistatic pouch until ready to install.
Do not attempt to reuse the old SOM PCA with the new Processor PCA.

Removing the Processor PCA involves disconnecting many cables and removing many screws. Note that the edges of the metal chassis may be sharp. Take care not to cut yourself or shear the wires.

Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Open and separate the case. See "Opening the Case" on page 87.
3. Remove the Rear Chassis. See "Front Chassis and Case Access" on page 134.
4. Remove the Printer PCA with the Printer ribbon cable and the Therapy Port Extension assembly. See "Printer PCA" on page 124.
5. If present, remove the SpO_2 PCA. See "SpO2 PCA" on page 126.

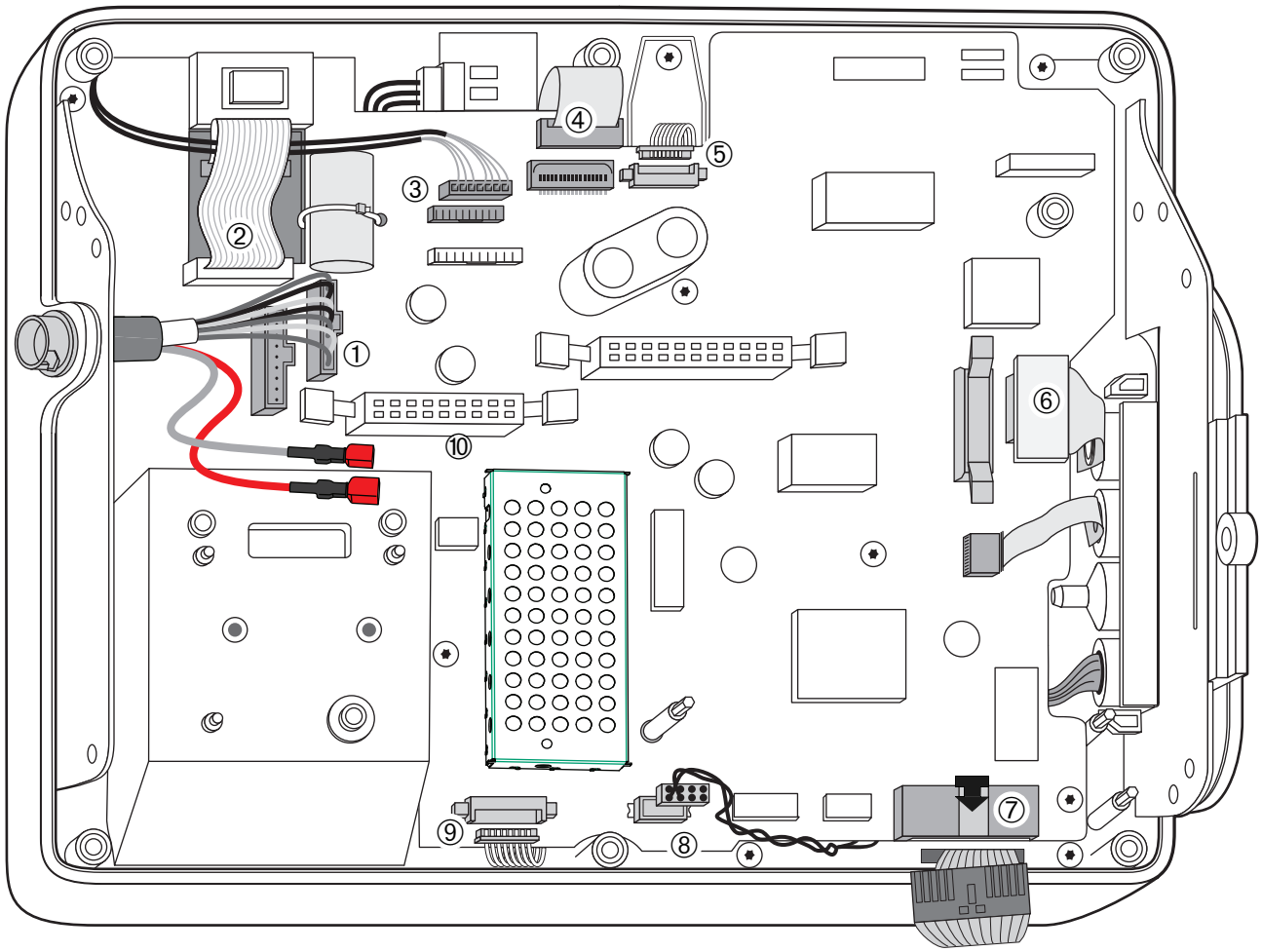
Removal

1. Disconnect all cables (cable ⑨ is already removed with the Printer PCA.)
   See Table 35 and Figure 91 on page 136. The order in Table 35 begins from the Therapy Port and then works clockwise around the front case to the Printer compartment.

Table 35 **Processor PCA Connections**

Ref. #	PCA Mark	Description	Connects To	Disconnect By
①	J19	10-wire bundle	Therapy Port	Push on latch to release, pull, wiggle
②	J18	ribbon cable	Therapy Knob	
③	J17	7-wire bundle	HIF PCA	
④	J7	ribbon cable	Display	Gently pull, wiggle
⑤	J13	8-wire bundle	CO_2 Port	Gently pull the bundle, wiggle
⑥	J1001	ribbon cable	ECG Port	Release latches at edges of connector, pull
⑦	J16	ribbon cable	Front keypad buttons	Push on latch to release, pull, wiggle
⑧	J12	2-wire bundle	Speaker	Pull, wiggle
⑨	J8	8-wire bundle	Inverter PCA	Gently pull the bundle, wiggle
⑩	J11	ribbon cable	Printer PCA	Already removed with the Printer PCA

Figure 91 **Processor PCA Connectors**



2 Remove the Measurement Module. See "Measurement Module and the Ports" on page 128.

3 Loosen and remove the seven T10 screws ❶ – ❼. See Figure 92.

4 Lift the Processor PCA out of the case.
Be careful to guide the many cables out of the way so the Processor PCA can be lifted clear.

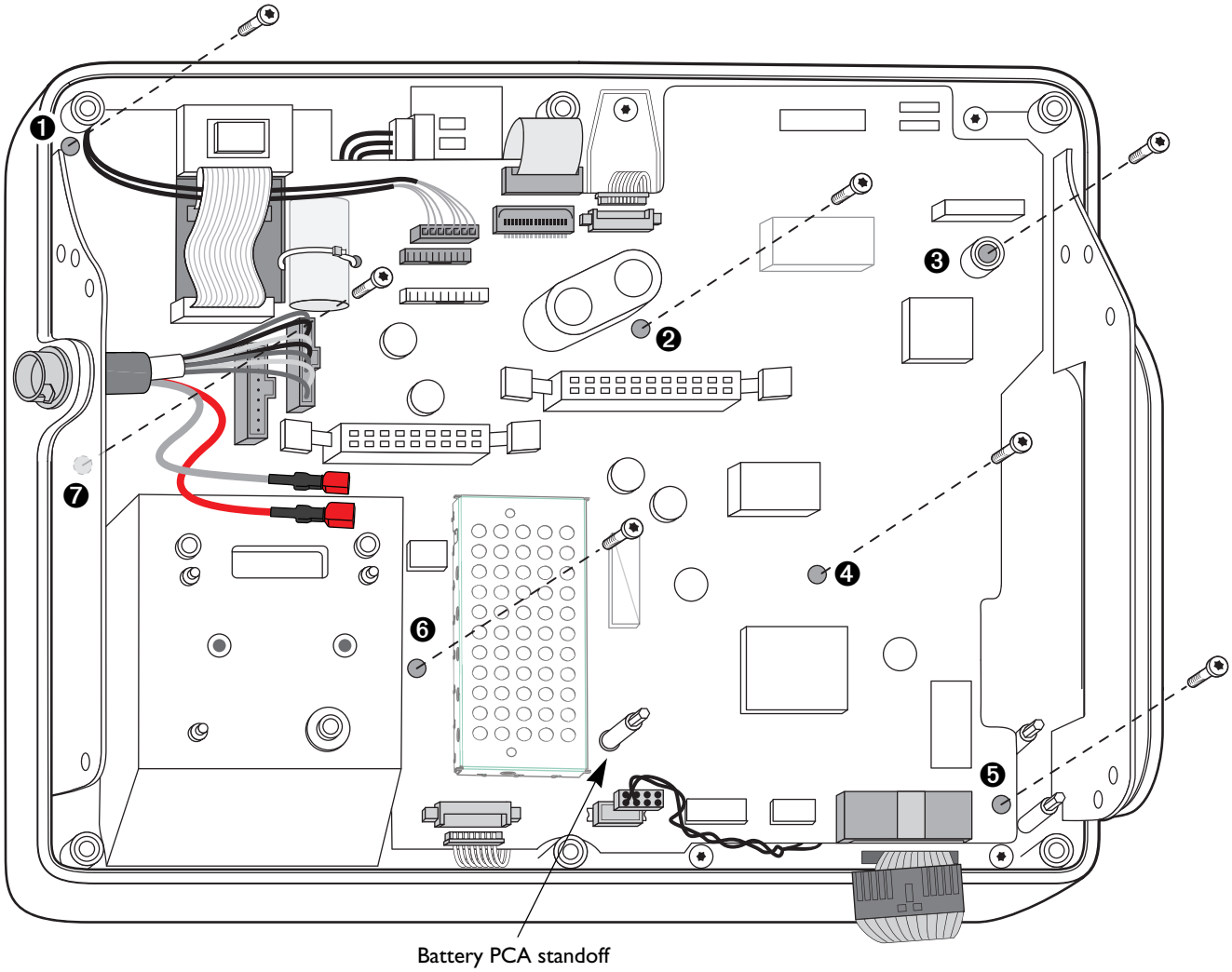
a First, lift the lower side holding at the screw positions ❺ and ❻ and clearing the Battery PCA standoff, see Figure 92.

b Lift the right side holding the corners at the screw positions ❺ and ❸.

c Guide the Therapy Switch ribbon cable ② through the square opening in the Processor PCA and the Therapy Port cables out of the way, while lifting the Processor PCA straight up.

NOTE: Leave the Clock Battery in place when returning the Processor PCA for repair. This helps preserve information for factory troubleshooting.

Figure 92 **Processor PCA Screws**



Replacement

1. Install the Clock Battery to the new Processor PCA, see "Clock Battery" on page 118.
2. Place the Processor PCA in position, see Figure 91 on page 136 and Figure 92 on page 137.
   a. Position an M3x8 (T10) screw in the Processor PCA difficult-to-access point ❷.
   b. Guide the cables ①, ③, and ④ out of the way and the Therapy Switch ribbon cable ② through the square opening in the Processor PCA.
   c. Guide the cables ⑦, ⑧, and ⑨ out of the way and the Battery PCA standoff through the round opening in the Processor PCA.
   d. Line up the holes in the Processor PCA with the threaded standoffs underneath. Make sure there are no cables or wires trapped underneath the PCA.
3. Replace the seven M3x8 (T10) screws and tighten to 6 inch-lb (0.7 N m). See Figure 92. Note that the screw ❸ is M3x16 mm, and the remaining screws are M3x8 mm. See "Screw Usage" on page 70.
4. Replace the Measurement Module. See "Measurement Module and the Ports" on page 128.
5. Connect cables ① – ⑨, see Figure 91 on page 136 and Table 35 on page 135.
   Connect cable ③ before ribbon cable ②.

6 Replace the Printer PCA, the Therapy Port Extension assembly, and the Printer ribbon cable. See "Printer PCA" on page 124.

7 Ensure the connectors are fully seated.

8 If present, replace the SpO_2 PCA. See "SpO2 PCA" on page 126.

9 Close the device. See "Closing the Case" on page 151.

Entering the Serial Number

After you have replaced the Processor PCA and reassembled the device, you must enter the device's serial number to make the HeartStart XL+ operational. If the serial number is not entered, the device powers up with the message **Equipment Disabled: Therapy**. *Normal operation is not possible,* and the device powers up into Service Mode, where you can enter the serial number.

To enter the serial number:

1 Turn the device off.

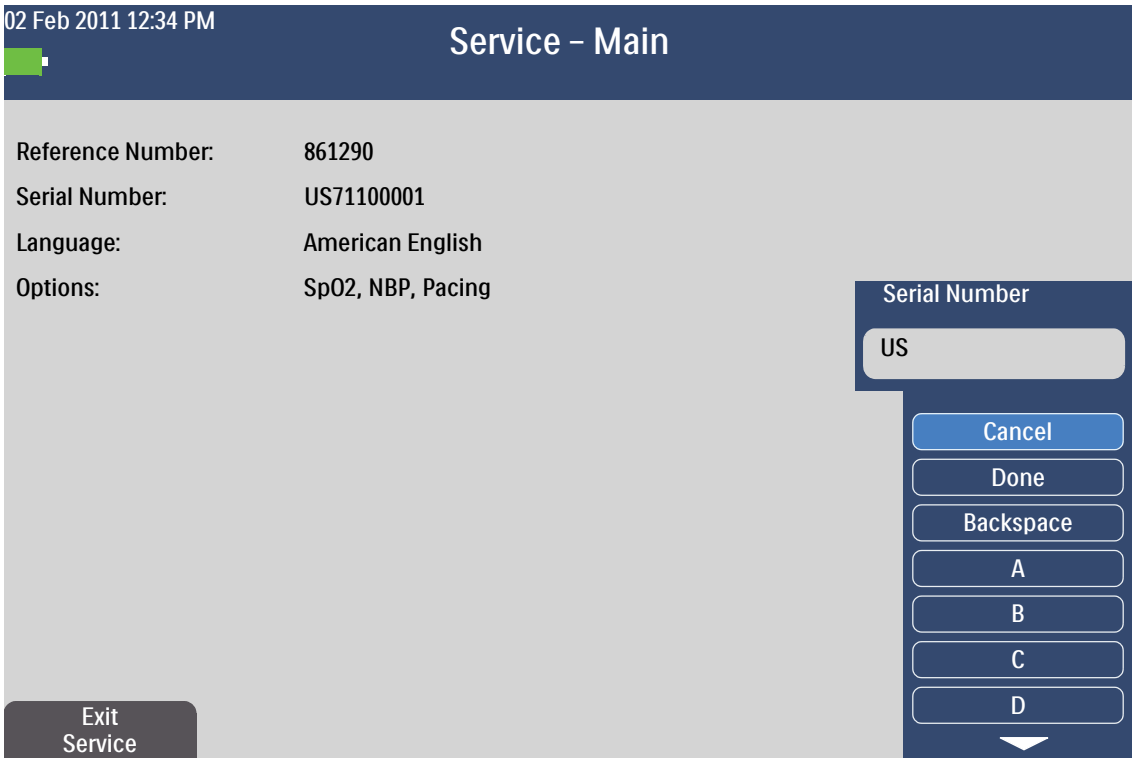
2 Record the model number, serial number, and options key(s) from the bottom of the device.

3 Insert AC power and a battery (charged to at least 20%) and turn the Therapy Knob to **Monitor**. The device powers up into Service Mode.

4 From the Service Mode Main menu, select **Device Info**.

5 From the **Device Info** menu, select **Serial Number**. An alphanumeric menu is displayed, see Figure 93.

Figure 93 **Entering Serial Number**



6 Enter the serial number using the Navigation buttons to scroll through the letters and numbers. Press the Menu Select button to complete each selection.

Select **Cancel** or **Backspace** to cancel a selection.

7 Scroll through the list and select **Done** when you have finished entering the serial number.

CAUTION: Once you have entered the correct serial number, do not change it. If you clear or change the serial number, the options are cleared and you must re-enter the correct serial number and the options key.

Installing Software

See "Software Upgrades" on page 11 for details on software installation.

To install software onto the device or to change the device's language:

1 Be sure both an AC power module and battery charged to at least 20% are in place.

2 Turn the Therapy Knob to **Monitor**.

3 Enter the Service Mode

4 Insert the Software Support flash drive into the USB port.

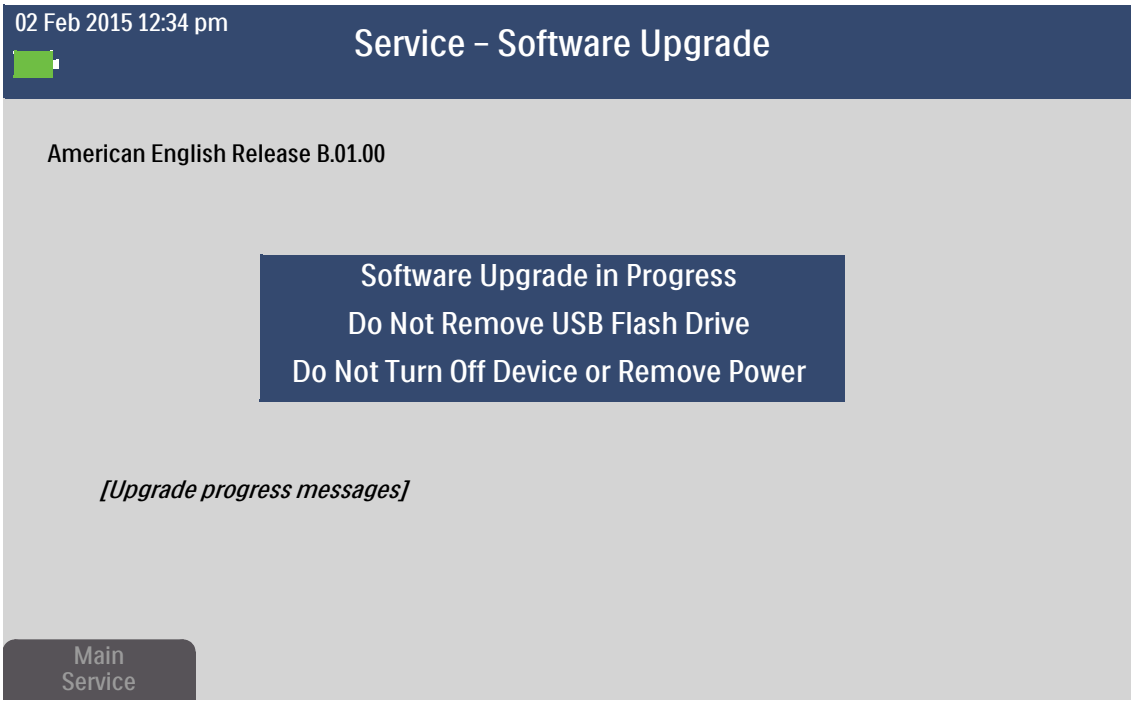
5 From the Service Mode Main menu, select **Device Info**.

6 From the Service Mode Main menu, select **Software Upgrade**.
Make sure the software release and language displayed on the screen are correct.

7 Press the **Upgrade** soft key. The software installation starts.

CAUTION: After the upgrade start, be careful not to interrupt the software installation process by removing the USB flash drive or power source or turning the Therapy Knob.

Figure 94 **Software Upgrade Progress Screen**



8 The software is installed on the device. This process takes a few minutes. While the software is being updated, progress messages are displayed and the soft keys are disabled.

9 When the software or language installation process is complete, turn the device off and on.

10 Remove the Software Support flash drive from the USB port.

Enabling Options

Once you enter the serial number and install software, you need to enable the options. If you enter the options key incorrectly, the device's options will not function.

To enable options:

1 From the Device Info menu, select **Options Key**. An alphanumeric menu is displayed, see Figure 95.

Figure 95 **Enabling Options**

2 Enter the options key using the Navigation buttons to scroll through the letters and numbers. Press the Menu Select button to complete each selection.

Select **Cancel** or **Backspace** to cancel a selection.

When the options key has been entered, the corresponding product options are displayed.

3 Select **Done** when you have finished entering the options key.

4 Repeat Step 2 through Step 3 for each options key.

5 Check the information on the screen to ensure it is correct.

CAUTION: Once you have entered the correct serial number, do not change it. If you clear or change the serial number, the options are cleared and you must re-enter the correct serial number and the options key.

6 Run an Operational Check.

7 Review the Operational Check results to ensure all tests have passed.

See "Operational Check" on page 33.

8 Print the Device Info to ensure the product version and language are correct.

See "Device Information" on page 10.

Completing the Repair

To Complete the Processor PCA Replacement:

1. Enter the device's serial number, see "Entering the Serial Number" on page 138.
2. Install the most recent software in the appropriate language, see "Installing Software" on page 139.
3. Enable options, see "Enabling Options" on page 140.
4. Give the user the *README* document that contains instructions for downloading the most recent *HeartStart XL+ Instructions for Use* from the Philips' Documentation and Download web site (http://www.philips.com/ProductDocs).
5. Affix the appropriate Hardware Version label to the bottom of the device.

   The Processor PCA ships with a set of Hardware Version labels.

   a. Clean the surface with isopropyl alcohol. Allow it to dry.
   b. Affix the appropriate label found in the Processor PCA kit to the bottom of the device, see "Primary Label" on page 10.
6. Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Front Chassis Removal and Replacement

Remove the Front Chassis with the Processor PCA to access these Front Case assemblies:

- Human Interface PCA
- Therapy Buttons
- Display Assembly
- Speaker Assembly

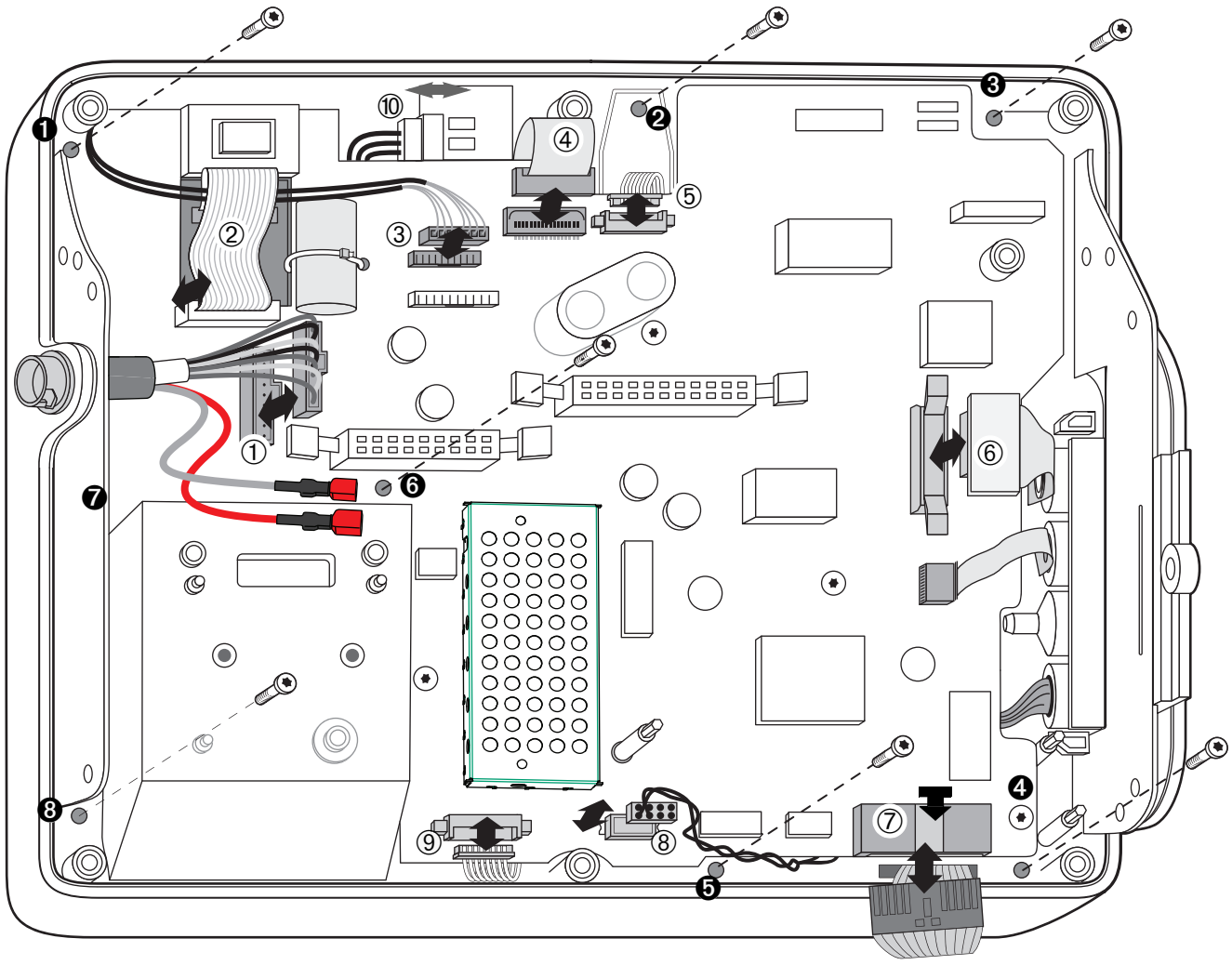
Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Open the device. See "Opening the Case" on page 87.
3. Remove the Rear Chassis. See "Front Chassis and Case Access" on page 134.
4. Remove the Printer PCA. See "Printer PCA" on page 124.
5. If present, remove the SpO_2 PCA. See "SpO2 PCA" on page 126.

Removal

1. Disconnect cables ① – ⑨. See Table 35 on page 135 and Figure 96.

Figure 96 **Front Chassis Connectors and Screws**



2 Use tweezers to gently disconnect the Inverter PCA cable ⑩.

3 Remove the screws and the chassis:
   - **a** Loosen and remove the six T15 screws ❶ – ❻ as shown in Figure 96.
   - **b** Loosen the screws ❼ and ❽ and remove them with tweezers or leave them in the Front Chassis' screw holes.
   - **c** Move the wires out of the way.
   - **d** Hold the Front Chassis by the metal frame and lift it with the Processor PCA straight up out of the Front Case.

Replacement

1 Replace the chassis and the screws:
   - **a** Move the wires out of the way.
   - **b** Place the screws ❼ and ❽ into the screw holes.
   - **c** Position the Front Chassis in the Front Case.
     Make sure no wires are pinched under the Front Chassis, see Figure 97.
   - **d** Reconnect the Inverter PCA cable ⑩.
   - **e** Start the screws ❼ and ❽.
   - **f** Manually start the screws ❶ – ❻.
     If you have the $EtCO_2$ option installed, then do not install screw ❷ yet; you will need it to replace the CO_2 cable retainer.
   - **g** Tighten the M4x10 (T15) screws ❶ – ❽ to 10 inch-lb. (1.1 N m). Use a criss-cross sequence, e.g. ❶-❹-❼-❸-❽-❷-❺-❻.

2 Reconnect cables ① – ⑨. See Table 35 on page 135 and Figure 96.

3 Ensure the connectors are fully seated.

4 Replace the Printer PCA. See "Printer PCA" on page 124.

5 If present, replace the SpO_2 PCA. See "SpO2 PCA" on page 126.

6 Replace the Rear Chassis. See "Front Chassis and Case Access" on page 134.

7 Close the device. See "Closing the Case" on page 151.

8 Replace the Printer Assembly. See "Printer Assembly" on page 85.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Inverter PCA and Front Chassis

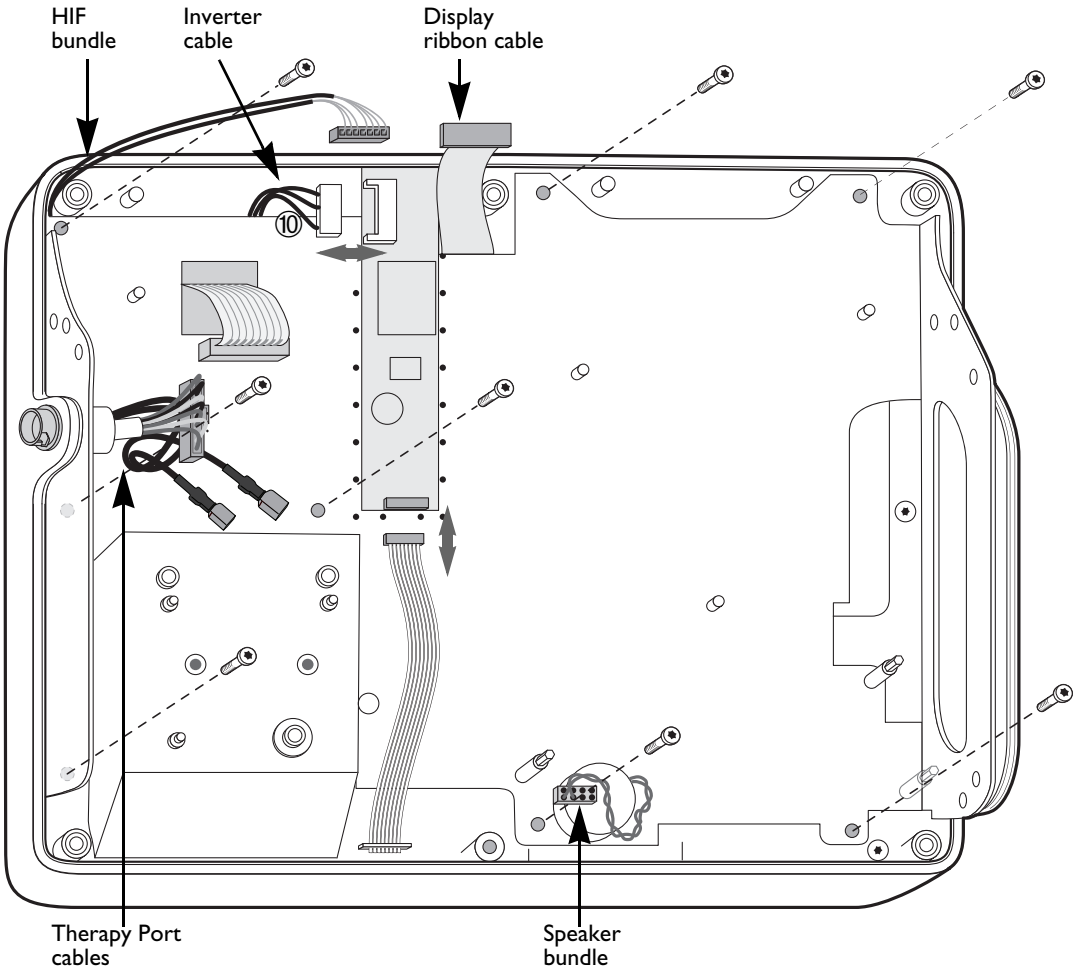
Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Open and separate the case. See "Opening the Case" on page 87.
3. Remove the Rear Chassis. See "Front Chassis and Case Access" on page 134.
4. Remove the Processor PCA. See "Processor PCA" on page 135.

Removal

1. Disconnect the Inverter PCA cable ⑩, see Figure 97.

Figure 97 **Front Chassis Screws**



2. Remove the screws and the chassis:
   - **a** Loosen and remove the six T15 screws ❶ – ❻ as shown in Figure 97.
   - **b** Loosen the screws ❼ and ❽ last and leave them in the Front Chassis.
   - **c** Move the wires out of the way.
   - **d** Lift the Front Chassis straight up.
   - **e** Remove the screws ❼ and ❽.

Replacement

1. Replace the chassis and the screws. See "Front Chassis Removal and Replacement" on page 142.
2. Replace the Processor PCA. See "Processor PCA" on page 135.
3. Replace the Rear Chassis. See "Front Chassis and Case Access" on page 134.
4. Replace the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
5. Close the case. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Speaker Assembly

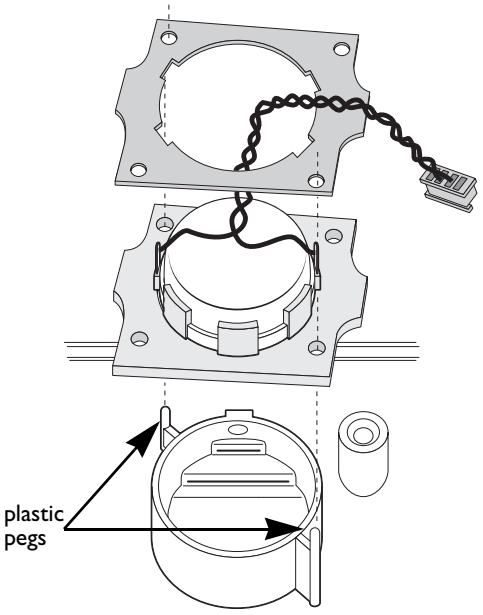
Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Open and separate the case. See "Opening the Case" on page 87.
3. Remove the Rear Chassis. See "Front Chassis and Case Access" on page 134.
4. Remove the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.

Removal and Replacement

1. Lift the Speaker Assembly off the plastic pegs, see Figure 98.

Figure 98 **Speaker Assembly**



2. Install the Speaker Assembly on the plastic pegs.
3. Install the foam pad on the plastic pegs with tabs positioned sideways, see Figure 98.
4. Replace the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.
5. Replace the Rear Chassis. See "Front Chassis and Case Access" on page 134.
6. Close the case. See "Closing the Case" on page 151.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Human Interface PCA

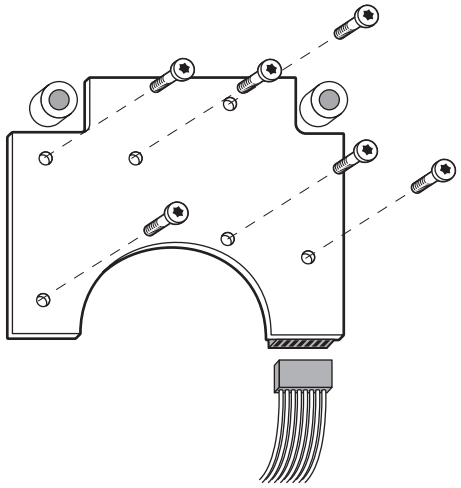
Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Open and separate the case. See "Opening the Case" on page 87.
3. Remove the Rear Chassis. See "Front Chassis and Case Access" on page 134.
4. Remove the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.

Removal and Replacement

1. Remove the six T15 screws, see Figure 99.

Figure 99 **Human Interface PCA**



2. Disconnect the HIF PCA cable.
   Push on the latch to release, pull, wiggle.
3. Install the HIF PCA cable on the new HIF PCA.
   Ensure the connector is fully seated.
4. Replace the HIF PCA. Tighten the plastite screws to 10 inch-lb. (1.1 N m).
5. Replace the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.
6. Replace the Rear Chassis. See "Front Chassis and Case Access" on page 134.
7. Close the case. See "Closing the Case" on page 151.

To Complete the Replacement:

1. Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.
2. Run the Button Tests.

Therapy Buttons

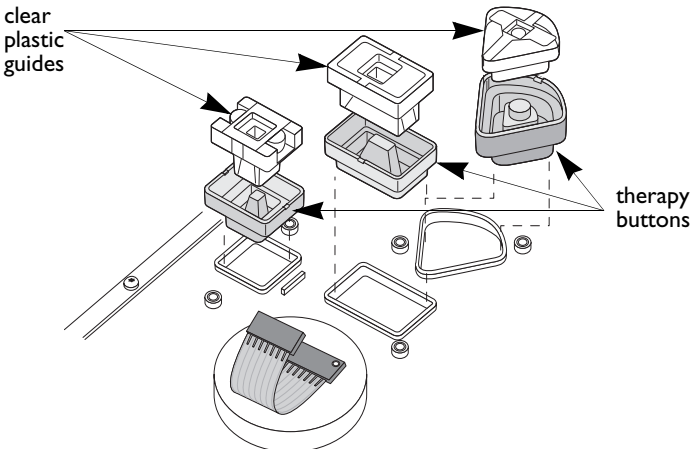
Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Open and separate the case. See "Opening the Case" on page 87.
3. Remove the Rear Chassis. See "Front Chassis and Case Access" on page 134.
4. Remove the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.
5. Remove the HIF PCA. See "Human Interface PCA" on page 147.

Removal and Replacement

1. Remove and replace the buttons and their guides, see Figure 100.

Figure 100 **Therapy Buttons**



2. Replace the HIF PCA, see "Human Interface PCA" on page 147.
3. Replace the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.
4. Replace the Rear Chassis. See "Front Chassis and Case Access" on page 134.
5. Close the case. See "Closing the Case" on page 151.

To Complete the Replacement:

1. Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.
2. Run the Buttons Tests.

Display Assembly

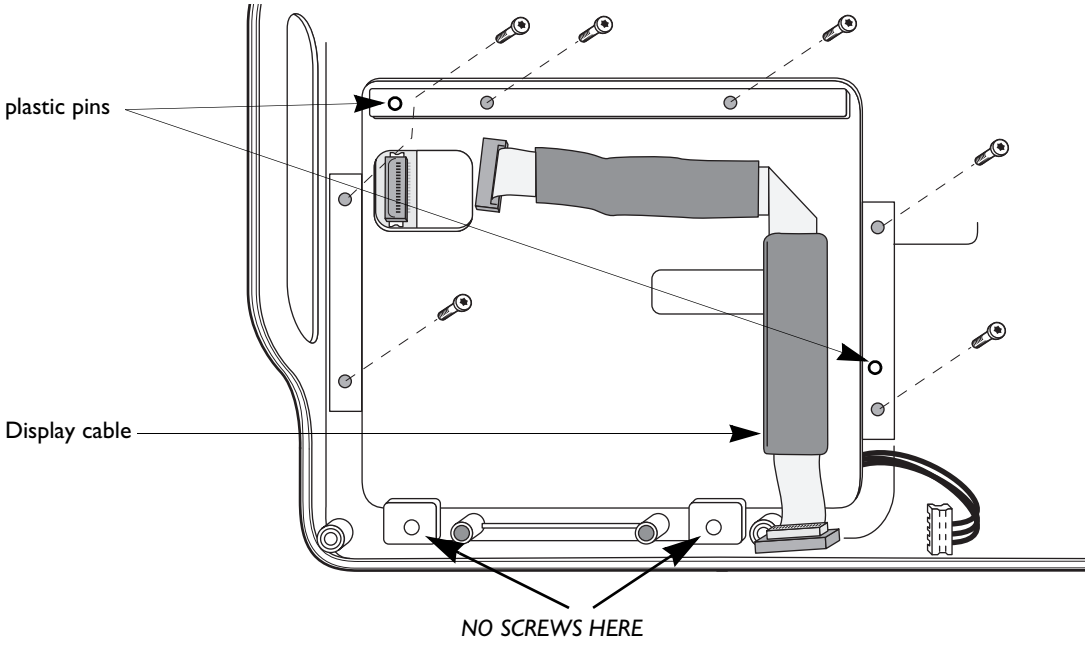
Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Open and separate the case. See "Opening the Case" on page 87.
3. Remove the Rear Chassis. See "Front Chassis and Case Access" on page 134.
4. Remove the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.

Removal and Replacement

1. Remove the six T15 screws, see Figure 99.

Figure 101 **Display Assembly**



2. Disconnect the Display cable from the Display.
3. Install the Display cable on the new Display.
4. Ensure the connectors are fully seated.
5. Install the new Display on two plastic pins in the Front Case.
   – The pins are fragile, take care not to break them.
   – Make sure the Inverter PCA cable is not pinched.
   – Start the screws manually, then tighten in a criss-cross pattern.
   – Tighten the plastite screws to 10 inch-lb. (1.1 N m).
   – *Do not install screws in the two lower positions!*
6. Replace the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.
7. Replace the Rear Chassis. See "Front Chassis and Case Access" on page 134.
8. Close the case. See "Closing the Case" on page 151.

To Complete the Replacement:

1. Run Performance Verification and Safety testing as described in Performance Verification.
2. Run the Display Test, see "Display Test" on page 163.

Front Case Assembly

The front case replacement involves moving existing parts from the old case to the new.

Preparation

1. Remove the Printer Assembly. See "Printer Assembly" on page 85.
2. Open and separate the case. See "Opening the Case" on page 87.
3. Remove the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
4. Remove the Rear Chassis. See "Front Chassis and Case Access" on page 134.

Removal

1. If present, remove the SpO_2 PCA. See "SpO2 PCA" on page 126.
2. Remove the Measurement Module. See "Measurement Module and the Ports" on page 128.
3. Remove the Printer PCA. See "Printer PCA" on page 124.
4. Disassemble the Front Case:
   a. Remove the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.
   b. Remove the Speaker Assembly. See "Speaker Assembly" on page 146.
   c. Remove the Therapy Port. See "Therapy Port" on page 119.
   d. Remove the Therapy Switch. See "Therapy Switch" on page 121.
   e. Remove the Display Assembly. See "Display Assembly" on page 149.
   f. Remove the HIF PCA. See "Human Interface PCA" on page 147.
   g. Remove the Therapy Buttons. See "Therapy Buttons" on page 148.

Replacement

1. Reassemble the Front Case:
   a. Replace the Therapy Buttons. See "Therapy Buttons" on page 148.
   b. Replace the HIF PCA. See "Human Interface PCA" on page 147.
   c. Replace the Display Assembly. See "Display Assembly" on page 149.
   d. Replace the Therapy Switch. See "Therapy Switch" on page 121.
   e. Replace the Therapy Port. See "Therapy Port" on page 119.
   f. Replace the Speaker Assembly. See "Speaker Assembly" on page 146.
   g. Replace the Front Chassis. See "Front Chassis Removal and Replacement" on page 142.
2. Replace the Measurement Module. See "Measurement Module and the Ports" on page 128.
3. If present, replace the SpO_2 PCA. See "SpO2 PCA" on page 126.
4. Replace the Printer PCA. See "Printer PCA" on page 124.
5. Replace the Rear Chassis. See "Front Chassis and Case Access" on page 134.
6. Replace the Rear Chassis Shelf. See "Rear Chassis Shelf" on page 93.
7. Close the case. See "Closing the Case" on page 151
8. Replace the Printer. See "Printer Assembly" on page 85.
9. Replace the Handle. See "Handle Assembly" on page 78.
10. Apply the Control Panel label to the Front Case. See "Labels" on page 75.

To Complete the Replacement:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

Closing the Case

To close the Case:

1 Recheck the connections. Make sure all connections are fully seated and latched.

WARNING: Any connections that are not seated and latched properly during the device assembly may become loose over time, causing devices to fail when in clinical use. Check all connections before closing the device case.

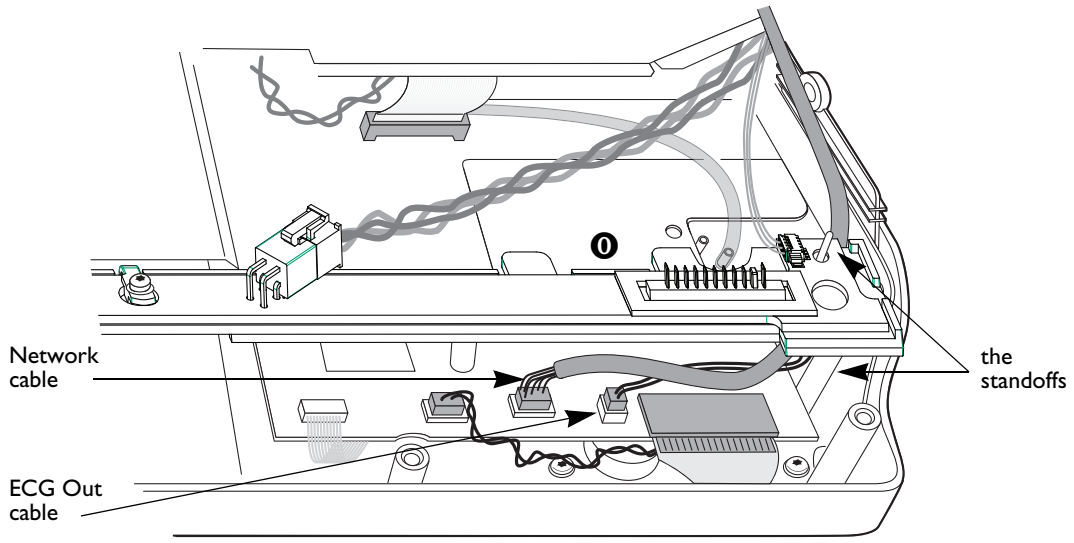
2 If the Measurement Module is disassembled, then:
   - **a** Inspect the tubing gasket on the Measurement Module face plate, see Figure 89 on page 133.
   - **b** If the gasket is cracked, frayed, damaged, or there is a gap between the gasket ends, then replace the gasket. See "Tubing Gasket Replacement" on page 96.
   - **c** Assemble the Measurement Module. See "Measurement Module and the Ports" on page 128.

3 Assemble the Rear Chassis:
   - **a** If the Rear Chassis is removed, then replace the Rear Chassis. See "Front Chassis and Case Access" on page 134.
   - **b** If the Rear Chassis is tilted or pivoted, then bring it into the upright position. See "Tilting Rear Chassis" on page 91, "Pivoting Rear Chassis Downward" on page 108, or "Pivoting Rear Chassis Upward" on page 122.
   - **c** If the Rear Chassis Shelf is removed, then replace the Shelf. See "Rear Chassis Shelf" on page 93.

4 Position the device display side down, Capacitor to your left.

5 Ensure proper wire threading around the Battery PCA, see Figure 102:
   - **a** No wires are positioned in front of the Battery PCA.
   - **b** No wires are threaded in the area between the Battery PCA support pad tabs marked ❶ to avoid pinching between the lower Fan and Battery PCA support pad.
   - **c** The Network and ECG Out cables are threaded between the two tall standoffs to the right and under the Battery PCA.

Figure 102 **Rear Case Wire Threading**



6 Inspect the tubing gasket on the perimeter of the Front Case.

7 If the gasket is cracked, frayed, damaged, or there is a gap between the gasket ends, then replace the gasket. See "Tubing Gasket Replacement" on page 96.

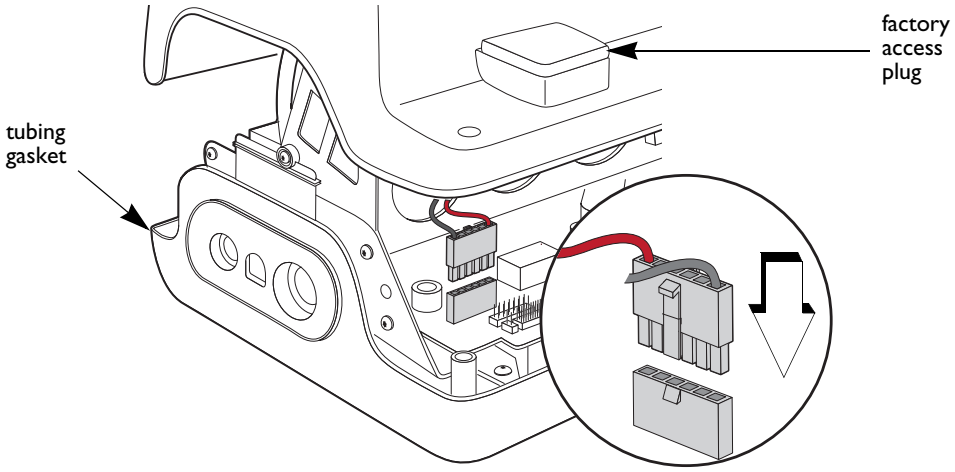
8 Position the device display side down, Rear Chassis Shelf facing you.

9 Put your right hand fingers through the AC mains and LAN openings of the Rear Case and lower the Rear Case on the device to a level about 2" (5 cm) above the Front Case.

10 Reconnect the paddle connector with your left hand, see Figure 103.
Make sure the latch behind the connector clicks to lock.

CAUTION: Be careful not to bend or damage the pins in front of the paddle connector. You may remove the factory access plug to observe positioning of the paddle connector. Replace the factory access plug if removed.

Figure 103 **Connecting the Rear Case Cover**



11 Align the cases and carefully lower the Rear Case on the Front Case.
Make sure no wires are pinched between the Battery PCA and the Rear Case. Confirm that the entire perimeter of the Front and Rear Cases have mated properly.

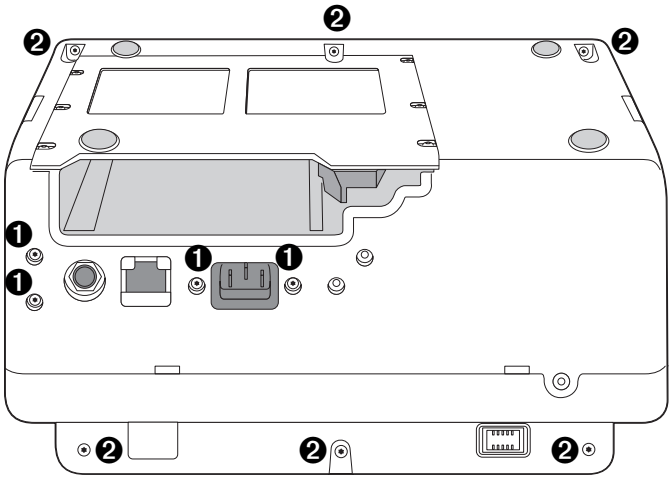
CAUTION: Be careful not to pinch any cables between the Rear Case and Battery PCA.

12 Install the case screws, see Figure 104.

a Install the four M3x12 (T10) screws in the back of the case (❶). Tighten to 6 inch-lb (0.7 N m).

b Install the six M4 (T15) screws in the perimeter of the case in a criss-cross pattern (❷). Tighten to 10 inch-lb. (1.1 N m).

Figure 104 **Case Screws**



13 Install the Handle Assembly, see "Handle Assembly" on page 78.

14 If removed, install the Printer Assembly, see "Printer Assembly" on page 85.

15 If present, install the bedrail / roll stand mount. See "Bedrail / Roll Stand Mount" on page 74.

16 If present, install accessory pouches.

To Complete the Repair:

- Run Performance Verification and Safety testing as described in the "Performance Verification" chapter.

NOTES

5

Performance Verification

Overview

This chapter describes how to verify the performance of the HeartStart XL+ monitor/defibrillator after repairs are complete. This chapter is organized into the following sections:

Required Testing Levels

The Performance Verification and Safety Tests are intended to verify proper operation of the device following repair. The level of testing required corresponds to the type of repair performed.

External Repairs/Replacements

External repairs/replacements are those involving the repair or replacement of one or more of the following items. The key point is that *the case has not been opened and Handle not removed.*

- Battery Compartment Cover and Latch
- Bedrail / Roll Stand Mount
- Labels
- Printer Assembly
- Therapy Knob

The following tests are required after an External Repair or Replacement when *the case has not been opened and Handle not removed:*

- Perform the Visual Inspection (see "Visual Inspection" on page 160).
- Run the Operational Check (see "Operational Check" on page 161).
- Check the Error Logs for critical errors (see "Error Log Messages" on page 41).
- *After the **Therapy Knob** replacement only:* Run the Controls test (see "Controls Test" on page 162).
- *After the **Printer Assembly** replacement only:* Run the Printer Test (see "Printer Test" on page 164).

Top Assembly Repairs (Handle Removed)

The RFU-and-USB PCA is located inside the Handle and accessible for replacement without opening the case. If the Handle Assembly or RFU-and-USB PCA was replaced or removed, *and the case was not opened,* the following tests are required:

- Perform the Visual Inspection (see "Visual Inspection" on page 160).
- Run the Operational Check (see "Operational Check" on page 161).
- Inspect the Error Logs for critical errors (see "Error Log Messages" on page 41).
- Run the Safety Tests (see "Safety Tests" on page 171).
- *After the **Paddle Tray and Plates** and **Paddle Tray Load Resistor** replacement only:* Run the Paddles Safety Check (see "Paddles Safety Check" on page 171).

Internal Repairs

If *the case was opened* (regardless of what else the repair involved), perform *all* the Performance Verification and Safety tests:

- Run the Performance Verification and Safety tests (see "Test and Inspection Matrix" on page 157 and "Performance Verification Procedures" on page 160).

Verification Test Equipment

Table 36 lists the equipment needed to perform the Performance Verification and Safety tests, and provides specifications for commercially available analyzers and simulators. Test equipment is called out within each test procedure when needed.

Table 36 **Verification Test Equipment**

Equipment	Specification
ECG Simulator (for Leads/Pads/Paddles)	
Leads simulated	3 and 5
Amplitude accuracy	±2%
Rate accuracy	±2%
Defibrillator Analyzer	
Waveform compatibility	Meets all specs below using biphasic truncated exponential waveform
Load resistance	50 Ω ±1% (non-inductive)
Maximum energy	≥ 200 J
Maximum voltage	≥ 2500 V
Maximum current	≥ 50 A
Energy measurement accuracy	< 20 J: ≤ ±0.4 J; ≥ 20 J: ≤ ±2% of reading
Cardioversion measurement range	–120 to +380 ms
Test Load	50 Ω ±1% (non-inductive)
Pacer test	
Load impedance	≤ 400 Ω
Current measurement accuracy	10 mA–50 mA: ≤ ±2 mA; 50 mA–175 mA: ≤ ±4%
Rate measurement accuracy	30–180 ppm: ≤ ±0.5%
Waveform duration measurement accuracy	30–180 ppm: ±1 ms
NBP test	
Pressure range	> 280 mmHg
Pressure measurement accuracy	±3 mmHg
Safety test	
Leakage current measurement range	0 – 5000 µA
Leakage current measurement accuracy	±2% or ±2 µA

Test and Inspection Matrix

Table 37 summarizes Performance Verification tests and inspections for the HeartStart XL+.

Table 37 **Test and Inspection Matrix**

Test Group Name	Test or Inspection to Perform	Expected Test Results	Data to Record x = p (pass) or f (fail)
Visual Insp. (V)	Inspect the device, accessories, cables, etc., see "Visual Inspection" on page 160.	If no unusual damage, no missing items, then Visual Inspection passes.	*V:x* Example V:p
Service Mode Tests			
Operational Check (OC)	Run the Op Check. See "Operational Check" on page 161.	If "Pass" reported on all tests applicable to the device configuration and options, then Op Check passes.	*OC:x* Example OC:p
Error Logs (EL)	Check the Error Logs after the Operational Check. See "Error Log Messages" on page 41.	If no critical errors after the last successful Op Check, then Error Logs pass.	*EL:x* Example EL:p
Controls test (C)	Run test to check buttons, Therapy Knob, Functional Keys, and soft keys. See "Controls Test" on page 162.	If all keys respond as expected, then Controls test passes.	*C:x* Example C:p
Display (DP)	Run Display test. See "Display Test" on page 163.	If pattern displays correctly, then Display test passes	*DP:x* Example DP:p
Fan (F)	Run Fan test. See "Fan Test" on page 164.	If test passes, Fans pass.	*F:x* Example F:p
Printer (Pr)	Run Printer test. See "Printer Test" on page 164.	If print quality is adequate; no stray marks or lines and print speed: 25 mm ± 5% (1.25 mm) then Printer test passes.	*Pr:x* Example Pr:p
USB (USB)	Run USB test. See "USB Test" on page 165.	If test passes, USB passes.	*USB:x* Example USB:p
NBP Cal Check (NC)	Run the "NBP Module Tests" on page 22.	If all data passes within limits, then NBP calibration check passes.	*NC:x* Example N:p
Functional Checks: In normal Clinical Mode, perform the following functional checks:			
ECG (E)	Using an ECG simulator, perform Leads ECG and Pads cable ECG test. See "ECG Check" on page 166.	If all checks pass, and all data within limits: • Waveform clear on display • HR correct on display and matches defib analyzer at 2 data points: 30 and 200 bpm • HR alarm works • Leads off indicators perform as expected • Cycles through different views then ECG test passes.	*E:x* Example E:p
SpO_2 (Sp)	Using the SpO_2 sensor, perform SpO_2 check. See "SpO2 Check" on page 167.	If pleth wave is clear, pulse rate is displayed, and saturation reads between 95% -100%, then SpO_2 check passes.	*SP:x* Example Sp:p

Table 37 **Test and Inspection Matrix *(Continued)***

Test Group Name	Test or Inspection to Perform	Expected Test Results	Data to Record x = p (pass) or f (fail)
NBP Measurement (NM)	Take a blood pressure measurement on yourself or another person. See "NBP Check" on page 167.	If you are able to complete a measurement, the NBP check passes.	*NM:x* Example: NM:p
Synchronized Cardioversion (SC)	Using an ECG simulator and defibrillator analyzer, perform the "Synchronized Cardioversion Test" on page 170.	If all checks pass, and all data within limits: • Sync markers appear on the display, at the peak or on the falling side of the QRS • Shock delivered on next QRS • Shock delivered 6 J ± 2 J • If applicable, strip prints with the correct information on it • Delay between the peak of the QRS and the delivered shock is ≤ 30 ms • If clinicians use an external monitor as the ECG source, verify that the external monitor and the device combination will deliver a synchronized shock within 60 ms of the peak of the R-wave. then Synchronized cardioversion test passes.	*SC:x* Example SC:p
Pacing Test (P)	Using a defibrillator analyzer, perform the "Pacer Test" on page 169. • (70 ppm) 30 mA • (180 ppm) 140 mA	If all checks pass, and all data within limits: • 30 mA ± 5 mA • 140 mA ± 14 mA then Pacing test passes.	*P:x* Example P:p
Defibrillator Test — AC Power (DA) (if AC Power used in normal operation)	Using only AC power and a defibrillator analyzer, run the "Defibrillator Test (AC Power at 200 J)" on page 168.	If all checks pass, and all data within limits:	*DA:x* Example DA:p
	Energy measured by analyzer: Delivered into 50-ohm test load	200 ± 20 J	
	Setting displayed by HeartStart XL+:	200 J	
	Delivered energy	Actual delivered energy ± 10% then Defibrillator Measurement test passes	
Defibrillator Test — Battery Power (DB)	Using only battery power and a defibrillator analyzer, run the "Defibrillator Test (Battery Power at 200 J)" on page 168):	If all checks pass, and all data within limits:	*DB:x* Example DB:p
	Energy measured by analyzer: Delivered into 50-ohm test load	200 ± 20 J	
	Setting displayed by HeartStart XL+:	200 J	
	Delivered energy	Actual delivered energy ± 10% then Defibrillator Measurement test passes.	

Table 37 **Test and Inspection Matrix** ***(Continued)***

Test Group Name	Test or Inspection to Perform	Expected Test Results	Data to Record x = p (pass) or f (fail)
Defibrillator Disarm Test (D)	Run the "Defibrillator Disarm Test" on page 169.	Verify that the device is disarmed Verify that the charge tone stopped then the Defibrillator Disarm test passes.	*D:x* Example D:p
Paddles Safety Check (Pa)	Perform "Paddles Safety Check" on page 171.	If PCI flashes as expected, then Paddles test passes.	*Pa:x* Example Pa:p
Safety Tests Using a Safety Analyzer **NOTE:** All leakage current tests include both Normal and Reverse Polarity Conditions. Report worst case values.			
AC Mains (S1)	Earth Leakage Current NC (Normal Condition). See "AC Mains (Ground Leakage)" on page 172 — aaa	If Normal Condition Maximum leakage current: < 300 µA (UL, 120 VAC) < 500 µA (IEC, 240 VAC)	*S1:x/aaa/bbbb* Example: S1:p/125/800
	Earth Leakage Current SF (Single Fault, open neutral) — bbbb	If Single Fault Maximum leakage current: < 1000 µA, then Earth Leakage Safety test passes	
Chassis Leakage (S2)	Use ECG Out (Sync) jack as ground NC (Normal Condition). See "Chassis (Enclosure) Leakage" on page 173 — cc	If Normal Condition Maximum leakage current: < 100 µA	*S2:x/cc/ddd* Example: S2:p/99/299
	Single Fault condition — ddd	If Single Fault Maximum leakage current: < 300 µA (UL) < 500 µA (IEC) then Chassis Leakage test passes.	
Patient Lead Leakage (S3) (see "Patient Lead Leakage" on page 173)	**ECG Patient Cable / Pads / SpO_2 Cable (as applicable)** • Source (Normal cond.) — ee / hh / kk • Source (Single Fault condition — open earth, open neutral) — ff / ii / ll • With Mains on applied part (Single Fault condition) — gg / jj / mm	If readings are as expected: • < 10 µA • < 50 µA • < 50 mA then Cable Leakage test passes	*S3: x/ee/ff/gg/hh/ii/jj/kk/ll/mm/nnn/ooo/ppp* Example: S3:p/9/49/49/9/49/49/9/49/49/99/499/499
	Paddles Cable • Source (Normal Condition) — nnn • Source (Single Fault Condition — open earth, open neutral) — ooo • With Mains on applied part (Single Fault condition) — ppp	If readings are as expected: • < 100 µA • < 500 µA • < 500 µA then Paddles Cable Leakage test passes	

NOTE: When recording test results, separate results within a test by slashes (/); separate tests by semicolons (;); and use no empty spaces.

V:x;OC:x;EL:x;C:x;DP:x;F:x;Pr:x;USB:x;NC:x;E:x;SP:x;NM:x;SC:x;P:x;DA:x;DB:x;D:x;Pa:x;S1:x/aaa/bbbb;S2:x/cc/ddd;S3:x/ee/ff/gg/hh/ii/jj/kk/ll/mm/nnn/ooo/ppp

For example: V:p;OC:p;EL:p;C:p;DP:p;F:p;Pr:p;USB:p;NC:p;E:p;SP:p;NM:p;SC:p;P:p;DA:p;DB:p;D:p;Pa:p;S1:p/9/49/49/9/49/49/9/49/49/99/499/499

Performance Verification Procedures

This section gives instructions for performing inspections and running Performance Verification and Safety tests on the HeartStart XL+. If desired, you can make copies of the "Test and Inspection Matrix" on page 157 and use it to record results.

The Performance Verification procedures are divided into two levels:

- **Visual Inspection** — examining for damage, wear, contamination
- **Performance Verification and Safety tests** — consist of the following tests and checks:
  - Service Mode tests (including Operational Check), which consist of running the device in Service Mode, applying signals, measuring, observing behavior, and recording results.
  - Functional checks, which consist of running the device in its normal operating mode, applying signals, measuring, observing behavior, and recording results.
  - Safety tests, which consist of connecting the HeartStart XL+ to a safety analyzer and measuring results.

The Performance Tests are sequenced to check more basic functions first, and then build on that to check more complex functions. We recommend you perform these tests in this sequence.

This section is organized into the following topics:

Visual Inspection

A thorough visual inspection of the device should include at least the checks described below.

Check Cables, Supplies and Accessories

1. Are they the right ones? Sometimes a problem can be resolved simply by using the cables and supplies with which the device was designed to operate.
   - Are they the correct Philips models recommended for use with the HeartStart XL+, or are they some other brand?
2. Are they all present? The device should have:
   - An undamaged, sufficiently charged Philips battery.
   - A new, dry roll of Philips printer paper. The Printer may jam if the paper is wet. Also, the Printer may be damaged if wet paper is allowed to dry while in contact with the printhead elements.
   - Cables and sensors which are approved by Philips and known to be in working order. Also make sure that all external cables are fully inserted in their receptacles.
   - A new, empty USB flash memory drive.
3. Are the consumables fresh?
   Check the ECG electrodes and multifunction electrode pads for freshness (date code or expiration date) and condition.

PASS: Accessories and supplies are those specified by Philips. Electrodes and pads are within their expiration date and appear usable. For single-use items, packaging is unopened and shows no tears or punctures. No corrosion is visible on connector sockets, electrodes, or pads.

Check the Device

1 Inspect the device on all sides, looking for:

- Signs of mechanical damage to the case, controls, display, or printer.
- Loose or missing hardware.
- Evidence of liquid spill, mechanical damage, pin corrosion, or debris:
  - Open the printer door and clean out any accumulation using gloves and an approved cleaner.
  - Inspect the battery connector using a flashlight.
  - Check for residue in the patient connectors on either side of the device (ECG, SpO_2, NBP, Therapy port, USB port, ECG Out, network port, AC mains socket).
- Residue on the thermal printhead.
- Printer roller wear.

2 Inspect the paddles, power cord, battery, cables, and sensors for signs of the following:

- Wear or damage to paddles, cables, and adapters.
- Wear or damage to patient cables and associated strain reliefs.
- Wear or damage to power cord and associated strain relief.

PASS: Only normal wear, no damage serious enough to inhibit performance. No corrosion visible.

Service Mode Tests

The following tests are available from Service Mode:

Operational Check . . . . . p. 161

Battery test is a part of the battery calibration procedure, see "Battery Calibration" on page 16.

Printer Test . . . . . p. 164
Controls Test . . . . . p. 162
Display Test . . . . . p. 163
Fan Test . . . . . p. 164
USB Test . . . . . p. 165

Service Mode also allows you to view and print the Error Logs (see "Error Log Messages" on page 41); check and enter device information, such as serial number and options (see "Device Information" on page 10); and upgrade the software and set the device's language (see "Software Upgrades" on page 11).

CAUTION: Be sure that the defibrillator/monitor is not connected to a patient when performing any functions in Service Mode.

Operational Check

Operational Check (Op Check) should be performed at regular intervals to supplement the hourly, daily, and weekly Automated Tests executed by the HeartStart XL+. Automated Tests provide adequate assurance that the device is in a functional state of readiness. Op Check supplements the Automated Tests by verifying therapy cables, the ECG cable, paddles, and audio functionality, along with replicating the Weekly test. Op Check also notifies you if the battery or NBP module need calibration.

Always run an Op Check and check the Error Logs after a repair.

To run Op Check:

1 Insert a a sufficiently charged battery (at least two LEDs light up).

2 Access Service Mode (see "Accessing Service Mode" on page 8).

3 From the Service Mode Main menu, select **Operational Check** and press the Menu Select button.

NOTE: You can run Op Check from the **Other** menu in Monitor Mode or from the Service Mode Main menu — the Op Check is the same in both modes.

4 When a response is required, use the Navigation buttons to select your answer and the Menu Select button to confirm your choice.

See "Operational Check" on page 33 for more information on the Op Check procedure.

To check the Error Logs:

▶ Select **Hardware Error Log** or **Software Error Log** from the Service Mode Main menu.

The Error logs includes entries for all messages logged during all operating modes, Automated tests, Service tests, and Op Checks. See "Error Log Messages" on page 41 for more information.

Battery Test

See "Battery Maintenance" on page 16.

Controls Test

Run these tests when the controls performance becomes a suspect.

To perform controls test:

1 Access Service Mode

2 Select **Controls Test** from the Service Mode menu.
The controls test screen appears (Figure 105 on page 163).

3 Press all the indicated keys in turn and observe check marks appearing in the corresponding boxes.
If after pressing a key, the corresponding check mark does not appear, or appears in a wrong box, note the malfunctioning key.

NOTE: Press the soft key #1 once to check the box and enable the **Main Service** function. If pressed again, soft key #1 returns you to the Main Service screen.

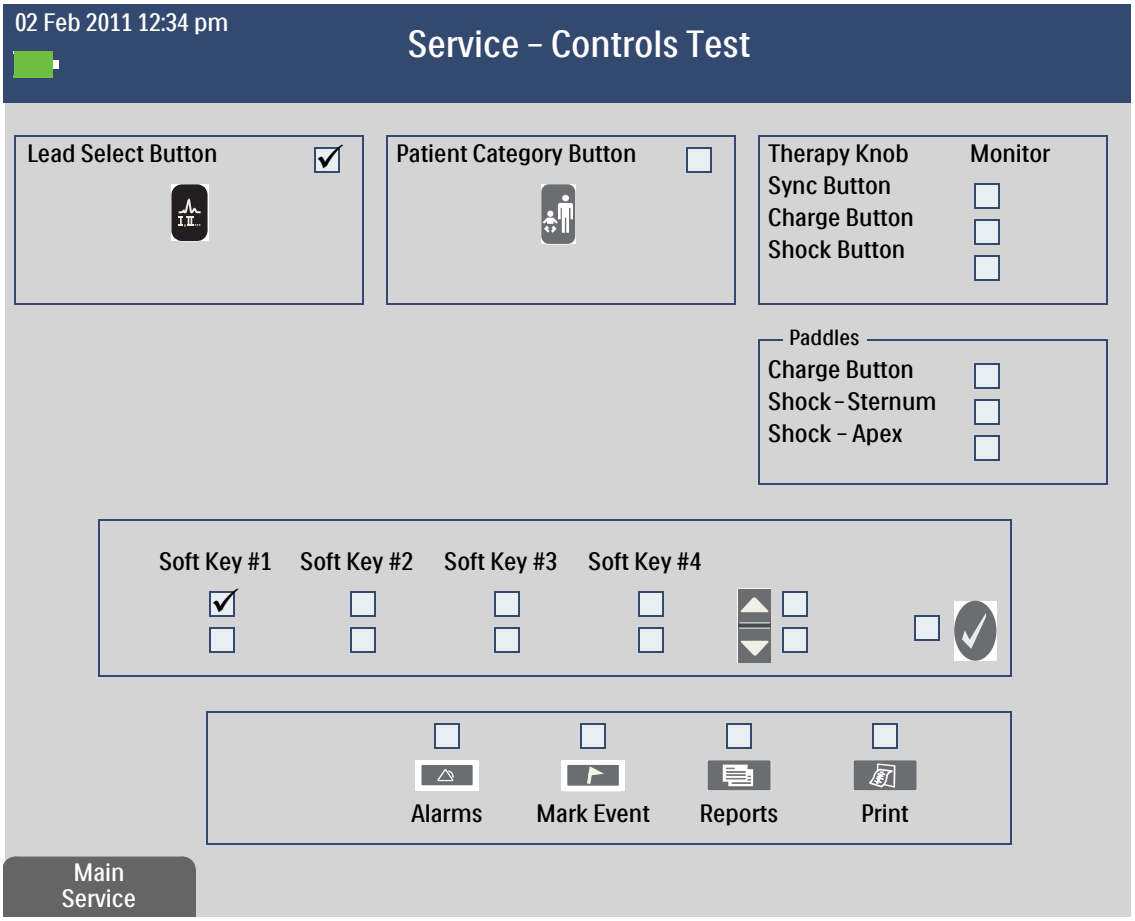
4 Turn the Therapy Knob to every position and observe the screen designation changing accordingly.

5 If there is a mismatch, then:

- If there is a mismatch in Therapy Knob, then check the Therapy Knob connections and replace the Therapy Knob or Therapy Switch as necessary.
- If there is a mismatch in the Paddles group, then check the Paddles connections and test the Paddles.
- If there is a mismatch in the Charge/Shock/Sync buttons, then check the Human Interface PCA connections and replace the Human Interface PCA if necessary.
- If there is a mismatch in other buttons or keys, then check the Front Case connections and replace the Front Case if necessary.

If all results pass, the device passes that portion of the test. Return to the Service Mode Main screen by pressing the **Main Service** soft key. If there is any failure, begin troubleshooting and repair the device as needed.

Figure 105 **Controls Test Screen**



Display Test

These instructions tell you how to run the Display test.

If all results pass, the device passes that portion of the test. Return to the Service Mode Main screen by pressing the **Main Service** soft key. If there is any failure, troubleshoot and repair the device as needed. See "Display Problems" on page 63.

1. Access the Service Mode Main menu as described in "Accessing Service Mode" on page 8.
2. From the Service Mode Main menu, select **Display Test**.
3. Check for any defective pixels, random lines or dots, or flickering while test patterns are displayed:
   - **a** the display is filled with white,
   - **b** the display is filled with black,
   - **c** red fills the display from top to bottom,
   - **d** green fills the display from left to right,
   - **e** blue fills the display from right to left,
   - **f** intensity test pattern is displayed.
4. Inspect the intensity test pattern to ensure that 32 intensity levels are visible in each color.
5. Press the **Main Service** soft key to terminate the test.
6. There is no pass / fail result or message for the display test. Make your subjective decision based on your observations.

Fan Test

Use the Fan On/Off soft key to verify both fans can rotate and stop.

Printer Test

The printer test checks printer parameters, and prints test patterns to check the print head and the paper drive mechanism.

To start the Printer Test:

1 Select Printer Test from the Service Mode Main menu and press the Menu Select button.
The printer prints a series of test patterns.

NOTE: It can take up to 30 seconds for the printout to start on devices that have Asian fonts.

2 Stop the printout.
Once the patterns have printed, press the Print button to stop the printout.

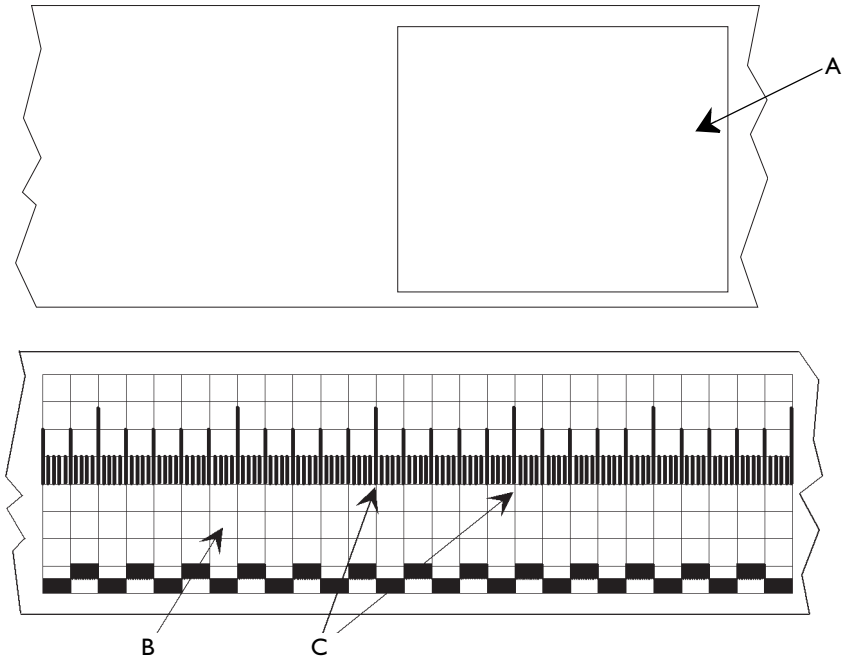
To inspect the test patterns:

- Check the print quality. Verify that the test patterns on the strip are as indicated in Figure 106.
  - **a** Area "A" contains printouts of all characters and symbols. Verify that they are readable.
  - **b** Check Area "B" for stray marks or lines.
  - **c** Check for white lines (printhead elements stuck off) or black lines (printhead elements stuck on).

To measure the print speed:

- Verify the print speed.
  Measure between the long tick marks (area "C") to verify paper speed. The distance should be 25 ± 1.25 mm (± 5%) matching the print speed of 25 mm/sec.

Figure 106 **Printer Test Output**



USB Test

Test the USB if indicated by the troubleshooting outcome.

The USB test is safe for the data on the USB drive.

The USB test verifies both the USB flash drive and HeartStart XL+ USB port performance. If in doubt, test the suspect USB flash drive on different devices or different USB flash drives on the suspect device.

To test the USB:

1. Check the physical integrity of the connection:
   a. Verify there is no dirt, debris, rust, or liquid spill in the USB port or flash drive.
   b. Verify there is no physical damage to the USB port or flash drive.

   If any of these conditions present, then replace both the RFU-and-USB PCA and USB flash drive to avoid damaging other ports and drives.
2. Access the Service Mode Main menu as described in "Accessing Service Mode" on page 8.
3. From the Service Mode Main menu, select **USB Test**.
4. Observe the **USB Test Passed** or **USB Test Failed** message.
5. Press the **Menu Select** button to acknowledge the **Test Done** message.

Functional Checks

The functional checks exercise the basic functions of the defibrillator/monitor. They are intended as a broad check of the device's performance and are used in conjunction with the Service Mode and Safety tests to verify the performance of the device.

Perform functional checks with the device in a normal clinical operating mode, not in Service Mode.

TIP: Perform functional checks only for the options installed on your device.

If all elements of a test pass, record that test as a PASS. If there is any failure, begin troubleshooting and repair as needed.

This section is organized into the following topics:

ECG Check

This section describes how to check the operation of the ECG functions. Each of the ECG checks assumes the device and the simulator are still set up as they were at the end of the previous ECG check.

Setup

1. Set up the simulator:
   - **a** Connect a Therapy cable and ECG cable to the HeartStart XL+.
   - **b** Connect the ECG simulator to both the Therapy cable and the 3- or 5-lead ECG cable.
   - **c** Set the simulator for normal sinus rhythm (NSR), 1 mV amplitude, and 30 bpm.
2. Set up the HeartStart XL+:
   Turn the Therapy Knob to Monitor.

Check ECG Display, HR, Leads Off

1. Check the waveform.
   Using the Lead Select button, verify that the display shows a clear waveform for all Leads and Pads.
2. Check the Heart Rate (HR).
   Verify that the Heart Rate (HR) displayed is correct.
3. Check the alarms.
   - **a** Verify that the Extreme Brady alarm sounds (assuming 30 bpm is below the configured lower limit).
   - **b** Set the simulator to 60 bpm.
     Verify that the Extreme Brady alarm does not stop.
4. Check the Leads Off condition.
   - **a** Using the Lead Select button, select Pads (or Paddles).
   - **b** Disconnect the ECG simulator from the Therapy cable and verify that the display shows a dashed line in place of the waveform and that the device sounds an alert and displays the Cannot Analyze ECG message
   - **c** If you are testing a 3-lead cable, use the Lead Select button to select Lead II.

NOTE: If you are testing anything other than a 3-lead ECG cable, make sure an ECG waveform appears in Wave Sectors 1 and 2.

   - **d** If you are testing a 5-lead cable, select the V or V/C lead (depending on the electrode configuration).
   - **e** Disconnect each of the ECG electrodes from the simulator one at a time, and verify that the display shows a dashed line in place of the waveform when that electrode is disconnected.
   - **f** Verify that the device sounds an alert and displays the Leads Off message.
5. Repeat the above test, setting the simulator for normal sinus rhythm (NSR), 1 mV amplitude, at 200 bpm.
   Verify that the Extreme Tachy alarm sounds (assuming 200 bpm is above the configured upper limit).

Check ECG Printing

1. Reconnect the simulator to the device as described in the Setup section above.
2. Press the Print button to print a strip.
   a. Verify that it shows a normal ECG with a clean baseline.
   b. Verify that the date, time, and configuration information printed at the top of the strip are correct.
3. Press the Print button again to stop printing.

SpO_2 Check

NOTE: A functional tester (i.e. simulator or safety analyzer) can not be used to assess the accuracy of an SpO_2 probe or an SpO_2 monitor.

1. Connect the sensor.
   Attach the SpO_2 sensor to your finger and to the HeartStart XL+.
2. Turn the Therapy Knob to Monitor. Observe:
   a. The pleth wave is clear.
   b. The SpO_2 value displayed is in the range of 95-100%. If the value is less than 95%, check that your finger is fully inserted into the sensor and properly positioned.
   c. The pulse rate is displayed.

NBP Check

1. Perform a non-invasive blood pressure check on yourself or another person.
2. Make sure the measurement completes.
3. Perform the NBP module tests only if you suspect a problem with the module. See "NBP Module Tests" on page 22 for information on these tests.

Defibrillator Measurement Test

These instructions describe how to test the defibrillation functions. The test sequence causes the HeartStart XL+ to:

- Charge and deliver a shock when powered by AC power alone.
- Charge and deliver a shock when powered by battery alone.
- Disarm when the Disarm soft key is pressed.

If all results are as described, the device passes that portion of the test. If there is any failure, troubleshoot and repair the device as needed. See "Troubleshooting" on page 29.

Defibrillator Test (AC Power at 200 J)

These instructions describe how to test the defibrillation function when powered only by AC power (no battery installed).

Setup

1. Configure the defibrillator analyzer for a 50-ohm load.
2. Turn the HeartStart XL+ off and remove the battery.
3. Plug the AC mains power cord into an outlet.
4. Connect the Pads cable to the HeartStart XL+.
5. Connect the defibrillator analyzer to the Pads cable.
6. Set the analyzer to measure delivered energy.

Test the Charge/Shock Functions

1. Charge and deliver a 200-J shock:
   a. Turn the HeartStart XL+'s Therapy Knob to 200 J.
   b. Press the **Charge** button to charge the HeartStart XL+.
   c. Press the **Shock** button to deliver the shock to the defibrillator analyzer.
   d. If the device is not configured to print on the **Charge** command, press the **Print** button.
2. Check the analyzer readings.
   The delivered energy should be 200 J ± 10%.
3. Check the printed strip from the HeartStart XL+.
   The selected energy should be 200 J. The delivered energy should be 200 J ± 10% and will be printed on the strip if the device is configured to print on shock.
4. Repeat the test using paddles, pressing the **Shock** button on the paddles in Step 1c.

Defibrillator Test (Battery Power at 200 J)

These instructions describe how to test the defibrillation function when powered only by a battery with no AC power connected.

Setup

1. Configure the defibrillator analyzer for a 50-ohm load.
2. Insert a sufficiently charged battery (at least two LEDs light up) and disconnect the AC power cord.
3. Connect the Pads cable to the HeartStart XL+.
4. Connect the defibrillator analyzer to the Pads cable.
5. Set the analyzer to measure delivered energy.

Test the Charge/Shock Functions

1. Charge and deliver a 200-J shock.
   a. Turn the defibrillator/monitor's Therapy Knob to 200 J.
   b. Press the **Charge** button to charge the HeartStart XL+.
   c. Press the **Shock** button to deliver the shock to the defibrillator analyzer.
   d. If the device is not configured to print on the **Charge** command, press the **Print** button.
2. Check the analyzer readings.
   The delivered energy should be 200 J ± 10%.

3 Check the printed strip from the HeartStart XL+.
The energy setting should be 200 J. The delivered energy should be 200 J ± 10% and will be printed on the strip if the device is configured to print on shock.

4 Repeat the test using paddles, pressing the **Shock** button on the paddles in Step 1c.

Defibrillator Disarm Test

These instructions describe how to test the disarm function.

Setup

1 Insert a sufficiently charged battery (at least two LEDs light up) and disconnect the AC power cord.

2 Connect the Pads cable to the HeartStart XL+.

3 Connect the defibrillator analyzer to the Pads cable.

4 Set the analyzer to measure delivered energy. If needed, reset the analyzer's display to read 0.

Test the Disarm soft key

1 Charge to 200 J.
   a Turn the HeartStart XL+'s Therapy Knob to 200 J.
   b Press the Charge button to charge the HeartStart XL+.

2 Press the **Disarm** soft key.
The HeartStart XL+ should disarm itself by discharging into an internal load resistor.

3 Check the results.
Verify that the **Defib Disarmed** message appears on the HeartStart XL+. Verify that the charge tone stopped.

4 Check the analyzer readings.
Read the delivered energy indicated by the defibrillator analyzer. It should be 0 or blank.

Pacer Test

These instructions describe how to test the pacing function. Only run this test if the Pacing option is installed on your defibrillator/monitor. If all results are as described, the device passes the test. If there is any failure, troubleshoot and repair the device as needed. See "Troubleshooting" on page 29.

Setup

1 Insert a sufficiently charged battery (at least two LEDs light up) and disconnect the AC power cord.

2 Connect the Pads cable to the HeartStart XL+.

3 Connect the defibrillator analyzer to the Pads cable.

4 Turn the Therapy Knob on the HeartStart XL+ to **Pacer**.

5 Set Pacer mode to **Fixed**.

Test Pacing

1 Generate a fixed pacing waveform on the HeartStart XL+ for 70 ppm @ 30 mA.
   a Press the **Pacer Rate** soft key and use the navigation buttons to set the rate to 70 ppm.
   b Press the **Pacer Output** soft key and use the Navigation buttons to set the rate to 30 mA.
   c Press the **Start Pacing** soft key.

2 Check the default output on the defibrillator analyzer.
The output should read 70 ± 1 ppm and 30 ± 5 mA.

3 Test the maximum output by generating a fixed pacing waveform on the HeartStart XL+ for 180 ppm @ 140 mA.
   a Press the Pacer Rate soft key and use the Navigation buttons to increase the rate to 180 ppm.
   b Press the Pacer Output soft key and use the Navigation buttons to increase the output to 140 mA.

4 Check the output on the defibrillator analyzer. The output should read 180 ppm and 140 ± 14 mA.

Synchronized Cardioversion Test

This section describes how to check the synchronized cardioversion function.

NOTE: Whenever possible, Philips Healthcare recommends that clinicians perform synchronized cardioversion procedures while directly monitoring the patient through the HeartStart XL+'s electrodes or lead inputs. If clinicians use an external monitor as the ECG source, you *must* verify that the external monitor and the HeartStart XL+ combination will deliver a synchronized shock within 60 ms of the peak of the R-wave. Use a 1 mV QRS complex with a QRS width of 40 ms. This performance cannot be guaranteed with all commercially available monitors.

Setup

1 Set up the defibrillator analyzer.
   a Connect the ECG cable and the Pads cable to the HeartStart XL+.
   b Connect the ECG cable to the analyzer.
   c Connect the Pads cable to the analyzer.
   d Set the analyzer to a sync. measurement, 1 mV amplitude, at some nominal rate (e.g., 60 bpm).

2 Set up the HeartStart XL+.
   a Turn the Therapy Knob to 1-10 J.
   b Press the Sync button. Check that a Sync message appears in the upper right corner of Wave Sector 1.

Check Display, Shock, Print

1 Check the displayed waveform.

   Verify that sync markers appear on the display, at or near the peak of the QRS complex. Adjust the size of the displayed ECG as needed to view it more clearly.

TIP: To adjust the size of the displayed ECG, navigate the following menus:
Menu –> Displayed Waves –> select Wave1 or Wave 2 –> I, II, or III –> select size.

2 Check shock delivery.
   a Select an energy of 6 J.
   b Press the Charge button.
   c Press and hold the Shock button until the shock is delivered (at next QRS).
   d Verify on the defibrillator analyzer that the shock was delivered, and was 6 ± 2 J.
   e If the device is configured to do so, verify that it prints a strip with the correct information on it (waveform, text, shock).
   f Verify on the defibrillator analyzer that the delay between the peak of the QRS and the delivered shock was ≤ 30 ms.

Paddles Safety Check

This section describes how to test the paddles to ensure they are connected correctly. This test checks the Patient Contact Indicator (PCI) function of the paddles. The PCI measurement is used to detect Pads Off and Paddles Off, and to illuminate the PCI LEDs on PCI-equipped paddle sets. If all results are as described, the device passes that portion of the test.

NOTE: Test internal paddles (IEC Type CF) only if the device is used for internal defibrillation.

1. Connect a set of external paddles to the device.
   a. Make sure the metal surfaces of the paddles and slide-on adapters are clean and dry. Also make sure the slide-on adapters are clean, shiny, and making good contact to the paddle surface.
   b. Put the paddles in the paddle tray.
2. Turn the Therapy Knob to Monitor.
3. Verify that the PCI is not lit.
4. Take one paddle out of the paddle tray.
5. Verify that one red LED of the PCI flashes.
6. Take both paddles from the paddle tray and hold them firmly together, face to face (metal to metal). Be sure the paddles are clean and are making good contact with one another.
7. Verify that all LEDs on the PCI are lit.

Safety Tests

This section discusses tests of the HeartStart XL+'s electrical safety. The Philips Safety Test designation for each test is provided for reference of Philips service personnel.

Test Notes

HeartStart XL+ complies with the international electrical safety standards:

- IEC 60601, Medical Electrical Equipment, General Requirements for Safety, and
- IEC 62353, Medical Electrical Equipment, Recurrent Test and Test After Repair of Medical Electrical Equipment.

To successfully complete HeartStart XL+ safety testing, please note the following:

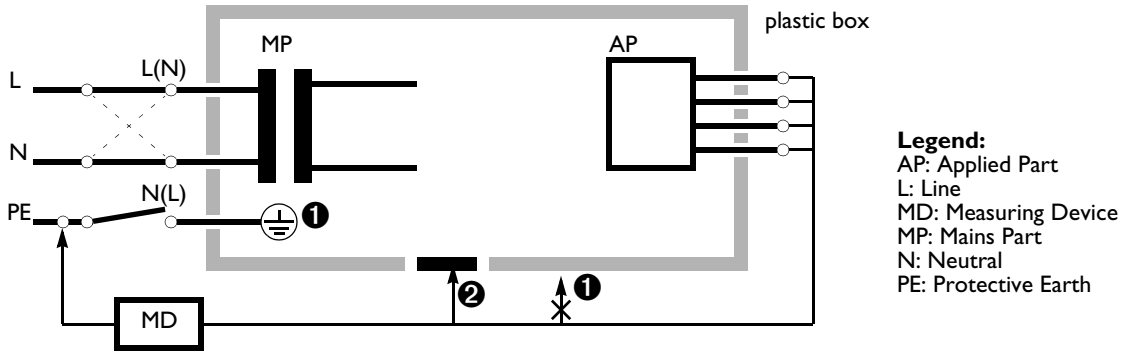
- Use the procedures called out by the manufacturer of the safety analyzer in use.
- Only test the AC Mains (line) voltage used in the customer's facility — there is no need to test both 120 V AC and 240 V AC.
- Test both Normal and Reverse Polarity line connections for each test, and record the worst case value.
- If a chassis reference point is needed for the testing, connect to the inside metal shaft on the ECG Out (Sync) jack. (This is *not* earth ground).
- Insert a battery charged to at least 20% before performing safety tests.

Test Method

The HeartStart XL+ does not have an earth ground node that could be used for protective earth continuity testing purposes. The only accessible earth ground node is at the AC inlet on the AC power module. All accessible parts of HeartStart XL+ are protected from mains by double or reinforced insulation. Therefore the tests IEC 60601: 8.6.2 "Protective Earth Terminal" and IEC 62353: "Protective Earth Resistance" are not applicable.

Figure 107 illustrates the HeartStart XL+ circuitry. Compare with Class I test diagram shown in IEC 62353.

Figure 107 **HeartStart XL+ Safety Test Diagram**



NOTES: ❶ Protective earth does not connect to any accessible parts.

❷ Check accessible conductive parts for touch current (enclosure leakage current), but not for protective earth resistance because they are not protectively earthed.

Test Cables

Safety Test Cables can provide a convenient way to perform electrical safety tests. You may order these cables via the Philips SPS organization, see Table 38:

Table 38 **Safety Test Cables**

Tool Code #	Part Number	Description
TC352	451261026041	Cable for SpO_2 safety test
TC356	451261026081	Cable for ECG safety test
TC366	451261026191	Cable for Defib. Pads/Paddles safety test

AC Mains (Ground Leakage)

Leakage through earth (ground) wire of AC power cord.

- Normal Condition (Open ground), both AC line connections intact
  - Should be ≤ 300 µA (UL, 120 VAC).
  - Should be ≤ 500 µA (IEC 240 VAC).
  - Record as “aaa”.
- Single Fault Condition (Open ground, open neutral), one AC line connection open
  - Should be ≤ 1000 µA. Record as “bbbb”.

Chassis (Enclosure) Leakage

Use ECG Out (Sync) jack to measure enclosure leakage current. (This is *not* earth ground.)

- Normal Condition
  - Should be ≤ 100 µA. Record as “cc”.
- Single Fault condition (Open neutral)
  - Should be ≤ 300 µA (UL)
  - Should be ≤ 500 µA (IEC)
  - Record as “dd”.

Patient Lead Leakage

Leakage out of (Source) or into (Sink) patient-connected inputs (Applied Parts).

When performing the leakage test on the Therapy Port, only one style cable needs to be tested. If the customer uses internal paddles, then the Internal Paddles test should be performed (note: use CF limits). If the device is not used for internal defibrillation such as in the pre-hospital market, then either external paddles or pads cable (whichever is available) can be used to test the leakage current (note: use BF limits).

CAUTION: Do not touch the leads during these tests.

ECG leads (IEC Type CF)

- Source (out of leads into HeartStart XL+)
  - Normal Condition (both AC line connections and earth ground intact)

    Should be ≤ 10 µA. Record as “eee”.
  - Single Fault Condition (separately open neutral and open earth, each in turn)

    Should be ≤ 50 µA. Record as “fff”.
- Sink (out of HeartStart XL+ into leads)
  - Single Fault Condition is with AC Mains voltage on Applied Parts (both AC line connections and earth ground intact)

    Should be ≤ 50 µA. Record as “ggg”.

External Paddles/Pads (IEC type BF)

- Source:
  - Normal Condition (both AC line connections and earth ground intact)

    Should be ≤ 100 µA. Record as “hhh”.
  - Single Fault Condition (separately open neutral and open earth, each in turn)

    Should be ≤ 500 µA. Record as “iii”.
- Sink
  - Single Fault Condition (with AC Mains voltage on Applied Parts)
    (both AC line connections and earth ground intact)

    Should be ≤ 500 µA. Record as “jjj”.

Internal Paddles (IEC type CF)

NOTE: Test internal paddles only if the device is used in internal defibrillation.

- Source (out of leads into HeartStart XL+)
  - Normal Condition (both AC line connections and earth ground intact)

    Should be ≤ 10 µA. Record as “kkk”.
  - Single Fault Condition (separately open neutral and open earth, each in turn)

    Should be ≤ 50 µA. Record as “lll”.
- Sink (out of HeartStart XL+ into leads)
  - Single Fault Condition is with AC Mains voltage on Applied Parts (both AC line connections and earth ground intact)

    Should be ≤ 50 µA. Record as “mmm”.

SpO_2 Probe (if the SpO_2 option is installed, IEC type CF)

You need a special tool to test the SpO_2:

- You may purchase a 451261026041 cable (tool # TC352), or
- Prepare a modified SpO_2 cable for this test:
  - **a** Cut an SpO_2 cable close to the sensor.
  - **b** Clean and connect the wires in a single bundle.
  - **c** Solder them into a banana plug.

Connect this cable to the SpO_2 port and your safety analyzer. Measure as follows:

- Source (Out of leads into HeartStart XL+)
  - Normal Condition (both AC line connections and earth ground intact)

    Should be ≤ 10 µA. Record as “nnn”.
  - Single Fault Condition (separately open neutral and open earth, each in turn)

    Should be ≤ 50 µA. Record as “ooo”.
- Sink (out of HeartStart XL+ into leads)
  - Single Fault Condition is with AC Mains voltage on Applied Parts (both AC line connections and earth ground intact)

    Should be ≤ 50 µA. Record as “ppp”.

Appendix A

Parts and Accessories

Overview

This appendix provides information on ordering replacement parts, supplies, and accessories for the HeartStart XL+ defibrillator/monitor. Information on Key Component tracking is also provided. This appendix is organized into the following sections:

Parts and Accessories Notes

The tables in this chapter list 12-digit "12NC" numbers for every component. Use these numbers when ordering replacement parts, support part kits (SPKs) and accessories, or calling the Response Center.

The following notes contain some important information relating to replacement parts.

Ordering Replacement Parts

To order replacement parts:

- In the US, call 800-722-9377.
- Outside the US, contact your local Philips Healthcare office.

Ordering Supplies and Accessories

To order accessories and supplies:

- Visit Philips Healthcare web site at: http://www.healthcare.philips.com/main/products/resuscitation/products/als/index.wpd.
- In the US, call 800-225-0230.
- Outside the US, contact your local Philips Healthcare Sales Office or your authorized Philips Healthcare Dealer or Distributor.

Key Component Tracking

Replacement assemblies marked with an asterisk (*) contain one or more Key Components. Key Components require detailed tracking, by recording the Key Component part number and either the Key Component's date code or its serial number. This data must be recorded for both the failed assembly and the replacement assembly. Philips Healthcare service personnel must record this information on the Customer Service Order (CSO).

The Key Components that are part of the replacement assemblies are listed in Table 60 on page 189.

Electrical Assemblies

The following tables list all the electrical field-replaceable assemblies.

NOTE: Items marked with an asterisk (*) are Key Components that require tracking. See Table 60 on page 189.

Software Support Tool

Install the most recent software in the appropriate language using the Software Support tool whenever you replace the Processor PCA (replacement kit 453564570781), see Table 40 on page 177.

NOTE: The SOM PCA is a Key Component that requires tracking. See Table 60 on page 189.

Table 39 **Software Support Tool**

Description	12NC
American English	453564205861
Commonwealth English	453564205871
Chinese (simplified)	453564205881
Chinese (traditional)	453564205891
Danish	453564205901
Dutch	453564205911
Finnish	453564205921
French	453564205931
German	453564205941
Greek	453564205951
Italian	453564205961
Japanese	453564205971
Korean	453564266321
Norwegian	453564205981
Polish	453564418301
Portuguese (European)	453564205991
Portuguese (Brazilian)	453564206001
Spanish	453564206021
Swedish	453564206031

Replacement PCAs and Assemblies

These PCAs come with specific parts, as noted.

Table 40 **Replacement PCAs**

Description	12NC
Processor PCA *	453564570781
Therapy PCA*	453564570771
HIF PCA	453564206071
RFU-and-USB PCA Assembly	453564206081
Battery PCA	453564570761
Printer PCA	453564206101
Inverter PCA	453564206111
SpO_2 PCA	453563476681

These assemblies come with specific parts, as noted.

Table 41 **Electrical Assemblies**

Description	Field Replacement Kit or SPK #
Power Supply Assembly	453564206121
Display Assembly	453564206141
RFU Indicator	453564206151
Front Case, also order the Label Set, see "Instruction Label Sets" on page 180	453564206161
Rear Case, also order the Label Set, see "Instruction Label Sets" on page 180	453564206171
NBP Module	453563476761
Internal Resistor Assembly	453564280161
Fan Assembly (set of 2)	453564206371
Speaker Assembly *	453564570731
Printer Assembly	453564206131
Therapy Switch (optical),* also order Therapy Knob, 453564206311	453564206301
Therapy Capacitor *	453564206351
50-ohm load resistor assembly	453564279941

Table 42 **Individual Electrical Parts**

Description	12NC
Clock battery replacement kit	453564206331 Includes battery, wipes, and cable tie wrap
USB flash drive	989803171261

External components are visible outside of the case, and the user interacts with them.

Table 43 **External Electrical Components**

Description	12NC	Comment
Therapy Port *	453564570661	Including the Therapy Port Extender assembly.
Measurement Modules:		
ECG only	453564206201	
ECG and SpO_2	453564206211	If required, order the SpO_2 and NBP Ports listed below (for the 453564206211 and 453564206221 modules only). Also order the Label Set, see "Instruction Label Sets" on page 180.
ECG, SpO_2, and NBP	453564206221	
ECG and $EtCO_2$	453564570691	
ECG, SpO_2, and $EtCO_2$	453564570701	
ECG, SpO_2, $EtCO_2$, and NBP	453564570711	
ECG Port SPK	453564570721	Fits any Measurement Module
SpO_2 Port	453564206241	Fits Measurement Module 453564206211, 453564206221, 453564570701, or 453564570711
NBP Port	453564206251	Fits Measurement Module 453564206221 or 453564570711
Rear I/O Assembly	453564570651	Includes Power, ECG-Out, and LAN ports
RFU-and-USB PCA Assembly	453564206081	
Paddle Tray Assembly	453564206271	
Paddle Tray Blank	453564206281	Also order the Label Set, see "Instruction Label Sets" on page 180
Paddle Tray Plates	453564206291	

Internal Cables

Table 44 lists the orderable cables.

Table 44 **Internal Cables**

Description	12NC	Connects …	and …
LAN Internal cable	453564570671	LAN Port	Processor PCA
USB cable	453564206431	USB Port	Processor PCA
Paddle Tray cable	453564206441	Paddle Tray	Processor PCA
Power Supply cable	453564570681	Power Supply	Therapy PCA
Printer cable	453564206461	Printer PCA	Processor PCA
Processor-Therapy cable	453564206471	Therapy PCA	Processor PCA
HIF cable	453564206481	HIF PCA	Processor PCA
Inverter cable	453564206491	Inverter PCA	Processor PCA
Battery Power cable	453564206501	Battery PCA	Therapy PCA
Battery Data cable	453564274671	Battery PCA	Therapy PCA
Display cable	453564274851	Display	Processor PCA
NBP Module cable	453563478331	NBP Module	Processor PCA

Paddles

For the convenience of Philips field personnel, the 453563476991 water-resistant paddle assembly* including labels is available through normal parts-ordering channels.

This number is for the use of Philips personnel only. Users and non-Philips repair personnel should refer to "Supplies and Accessories" on page 181.

Mechanical Assemblies

These assemblies come with specific parts, as noted.

Replacement Mechanical Assemblies

Table 45 **Replacement Mechanical Assemblies**

Description	12NC
Handle assembly	453564206181
Front Case assembly*	453564206161
Rear Case assembly*	453564206171
Bedrail / Roll Stand Mount	989803171701

* Also order an Instruction Label set for your language option, see "Instruction Label Sets" on page 180.

Individual Mechanical Parts

Table 46 **Individual Mechanical Parts**

Description	12NC	Comment
Therapy Buttons	453564206401	Charge, Shock, and Sync
Therapy Knob	453564206311	
Battery Latch assembly	453564206341	
Therapy Capacitor Tray	453564206361	
Silicone gasket tubing	453564281001	gray and red
Bumper Foot	453563345901	set of 4
USB Port cover	453564206411	
Insulators and plastic shields	453564280531	excluding SpO_2 Deflector
Standoffs	453564280541	for Processor PCA
SpO_2 Deflector	453564280571	SpO_2 cover

Labels

There are two groups of labels that are available to order for the HeartStart XL+: the Branding (or Nameplate) label 453564280551 and the Instruction Labels set. The Primary Label is only available as part of field replacement kits or SPKs.

Instruction Label Sets

There is one Instruction Label set for each language. Each set of labels is one sheet containing all the labels in that set. See "Labels" on page 75 for detailed description of the set.

Table 47 **Instruction Label Sets**

Language	12NC
English	453564254761
French	453564254771
German	453564254791
Italian	453564254811
Spanish	453564254821
Dutch	453564254831
Finnish	453564254851
Greek	453564254861
Japanese	453564254871
Norwegian	453564254881
Danish	453564254891
Chinese (simplified)	453564254901
Chinese (traditional)	453564254911
Portuguese (Brazilian)	453564254921
Portuguese (European)	453564254931
Swedish	453564254941
Korean	453564273321
Polish	453564451351

Supplies and Accessories

HeartStart XL+ upgrades are listed in the section "Upgrades" on page 6.

Approved supplies and accessories for the HeartStart XL+ are listed in Tables 48 – 60 below. To order:

- In the USA, call 1-800-225-0230 (pads, electrodes, cables, paper, etc.).
- Outside the USA, contact your authorized Philips Healthcare Dealer, Distributor or Sales Office, or visit our website at http://philips.com/healthcarestore and follow the Medical Supplies link.

NOTE: The list of supplies and accessories is subject to change without notice.

Defibrillation Accessories

Table 48 **Defibrillation Pads and Pad Accessories**

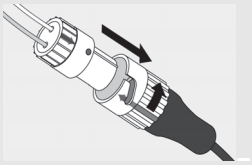
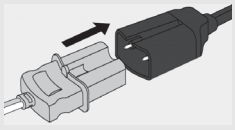
Part Number	Description
	Defibrillation Pads, Pad Cables, and Test Load (white twist lock, or barrel connector M3507A) 
M3507A *	Defib Hands-free Pads Cable, barrel style, 7 ft. (2.2 m)
M3501A	Adult Defib Multifunction Pads, AAMI
M3504A	Infant Defib Multifunction Pads, AAMI
M1781A	50-ohm defibrillator test load, barrel connector (use with M3507A)
05-10200	HeartStart Pads Adapter, barrel connector (use with M3507A)
	Defibrillation Pads, Pad Cables, Adapters, and Test Load (gray flat connector M3508A) 
M3508A *	Hands-free Pads Cable, plug style, 7 ft. (2.2 m)
M3713A	Adult Plus Multifunction Pads
989803148801	Adult Solid Gel Snap Electrode (Foam)
989803148821	Adult Radiolucent Electrode (Foam)
M3716A	Adult Radiolucent Multifunction Pads
M3717A	Infant Plus Multifunction Pads
M3718A	Adult Radiotransparent/Reduced Skin Irritation Multifunction Pads
M3719A	Infant Radiotransparent/Reduced Skin Irritation Multifunction Pads
M3725A	50-ohm defibrillator test load, plug connector (use with M3508A)
989803171271	Defibrillator Test Plug
989803139261	SMART Pads II for adults, children, and infants
989803149981	SMART Pads III for adults, children, and infants
989803158211	HeartStart Adult Multifunction Electrode Pads (1 set)
989803158221	HeartStart Adult Multifunction Electrode Pads (5 sets)
989803166021	HeartStart Adult/Child Preconnect Pads

Table 49 **Defibrillation Paddles**

Part Number	Description
External Paddles	
M3543A *	Water-resistant External Paddles
M4759A *	Rectangular paddle electrode replacement (clip-on)
Internal Switched Paddles	
M4741A *	7.5-cm Switched Internal Paddles
M4742A *	6.0-cm Switched Internal Paddles
M4743A *	4.5-cm Switched Internal Paddles
M4744A *	2.8-cm Switched Internal Paddles
Internal Switchless Paddles	
M1741A *	7.5-cm Switchless Internal Paddles
M1742A *	6.0-cm Switchless Internal Paddles
M1743A *	4.5-cm Switchless Internal Paddles
M1744A *	2.8-cm Switchless Internal Paddles
M4740A *	Internal Paddles Adapter Cable

ECG Cables

Table 50 **3-Lead ECG Cables**

Part Number	Description
M1500A	3-Lead ECG Trunk Cable (AAMI)
M1510A	3-Lead ECG Trunk Cable (IEC)
M1605A	3-Lead ECG Set with Snaps (AAMI)
M1615A	3-Lead ECG Set with Snaps (IEC)
M1669A	3-Lead ECG Trunk Cable (AAMI/IEC)
M1671A	3-Lead ICU grabber (AAMI)
M1672A	3-Lead ICU grabber (IEC)
M1673A	3-Lead ICU snaps (AAMI)
M1674A	3-Lead ICU snaps (IEC)
M1675A	3-Lead OR grabber (AAMI)
M1678A	3-Lead OR grabber (IEC)
M3526A	3-wire Lead Set with Snap (AAMI)
M3528A	3-wire Lead Set with Snap (IEC)
989803173121	3-Lead ECG disposable, bedside (AAMI)
989803173141	3-Lead ECG disposable, telemetry (AAMI)
989803174201	3-Lead ECG disposable, bedside (IEC)
989803170171	3-wire Lead ECG OR trunk, 2.7m (AAMI, IEC)

Table 51 **5-Lead ECG Cables**

Part Number	Description
M1668A	5-Lead ECG Trunk Cable (AAMI/IEC)
M1520A	5-Lead ECG Trunk Cable (AAMI)
M1625A	5-Lead ECG set with Snaps (AAMI)
M1530A	5-Lead ECG Trunk Cable (IEC)
M1635A	5-Lead ECG set with Snaps (IEC)
M1968A	5-Lead ICU grabber (AAMI)
M1971A	5-Lead ICU grabber (IEC)
M1644A	5-Lead ICU snaps (AAMI)
M1645A	5-Lead ICU snaps (IEC)
M1973A	5-Lead ICU grabber (AAMI)
M1974A	5-Lead ICU grabber (IEC)
989803173131	5-Lead ECG disposable, bedside (AAMI)
989803173151	5-Lead ECG disposable, telemetry (AAMI)
989803174211	5-Lead ECG disposable, bedside (IEC)
989803170181	5-Lead ECG OR trunk, 2.7m (AAMI, IEC)

Table 52 **Other ECG Cables and Electrodes**

Part Number	Description
M3525A	2.7 meter 10-Lead ECG Trunk Cable, 12-pin Connector (for 3- / 12-Lead use)
M1663A	10-Lead ECG Patient Trunk Cable (AAMI), 2 m
M1665A	10-Lead ECG Patient Trunk Cable (AAMI), 2.7 m
M1667A	6-Lead Trunk cable (AAMI)
M1680A	6-Lead ICU grabber, limb (AAMI)
M1681A	6-Lead ICU grabber, limb (IEC)
M1682A	6-Lead ICU snap, limb (AAMI)
M1683A	6-Lead ICU snap, limb (IEC)
M1684A	6-Lead OR grabber, limb (AAMI)
M1685A	6-Lead OR grabber, limb (IEC)
M1949A	5+5 ECG Trunk cable AAMI (IEC)
Sync Cables and Electrodes	
M2202A	High-Tack Foam ECG Electrodes — 5 electrodes/pack (60 packs/case)

Blood Pressure Accessories

Table 53 **Reusable Blood Pressure Cuffs and Tubes**

Part Number	Description
40400A	Reusable Cuff set, 3 sizes (Pediatric, Adult, Large adult)
40400B	Reusable Cuff set, 5 sizes (Infant, Pediatric, Adult, Large adult, Thigh)
40401A	Traditional Reusable Cuff — Infant
40401B	Traditional Reusable Cuff — Pediatric
40401C	Traditional Reusable Cuff — Adult
40401D	Traditional Reusable Cuff — Large adult
40401E	Traditional Reusable Cuff — Thigh
M4552B	Easy Care Reusable Cuff — Infant
M4553B	Easy Care Reusable Cuff — Pediatric
M4554B	Easy Care Reusable Cuff — Small Adult
M4555B	Easy Care Reusable Cuff — Adult
M4556B	Easy Care Reusable Cuff — Adult Long
M4557B	Easy Care Reusable Cuff — Large Adult
M4558B	Easy Care Reusable Cuff — Large Adult X-long
M4559B	Easy Care Reusable Cuff — Thigh
M1571A	Multi-Patient Comfort Cuffs — Infant
M1572A	Multi-Patient Comfort Cuffs — Pediatric
M1573A	Multi-Patient Comfort Cuffs — Small Adult
M1574A	Multi-Patient Comfort Cuffs — Adult
M1575A	Multi-Patient Comfort Cuffs — Large Adult
M1576A	Multi-Patient Comfort Cuffs — Thigh
M1577A	Multi-Patient Comfort Cuffs Assortment Set — Pediatric sizes
M1578A	Multi-Patient Comfort Cuffs Assortment Set — Adult sizes
M1579A	Multi-Patient Comfort Cuffs Assortment Set — All sizes
989803183311	Multi Care Infant Cuff
989803183321	Multi Care Pediatric Cuff
989803183331	Multi Care Small Adult Cuff
989803183341	Multi Care Adult Cuff
989803183351	Multi Care Adult Long Cuff
989803183361	Multi Care Large Adult Cuff
NBP Interconnect Tubing	
M1598B	Adult Pressure Interconnect Cable 1.5 M (5 ft.)
M1599B	Adult Pressure Interconnect Cable 3 M (10 ft.)

Table 54 **Disposable Blood Pressure Cuffs and Tubes**

Part Number	Description
M1874A	Disposable NBP Cuff — Infant
M1875A	Disposable NBP Cuff — Pediatric
M1876A	Disposable NBP Cuff — Small Adult
M1877A	Disposable NBP Cuff — Adult
M1878A	Disposable NBP Cuff — Large Adult
M1879A	Disposable NBP Cuff — Thigh
M4572B	Soft Single-Patient Disposable Cuff — Infant
M4573B	Soft Single-Patient Disposable Cuff — Pediatric
M4574B	Soft Single-Patient Disposable Cuff — Small Adult
M4575B	Soft Single-Patient Disposable Cuff — Adult
M4576B	Soft Single-Patient Disposable Cuff — Adult X-Long
M4577B	Soft Single-Patient Disposable Cuff — Large Adult
M4578B	Soft Single-Patient Disposable Cuff — Large Adult X-Long
M4579B	Soft Single-Patient Disposable Cuff — Thigh
989803182281	Single Care Pediatric Cuff
989803182291	Single Care Small Adult Cuff
989803182301	Single Care Adult Cuff
989803182311	Single Care Adult Long Cuff
989803182321	Single Care Large Adult Cuff

Capnometry Accessories

Table 55 **CO_2 Sensors and Tubes — Mainstream**

Part Number	Description
M2501A	Capnostat® 5 external sensor
M2513A	Capnostat 5 Reusable Adult Airway Adapter
M2516A	Capnostat 5 Reusable Neonatal Airway Adapter
M2533A	Capnostat 5 SPU Pediatric/Adult Airway Adapter (10/box)
M2536A	Capnostat 5 SPU Neonatal Airway Adapter (10/box)

Table 56 **CO_2 Sensors and Tubes — Microstream**

Part Number	Description
M1920A	Intubated FilterLine Set — Adult
M1921A	Intubated Filter H Set — Adult/Pediatric
M1923A	Intubated Filter H Set — Infant/Neonatal (yellow, 25 sets/case)
M2520A	Non-intubated dual purpose circuit (CO_2 and O_2) Smart CapnoLine — Pediatric
M2522A	Non-intubated dual purpose circuit (CO_2 and O_2) Smart CapnoLine — Adult
M2524A	Non-intubated single purpose circuit (CO_2) Smart CapnoLine — Pediatric
M2526A	Non-intubated single purpose circuit (CO_2) Smart CapnoLine — Adult
M4686A	CapnoLine non-intubated — Adult
M4687A	CapnoLine non-intubated — Pediatric
M4680A	CapnoLine H O_2 non-intubated — Adult
M4681A	CapnoLine H O_2 non-intubated — Pediatric
M4689A	CapnoLine H non-intubated — Adult
M4691A	CapnoLine H non-intubated infant/neonatal
989803159571	Intubated VitaLine H Set — Adult/Pediatric
989803159581	Intubated VitaLine H Set — Infant/Neonatal
989803160241	Intubated FilterLine Set Long — Adult/Pediatric
989803160251	Intubated FilterLine H Set Long — Adult/Pediatric
989803160261	Intubated FilterLine H Set Long — Infant/Neonatal
989803160271	Smart CapnoLine O_2 Long — Pediatric
989803160281	Smart CapnoLine O_2 Plus Long — Adult
989803160301	Smart CapnoLine Plus Long — Adult
989703177951	Smart CapnoLine H O_2 — Adult
989703177961	Smart CapnoLine H O_2 — Adult Long
989703177971	Smart CapnoLine H O_2 — Pediatric
989703177981	Smart CapnoLine H O_2 — Pediatric Long
989803178001	CapnoLine H O_2 — Infant/Neonatal
989803178011	CapnoLine H O_2 — Infant/Neonatal Long
989803178021	Nasal FilterLine — Infant/Neonatal
989803179101	Nasal FilterLine O_2 — Adult
989803179111	Nasal FilterLine O_2 — Adult Long
989803179121	Nasal FilterLine O_2 — Pediatric
989803183161	Oridion MicroStream MicroPod

Table 57 **CO_2 Sensors and Tubes — Sidestream**

Part Number	Description
M2741A	LoFlo Sensor, includes mounting bracket
M2741-60000	LoFlo mounting bracket only
M2744A	LoFlo CO_2 Nasal Cannula — Adult (10/box)
M2745A	LoFlo CO_2 Nasal Cannula — Pediatric (10/box)
M2746A	LoFlo CO_2 Nasal Cannula — Infant (10/box)
M2750A	LoFlo CO_2 Nasal Cannula with O_2 — Adult (10/box)
M2751A	LoFlo CO_2 Nasal Cannula with O_2 — Pediatric (10/box)
M2756A	LoFlo CO_2 Oral/Nasal Cannula — Adult (10/box)
M2757A	LoFlo CO_2 Oral/Nasal Cannula — Pediatric (10/box)
M2760A	LoFlo CO_2 Oral/Nasal Cannula with O_2 — Adult (10/box)
M2761A	LoFlo CO_2 Oral/Nasal Cannula with O_2 — Pediatric (10/box)
M2768A	LoFlo Airway Adapter — Pediatric/Adult ET tube > 4.0 mm (10/box)
M2772A	LoFlo Airway Adapter with Nafion — Pediatric/Adult ET tube > 4.0 mm (10/box)
M2773A	LoFlo Airway Adapter with Nafion — Pediatric/Infant ET tube ≤ 4.0 mm (10/box)
M2776A	LoFlo Sample Line with Male Luer (10/box)
M2777A	LoFlo Sample Line with Male Luer and Nafion (10/box)
989803144471	LoFlo CO_2 Nasal Cannula with O_2 — Infant/Neonatal (10/box)
989803144531	LoFlo Airway Adapter — Pediatric/Infant ET tube ≤ 4.0 mm (10/box)

Oximetry Accessories

Table 58 **SpO_2 Sensors and Cables**

Part Number	Description
M1191A	Reusable SpO_2 Sensor — Adult finger
M1191AL	Reusable SpO_2 Sensor — Adult finger (3 m)
M1191B	Reusable SpO_2 Sensor — Adult finger
M1191BL	Reusable SpO_2 Sensor — Adult finger (3 m)
M1191T	Reusable SpO_2 Sensor — Adult finger (Nellcor 9-pin D-sub connector)
M1192A	Reusable SpO_2 Sensor — Pediatric/Small Adult
M1192T	Reusable SpO_2 Sensor — Pediatric (Nellcor 9-pin D-sub connector)
M1194A	Reusable SpO_2 Sensor — Adult ear clip
M1195A	Reusable SpO_2 Sensor — Infant
M1196A	Reusable SpO_2 Sensor — Adult clip
M1196S	Reusable SpO_2 Sensor — Adult clip (2 m)
M1196T	Reusable SpO_2 Sensor — Adult clip (Nellcor 9-pin D-sub connector)
M1131A	Disposable SpO_2 Sensor — Adult/Pediatric Finger
M1132A	Disposable SpO_2 Sensor — Pediatric Finger
M1133A	Disposable SpO_2 Sensor — Neonatal/Adult Finger
M1902B	Disposable SpO_2 Sensor — Infant finger *(available outside the US only)*
M1903B	Disposable SpO_2 Sensor — Pediatric finger *(available outside the US only)*
M1904B	Disposable SpO_2 Sensor — Adult finger *(available outside the US only)*
M1941A	SpO_2 Extension Cable 2 m (6.5 ft.)
M1943A	Nellcor SpO_2 Sensor Adapter Cable, 1.1 m (3.6 ft.)
M1943AL	Nellcor SpO_2 Sensor Adapter Cable, long

Other Supplies

Table 59 **Other Supplies**

Part Number	Description
989803167281 *	Lithium-Ion Battery
Paper	
40457C	50-mm Chemical Thermal Paper, gray grid (10 rolls)
40457D	50-mm Chemical Thermal Paper, gray grid (80 rolls)
Miscellaneous	
989803171701	Bedrail / roll stand mount
PH-0050-60	GCX Roll Stand with basket (orderable through GCX)
PH-0050-03	GCX Flush Wall Mount (orderable through GCX)
989803171281	Accessory storage system
989803171291	Cable wraps
989803171261	USB flash drive

Key Components

Key Components require tracking, as indicated in Table 60. Record the part number and tracking method (the date code, serial number, or lot/batch#) for *both* the failed *and* replacement components.

Table 60 **Key Components**

Replacement Assembly Kit or SPK		Key Component		
Description	**Part Number**	**Description**	**Part Number**	**Tracking Method**
Replacement PCAs				
Processor PCA SPK	453564570771	Processor PCA	453564081201	
Therapy PCA SPK	453564570781	Therapy PCA	453564081221	Serial Number
HIF PCA kit	453564206071	HIF PCA	453564206071	
Electrical Assemblies				
Display Assembly	453564206141	LED Display Inverter PCA	453564105151 453564176811	Serial Number and Date Code
Therapy Capacitor Assembly	453564206351	Therapy Capacitor	453564222111	Serial Number
Therapy Port SPK	453564570661	Therapy Port	453564570661	Date Code
Speaker Assembly	453564570731	Speaker	453564570731	Date Code
Therapy Switch Assembly	453564206301	Switch Encoder	453564128851	Serial Number
Lithium-Ion Battery	989803167281	Lithium-Ion Battery	453564088931	Serial Number
Power Supply	453564206121	Power Supply	453564088941	Date Code
Internal Resistors	453564258081	Internal Resistors	453564258081	Date Code
Ports and Cables				
Therapy Port	453564206501	Therapy Receptacle	453564104981	Date Code
Pads Cable	M3507A M3508A	barrel connector plug connector	M3507-60007 M3508-60008	
Supplies & Accessories				
External Defibrillation Paddles				
External Paddles	453564104911	External Paddles Assembly	453564104911	Date Code
	M3543A	External Paddles	M3543A	Serial Number
Internal Defibrillation Paddles				
Internal Defibrillation Paddles	M1741A M1742A M1743A M1744A	7.5-cm Switchless 6.0-cm Switchless 4.5-cm Switchless 2.8-cm Switchless	M1741A M1742A M1743A M1744A	Date Code
	M4741A M4742A M4743A M4744A	7.5-cm Switched 6.0-cm Switched 4.5-cm Switched 2.8-cm Switched	M4741A M4742A M4743A M4744A	Two Date Codes: paddles, connector
	M4740A	Adapter Cable	M4740-61601	Date Code

Table 60 **Key Components** ***(Continued)***

Replacement Assembly Kit or SPK		Key Component		
Description	**Part Number**	**Description**	**Part Number**	**Tracking Method**
Defibrillation Pads				
Multifunction Pads	M3713A	Adult Plus		Lot/Batch#
	M3716A	Adult Radiolucent		Date Code
	M3717A	Infant Plus		
	M3718A	Adult Radiotransparent, Reduced Skin Irritation		
	M3719A	Infant Radiotransparent, Reduced Skin Irritation		
	M3501A	Adult, AAMI		Lot/Batch#
	M3502A	Adult, IEC		
	989803158211/ 989803158221	HeartStart Adult		
	989803166021	Adult pre-connect		
SMART Pads II	989803139261	SMART Pads II		Lot/Batch#
SMART Pads III	989803149981	SMART Pads III		

Appendix B

Theory of Operation

This chapter provides waveforms, system level interconnection schematics, and functional descriptions of the components contained in the HeartStart XL+.

Waveforms

The following diagrams show the waveforms of a 200-J shock and of a pacing pulse.

Figure 108 **Waveforms of a 200-J Shock**

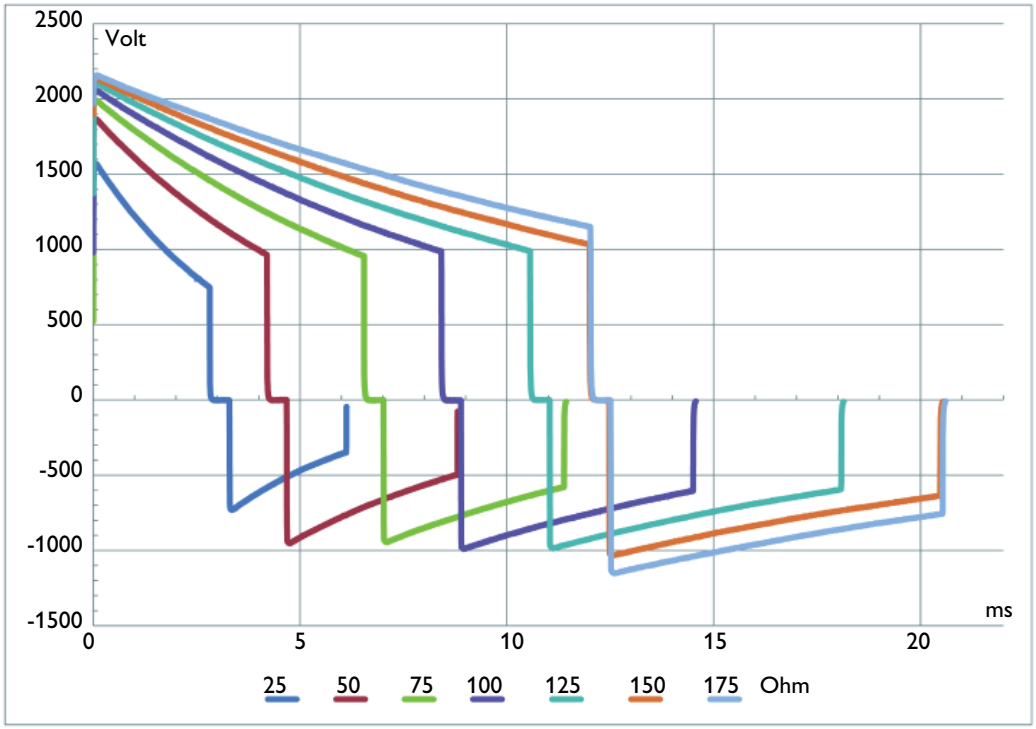
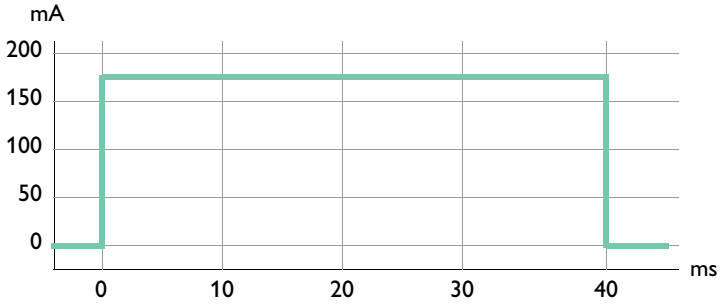
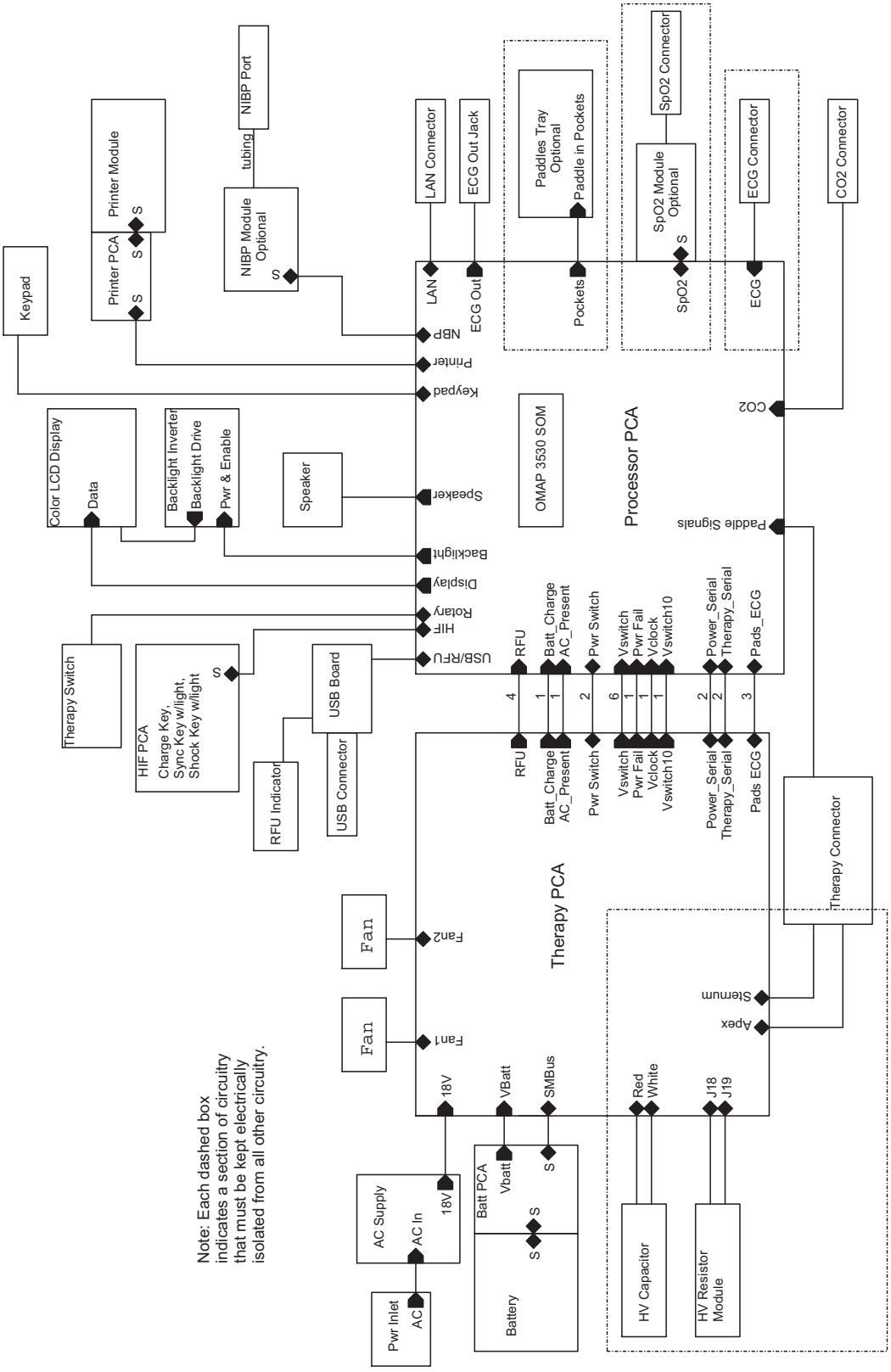


Figure 109 **Waveform of a 175-mA 40-ms Pacing Pulse into 100-ohm Load**



System Level Interconnections

Figure 110 **System Interconnection Schematic**



Assemblies Descriptions

The electrical core of HeartStart XL+ consists of custom-designed Processor and Therapy PCAs and several smaller PCAs such as the Printer PCA, Battery PCA, Inverter PCA, and Human Interface (HIF) PCA. The Processor PCA includes the System-on-Module (SOM) PCA. These PCAs functions are described below.

The HeartStart XL+ assemblies are completely lead-free.

This section is organized into the following sections:

Processor PCA

The Processor PCA, together with the SOM PCA, is the “brain” of the device. It provides all the general purpose computer resources needed for the overall functionality of the device including memory, human interface control, external communication ports, and interfaces to all the supporting modules and circuits not directly related to the therapy functions (Battery, AC Power, Defibrillation, Pacing, and Pads ECG.)

The Processor PCA performs the following functions:

- Overall system control.
- High-level control of all modules and subsystems.
- Control of power up and power down sequences.
- All user interface functions, including:
  - Generation and control of tones and audio prompts and detecting of front panel button presses.
  - Generation and formatting of information for the display and printer.
  - Control of indicator LEDs for Shock button backlight and External Power.
  - Alarm generation when the limits are violated.
- Exchange information via the USB port.
- Supervision of defibrillation functions on the Therapy PCA, including:
  - Initiating a capacitor charge sequence.
  - Secondary monitoring of capacitor voltage.
  - Initiating a shock delivery sequence.
  - Controlling therapy isolation and internal paddles relays.

- Control of pacing functions on the Therapy PCA, including:
  - Monitoring pacing current delivered.
  - Controlling enabling of pacing and pacing isolation relays.
- All ECG processing including filtering, beat detection, and rhythm analysis.
- Interconnection site for ECG leads cable, ECG-Out cable, and SpO_2 PCA.
- ECG analog front end for ECG from 3- and 5-lead cables.
- Sensing the paddle ID resistor and identifying the type of paddles or pads connected.
- SpO_2 logic and patient isolation.
- Power and communication interface for an external CO_2 measurement module.
- Measurement of device temperature.
- Monitoring of overall system health.

SOM PCA

The System-on-Module (SOM) PCA provides the memory and computing power. It is located directly on the Processor PCA and stores user configuration selections, operating software (including data for generating display formats and graphics), alarm limits, etc.

It performs the following functions:

- Processing power
- Random Access Memory (RAM)
- Program Flash Memory
- Database Flash Memory
- USB Interface
- Audio Signals

Therapy PCA

If the Processor PCA is the “brain” of the device, the Therapy PCA is “senses” and “muscle”. It consists of three major sections: The Power circuit, the Therapy circuit, and the Pads ECG circuit. It performs the following functions, as directed by the Processor PCA:

- Charges and keeps the capacitor charged to the correct energy level.
- Delivers defibrillator shocks and controls the waveform.
- Disarms the Capacitor and controls the disarmed energy absorption into Internal Resistors.
- Generates pacing waveforms.
- Charges the battery.
- Provides analog front end for ECG from the pads/paddles.
- Measures impedance for the Patient Contact Indicator (PCI) function.
- Monitors the overall system power, including detecting the battery or the presence of external power.
- Control of the RFU indicator (the RFU signal is sent through the Processor PCA).

Power and Battery

The HeartStart XL+ can be powered by the Battery alone, AC supply alone, or by the Battery and AC supply together (this configuration is used to charge batteries). The device transitions between power sources as sources are added and removed without interrupting any operation as long as at least one source of power is always present.

Battery PCA

The Battery PCA provides the contacts with which the Battery mates. It is an interconnection PCA only, and has no active circuitry.

Power Supply Assembly

The Power Supply has a standard power connector and operates between 100-240 V AC at 50 or 60 Hz; it can power the device and charge the battery.

The Power Supply may draw up to 65 watt of AC power, which is then converted to regulated 18 V DC power. The primary purpose of this supply is to charge the battery, but it can also be used to power the entire device even in the absence of a battery.

The Power Supply is compatible with world-wide AC mains voltages and frequencies.

Battery

The batteries used in the HeartStart XL+ utilize lithium-ion chemistry. Lithium-ion batteries feature high energy density, allowing the use of smaller and lighter batteries to achieve high power levels. In addition, lithium-ion batteries are more environmentally friendly than nickel-cadmium or lead-acid batteries, and do not suffer from the “memory effect” that plagues nickel-cadmium chemistries.

Each battery pack includes built-in protective circuitry to prevent damage from overcharging, excessive discharge current, and other types of electrical abuse. It contains circuitry to monitor the amount of charge available in the battery. The Battery PCA communicates this information to the Therapy PCA which provides battery status information on the display. In addition, the battery pack has on-board temperature sensing which is monitored by the Therapy PCA for battery charging purposes.

WARNING: Never crush, penetrate or attempt to open these or any lithium-ion batteries. Never incinerate any lithium-ion batteries. High case temperatures resulting from abuse of the battery could cause physical injury. Rupture of the battery pack may cause venting and flame.

CAUTION: Due to their high energy density, the lithium-ion batteries can deliver significant power. Use care when working with or testing these or any lithium-ion batteries. Do not short-circuit the terminals.

NOTE: When the battery is removed from the HeartStart XL+, it disconnects power to the output terminal. Thus, it is not possible to test the battery with a voltmeter.

Display Assembly

The Display assembly contains:

- the 6.5" color TFT VGA LCD display, 640 by 480 pixel, 18-bit color flat panel display illuminated by cold cathode fluorescent lamps
- the Backlight Inverter; the power for the display backlight is provided by a Backlight Inverter PCA.

LCD Display

All display functions are handled by the Processor PCA. Display formats, graphics, waveforms, numeric values and messages are all generated and formatted by the Processor PCA. The LCD display accepts these digital data from the Processor PCA and maps it into pixels on the display.

Backlight Inverter

The display also contains a backlight, which is powered by the Backlight Inverter PCA. The Backlight Inverter PCA converts DC current from the system power supply to high voltage alternating current. The Backlight Inverter PCA is mounted on the Front Chassis.

Indicators

The Battery and External Power LEDs are mounted on the Display Assembly and controlled by the Processor PCA.

The Shock button backlight LED is mounted on the HIF PCA directly behind the Shock button and is controlled by the Therapy PCA through the Processor PCA circuitry. The Shock button backlight illuminates only when the button is active (the device is shock-ready). When using pads or switchless internal paddles, the Shock button is active and lit when the device is charged and ready to deliver a shock. When using external or switched internal paddles, the Shock button is disabled and not lit—the Shock buttons on the paddles are active instead.

RFU Indicator

Displays the status of the device with an hourglass indicating the device is ready for use and a solid red "X" indicating a critical failure. This indicator is visible even when the device is turned off.

Controls

Front Panel Buttons

The Charge, Shock, and Sync buttons are mounted in the front case. They operate by actuating four small switches mounted on the HIF PCA directly behind each button.

All of the buttons around the display (Navigation, Function, Menu Select, Lead Select, and Patient Category) and the soft keys are part of a membrane keypad on the Display Assembly. They are connected to the Processor PCA by a flex circuit.

Presses from all buttons and soft keys are detected and processed by the Processor PCA. The Processor PCA then interacts with the other parts of the system as needed to respond to the soft key or button press.

HIF PCA

The HIF PCA contains three individual discrete switches for the Sync, Charge, and Shock buttons. The Shock and Sync buttons are illuminated from behind by board-mounted LEDs.

Therapy Switch

The Therapy Switch selects operation in either AED Mode, Pacer Mode, or Manual Mode.

In Manual Defibrillation Mode, energy selection is made by rotating the Therapy Switch to the appropriate position. The Therapy Switch operates an optical rotary switch. The signals pass through the switch's ribbon cable and then on to the Processor PCA. The Processor PCA then interacts with the other parts of the system as needed to respond to the setting of the Therapy Switch.

Paddle Indicators and Controls

External and switched internal paddles have a Shock button located on the paddles. Additionally, external paddles have a Charge button on the right-hand paddle. When the paddles are connected to the defibrillator/monitor, the paddle Shock button is active and the Shock button on the defibrillator/monitor is disabled. External paddles have a Patient Contact Indicator (PCI) located on the Sternum paddle. The contact quality is indicated on the PCI using red, orange, and green LEDs. Once proper contact has been made, the PCI illuminates a green LED.

Printer Assembly and PCA

The Printer Assembly provides hard copy output of text, waveforms, event data, etc. The printer module receives print commands from the Processor PCA and drives the printhead and paper motor accordingly. It senses when the paper is out, or the door is left open.

The Printer PCA is an interconnection PCA only, and has no active circuitry. It transmits 3.3-V serial and logic communication signals and 7-V printhead power from the Processor PCA to the Printer Assembly.

Printing

All printing of data is handled by the Processor PCA. Waveforms, graphics, numeric values, and messages are all generated and formatted by the Processor PCA, using either data it has or data it receives from other parts of the device. This data is then passed to the Printer PCA in serial digital messages, via a ribbon cable, and then on to the printer.

Contrast

The printing contrast is controlled automatically by the printer itself. The printer module senses printhead supply voltage, temperature and impedance, and adjusts drive voltage to the printhead (and thus contrast) based on these readings.

Out of Paper/Door Open

The printer incorporates an optical sensor that detects when there is no paper left, or when the printer door is open. The information is passed to the Processor PCA in serial digital messages via the Printer PCA and the flex circuit, and the Processor PCA generates the appropriate screen message and tones to alert the user.

Clock Backup Battery

The Clock Backup Battery (lithium-ion battery located on the Processor PCA) provides standby power to maintain the system time and date during times when the main battery is either absent or discharged and no external power is supplied.

NBP Module

The NBP module handles the following functions:

- Inflation and deflation of the NBP cuff.
- Measurement of pressure in cuff.
- Detection of pressure waveform, and extraction of the systolic and diastolic values from that waveform.
- Calculation of mean pressure from waveform, systolic, and diastolic data.

The NBP module communicate with the Processor PCA via a full duplex 9600 baud serial link and uses 5 V signaling.

SpO_2 PCA

The SpO_2 PCA serves as the interface to the SpO_2 sensor, including:

- Generation and control of voltages to drive the LEDs in the sensor.
- Receiving and processing signals from the SpO_2 sensor.
- Derivation of the SpO_2 waveform, SpO_2 value, and pulse rate.
- Providing the digital SpO_2 value to the Processor PCA.

The SpO_2 signal from the sensor is carried by the external SpO_2 cable to the SpO_2 port, and then to the SpO_2 PCA. There it is analyzed to derive SpO_2 saturation level, pulse rate, and the waveform. This information is then passed to the Processor PCA via an 18-pin connector (power for the SpO_2 PCA and sensor is provided by the Processor PCA via the same 18-pin connector). The Processor PCA provides the patient isolation and power supply for SpO_2.

The Processor PCA is then responsible for:

- Formatting and presenting the O_2 saturation level, pulse rate and waveform to the display.
- Generating O_2 saturation level alarms.
- Reporting on the status of the sensor and its connections, and alerting the user to measurement problems.

Functional Descriptions

This section is organized into the following sections:

ECG Monitoring Functions

There are two separate ECG front ends: one for signals coming in on the paddles or pads cable, and one for signals coming in on the 3- or 5-lead ECG cable.

Leads ECG

The ECG signal picked up by the ECG monitoring electrodes is carried by the ECG cable to the ECG port, and then to the Processor PCA, where it is amplified, filtered, and digitized.

The Processor PCA then performs digital signal processing on the ECG data, and is responsible for:

- Formatting and presenting the ECG to the display and to the printer.
- Counting heart rate and generating heart rate alarms.
- Reporting on the status of the patient connection, and alerting the user to measurement problems.
- Arrhythmia analysis and alarms.

Pads/Paddles ECG

The ECG signal picked up by the paddles or disposable defibrillation pads is carried by the cable to the Therapy port via the Therapy PCA, where it is amplified, filtered, digitized and passed across a patient isolation barrier before being passed to the Processor PCA.

The Processor PCA then performs digital signal processing on the ECG data, and is responsible for:

- ECG waveform analysis and Shock Advisory (in AED Mode).
- Formatting and presenting the ECG to the display and to the printer.
- Counting heart rate and generating heart rate alarms.
- Reporting on the status of the patient connection.

Patient Impedance Functions

The HeartStart XL+ measures patient impedance in two ways: an impedance measurement before the shock, and a impedance measurement during the shock.

Before the Shock

The HeartStart XL+ makes a small-signal AC impedance measurement (at 32 kHz) in the steady state situation before a shock is delivered. This measurement is used to detect Pads Off and Paddles Off. It is also used for the Patient Contact Indicator (PCI) function, in which the quality of the contact the paddles are making with the patient is indicated on an LED bar graph on the Sternum paddle.

During the Shock

The HeartStart XL+ also makes an impedance measurement during shock delivery. This impedance is derived from measurements of voltage and current, and is reported on the printed event summary. The device uses the value of the impedance to adjust the phase durations of the biphasic waveform and to provide the optimal waveform delivery. This information is also used to abort the shock if necessary.

Since the before-the-shock measurement is a small-signal AC measurement of impedance, and the during-the-shock one is a high-voltage/high-current measurement of impedance, it is normal and expected for the two measurements to produce slightly different numerical results. The high-current measurement is used in shock delivery, therefore it may seem inconsistent with the PCI indication.

Defibrillation

The following sections describe the defibrillation functions.

Charge

There are three basic events that can initiate a charging cycle:

- In AED Mode, when the Processor PCA shock advisory analysis algorithm determines from the pads ECG waveform that a shock is needed.
- In Manual Defibrillation Mode with either pads or paddles, when the front panel **Charge** button is pressed, the button press is then detected and processed by the Processor PCA.
- In Manual Defibrillation Mode with external paddles only, when the Apex paddle **Charge** button is pressed, the button press is transferred from the button to the Processor PCA. The button press is then detected and processed by the Processor PCA.

In all cases, the charging cycle is initiated by the Processor PCA. It directs the Therapy PCA to charge the Therapy capacitor to a specified level. A controller on the Therapy PCA is responsible for all aspects of charging the Therapy capacitor to the specified level. However, the Processor PCA monitors the voltage on the capacitor and aborts the shock if the capacitor voltage is not consistent with the specified level.

When the Therapy PCA detects that the selected energy (voltage) level has been reached, it stops charging. It then continues to monitor the voltage on the capacitor, and as the voltage bleeds down, it resumes charging to top up the charge to the correct level.

Should a decision be made to change the selected energy to a lower value, the user would turn the Therapy Knob to the desired setting. At the lower energy setting, the Processor PCA directs the Therapy PCA to charge to the new level. The Therapy PCA then disarms (completely discharges) the capacitor and charges up to the new (lower) level. At a higher energy setting, the Therapy PCA charges the capacitor until the new level is reached.

If the requested charge is not used within the configured “time to auto disarm” (30, 60, or 90 seconds), the Processor PCA automatically directs the Therapy PCA to disarm the capacitor as a safety precaution.

Shock Delivery

The discharging cycle (shock delivery) is initiated by any of the following three events:

- Pressing the front panel **Shock** button when using pads or switchless internal paddles. (The button is disabled when using external paddles or switched internal paddles). This button press is then detected and processed by the Processor PCA.
- Simultaneously pressing the **Shock** buttons on both the external Sternum and Apex paddles. These button presses are transferred from the buttons to the Processor PCA that detects and processes the signal.
- Pressing the **Shock** button on the switched internal paddles. This button press is transferred from the button to the Processor PCA that detects and processes the signal.

In any case, the Processor PCA directs the Therapy PCA to deliver the shock. Patient resistance is derived from the current and voltage delivered during the initial portions of the waveform, and the biphasic waveform timing is then adjusted as needed to deliver the correct shock energy, duration, and shape.

The Therapy PCA aborts delivery of the shock if during the impedance measurement, the impedance is outside of operating limits (too high or too low).

If this condition is detected, the Therapy PCA terminates delivery of the waveform and disarms the capacitor. The problem is reported to the Processor PCA, which displays and/or prints the appropriate messages.

Another safety feature is the presence of an identification resistor in the pads and paddles cables. If the device does not sense that resistance, it generates a **Cable Off** message and does not charge the capacitor.

Synchronized Cardioversion Delivery

Synchronized cardioversion operates the same as delivering a shock, except that the shock must be synchronized to the R wave of the ECG. The Processor PCA is responsible for detecting the R wave and placing markers on the printed strip and on the display to indicate the timing of the proposed cardioversion shock.

A synchronized shock can be delivered in either of two ways:

- First, when using pads, by pressing and holding the Shock button until the next time an R wave is detected.
- Second, by simultaneously pressing and holding the Shock buttons on both the Sternum and Apex paddles until the next time an R wave is detected.

When both events occur (either type of button press *and* detection of an R wave), then the Processor PCA directs the Therapy PCA to deliver the shock.

Transcutaneous Pacing

Pacing is initiated and controlled by pressing front panel buttons. These button presses are transferred from the buttons to the Processor PCA via a flex circuit. The button presses are detected and processed by the Processor PCA.

The Processor PCA directs the Therapy PCA to deliver the pacing pulses at the rate and output current selected by the user. The Therapy PCA controls the output current and the pulse duration, and the Processor PCA provides the rate setting and the R-wave indications to the Therapy PCA, which controls the timing of the delivered pulses. The pacing pulses are delivered via the pads cable to the multifunction electrode pads. The pacing current delivered is reported back to the Processor PCA, which sends the information to the display and activates the printouts and messages as needed.

CO_2

The HeartStart XL+ supplies 5 V DC power to an external CO_2 module which performs all measurement functions and communicates the results via a serial interface to the HeartStart XL+. Several types of external CO_2 measurement modules are supported. Power is enabled only when a module is present. A module is detected when the module connects pin 7 to pin 3. The type of module present is then determined based on the signal provided on pin 8.

Audio

The HeartStart XL+ has three types of audio output: voice prompts, tones, and "chirp" when there is a "red **X**" RFU condition. The voice prompts and tones are generated and controlled by the Processor PCA, which also amplifies the signals and passes them directly to the speaker via a wire pair.

When the device is turned off, the audio controller on the Therapy PCA remains active and powers the audio amplifier on the Processor PCA as needed to produce the "chirps" through the same amplifier.

Data Storage

The HeartStart XL+ has the capability of storing the following information:

- Patient data — acquired during an event.
- Configuration data — set up by the user to define specific settings related to the behavior of the device.
- Support data — generated by the device to support the maintenance and service of the device.
- Device data — set up by the manufacturer to define installed options, serial numbers, etc.

The data are stored on the SOM PCA and can be imported or exported via a USB flash drive.

Repair Record

This is a sample repair record. Make copies of these pages and fill out after each repair.

I: Incoming

Customer (name of facility): _

Customer Issue (describe): _

_ _

Device Model: ☐ 861290 Serial #: US _ _ _ _ _ _ _ _ _

SW: Incoming_ _ _ Accessory Lot Code / Serial # (if received with the unit): _ _ _ _ _ _ _ _ _ _ _

II: Diagnosis

Visual Inspection: ☐ PASS ☐ FAIL / Comments: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

_ _

RFU Status: ☐ Hourglass ☐ Solid Red **X** ☐ Flashing Red **X**

Tech. Alarms / Screen messages: _

_ _

Print and evaluate logs (check all that apply): ☐ Software Error Log ☐ Hardware Error Log

Errors noted: _

_ _

Errors related to customer complaint found? ☐ YES ☐ NO / Comments: _ _ _ _ _ _ _ _ _ _ _

_ _

Other Test Data:

Op Check:	☐ PASS	☐ FAIL	☐ N/A
Shock:	☐ PASS	☐ FAIL	☐ N/A
Pace:	☐ PASS	☐ FAIL	☐ N/A
Pads/Paddles ECG:	☐ PASS	☐ FAIL	☐ N/A
Leads ECG Test:	☐ PASS	☐ FAIL	☐ N/A

Other Test Data comments: _

_ _

Customer complaint reproduced? ☐ YES ☐ NO / Comments: _ _ _ _ _ _ _ _ _ _ _ _ _ _

_ _

Additional problems found? ☐ NO ☐ YES / Comments: _ _ _ _ _ _ _ _ _ _ _ _ _ _

_ _

Other comments on the Diagnosis: _

_ _

III: Repair

Repair Parts Replaced (consumed): _

_ _

Calibration performed: ☐ Battery ☐ NBP ☐ $EtCO_2$

SW: Outgoing _ _ _ _ _ _ _ _ _ _ _ _ _ _

Post-repair Delivery Checklist

☐ Performance Verification passed.

☐ Safety Tests passed.

☐ Accessories and carrying case in place.

☐ Unit placed on shipping shelf / delivered to the customer.

Repair / maintenance performed by:

_ (name, signature, and date)

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